ELECTRONIC
INNOVATIONS
IN ACTION

TUBES

ET-T3063
12-68

MILITARY EQUIPMENT TYPES TUBE MANUAL

TUBE DEPARTMENT

GENERAL ELECTRIC

Schenectady, New York 12305, U.S.A.

Printed in U.S.A.

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ELECTRONIC INNOVATIONS IN ACTION

TUBES

MILITARY EQUIPMENT TYPES TUBE MANUAL

REGISTRATION PAGE

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	12-28-65
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Mr. P. G. Durham
Chief of Technical Pub. Dept.
English Electric Valve Co., Ltd.
Chelmsford Essex, England

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General Electric Company
Advertising and Sales Promotion
316 E. 9th St.
Owensboro, Ky. 42301

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TUBE PRODUCTS DEPARTMENT

GENERAL ELECTRIC

Schenectady, New York 12305, U.S.A.

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PRODUCT INFORMATION

SAFETY PRECAUTIONS

WARNING: WITHOUT PROPER AND ADEQUATE PRECAUTIONS, THE OPERATION, HANDLING, OR SHIPMENT OF MICROWAVE AND HIGH-VOLTAGE ELECTRONIC TUBES CAN BE HAZARDOUS TO PERSONNEL AND PROPERTY. READ THE FOLLOWING INFORMATION. TAKE ALL REQUIRED PRECAUTIONS.

GENERAL

This information is provided to alert the purchaser of high-voltage tubes and microwave tubes to the potential hazards which may be created by improper operation, handling or shipment of these devices. All persons responsible for the operation, handling and shipping of these tubes should familiarize themselves with the potential hazards, and suitable safety precautions should be established and followed for the protection of personnel and equipment.

Do not operate high-voltage and microwave tubes except in accordance with adequate understanding of the potential hazards and with proper equipment-operating instructions and safety precautions.

Questions regarding proper and safe use of such tubes should be addressed to:

General Electric Company
Microwave Tube Operation
Building 269 – Application Engineering
1 River Road
Schenectady, New York 12305

Several of the potential hazards are defined and regulated by state or federal governmental agencies and bureaus. Since the documentation and specifications of such agencies and bureaus are frequently revised, it is not feasible to make full or precise reference to their content in this publication. If current governmental information is desired or if there are questions, the appropriate agency should be consulted.

HIGH VOLTAGE

The voltages used to operate microwave and high-voltage electronic tubes can cause death or serious injury due to electric shock and burns. Depending on the device and equipment designs, and considering the possibility of malfunctions in either, part or all of the exterior tube surfaces may be at, or may quickly reach, dangerous voltages. Equipment design and laboratory testing must take this into account by following design and operating precautions so that contact with, and proximity to, high-voltage circuits is not possible under operating conditions. High-voltage circuits should be enclosed in protective housings, and interlock circuits should be provided so that primary power is removed, and high-voltage terminals and capacitors are quickly grounded, whenever the enclosure is open. It is always dangerous and unsafe practice to defeat or avoid the proper safety devices and safety procedures (as bypassing an interlock circuit) while operating or testing the equipment.

GROUNDS

Many microwave tubes are operated in a grounded electrode mode in which the envelope and output cables are operated at ground potential. Care must be taken to be certain that the tube envelope is properly grounded before the operating voltages are applied. The grounding should never be done through the output cables since a break in the cable will then result in the tube envelope being raised to high voltage.

X-RADIATION

X-radiation is produced by the impact of high energy electrons on electron tube surfaces. Such high-energy electrons are produced when accelerated by the applied electrode voltages. Depending on the construction of the electron tube and the materials involved, X-radiation may be produced at voltages as low as 5 kilovolts. The production of highly penetrating X-radiation and energy increases to relatively more dangerous proportions as the electrode voltages and currents are increased. All electron tubes operating in high-voltage ranges constitute potential hazards, and applications of such tubes should be carefully reviewed before operation.

When X-radiation shielding is required, it should be provided with proper interlocks to prevent accidental exposure of personnel to X-radiation. Where hazards are high, periodic X-radiation level surveys should be made. Furhter, when continuous operation is in effect, personnel-monitoring devices should be worn by the personnel and controlled access to the area implemented.

Most high-voltage and microwave electronic devices are not designed, nor intended, to be fully self-shielded to X-radiation under all possible conditions of their application and use. External radiation shielding will usually be necessary. This shielding should be designed by the equipment manufacturer as a part of the user's equipment to protect the user against possible personal injury. It is the responsibility of the manufacturer of the equipment using such tubes to provide any and all enclosures required, and to provide the instructions and maintenance procedures for the proper use of the equipment.

Generally, the spatial distribution of X–radiation from power tubes is complex and changes from tube to tube. The same tube does not radiate the same 360^{o} around. Also, the surrounding metallic construction will tend to prevent, distort, or further filter the passage of X–radiation to regions external to the tube. Of major concern are the areas in which materials used in tube construction present the least attenuation of X–radiation.

The search for possible X–radiation is not to be confined to those directions in which emission may be expected; unintended emissions in high power tubes have sometimes caused X–radiation in unexpected directions. A thorough search in all directions around the tube is necessary to ensure that the regions of emissions is correctly determined.

Tubes presenting X–radiation hazards or other possible hazards will have radiation precaution labels or tags affixed to the device at the time of shipment. These should not be removed at any time. If these labels or tags are removed by the user, they should be prominently displayed in close visual proximity to the device.

MICROWAVE RADIATION

The radio-frequency output power of many electron tubes may exceed those power densities considered safe for human exposure. The design, operating instructions, and maintenance procedures of equipment utilizing such tubes must ensure that the radio-frequency energy is properly restricted to and contained in the circuits, transmission lines, waveguides, or cavity resonators and that these are frequently monitored to ensure that the radiation of radio-frequency energy from joints or connectors is below the hazardous limit. Antenna systems should also be frequently monitored for stray or indirect radiation. Operating and service personnel should be advised of exposure hazards and arrangements made to prevent accidental exposure.

MERCURY

Some devices contain mercury as a necessary constituent to their operation. Under certain circumstances, the presence of free mercury may generate air contamination or other pollution that is considered toxic. Disposal of tubes or handling of damaged tubes must be done with adequate precaution given to this possible hazard. If disposal presents questions, these questions should be directed in writing to the General Electric Company, Microwave Tube Operation, at the address shown on the front side of this sheet.

Air shipment regulations allow air transportation of devices containing mercury only under special packing and marking requirements. The current requirements should be obtained directly from the airline.

The packing containers of devices containing mercury will be marked accordingly when they are shipped from the tube manufacturer.

IMPLOSION

Most electronic tubes and devices operate with their internal volumes under high vacuum, and many gas-filled tubes also have their internal volumes considerably below atmospheric pressure. In the event that the envelope of some of these tubes is punctured or broken, the inrush of air can be violent under certain conditions. Tubes with large glass envelopes should be handled and stored with particular care, and implosion-proof shields should be installed in operating equipments. Particular care should also be given to shielding of the eyes and face.

MAGNETIC FORCES

The attractive force between magnetic and feromagnetic objects increases rapidly as separation between the objects is decreased and the objects will be accelerated toward one another, meeting with considerable impact. When handling or working near large permanent magnets, care must be taken to prevent injury which could result from this hazard.

Air shipment regulations allow air transportation of devices containing magnetized materials only under special packing and marking requirements. The current requirements should be obtained directly from the airline.

TUBE PRODUCTS DEPARTMENT
GENERAL ELECTRIC
Schenectady, New York 12305

ELECTRONIC INNOVATIONS IN ACTION

TUBES
REED SWITCHES AND
ALPHA-NUMERIC DEVICES

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ET-T1730G

This tabulation lists all tubes and devices in the current tube manuals and the manual in which each component may be located. Type numbers are arranged in alpha-numerical order.

There is duplication of type numbers in the four-digit series of designations. In this numbering sequence, particularly in the 6000 and higher series, the developmental type-number system employed by the Microwave Tube Business Section parallels the standardized Electron Industries Association (EIA) industry-wide numbering system for tubes other than home-entertainment and television picture types. Microwave Tube Business Section developmental numbers use the prefix "Z" followed by another letter: e.g., ZG, ZM, ZP (EIA standardized MTBS designations have the prefix "GL", a few old thyratrons use the prefix "FG").

The receiving tube component of the Tube Products Department does not employ prefix letters except in the case of reed switches, and a few types transferred from other components where prefixes were used. For this reason designations in the four-digit series without prefixes represent standardized EIA designations, whereas those with prefixes (other than "GL") as mentioned in the foregoing paragraph are MTBS developmental types.

TYPE	MANUAL*				
1AY2-A				R-2	
1BC2-A				R-2	
1BH2-A				R-2	
1BY2-A				R-1	
1DG-3				R-2	
1G3-GTA				R-2	
1K3A				R-2	
1V2				R-2	
1X2-C				R-2	
2AS2-A				R-1	
2AV2				R-2	
2B22	FS				
2BU2				R-1	
2C39-B	FS				
2C40	FS				
2C40-A	FS				
2C43	FS				
2CN3-B				R-2	
2CY5				R-2	
2D21	FS				
2DF4	FS				
2GK5				R-2	
3A3-C				R-2	
3AT2-B				R-1	
3AW2-A				R-1	
3BN2-A				R-1	
3BW2				R-1	
3BZ6				R-2	
3C23	FS				
3CB6				R-2	
3CN3-B				R-2	
3CS6				R-2	
3CU3-A				R-2	
3CX100A5	FS				
3DK6				R-2	
3DA3				R-2	
3DB3				R-2	
3DC3				R-2	
3DF3				R-2	
3DH3				R-2	
3DJ3				R-2	
3DT6				R-2	
3GK5				R-2	
3HA5				R-2	
3HM5				R-2	
3HS8				R-2	
3JC6A				R-2	
4AU6				R-2	
4BZ6				R-2	
4CB6				R-2	
4CS6				R-2	
4DE6				R-2	
4DK6				R-2	
4DT6				R-2	
4GK5				R-2	
4HS8				R-2	
4JC6A				R-2	
4JD6				R-2	
4JH6				R-2	
4LU6				R-2	
5AQ5				R-2	
5AR4				R-2	
5CG8				R-2	
5EW6				R-2	
5GH8				R-2	
5KZ8				R-2	
5R4-GYA	FS				
5U4-GB				R-2	
5Y3-GT				R-2	
6AB4				R-2	
6AC10				R-1	
6AD10				R-1	
6AF11				R-1	
6AG9				R-1	
6AH9				R-1	
6AK6	FS				
6AK9				R-1	
6AK10				R-1	
6AL5				R-2	
6AM4				R-2	
6AQ5-A				R-2	
6AR11				R-1	
6AS7-GS	FS				
6AU6-A				R-2	
6AU8-A				R-2	
6AV6				R-2	
6AV11				R-1	
6AW8-A				R-2	
6AX3				R-1	
6AY3-B				R-2	
6B10				R-1	
6BA6				R-2	
6BA10				R-1	
6BD11				R-1	
6BE3				R-2	
6BE6				R-2	
6BF11				R-1	
6BH6				R-2	
6BH11				R-1	
6BK7-B				R-2	
6BN6				R-2	
6BN11				R-1	
6BQ5				R-2	
6BQ7-A				R-2	
6BV10				R-1	
6BW3				R-1	
6BW11				R-1	
6BZ3				R-1	
6BZ6				R-2	
6C4				R-2	
6CA11				R-1	
6CB6-A				R-2	
6CG3				R-1	
6CG8-A				R-2	
6CJ3				R-2	
6CL8-A				R-2	
6CS6				R-2	
6CU5				R-2	
6CY5				R-2	
6DJ8	FS				

*FS = Special Products and Microwave Devices for Industry Manual.
I = Industrial Equipment Types Manual.
RS = Reed Switches and Photoconductive Cells Manual.
M = Military Equipment Types Manual.
R-1 = Receiving Types Manual, Vol 1, Compactrons.
R-2 = Receiving Types Manual, Vol. 2, Conventional Types.

If a customer holds the single-volume combined Industrial and Military Equipment Types Manual, designations listed above in the I and M columns will be in that book following tab divider "Industrial," "Military."

TYPE	MANUAL*	TYPE	MANUAL*	TYPE	MANUAL*
6DK6	R-2	6SN7-GTA	R-2	12GE5	R-1
6DT6	R-2	6SN7-GTB	R-2	12GN7-A	R-2
6DT8	R-2	6T8-A	R-2	12HG7	R-2
6EA8	R-2	6T10	R-1	12HL7	R-2
6EF4	R-1	6U10	R-1	12JN6	R-1
6EH4-A	R-1	6V6-GTA	R-2	12JN8	R-2
6EJ4A	R-1	6X4	R-2	12SL7-GT	R-2
6EL4-A	R-2	6Z10	R-1	12SN7-GTA	R-2
6EW6	R-2	7KY6	R-2	13JZ8	R-1
6EZ8	R-2	8AC10	R-1	13V10	R-1
6FM7	R-1	8AL9	R-1	13Z10	R-1
6FQ7	R-2	8AR11	R-1	14BL11	R-1
6FY7	R-1	8AW8-A	R-2	14BR11	R-1
6GE5	R-1	8B10	R-1	15AF11	R-1
6GK5	R-2	8BA11	R-1	15BD11	R-1
6GK6	R-2	8BM11	R-1	15FM7	R-1
6GM6	R-2	8BN11	R-1	15FY7	R-1
6GN8	R-2	8BQ11	R-1	15MF8	R-1
6GU7	R-2	8BU11	R-1	16AK9	R-1
6GV5	R-1	8CB11	R-1	16BQ11	R-1
6GX6	R-2	8FQ7	R-2	16BX11	R-1
6GY5	R-1	8GN8	R-2	16GY5	R-1
6GY6	R-2	8JU8-A	R-2	16LU8-A	R-1
6GY8	R-2	8JV8	R-2	17AB10	R-1
6HA5	R-2	8LT8	R-2	17AX3	R-1
6HB5	R-1	9AH9	R-1	17AY3-A	R-2
6HB6	R-2	9AK10	R-1	17BE3	R-1
6HE5	R-1	9MN8	R-1	17BF11	R-1
6HM5	R-2	10GK6	R-2	17BF11-A	R-1
6HS8	R-2	10GN8	R-2	17BW3	R-1
6HZ6	R-2	10JY8	R-2	17BZ3	R-1
6HV5-A	R-1	10KR8	R-2	17CU5	R-2
6J6-A	R-2	10LW8	R-2	17GE5	R-1
6JB5	R-1	10LZ81	R-2	17GV5	R-1
6JH6	R-2	10T10	R-1	17JM6	R-1
6JC6-A	R-2	10Z10	R-1	17JN6	R-1
6JD5	R-1	11AR11	R-1	17JZ8	R-1
6JD6	R-2	11BQ11	R-1	18AJ10	R-1
6JM6	R-1	11BT11	R-1	19CG3	R-1
6JN6	R-1	11CA11	R-1	19DE3	R-1
6JN8	R-2	11CF11	R-1	19JN8	R-2
6JU8-A	R-2	11FY7	R-1	19T8	R-2
6JV8	R-2	11LT8	R-2	21GY5	R-1
6JZ6	R-1	12AE10	R-1	21HB5-A	R-1
6JZ8	R-1	12AL5	R-2	21JZ6	R-1
6KD6	R-1	12AT7	R-2	21LU8	R-1
6KR8-A	R-2	12AU6	R-2	22BW3	R-1
6KS6	R-2	12AU7	R-2	23Z9	R-1
6KT8	R-2	12AU7-A	R-2	24BF11	R-1
6L6-GC	R-2	12AV6	R-2	24JZ8	R-1
6LB6	R-1	12AV7	R-2	25C5	R-2
6LE8	R-2	12AX3	R-1	25CG3	R-1
6LG6	R-1	12AX7	R-2	25EH5	R-2
6LJ6-A	R-2	12AX7-A	R-2	25JZ8	R-1
6LJ8	R-2	12AY7	FS R-2	26LX6	R-1
6LT8	R-2	12BA6	R-2	31AL10	R-1
6LU8	R-1	12BE3	R-1	30JZ6	R-1
6LY8	R-2	12BE6	R-2	32HO7	R-1
6M11	R-1	12BF11	R-1	33GY7A	R-1
6MD8	R-2	12BV11	R-1	34CE3	R-1
6MJ8	R-1	12BY7-A	R-2	35C5	R-2
6MK8A	R-2	12C5	R-2	35W4	R-2
6MN8	R-1	12CU5	R-2	36KD6	R-1
6MV8	R-2	12DQ7	R-2	38HE7	R-1
6SL7-GT	R-2	12FQ7	R-2	38HK7	R-1

TYPE	MANUAL*				
50C5				R-2	
50DC4				R-2	
50EH5				R-2	
53HK7				R-1	
FG-81-A	FS				
FG-97	FS				
FG-98-A	FS				
DR100	FS				RS
DR101	FS				RS
DR103	FS				RS
DR104	FS				RS
FG-105	FS				
DR113	FS				RS
DRV120	FS				RS
DR121	FS				RS
DR123	FS				RS
DR125	FS				RS
DR-138	FS				RS
DR-145	FS				RS
DR-157	FS				
DR-158	FS				
DR-159	FS				
FG-172		I			
FG-280		I			
393-A	FS				
GL-414		I			
502-A	FS				
807	FS				
GL-857-B		I			
GL-869-B		I			
GL-870-A		I			
ZP-1015			M		
ZP-1026			M		
ZP-1034			M		
Y-1938	FS				
ZP-1039			M		
ZP-1065			M		
ZP-1079			M		
C-2002A	FS				
C-2003C	FS				
C-2006C	FS				
C-2007	FS				
C-2013	FS				
C-2014	FS				
C-2015	FS				
C-2020A	FS				
C-2035C	FS				
2050-A	FS				
C-2062	FS				
5544	FS				
GL-5550		I			
GL-5551-A		I			
GL-5552-A		I			
GL-5553-B		I			
GL-5554		I			
GL-5555		I			
5557	FS				
5558	FS				
5559	FS				
5560	FS				
5561	FS				
GL-5564		I			
GL-5630		I	M		
5654	FS				
5663	FS				
5670	FS				
5686	FS				
5687	FS				
5696-A	FS				
5720	FS				
5725	FS				
5726	FS				
5727	FS				
5749	FS				
5750	FS				
5751	FS				
GL-5779		I			
GL-5788		I			
5814-A	FS				
GL-5822-A		I			
5824	FS				
GL-5830		I			
5844	FS				
5855	FS				
5963	FS				
5965	FS				
5965-A	FS				
5998-A	FS				
6005	FS				
6011/710	FS				
6046	FS				
ZM-6046			M		
ZM-6047			M		
ZM-6051			M		
6072-A	FS				
6080	FS				
ZM-6085			M		
ZM-6086			M		
6087	FS				
ZM-6087			M		
6135	FS				
6136	FS				
6146	FS				
6146-A	FS				
6189	FS				
6197	FS				
6201	FS				
6202	FS				
6203	FS				
ZM-6203			M		
ZM-6205			M		
6211-A	FS				
ZM-6211-A			M		
ZM-6215			M		
6216	FS				
ZM-6220			M		
ZM-6222			M		
ZM-6231			M		
GL-6228		I	M		
ZM-6238			M		
ZM-6239			M		
ZM-6240			M		
ZM-6242			M		
ZM-6243			M		
ZM-6246			M		
GL-6251			M		
ZM-6257			M		
6265	FS				
ZM-6276			M		
ZM-6277			M		
GL-6283			M		
ZM-6287		I			
6299	FS				
6350	FS				
6386	FS				
6414	FS				
ZM-6287		I			
6442	FS				
6463	FS				
6485	FS				
GL-6504		I			
GL-6509		I			
GL-6512		I			
GL-6513		I			
GL-6514		I			
GL-6515		I			
6660	FS				
6661	FS				
6662	FS				
6663	FS				
6664	FS				
6669	FS				
6676	FS				
6677	FS				
6678	FS				
6679	FS				
6680	FS				
6681	FS				
6688	FS				
6771	FS				
ZM-6802			M		
6807	FS				
6808	FS				
6809	FS				
6829	FS				
GL-6848			M		
GL-6878		I			
6897	FS				
6919	FS				
GL-6942			M		
GL-6958		I			
ZT-7004			M		
7025	FS			R-2	
7036	FS				
GL-7042		I			
7044	FS				
7077	FS				
GL-7151		I			
7167	FS				
GL-7171		I	M		
7189-A	FS			R-2	
7233	FS				
7239	FS				
7247	FS			R-2	
7266	FS				
7289	FS				
7296	FS				
7355	FS			R-2	
7370	FS				
GL-7390			M		
GL-7390-A			M		
7391	FS				
GL-7399			M		
7408	FS			R-2	
7462	FS				

TYPE	MANUAL*				
7486	FS				
ZR-7512			M		
ZR-7513			M		
ZR-7516			M		
ZR-7517			M		
7518/710L	FS				
7581-A	FS			R-2	
7588	FS				
GL-7669		I			
GL-7670		I			
GL-7671		I			
GL-7672		I			
GL-7673		I			
GL-7681		I			
7701	FS				
GL-7703		I	M		
7716	FS				
7717	FS				
7720	FS				
7724	FS				
7725	FS				
7726	FS				
7734	FS				
GL-7736		I			
7768	FS				

TYPE	MANUAL*				
7784	FS				
7815	FS				
7815R	FS				
7841	FS				
7861	FS				
GL-7890			M		
7910	FS				
7911	FS				
7913	FS				
GL-7964			M		
GL-7964-1			M		
7984	FS			R-1	
GL-7985			M		
GL-7998		I			
8068	FS				
8102	FS				
8106	FS				
8113	FS				
8136	FS				
8156	FS				
GL-8205		I			
GL-8326			M		
GL-8360		I			
GL-8420		I			
GL-8465		I			

TYPE	MANUAL*				
GL-8466		I			
GL-8500			M		
GL-8513			M		
GL-8559			M		
GL-8866			M		
GL-37207		I	M		
GL-37248		I	M		
GL-51025			M		
GL-51038			M		
GL-51038R			M		
GL-51064			M		
GL-51065			M		
GL-51070			M		
GL-51074			M		

MILITARY EQUIPMENT TYPES MANUAL

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MILITARY EQUIPMENT TYPES MANUAL

INTRODUCTION

CONTENTS

This manual contains data on tubes and allied devices of interest to manufacturers designing military systems. It is designed to give you information on products useful in equipment in the current design stage, as well as to keep you abreast of the latest trends now under development in order to assist you in advance equipment design. For that reason it includes data on Electronic Industries Association registered types as well as on types currently in development or currently being produced at less than full-scale quantities.

USE

Although this manual will be kept current with regular mailings, it does not attempt to bring you all advance tube programs since many are still so advanced that they are subject to general objectives. Consultation with your nearest General Electric Electronic Components Sales Operation Office is encouraged in order to put you in touch with such programs.

ARRANGEMENT

The technical information here is tabbed by tube class. Specific types within each class are arranged in numerical order.

KIND OF DATA

As a standard practice, information is given in two distinctly different forms: data sheets on commercial types identified by the prefix GL in the case of EIA-registered tube types and data sheets on developmental types. The latter can be identified by the prefix Z or Z followed by another letter; e.g., ZM, ZP. Data on the developmental types may appear in either of two classifications, "Objective Technical Information" (OTI) or "Preliminary Technical Information" (PTI). Both forms for some types may be included for your convenience.

OBJECTIVE TECHNICAL INFORMATION

The Objective Technical Information represents the design objective for the type. When significant ratings approaching the design objective are available, Preliminary Technical Information is issued. When only Objective Technical Information exists consult your nearest Electronic Components sales office for current status.

Preliminary Technical Information

Preliminary Technical Information describes the characteristics of products during the period progressing toward the achievement of design objectives. Preliminary ratings (PTI) reflect current performance. While delivery of types to Preliminary Technical Information specifications does not imply continued availability of types with identical characteristics or dimensions, arrangements can be made to do so depending on the nature of the requirement. Consult your General Electric Electronic Components sales office.

SUMMARY INFORMATION

In addition to the above, selection charts for each class are included directly following the divider for the class. These are furnished to provide you a quick selection listed by main characteristic.

CONDITIONS OF SALE

The specifications in this manual applying to types in development are naturally subject to some change. Small-quantity lots are usually available. Such availability is subject to prior order. Standard Conditions of Sale apply to all developmental types in availability status. Your purchasing agent usually has information on availability. If he does not have it, he can readily obtain it from your General Electric Electronic Components sales representative.

PRICE AND WARRANTY

Specific prices and warranties have been established for most listings. Your Purchasing Agent or General Electric sales representative can readily provide this information.

Ordering

When ordering a product from developmental data be sure to include date of the OTI or PTI for best service, and so that your requirements are completely described.

ADDITIONAL INFORMATION

Your nearest Electronic Components Sales Operation representative can provide you additional information promptly. You are invited to consult him.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

ECSO PRODUCT LISTING AND SALES OFFICES

ET-F20B

The General Electric Electronic Component Sales Operation offers a complete electronic components "market basket" of products. A listing follows:

TUBE PRODUCTS

1. Transmitter tubes
1A. Camera tubes
2. Klystrons
3. VTM's
4. Ignitrons
4A. Vacuum gaps
4B. Hydrogen thyratrons
5. Ceramic tubes
6. Photocells
7. Reed switches
8. Compactrons
9. Conventional receiving tubes

SEMICONDUCTOR PRODUCTS

10. Germanium rectifiers
 low current (0 to 1.4 amp)
11. Silicon rectifiers
 low current (0 to 1.4 amp)
 medium current (1.5 to 35.0 amp)
 high current (over 35 amp)
12. SCR's
 low current (0 to 7.5 amp)
 high current (over 35 amp)
 light activated
13. Silicon controlled combination stacks
14. AC controlled switches
15. Rectifier stacks (Germanium, silicon, potted blocks)
16. Assemblies (thyratron replacements, specials)
17. Selenium and copper oxide rectifiers
18. Functional components
19. Silicon controlled switches
20. Unijunction transistors
21. Silicon grown-diffused passivated NPN transistor
22. Tunnel diodes and back diodes
23. Reference amplifiers
24. Silicon planar epitaxial passivated amplifiers and switches
25. Active discrete pellet functional devices
26. Signal diodes
27. Matched pairs and quads
28. Silicon mesa NPN passivated power transistors

CAPACITOR PRODUCTS

29. Film capacitors
30. Large D-c capacitors
31. Energy Storage capacitors
32. Network capacitors
33. D-c specialty capacitors
34. A-c specialty capacitors
35. Aluminum electrolytic capacitors
36. Tantalum electrolytic capacitors

VACUUM PROCUCTS

37. Vacuum system
38. Triode ion pumps
39. Trigger gages
40. Mercury diffusion pumps
41. Ion gages
42. Leak detectors
43. Partial pressure analyzers
44. Permeation leak-gas purifiers
45. Sublimation pumps
46. Vacuum accessories

OTHER PRODUCTS

47. Adjustable speed drives
48. Appliance controls
49. Ballasts (fluorescent)
50. Circuit protective devices
51. General purpose control
52. Magnets
53. Nickel cadmium rechargeable batteries
54. Sealed relays
55. Soldering Irons
56. Thermistors
57. Varistor
58. Volt Pac® specialty transformers

INSTRUMENTS

59. Panel Meters
60. Time Meters
61. Meter Relays
62. Shunts
63. Switchboard Indicators
64. Recorders (Direct Acting)
65. Transducers

RECORDING INSTRUMENTS

66. Direct - operated, strip - chart recorders (inking, inkless, hook-on)
67. Miniature (4-inch) servo-operated recorders
68. Servo-operated (12-inch) strip and round chart recorders/recorder controllers (one, two or multipoint pen)

MOTORS

69. A-C Tri-Clad '55'® induction 1-125 HP
70. A-c fractional
71. D-c integral
72. D-c fractional
73. Specialty motors
74. DCM&G sets

Electronic Components Sales Operation Offices on Page 2.

ELECTRONIC COMPONENT SALES OPERATION OFFICES

ARIZONA

Phoenix 85012
Guaranty Bank Bldg., Suite 712
3550 N. Central Ave.
Phone A/C 602 264-1751

CALIFORNIA

***Los Angeles 90064**
11840 W. Olympic Blvd.
Phone: A/C 213 479-7763
A/C 213 272-8566
A/C 213 879-1350

Portola Valley 94025
3210 Alpine Road
Phone: A/C 415 854-4010

COLORADO

Denver 80206
201 University Blvd.
P.O. Box 2331
Phone: A/C 303 388-5771

CONNECTICUT

Bridgeport 06602
1285 Boston Ave.,
Phone: A/C 203 334-1012

DISTRICT OF COLUMBIA

Washington 20005
777 - 14th St., N.W.
Phone: A/C 202 393-3600

FLORIDA

North Palm Beach 33403
321 North Lake Blvd., Room 201
Phone: A/C 305 844-5202

Tampa 33609
P.O. Box 10577
2104 S. Lois Ave.
Phone: A/C 813 877-8311

Winter Park 32789
John Hancock Bldg., Suite 250
370 Wymore Rd.
Phone: A/C 305 425-8634

ILLINOIS

***Chicago 60641**
3800 N. Milwaukee Ave.
Phone: A/C 312 777-1600

INDIANA

Fort Wayne 46806
6001 S. Anthony
Phone: A/C 219 447-1511

Indianapolis 46208
3750 N. Meridian St.
Phone: A/C 317 923-7221

IOWA

Cedar Rapids 52401
210 2nd St., S.E.
303 Dows Bldg.
Phone: A/C 319 364-9149

KENTUCKY

Owensboro 42301
316 E. 9th St.
Phone: A/C 502 683-2401
Ext. 482 (Receiving Tubes)
Ext. 422 (I&M Tubes)

MASSACHUSETTS

Wellesley 02181
1 Washington St.
Phone: A/C 617 237-2050

MICHIGAN

***Detroit 48237**
15160 W. Eight Mile Rd.
Phone: A/C 313 564-5228

MINNESOTA

Minneapolis 55424
4900 Viking Dr., Rm. 108
Phone: A/C 612 927-5458

MISSOURI

Kansas City 64199
911 Main St., Suite 518
P.O. Box 13566
Phone: A/C 816 221-4033

NEW JERSEY

***Clifton 07014**
200 Main Ave.
Phone: A/C 201 472-8100

NEW YORK

Albany 12205
11 Computer Drive West
(518) 869-3576

New York City
(*Great Neck 11021)
425 Northern Blvd.
Phone: A/C 516 466-8800

***North Syracuse 13212**
Northern Concourse Office Bldg.
Room 102
315-456-3412

Rochester 14624
35 Deep Rock Rd.
(716) 436-3480

NORTH CAROLINA

Greensboro 27408
1828 Banking St.
Phone: A/C 919 273-6982

OHIO

***Cleveland 44117**
25000 Euclid Ave.
Phone: A/C 216 266-2900

Dayton 45429
3430 S. Dixie Hwy.
P.O. Box 2143
Kettering Branch
Phone: A/C 513 298-0311

OKLAHOMA

Oklahoma City 73112
3022 N.W. Expressway
May-Ex Building, Room 412
Phone: A/C 405 943-9015

PENNSYLVANIA

Erie 16505
2318 W. 8th Street
Phone: A/C 814 455-8377

***Philadelphia 19102**
3 Penn Center Plaza
Phone: A/C 215 568-1800

Pittsburgh 15220
875 Greentree Rd. - Room 304
3 Parkway Center
Phone: A/C 412 921-4134

TEXAS

Dallas 75205
4447 N. Central Expressway,
Phone: A/C 214 521-1931

Houston 77006
3110 S.W. Freeway
Room 220
Phone: A/C 713 524-3061

VIRGINIA

Charlottesville 22902
2007 Earhart St.
P.O. Box 319
Phone: A/C 703 296-8118

Portsmouth 23707
3205 King St.
P.O. Box 7175
Phone: A/C 703 393-6780

WASHINGTON

Seattle 98188
225 Tukwila Pky.
Phone: A/C 206 244-7750

WISCONSIN

***Milwaukee 53202**
615 East Michigan St.
Phone: A/C 414 271-5000

INQUIRIES FROM OUTSIDE CONTINENTAL UNITED STATES, EXCLUDING HAWAII AND ALASKA, SHOULD BE SENT TO:

Electronic Sales
IGE Export Division
159 Madison Avenue
New York, N.Y. 10016
Phone: A/C 212 751-1311

IN CANADA, ADDRESS INQUIRIES TO:

Canadian General Electric Co.
189 Dufferin Street
Toronto, Ontario, Canada
Phone: A/C 416 537-4481

GOVERNMENT PROGRAMS OPERATION OFFICES

ALABAMA

Huntsville 35801
3322 Memorial Parkway South,
Suite 13
Phone: A/C 205 883-3131

DISTRICT OF COLUMBIA

***Washington 20005**
777 - 14th St., N.W.
Phone: A/C 202 393-3600

OHIO

Dayton 45439
3430 S. Dixie Hwy.
P.O. Box 2143
Kettering Branch 45529
Phone: A/C 513 298-0311

CALIFORNIA

Los Angeles 90064
11840 W. Olympic Blvd.
Phone: A/C 213 479-7763
A/C 213 272-8566
A/C 213 879-1350

*Region Office

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

MET-10C

MILITARY EQUIPMENT TYPES MANUAL

IGNITRONS

Selection Chart

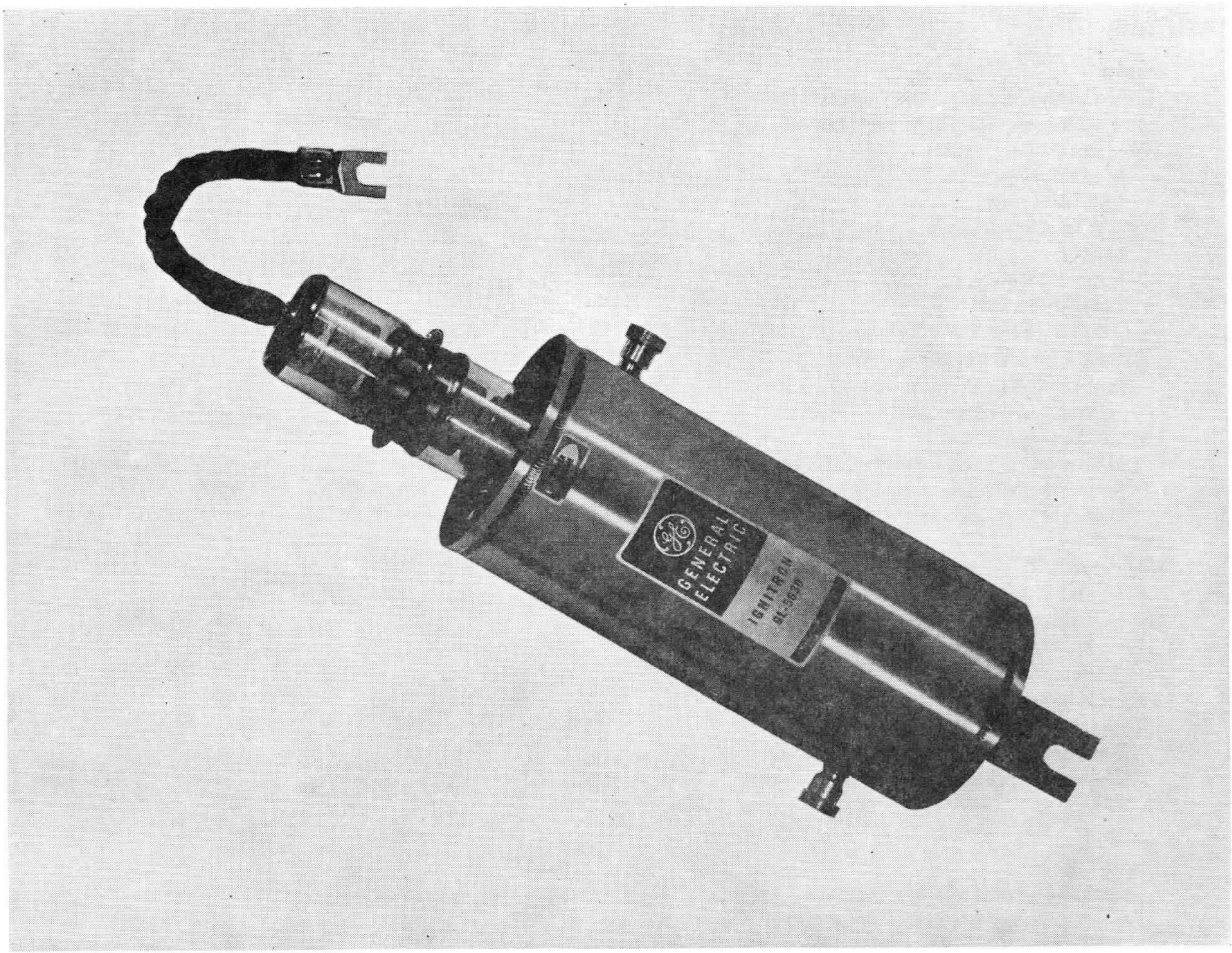
CAPACITOR-DISCHARGE AND DC-SHORT-CIRCUITING-SWITCH SERVICE

Capacitor Discharge

Maximum Peak Current in Amperes	Inductance in Nanohenrys Approx	Peak Inverse and Forward Anode Volts	Repetition Rate per Minute Max	Type
35,000	30	10,000	1	GL-7171
100,000	30	20,000	2	GL-7703
300,000	90	25,000	500	GL-37207

DC Short-Circuiting Switch

Current-Amperes RMS	Current-Amperes Peak	Peak Inverse Volts	Type
—	10,000	50,000	GL-37248
15	35,000	10,000	GL-7171
15	35,000	20,000	GL-7703
175	20,000	30,000	GL-5630
500	30,000	45,000	GL-6228
—	300,000	25,000	GL-37207



IGNITRON

The GL-5630 ignitron is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube designed primarily for use in radio-transmitter power supplies. In this service 6 tubes will rectify up to 2500 kilowatts at 17,000 volts. Use of the grid to prevent conduction gives one-cycle circuit-breaker action.

X-RAY WARNING NOTICE

This device may produce X-rays when energized. X-ray warning signs or labels should be permanently attached to the equipment.

Precautions must be exercised during the service and operation of equipment to assure that any shielding components are replaced to their intended position before the equipment is operated.

GENERAL

Electrical

Type Cathode Excitation—Cyclic
Type Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Holding Anodes	1	
Ignitors	2	
Control Grids	1	
Gradient Grids	1	
Arc Drop at 150 Peak Amperes	18 ± 1	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	450	Volts
Ignitor Current Required to Fire	42	Amperes
Grid Requirements		
Positive Current to Establish Conduction	0.200	Amperes
Minimum Voltage to Establish Conduction	+100	Volts
Minimum Voltage to Prevent Conduction	−50	Volts

Mechanical

Envelope Material—Metal

Over-all Length, maximum	$22\frac{3}{16}$	Inches
Over-all Width, maximum	$5\frac{3}{4}$	Inches
Net Weight	23 ± 2	Pounds

Type Cooling—water
Characteristics for Water Cooling

Water Temperature Rise, maximum	2	C
Pressure Drop at 3 Gallons per Minute	4	Pounds per Square Inch

Thermal

Water Cooling

Maximum Outlet Water Temperature	45	C
Minimum Inlet Water Temperature	35	C
Minimum Water Flow at Continuous Rated Average Current	3	Gallons per Minute
Minimum Water Flow at no Load	3	Gallons per Minute

MAXIMUM RATINGS

AS POWER RECTIFIER TUBE

Ratings are for zero phase-control angle.
Maximum Peak Anode Voltage

Inverse	20,000	Volts
Forward	20,000	Volts
Main Anode Current		
Peak	200	Amperes
Average		
Continuous	50	Amperes
2 Hours	50	Amperes
1 Minute	50	Amperes
Surge	2000	Amperes
Maximum Duration of Surge Current	0.15	Seconds
Frequency Range	25–60	Cycles per Second

IGNITOR

Maximum Voltage	
Positive	1000 Volts
Negative	5 Volts
Maximum Current	
Peak	100 Amperes
RMS	17.5 Amperes
Average	2.5 Amperes
Maximum Averaging Time	10.0 Seconds
Starting Time at Required Voltage or Current	100 Microseconds

HOLDING ANODE

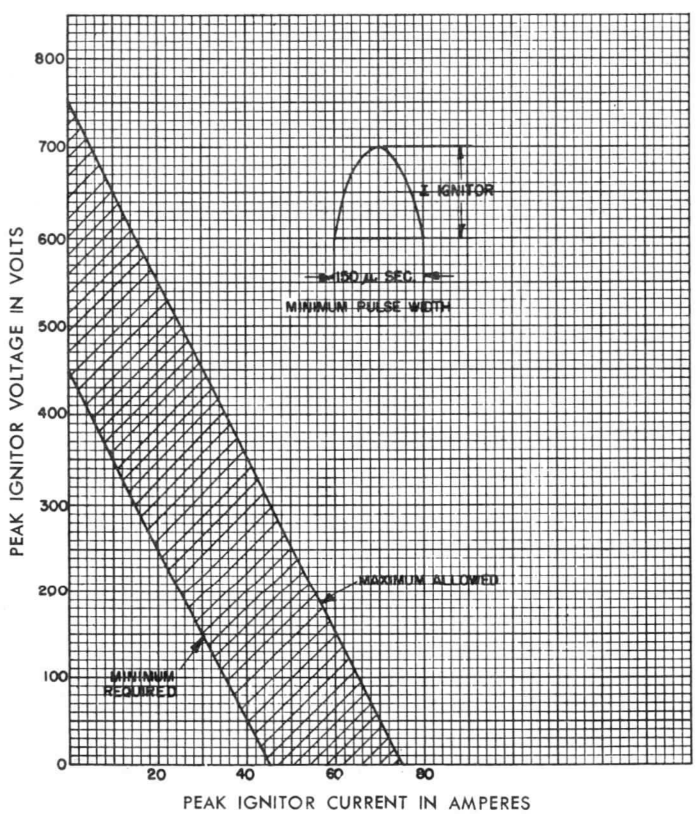
Maximum Current	
Peak	20 Amperes
Average	5 Amperes
Maximum Averaging Time	1 Second
RMS	10 Amperes
Maximum Peak Forward Voltage	200 Volts
Maximum Peak Inverse Voltage	
Main Anode Conducting	25 Volts
Main Anode not Conducting	150 Volts

CONTROL GRID

Maximum Peak Forward Voltage	500 Volts
Maximum Peak Inverse Voltage	200 Volts
Maximum Grid-Current	
Peak Positive	5.0 Amperes
Peak Negative	0.1 Amperes
Average	1.0 Amperes
RMS	2.0 Amperes

IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA.



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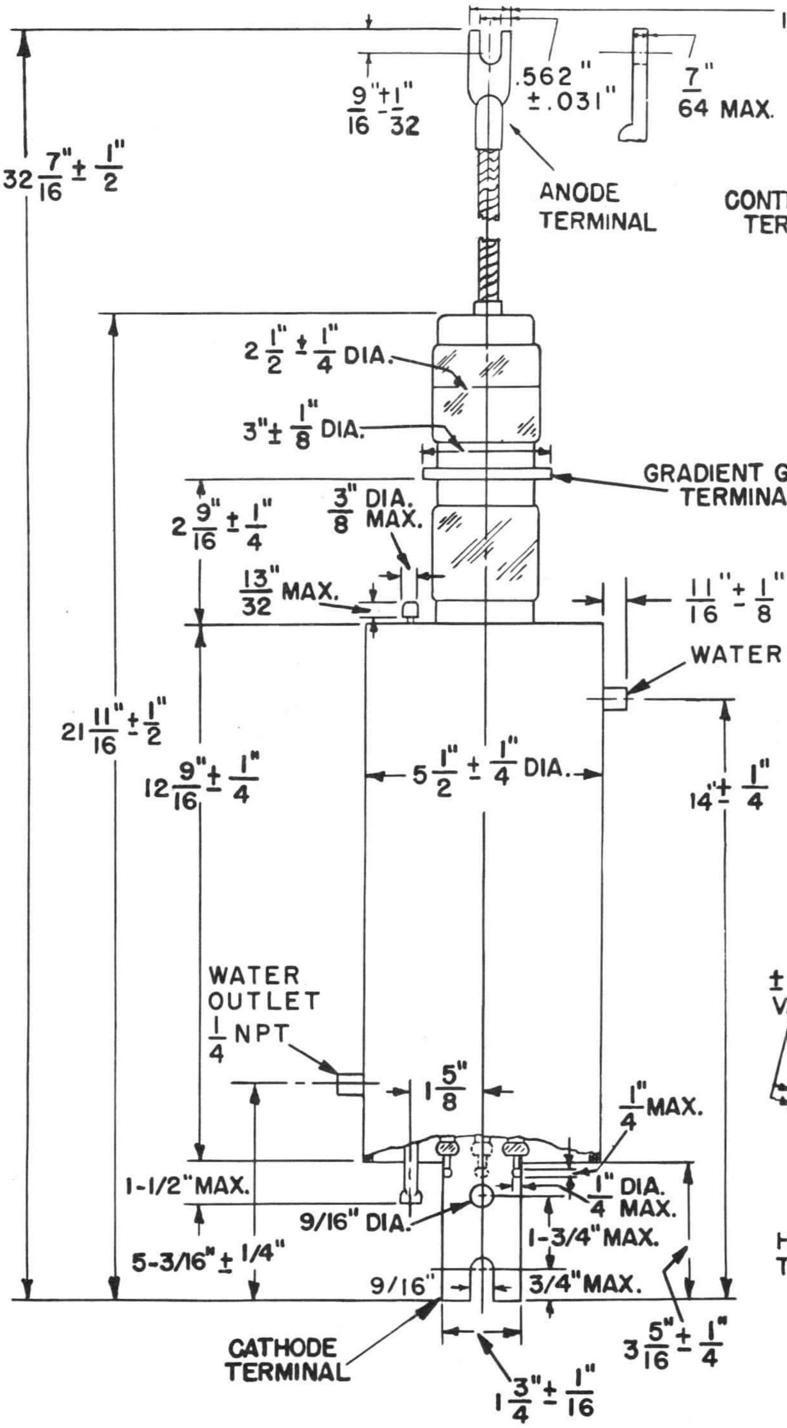
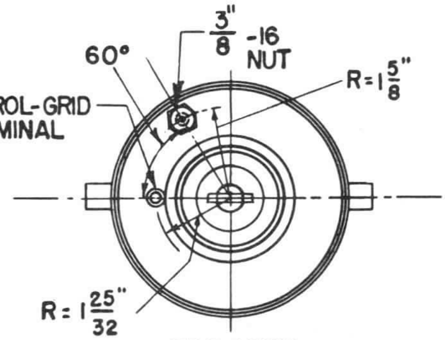
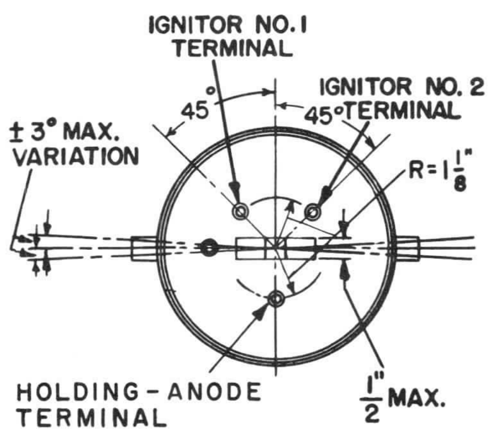




TOP VIEW



BOTTOM VIEW

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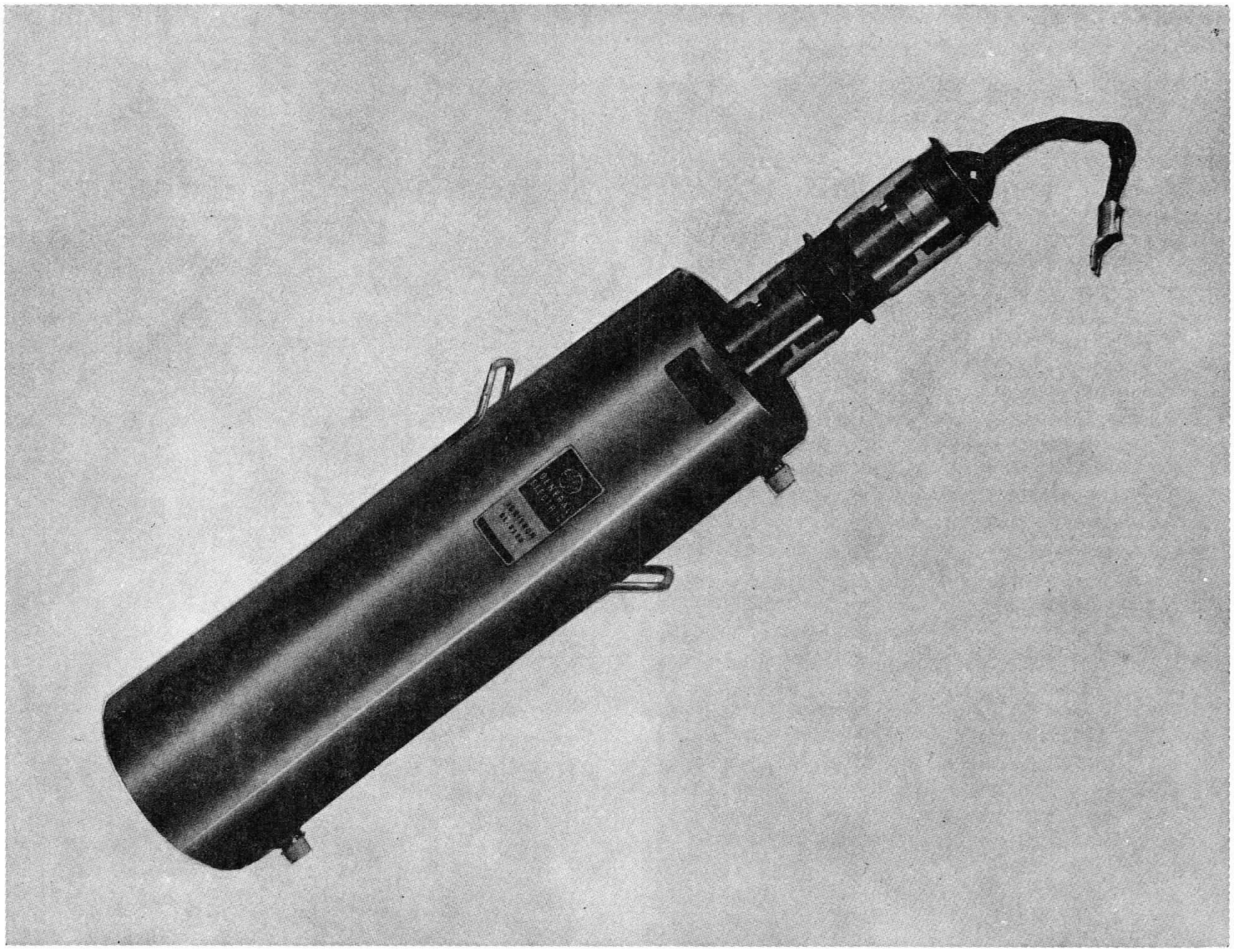


IGNITRON

PENTODE TYPE — FREQUENCY-CHANGER SERVICE

The GL-6228 ignitron is a sealed, stainless-steel-jacketed, water-cooled mercury-pool tube designed primarily for use in electronic frequency changers. In this service, six tubes will rectify or invert up to 7500 kilowatts at 17,000 volts. The tube is also designed for use in intermittent-rectifier service, capacitor-discharge service, and as a d-c short-circuiting switch.

GENERAL

Electrical

Type cathode excitation—Cyclic

Type cathode-spot starting—Ignitor

Number of electrodes

Main anodes	1
Main cathode	1
Ignitors	3
Holding anodes	2
Shield grids	1
Control grids	1
Gradient grids	1

Arc drop

At 600 amperes peak	20 ± 2 volts
At 2000 amperes peak	30 ± 2 volts

GENERAL (CONT'D)

Electrical (Cont'd)

Cathode-excitation requirements
See specific class of service
Grid-excitation requirements
See specific class of service

Mechanical

Envelope material—metal
Net weight . . . . . 100±10 pounds

Thermal

Type of cooling—water
Characteristics for water cooling

Water temperature rise	4	C
Pressure drop at 5 gallons per minute, maximum	4	pounds per square inch
Inlet water temperature, minimum	35	C
Outlet water temperature, maximum	45	C
Water flow, minimum	5	gallons per minute
Recommended temperature range	40 to 45	C

MAXIMUM RATINGS

POWER-RECTIFIER SERVICE

	Minimum	Maximum	
ASA (See ASA Standards C34.1-1949)			
Peak anode voltage			
Inverse	—	20,000	volts
Forward	—	20,000	volts
Anode current*			
Peak	—	900	amperes
Average			
Continuous	—	150	amperes
2 hours	—	200	amperes
1 minute	—	300	amperes
Fault	—	6000	amperes
Duration of fault current ‡		0.15	second
Peak control-grid voltage			
Forward	200	500	volts
Inverse	100	200	volts
Peak shield-grid voltage			
Forward	200	500	volts
Inverse	50	200	volts
Peak control-grid current			
Forward	—	5	amperes
Inverse	—	0.4	amperes
Peak shield-grid current			
Forward	—	5	amperes
Inverse	—	0.2	amperes
Peak gradient-grid voltage			
Forward	1/2	1/2	anode-cathode voltage
Inverse	1/2	1/2	anode-cathode voltage
Peak gradient-grid current			
Forward	0.010	0.020	amperes
Inverse	0.010	0.020	amperes
Ignitor ratings			
Peak ignitor voltage			
Forward, open-circuit voltage	450	750	volts
Inverse	0	5	volts
Width of current pulse, sinusoidal waveshape			
At 60 cycles	500	1500	microseconds
At 25 cycles	500	4000	microseconds
Peak ignitor current, short-circuit current	45	75	amperes

MAXIMUM RATINGS (CONT'D)

POWER-RECTIFIER SERVICE (CONT'D)

	Minimum	Maximum	
Holding anode ratings			
Available instantaneous holding anode voltage during desired conduction period	40	—	volts
Peak holding-anode voltage			
Forward	—	200	volts
Inverse	—	25	volts
Peak holding-anode current			
Forward	—	20	amperes
Inverse	—	0.100	amperes
Average	—	5	amperes
RMS	—	10	amperes
Minimum			
Forward current during desired conduction period	7	—	amperes
Continuous Duty, No Overloads			
Peak anode voltage			
Inverse	—	20,000	volts
Forward	—	20,000	volts
Anode current*			
Peak	—	600	amperes
Average	—	200	amperes
Fault	—	6000	amperes
Duration of fault current‡	—	0.15	second
Product of inverse or forward voltage and average current	—	3	megavolt-amperes
Peak control-grid voltage			
Forward	200	500	volts
Inverse	100	200	volts
Peak shield-grid voltage			
Forward	200	500	volts
Inverse	50	200	volts
Peak control-grid current			
Forward	—	5	amperes
Inverse	—	0.4	amperes
Peak shield-grid current			
Forward	—	5	amperes
Inverse	—	0.2	amperes
Peak gradient-grid voltage			
Forward	1/2	1/2	anode-cathode voltage
Inverse	1/2	1/2	anode-cathode voltage
Peak gradient-grid current			
Forward	0.010	0.020	amperes
Inverse	0.010	0.020	amperes
Ignitor ratings			
Peak ignitor voltage			
Forward	450	750	volts
Inverse	0	5	volts
Width of current pulse, sinusoidal waveshape	500	—	microseconds
At 60 cycles	—	1500	microseconds
At 25 cycles	—	9000	microseconds
Peak ignitor current	45	75	amperes
Holding anode ratings			
Available instantaneous holding anode Voltage during desired conduction period	40	—	volts
Peak holding-anode voltage			
Forward	—	200	volts
Inverse	—	25	volts
Peak holding-anode current			
Forward	—	20	amperes
Inverse	—	0.100	amperes

MAXIMUM RATINGS (CONT'D)

POWER-RECTIFIER SERVICE (CONT'D)

	Minimum	Maximum	
Average	—	5	amperes
Rms	—	10	amperes
Minimum			
Forward current during desired conduction period	7	—	amperes
Intermittent Duty†			
Peak anode voltage			
Inverse	—	20,000	volts
Forward	—	20,000	volts
Anode current*			
Peak	—	1500	amperes
Average	—	150	amperes
Averaging time	—	0.15	second
Rms	—	500	amperes
Averaging time	—	0.15	second
Fault	—	6000	amperes
Duration of fault current ‡	—	0.15	second
Product of inverse or forward voltage and peak anode current	—	22.5	megavolt-amperes
Peak control-grid voltage			
Forward	200	500	volts
Inverse	100	200	volts
Peak shield-grid voltage			
Forward	200	500	volts
Inverse	50	200	volts
Peak control-grid current			
Forward	—	5	amperes
Inverse	—	0.4	amperes
Peak shield-grid current			
Forward	—	5	amperes
Inverse	—	0.2	amperes
Peak gradient-grid voltage			
Forward	1/2	1/2	anode-cathode voltage
Inverse	1/2	1/2	anode-cathode voltage
Peak gradient-grid current			
Forward	0.010	0.020	amperes
Inverse	0.010	0.020	amperes
Ignitor ratings			
Peak ignitor voltage			
Forward	450	750	volts
Inverse	0	5	volts
Width of current pulse, sinusoidal waveshape	500	—	microseconds
At 60 cycles	—	1500	microseconds
At 25 cycles	—	9000	microseconds
Peak ignitor current	45	75	amperes
Holding anode ratings			
Available instantaneous holding anode voltage during desired conduction period	40	—	volts
Peak holding-anode voltage			
Forward	—	200	volts
Inverse	—	25	volts
Peak holding-anode current			
Forward	—	20	amperes
Inverse	—	0.100	amperes
Average	—	5	amperes
Rms	—	10	amperes
Minimum			
Forward current during desired conduction period	7	—	amperes

AC CONTROL OR CAPACITOR-DISCHARGE SERVICE—SINUSOIDAL CURRENT, PULSE DUTY†

	Minimum	Maximum	
Peak anode voltage			
Inverse	—	20,000	volts
Forward	—	20,000	volts
Anode current			
Peak	—	2000	amperes
Average	—	200	amperes
Maximum averaging time—one conduction pulse plus one nonconducting period			
Rms	—	500	amperes
Maximum averaging time—one conduction pulse plus one nonconducting period			
Fault	—	2000	amperes
Duration of fault current	—	0.15	second
Product of inverse or forward voltage and average current	—	3	megavolt-amperes
Equivalent frequency—25 to 60 cycles			
Above 60 cycles use commutating reactors			
Current at start of commutation period	—	60	amperes
Current at end of commutation period	—	0	amperes
Length of commutation period	200	—	microseconds

DC SHORT-CIRCUITING SWITCH†

	Minimum	Maximum	
Anode voltage			
Peak	—	20,000	volts
Forward	100	—	volts
Anode current			
Peak	—	6000	amperes
Average	—	90	amperes
Averaging time	—	10	seconds
Frequency of current-conduction periods	—	100	per hour
Ionization time	—	10	microseconds
Control-grid open-circuit voltage	1500	2500	volts
Control-grid short-circuit current	5	10	amperes
Shield-grid open-circuit voltage	1500	2500	volts
Shield-grid short-circuit current	2.5	5.0	amperes
Time constant of shield- and control-grid circuits	50	100	microseconds
Peak gradient-grid voltage			
Forward	1/2	1/2	anode-cathode voltage
Inverse	1/2	1/2	anode-cathode voltage
Peak gradient-grid current			
Forward	0.010	0.020	amperes
Inverse	0.010	0.020	amperes
Ignitor ratings			
Ignitor voltage			
Forward open-circuit voltage	1500	2500	volts
Negative voltage	—	5	volts
Ignitor current			
Short-circuit current	200	250	amperes
Time constant of ignitor circuit	50	100	microseconds

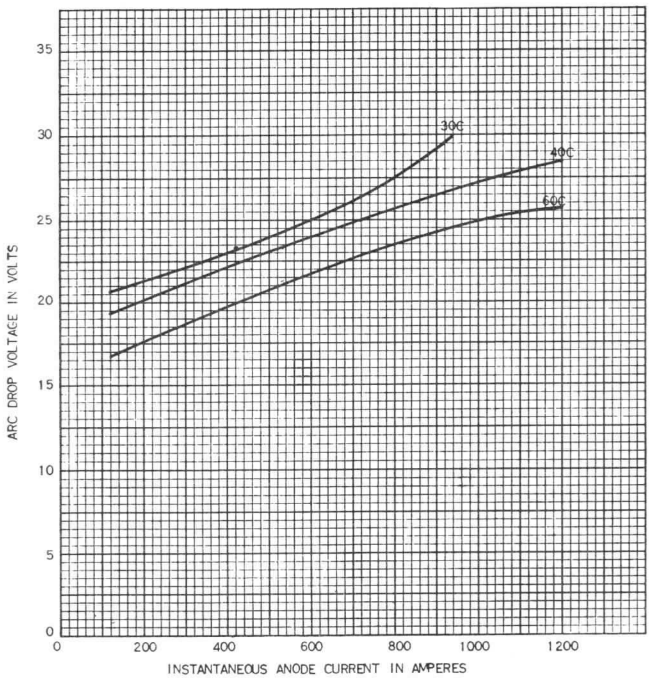
* Ratings are for zero-phase-control angle—See curve K-69087-72A513 for ratings at other phase-control angles.
‡ Reduce duration of fault current by suppressing rectifier by removing ignitor and grid excitation.
† Precautions should be taken to assure that magnetic fields of adjacent conductors do not deflect the arc in the tube.

X-RAY WARNING NOTICE

This device may produce X-rays when energized. X-ray warning signs or labels should be permanently attached to the equipment.

Precautions must be exercised during the service and operation of equipment to assure that any shielding components are replaced to their intended position before the equipment is operated.

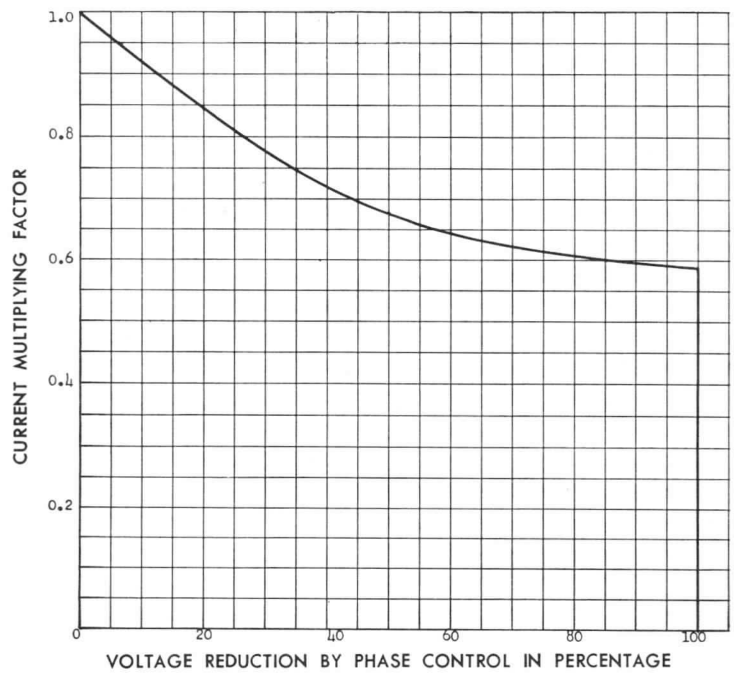
ARC-DROP CHARACTERISTIC
FOR COOLING-WATER TEMPERATURES OF
30–60 C



K 69087-72A196 5-2-49

PHASE CONTROL

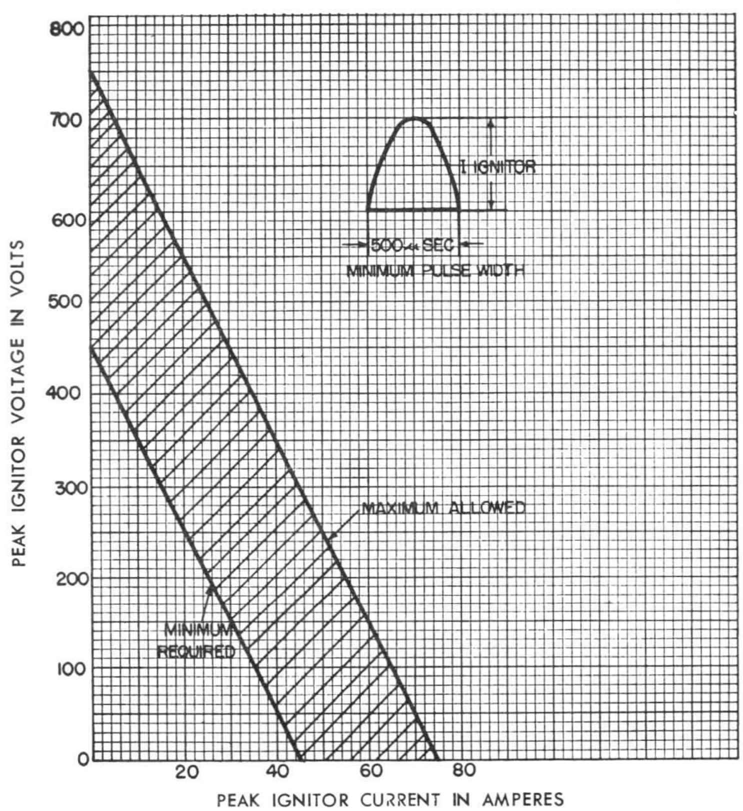
THREE-PHASE SINGLE-WAY
DOUBLE-WAY CIRCUITS



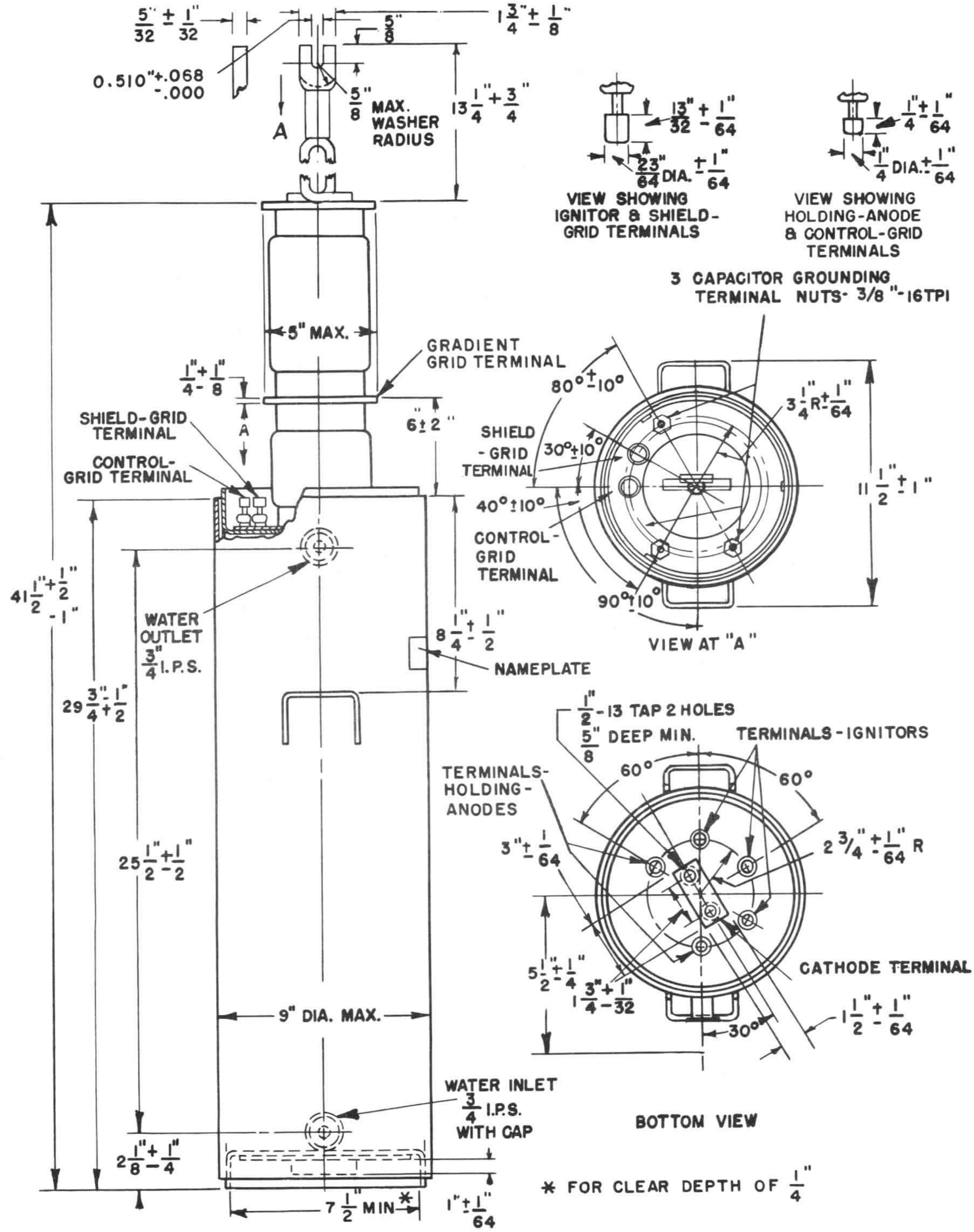
K-69087-72A513 8-21-53

IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION SEALED-IGNITRON RECTIFIERS

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA

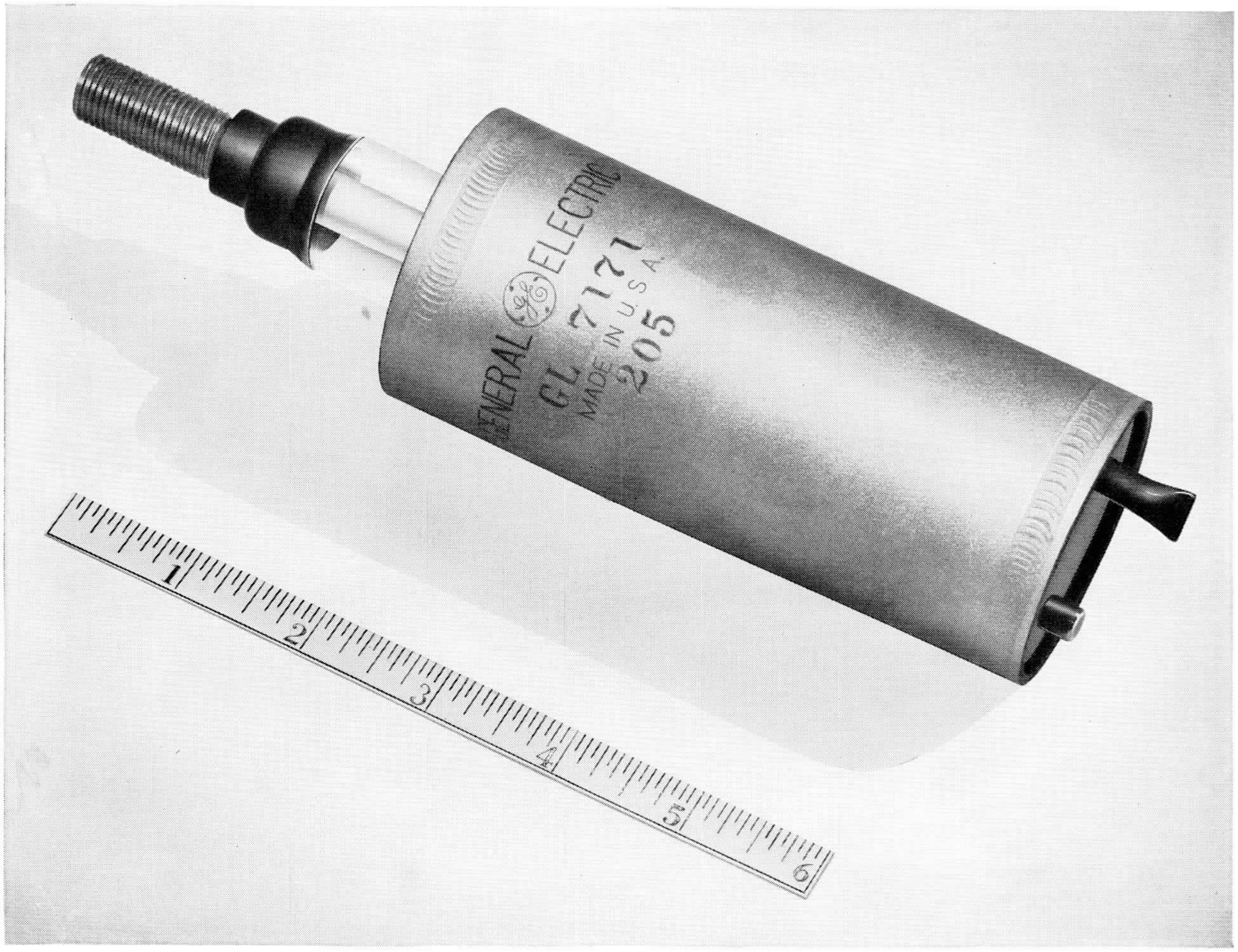


K-69087-72A741 12-9-55



N-22002AZ

4-2-63



IGNITRON

CAPACITOR-DISCHARGE SERVICE **DC SHORT-CIRCUITING-SWITCH SERVICE**

35,000 AMPERES PEAK

The GL-7171 is a sealed, stainless-steel jacketed ignitron for use as a switch in capacitor-discharge circuits operating up to 10,000 volts. In this service the tube will carry peak currents up to 35,000 amperes.

GENERAL

Electrical

Cathode Excitation—Cyclic		
Cathode Spot Starting—Ignitor		
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Ignitors	1	
Arc Drop		
At 4000 Amperes	20	Volts
At 30,000 Amperes	55	Volts
Peak Inverse Voltage, maximum	10,000	Volts

Mechanical

Envelope Material—Stainless Steel		
Mounting Position—Axis Vertical, Anode Lead Up		
Net Weight	2	Pounds

Thermal

Type of Cooling—Convection		
Ambient Temperature, minimum	25	C
Cathode Temperature, maximum	35	C
Anode-Header Temperature, maximum*	55	C

GENERAL ELECTRIC

Supersedes ET-T1512 dated 12-58

MAXIMUM RATINGS AND TYPICAL OPERATION

Capacitor-Discharge Service, Pulse Duty, Sinusoidal Current

Peak Anode Voltage		
Forward	10,000	Volts
Inverse	10,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts
Anode Current (See Curve K-69087-72A858 for Details)		
Peak†	35,000	Amperes
Average	0.1	Amperes
Maximum Averaging Time	1	Cycle
Fault	35,000	Amperes
Maximum Duration	0.002	Seconds
Rate of Rise of Current		
Maximum	5600	Amperes per Microsecond
Minimum	1400	Amperes per Microsecond
Frequency of Current Conduction Periods, maximum	1	Per Minute
Ionization Time	0.5	Microseconds

DC Short-Circuiting-Switch Service

Peak Anode Voltage		
Forward	10,000	Volts
Inverse	10,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts
Anode Current (See Curve K-69087-72A858 for Details)		
Peak‡	35,000	Amperes
Average	0.25	Amperes
Maximum Averaging Time	1	Cycle
Fault	35,000	Amperes
Maximum Duration	0.002	Seconds
Rate of Rise of Current		
Maximum	5600	Amperes per Microsecond
Minimum	1400	Amperes per Microsecond
Frequency of Current Conduction Periods, maximum	1	Per Minute
Ionization Time	0.5	Microseconds

Ignitor Ratings	Minimum	Maximum	
Separate Excitation			
Ignitor Voltage			
Forward Open Circuit	1500	3000	Volts
Inverse, maximum	—	5	Volts
Ignitor Current Short Circuit	200	250	Amperes
Length of Firing Pulse, sine wave	5	10	Microseconds
Anode Firing			
Ignitor Voltage			
Forward, maximum		3000	Volts
Inverse, maximum		5	Volts
Peak Ignitor Current	200	250	Amperes

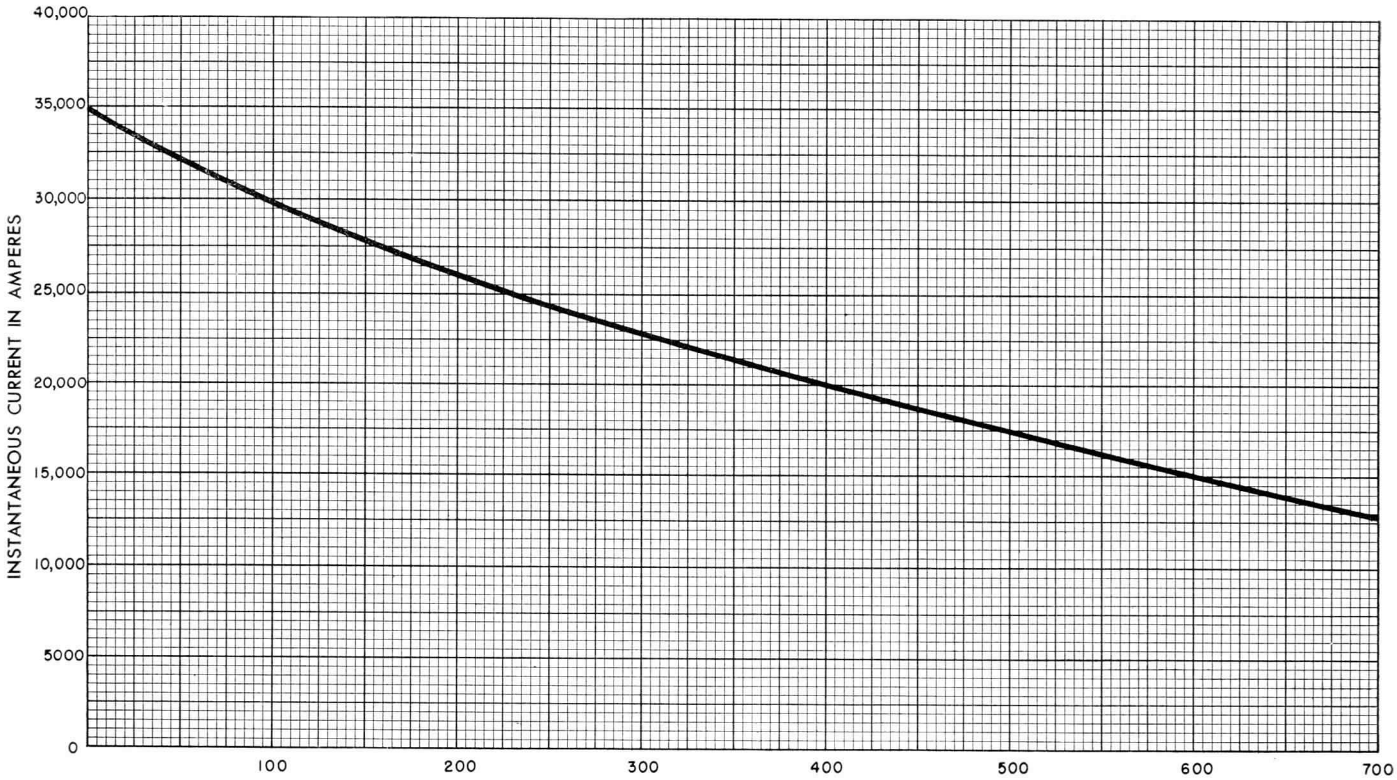
*To prevent mercury condensation, the anode-header temperature should be higher than the cathode temperature at all times. Mercury must be kept away from the anode and anode seals. Before tube operation, the anode seals must be warmed, with respect to the cathode, long enough to vaporize all mercury from the seal area.

†Dampened oscillations are permissible provided the dampening coefficient is less than the value shown on the current-waveform curve. The peak of the oscillation must not exceed 48,000 amperes.

‡Tube must be operated within the area specified on the current-waveform curve.

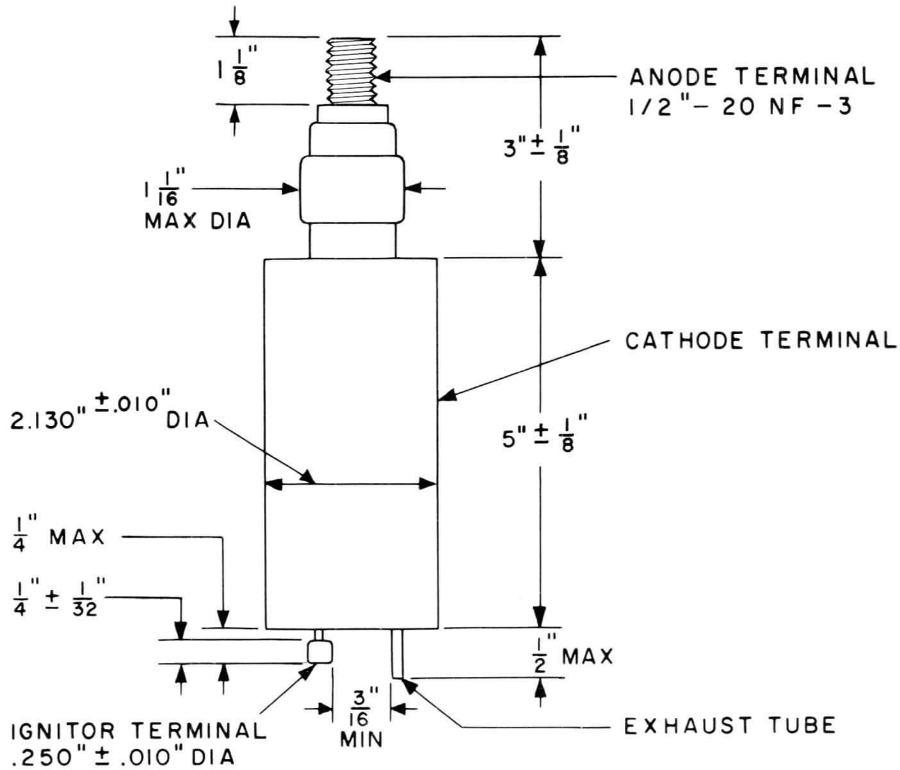
CURRENT-WAVEFORM CURVE

MAXIMUM PERMISSIBLE CURRENT

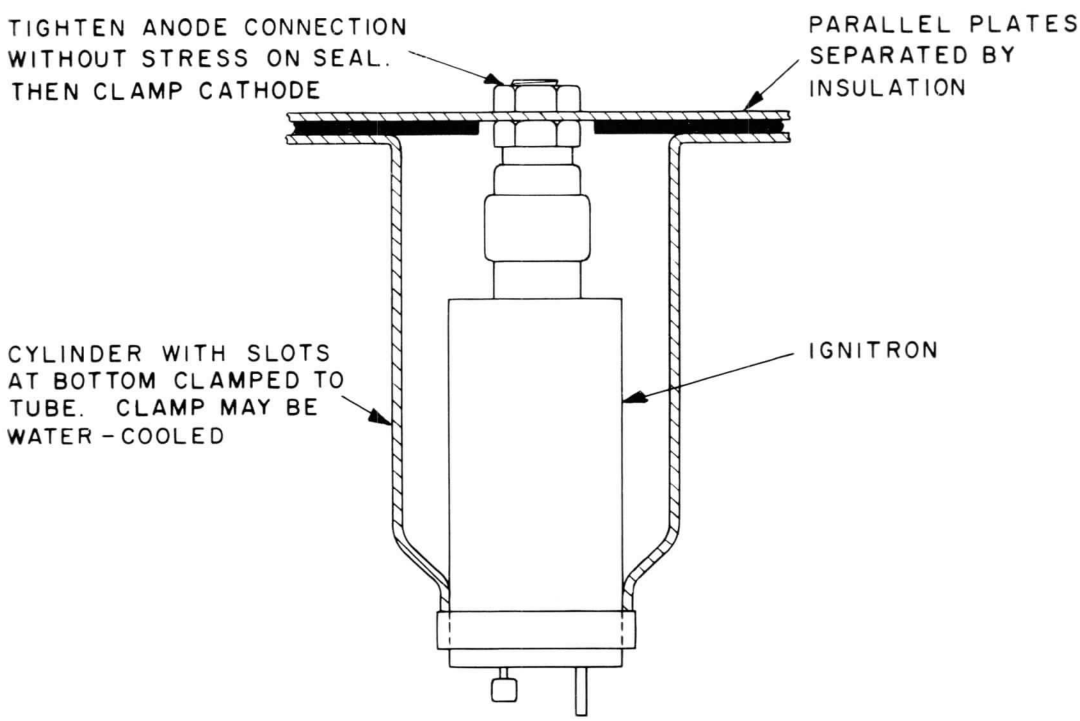


K-69087-72A858

12-6-60



COAXIAL MOUNTING



K-69087-72A819

9-61

GENERAL ELECTRIC
POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

PRINTED IN U.S.A.

GENERAL ELECTRIC
TUBE DEPARTMENT
Schenectady 5, N. Y.

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

DEVELOPMENTAL TYPE

IGNITRON

ZG-7219

The ZG-7219 is an ignitron for capacitor-discharge service. Features of the tube include a potential-dividing grid to improve reliability for high voltage hold-off.

GENERAL

Electrical	
Cathode Excitation	Cyclic
Cathode Spot Starting	Ignitor
Number of Electrodes	
Main Anode	1
Main Cathode	1
Ignitors	1
Mechanical	
Envelope	Encapsulated Glass and Fernico
Mounting Position	Axis Vertical, Anode Terminal Up
Net Weight	14 Pounds
Thermal	
Type of Cooling	Forced Air or Water
Cathode Temperature, Maximum	35 C
Insulating Compound Temperature, Maximum	70 C*

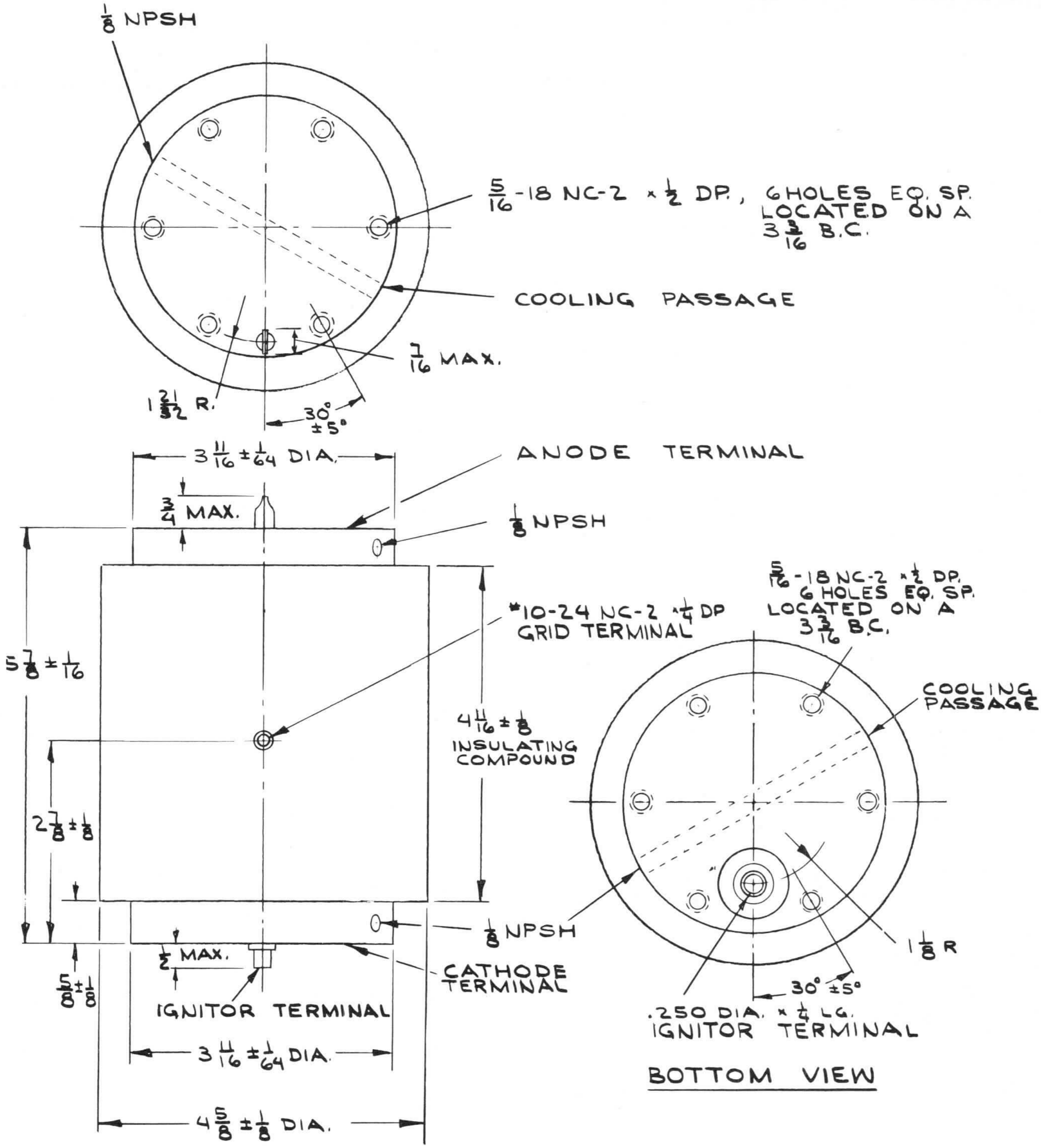
MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Capacitor-Discharge Service, Intermittent Pulse Duty	
Peak Anode Voltage	50,000 Volts
Peak Anode Current	
1/2 cycle of 75 μsec	30,000 Amperes
1/2 cycle of 5 μsec	60,000 Amperes
Discharge Rate	2 Per Minute
DC Short-Circuiting-Switch (Crowbar) Service	
Peak Anode Voltage	50,000 Volts
Peak Anode Current	15,000 Amperes

IGNITOR CIRCUIT RATINGS

	Minimum	Maximum
Ignitor Voltage		
Forward Open-Circuit (Ignitor +)	1500	3000 Volts
Inverse (Ignitor -)	-	5 Volts
Ignitor Short-Circuit Current	100	250 Amperes
Length of Firing Pulse, sine wave	5	Microseconds

* The temperature of the anode end of the tube must be kept higher than that of the cathode end to prevent mercury condensation on the anode and anode seal, which in turn can cause failures to hold off voltage. Before operation the top of the tube must be heated while the bottom kept cool to vaporize all mercury which may have been condensed or splashed into the top during handling.



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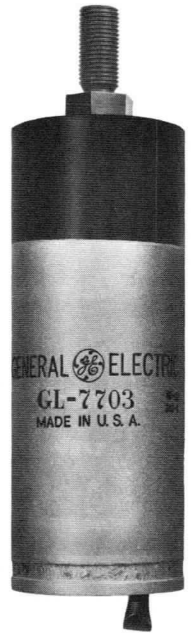


GL-7703

IGNITRON

CAPACITOR-DISCHARGE SERVICE — **20,000 VOLTS PEAK**
DC SHORT-CIRCUITING-SWITCH SERVICE — **100,000 AMPERES PEAK**

The GL-7703 is a sealed, stainless-steel-jacketed ignitron for use as a switch in capacitor-discharge circuits operating up to 20,000 volts. In this service the tube will carry peak currents up to 100,000 amperes. The anode seal is enclosed in an insulating compound to prevent external voltage flashover.

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1
Main Cathodes	1
Ignitors	1

Mechanical

Envelope—Stainless Steel
Mounting Position—Axis Vertical, Anode Terminal Up

Net Weight	2	Pounds

Thermal

Type of Cooling—Air or Liquid, by clamp around lower portion of tube

Clamp Temperature	10 to 30	C
Cathode Temperature, maximum	35	C
Anode Insulating-Compound Temperature*, maximum	70	C

Capacitor-Discharge Service, Intermittent Pulse Duty, Sinusoidal Current†

Peak Anode Voltage‡		
Forward	20,000	Volts
Inverse	20,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts

Anode Current¶		
Peak, for ½ cycle of 120 microseconds	60,000	Amperes
Peak, for ½ cycle of 20 microseconds	100,000	Amperes
Maximum Discharge Rate	2	Per Minute
Rate of Rise of Current§, tube inductance approx.	0.04	Microhenrys
Ionization Time	0.5	Microseconds

DC Short-Circuiting-Switch Service

Peak Anode Voltage‡		
Forward	20,000	Volts
Inverse	20,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts

Anode Current		
Peak	35,000	Amperes
Average	0.25	Amperes
Maximum Averaging Time	1	Cycle
Rate of Rise of Current§, tube inductance approx.	0.04	Microhenrys
Ionization Time	0.5	Microseconds

Ignitor Ratings

	Minimum	Maximum	
Separate Excitation			
Ignitor Voltage			
Forward Open Circuit	1500	3000	Volts
Inverse, maximum	—	5	Volts
Ignitor Short-Circuit Current	200	250	Amperes
Length of Firing Pulse, sine wave	5	10	Microseconds

	Minimum	Maximum	
Anode Firing			
Ignitor Voltage			
Forward, maximum	—	3000	Volts
Inverse, maximum	—	5	Volts
Peak Ignitor Current	200	250	Amperes

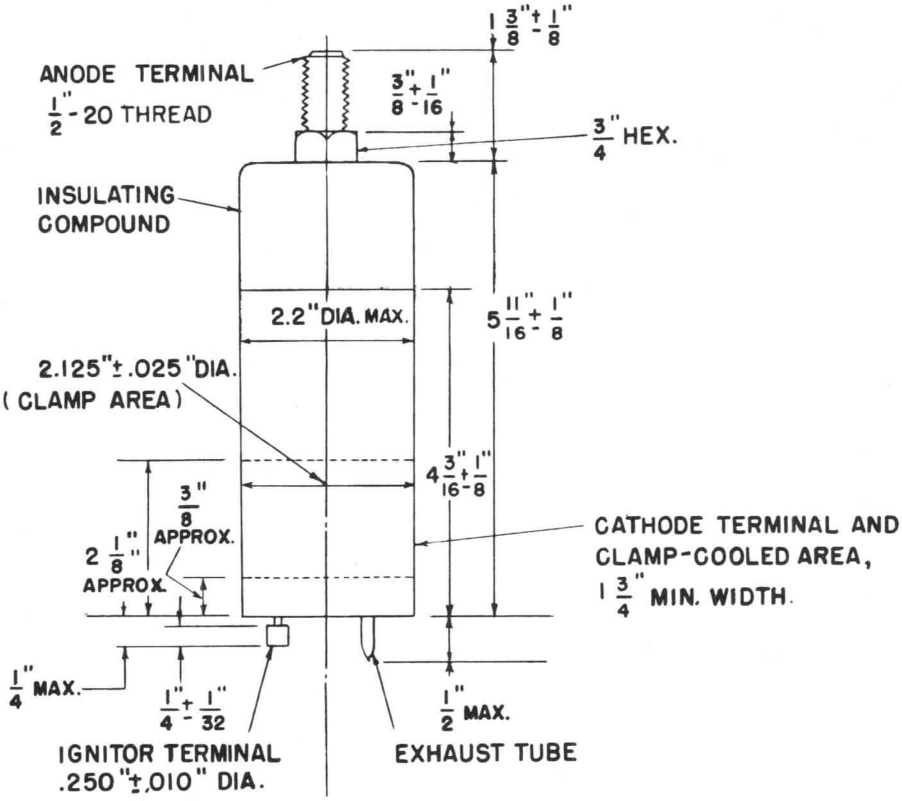
* Anode-seal, insulating-compound temperature must always be higher than the cathode temperature to prevent mercury condensation on the anode and anode seal. Before tube operation, the anode seals must be heated long enough to vaporize all mercury from the seal area.

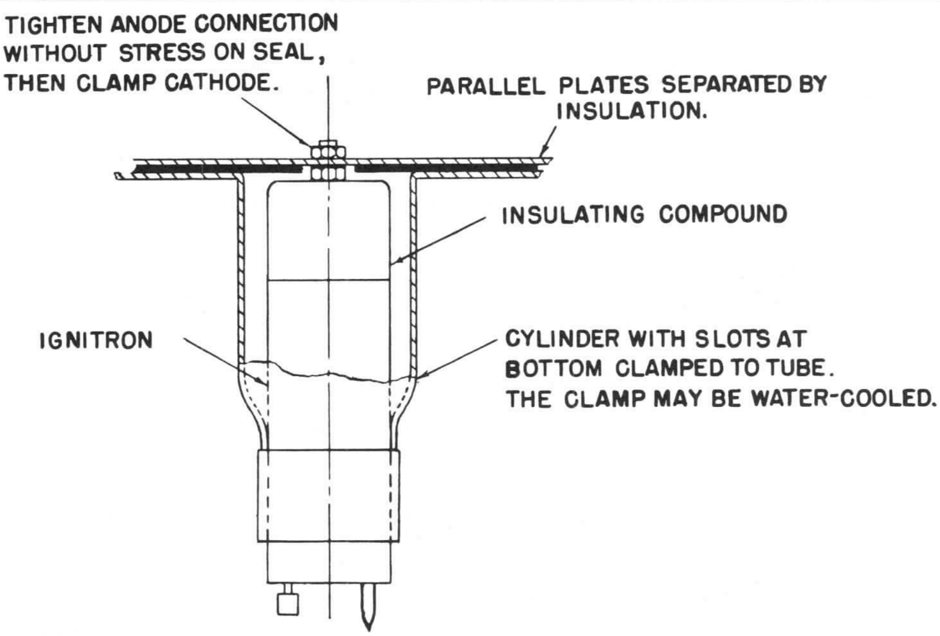
† The tube may become a closed switch (does not open) carrying current in both directions until the current dampens out.

‡ The tube cannot hold off this voltage immediately after conduction. A 1-to-10-second delay may be required before reapplication of voltage.

¶ Dampened oscillations are permissible provided the oscillating cycles do not exceed 20. The peak current value for one-half cycle must not be exceeded.

§ Rate of rise depends on circuit.





SUGGESTED METHOD FOR PROVIDING MOUNTING FOR COAXIAL CONNECTION

K-69087-72A948 8-60

—PRODUCT INFORMATION—

IGNITRON

GL-37207

The GL-37207 is a stainless-steel-water-jacketed ignitron for use as a switch in capacitor-discharge circuits, or for DC short-circuiting-switch (crowbar) protective service.

GENERAL

Electrical

Cathode Excitation	Cyclic
Cathode Spot Starting	Ignitor
Number of Electrodes	
Main Anode	1
Main Cathode	1
Ignitors	3

Mechanical

Envelope	Stainless Steel
Mounting Position	Axis Vertical-Anode Terminal Up
Net Weight	20 Pounds
Length (excluding flexible anode cable)	18-3/4 Inches
Diameter (excluding water nipples)	5-1/2 Inches

Thermal

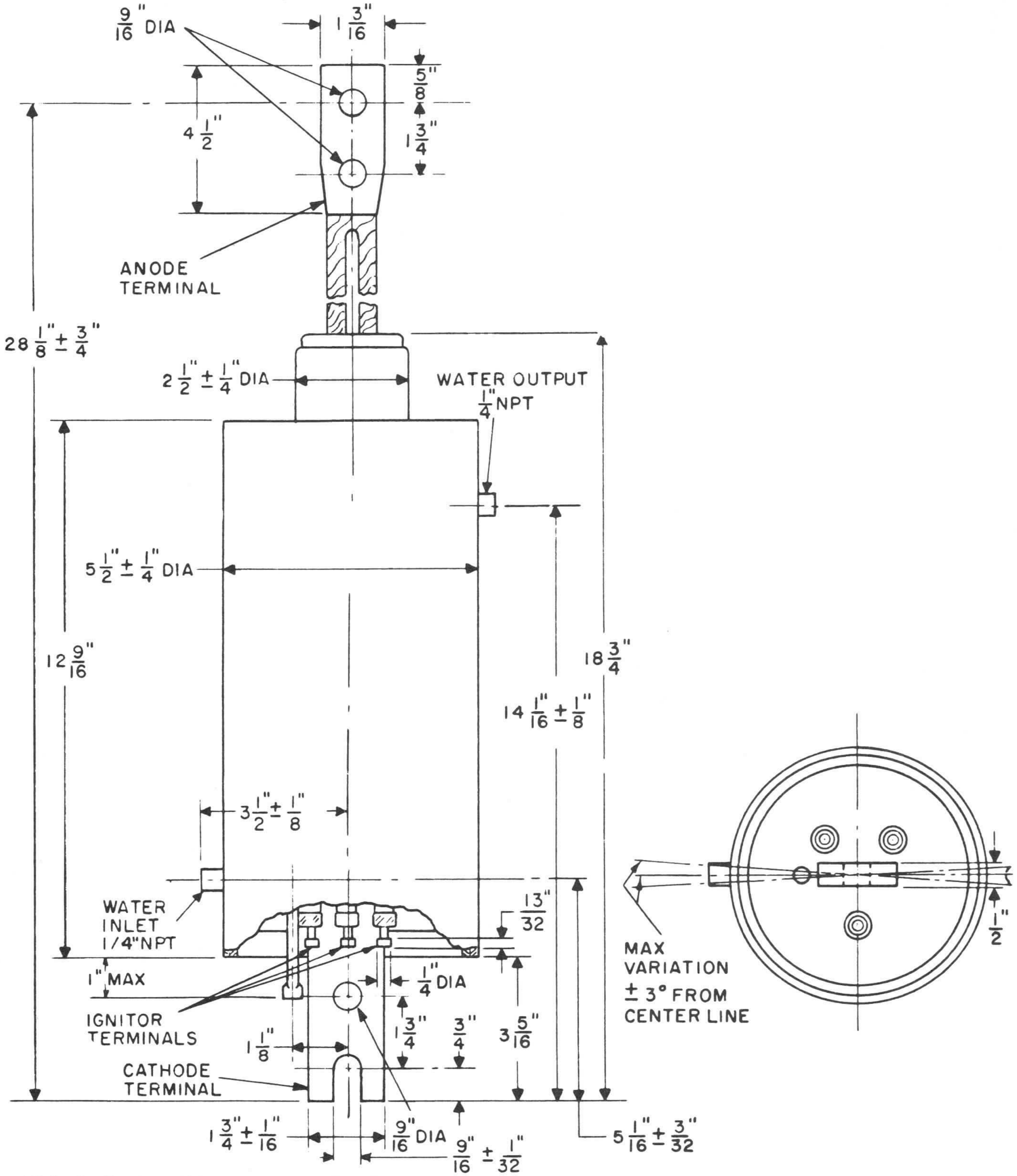
Type of Cooling — Water	
Inlet Water Temperature, minimum	6 C
Inlet Water Temperature, maximum	30 C
Nominal Water Flow	1.5 Gallons Per Minute

MAXIMUM RATINGS (Not simultaneous conditions)

Peak Anode Voltage	25,000 Volts
Peak Anode Current	300,000 Amperes
Length of Conduction	10 Milliseconds
Repetition Rate	500 Per Minute
Maximum Coulombs per Discharge	200 Amp-Sec.
Maximum Coulombs per Minute	200 Amp-Sec/Min.
Maximum Voltage Reversal	10 Percent

IGNITOR-CIRCUIT RATINGS

	Minimum	Maximum
Ignitor Voltage		
Forward Open-Circuit (ignitor +)	1500	3000 Volts
Inverse (ignitor —)	—	5 Volts
Ignitor Short-Circuit Current	100	250 Amperes
Length of Firing Pulse, 1/2 sine wave	5	10 Microseconds



NOTE: ONE IGNITOR USED AT A TIME

69087-72B63

IGNITRON

GL-37248

The GL-37248 ignitron is designed primarily for DC short-circuiting-switch (crowbar) protective service. Features of the tube include a holding anode which provides a means for keeping the tube ionized should voltage reversals occur during the discharge.

GENERAL

Electrical

Cathode Excitation	Cyclic
Cathode Spot Starting	Ignitor
Number of Electrodes	
Main Anode	1
Auxiliary Anode	1
Ignitors	1
Main Cathode	1
Approximate Inductance	30 Nanohenrys

Mechanical

Envelope	Stainless Steel
Mounting Position	Axis Vertical-Anode Terminal Up
Net Weight	2 Pounds
Diameter	2-1/8 Inches
Height	7-1/2 Inches

Thermal

Type of Cooling — Clamp around lower half of cylinder which also serves as cathode connection*

Clamp Temperature	10-30 C
Cathode Temperature, Max.	35 C
Anode Insulating-Compound Temperature and anode-Lead Temperature, maximum	70 C*

MAXIMUM RATINGS

Peak Anode Voltage	50,000 Volts
Peak Anode Current	10,000 Amperes
Length of Conduction	20 Milliseconds
Repetition Rate	6 Per Hour*
Voltage Reversal	50 Percent

IGNITOR-CIRCUIT RATINGS

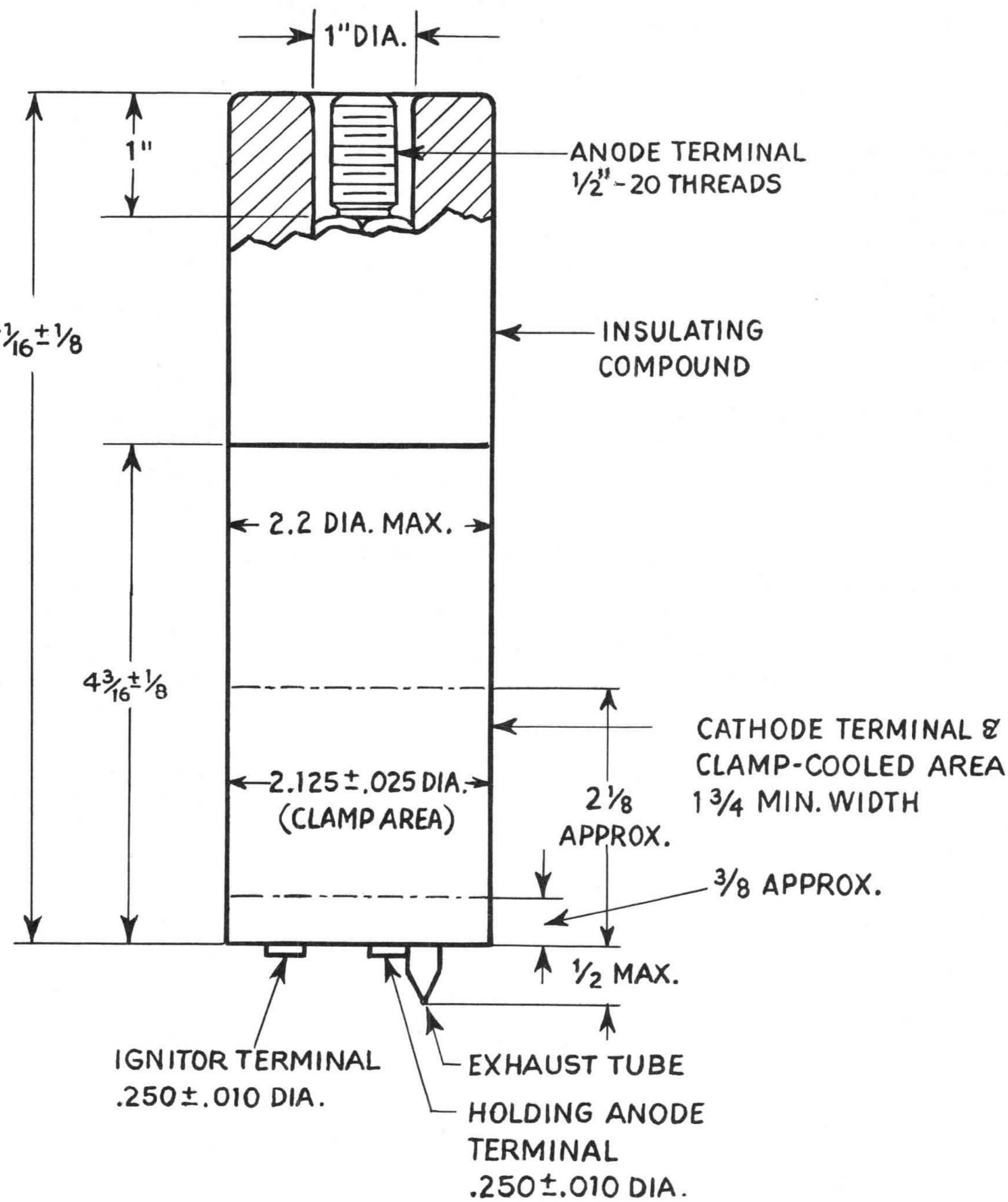
	Minimum	Maximum
Ignitor Voltage		
Forward Open Circuit (ignitor +)	1500	3000 Volts
Inverse (ignitor —)	—	5 Volts
Ignitor Short-Circuit Current	100	250 Amperes
Length of Firing Pulse, sine wave	5	10 Microseconds

HOLDING-ANODE CIRCUIT RATINGS†

Holding-Anode Voltage (Positive d-c)	80	150 Volts
Holding-Anode Current	5	10 Amperes

* The temperature of the anode end of the tube must be kept higher than that of the cathode end to prevent mercury condensation on the anode and anode seal. Before operation the top of the tube must be heated sufficiently to vaporize all mercury from the anode area. The repetition rate may be increased by a factor of ten by water cooling the clamp around the lower half of the cylinder.

† It is anticipated that a holding-anode rectifier will be provided to supply the required power and that its supply will drop to zero at the end of the crowbar operation so the ignitron will regain control. An alternate method is to discharge a **large capacitor** into the holding anode with a time constant longer than the crowbar time.



ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

MILITARY EQUIPMENT TYPES MANUAL

MET-9E

HYDROGEN THYRATRONS

Selection Chart

Peak Power in Megawatts	Anode Dissipation Factor	Peak Forward Anode Voltage in Volts	Current in Amperes Average	Current in Amperes Peak	Type
33.0	30×10^9	33,000	4.0	2000	GL-7390
Integral Temperature Indicator Design – GL-7390-A					
48.0	55×10^9	40,000	4.0	2400	GL-7890
40.0	55×10^9	33,000	7.0	4000	GL-8326
90.0	55×10^9	50,000	7.0	4000	ZT-7004

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZT-7004

HYDROGEN THYRATRON

50 Kilovolts Peak
90 Megawatts at 55 Kilowatts
Anode Dissipation Factor – 55 x 10^9

Ceramic Envelope
External Electrodes
Gradient Grid

The ZT-7004 is a hydrogen thyratron for radar modulating and other pulsing applications. It will switch a peak power of 90 megawatts at an average power of 55 kilowatts. At other peak levels average power in excess of 150 kilowatts is possible.

Mechanically the tube features a heavy-duty ceramic envelope, external electrodes to improve heat dissipation, and a design that permits cooling by forced air. In addition the ZT-7004 incorporates a gradient grid. This grid permits much more effective hold-off of the d-c forward voltage near maximum voltage ratings than is possible with single-grid design.

The high peak power rating of this tube and its mechanical design features assure reliable service under the stringent operating conditions encountered in high-power pulse equipment.

ELECTRICAL

	Minimum	Bogey	Maximum	
Cathode – Indirectly Heated				
Cathode is Tied to Heater Midpoint				
Heater Voltage	6.0	6.3	6.6	Volts
Heater Current, Ef=6.3 volts	35	--	55	Amperes
Reservoir				
Heater Voltage	3.5	4.5	5.5	Volts
Heater Current	--	--	24	Amperes
Heating Time	15	--	--	Minutes
Direct Interelectrode Capacitances				
Anode to Gradient Grid	--	90	--	uuf
Gradient Grid to Control Grid	--	30	--	uuf
Control Grid to Cathode	--	40	--	uuf
Anode Current Time Jitter	--	0.005	0.01	Microseconds
Anode Delay Time*	--	--	1	Microseconds
Anode Voltage Drop	--	--	400	Volts
Grid Drive†				

MECHANICAL

Mounting Position – Vertical with Base Down

Altitude, maximum	10,000	Feet
Net Weight, approximate	15	Pounds

THERMAL

Ambient Temperature Limits	-55 to +75	C
Type of Cooling – Forced Air		
Air Flow Rate, at 40 C Inlet Temperature	160	Cubic Feet per Minute
Velocity, Minimum	2000	Feet per Minute

At higher inlet temperatures increased air flow may be required

MAXIMUM RATINGS - ABSOLUTE VALUES

Maximum Peak Anode Voltage		
Inverse	50,000	Volts
Forward, minimum supply voltage = 3500 volts d-c	50,000	Volts
Maximum Cathode Current		
Peak	4000	Amperes
Average	7.0	Amperes
Maximum Averaging Time	1	Cycle
RMS #	120	Amperes
Anode Dissipation Factor **	55×10^9	
Maximum Negative Control-Grid Voltage before Conduction	650	Volts
Maximum Rate of Rise of Anode Current	10,000	Amperes per Microsecond

* The time interval between the point on the rising portion of the grid pulse which is 26 percent of the peak unloaded pulse amplitude and the start of the anode current pulse.

† Driver pulse measured at tube socket with thyratron control grid disconnected; amplitude = 1300 volts minimum, 2500 volts maximum, above 0; time of rise = 0.35 microsecond maximum measured from 26 percent to 70 percent of peak value; grid pulse duration = 2 microseconds minimum, measured between 70 percent of peak on rising side to 70 percent of peak on falling side; impedance of drive circuit = 10 to 25 ohms.

The RMS current of hydrogen thyratrons is the square root of the product of the average and peak currents.

** The product of the peak forward anode voltage, pulse repetition rate, and peak anode current. Highest value tested not upper limit.

OPERATING NOTES

Thermal

The optimum reservoir voltage for operation at maximum tube voltage, maximum peak and average tube currents, and at a repetition corresponding to the rated anode dissipation factor is inscribed on the base of the tube and must be held within ±5 percent. Applications involving operation at other conditions will necessitate a redetermination of the optimum reservoir range.

Electrical

For operation above 36 kilovolts, a compensating capacitor of approximately 60 uuf rated to 50 kilovolts should be connected between the gradient and control grids to equalize voltage distribution between the control grid and the anode. With this arrangement, the procedure for starting at low anode voltage is:

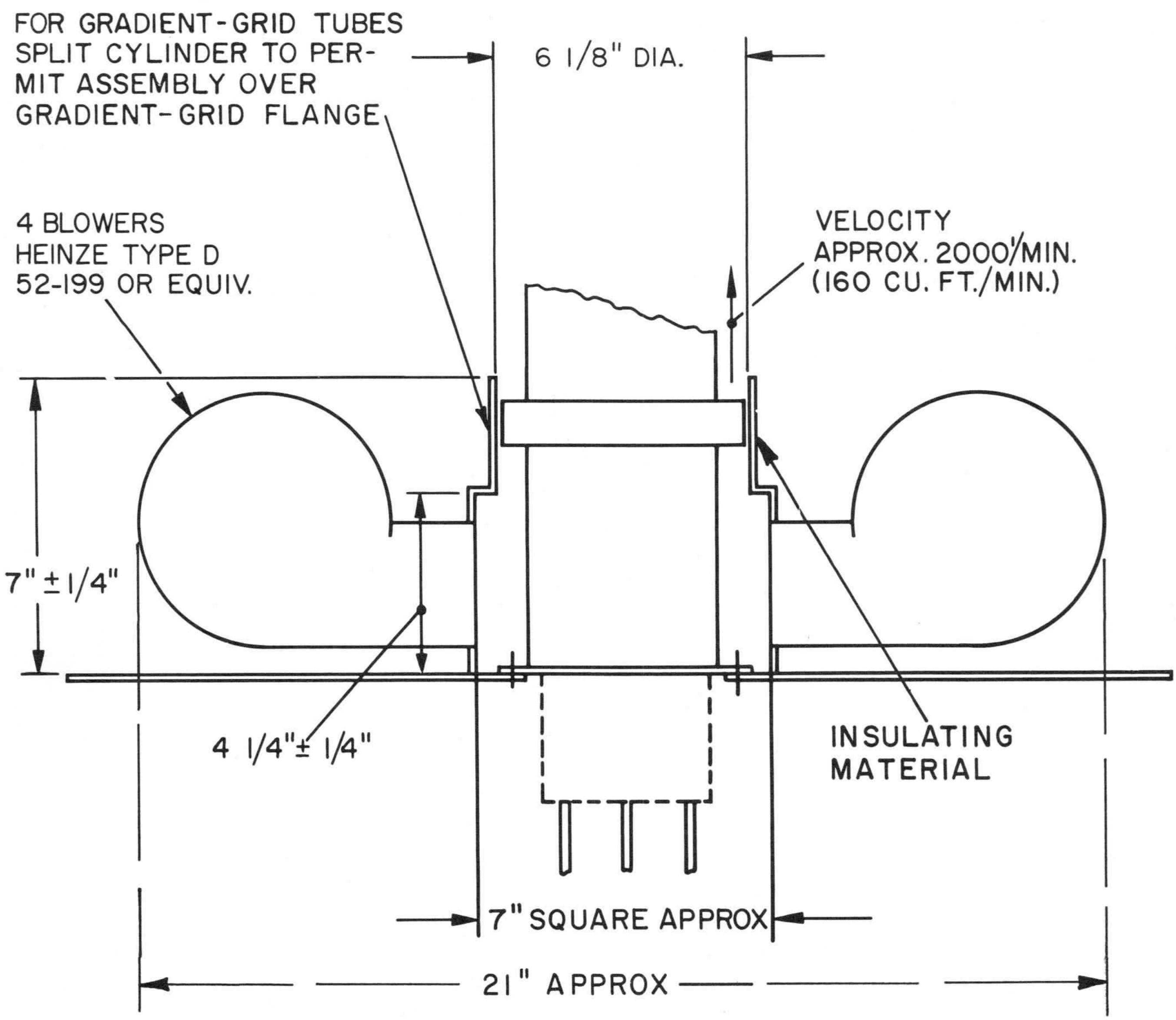
1. Preset anode power supply to a voltage exceeding 3500 volts
2. Apply trigger signal to control grid
3. Apply anode voltage instantaneously

An alternate arrangement is a resistance of approximately 20 megohms total connected from the anode to the control grid with its midpoint connected to the gradient grid. With this arrangement, starting at low anode voltage can be accomplished by applying any anode voltage and gradually increasing it while triggering the control grid.

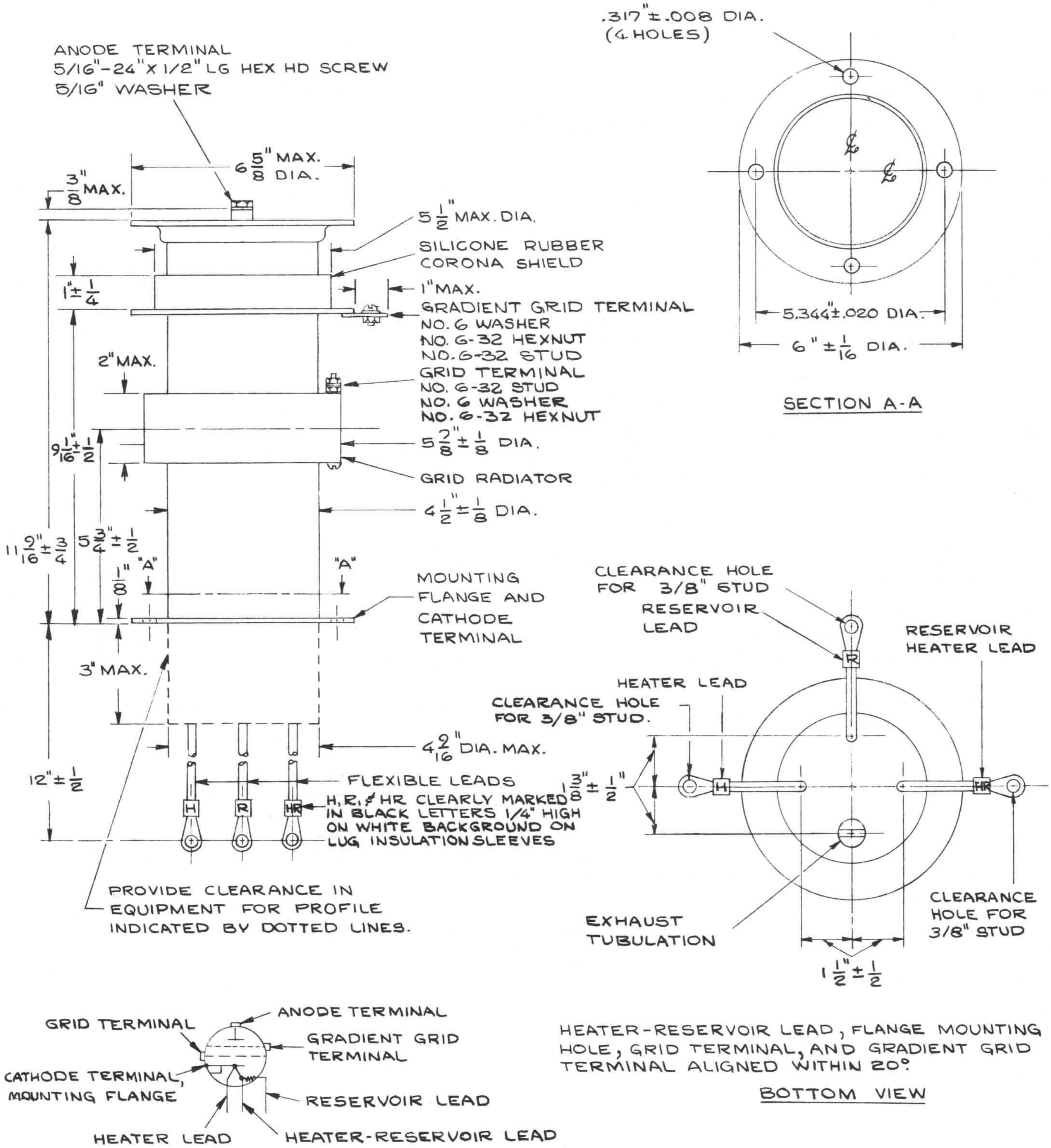
X-RAY WARNING NOTICE

If the ZT-7004 is operated at anode voltages in excess of 16 kilovolts, X-ray radiation shielding may be necessary to protect the user against possible danger of personal injury from prolonged exposure at close range. For further information consult the following references or other standard texts on the subject:

X-RAY PROTECTION DESIGN, Handbook No. 50. National Bureau of Standards, Washington, D. C.
X-RAY PROTECTION, Handbook No. 60. National Bureau of Standards, Washington, D. C.
The above references are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.
SAFETY CODE FOR THE INDUSTRIAL USE OF X-RAYS, Bulletin No. Z54-1. American Standards Association, New York 17, N. Y.
Schneider, S. and Reich, B., "X-Ray Emission from High-Voltage Hydrogen Thyratrons," PROC. IRE, Vol. 43, No. 6, June, 1955.


FOR GRADIENT-GRID TUBES SPLIT CYLINDER TO PERMIT ASSEMBLY OVER GRADIENT-GRID FLANGE
6 1/8" DIA.
4 BLOWERS HEINZE TYPE D 52-199 OR EQUIV.
VELOCITY APPROX. 2000'/MIN. (160 CU. FT./MIN.)
7" ± 1/4"
4 1/4" ± 1/4"
INSULATING MATERIAL
7" SQUARE APPROX
21" APPROX

OUTLINE ZT-7004



A-69087-72B97

GL-7390
HYDROGEN THYRATRON

40 KILOVOLTS PEAK
33 MEGAWATTS AT 60 KILOWATTS

CERAMIC ENVELOPE
EXTERNAL ELECTRODES

The GL-7390 is a hydrogen thyratron for radar modulating and other pulsing applications. It will carry high peak currents and withstands very high voltages.

Mechanically the tube features a heavy-duty ceramic envelope and external electrodes to improve heat dissipation.

The high-peak-power ratings of this tube and its mechanical design features assure reliable service under the stringent operating conditions encountered in high-power pulse equipment.

Electrical

	Minimum	Bogey	Maximum	
Cathode—Indirectly Heated				
Cathode is Tied to Heater Midpoint				
Heater Voltage	6.0	6.3	6.6	Volts
Heater Current, Ef = 6.3 volts	27	32	35	Amperes
Reservoir				
Heater Voltage*	3.5	4.5	5.5	Volts
Heater Current				
E_{res} = 4.5 volts	8	9	10	Amperes
E_{res} = 5.5 volts	—	—	12	Amperes
Cathode and Reservoir Heating Time**	15	—	—	Minutes
Direct Interelectrode Capacitances				
Anode to Grid	—	40	—	μμf
Grid to Cathode	—	30	—	μμf
Anode Current Time Jitter	—	—	0.01	Microseconds
Ionization Time†, approximate	—	—	1	Microseconds
Grid Drive‡				

Mechanical

Mounting Position—Vertical, Base Down
Net Weight, approximate .... 9 Pounds

Thermal

Type of Cooling—Convection¶
Ambient Temperature Limits ...... −55 to +75 C

MAXIMUM RATINGS—ABSOLUTE VALUES

Maximum Peak Anode Voltage		
Inverse▲		
Forward, ♦ minimum supply voltage = 3500 volts d-c	33,000	Volts
Maximum Cathode Current		
Peak	2000	Amperes
Average	4.0	Amperes
Maximum Averaging Time	1	Cycle
RMS‖	75	Amperes
Anode Dissipation Factor ♥	30×10^9	
Maximum Negative Control-Grid Voltage before Conduction	650	Volts
Maximum Rate of Rise of Anode Current	10,000	Amperes per Microsecond

The above limits are interrelated and it does not necessarily follow that combinations of limits can be attained simultaneously. For further information consult the Tube Department, Schenectady 5, N. Y.

* The optimum reservoir voltage for operation at maximum tube voltage, maximum peak and average tube currents, and at a repetition corresponding to the rated operation factor is inscribed on the base of the tube and must be held within ±2.5 percent. Applications involving operation at other conditions will necessitate a redetermination of the optimum reservoir voltage.

**Stand-by operation with heater and reservoir voltages is not recommended. Where necessary, the tube should be operated at full equipment conditions for a minimum of two hours during each twelve-hour period of stand-by.

† The time interval between the point on the rising portion of the grid pulse which is 26 percent of the peak unloaded pulse amplitude, and the start of the anode-current pulse.

‡ Driver pulse measured at tube socket with thyratron-grid disconnected; amplitude = 1300 volts minimum, 2500 volts maximum above 0; time of rise = 0.35 microsecond maximum, measured from 26 percent to 70 percent of peak value; grid pulse duration = 2 microseconds minimum, measured between 70 percent of peak on rising side to 70 percent of peak on falling side; impedance of drive circuit = 10 to 25 ohms maximum.

¶ An air blast may be directed at the anode and upper portions of the tube envelope to extend performance under high-anode-dissipation-factor operation, provided envelope and anode temperatures exceed 150 C.

▲The minimum inverse anode voltage permissible is 5 percent of the peak forward voltage and the maximum is 5000 volts during the first 25 microseconds following the anode pulse exclusive of a spike of 0.05 microsecond maximum duration.

♦ Instantaneous starting is not recommended. However, in cases where it is necessary to apply anode voltage instantaneously, the maximum permissible forward starting voltage is 22,000 volts peak. The power-supply filter should be designed to limit the rate of application of this voltage to 550,000 volts per second.

‖ The RMS current of hydrogen thyratrons is the square root of the product of the average and peak currents.

♥Product of the peak forward anode voltage, pulse repetition rate, and peak anode current.

X-RAY WARNING NOTICE

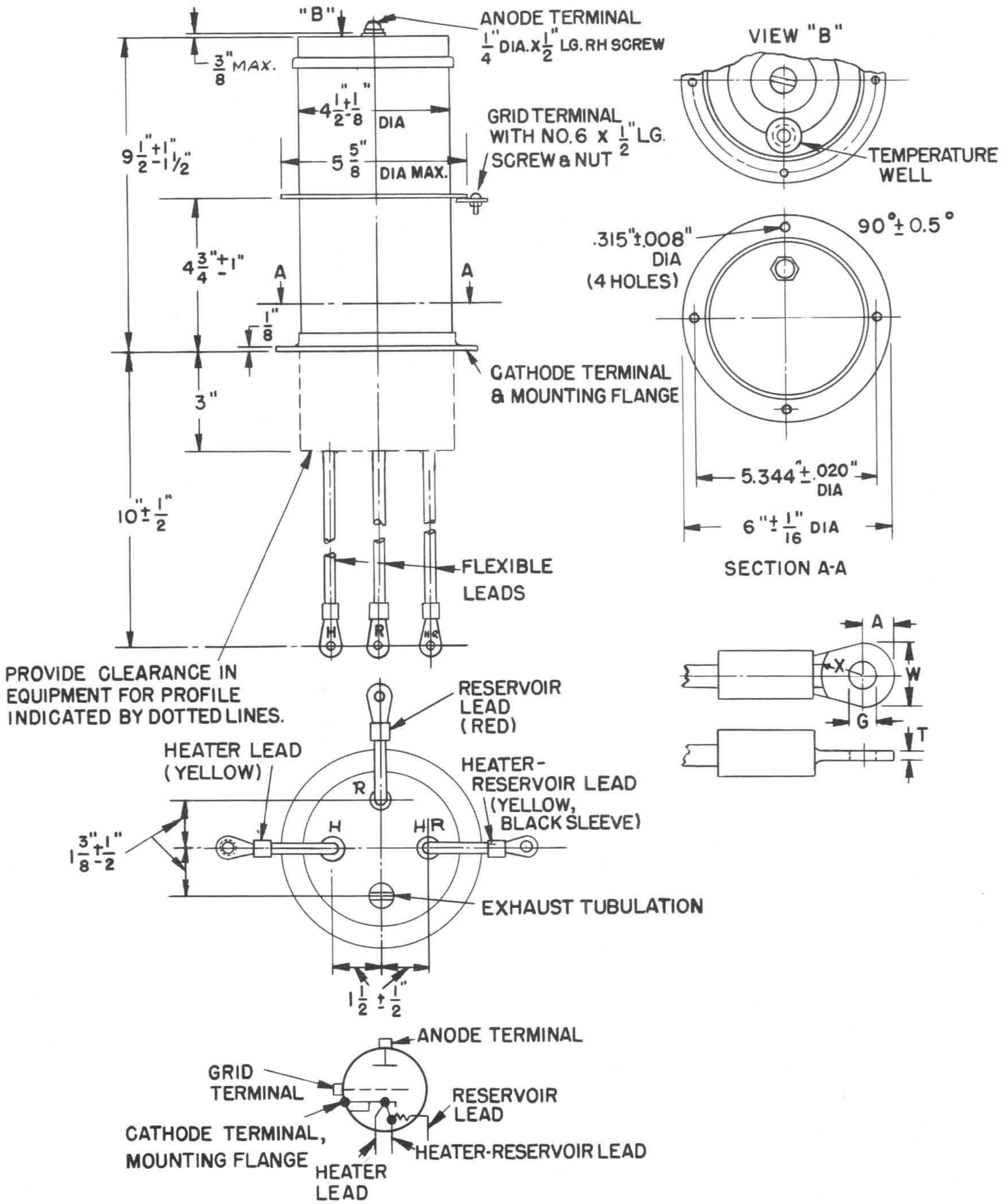
If the GL-7390 is operated at anode voltages in excess of 16 kilovolts, X-ray radiation shielding may be necessary to protect the user against possible danger of personal injury from prolonged exposure at close range. For further information consult the following references or other standard texts on the subject:

(a) X-RAY PROTECTION DESIGN, Handbook No. 50. National Bureau of Standards, Washington, D. C.

(b) X-RAY PROTECTION, Handbook No. 60. National Bureau of Standards, Washington, D. C.
The above references are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

(c) SAFETY CODE FOR THE INDUSTRIAL USE OF X-RAYS, Bulletin No. Z54-1. American Standards Association, New York 17, N. Y.

(d) Schneider, S. and Reich, B., "X-Ray Emission from High-Voltage Hydrogen Thyratrons," PROC. IRE, Vol. 43, No. 6, June, 1955.



PRESSURE-TYPE LUGS (WITH INSULATING SLEEVES)

LEADS	LUG DESIGNATION	"G" INCHES	"W" INCHES	"A" INCHES	"X" INCHES	"T" INCHES
RESERVOIR	# 10	.187 TO .207	.395 MAX.	.200 MAX.	.275 MIN.	.060 MAX.
HEATER-RESERVOIR	1/4"	.260 TO .313	.605 MAX.	.305 MAX.	.380 MIN.	.060 MAX.
HEATER	1/4"	.260 TO .313	.605 MAX.	.305 MAX.	.380 MIN.	.060 MAX.

NOTE: THERE SHALL BE NO OBSTRUCTION WITHIN THE DISTANCE OF "X" FROM THE CENTER OF THE LUG SCREW HOLE.

TUBE DEPARTMENT

GENERAL ELECTRIC

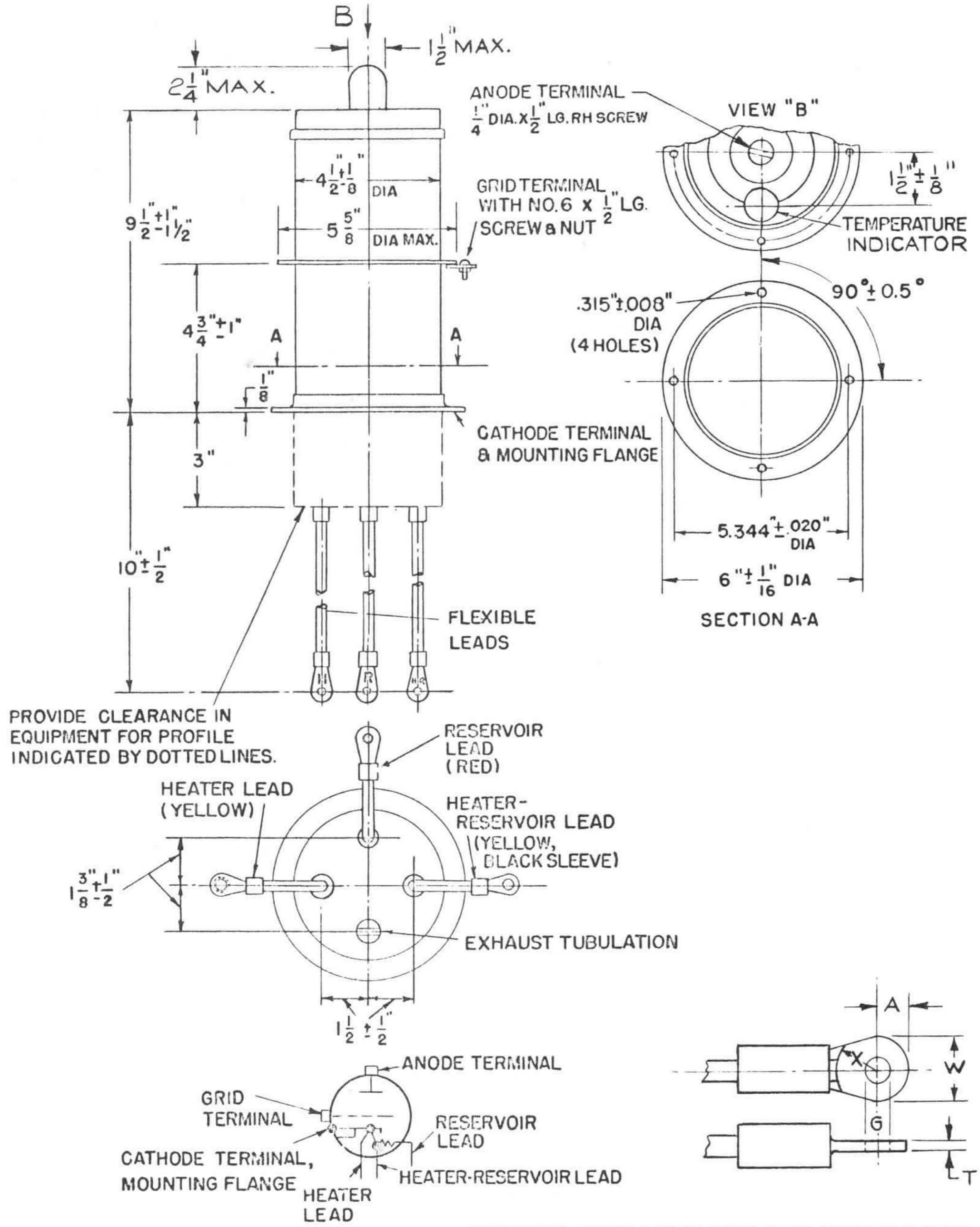
Owensboro, Kentucky

GL-7390-A
HYDROGEN THYRATRON

The GL-7390-A hydrogen thyratron is identical to the GL-7390 except for the addition of a temperature indicator at the top of the tube. An outline drawing showing this addition is on page 2.

For technical data on Type GL-7390-A, please refer to the GL-7390 technical information sheet in the manual.

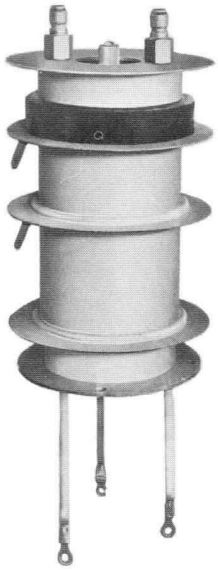
GL-7390-A



PRESSURE-TYPE LUGS (WITH INSULATING SLEEVES)

LEADS	LUG DESIGNATION	"G" INCHES	"W" INCHES	"A" INCHES	"X" INCHES	"T" INCHES
RESERVOIR	# 10	.187 TO .207	.395 MAX.	.200 MAX.	.275 MIN.	.060 MAX.
HEATER - RESERVOIR	$\frac{1}{4}$"	.260 TO .313	.605 MAX.	.305 MAX.	.380 MIN.	.060 MAX.
HEATER	$\frac{1}{4}$"	.260 TO .313	.605 MAX.	.305 MAX.	.380 MIN.	.060 MAX.

NOTE: THERE SHALL BE NO OBSTRUCTION WITHIN THE DISTANCE OF "X" FROM THE CENTER OF THE LUG SCREW HOLE.



GL-7890

HYDROGEN THYRATRON

40 KILOVOLTS PEAK
48 MEGAWATTS AT 44 KILOWATTS
ANODE DISSIPATION FACTOR—55 x 10^9

CERAMIC ENVELOPE
EXTERNAL ELECTRODES
GRADIENT GRID

The GL-7890 is a hydrogen thyratron for radar modulating and other pulsing applications. It is capable of switching a peak power of 48 megawatts at an average power of 44 kilowatts. At other peak levels average power in excess of 70 kilowatts is possible.

Mechanically the tube features a heavy-duty ceramic envelope, external electrodes to improve heat dissipation, and a design that permits cooling by forced air, water, or other fluids. In addition the GL-7890 incorporates a gradient grid. This grid permits much more effective hold-off of the d-c forward voltage near maximum voltage ratings than is possible with single-grid design.

The high peak power rating of this tube and its mechanical design features assure reliable service under the stringent operating conditions encountered in high-power pulse equipment.

Electrical

	Minimum	Bogey	Maximum	
Cathode—Indirectly Heated				
Cathode is Tied to Heater Midpoint				
Heater Voltage	6.0	6.3	6.6	Volts
Heater Current, Ef = 6.3 volts	27	33	40	Amperes
Heating Time	15	—	—	Minutes
Reservoir				
Heater Voltage	2.5	3.5	5.5	Volts
Heater Current				
$E_{res} = 3.5$ volts	7.0	10.5	12.0	Amperes
$E_{res} = 5.5$ volts	—	—	16	Amperes
Heating Time	15	—	—	Minutes
Direct Interelectrode Capacitances				
Anode to Gradient Grid	—	90	—	$\mu\mu f$
Gradient Grid to Control Grid	—	30	—	$\mu\mu f$
Control Grid to Cathode	—	30	—	$\mu\mu f$
Anode Current Time Jitter	—	0.005	0.01	Microseconds
Anode Delay Time*	—	—	1	Microseconds
Anode Voltage Drop	—	—	400	Volts
Grid Drive†				

Mechanical

Mounting Position—Vertical with Base Down

Altitude, maximum	10,000	Feet
Net Weight, approximate	10	Pounds

Thermal

Ambient Temperature Limits	−55 to +90	C
Type of Cooling—Forced Air or Fluid		
Water Cooling		
Inlet Water Temperature, minimum	5	C
Outlet Water Temperature, maximum	95	C
Water Flow, minimum	1	Gallon per Minute
Water Temperature Rise, maximum	5	C
Pressure Drop at 1 Gallon Per Minute, approximate	1	Pound per Square Inch
Forced-Air Cooling		
Inlet Temperature 40 C		
Air Flow, minimum	6	Cubic Feet per Minute
Pressure Drop, approximate	2	Pounds per Square Inch

At higher inlet temperatures increased air flow may be required.

Natural Convection

The tube will operate satisfactorily without artificial cooling at anode dissipation factors up to 30 x 10^9.

MAXIMUM RATINGS—ABSOLUTE VALUES

Maximum Peak Anode Voltage		
Inverse	40,000	Volts
Forward, minimum supply voltage = 3500 volts d-c	40,000	Volts
Maximum Cathode Current		
Peak	2400	Amperes
Average	4.0	Amperes
Maximum Averaging Time	1	Cycle
RMS‡	75	Amperes
Anode Dissipation Factor§	55 x 10^9	
Maximum Negative Control-Grid Voltage before Conduction	650	Volts
Maximum Rate of Rise of Anode Current	10,000	Amperes per Microsecond

* The time interval between the point on the rising portion of the grid pulse which is 26 per cent of the peak unloaded pulse amplitude and the start of the anode current pulse.

† Driver pulse measured at tube socket with thyratron grid disconnected; amplitude = 1300 volts minimum, 2500 volts maximum, above 0; time of rise = 0.35 microsecond maximum, measured from 26 per cent to 70 per cent of peak value; grid pulse duration = 2 microseconds minimum, measured between 70 per cent of peak on rising side to 70 per cent of peak on falling side; impedance of drive circuit = 10 to 25 ohms.

‡ The RMS current of hydrogen thyratrons is the square root of the product of the average and peak currents.
§ The product of the peak forward anode voltage, pulse repetition rate, and peak anode current.

OPERATING NOTES

Thermal

If the anode is operated at a high potential above ground, the leakage current should be held to a low value by using water of low conductivity and a water path of sufficient length between anode and ground to assure a high-resistance leakage path. Otherwise excessive deterioration of target electrodes and anode cooling coil will occur. Replaceable flow-through target electrodes at anode potential are required in coolant lines approximately 6 inches from the anode cooling-coil terminals.

The product of water flow in gallons per minute and water temperature rise in degrees centigrade must not exceed 5. A higher value indicates that the reservoir voltage is set too low.

The optimum reservoir voltage for operation under artificial-cooling conditions at maximum tube voltage, maximum peak and average tube currents, and at a repetition corresponding to the rated anode dissipation factor is inscribed on the base of the tube and must be held within ±5 per cent. Applications involving operation at other conditions will necessitate a redetermination of the optimum reservoir range.

Flow rates and pressure drops for fluids other than air or water will be provided on request.

Electrical

In operation, a compensating capacitor of approximately 60 $\mu\mu$f rated to 40 kilovolts should be connected between gradient grid and control grid to equalize the voltage distribution between control grid and anode.

The minimum inverse anode voltage permissible is 5 per cent of the peak forward voltage, and the maximum is 30 per cent during the first 25 microseconds following the anode pulse, exclusive of a spike of 0.05 microsecond maximum duration.

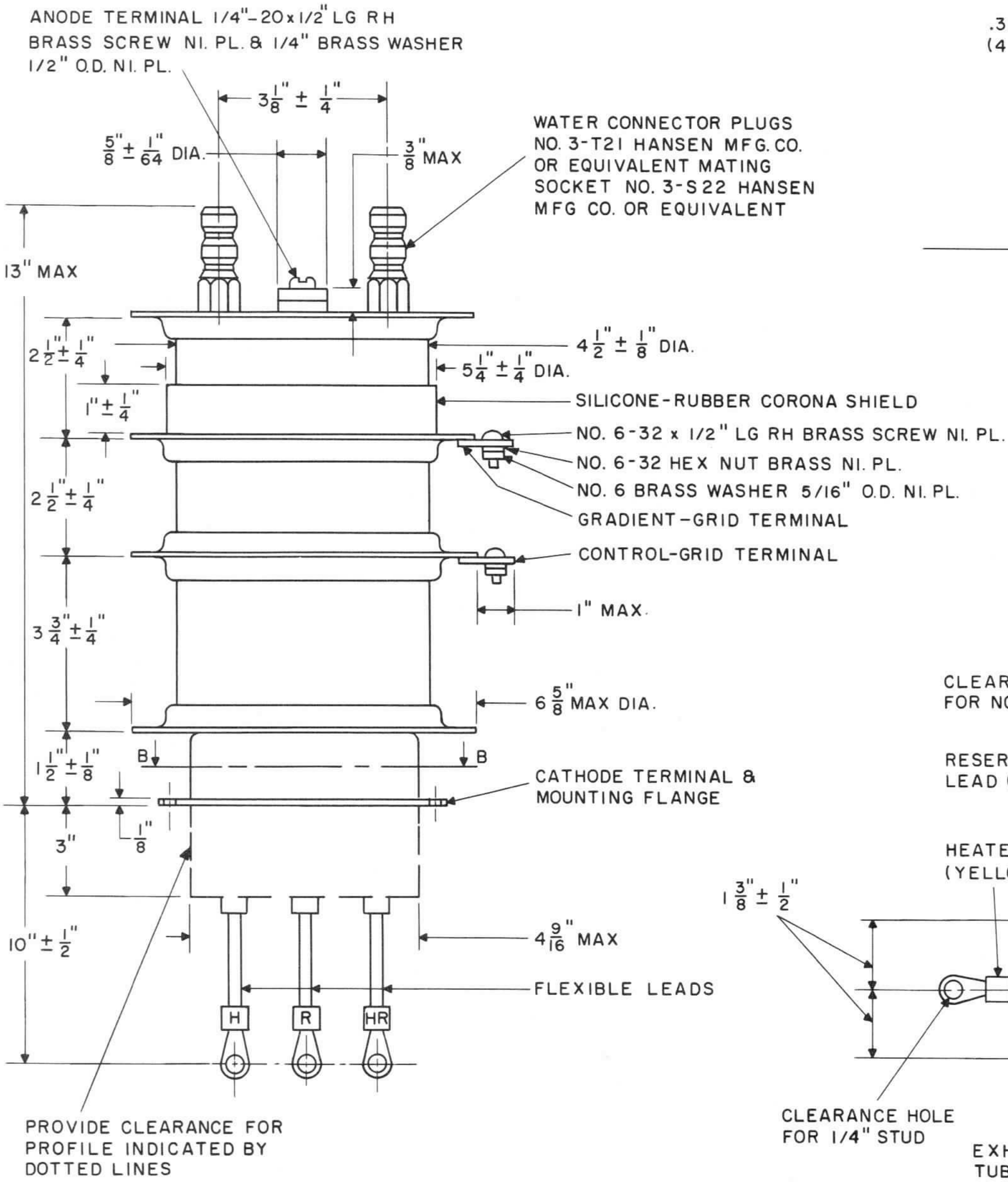
If the forward anode voltage is applied instantaneously, it should be limited to a maximum of 30 kilovolts peak. For starting at low anode voltages the following procedure is recommended:

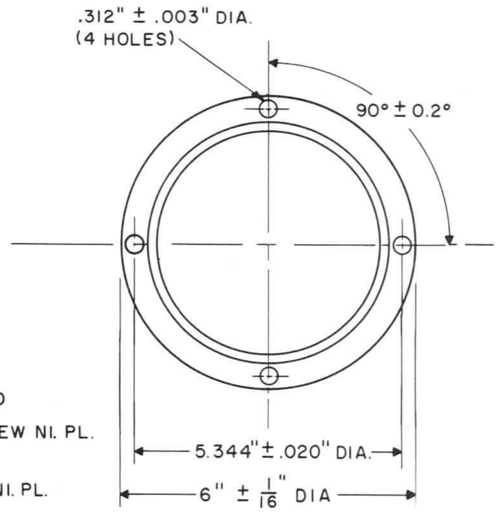
1. Preset anode power supply to a voltage exceeding 3500 volts.
2. Apply trigger signal to grid.
3. Apply anode voltage instantaneously.

X-RAY WARNING NOTICE

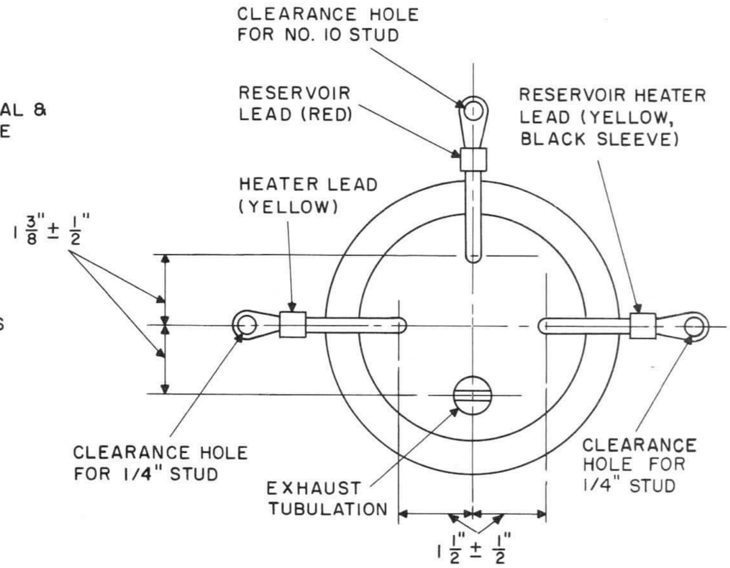
If the GL-7890 is operated at anode voltages in excess of 16 kilovolts, X-ray radiation shielding may be necessary to protect the user against possible danger of personal injury from prolonged exposure at close range. For further information consult the following references or other standard texts on the subject:

(a) X-RAY PROTECTION DESIGN, Handbook No. 50. National Bureau of Standards, Washington, D. C.
(b) X-RAY PROTECTION, Handbook No. 60. National Bureau of Standards, Washington, D. C.
The above references are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.
(c) SAFETY CODE FOR THE INDUSTRIAL USE OF X-RAYS, Bulletin No. Z54-1. American Standards Association, New York 17, N. Y.
(d) Schneider, S. and Reich, B., "X-Ray Emission from High-Voltage Hydrogen Thyratrons." PROC. IRE, Vol. 43, No. 6, June, 1955.


ANODE TERMINAL 1/4"-20x1/2" LG RH BRASS SCREW NI. PL. & 1/4" BRASS WASHER 1/2" O.D. NI. PL.
$3\frac{1}{8}" \pm \frac{1}{4}"$
$\frac{5}{8}" \pm \frac{1}{64}"$ DIA.
$\frac{3}{8}"$ MAX
WATER CONNECTOR PLUGS NO. 3-T21 HANSEN MFG. CO. OR EQUIVALENT MATING SOCKET NO. 3-S22 HANSEN MFG CO. OR EQUIVALENT
13" MAX
$2\frac{1}{2}" \pm \frac{1}{4}"$
$1" \pm \frac{1}{4}"$
$4\frac{1}{2}" \pm \frac{1}{8}"$ DIA.
$5\frac{1}{4}" \pm \frac{1}{4}"$ DIA.
SILICONE-RUBBER CORONA SHIELD
NO. 6-32 x 1/2" LG RH BRASS SCREW NI. PL.
NO. 6-32 HEX NUT BRASS NI. PL.
NO. 6 BRASS WASHER 5/16" O.D. NI. PL.
GRADIENT-GRID TERMINAL
$2\frac{1}{2}" \pm \frac{1}{4}"$
CONTROL-GRID TERMINAL
1" MAX.
$3\frac{3}{4}" \pm \frac{1}{4}"$
$6\frac{5}{8}"$ MAX DIA.
$1\frac{1}{2}" \pm \frac{1}{8}"$
B
B
CATHODE TERMINAL & MOUNTING FLANGE
$\frac{1}{8}"$
3"
$10" \pm \frac{1}{2}"$
$4\frac{9}{16}"$ MAX
FLEXIBLE LEADS
H
R
HR
PROVIDE CLEARANCE FOR PROFILE INDICATED BY DOTTED LINES


.312" ± .003" DIA. (4 HOLES)
90° ± 0.2°
5.344" ± .020" DIA.
$6" \pm \frac{1}{16}"$ DIA

SECTION B-B

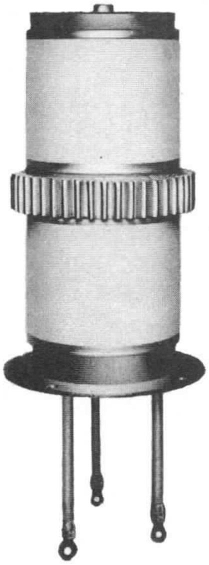

CLEARANCE HOLE FOR NO. 10 STUD
RESERVOIR LEAD (RED)
RESERVOIR HEATER LEAD (YELLOW, BLACK SLEEVE)
HEATER LEAD (YELLOW)
$1\frac{3}{8}" \pm \frac{1}{2}"$
CLEARANCE HOLE FOR 1/4" STUD
EXHAUST TUBULATION
CLEARANCE HOLE FOR 1/4" STUD
$1\frac{1}{2}" \pm \frac{1}{2}"$

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.

PRINTED IN U.S.A.



GL-8326

HYDROGEN THYRATRON

33 KILOVOLTS PEAK
100 KILOWATTS AVERAGE POWER

CERAMIC ENVELOPE
EXTERNAL ELECTRODES

The GL-8326 is a hydrogen thyratron for radar-modulating and other pulsing applications. It is capable of switching an average power of 100 kilowatts.

Mechanically, the tube features a heavy-duty ceramic envelope and external electrodes to improve heat dissipation.

The high peak power rating of this tube and its mechanical design features assure reliable service under the stringent operating conditions encountered in high-power pulse equipment.

Electrical

	Minimum	Bogey	Maximum	
Cathode—Indirectly Heated				
Cathode is Tied to Heater Midpoint				
Heater Voltage	6.0	6.3	6.6	Volts
Heater Current, Ef = 6.3 volts	35	—	55	Amperes
Reservoir				
Heater Voltage	3.5	4.5	5.5	Volts
Heater Current	—	—	24	Amperes
Heating Time	15	—	—	Minutes
Direct Interelectrode Capacitances				
Anode to Grid	—	40	—	$\mu\mu$f
Grid to Cathode	—	40	—	$\mu\mu$f
Anode Current Time Jitter	—	0.005	0.01	Microseconds
Anode Delay Time*	—	—	1	Microcesond
Delay Time Drift†	—	—	0.1	Microsecond
Anode Voltage Drop	—	—	400	Volts
Grid Drive‡				

Mechanical

Mounting Position—Vertical with Base Down
Altitude, maximum .... 10,000 Feet
Net Weight, approximate .... 15 Pounds

Thermal

Ambient Temperature Limits .... —55 to +75 C
Type of Cooling—Forced Air
Air Flow Rate, at 40 C Inlet Temperature .... 160 Cubic Feet Per Minute
Velocity, minimum .... 2000 Feet per Minute

At higher inlet temperatures increased air flow may be required.

MAXIMUM RATINGS—ABSOLUTE VALUES

Maximum Peak Anode Voltage
Inverse (See OPERATING NOTES, Electrical)
Forward, minimum supply voltage = 3500 volts d-c .... 33,000 Volts
Maximum Cathode Current
Peak .... 4000 Amperes
Average .... 7.0 Amperes
Maximum Averaging Time .... 1 Cycle
RMS¶ .... 100 Amperes

Anode Dissipation Factor§ .... 55 x 10^9
Maximum Negative Control-Grid Voltage before Conduction .... 650 Volts
Maximum Rate of Rise of Anode Current .... 10,000 Amperes per Microsecond

* The time interval between the point on the rising portion of the grid pulse which is 26 percent of the peak unloaded pulse amplitude and the start of the anode current pulse.

† Change in anode delay time relative to the delay time observed after five minutes of operation.

‡ Driver pulse measured at the tube socket with thyratron grid disconnected; amplitude = 1300 volts minimum, 2500 volts maximum, above 0; time of rise = 0.35 microsecond maximum, measured from 26 percent to 70 percent of peak value; grid pulse duration = 2 microseconds minimum, measured between 70 percent of peak on rising side to 70 percent of peak on falling side; impedance of drive circuit = 10 to 25 ohms.

¶ The RMS current of hydrogen thyratrons is the square root of the product of the average and peak currents.

§ Highest rating to which tube has been tested. This is not necessarily maximum tube capability.

OPERATING NOTES

Thermal

The optimum reservoir voltage for operation under artificial-cooling conditions at maximum tube voltage, maximum peak and average tube currents, and at a repetition corresponding to an anode dissipation factor of 50 x 10^9 is inscribed on the base of the tube and must be held within ±5 percent. Applications involving operation at other conditions may necessitate a redetermination of the optimum reservoir range.

Electrical

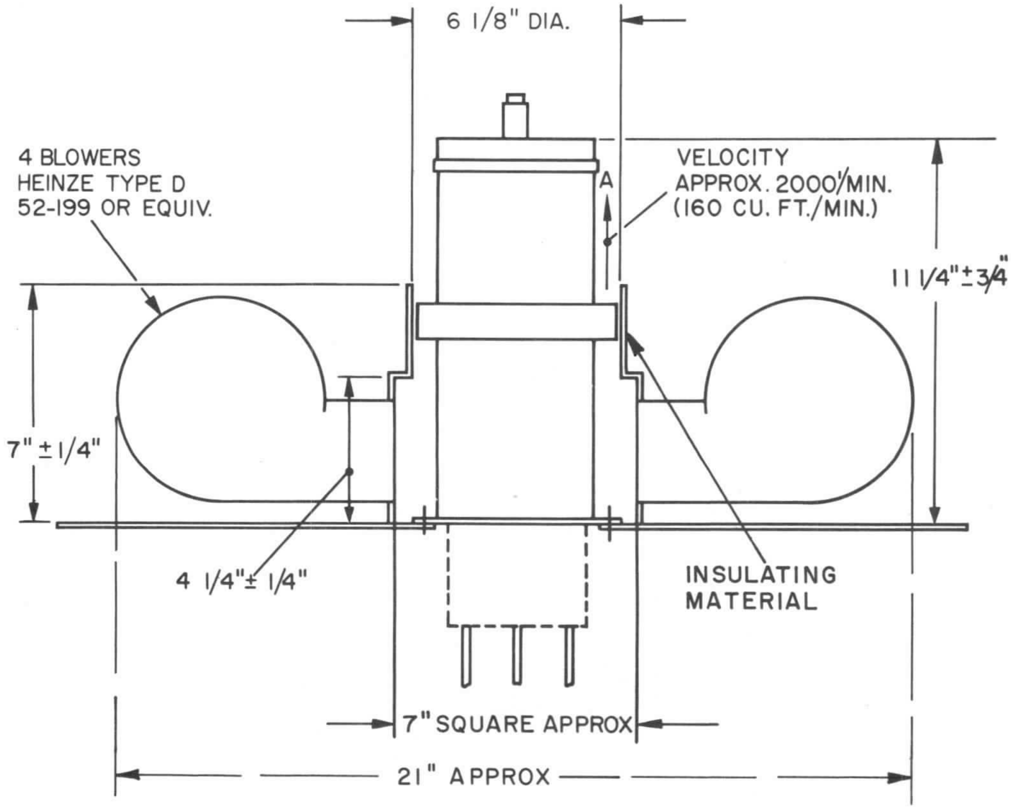
In switching and line-type modulator circuits the minimum inverse anode voltage permissible is 5 percent of the peak forward voltage, and the maximum is 5000 volts during the first 25 microseconds following the anode pulse, exclusive of a spike of 0.05 microsecond maximum duration.

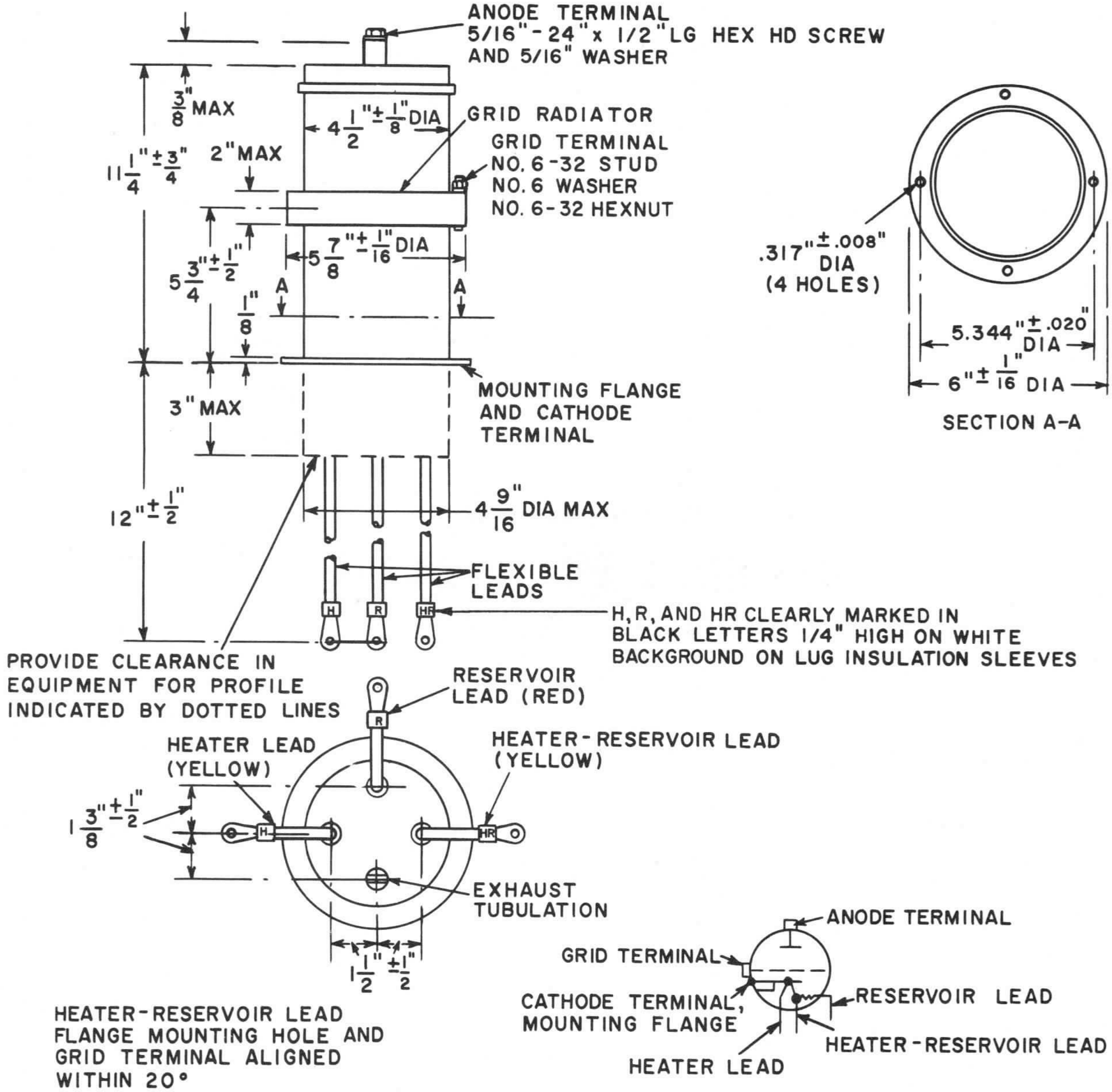
If the forward anode voltage is applied instantaneously, it should be limited to a maximum of 22 kilovolts peak. The power-supply filter should be designed to limit the rate of application of this voltage to 550,000 volts per second.

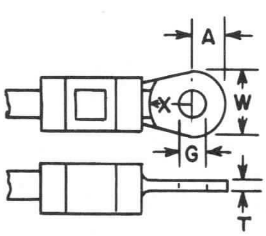
X-RAY WARNING NOTICE

If the GL-8326 is operated at anode voltages in excess of 16 kilovolts, X-ray radiation shielding may be necessary to protect the user against possible danger of personal injury from prolonged exposure at close range. For further information consult the following references or other standard texts on the subject:

(a) X-RAY PROTECTION DESIGN, Handbook No. 50. National Bureau of Standards, Washington, D. C.
(b) X-RAY PROTECTION, Handbook No. 60. National Bureau of Standards, Washington, D. C.
The above references are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.
(c) SAFETY CODE FOR THE INDUSTRIAL USE OF X-RAYS, Bulletin No. Z54-1. American Standards Association, New York 17, N. Y.
(d) Schneider, S. and Reich, B., "X-Ray Emission from High-Voltage Hydrogen Thyratrons," PROC. IRE, Vol. 43, No. 6, June, 1955.







PRESSURE-TYPE LUGS WITH INSULATING SLEEVES

LEADS	LUG DESIGNATION	"G" INCHES	"W" INCHES	"A" INCHES	"X" INCHES	"T" INCHES
RESERVOIR	NO. 10	.187 TO .207	.395 MAX	.200 MAX	.275 MIN	.060 MAX
HEATER-RESERVOIR	1/4"	.260 TO .313	.605 MAX	.305 MAX	.380 MIN	.060 MAX
HEATER	1/4"	.260 TO .313	.605 MAX	.305 MAX	.380 MIN	.060 MAX

NOTE: THERE SHALL BE NO OBSTRUCTION WITHIN THE DISTANCE OF "X" FROM THE CENTER OF THE LUG SCREWHOLE

TUBE DEPARTMENT

GENERAL ELECTRIC

Schenectady 5, N. Y.

PRINTED IN U.S.A.

The Triggered Spark Gap

The gap currently available is a miniature switching device designed to deliver short pulses of high peak current with a minimum delay and jitter in applications involving high hold-off voltages and low leakage currents. Since minimum external energy is required to initiate the discharge, its use eliminates some components with consequent savings in space and cost reduction. Rugged ceramic-metal construction assures ability to withstand shock and vibration and permits reliable operation over temperatures from as low as -80 to as high as +300 F.

Applications include energy switching into low-impedance resistive or inductive loads for such missile functions as ignition, stage separation, thrust-reversal, and missile destruction.

The design presently available will pass 4000 amperes of unidirectional current, or 1500 amperes of ringing current, for pulses of approximately 10 microseconds. In the energy field it will switch 18 joules.

These ratings by no means cover all the possibilities inherent in a device of this nature. If interest warrants, similar gaps with different ratings will be made available.

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZR-7512

TRIGGERED VACUUM GAP

45 Kilovolts
50,000 Amperes
15,000 Joules

Fires at 300 Volts
Ceramic Envelope

The ZR-7512 is a cold-cathode, vacuum, triggered spark gap capable of switching 15,000 joules at high voltage. Unique design combines the desirable features of vacuum and gas devices. These include extremely wide voltage range, ease of triggering, high voltage capability, rapid recovery time, stability of characteristics and reliability.

Although capable of withstanding a hold-off voltage of 55 kilovolts indefinitely, the ZR-7512 will fire reliably at voltages as low as 300 volts. It will reliably switch non-repetitive high-current pulses with minimum delay and jitter in high-voltage circuits. Applications include "crowbars"* and switching stored electrical energy systems into low-impedance loads, or energy-storage capacitors into resistive or inductive loads.

ELECTRICAL

Heater Voltage . . . . None Required

MECHANICAL

Mounting Position – Any
Net Weight . . . . Approx. 4 lbs.

MAXIMUM RATINGS

Interelectrode Leakage Resistance	10,000	Megohms
Main Gap		
Operating Voltage	300V to 45	Kilovolts
Hold-Off Voltage, Indefinite Time, minimum	55	Kilovolts
Peak Current		
Unidirectional Pulse, maximum	50,000	Amperes
Charge Conducted Through Gap per Operation**, maximum	0.7	Coulombs
Discharge Rate, maximum	2	Per Minute
Delay Time †, V app. = 45 KV, maximum	0.1	Microseconds
Jitter †, V app. = 45 KV, maximum	0.1	Microseconds
Trigger Gap		
Typical Trigger Firing Circuit:		
Peak Voltage ‡, typical	5	Kilovolts
Short-Circuit Current ¶, typical	40	Amperes

* In a "crowbar" application the gap acts as a short-circuiting switch to protect vulnerable high-voltage equipment by removing the direct-current supply voltage within tenths of a microsecond after initiation of the trigger-pulse. Unless the fault is self-clearing, the circuit must subsequently be opened in the usual manner.

** This rating refers to the charge originating from the capacitor bank. For further information concerning "follow-thru" current from the power supply in a given application consult the General Electric Microwave Tube Business Section.

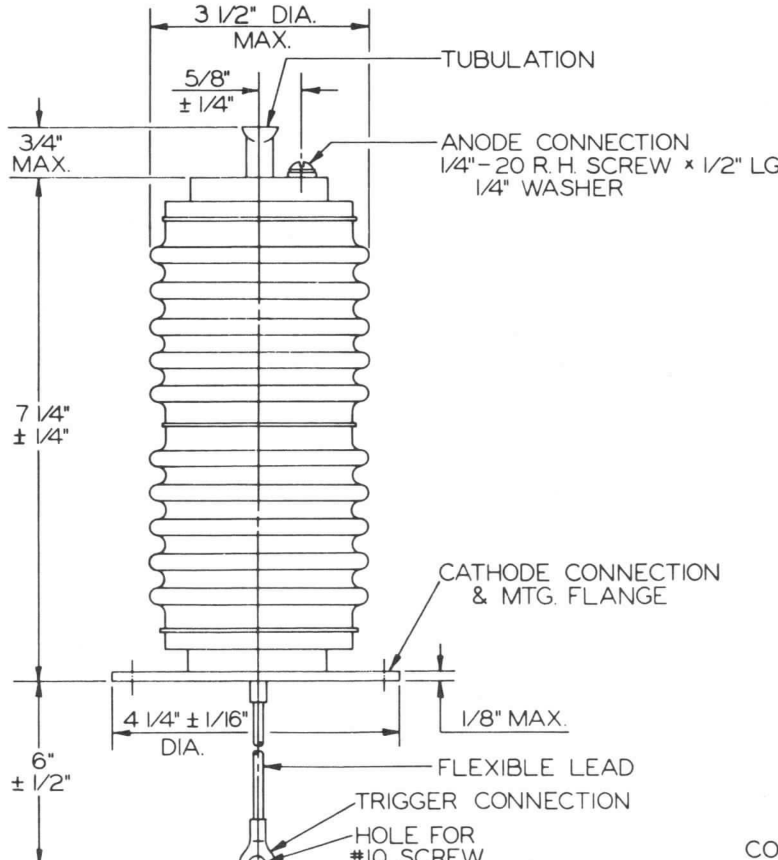
† From trigger-gap breakdown to main-gap breakdown.

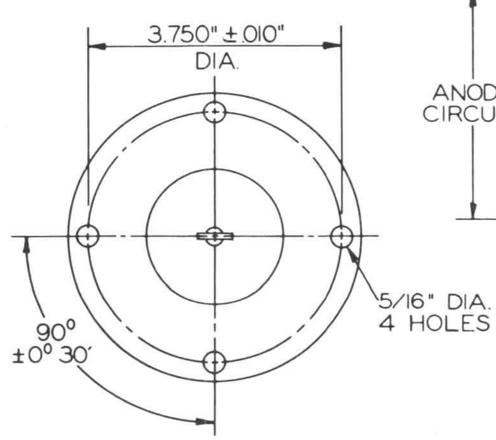
‡ The voltage rise time should be as fast as is consistent with the firing speed and accuracy required. The trigger will fire typically at 1 to 3 kilovolts on the leading edge of the pulse but may fire at lower trigger voltages. Only pulse voltage shall be applied to the trigger.

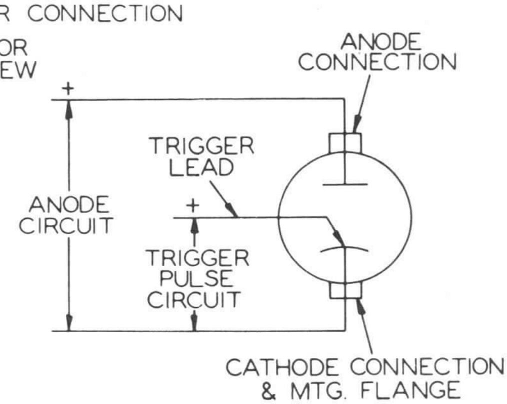
¶ Delay time and jitter may be decreased and gap life increased by increasing trigger short-circuit current. Currents up to 100 amperes may be used. The pulse width should preferably not exceed 2 microseconds.

OPERATING NOTES

When discharging or crowbaring energy-storage capacitors, repetitive firing for short periods may be necessary to maintain sufficiently low voltage to protect electrical equipment until circuit is cleared. Restoration of power-supply voltage to maintain service continuity without circuit-breaker action after a self-clearing fault is feasible in a typical circuit by blocking the trigger pulse. This is due to the rapid deionization time and excellent voltage recovery capability of the ZR-7512. For further information consult the Microwave Tube Business Section, Bldg. 269, Schenectady, New York, FRanklin 4-2211, Extension 5-2507.







GENERAL ELECTRIC

TUBE DEPARTMENT

Schenectady, N. Y. 12305

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZR-7513

TRIGGERED VACUUM GAP

6 Kilovolts
4,000 Amperes
25 Joules

Fires at 150 Volts
Ceramic Envelope

The ZR-7513 is a cold-cathode, vacuum, triggered spark gap capable of switching 25 joules at high voltage. Unique design combines the desirable features of vacuum and gas devices. These include extremely wide voltage range, ease of triggering, high voltage capability, rapid recovery time, stability of characteristics and reliability.

Although capable of withstanding a hold-off voltage of 7.5 kilovolts indefinitely, the ZR-7513 will fire reliably at voltages as low as 150 volts. It will reliably switch non-repetitive high-current pulses with minimum delay and jitter in high-voltage circuits. Applications include "crowbars"* and switching stored electrical energy systems into low-impedance loads, or energy-storage capacitors into resistive or inductive loads.

ELECTRICAL

Heater Voltage . . . . None Required

MECHANICAL

Mounting Position . . . . Any
Net Weight, approximate . . . . 0.5 Ounces

MAXIMUM RATINGS

Interelectrode Leakage Resistance	10,000	Megohms
Main Gap		
Operating Voltage	150V to 6	Kilovolts
Hold-Off Voltage, Indefinite Time, minimum	7.5	Kilovolts
Peak Current		
Unidirectional Pulse, maximum	4,000	Amperes
Charge Conducted Through Gap per Operation**, maximum	0.05	Coulombs
Discharge Rate, maximum	2	Per Minute
Delay Time †, maximum	0.3	Microseconds
Jitter †, maximum	0.1	Microseconds
Trigger Gap		
Typical Trigger Firing Circuit		
Peak Voltage ‡, typical	1.0	Kilovolts
Short-Circuit Current ¶, typical	12	Amperes
Pulse Width, typical	0.5	Microseconds

*In a "crowbar" application the gap acts as a short-circuiting switch to protect vulnerable high-voltage equipment by removing the direct-current supply voltage within tenths of a microsecond after initiation of the trigger-pulse. Unless the fault is self-clearing, the circuit must subsequently be opened in the usual manner.

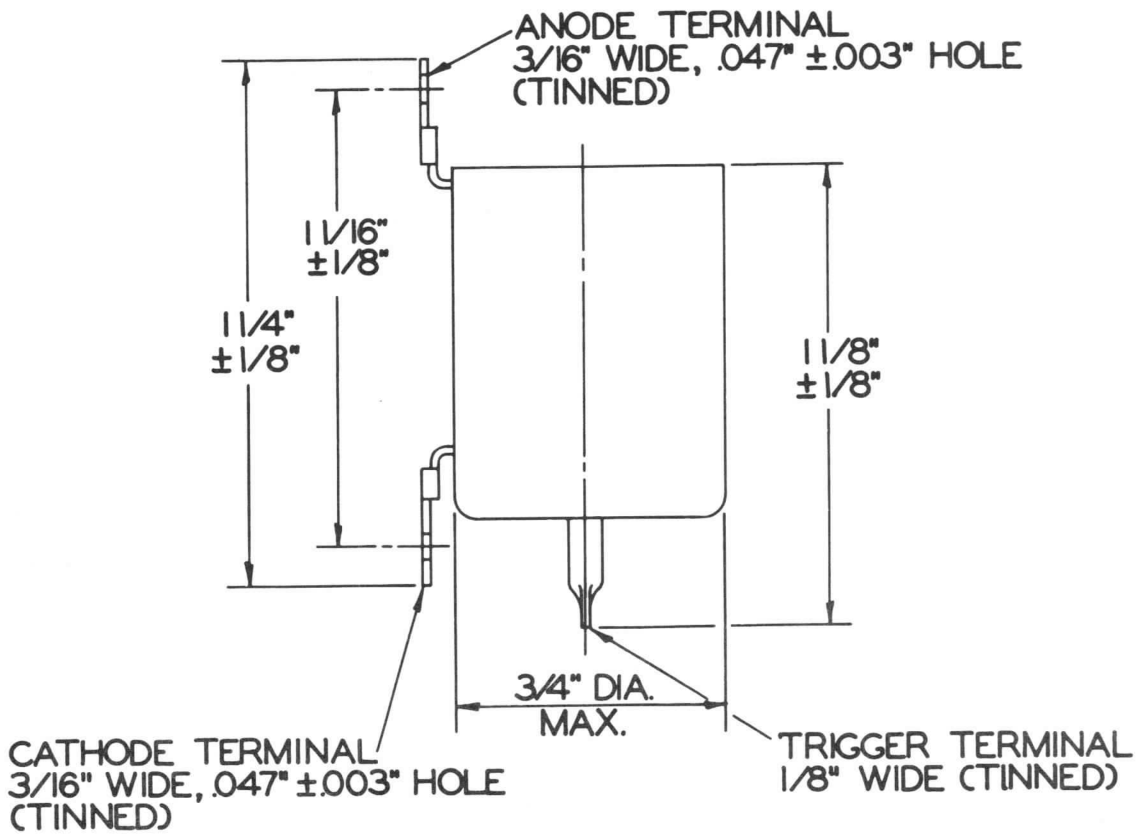
**This rating refers to the charge originating from the capacitor bank. For further information concerning "follow-thru" current from the power supply in a given application consult the General Electric Microwave Tube Business Section.

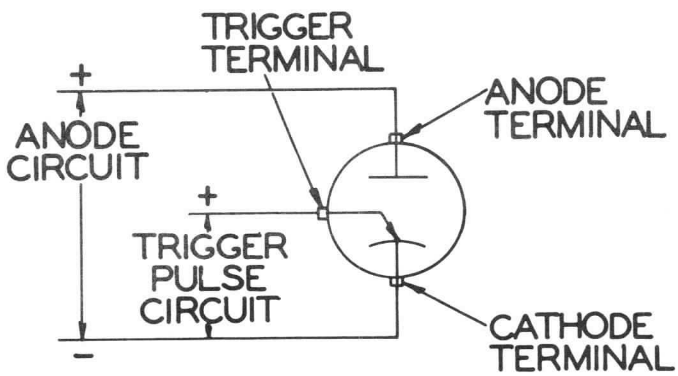
† From trigger-gap breakdown to beginning of main-gap breakdown at 1 KV or more.

‡ The voltage rise time should be as fast as is consistent with the firing speed and accuracy required. The trigger will fire typically at about 500 volts on the leading edge of the pulse but may fire at lower trigger voltages. Only pulse voltage shall be applied to the trigger.

¶ Delay time and jitter may be decreased and gap life increased by increasing trigger short-circuit current. Currents up to 25 amperes may be used.

GENERAL ELECTRIC


ANODE TERMINAL
3/16" WIDE, .047" ±.003" HOLE
(TINNED)
1 1/16"
±1/8"
1 1/4"
±1/8"
1 1/8"
±1/8"
3/4" DIA.
MAX.
CATHODE TERMINAL
3/16" WIDE, .047" ±.003" HOLE
(TINNED)
TRIGGER TERMINAL
1/8" WIDE (TINNED)


TRIGGER
TERMINAL
+
ANODE
CIRCUIT
ANODE
TERMINAL
+
TRIGGER
PULSE
CIRCUIT
CATHODE
TERMINAL
−

ELECTRONIC INNOVATIONS IN ACTION

TUBES

OBJECTIVE

TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

DEVELOPMENTAL TYPE

ZR-7516
OTI-101D
Page 1
12-68

ZR-7516

TRIGGERED VACUUM GAP

25 Kilovolts	Fires at 300 Volts
40,000 Amperes	Ceramic Envelope
8,500 Joules	

The ZR-7516 is a cold-cathode, vacuum, triggered spark gap capable of switching 8,500 joules at high voltage. Unique design combines the desirable features of vacuum and gas devices. These include extremely wide voltage range, ease of triggering, high voltage capability, rapid recovery time, stability of characteristics and reliability.

Although capable of withstanding a hold-off voltage of 30 kilovolts indefinitely, the ZR-7516 will fire reliably at voltages as low as 300 volts. It will reliably switch non-repetitive high-current pulses with minimum delay and jitter in high-voltage circuits. Applications include "crowbars"* and switching stored electrical energy systems into low-impedance loads, or energy-storage capacitors into resistive or inductive loads.

ELECTRICAL

Heater Voltage . . . . None Required

MECHANICAL

Mounting Position – Any
Net Weight, approximate . . . . 2 lbs.

MAXIMUM RATINGS

Interelectrode Leakage Resistance	10,000	Megohms
Main Gap		
Operating Voltage	300V to 25	Kilovolts
Hold-Off Voltage, Indefinite Time, minimum	30	Kilovolts
Peak Current		
Unidirectional Pulse, maximum	40,000	Amperes
Charge Conducted Through Gap per Operation**, maximum	0.7	Coulombs
Discharge Rate, maximum	2	Per Minute
Delay Time†, V app. = 25 KV, maximum	0.1	Microseconds
Jitter†, V app. = 25 KV, maximum	0.1	Microseconds
Trigger Gap		
Typical Trigger Firing Circuit		
Peak Voltage‡, typical	5	Kilovolts
Short-Circuit Current¶, typical	40	Amperes

*In a "crowbar" application the gap acts as a short-circuiting switch to protect vulnerable high-voltage equipment by removing the direct-current supply voltage within tenths of a microsecond after initiation of the trigger-pulse. Unless the fault is self-clearing, the circuit must subsequently be opened in the usual manner.

** This rating refers to the charge originating from the capacitor bank. For further information concerning "follow-thru" current from the power supply in a given application consult the General Electric Microwave Tube Business Section.

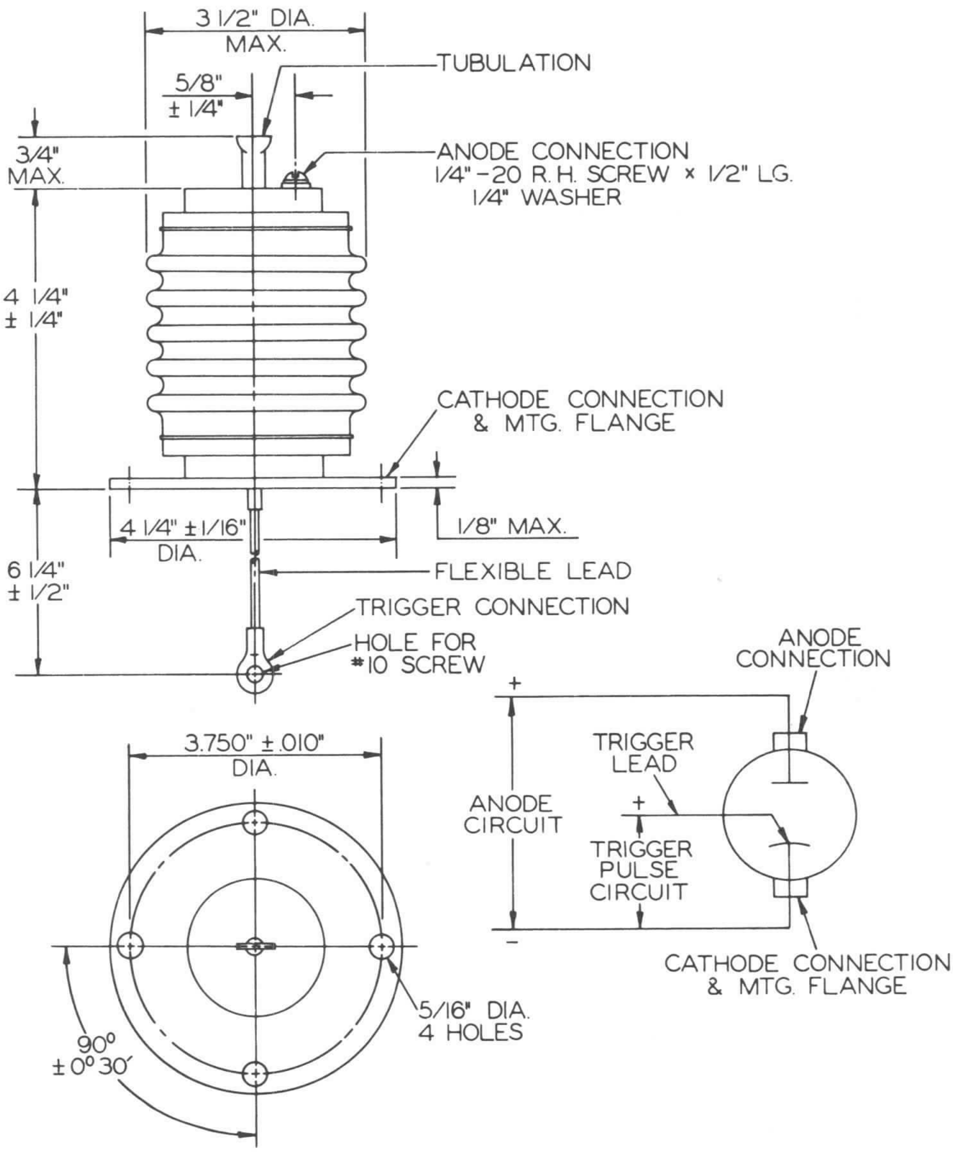
† From trigger-gap breakdown to main-gap breakdown.

‡ The voltage rise time should be as fast as is consistent with the firing speed and accuracy required. The trigger will fire typically at 1 to 3 kilovolts on the leading edge of the pulse but may fire at lower trigger voltages. Only pulse voltage shall be applied to the trigger.

¶ Delay time and jitter may be decreased and gap life increased by increasing trigger short-circuit current. Currents up to 100 amperes may be used. The pulse width should preferably not exceed 2 microseconds.

OPERATING NOTES

When discharging or crowbaring energy-storage capacitors, repetitive firing for short periods may be necessary to maintain sufficiently low voltage to protect electrical equipment until circuit is cleared. Restoration of power-supply voltage to maintain service continuity without circuit-breaker action after a self-clearing fault is feasible in a typical circuit by blocking the trigger pulse. This is due to the rapid deionization time and excellent voltage recovery capability of the ZR-7516. For further information consult the Microwave Tube Business Section, Bldg. 269, Schenectady, New York, FRanklin 4-2211, Extension 5-2507.



OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZR-7517

TRIGGERED VACUUM GAP

15 Kilovolts
20,000 Amperes
3,000 Joules

Fires at 300 Volts
Ceramic Envelope

The ZR-7517 is a cold-cathode, vacuum, triggered spark gap capable of switching 3,000 joules at high voltage. Unique design combines the desirable features of vacuum and gas devices. These include extremely wide voltage range, ease of triggering, high voltage capability, rapid recovery time, stability of characteristics and reliability.

Although capable of withstanding a hold-off voltage of 20 kilovolts indefinitely, the ZR-7517 will fire reliably at voltages as low as 300 volts. It will reliably switch non-repetitive high-current pulses with minimum delay and jitter in high-voltage circuits. Applications include "crowbars"* and switching stored electrical energy systems into low-impedance loads, or energy-storage capacitors into resistive or inductive loads.

ELECTRICAL

Heater Voltage . . . . None Required

MECHANICAL

Mounting Position – Any
Net Weight, approximate . . . . 1 lb.

MAXIMUM RATINGS

Interelectrode Leakage Resistance	10,000	Megohms
Main Gap		
Operating Voltage	300V to 15	Kilovolts
Hold-Off Voltage, Indefinite Time, minimum	20	Kilovolts
Peak Current		
Unidirectional Pulse, maximum	20,000	Amperes
Charge Conducted Through Gap per Operation**, maximum	0.4	Coulombs
Discharge Rate, maximum	2	Per Minute
Delay Time†, V app. = 15 KV, maximum	0.1	Microseconds
Jitter †, V app. = 15 KV, maximum	0.1	Microseconds
Trigger Gap		
Typical Trigger Firing Circuit		
Peak Voltage‡, typical	5	Kilovolts
Short-Circuit Current ¶, typical	40	Amperes

* In a "crowbar" application the gap acts as a short-circuiting switch to protect vulnerable high-voltage equipment by removing the direct-current supply voltage within tenths of a microsecond after initiation of the trigger-pulse. Unless the fault is self-clearing, the circuit must subsequently be opened in the usual manner.

** This rating refers to the charge originating from the capacitor bank. For further information concerning "follow-thru" current from the power supply in a given application consult the General Electric Microwave Tube Business Section.

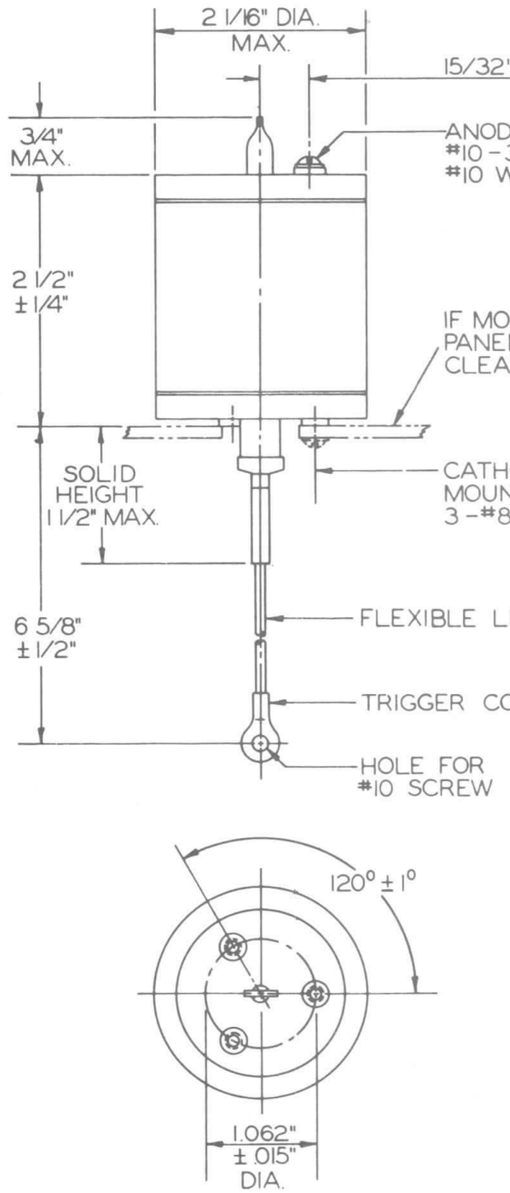
† From trigger-gap breakdown to main-gap breakdown.

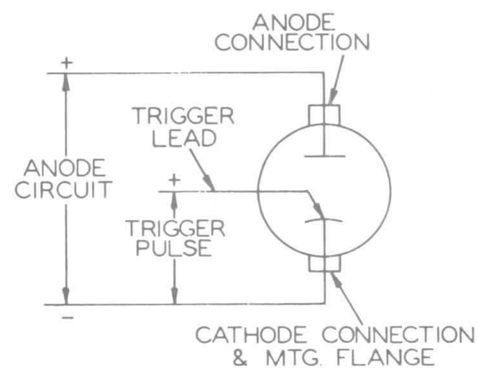
‡ The voltage rise time should be as fast as is consistent with the firing speed and accuracy required. The trigger will fire typically at 1 to 3 kilovolts on the leading edge of the pulse but may fire at lower trigger voltages. Only pulse voltage shall be applied to the trigger.

¶ Delay time and jitter may be decreased and gap life increased by increasing trigger short-circuit current. Currents up to 50 amperes may be used. The pulse width should preferably not exceed 2 microseconds.

OPERATING NOTES

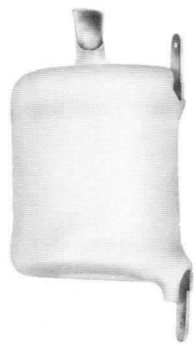
When discharging or crowbaring energy-storage capacitors, repetitive firing for short periods may be necessary to maintain sufficiently low voltage to protect electrical equipment until circuit is cleared. Restoration of power-supply voltage to maintain service continuity without circuit-breaker action after a self-clearing fault is feasible in a typical circuit by blocking the trigger pulse. This is due to the rapid deionization time and excellent voltage recovery capability of the ZR-7517. For further information consult the Microwave Tube Business Section, Bldg. 269, Schenectady, New York, FRanklin 4-2211, Extension 5-2507.





GL-7964

TRIGGERED SPARK GAP



MINIATURE SWITCHING DEVICE **3 KILOVOLTS**

18 JOULES

The GL-7964 is a small, cold cathode, gaseous, triggered spark gap capable of switching 18 joules of energy at high voltages. Since the device does not require external energy to initiate the discharge its use permits both equipment cost reduction and savings in space through component elimination.

Mechanical features include rugged metal-ceramic construction, ability to withstand high shock and vibration conditions, and reliable operation over temperatures ranging from as low as −80 to as high as +300 F.

The GL-7964 is especially designed to deliver short rapid pulses of current with minimum delay and jitter in applications where high hold-off voltages and low leakage currents exist.

Applications include switching single stored electrical energy systems into low impedance loads, or energy storage capacitors into resistive or inductive loads.

Electrical

Heater Voltage............................None Required

Mechanical

Mounting Position—Any
Net Weight....................................0.4 Ounces

Thermal

Ambient Temperature Range..............—80 to +300 F

MAXIMUM RATINGS

Interelectrode Leakage Resistance......10,000 Megohms
Main Gap
- Operating Voltage...............2.0 to 2.6 Kilovolts
- Hold-off Voltage, minimum—Terminal No. 1 Positive, Terminal No. 2 Negative
  - 1.0 Minute..........................4.0 Kilovolts
  - 10 Minutes..........................3.6 Kilovolts
  - Indefinite..........................3.0 Kilovolts
- Static Breakdown Voltage
  - Minimum ....4.25 Kilovolts
  - Maximum ....5.2 Kilovolts
- Peak Current
  - Unidirectional Pulse, maximum.....4000 Amperes
    - Pulse Duration, maximum..........10 Microseconds
  - Ringing*, maximum................1500 Amperes
- Arc Drop, approximate..................60 Volts
- Delay Time†, Vapp 2400 DC............1.0 Microseconds
- Jitter‡ ....0.5 Microseconds

Trigger Gap
- Hold-off Voltage, minimum—Terminal No. 2 Positive, Terminal No. 3 Negative
  - 1.0 Minute...........................1.2 Kilovolts
- Static Breakdown Voltage
  - Minimum ....1.5 Kilovolts
  - Maximum ....2.8 Kilovolts
- Trigger Firing Voltage§, minimum .....3.0 Kilovolts
- Trigger Firing Current..................5.0 Amperes
- Duration of Trigger Firing Pulse—Sinusoidal Pulse, 5.0 Kilovolts Peak Voltage, 18 Microseconds to Peak

* 1500 amperes for the first half cycle of a 10–12 kc ringing frequency. Circuit should be sufficiently damped to pass only 5 to 6 cycles.

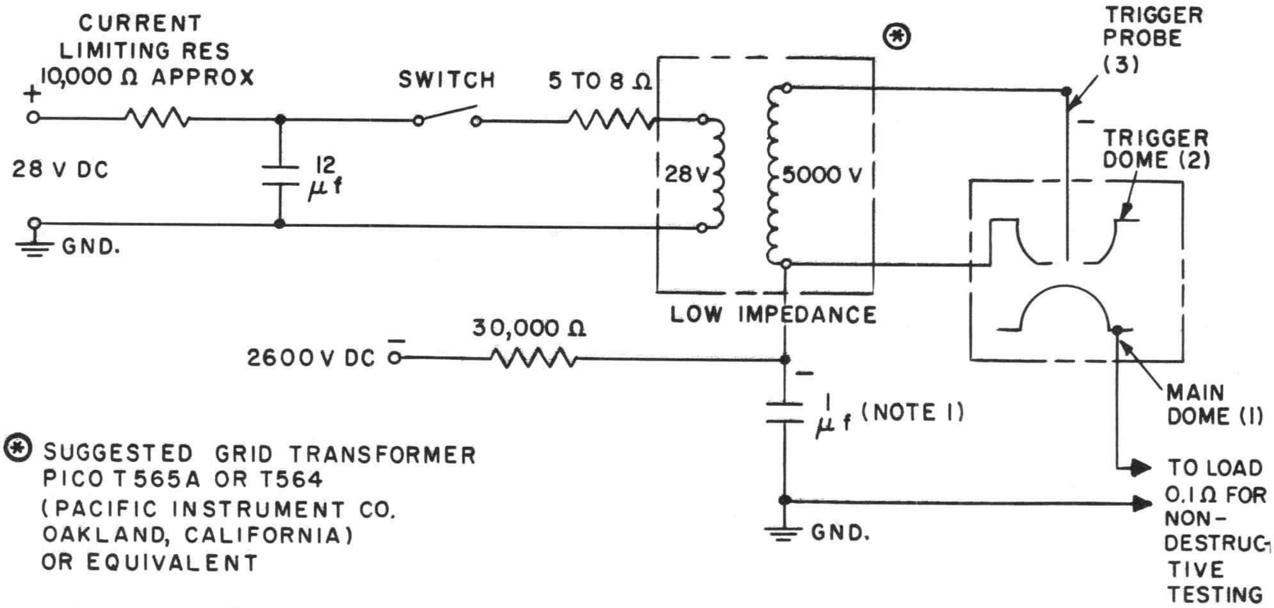
† From trigger-gap breakdown to main-gap breakdown.

‡ Main gap jitter is defined as the variation in main-gap delay time.

§ Breakdown to occur on leading edge of pulse having a rise time of 8 microseconds where rise time is defined as the interval of time between 10 percent and 90 percent of the trigger voltage pulse.

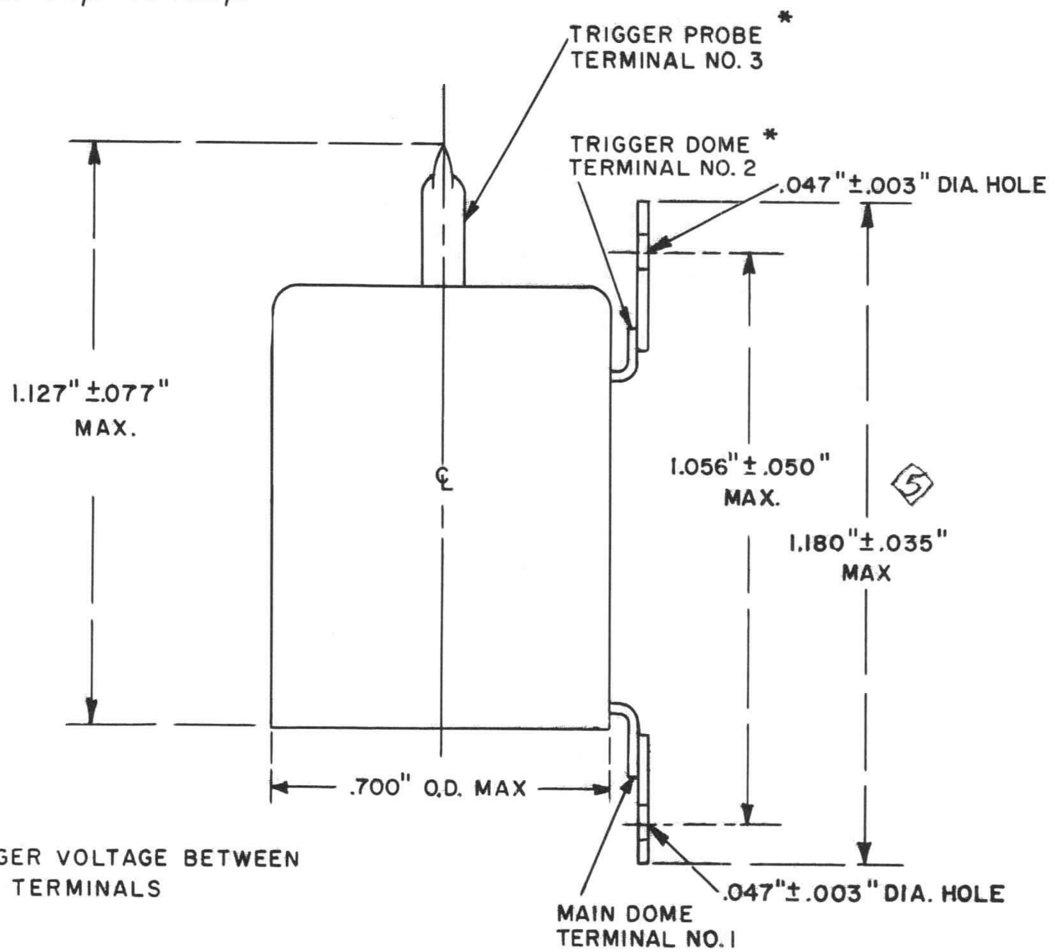
GENERAL ELECTRIC

Supersedes ET-T1655A dated 10-61



(*) SUGGESTED GRID TRANSFORMER
PICO T565A OR T564
(PACIFIC INSTRUMENT CO.
OAKLAND, CALIFORNIA)
OR EQUIVALENT

NOTE I - CAN BE ANY VALUE
FROM 0.1 μf TO 10.0 μf



* APPLY TRIGGER VOLTAGE BETWEEN
THESE TWO TERMINALS

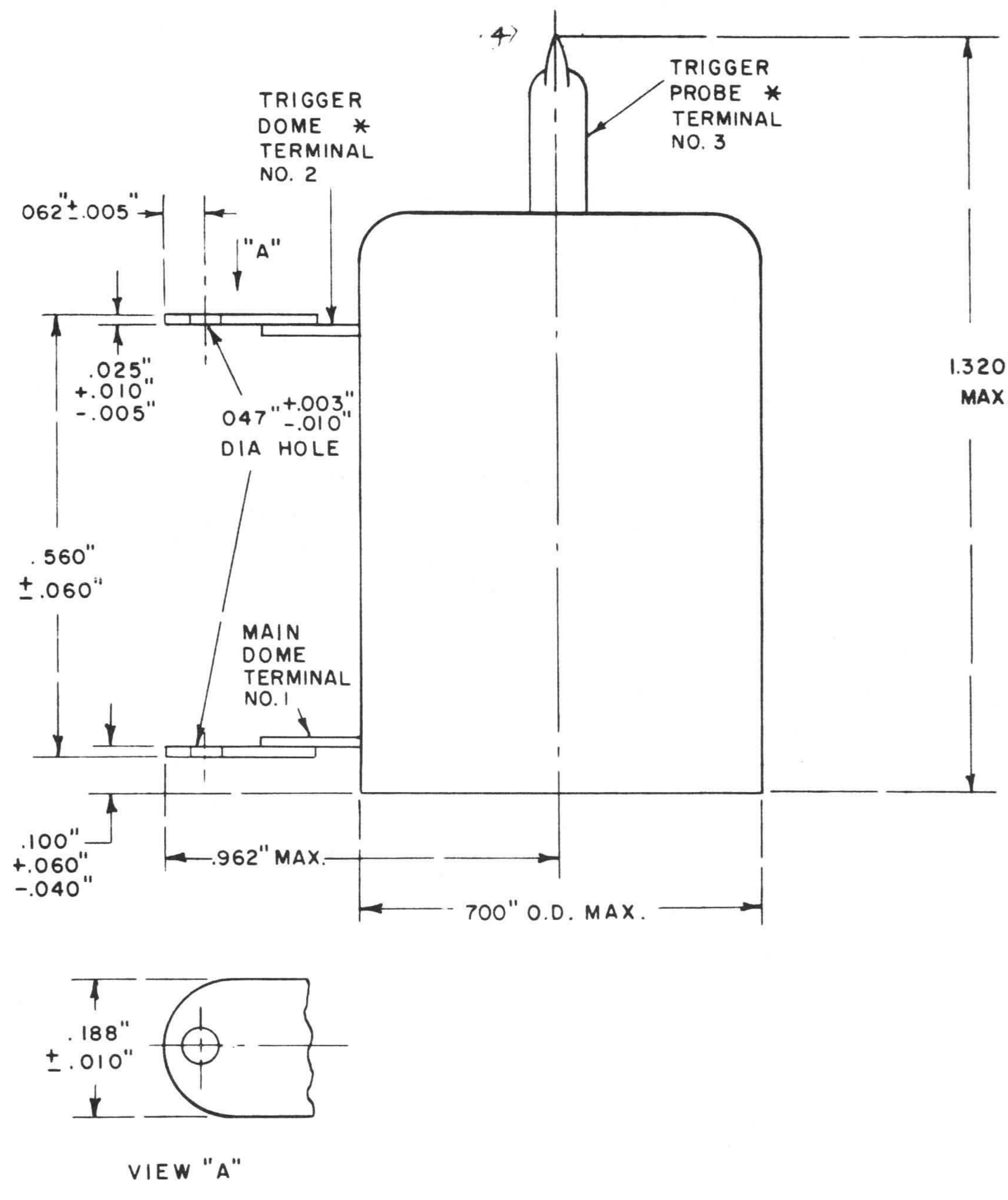
TUBE DEPARTMENT
GENERAL ELECTRIC
Owensboro, Kentucky

PRINTED IN U.S.A.

GL-7964-1

TRIGGERED SPARK GAP

Except for the position of the main dome and trigger dome terminals, this device is identical to the GL-7964. These terminals on the 7964-1 are perpendicular to the body of the gap instead of parallel.



* APPLY TRIGGER VOLTAGE BETWEEN THESE TWO TERMINALS.

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

PRINTED IN U.S.A.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

MILITARY EQUIPMENT TYPES MANUAL

MET-11B

HIGH-POWER KLYSTRONS

HIGH-POWER KLYSTRONS

General Electric has been manufacturing high-power multiple-resonator amplifier klystrons for nearly two decades and as a result has developed a wide and versatile design and manufacturing capability. Check these features which characterize General Electric klystrons.

- Entirely metal-and-ceramic construction. General Electric pioneered in the design and application of high-power ceramic RF output windows.
- Tunable types are designed such that each cavity tunes at the same rate; thus, multiple-cavity tuners ganged together will provide full specification performance across tuning ranges of up to 15 percent without trim-tuning individual resonators.
- Electron gun designs with non-intercepting shadow grids are now available to simplify modulator requirements, particularly where sophisticated pulse trains or very high pulse repetition rates are needed. These grids are capable of pulsing beam current with a grid voltage swing on the order of 5 percent of beam voltage.
- Ion pumps are an integral part of each klystron. This device provides continuous pumping action thus assuring the maintenance of excellent vacuum conditions conducive to long life and reliability. The current drawn by the pump, on the order of a few microamperes, is a direct indicator of the amount of gas present in the tube and can be a valuable aid in detecting adverse operating or environmental conditions and in forecasting end of life.
- Conservative design is the key word for long life and reliability. With respect to emission densities, electron beam densities, collector-dissipation capability, voltage gradients and RF window designs, we strive for reserve capability. These factors of safety contribute to stability and to invulnerability to adverse operating parameter adjustments or fluctuations.
- Our broadband tubes exhibit outstanding performance as described below and are completely tunerless. The excellent broadband response is rigidly and permanently determined in the process of manufacture.
- Modular design facilitates the practical and economical repair of General Electric klystrons. Any major subassembly can be readily replaced. The need for costly new replacement tubes is virtually eliminated.

Types being produced are pulsed-amplifier klystrons for radar transmitters. Ratings on these types are presently U. S. classified and can be made available on request with the establishment of appropriate "need to know."

Tunable multi-megawatt products in both L and S frequency bands are available. Tunerless broadband klystrons in UHF, L and S Bands have been successfully produced to provide responses that are flat within 1 decibel over bandwidths ranging up to 8 percent under constant RF drive conditions. Minimum efficiencies are typically 35 percent.

Techniques for achieving broadband performance have been highly refined and computer-optimized. We are in a position to apply these techniques in deriving new types for bandwidths up to 10 percent, depending upon power level and frequency, with interest in the range from UHF to X-Band.

In our research and development activities, too, various techniques are continually under investigation for improving klystron efficiency, with space and airborne applications in mind. One experimental computer-optimized klystron, for example, has demonstrated an efficiency in excess of 60 percent without collector voltage depression.

Additional information on how these techniques can be applied to your klystron needs may be obtained by contacting your local GE Electronic Components Sales Office.

ZM-6802

KLYSTRON

1250 – 1350 Megacycles	10 Megawatts Peak Output
Pulsed	40-Decibel Gain

The ZM-6802 is a broad-band pulsed amplifier designed to deliver 10 megawatts of peak power over a frequency range of 1250 to 1350 megacycles at a maximum radio-frequency duty cycle of 0.0015. This tube features notably uniform performance over the frequency range. The variation in power output over the entire 100-megacycle bandwidth is 1 decibel or less with a constant amount of radio-frequency driving power.

GENERAL

Electrical	Minimum	Bogey	Maximum	
Frequency	1250	--	1350	Megacycles
Heater				
Voltage	14.5	15.5	16.5	Volts
Current	--	16.0	--	Amperes
Surge Current	--	--	24	Amperes
Cathode Preheat Time	10	--	--	Minutes
Focusing				
Field	--	1000	--	Gausses
Field Power	--	4.5	--	Kilowatts
Ion-Pump Voltage *	--	2.5	--	Kilovolts

Mechanical
- Mounting Position – Vertical, Cathode Down
- Cooling – Water or 60% Ethylene Glycol and Water †
  - Flow Rate, minimum . . . . . 30 Gallons per Minute
  - Pressure Drop, approximate . . . . . 50 Pounds per Square Inch
- Dimensions
  - Overall Length, maximum . . . . . 72.675 Inches
  - Weight, approximate . . . . . 150 Pounds
- Connections
  - RF Input – To Fit Coaxial Connector UG-21B/U
  - RF Output – To Fit Waveguide Flange UG-417A/U
  - Cathode – For Plug-in Installation(See Outline)
  - Coolant – To Fit Hanson No. 6S32 Socket or Equivalent
- Waveguide Pressure . . . . . 15 Pounds per Square Inch
- X-Ray Shielding ‡
- Cathode Insulation – The Cathode Insulator Must be Immersed in General Electric No. 10C Insulating Oil or Equivalent

ACCESSORIES

Collector Magnet Coil

Electrical	Typical Operation	Maximum	
Voltage	145	--	Volts
Current	8	10	Amperes

Mechanical
- Connection – Amphenol, MS-3102A-16-9P or Equivalent
- Coolant Interconnections
  - Collector – Hanson No. 6S32 or Equivalent
  - Body – Hanson No. 2S16 or Equivalent
- Weight, approximate . . . . . 90 Pounds

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

PULSED RADIO-FREQUENCY AMPLIFIER

Maximum Ratings, Absolute Values

Beam		
Pulse Voltage	205	Kilovolts
Pulse Current	170	Amperes
Pulse Length	7	Microseconds
Duty Cycle	0.0017	
Radio-Frequency Duty Cycle	0.0016	
Power Input		
Peak	35	Megawatts
Average	60	Kilowatts
Body Power Dissipation ¶	7	Kilowatts

Typical Operation

Beam		
Pulse Voltage	190	Kilovolts
Peak Current	158	Amperes
Average Current	270	Milliamperes
Peak Power Input	30	Megawatts
Pulse Repetition Rate	244	Pulses per Second
Radio-Frequency Output Pulse Length	6.2	Microseconds
Radio-Frequency Output Duty Cycle	0.0015	
Radio-Frequency Output Power		
Peak	10	Megawatts
Average	15	Kilowatts
Radio-Frequency Peak Driving Power	1	Kilowatt
Power Gain §	40	Decibels
Efficiency	33	Percent
Bandwidth, 1-decibel point for constant drive	100	Megacycles

* This tube features an integral ion pump capable of absorbing gas which may evolve from or diffuse through tube materials. Operation of the pump requires the indicated d-c voltage and a magnetic field. When installed in the socket it utilizes the magnetic field provided to focus the electron beam.

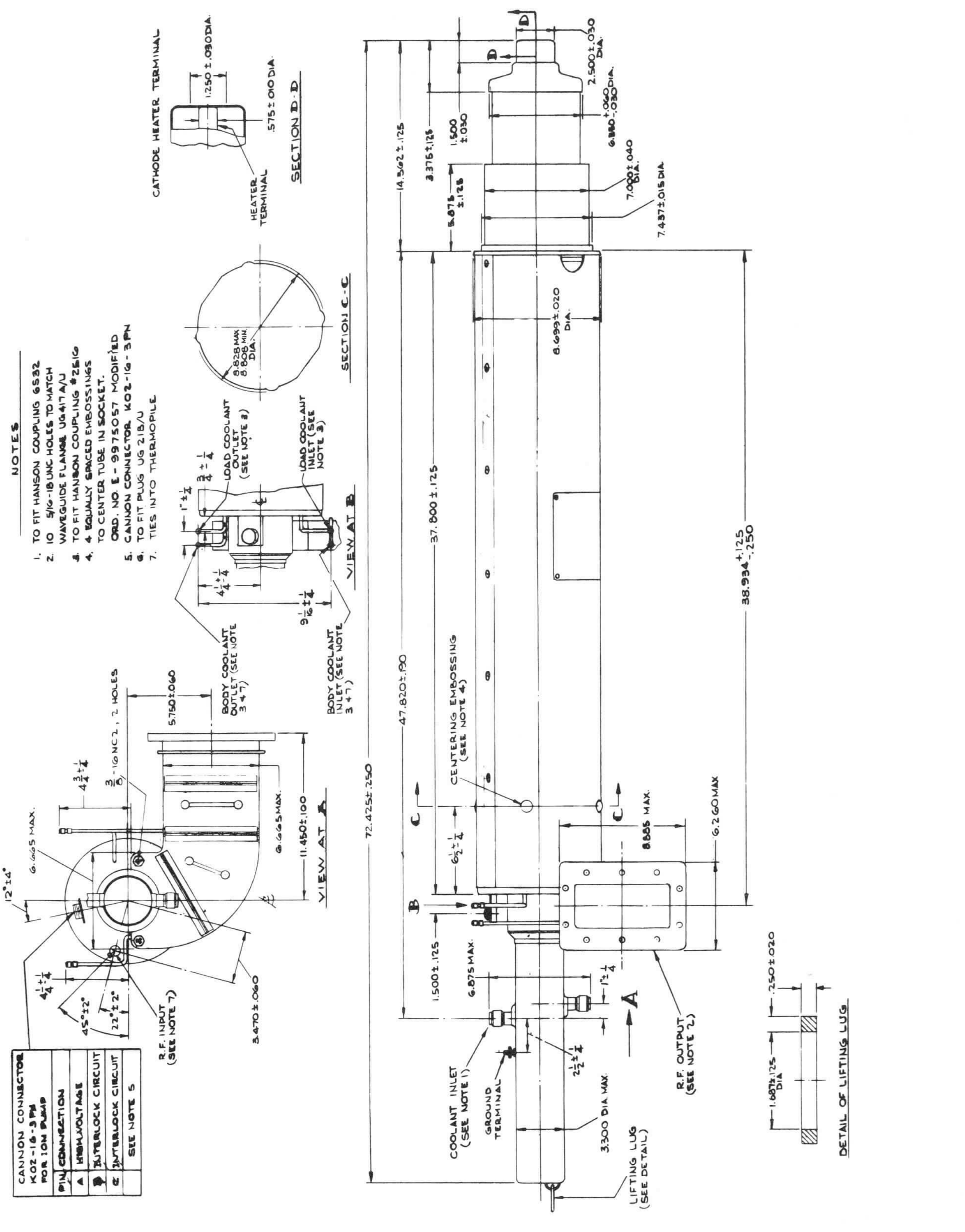
† Liquid cooling of the collector and body of the tube and of the collector magnet coil is required. These coolant circuits are connected in parallel when the collector magnet coil is properly installed on the tube. The flow specified is for maximum ratings and includes all coolant circuits. A recirculating coolant system constructed of non-corrosive material should be used in conjunction with distilled or deionized water and pure ethylene glycol. Rust inhibiting additives must not be used.

‡ The ZM-6802 is a source of dangerous X-ray radiation whenever beam voltage is applied. Adequate shielding must be provided for the protection of personnel. In designing a shield for protection to a specific level and for a specific application the following sources should be consulted:

X-RAY PROTECTION DESIGN, Handbook No. 50, National Bureau of Standards, Washington, D. C.
X-RAY PROTECTION, Handbook No. 60, National Bureau of Standards, Washington, D. C.
The above references are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.
SAFETY CODE FOR THE INDUSTRIAL USE OF X-RAYS, Bulletin No. Z54-1. American Standards Association, New York 17, N. Y.

¶ A thermopile unit mounted on the collector coil measures the rise in temperature in the coolant circuit which absorbs heat produced by interception of electron energy by the klystron tunnels. This temperature rise converted to kilowatts provides a means of detecting and protecting against excessive body dissipation which can damage or destroy the tube.

§ The indicated power gain is computed from the ratio of peak radio-frequency power output to peak radio-frequency power input. The typical-operation parameters are based on the use of a drive pulse which is somewhat longer than the beam-voltage pulse in order to convert the maximum amount of d-c beam power into radio-frequency power.


NOTES
1. TO FIT HANSON COUPLING 6532
2. 10 5/16-18UNC HOLES TO MATCH WAVEGUIDE FLANGE UG417A/U
3. TO FIT HANSON COUPLING #2610
4. 4 EQUALLY SPACED EMBOSSINGS TO CENTER TUBE IN SOCKET.
ORD. NO. E-9975057 MODIFIED
5. CANNON CONNECTOR K02-16-3PN
6. TO FIT PLUG UG 218/U
7. TIES INTO THERMOPILE
CANNON CONNECTOR K02-16-3PN FOR ION PUMP
PIN | CONNECTION
A | HIGH VOLTAGE
B | INTERLOCK CIRCUIT
C | INTERLOCK CIRCUIT
SEE NOTE 5
VIEW AT A
VIEW AT B
SECTION C-C
SECTION D-D
CATHODE HEATER TERMINAL
HEATER TERMINAL
BODY COOLANT OUTLET (SEE NOTE 3+7)
BODY COOLANT INLET (SEE NOTE 3+7)
LOAD COOLANT OUTLET (SEE NOTE 3)
LOAD COOLANT INLET (SEE NOTE 3)
R.F. INPUT (SEE NOTE 7)
R.F. OUTPUT (SEE NOTE 2)
COOLANT INLET (SEE NOTE 1)
GROUND TERMINAL
CENTERING EMBOSSING (SEE NOTE 4)
LIFTING LUG (SEE DETAIL)
DETAIL OF LIFTING LUG
72.425±.250
47.820±.190
37.800±.125
14.562±.125
38.934 +.125 -.250
11.450±.100
5.750±.060
3.470±.060
8.699±.020 DIA.
7.457±.015 DIA.
7.000±.040 DIA.
2.500±.030 DIA.
3.300 DIA MAX.
6.260 MAX
8.885 MAX.
6.665 MAX.
6.875 MAX.
1.500±.125
1.250±.030 DIA.
.575±.010 DIA.
.250±.020
1.687±.125 DIA

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

MILITARY EQUIPMENT TYPES MANUAL

MET-12J

VOLTAGE-TUNABLE MAGNETRONS

Selection Chart

LOW-POWER VOLTAGE-TUNABLE MAGNETRONS (up to 1 watt)

TUBE TYPE	FREQUENCY RANGE (MC)	MINIMUM POWER OUTPUT (WATTS)	NOISE (DB/MC)	POWER VARIATION DB	TUNING SENSIT. MC/V	SIZE CU. IN.	WGT. LBS.	MAXIMUM VOLTAGES (VOLTS)			MAXIMUM CURRENTS		
								ANODE	INJ.	FIL.	MA ANODE	MA INJ.	A FIL.
ZM-6085	885-1485	0.036[d]	—86[f]	5[i]	1.00	130	4.00	1625	250	2.6	20	1.0	2.10
ZM-6051	1000-2000[c]	0.100	—75[g]	6[j]	1.50	64	3.00	2000	300	2.3	10	1.0	2.50
ZM-6238[a]	1000-2000	1.000	—	3[j]	1.15	24	1.50	2000	300	3.0	25	1.0	2.1
ZM-6086	1420-2607	0.036[d]	—86[f]	5[i]	1.66	130	4.00	1740	250	2.6	20	1.0	2.1
ZM-6222[a]	2000-4000	1.000	—	4[j]	2.30	24	1.50	2000	400	3.0	25	1.0	2.1
ZM-6087	2507-4310	0.036[e]	—86[f]	5[i]	2.88	130	4.00	1700	250	2.6	20	1.0	2.10
ZM-6205[b]	2750-3090	1.000	—95[h]	1.2	3.35	60	2.75	1000	205	3.0	12	0.1	2.05

(a) These VTM's are magnetically and RFI shielded. Integral isolator optional.
(b) All characteristics for this VTM have been obtained with a 3:1 mismatch. This tube has integral isolator.
(c) Frequency range can be extended for this tube on special order to 1000-2500 mc.
(d) This power level is measured at the output of a 10 db integral attenuator; this VTM is available with 0.300 watts.
(e) This power level is measured at the output of a 13 db integral attenuator; this VTM is available with 0.55 watts.
(f) These noise levels are measured with respect to the carrier level over a noise band of 59-61 mc from carrier.
(g) These noise levels are measured with respect to the carrier level over a noise band of 56-64 mc from carrier.
(h) These noise levels are measured with respect to the carrier level at 30 mc away from carrier.
(i) This power variation is measured with the VTM operating into a 2:1 mismatch.
(j) This power variation is measured with the VTM operating into a matched load.

NOTE: Capability exists from 700 mc to 5600 mc and feasibility has been demonstrated in X-band and down to 100 mc. Tubes with specific center frequencies, power levels, bandwidths and pertinent parameters are available on special order. Consult your local GE Electronic Components Sales Office or the GE Microwave Tube Operation, Marketing Section, Bldg. 269, Schenectady, New York, 12305, telephone: (518) 374-2211, extensions 5-3433 or 5-2227.

MILITARY EQUIPMENT TYPES MANUAL

VOLTAGE-TUNABLE MAGNETRONS

INTERMEDIATE-POWER VOLTAGE-TUNABLE MAGNETRONS (1 to 10 watts)

TUBE TYPE	FREQUENCY RANGE (MC)	MINIMUM POWER OUTPUT (WATTS)	SWEPT EFF. %	POWER VARIATION DB	TUNING SENSIT. MC/V	SIZE CU. IN.	WGT. LBS.	MAXIMUM VOLTAGES (VOLTS)			MAXIMUM CURRENTS		
								ANODE	INJ.	FIL.	MA ANODE	MA INJ.	A FIL.
ZM-6242[ab]	1775-1925	3.00	30	1[c]	1.75	21	2.0	1500	500	2.2	20	1.0	2.54
ZM-6203	2475-2725	1.75	10	3.5[c]	2.50	46	3.5	1200	315	2.8	22	1.0	2.00
ZM-6220	2475-2725	1.50	15	3[c]	2.50	46	3.5	1200	315	2.8	22	1.0	2.00
ZM-6211A[a]	2500-3500	10.00	25	3[d]	1.80	22	1.5	2500	700	2.6	40	1.0	3.20
ZM-6265[ab]	2500-3500	10.00	25	3[d]	1.80	9	1.0	2500	700	2.7	40	1.0	3.00
ZM-6243[ab]	2890-3110	3.00	15	1[c]	3.00	21	2.0	1500	500	2.2	30	1.0	2.54
ZM-6257[a]	3500-4500	10.00	45	3.0[c]	2.20	24	1.5	2000	500	2.5	40	1.0	3.40

(a) This VTM is magnetically shielded.
(b) This VTM has integral isolator.
(c) Readings taken with matched load.
(d) Maximum rating into a matched load is 1.5 db.

NOTE: Capability exists from 700 mc to 5600 mc and feasibility has been demonstrated in X-band and down to 100 mc. Tubes with specific center frequencies, power levels, bandwidths and pertinent parameters are available on special order. RFI shielding and integral isolators can also be added to VTM's which do not have them, upon request. Consult your local GE Electronic Components Sales Office or the GE Microwave Tube Operation, Marketing Section, Bldg. 269, Schenectady, New York, 12305, telephone: (518) 374-2211, extensions 5-3433 or 5-2227.

HIGH-POWER VOLTAGE-TUNABLE MAGNETRONS (above 10 watts)

TUBE TYPE	FREQUENCY RANGE (MC)	MINIMUM POWER OUTPUT (WATTS)	SWEPT EFF. %	POWER VARIATION DB	TUNING SENSIT. MC/V	SIZE CU. IN.	WGT. LBS.	MAXIMUM VOLTAGES (VOLTS)			MAXIMUM CURRENTS		
								ANODE	INJ.	FIL.	MA ANODE	MA INJ.	A FIL.
ZM-6231ab	1220–1450	90	55	1.4c	0.45	50	7.0	3400	1500	2.5	70	1.0	6.0
ZM-6239ab	2600–3050	90	60	1.4c	0.90	45	4.5	3500	1500	2.5	70	1.0	6.0
ZM-6046b	2600–2900	90	60	1.0c	1.00	100	7.5	3100	1300	2.5	70	±0.5	5.7
ZM-6276ab	2600–3200	100	60	1.4c	1.00	45	4.5	3400	1700	2.5	80	1.0	6.0
ZM-6240ab	2860–3310	90	55	1.4c	1.00	45	4.5	3500	1500	2.5	70	1.0	6.0
ZM-6277ab	2860–3460	100	55	1.4c	1.00	45	4.5	3400	1700	2.5	80	1.0	6.0
ZM-6047b	2900–3200	90	55	1.0c	1.00	100	7.5	3100	1300	2.5	70	±0.5	5.7
ZM-6246b	4800–5300	75	55	1.4c	2.00	100	7.0	3200	1500	2.5	70	1.0	6.0

(a) This VTM is magnetically shielded.
(b) This VTM has integral isolator.
(c) Readings taken with matched load.

NOTE: Power levels in excess of 500 watts have been attained. Capability exists from 1000 mc to 5600 mc. Tubes with specific center frequencies, power levels, bandwidths and pertinent parameters are available on special order. RFI shielding and integral isolators can also be added to VTM's which do not have them, upon request. Consult your local GE Electronic Components Sales Office or the GE Microwave Tube Operation, Marketing Section, Bldg. 269, Schenectady, New York, 12305, telephone: (518) 374-2211, extensions 5-3433 or 5-2227.

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZM-6046

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2600-2900 Megacycles — 90 Watts Average CW Output

Integral Magnet and Isolator

The ZM-6046 is a voltage-tuned magnetron designed for CW/FM transmitting-tube operation at low- or high-modulation frequencies. The tube has a minimum power output of 75 watts at any point in the band. The typical tube averages 90 watts across the band. The high efficiency allows air cooling to be used. The tube is protected against load mismatch by an integral isolator. The voltage-frequency relationship is approximately linear. The anode is integral with the tube body and is normally grounded, anode voltage being applied negatively to the cathode and filament.

GENERAL

Electrical

Cathode (filament) - Directly Heated		
Warm-up Time, maximum	10	Seconds
Cathode Input Capacitance		
Maximum	35	μμf
Typical	32	μμf

Mechanical

Mounting Position - Any		
Net Weight	7.0	Pounds

Thermal

Cooling - Forced Air *		
Air Temperature, maximum	110	C
Body Temperature, maximum †	125	C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values

Filament Voltage	2.5	Volts
Filament Current ‡	6.0	Amperes
Anode Voltage	3200	Volts
Sweep Voltage	500	Volts
Anode Current, swept	70	Milliamperes
Power Input	225	Watts
Injection Electrode Voltage	1300	Volts
Voltage Standing Wave Ratio of Load	2.0	
Frequency Range **	2550-2950	Megacycles

Typical Operating Conditions

Operation with 60-cycle Sweep Voltage

Filament Voltage, approximate	2.1	Volts
Filament Current ‡	4.4 to 5.6	Amperes
Swept Frequency Range	2600 to 2900	Megacycles
Sweep Voltage, Peak to Peak, typical	350	Volts
Anode Voltage at 2.75 Gigacycles	2800	Volts
Anoce Current	55	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	500 to 1300	Volts ¶
Injection Electrode Current, may be either polarity but less than	0.5	Milliamperes

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd.)

Typical Operating Conditions (Cont'd.)

Operation with 60-cycle Sweep Voltage (Cont'd)

Power Output		
Average, Swept Across Full Band	90	Watts ***
Minimum, At Any Point Without Sweep Voltage	75	Watts ***
Variation Across Band		
Typical	1.4	Decibels
Maximum	2.0	Decibels
Efficiency, minimum		
At Any Frequency	50	Percent
Swept Across Full Band	60	Percent

ENVIRONMENTAL

Altitude, maximum		
Operating	15,000	Feet
Non-operating	70,000	Feet

* Hold temperature to 125 C or less at point shown on the outline drawing. At the maximum inlet temperature of 110 C, 100 cubic feet per minute is required but this drops rapidly for lower inlet temperatures.

† Measured at point shown on the outline drawing.

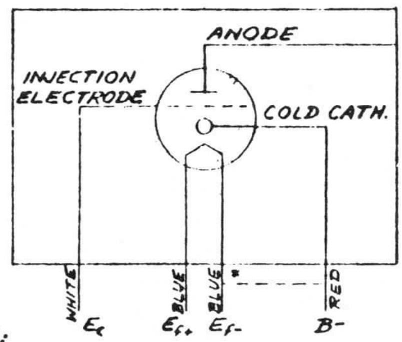
‡ Set to value marked on tube within ± 0.1 ampere.

** VTM operable over this frequency range but at reduced power level.

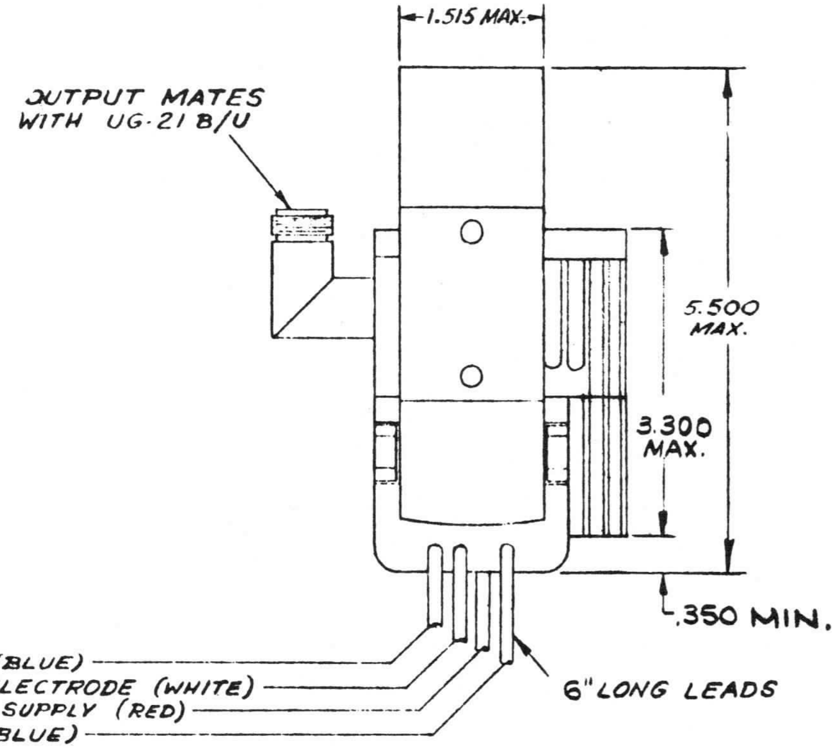
¶ Set to give anode current marked on tube within ± 2 milliamperes.

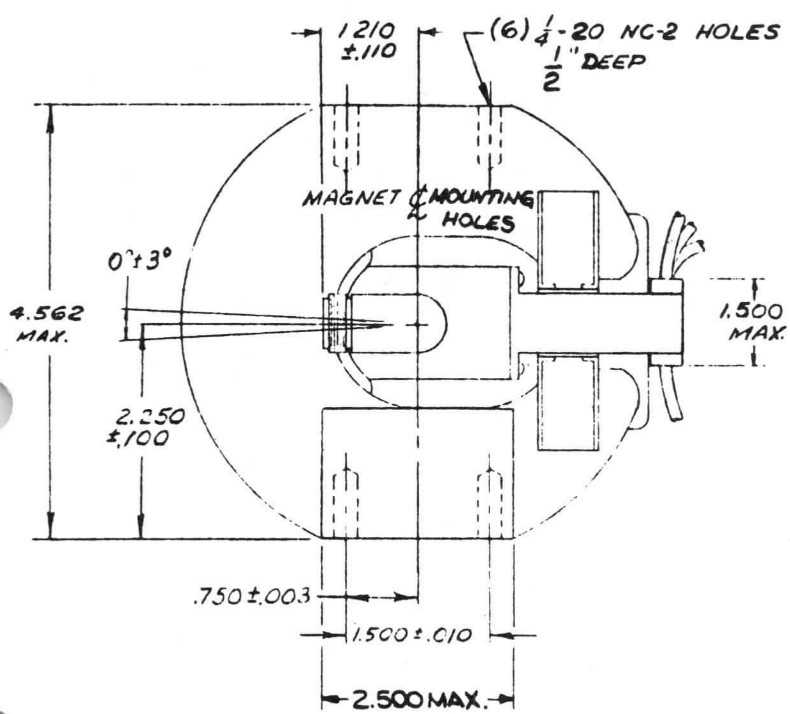
*** Measured with load VSWR < 1.2; for loads between 1.2 and 2.0 VSWR the power output is diminished by the amount reflected, plus a positive or negative change due to residual pulling. At 2.0 VSWR the theoretical reduction at the worst load phase is down to 85 percent, and the guaranteed performance is not less than 75 percent of rated power.

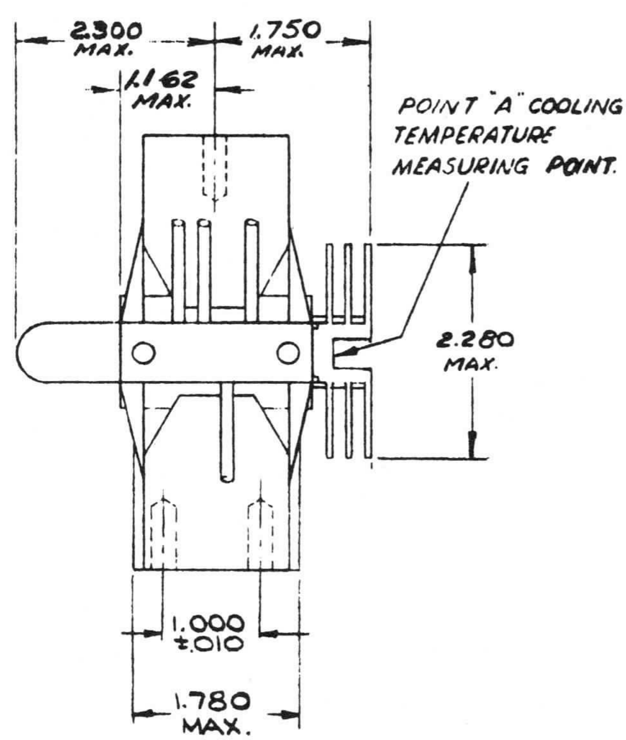
CAUTION: A CLEARANCE OF SIX INCHES BETWEEN FERROMAGNETIC MATERIALS AND THE TUBE WILL PREVENT ANY SERIOUS CHANGE OF THE OPERATING CHARACTERISTICS.



*NOTE:
AN EXTERNAL CONNECTION IS REQUIRED BETWEEN THE COLD CATH. LEAD ¢ ONE OF THE HEATER LEADS







ZM-6047

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2900-3200 Megacycles — 90 Watts Average CW Output

Integral Magnet and Isolator

The ZM-6047 is a voltage-tuned magnetron designed for CW/FM transmitting-tube operation at low- or high-modulation frequencies. The tube has a minimum power output of 75 watts at any point in the band. The typical tube averages 90 watts across the band. The high efficiency allows air cooling to be used. The tube is protected against load mismatch by an integral isolator. The voltage-frequency relationship is approximately linear. The anode is integral with the tube body and is normally grounded, anode voltage being applied negatively to the cathode and filament.

GENERAL

Electrical		
Cathode (filament) – Directly Heated		
Warm-up Time, maximum	10	Seconds
Cathode Input Capacitance		
Maximum	35	μμf
Typical	32	μμf
Mechanical		
Mounting Position – Any		
Net Weight	7.0	Pounds
Thermal		
Cooling – Forced Air *		
Air Temperature, maximum	110	C
Body Temperature, maximum †	125	C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values		
Filament Voltage	2.5	Volts
Filament Current ‡	6	Amperes
Anode Voltage	3200	Volts
Sweep Voltage	500	Volts
Anode Current, swept	70	Milliamperes
Power Input	225	Watts
Injection Electrode Voltage	1300	Volts
Voltage Standing Wave Ratio of Load	2.0	
Frequency Range **	2850-3250	Megacycles
Typical Operating Conditions		
Operation with 60-cycle Sweep Voltage		
Filament Voltage, approximate	2.1	Volts
Filament Current ‡	4.4 to 5.6	Amperes
Swept Frequency Range	2900 to 3200	Megacycles
Sweep Voltage, Peak to Peak, typical	350	Volts
Anode Voltage at 3.05 Gigacycles	2800	Volts
Anode Current	65	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	500 to 1300	Volts ¶
Injection Electrode Current, may be either polarity but less than	0.5	Milliamperes

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd.)

Typical Operating Conditions (Cont'd.)

Operation with 60-cycle Sweep Voltage (Cont'd.)

Power Output		
Average, Swept Across Full Band	90	Watts ***
Minimum, At Any Point Without Sweep Voltage	75	Watts ***
Variation Across Band		
Typical	1.4	Decibels
Maximum	2	Decibels
Efficiency, minimum		
At Any Frequency	50	Percent
Swept Across Full Band	55	Percent

ENVIRONMENTAL

Altitude, maximum		
Operating	15,000	Feet
Non-operating	70,000	Feet

* Hold temperature to 125 C or less at point shown on the outline drawing. At the maximum inlet temperature of 110 C, 100 cubic feet per minute is required but this drops rapidly for lower inlet temperatures.

† Measured at point shown on the outline drawing.

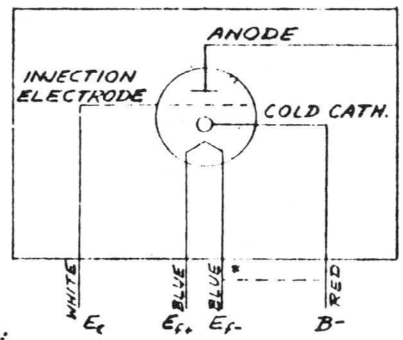
‡ Set to value marked on tube within ±0.1 ampere.

** VTM operable over this frequency range but at reduced power level.

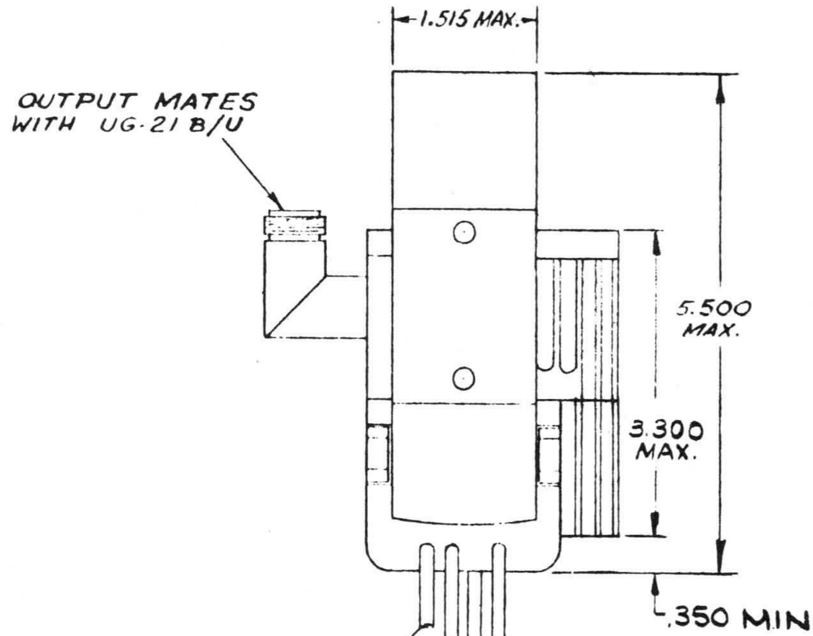
¶ Set to give anode current marked on tube within ±2 milliamperes.

*** Measured with load VSWR <1.2; for loads between 1.2 and 2.0 VSWR the power output is diminished by the amount reflected, plus a positive or negative change due to residual pulling. At 2.0 VSWR the theoretical reduction at the worst load phase is down to 85 percent, and the guaranteed performance is not less than 75 percent of rated power.

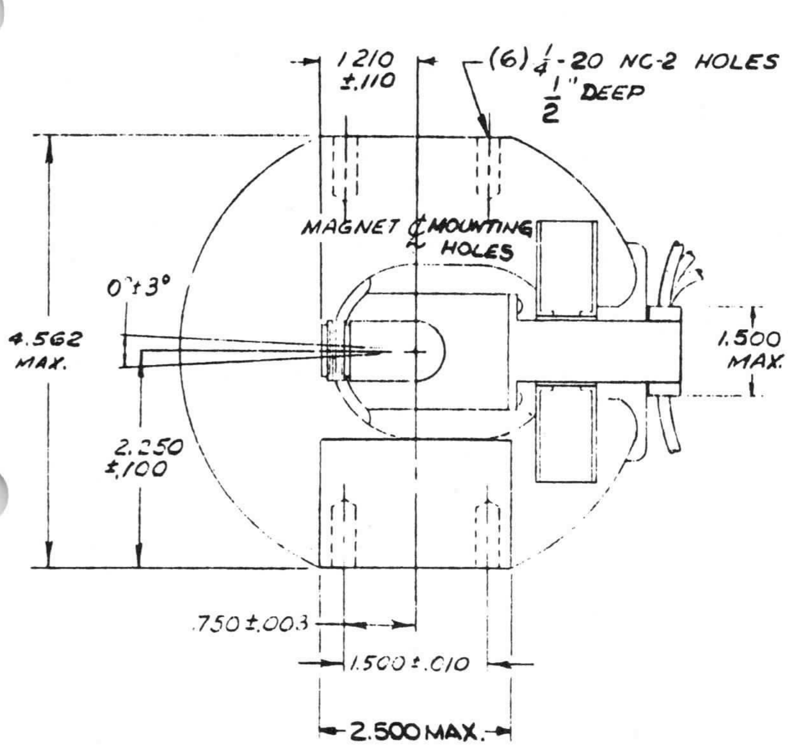
CAUTION: A CLEARANCE OF SIX INCHES BETWEEN FERROMAGNETIC MATERIALS AND THE TUBE WILL PREVENT ANY SERIOUS CHANGE OF THE OPERATING CHARACTERISTICS.

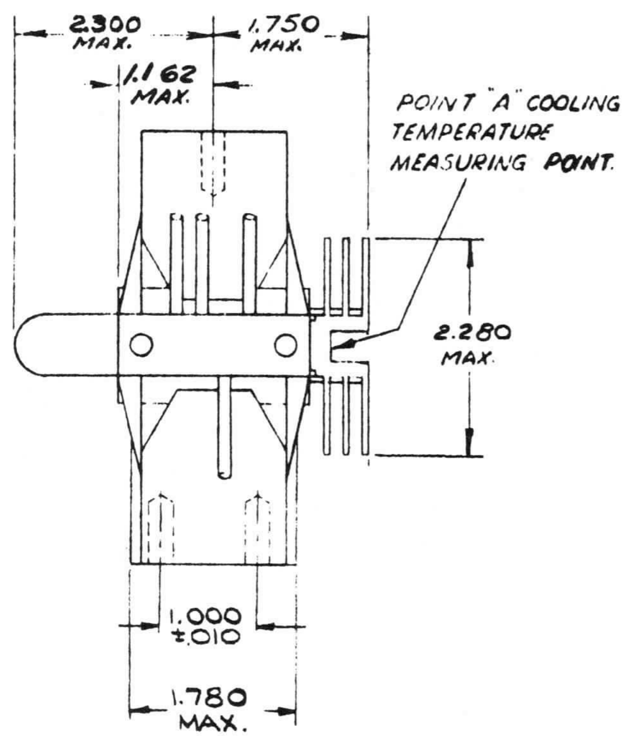


*NOTE:
AN EXTERNAL CONNECTION IS REQUIRED BETWEEN THE COLD CATH. LEAD & ONE OF THE HEATER LEADS



CONNECTS TO FILAMENT SUPPLY (BLUE)
CONNECTS TO POS. OF INJECTION ELECTRODE (WHITE)
CONNECTS TO NEGATIVE OF ANODE SUPPLY (RED)
CONNECTS TO FILAMENT SUPPLY (BLUE)





ZM-6051

PACKAGED VOLTAGE-TUNABLE MAGNETRON

1000-2000 Megacycles — 100 Milliwatts CW Output

The ZM-6051 is a packaged voltage-tunable magnetron designed for low-noise, voltage-tunable operation in the 1000-to-2000-megacycle frequency range. It is a complete r-f power source package requiring only input power connections and an r-f power-output connection and has a minimum CW power output of one-hundred milliwatts across the entire frequency range. The tube may be voltage-tuned over a portion or all of the frequency range for which it is designed or operated at a fixed frequency. The voltage-frequency relationship is essentially linear.

TECHNICAL INFORMATION

GENERAL

Electrical

Cathode-Directly Heated

Filament Voltage*, DC	2-3	Volts
Filament Current*	2	Amperes

Mechanical

Mounting Position — Any

Net Weight	3.5	Pounds

Thermal

Type of Cooling - Conduction or Convection

Ambient Air Temperature, Operating, Maximum	85	C
Temperature Compensation, -35 to +85C	0.4	Percent

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

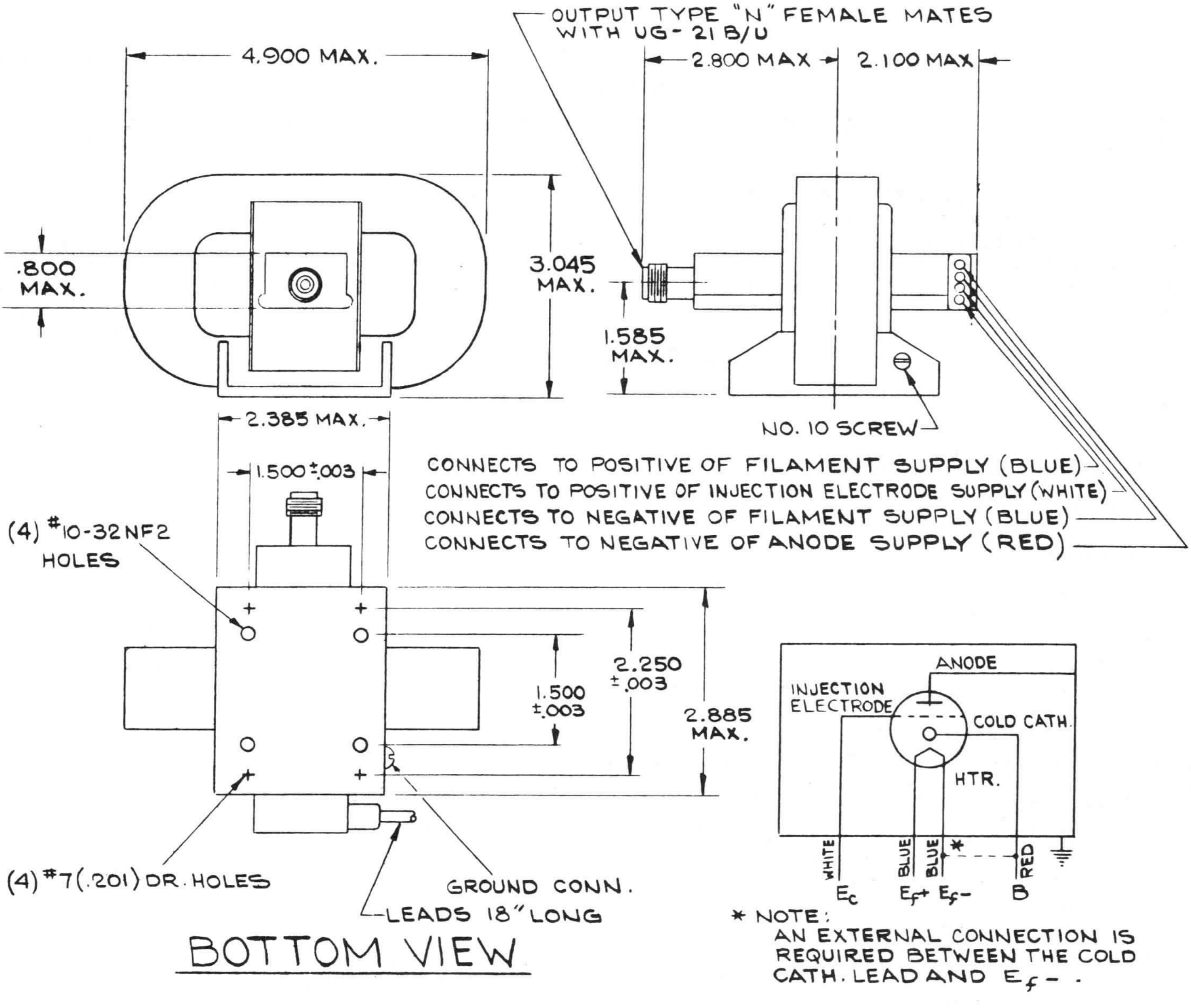
Maximum Ratings, Absolute Values

Anode Voltage	1500	Volts
Anode Current	10	Milliamperes
Injection Electrode Voltage	200	Volts
Injection Electrode Current	1.0	Milliamperes
Filament Current	2.1	Amperes
Voltage Standing Wave Ratio of Load	1.5	

Typical Operating Conditions

Tunable Range †	1000-2000	Megacycles
Filament Voltage	2.7	Volts
Filament Current *	2.0	Amperes
Average Tuning Sensitivity	1.44	Megacycles per Volt
Anode Voltage	755-1450	Volts
Anode Current	1.5-4.0	Milliamperes
Injection Electrode Voltage	140	Volts
Injection Electrode Current	0	Microamperes
Voltage Standing Wave Ratio of Load	1.2/1	
Power Output	250-350	Milliwatts
Power Variation over Band	Less than 3:1	
Noise ‡	75	Decibels below Carrier

* Filament current should be adjusted to the value specified on the nameplate.
† Frequency controlled by anode voltage.
‡ Measured 60 megacycles from carrier using the tube as the local oscillator of a receiver with a bandwidth of 2 megacycles about the carrier.


OUTPUT TYPE "N" FEMALE MATES WITH UG-21 B/U
4.900 MAX.
2.800 MAX
2.100 MAX
.800 MAX.
3.045 MAX.
1.585 MAX.
NO. 10 SCREW
2.385 MAX.
1.500 ±.003
(4) #10-32NF2 HOLES
CONNECTS TO POSITIVE OF FILAMENT SUPPLY (BLUE)
CONNECTS TO POSITIVE OF INJECTION ELECTRODE SUPPLY (WHITE)
CONNECTS TO NEGATIVE OF FILAMENT SUPPLY (BLUE)
CONNECTS TO NEGATIVE OF ANODE SUPPLY (RED)
1.500 ±.003
2.250 ±.003
2.885 MAX.
ANODE
INJECTION ELECTRODE
COLD CATH.
HTR.
WHITE
BLUE
BLUE
RED
E_c E_f+ E_f- B
(4) #7 (.201) DR. HOLES
GROUND CONN.
LEADS 18" LONG
BOTTOM VIEW
* NOTE:
AN EXTERNAL CONNECTION IS REQUIRED BETWEEN THE COLD CATH. LEAD AND E_f-.

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZM-6085, ZM-6086, ZM-6087

PACKAGED VOLTAGE-TUNABLE MAGNETRONS

885 – 1485, 1420 – 2607,
2507 – 4310 Megacycles

36 Milliwatts
CW Output

These tubes are a complete r-f power-source package requiring only input power connections and an r-f power-output connection. The minimum CW power output across the frequency range is 36 milliwatts. The tubes may be voltage-tuned over a portion or all of the frequency range for which they are designed. Power output variation into 2/1 VSWR load is less than 6 decibels.

A built-in 10 decibel attenuator makes these tubes particularly suitable for use without a circulator or isolator.

GENERAL

	ZM-6085	ZM-6086	ZM-6087	
Electrical				
Cathode – Directly Heated				
Filament Voltage *			2.3	Volts
Filament Current *			2.0	Amperes
Mechanical				
Mounting Position – Any				
Net Weight			4.0	Pounds
Altitude			100,000	Feet
Thermal				
Type of Cooling – Conduction or Convection				
Ambient Air Temperature, operating			85	C Max

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

	ZM-6085	ZM-6086	ZM-6087 (see page 2)
Maximum Ratings, Absolute Values			
Filament Current	2.1	2.1	Amperes
Anode Voltage	1625	1740	Volts
Anode Current	20	20	Milliamperes
Power Input, with forced-air cooling	25	25	Watts
Injection-Electrode Voltage	250	250	Volts
Power Output	150	150	Milliwatts
Typical Operating Conditions			
Operation with 60-cycle Sweep Voltage			
Tunable Range †	885 – 1485	1420 – 2607	Megacycles
Filament Voltage	2.2 – 2.3	2.4 – 2.6	Volts
Filament Current *	2.0	2.0	Amperes
Tuning Sensitivity, average	1.0	1.66	Megacycles per volt
Anode Voltage	980 – 1575	964 – 1664	Volts
Anode Current	3 – 8	3 – 10	Milliamperes
Voltage Standing Wave-Ratio of Load	1.2/1	1.2/1	
Power Output	50 – 80	50 – 70	Milliwatts
AM Noise # – Adjusted for Minimum			
FM Noise # – Adjusted for Minimum			
Injection-Electrode Voltage	170	160	Volts

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont.)

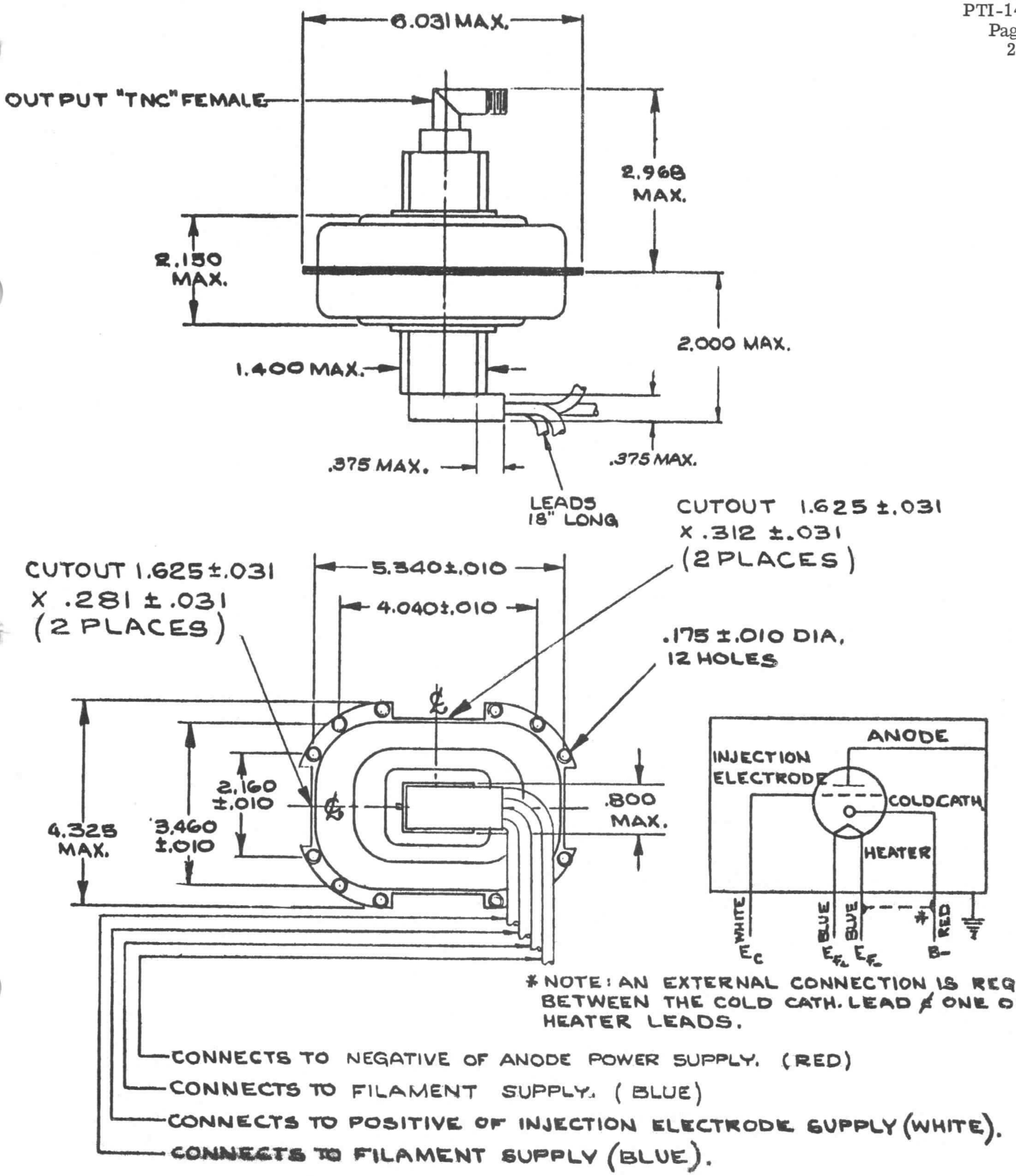
	ZM-6087	
Maximum Ratings, Absolute Values		
Filament Current	2.1	Amperes
Anode Voltage	1700	Volts
Anode Current	20	Milliamperes
Power Input, with forced-air cooling	25	Watts
Injection-Electrode Voltage	250	Volts
Power Output	150	Milliwatts
Typical Operating Conditions		
Tunable Range †	2507 – 4310	Megacycles
Filament Voltage *	2.4 – 2.6	Volts
Filament Current *	2.0	Amperes
Tuning Sensitivity, average	2.88	Megacycles per Volt
Anode Voltage	955 – 1575	Volts
Anode Current	4 – 11	Milliamperes
Voltage Standing Wave-Ratio of Load	1.2/1	
Power Output	50 – 60	Milliwatts
AM Noise # – Adjusted for Minimum		
FM Noise # – Adjusted for Minimum		
Injection-Electrode Voltage	110	Volts

* Filament current should be adjusted to the value specified ± 1%.
† Frequency controlled by anode voltage.
\# Measured 60 megacycles from carrier using the tube as the local oscillator of a receiver with a bandwidth of 2 megacycles around the carrier. The noise should be adjusted to be at least -86 decibels below the carrier.

Note: Since a change in anode voltage of one volt produces the frequency change noted below, the ripple voltage of the anode supply should be low enough not to cause an excess of undesirable frequency modulation.

ZM-6085 1.0 megacycle, approximate
ZM-6086 1.66 megacycles, approximate
ZM-6087 2.88 megacycles, approximate

CAUTION: A CLEARANCE OF SIX INCHES BETWEEN FERROMAGNETIC MATERIALS AND THE TUBE WILL PREVENT ANY SERIOUS CHANGE OF THE OPERATING CHARACTERISTICS.



* NOTE: AN EXTERNAL CONNECTION IS REQUIRED BETWEEN THE COLD CATH. LEAD & ONE OF THE HEATER LEADS.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

DEVELOPMENTAL TYPE

ZM-6203
PTI-147A
Page 1
12-68

This technical information is proprietary and is furnished only as a service to customers.

ZM-6203
PACKAGED VOLTAGE-TUNABLE MAGNETRON

2475-2725 Megacycles — 1.75 Watts - 4.0 Watts Maximum

The ZM-6203 is a voltage-tunable magnetron for operation in the 2475 to 2725-megacycle frequency range. It is a complete r-f power-source package requiring only input power connections and an r-f power-output connection. The tube may be voltage tuned over a portion or all of the frequency range for which it is designed, or operated at a fixed frequency. The voltage frequency relationship is essentially linear.

GENERAL

	Min.	Bogey	Max.	
Electrical				
Cathode – Directly Heated				
Filament Voltage*	2.2		2.8	Volts
Filament Current*	1.9	2.0	2.1	Amperes
Mechanical				
Mounting Position – Any				
Net Weight, maximum			3.5	Pounds
Thermal				
Type of Cooling – Conduction through Mounting Surface				
Ambient Temperature, operating			125F	(Four Hours)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values

Filament Current	2.1	Amperes
Anode Voltage	1200	Volts
Anode Current	22	Milliamperes
Injection-Electrode Voltage**	315	Volts
Injection-Electrode Current, maximum	1.0	Milliamperes
VSWR of Load, maximum	1.3:1	

TYPICAL OPERATING CONDITIONS

Operation with 60-cycle Sweep Voltage

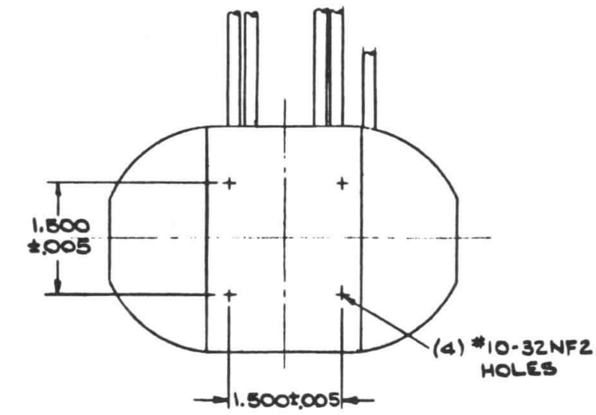
Tunable Range#	2475-2725	Megacycles
Tuning Sensitivity, approximate	2.5	Megacycles per Volt
Filament Voltage*, approximate	2.50	Volts
Filament Current*	2.0	Amperes
Anode Voltage at 2.6 gigacycles	1145	Volts
Anode Current, average	10	Milliamperes
Injection-Electrode Voltage (Positive with Respect to Cathode)**	300	Volts
Injection-Electrode Current	0.1	Milliamperes
Voltage Standing Wave Ratio of Load	1.1:1	
Power Output	1.75 Watts, minimum-4.0 Watts, maximum	

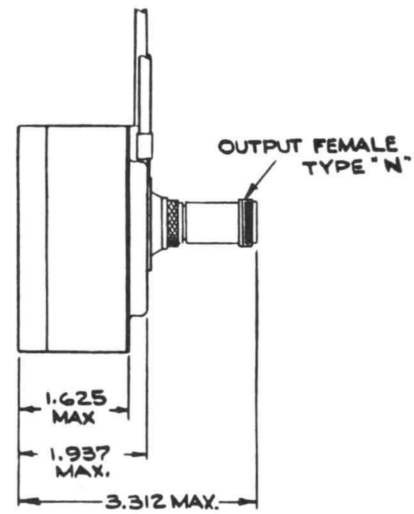
* Filament current should be adjusted to 2.0 amperes.

** Injection Electrode voltage should be adjusted to 300 volts $\pm 5\%$

\# Frequency controlled by anode voltage.

CAUTION: A clearance of 6 inches between ferromagnetic materials and the tube will prevent any serious change of the operating characteristics.


1.500
±.005
(4) #10-32NF2
HOLES
1.500±.005


OUTPUT FEMALE
TYPE "N"
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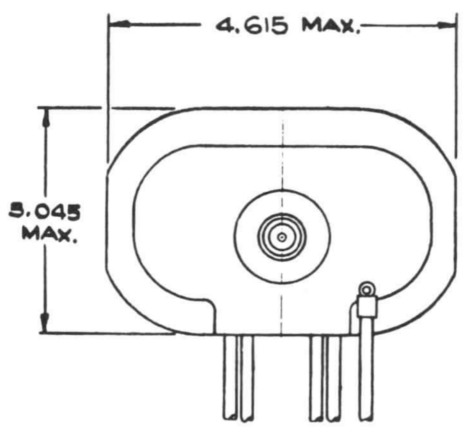
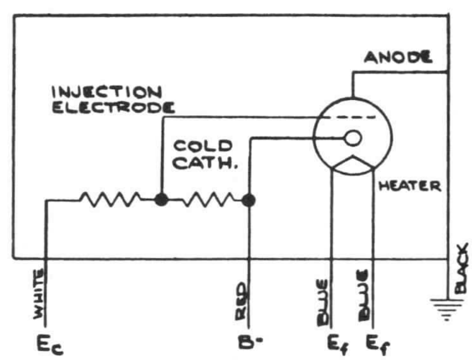
MAX
1.937
MAX.
3.312 MAX.


4.615 MAX.
3.045
MAX.


ANODE
INJECTION
ELECTRODE
COLD
CATH.
HEATER
WHITE
RED
BLUE
BLUE
BLACK
Ec
B-
Ef
Ef

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2750-3090 MEGACYCLES — 1.00-WATT OUTPUT

The ZM-6205 is a voltage-tunable magnetron with integral load isolator for voltage-tunable operation in the 2750-3090 megacycle frequency range. It is a complete r-f power source package requiring only input power connections and an r-f power-output connection and has a minimum CW power output of 1.00 watt across the entire frequency range. The tube may be voltage tuned over a portion or all of the frequency range for which it is designed.

The ZM-6205 has a noise level of -95 decibels with respect to carrier, a power variation limited to 1.2 decibels over its entire frequency range and is environmentalized for airborne applications.

GENERAL

	Min.	Bogey	Max.	
Electrical				
Cathode - Directly Heated				
Filament Voltage*	2.0	2.5	3.0	Volts
Filament Current*	1.95	2.0	2.05	Amperes
Mechanical				
Mounting Position - Any				
Net Weight			2.75	Pounds
Thermal				
Type of Cooling - Conduction or Convection				
Ambient Air Temperature, operating			+85	C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values		
Anode Voltage	1000	Volts
Anode Current	12	Milliamperes
Power Input, with Forced Air Cooling	18	Watts
Injection-Electrode Voltage	205	Volts
Injection-Electrode Current	0.1	Milliamperes
Filament Current	2.05	Amperes
Voltage Standing Wave Ratio of Load, maximum	3:1	
Typical Operating Conditions		
Operation with 60-cycle Sweep Voltage		
Filament Voltage*, approximate	2.50	Volts
Filament Current*	2.0	Amperes
Tunable Range#	2750-3090	Megacycles per Volt
Tuning Sensitivity, approximate	3.35	Megacycles per Volt
Anode Voltage at 2.945 gigacycles	1850	Volts
Anode Current, average	8	Milliamperes
Injection-Electrode Voltage, Positive with Respect to Cathode	75-205	Volts
Injection-Electrode Current	0.0	Microamperes
Power Output, minimum	1.0	Watts
Noise †	-95	Decibels/mc
Power Variation ‡	1.2	Decibels
Dynamic Tuning Rate Variation	±5	Percent

* Filament current should be adjusted to 2.0 amperes.

Frequency controlled by anode voltage.

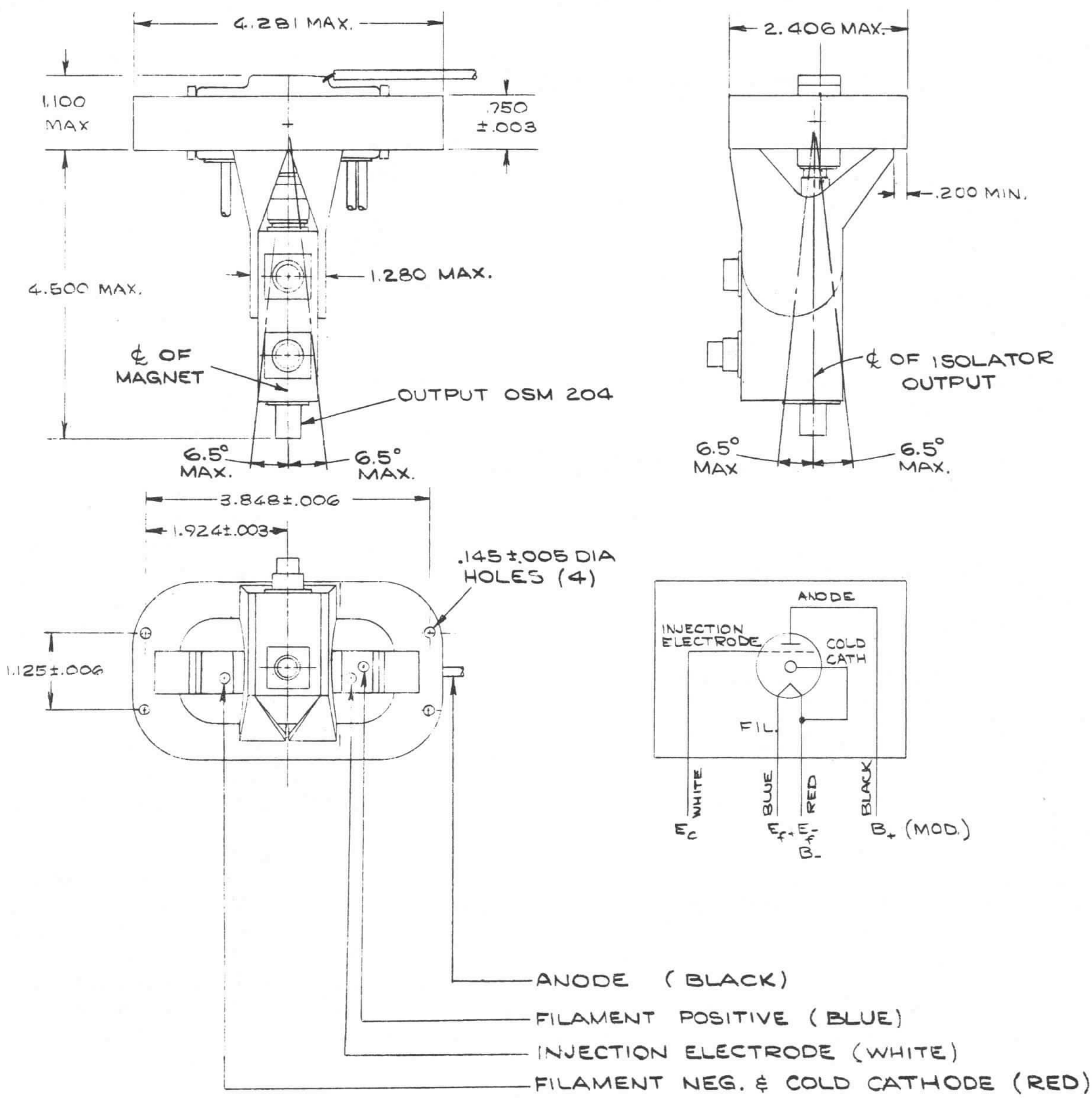
† This noise level is measured with respect to carrier level, 30 mc away from carrier.

‡ Measured across the entire frequency band and over a -55 C to +95 C magnet temperature range.

NOTE: Since a change in anode voltage of one volt produces a frequency change of approximately 3.35 megacycles, the anode supply should have sufficiently low ripple and high regulation to prevent an excess of frequency modulation.

CAUTION: A clearance of 6 inches between ferromagnetic materials and the tube will prevent serious change of the operating characteristics.

OUTLINE ZM-6205



NOTE:
USE NON-MAGNETIC STAINLESS STEEL MOUNTING SCREWS

A-69087-72B119

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZM-6211A

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2500-3500 Megacycles — 10 Watt CW Output

The ZM-6211A is a magnetically shielded voltage-tunable oscillator which operates at a minimum power output of 10 watts over the 2500 to 3500-megacycle frequency range. Unlike conventional electron devices employing magnetic fields, this shielded VTM is unaffected by passive magnetic materials. It does not require special tools, storage facilities or handling other than that normally given to a non-magnetic electron device. It is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned octave frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

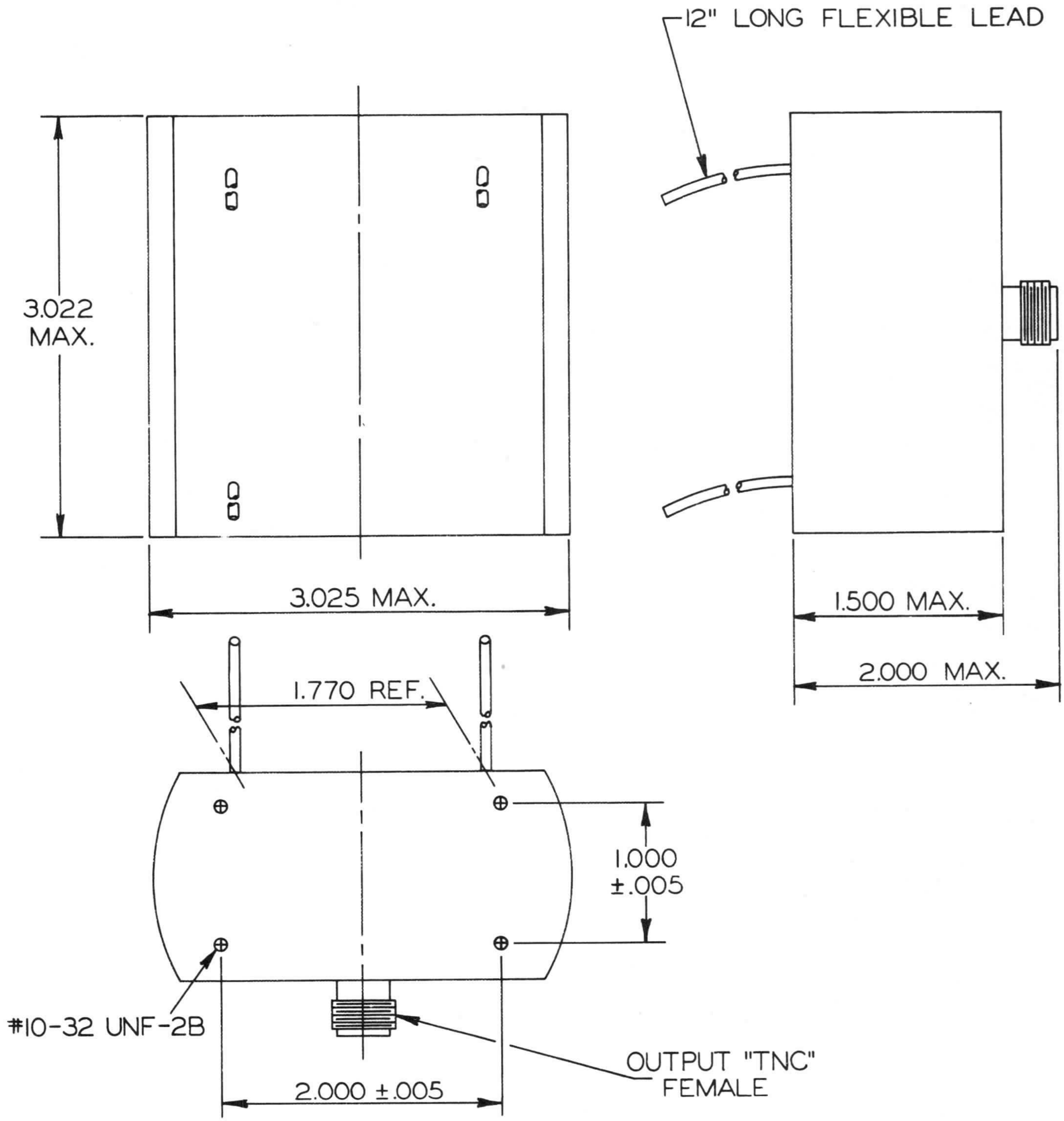
GENERAL

Electrical	Minimum	Bogey	Maximum	
Cathode – Directly Heated				
Filament Voltage *	2.0	2.3	2.6	Volts
Filament Current	–	3.0	–	Amperes

Mechanical		
Mounting Position		Any
Net Weight, maximum	1.5	Pounds
Thermal		
Type of Cooling – Forced Air		
Air Flow	30	Cubic Feet per Minute
Ambient Air Temperature, maximum	50	C
Typical Operating Conditions		
Operation with 60-cycle Sweep Voltage		
Filament Voltage *, approximate	2.30	Volts
Filament Current	3.0	Amperes
Tunable Range †	2500-3500	Megacycles
Tuning Sensitivity, approximate	1.8	Megacycles per Volt
Anode Voltage at 3.0 Gigacycles	1700	Volts
Anode Current, average	20	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	400	Volts
Injection Electrode Current	0.01	Milliamperes
Voltage Standing Wave Ratio of Load	1.15	
Power Output, minimum	10	Watts
Variation over Band	Less than 2.5:1	

* Filament voltage should be adjusted to provide 3.0 amperes of filament current under broadband swept oscillating conditions.

† Frequency controlled by anode voltage.


12" LONG FLEXIBLE LEAD
3.022
MAX.
3.025 MAX.
1.500 MAX.
2.000 MAX.
1.770 REF.
1.000
±.005
#10-32 UNF-2B
OUTPUT "TNC"
FEMALE
2.000 ±.005

ZM-6215

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2500-3500 MEGACYCLES — 10 WATT OUTPUT

The ZM-6215 is a small, lightweight, magnetically shielded voltage-tunable oscillator which operates at a minimum power output of 10 watts over the 2500-3500 megacycle frequency range. Unlike conventional electron devices employing magnetic fields, this shielded VTM is unaffected by passive magnetic materials. When specified, the ZM-6215 can be aligned for low-noise performance. Its noise power is at least 80 decibels per megacycle below the carrier at one megacycle away from the carrier. It is a complete radio-frequency power source requiring only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This shielded VTM may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

GENERAL

	Min.	Bogey	Max.	
Electrical				
Cathode – Directly Heated				
Filament Voltage*, approximate	2.2	2.5	2.7	Volts
Filament Current*	–	2.0	–	Amperes
Mechanical				
Mounting Position – Any				
Net Weight			1.0	Pounds
Thermal				
Type of Cooling – Forced Air				
Air Flow			30	Cubic Feet per Minute
Ambient Air Temperature			50	C

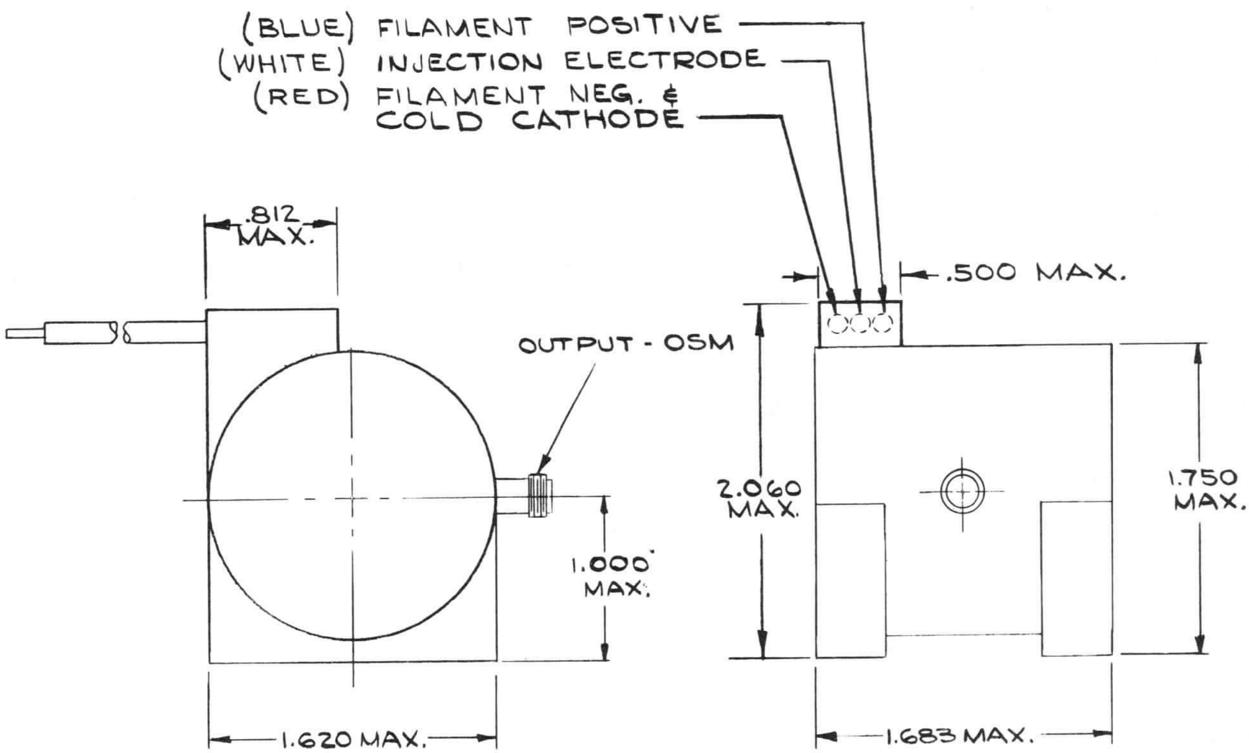
MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

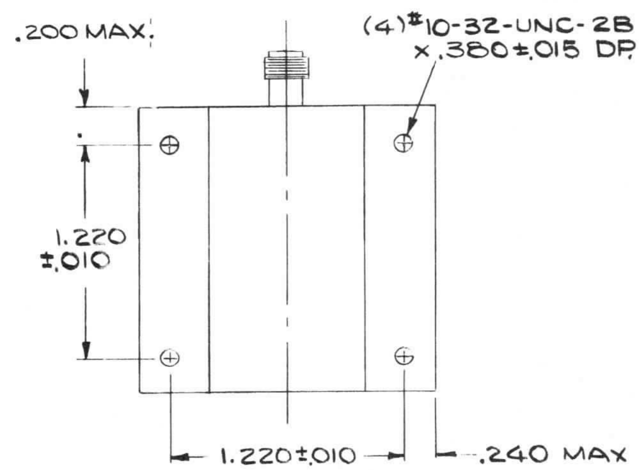
Absolute Values		
Anode Voltage	2500	Volts
Anode Current	40	Milliamperes
Power Input, with Forced Air Cooling	85	Watts
Injection Electrode Voltage	700	Volts
Injection Electrode Current	1.0	Milliamperes
Filament Current	2.2	Amperes
Typical Operating Conditions		
Operation with 60-cycle Sweep Voltage in Wide-band Circuit		
Filament Voltage*, approximate	2.50	Volts
Filament Current	2.0	Amperes
Tunable Range #	2500-3500	Megacycles
Tuning Rate, approximate	1.8	Megacycles per Volt
Anode Voltage at 3 Kilomegacycles	1850	Volts
Anode Current, Average	20-30	Milliamperes
Injection Electrode Voltage, Positive with Respect to Cathode	300-600	Volts
Injection Electrode Current	0.1	Milliamperes
Voltage Standing Wave Ratio of Load	1.3	
Power Output, Minimum	10.0	Watts
Noise †	-80	Decibels per Megacycle

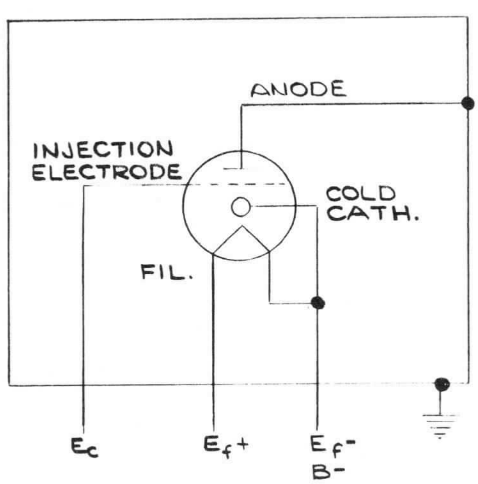
* Filament voltage should be adjusted to provide a filament current of 2.0 amperes under broadband swept oscillating conditions.
# Frequency controlled by anode voltage.

NOTE: Since a change in anode voltage of one volt produces a frequency change of approximately 1.8 megacycles, the anode supply should have sufficiently low ripple and high regulation to prevent an excess of frequency modulation.

† Measured at 1.5 megacycles away from carrier with respect to carrier power level. This is an optional parameter which is included on special order only.







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11-4-65

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZM-6220

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2475-2725 Megacycles — 1.5 Watts – 3.0 Watts Maximum

The ZM-6220 is a voltage-tunable magnetron for operation in the 2475 to 2725-megacycle frequency range. It is a complete r-f power-source package requiring only input power connections and an r-f power-output connection. The tube may be voltage tuned over a portion or all of the frequency range for which it is designed, or operated at a fixed frequency. The voltage frequency relationship is essentially linear.

GENERAL

	Min.	Bogey	Max.	
Electrical				
Cathode – Directly Heated				
Filament Voltage*	2.2	–	2.8	Volts
Filament Current*	1.9	2.0	2.1	Amperes
Mechanical				
Mounting Position – Any				
Net Weight, maximum			3.5	Pounds
Thermal				
Type of Cooling – Conduction through Mounting Surface				
Ambient Temperature, operating			125 F	(Four Hours)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values

Filament Current	2.1	Amperes
Anode Voltage	1200	Volts
Anode Current	14	Milliamperes
Injection-Electrode Voltage**	315	Volts
Injection-Electrode Current, maximum	1.0	Milliamperes
VSWR of Load, maximum	1.3:1	

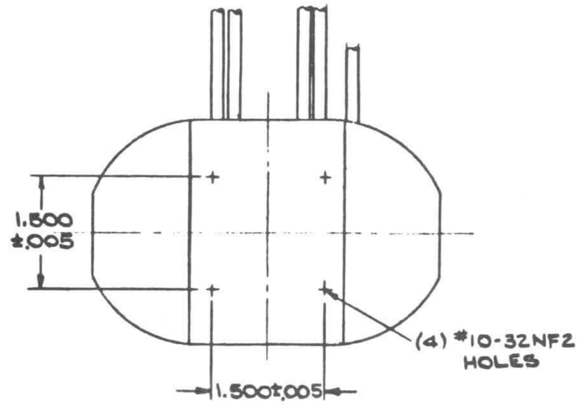
TYPICAL OPERATING CONDITIONS

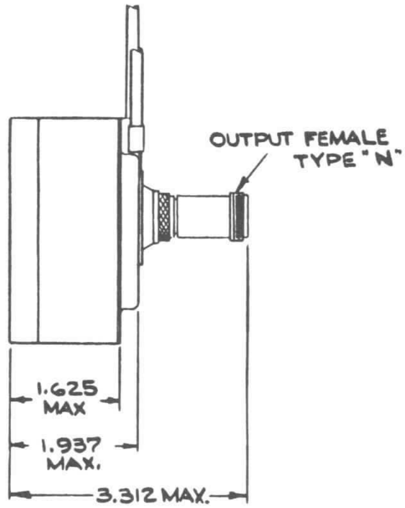
Operation with 60-cycle Sweep Voltage

Tunable Range#	2475-2725	Megacycles
Tuning Sensitivity, approximate	2.5	Megacycles per Volt
Filament Voltage*, approximate	2.50	Volts
Filament Current*	2.0	Amperes
Anode Voltage at 2.6 gigacycles	1145	Volts
Anode Current, average	10	Milliamperes
Injection-Electrode Voltage (Positive with Respect to Cathode)**	300	Volts
Injection-Electrode Current	0.1	Milliamperes
Voltage Standing Wave Ratio of Load	1.1:1	
Power Output	1.5 Watts, minimum-3.0 Watts, maximum	

* Filament current should be adjusted to 2.0 amperes.
** Injection Electrode voltage should be adjusted to 300 volts ±5%
\# Frequency controlled by anode voltage.

CAUTION: A clearance of 6 inches between ferromagnetic materials and the tube will prevent any serious change of the operating characteristics.


1.500
±.005
(4) #10-32NF2
HOLES
1.500±.005


OUTPUT FEMALE
TYPE "N"
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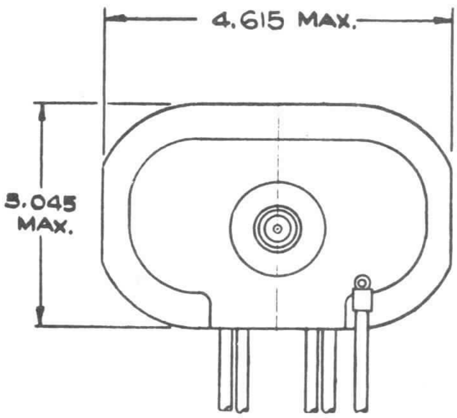
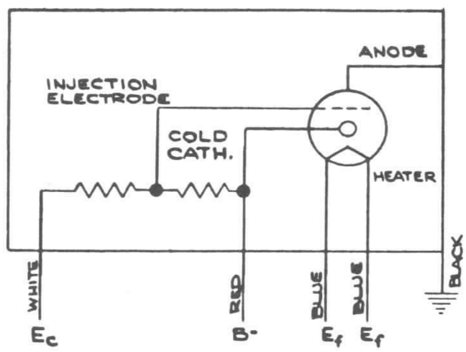
MAX
1.937
MAX.
3.312 MAX.


4.615 MAX.
5.045
MAX.


ANODE
INJECTION
ELECTRODE
COLD
CATH.
HEATER
WHITE
RED
BLUE
BLUE
BLACK
E_c
B-
E_f
E_f

OBJECTIVE
TECHNICAL INFORMATION

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PACKAGED VOLTAGE-TUNABLE MAGNETRON

2000-4000 Megacycles | 1.0 Watt CW Output

The ZM-6222 is a magnetically shielded voltage-tunable oscillator which operates at a minimum power output of one watt over the 2000 to 4000-megacycle frequency range. Unlike conventional electron devices employing magnetic fields, this shielded VTM is unaffected by passive magnetic materials. It does not require special tools, storage facilities or handling other than that normally given to a non-magnetic electron device. This shielded VTM also incorporates RFI shielding to attenuate stray radio-frequency on the d-c leads to levels below -40 dbc. It is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned octave frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

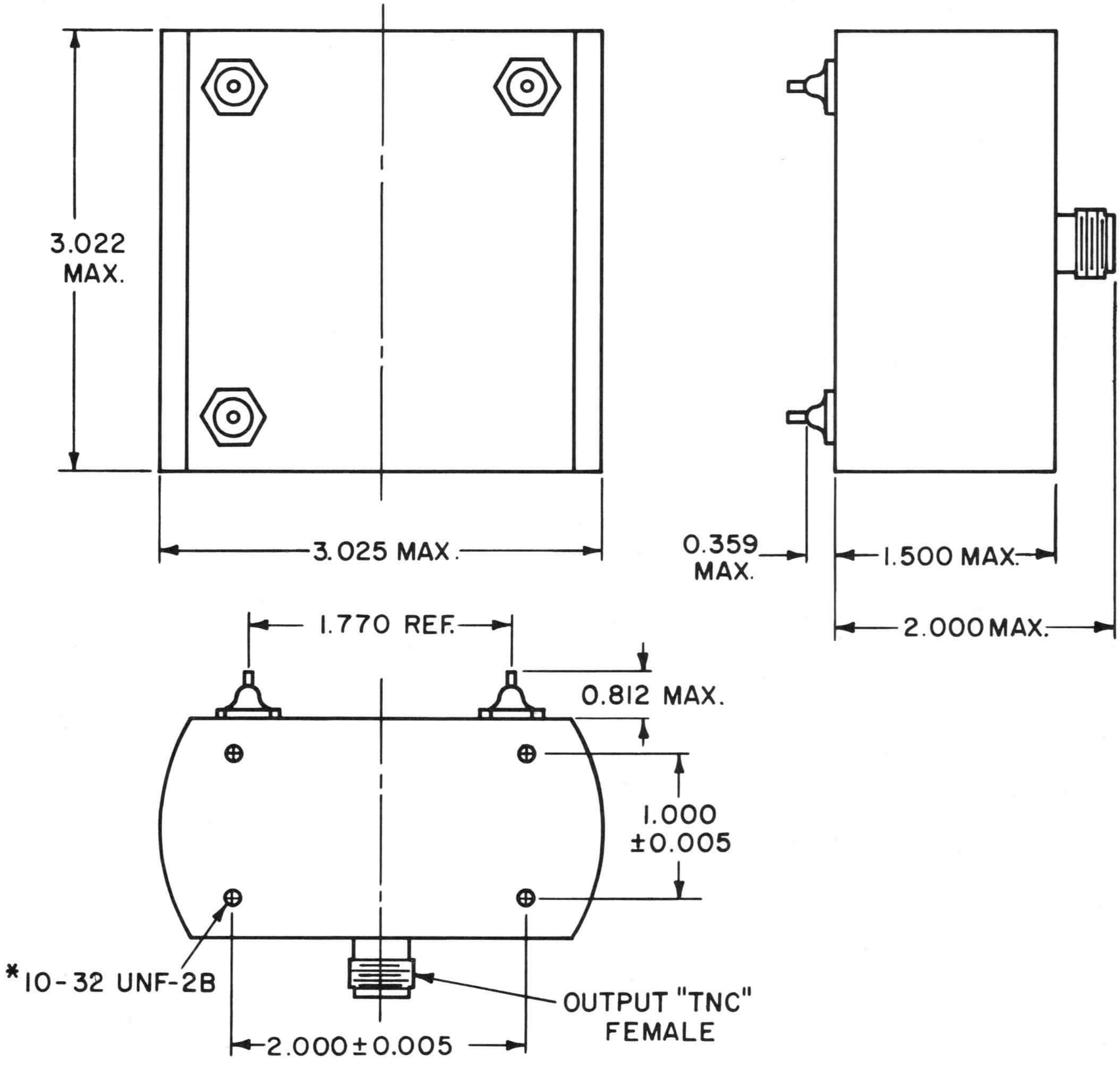
GENERAL

Electrical	Minimum	Bogey	Maximum	
Cathode - Directly Heated				
Filament Voltage*	2.0	2.5	3.0	Volts
Filament Current	-	2.0	-	Amperes

Mechanical		
Mounting Position - Any		
Net Weight, maximum	1.5	Pounds
Thermal		
Type of Cooling - Forced Air		
Air Flow	5	Cubic Feet per Minute
Ambient Air Temperature, maximum	50	C
Typical Operating Conditions		
Operation with 60-cycle Sweep Voltage		
Filament Voltage*, approximate	2.5	Volts
Filament Current	2.0	Amperes
Tunable Range†	2000-4000	Megacycles
Tuning Sensitivity, approximate	2.3	Megacycles per Volt
Anode Voltage at 3.0 Gigacycles	1300	Volts
Anode Current, average	10-15	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	100-400	Volts
Injection Electrode Current	0.01	Milliamperes
Voltage Standing Wave Ratio of Load	1.15	
Power Output, minimum	1.0	Watts
Variation over Band	Less than 2.5:1	

* Filament voltage should be adjusted to provide 2.0 amperes of filament current under broadband swept oscillating conditions.

† Frequency controlled by anode voltage.


3.022
MAX.
3.025 MAX.
0.359
MAX.
1.500 MAX.
2.000 MAX.
1.770 REF.
0.812 MAX.
1.000
±0.005
*10-32 UNF-2B
OUTPUT "TNC"
FEMALE
2.000±0.005

OBJECTIVE
TECHNICAL INFORMATION

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ZM-6231

PACKAGED VOLTAGE TUNABLE MAGNETRON

1220-1450 Megacycles — Integral Magnet and Isolator — 90 Watts Minimum CW Output

The ZM-6231 is a magnetically shielded voltage-tunable oscillator which operates at a minimum power output of 90 watts over the 1220 to 1450-megacycle range. It is designed for CW/FM transmitting-tube operation at low- or high-modulation frequencies. The high efficiency allows air cooling to be used and in many applications heat-sink cooling is adequate. The integral isolator protects the tube against load mismatches thus minimizing interface problems between the VTM and its associated equipment.

This shielded VTM is unaffected by passive magnetic materials and does not require the special tools, storage and handling necessitated by conventional electron devices employing magnetic fields. It is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

GENERAL

Electrical		
Cathode (filament) – Directly Heated		
Warm-up Time, maximum	10	Seconds
Cathode Input Capacitance		
Maximum	40	μμf
Typical	35	μμf
Mechanical		
Mounting Position		Any
Net Weight	7.0	Pounds
Thermal		
Cooling – Forced Air *		
Air Temperature, maximum	110	C
Body Temperature, maximum †	125	C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values		
Filament Voltage	2.5	Volts
Filament Current ‡	6.0	Amperes
Anode Voltage	3400	Volts
Sweep Voltage	700	Volts
Anode Current, swept	70	Milliamperes
Power Input	225	Watts
Injection Electrode Voltage	1500	Volts
Voltage Standing Wave Ratio of Load **	2.0	
Frequency Range ***	1220-1470	Megacycles
Typical Operating Conditions		
Operation with 60-cycle Sweep Voltage		
Filament Voltage, approximate	2.1	Volts
Filament Current ‡	4.4 to 5.6	Amperes
Swept Frequency Range	1220-1450	Megacycles
Sweep Voltage, Peak to Peak, typical	600	Volts
Anode Voltage at 1.45 Gigacycles	3250	Volts
Anode Current	65	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	700 to 1500	Volts ¶
Injection Electrode Current, less than	0.5	Milliamperes

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd.)

Typical Operating Conditions (Cont'd.)

Operation with 60-cycle Sweep Voltage (Cont'd.)

Power Output		
Average, Swept Across Full Band	90	Watts §
Minimum, At Any Point Without Sweep Voltage	75	Watts §
Variation Across Band		
Typical	1.4	Decibels
Maximum	2.0	Decibels
Efficiency, minimum		
At Any Frequency	50	Percent
Swept Across Full Band	55	Percent

* Hold temperature to 125 C or less at point shown on the outline drawing. At the maximum inlet temperature of 110 C, 100 cubic feet per minute is required but this drops rapidly for lower inlet temperatures.

† Measured at point shown on the outline drawing.

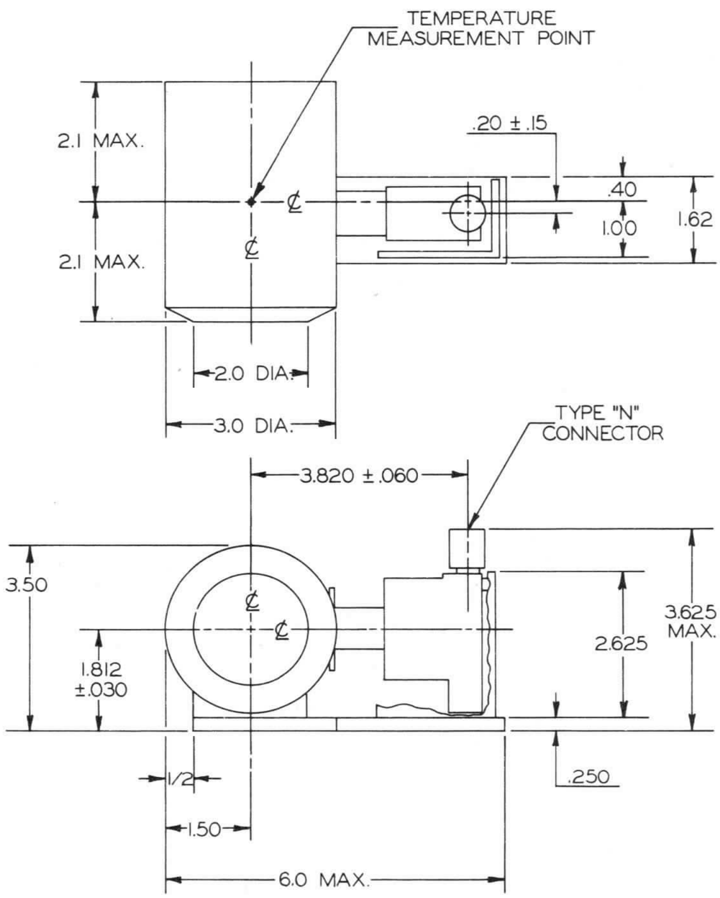
‡ Set to value marked on tube within ±0.1 ampere.

** With integral isolator. Without isolator maximum allowable VSWR is 1.2 to 1.

*** VTM operable over this frequency range but at reduced power level.

¶ Set to give anode current marked on tube within ±2 milliamperes.

§ Measured with load VSWR <1.2; for loads between 1.2 and 2.0 VSWR the power output is diminished by the amount reflected, plus a positive or negative change due to residual pulling. At 2.0 VSWR the theoretical reduction at the worst load phase is down to 85 percent, and the guaranteed performance is not less than 75 percent of rated power.



OBJECTIVE
TECHNICAL INFORMATION

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ZM-6238

PACKAGED VOLTAGE-TUNABLE MAGNETRON

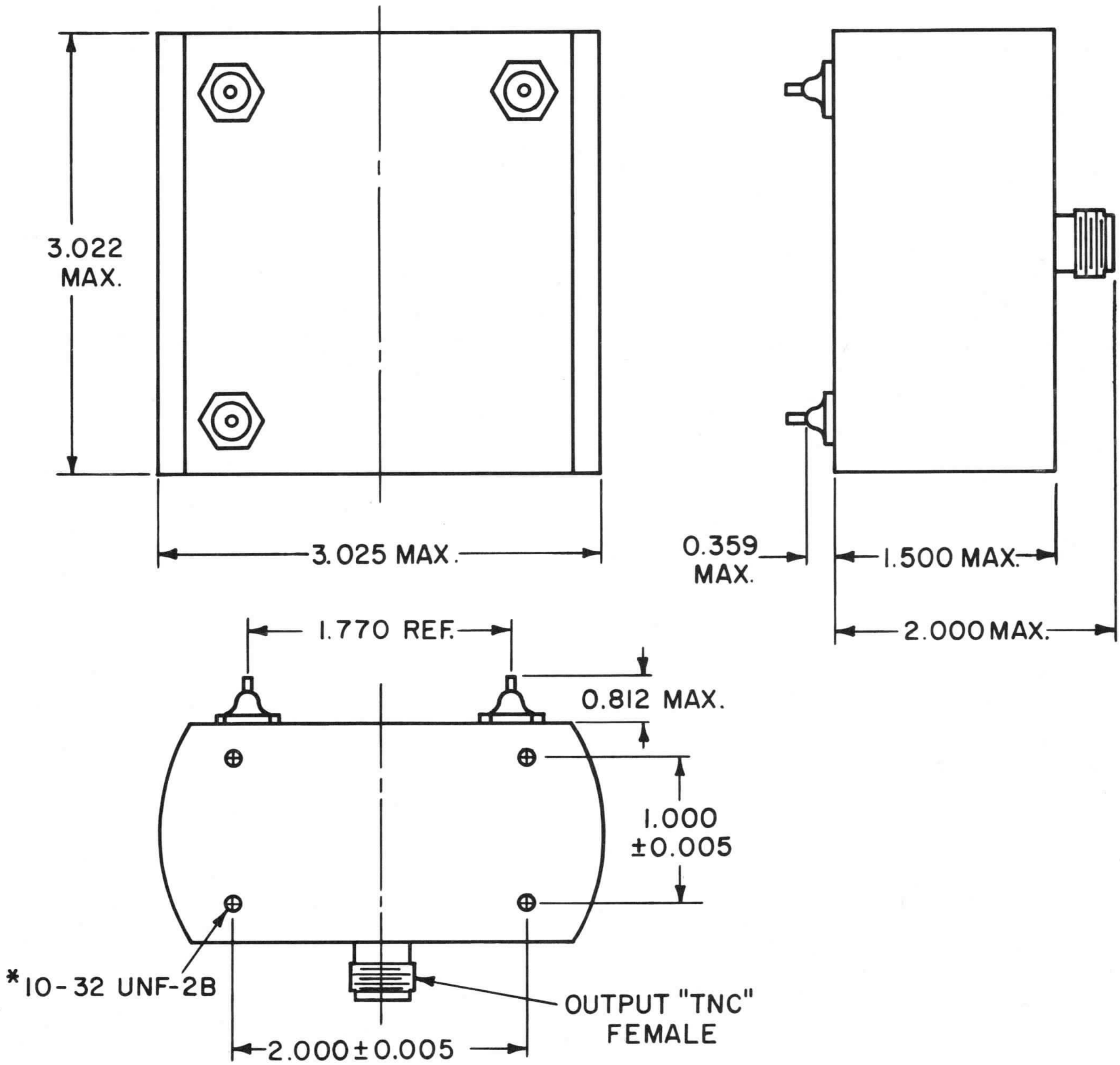
1000-2000 Megacycles — 1.0 Watt CW Output

The ZM-6238 is a magnetically shielded voltage-tunable oscillator which operates at a minimum power output of one watt over the 1000 to 2000-megacycle frequency range. Unlike conventional electron devices employing magnetic fields, this shielded VTM is unaffected by passive magnetic materials. It does not require special tools, storage facilities or handling other than that normally given to a non-magnetic electron device. This shielded VTM also incorporates RFI shielding to attenuate stray radio-frequency on the d-c leads to levels below -40 dbc. It is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned octave frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristics is essentially linear.

	Minimum	Bogey	Maximum	
Electrical				
Cathode – Directly Heated				
Filament Voltage*	2.0	2.5	3.0	Volts
Filament Current	–	2.0	–	Amperes
Mechanical				
Mounting Position – Any				
Net Weight, maximum			1.5	Pounds
Thermal				
Type of Cooling – Forced Air				
Air Flow			5	Cubic Feet per Minute
Ambient Air Temperature, maximum			50	C
Typical Operating Conditions				
Operation with 60-cycle Sweep Voltage				
Filament Voltage*, approximate			2.5	Volts
Filament Current			2.0	Amperes
Tunable Range†			1000-2000	Megacycles
Tuning Sensitivity, approximate			1.15	Megacycles per Volt
Anode Voltage at 1.5 Gigacycles			1300	Volts
Anode Current, average			10-15	Milliamperes
Injection Electrode Voltage, positive with respect to cathode			100-300	Volts
Injection Electrode Current			0.01	Milliamperes
Voltage Standing Wave Ratio of Load			1.15	
Power Output, minimum			1.0	Watts
Variation over Band			Less than 2.0:1	

* Filament voltage should be adjusted to provide 2 amperes of filament current under broadband swept oscillating conditions.

† Frequency controlled by anode voltage.


3.022
MAX.
3.025 MAX.
0.359
MAX.
1.500 MAX.
2.000 MAX.
1.770 REF.
0.812 MAX.
1.000
±0.005
*10-32 UNF-2B
OUTPUT "TNC"
FEMALE
2.000±0.005

ELECTRONIC INNOVATIONS IN ACTION

TUBES

OBJECTIVE
TECHNICAL INFORMATION

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This technical information is proprietary and is furnished only as a service to customers.

DEVELOPMENTAL TYPE

ZM-6239
OTI-109B
Page 1
12-68

ZM-6239

PACKAGED VOLTAGE TUNABLE MAGNETRON

2600-3050 Megacycles | Integral Magnet and Isolator | 90 Watts Minimum CW Output

The ZM-6239 is a magnetically shielded voltage-tunable oscillator which operates at a minimum power output of 90 watts over the 2600 to 3050 megacycle range. It is designed for CW/FM transmitting-tube operation at low- or high-modulation frequencies. The high efficiency allows air cooling to be used and in many applications heat-sink cooling is adequate. The integral isolator protects the tube against load mismatches thus minimizing interface problems between the VTM and its associated equipment.

This shielded VTM is unaffected by passive magnetic materials and does not require the special tools, storage and handling necessitated by conventional electron devices employing magnetic fields. It is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

GENERAL

Electrical

Cathode (filament) - Directly Heated		
Warm-up Time, maximum	10	Seconds
Cathode Input Capacitance		
Maximum	40	$\mu\mu f$
Typical	35	$\mu\mu f$

Mechanical

Mounting Position		Any
Net Weight	4.5	Pounds

Thermal

Cooling - Forced Air *		
Air Temperature, maximum	110	C
Body Temperature, maximum †	125	C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values

Filament Voltage	2.5	Volts
Filament Current ‡	6.0	Amperes
Anode Voltage	3280	Volts
Sweep Voltage	600	Volts
Anode Current, swept	70	Milliamperes
Power Input	250	Watts
Injection Electrode Voltage	1500	Volts
Voltage Standing Wave Ratio of Load	2.0	
Frequency Range ***	2550-3100	Megacycles

Typical Operating Conditions

Operation with 60-cycle Sweep Voltage

Filament Voltage, approximate	2.1	Volts
Filament Current ‡	4.4 to 5.6	Amperes
Swept Frequency Range	2600 to 3050	Megacycles
Sweep Voltage, Peak to Peak, typical	480	Volts
Anode Voltage at 2.75 Gigacycles	2900	Volts
Anode Current		
Injection Electrode Voltage, positive with respect to cathode	700 to 1500	Volts ¶
Injection Electrode Current, may be either polarity but less than	0.5	Milliamperes

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd.)

Typical Operating Conditions (Cont'd.)

Operation with 60-cycle Sweep Voltage (Cont'd.)

Power Output		
Average, Swept Across Full Band	110	Watts §
Minimum, At Any Point Without Sweep Voltage	90	Watts §
Variation Across Band		
Typical	1.4	Decibels
Maximum	2.0	Decibels
Efficiency, minimum		
At Any Frequency	50	Percent
Swept Across Full Band	60	Percent

* Hold temperature to 125 C or less at point shown on the outline drawing. At the maximum inlet temperature of 110 C, 100 cubic feet per minute is required but this drops rapidly for lower inlet temperatures.

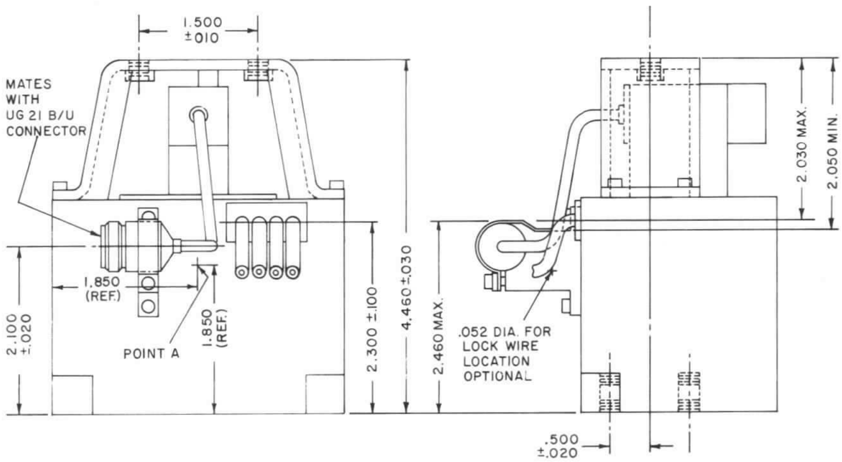
† Measured at point shown on the outline drawing.

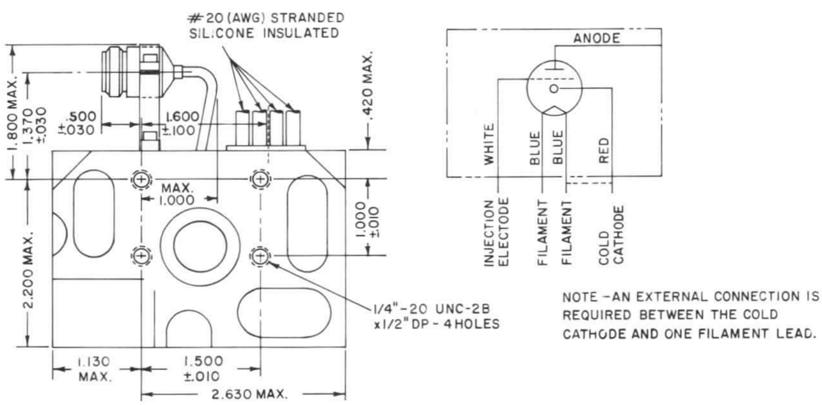
‡ Set to value marked on tube within ± 0.1 ampere.

*** VTM operable over this frequency range but at reduced power level.

¶ Set to give anode current marked on tube within ± 2 milliamperes.

§ Measured with load VSWR <1.2; for loads between 1.2 and 2.0 VSWR the power output is diminished by the amount reflected, plus a positive or negative change due to residual pulling. At 2.0 VSWR the theoretical reduction at the worst load phase is down to 85 percent, and the guaranteed performance is not less than 75 percent of rated power.





OBJECTIVE
TECHNICAL INFORMATION

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ZM-6240

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2860-3310 Megacycles — Integral Magnet and Isolator — 90 Watts Minimum CW Output

The ZM-6240 is a magnetically shielded voltage-tunable oscillator which operates at a minimum power output of 100 watts over the 2900 to 3200-megacycle range. It is designed for CW/FM transmitting-tube operation at low- or high-modulation frequencies. The high efficiency allows air cooling to be used and in many applications heat-sink cooling is adequate. The integral isolator protects the tube against load mismatches thus minimizing interface problems between the VTM and its associated equipment.

This shielded VTM is unaffected by passive magnetic materials and does not require the special tools, storage and handling necessitated by conventional electron devices employing magnetic fields. It is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

GENERAL

Electrical

Cathode (filament) - Directly Heated		
Warm-up Time, maximum	10	Seconds
Cathode Input Capacitance		
Maximum	40	$\mu\mu$f
Typical	35	$\mu\mu$f

Mechanical

Mounting Position		Any
Net Weight	4.5	Pounds

Thermal

Cooling - Forced Air*		
Air Temperature, maximum	110	C
Body Temperature, maximum †	125	C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values

Filament Voltage	2.5	Volts
Filament Current ‡	6	Amperes
Anode Voltage	3280	Volts
Sweep Voltage	600	Volts
Anode Current, swept	70	Milliamperes
Power Input	250	Watts
Injection Electrode Voltage	1500	Volts
Voltage Standing Wave Ratio of Load	2.0	
Frequency Range §	2810-3360	Megacycles

Typical Operating Conditions

Operation with 60-cycle Sweep Voltage

Filament Voltage, approximate	2.1	Volts
Filament Current ‡	4.4 to 5.6	Amperes
Swept Frequency Range	2860-3310	Megacycles
Sweep Voltage, Peak to Peak, typical	450	Volts
Anode Voltage at 3.05 Gigacycles	2900	Volts
Anode Current	65	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	700 to 1500	Volts ¶
Injection Electrode Current, may be either polarity but less than	0.5	Milliamperes

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd.)

Typical Operating Conditions (Cont'd.)
Operation with 60-cycle Sweep Voltage (Cont'd.)

Power Output		
Average, Swept Across Full Band	110	Watts***
Minimum, At Any Point Without Sweep Voltage	90	Watts***
Variation Across Band		
Typical	1.4	Decibels
Maximum	2	Decibels
Efficiency, minimum		
At Any Frequency	50	Percent
Swept Across Full Band	55	Percent

* Hold temperature to 125 C or less at point shown on the outline drawing. At the maximum inlet temperature of 110 C, 100 cubic feet per minute is required but this drops rapidly for lower inlet temperatures.

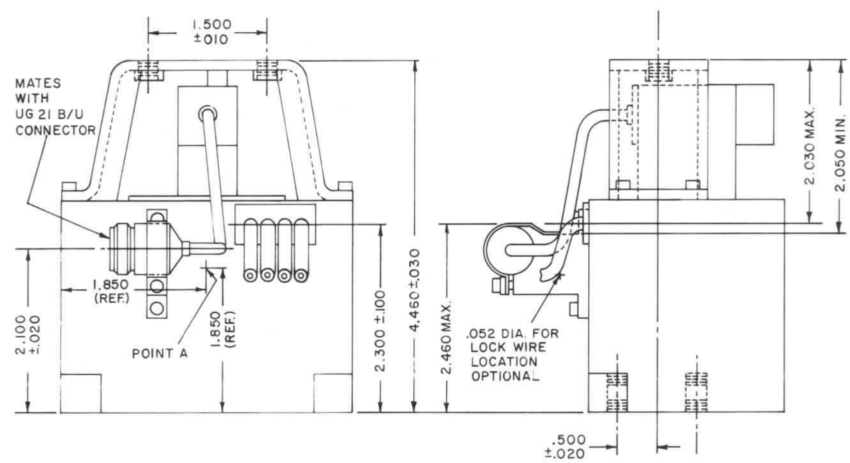
† Measured at point shown on the outline drawing.

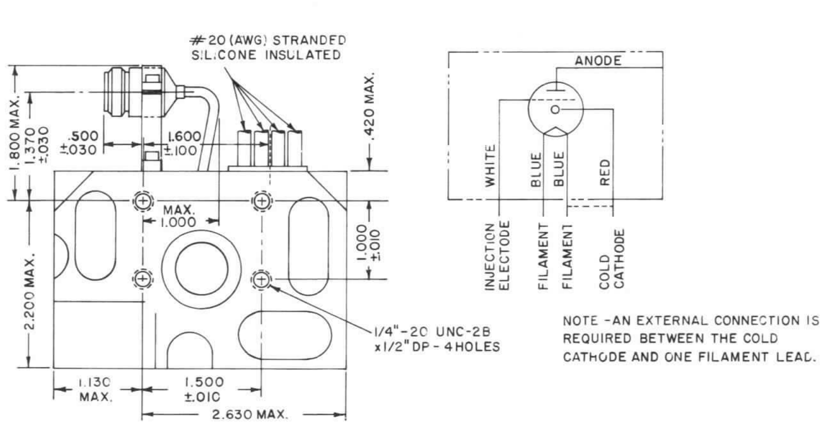
‡ Set to value marked on tube within ± 0.1 ampere.

§ VTM is operable over this frequency range but at reduced power levels.

¶ Set to give anode current marked on tube within ± 2 milliamperes.

*** Measured with load VSWR<1.2; for loads between 1.2 and 2.0 VSWR the power output is diminished by the amount reflected, plus a positive or negative change due to residual pulling. At 2.0 VSWR the theoretical reduction at the worst load phase is down to 85 percent, and the guaranteed performance is not less than 75 percent of rated power.





GENERAL ELECTRIC
TUBE DEPARTMENT
Schenectady 5, N. Y.

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

PACKAGED VOLTAGE-TUNABLE MAGNETRON

1775-1925 MEGACYCLES — 3.0-WATT OUTPUT

The ZM-6242 is a magnetically shielded, voltage-tunable oscillator incorporating an integral isolator. It operates at a minimum power output of three watts and is electronically tunable over its 1775-to-1925 megacycle frequency range. This shielded VTM is unaffected by passive magnetic materials and does not require special tools, storage facilities or handling other than that normally given to a non-magnetic electron device. The ZM-6242 is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range for which it is designed. Its power variation is limited to one decibel over the entire frequency range and its frequency-versus-voltage-tuning characteristic is essentially linear. This package is environmentalized.

GENERAL

	Minimum	Bogey	Maximum	
Electrical				
Cathode – Directly Heated				
Filament Voltage*	--	2.2	--	Volts
Filament Current*	2.26	2.4	2.54	Amperes
Mechanical				
Mounting Position – Any				
Net Weight			2.0	Pounds
Thermal				
Type of Cooling – Conduction or Convection				
Ambient Air Temperature, operating			75	C Max.
Heat-Sink Temperature			75	C Max.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values		
Anode Voltage	1500	Volts
Anode Current	20	Milliamperes
Power Input, with Forced Air Cooling	25	Watts
Injection-Electrode Voltage	500	Volts
Injection-Electrode Current	1.0	Milliamperes
Filament Current	2.54	Amperes
Temperature**	-55 C to +75 C	
Typical Operating Conditions		
Operation with 60-cycle Sweep Voltage		
Filament Voltage*	2.2	Volts
Filament Current*, approximate	2.4	Amperes
Tunable Range#	1775-1925	Megacycles
Tuning Sensitivity, approximate	1.75	Megacycles per Volt
Anode Voltage at 1.85 Kilomegacycles	965	Volts
Anode Current at 1.85 Kilomegacycles	12	Milliamperes
Injection-Electrode Voltage, Positive with Respect to Cathode	200	Volts
Injection-Electrode Current	<20	Microamperes
Voltage Standing Wave Radio of Load†	1.15	
Power Output, Minimum	4.0	Watts
Noise‡	-80	Decibels below carrier
Power Variation	1	Decibel
Linearity§, maximum	110	Percent
Warm-up Time¶, maximum	1.5	Seconds

* Filament voltage should be adjusted to 2.2 volts.

** Measured on surface opposite mounting plane.

\# Frequency controlled by anode voltage.

† Integral isolator contains 15-decibel isolation.

‡ This is background noise level measured from 200 kc to 8 mc away from carrier.

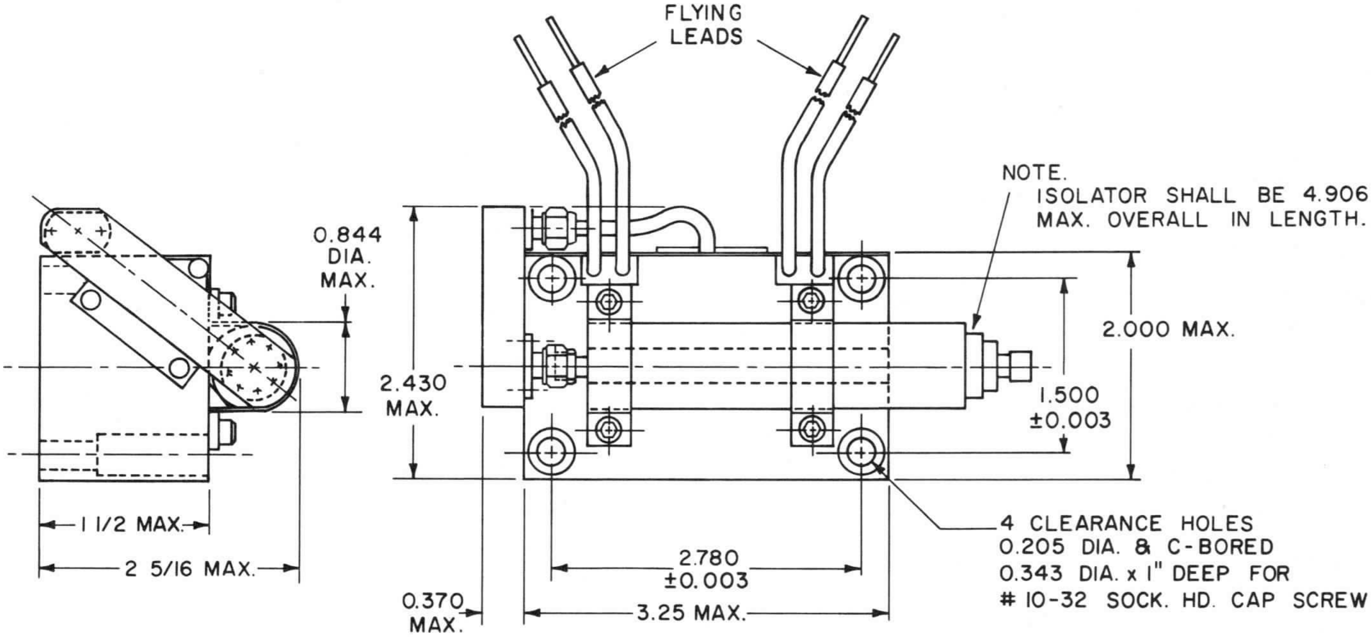
§ $\frac{\text{Maximum slope (mc/volt)}}{\text{Minimum slope (mc/volt)}} \times 100 \leq 110$ Percent (all temperatures -55 C to +75 C)

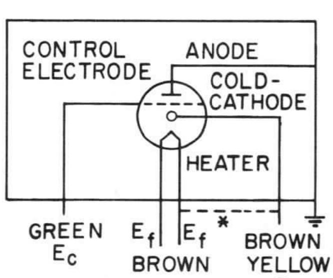
¶ Warm-up time is the time required for the output power to reach 70 percent of the value measured after one minute of operation.

NOTE: Since a change in anode voltage of one volt produces a frequency change of approximately 1.8 megacycles, the anode supply should have sufficiently low ripple and high regulation to prevent an excess of frequency modulation.

CAUTION: A clearance of one inch between ferromagnetic materials and the tube will prevent serious change of the operating characteristics.

OUTLINE ZM-6242





*NOTE: AN EXTERNAL CONNECTION IS REQUIRED BETWEEN THE COLD-CATHODE LEAD AND ONE OF THE HEATER LEADS

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2890-3110 MEGACYCLES | 3.0-WATT OUTPUT

The ZM-6243 is a magnetically shielded, voltage-tunable oscillator incorporating an integral isolator. It operates at a minimum power output of three watts and is electronically tunable over its 2890-to-3110 megacycle frequency range. This shielded VTM is unaffected by passive magnetic materials and does not require special tools, storage facilities or handling other than that normally given to a non-magnetic electron device. The ZM-6243 is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range for which it is designed. Its power variation is limited to one decibel over the entire frequency range and its frequency-versus-voltage-tuning characteristic is essentially linear. This package is environmentalized.

GENERAL

	Minimum	Bogey	Maximum	
Electrical				
Cathode – Directly Heated				
Filament Voltage*	--	2.2	--	Volts
Filament Current*	2.26	2.4	2.54	Amperes
Mechanical				
Mounting Position – Any				
Net Weight			2.0	Pounds
Thermal				
Type of Cooling – Conduction or Convection				
Ambient Air Temperature, operating			75	C Max.
Heat-sink Temperature			75	C Max.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values		
Anode Voltage	1500	Volts
Anode Current	30	Milliamperes
Power Input, with Forced Air Cooling	35	Watts
Injection-Electrode Voltage	500	Volts
Injection-Electrode Current	1.0	Milliamperes
Filament Current	2.54	Amperes
Temperature**	-55 C to +75 C	
Typical Operating Conditions		
Operation with 60-cycle Sweep Voltage		
Filament Voltage*	2.2	Volts
Filament Current*, approximate	2.4	Amperes
Tunable Range#	2890-3110	Megacycles
Tuning Sensitivity, approximate	3.0	Megacycles per Volt
Anode Voltage at 3 Kilomegacycles	965	Volts
Anode Current at 3 Kilomegacycles	22	Milliamperes
Injection-Electrode Voltage, Positive with Respect to Cathode	200	Volts
Injection-Electrode Current	<20	Microamperes
Voltage Standing Wave Ratio of Load‡	1.15	
Power Output, Minimum	4.0	Watts
Noise†	-80	Decibels below carrier
Power Variation	1	Decibel
Linearity§, maximum	110	Percent
Warm-up Time¶, maximum	1.5	Seconds

* Filament voltage should be adjusted to 2.2 volts.

** Measured on surface opposite mounting plane.

\# Frequency controlled by anode voltage.

† This is background noise level measured from 200 kc to 8 mc away from carrier.

‡ Integral isolator contains 15-decibel isolation.

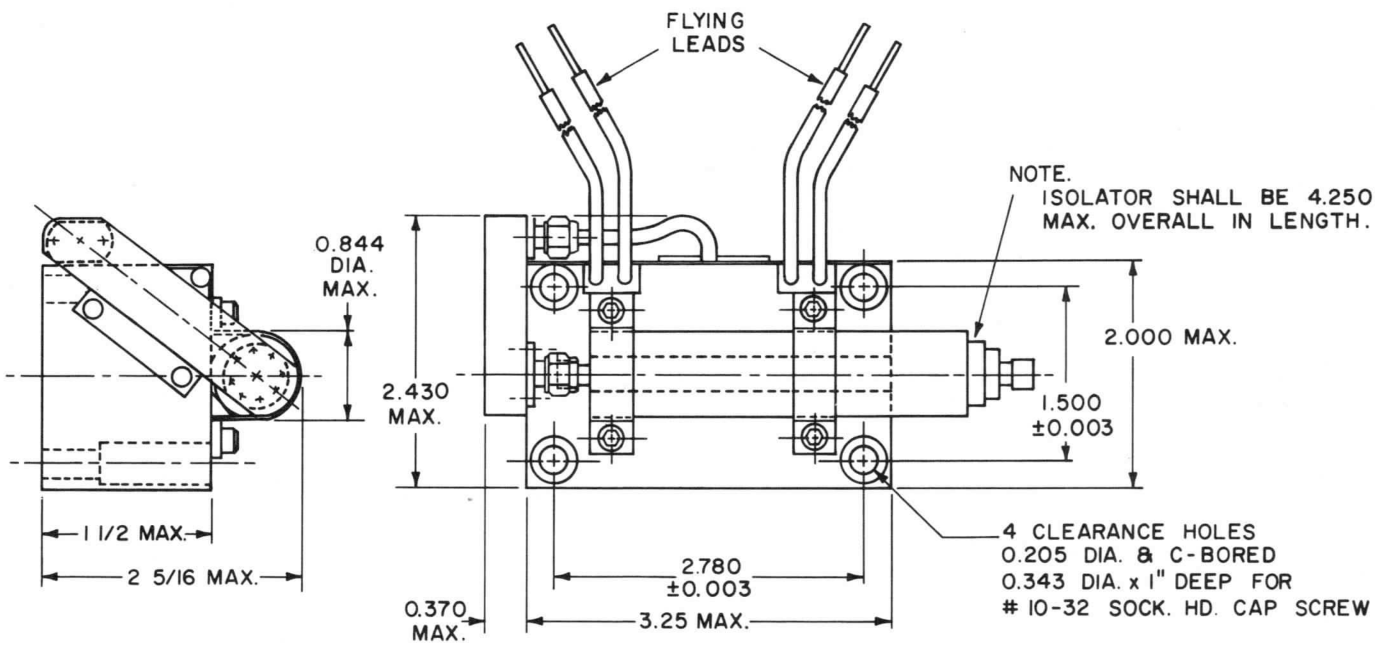
§ $\frac{\text{Maximum slope (mc/volt)}}{\text{Minimum slope (mc/volt)}} \times 100 \leq 110$ Percent (all temperatures -55 C to +75 C)

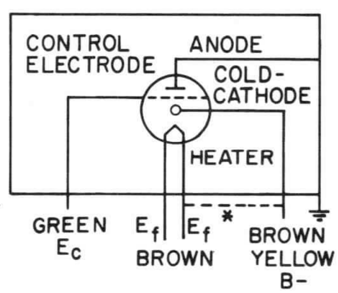
¶ Warm-up time is the time required for the output power to reach 70 percent of the value measured after one minute of operation.

NOTE: Since a change in anode voltage of one volt produces a frequency change of approximately 3.0 megacycles, the anode supply should have sufficiently low ripple and high regulation to prevent an excess of frequency modulation.

CAUTION: A clearance of one inch between ferromagnetic materials and the tube will prevent serious change of the operating characteristics.

OUTLINE ZM-6243





*NOTE: AN EXTERNAL CONNECTION IS REQUIRED BETWEEN THE COLD-CATHODE LEAD AND ONE OF THE HEATER LEADS

ELECTRONIC INNOVATIONS IN ACTION

TUBES

PRELIMINARY TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZM-6246

PACKAGED VOLTAGE-TUNABLE MAGNETRON

4800-5300 Megacycles — 90 Watts Average CW Output

Integral Magnet and Isolator

The ZM-6246 is a voltage-tuned magnetron designed for CW/FM transmitting-tube operation at low- or high-modulation frequencies. The tube has a minimum power output of 75 watts at any point in the band. The typical tube averages 90 watts across the band. The high efficiency allows air cooling to be used. The tube is protected against load mismatch by an integral isolator. The voltage-frequency relationship is approximately linear. The anode is integral with the tube body and is normally grounded, anode voltage being applied negatively to the cathode and filament.

GENERAL

Electrical

Cathode (filament) - Directly Heated		
Warm-up Time, maximum	10	Seconds
Cathode Input Capacitance		
Maximum	35	μμf
Typical	32	μμf

Mechanical

Mounting Position		Any
Net Weight	7.0	Pounds

Thermal

Cooling - Forced Air*		
Air Temperature, maximum	110	C
Body Temperature, maximum†	125	C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values

Filament Voltage	2.5	Volts
Filament Current‡	6	Amperes
Anode Voltage	3200	Volts
Sweep Voltage	500	Volts
Anode Current, swept	70	Milliamperes
Power Input	225	Watts
Injection Electrode Voltage	1500	Volts
Voltage Standing Wave Ratio of Load	2.0	
Frequency Range**	4750-5350	Megacycles

Typical Operating Conditions

Operation with 60-cycle Sweep Voltage

Filament Voltage, approximate	2.1	Volts
Filament Current‡	4.4 to 5.6	Amperes
Swept Frequency Range	4800-5300	Megacycles
Sweep Voltage, Peak to Peak, typical	350	Volts
Anode Voltage at 5.05 Gigacycles	2800	Volts
Anode Current	65	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	850-1500	Volts¶
Injection Electrode Current, less than	0.5	Milliamperes

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd.)
Typical Operating Conditions (Cont'd.)
Operation with 60-cycle Sweep Voltage (Cont'd.)
Power Output

Average, Swept Across Full Band	90	Watts***
Minimum, At Any Point Without Sweep Voltage	75	Watts***
Variation Across Band		
Typical	1.4	Decibels
Maximum	2	Decibels

Efficiency, minimum

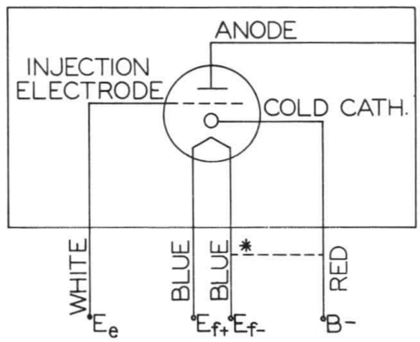
At Any Frequency	50	Percent
Swept Across Full Band	55	Percent

ENVIRONMENTAL
Altitude, maximum

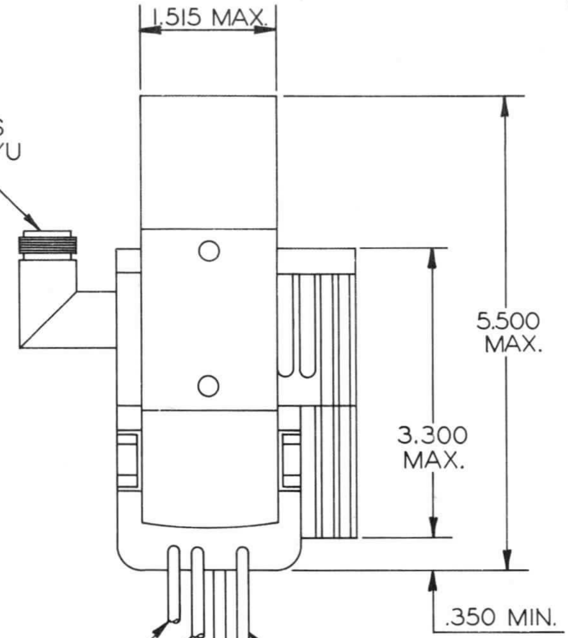
Operating	15,000	Feet
Non-operating	70,000	Feet

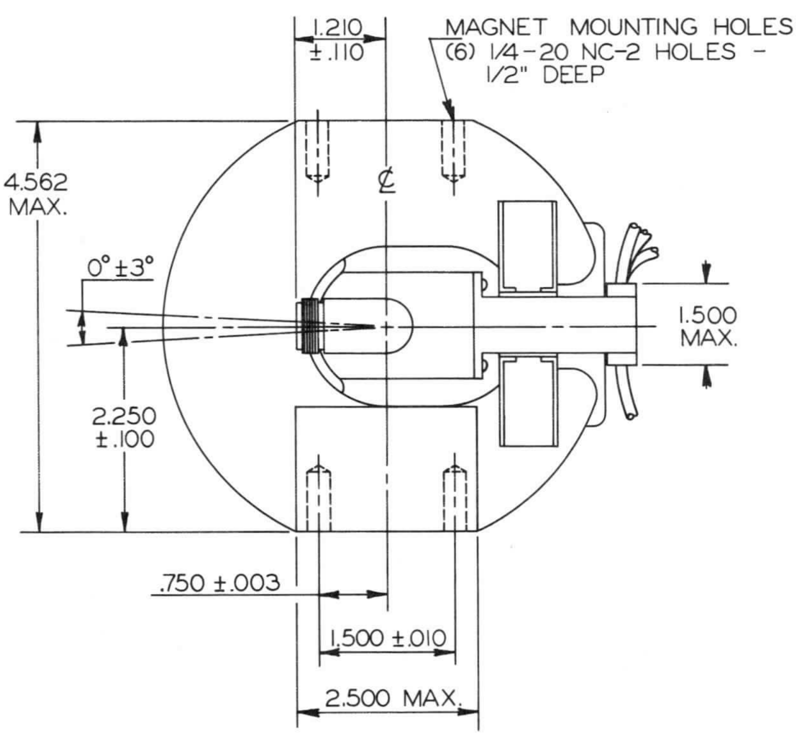
*Hold temperature to 125 C or less at point shown on the outline drawing. At the maximum inlet temperature of 110 C, 100 cubic feet per minute is required but this drops rapidly for lower inlet temperatures.
†Measured at point shown on the outline drawing.
‡Set to value marked on tube within ±0.1 ampere.
**VTM operable over this frequency range but at reduced power level.
¶Set to give anode current marked on tube within ±2 milliamperes.
***Measured with load VSWR <1.2; for loads between 1.2 and 2.0 VSWR the power output is diminished by the amount reflected, plus a positive or negative change due to residual pulling. At 2.0 VSWR the theoretical reduction at the worst load phase is down to 85 percent, and the guaranteed performance is not less than 75 percent of rated power.

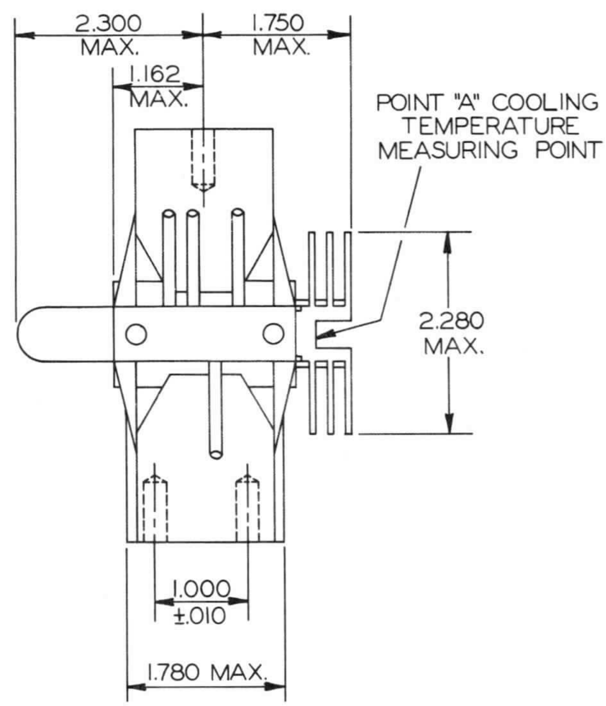
CAUTION: A CLEARANCE OF SIX INCHES BETWEEN FERROMAGNETIC MATERIALS AND THE TUBE WILL PREVENT ANY SERIOUS CHANGE OF THE OPERATING CHARACTERISTICS.



*NOTE:
AN EXTERNAL CONNECTION IS REQUIRED BETWEEN THE COLD CATHODE LEAD & ONE OF THE HEATER LEADS.







OBJECTIVE
TECHNICAL INFORMATION

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ZM-6257

PACKAGED VOLTAGE-TUNABLE MAGNETRON

3500-4500 Megacycles — 10 Watt CW Output

The ZM-6257 is a magnetically shielded voltage-tunable oscillator which operates at a minimum power output of 10 watts over the 3500 to 4500-megacycle frequency range. Unlike conventional electron devices employing magnetic fields, this shielded VTM is unaffected by passive magnetic materials. It does not require special tools, storage facilities or handling other than that normally given to a non-magnetic electron device. It is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

GENERAL

Electrical	Minimum	Bogey	Maximum	
Cathode – Directly Heated				
Filament Voltage *	2.0	2.3	2.6	Volts
Filament Current	–	3.0	–	Amperes

Mechanical		
Mounting Position		Any
Net Weight, maximum	1.5	Pounds

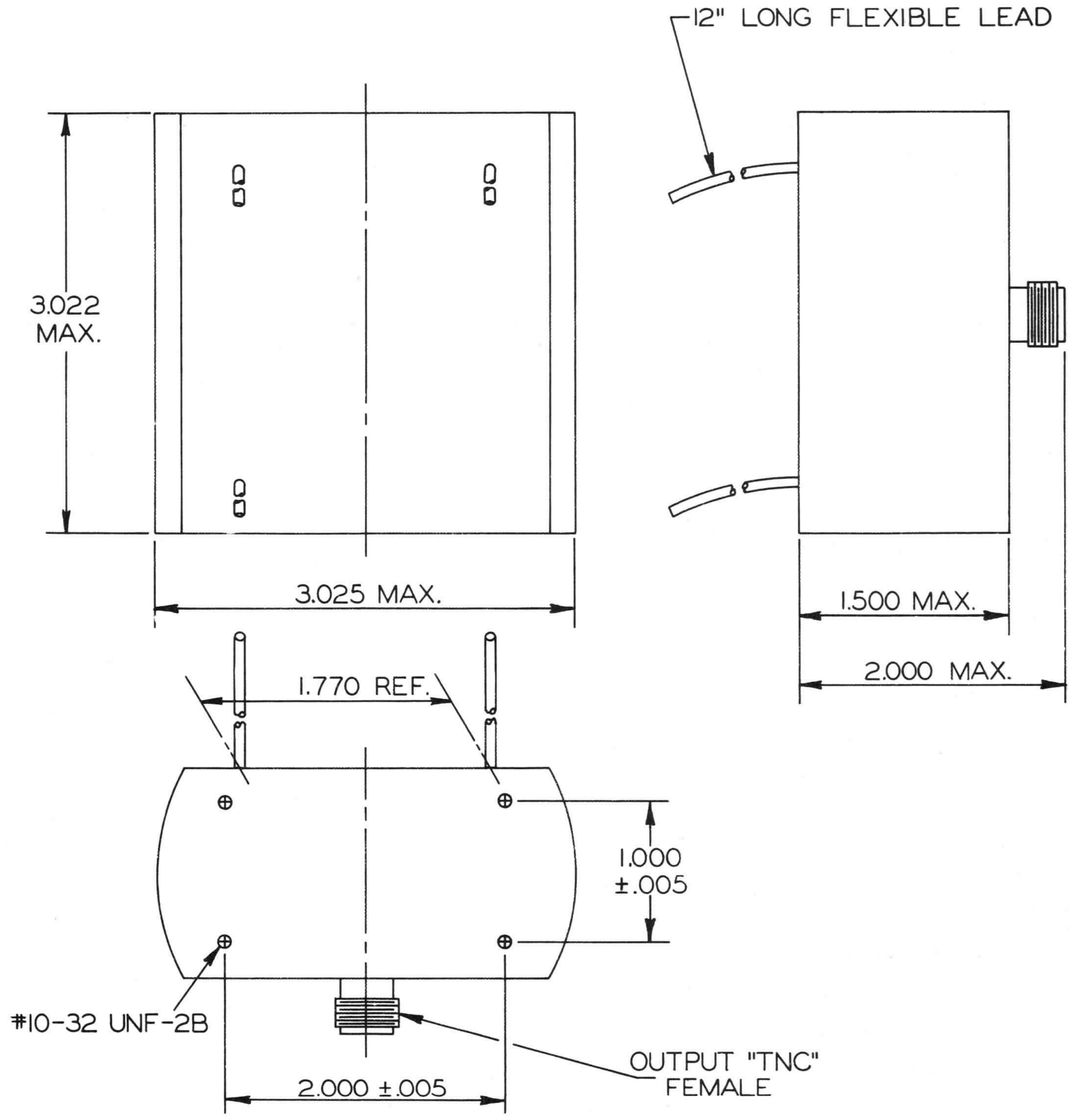
Thermal		
Type of Cooling – Forced Air		
Air Flow	30	Cubic Feet per Minute
Ambient Air Temperature, maximum	50	C

Typical Operating Conditions
Operation with 60-cycle Sweep Voltage

Filament Voltage *, approximate	2.3	Volts
Filament Current	3.0	Amperes
Tunable Range †	3500-4500	Megacycles
Tuning Sensitivity, approximate	2.2	Megacycles per Volt
Anode Voltage at 4.0 Gigacycles	1700	Volts
Anode Current, average	20	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	400	Volts
Injection Electrode Current	0.01	Milliamperes
Voltage Standing Wave Ratio of Load	1.15	
Power Output, minimum	10	Watts
Variation over Band	Less than 2.5:1	

Filament voltage should be adjusted to provide 3.0 amperes of filament current under broadband swept oscillating conditions.

Frequency controlled by anode voltage.


12" LONG FLEXIBLE LEAD
3.022
MAX.
3.025 MAX.
1.500 MAX.
2.000 MAX.
1.770 REF.
1.000
±.005
#10-32 UNF-2B
OUTPUT "TNC"
FEMALE
2.000 ±.005

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZM-6265A

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2500-3500 MEGACYCLES — 10 WATT OUTPUT

The ZM-6265A is a small, lightweight, magnetically shielded voltage-tunable oscillator with an integral isolator which operates at a minimum power output of 10 watts over the 2500-3500 megacycle frequency range. Unlike conventional electron devices employing magnetic fields, this shielded VTM is unaffected by passive magnetic materials. When specified, the ZM-6265A can be aligned for low-noise performance. Its noise power is at least 80 decibels per megacycle below the carrier at one megacycle away from the carrier. It is a complete radio-frequency power source requiring only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This shielded VTM may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

GENERAL

Electrical	Min.	Bogey	Max.	
Cathode – Directly Heated				
Filament Voltage*, approximate	2.2	2.5	2.7	Volts
Filament Current*	–	3.0	–	Amperes

Mechanical		
Mounting Position – Any		
Net Weight	1.0	Pounds
Thermal		
Type of Cooling – Forced Air		
Air Flow	30	Cubic Feet per Minute
Ambient Air Temperature	50	C

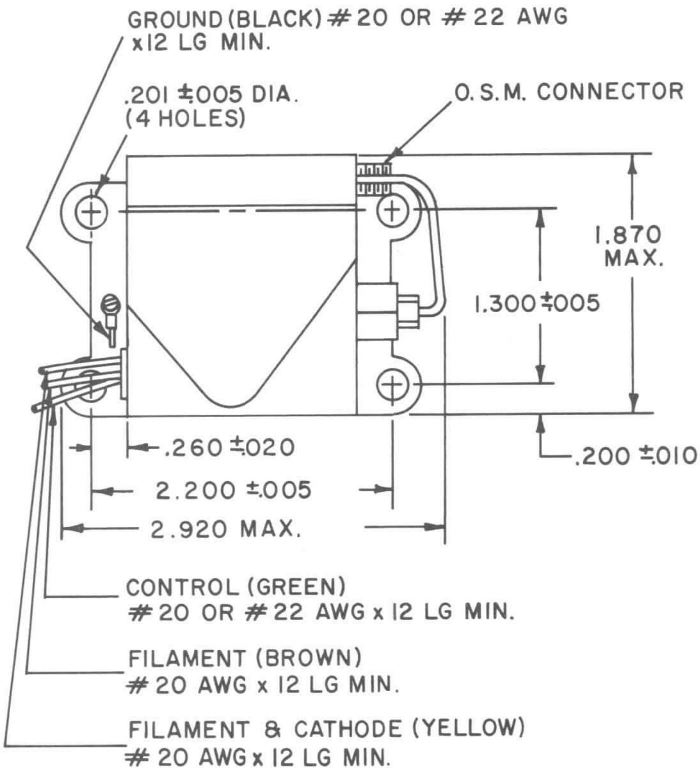
MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

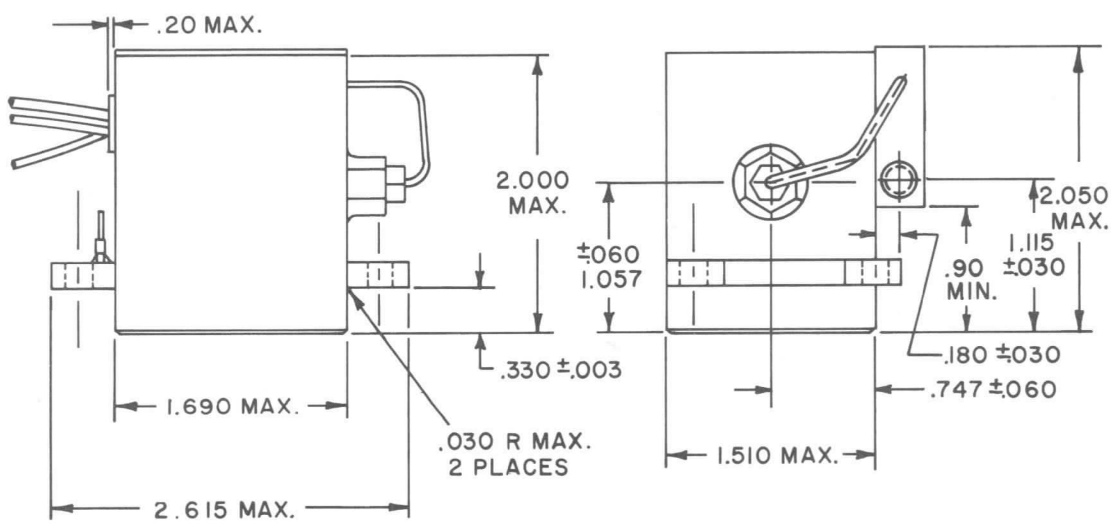
Absolute Values		
Anode Voltage	2500	Volts
Anode Current	40	Milliamperes
Power Input, with Forced Air Cooling	85	Watts
Injection Electrode Voltage	700	Volts
Injection Electrode Current	1.0	Milliamperes
Filament Current	3.5	Amperes
Typical Operating Conditions		
Operation with 60-cycle Sweep Voltage		
Filament Voltage*, approximate	2.50	Volts
Filament Current	3.0	Amperes
Tunable Range#	2500-3500	Megacycles
Tuning Rate, approximate	1.8	Megacycles per Volt
Anode Voltage at 3 Kilomegacycles	1850	Volts
Anode Current, Average	20-30	Milliamperes
Injection Electrode Voltage, Positive with Respect to Cathode	300-600	Volts
Injection Electrode Current	0.1	Milliamperes
Voltage Standing Wave Ratio of Load	2.0	
Power Output, Minimum	10.0	Watts
Noise †	-80	Decibels per Megacycle

* Filament voltage should be adjusted to provide a filament current of 3.0 amperes under broadband swept oscillating conditions.
# Frequency controlled by anode voltage.

NOTE: Since a change in anode voltage of one volt produces a frequency change of approximately 1.8 megacycles, the anode supply should have sufficiently low ripple and high regulation to prevent an excess of frequency modulation.

† Measured at 1.5 megacycles away from carrier with respect to carrier power level. This is an optional parameter which is included on special order only.





ELECTRONIC INNOVATIONS IN ACTION

TUBES

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZM-6276

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2600-3200 Megacycles

Integral Magnet and Isolator

100 Watts Minimum CW Output

The ZM-6276 is a magnetically shielded voltage-tunable oscillator which operates at a minimum power output of 100 watts over the 2600 to 3200-megacycle range. It is designed for CW/FM transmitting-tube operation at low- or high-modulation frequencies. The high efficiency allows air cooling to be used and in many applications heat-sink cooling is adequate. The integral isolator protects the tube against load mismatches thus minimizing interface problems between the VTM and its associated equipment.

This shielded tube is unaffected by passive magnetic materials and does not require the special tools, storage and handling necessitated by conventional electron devices employing magnetic fields. It is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

GENERAL

Electrical

Cathode (filament) – Directly Heated		
Warm-up Time, maximum	10	Seconds
Cathode Input Capacitance		
Maximum	40	μμf
Typical	35	μμf

Mechanical

Mounting Position		Any
Net Weight	4.5	Pounds

Thermal

Cooling – Forced Air *		
Air Temperature, maximum	110	C
Body Temperature, maximum †	125	C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values

Filament Voltage	2.5	Volts
Filament Current ‡	6.0	Amperes
Anode Voltage	3400	Volts
Sweep Voltage	700	Volts
Anode Current, swept	80	Milliamperes
Power Input	250	Watts
Injection Electrode Voltage	1700	Volts
Voltage Standing Wave Ratio of Load	2.0	

Typical Operating Conditions

Operation with 60-cycle Sweep Voltage

Filament Voltage, approximate	2.3	Volts
Filament Current ‡	5.3	Amperes
Swept Frequency Range	2600 to 3200	Megacycles
Sweep Voltage, Peak to Peak, typical	600	Volts
Anode Voltage at 2.9 Gigacycles	3000	Volts
Anode Current	65	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	700 to 1700	Volts¶
Injection Electrode Current, may be either polarity but less than	0.5	Milliamperes

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd.)

Typical Operating Conditions (Cont'd.)

Operation with 60-cycle Sweep Voltage (Cont'd.)

Power Output		
Average, Swept Across Full Band	120	Watts ***
Minimum, At Any Point Without Sweep Voltage	100	Watts ***
Variation Across Band		
Typical	1.4	Decibels
Maximum	2.0	Decibels
Efficiency, minimum		
At Any Frequency	55	Percent
Swept Across Full Band	60	Percent

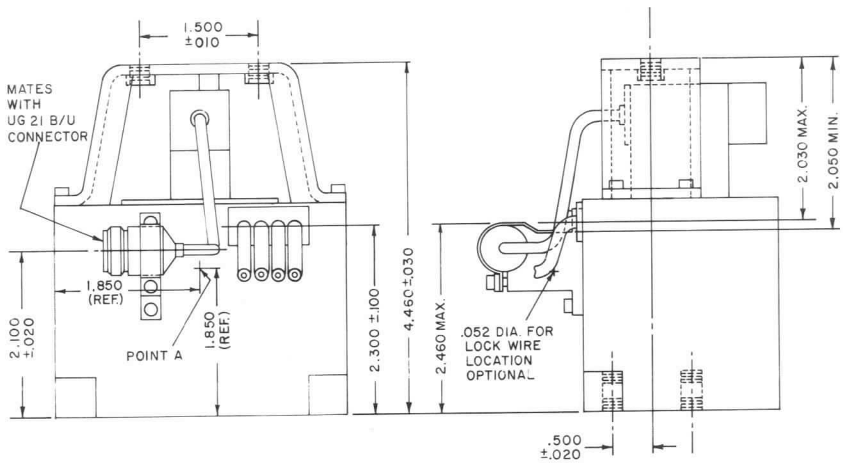
* Hold temperature to 125 C or less at point shown on the outline drawing. At the maximum inlet temperature of 110 C, 100 cubic feet per minute is required but this drops rapidly for lower inlet temperatures.

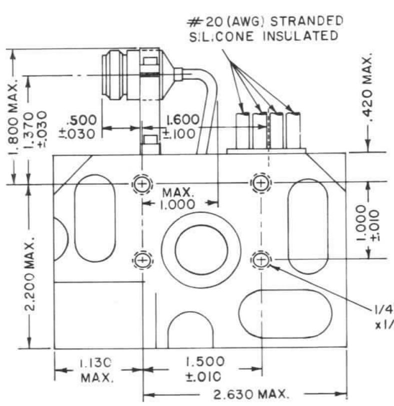
† Measured at point shown on the outline drawing.

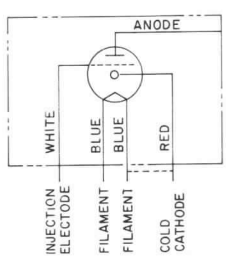
‡ Set to value marked on tube within ± 0.1 ampere.

¶ Set to give anode current marked on tube within ± 2 milliamperes.

*** Measured with load VSWR < 1.2; for loads between 1.2 and 2.0 VSWR the power output is diminished by the amount reflected, plus a positive or negative change due to residual pulling. At 2.0 VSWR the theoretical reduction at the worst load phase is down to 85 percent, and the guaranteed performance is not less than 75 percent of rated power.







NOTE - AN EXTERNAL CONNECTION IS REQUIRED BETWEEN THE COLD CATHODE AND ONE FILAMENT LEAD.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

OBJECTIVE TECHNICAL INFORMATION

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DEVELOPMENTAL TYPE

ZM-6277

PACKAGED VOLTAGE-TUNABLE MAGNETRON

2860-3460 Megacycles

Integral Magnet and Isolator

100 Watts Minimum CW Output

The ZM-6277 is a magnetically shielded voltage-tunable oscillator which operates at a minimum power output of 100 watts over the 2860-3460-megacycle range. It is designed for CW/FM transmitting-tube operation at low- or high-modulation frequencies. The high efficiency allows air cooling to be used and in many applications heat-sink cooling is adequate. The integral isolator protects the tube against load mismatches thus minimizing interface problems between the VTM and its associated equipment.

This shielded tube is unaffected by passive magnetic materials and does not require the special tools, storage and handling necessitated by conventional electron devices employing magnetic fields. It is a complete radio-frequency power source which requires only d-c input power and generates radio-frequency power over its electronically tuned frequency range. This voltage-tuned magnetron may be operated over a portion or all of the frequency range or operated at a fixed frequency. Its frequency versus voltage-tuning characteristic is essentially linear.

GENERAL

Electrical

Cathode (filament) - Directly Heated		
Warm-up Time, maximum	10	Seconds
Cathode Input Capacitance		
Maximum	40	μμf
Typical	35	μμf

Mechanical

Mounting Position		Any
Net Weight	4.5	Pounds

Thermal

Cooling - Forced Air *		
Air Temperature, maximum	110	C
Body Temperature, maximum †	125	C

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Absolute Values

Filament Voltage	2.5	Volts
Filament Current ‡	6.0	Amperes
Anode Voltage	3400	Volts
Sweep Voltage	700	Volts
Anode Current, swept	80	Milliamperes
Power Input	250	Watts
Injection Electrode Voltage	1700	Volts
Voltage Standing Wave Ratio of Load	2.0	

Typical Operating Conditions

Operation with 60-cycle Sweep Voltage

Filament Voltage, approximate	2.3	Volts
Filament Current ‡	5.3	Amperes
Swept Frequency Range	2860 to 3460	Megacycles
Sweep Voltage, Peak to Peak, typical	550	Volts
Anode Voltage at 3.16 Gigacycles	3000	Volts
Anode Current	65	Milliamperes
Injection Electrode Voltage, positive with respect to cathode	700 to 1700	Volts¶
Injection Electrode Current, may be either polarity but less than	0.5	Milliamperes

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd.)

Typical Operating Conditions (Cont'd.)

Operation with 60-cycle Sweep Voltage (Cont'd.)

Power Output		
Average, Swept Across Full Band	110	Watts ***
Minimum, At Any Point Without Sweep Voltage	100	Watts ***
Variation Across Band		
Typical	1.4	Decibels
Maximum	2.0	Decibels
Efficiency, minimum		
At Any Frequency	55	Percent
Swept Across Full Band	60	Percent

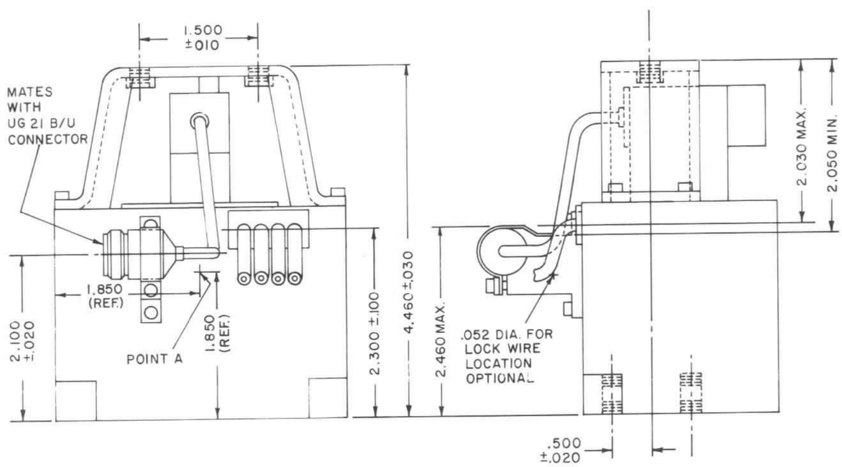
* Hold temperature to 125 C or less at point shown on the outline drawing. At the maximum inlet temperature of 110 C, 100 cubic feet per minute is required but this drops rapidly for lower inlet temperatures.

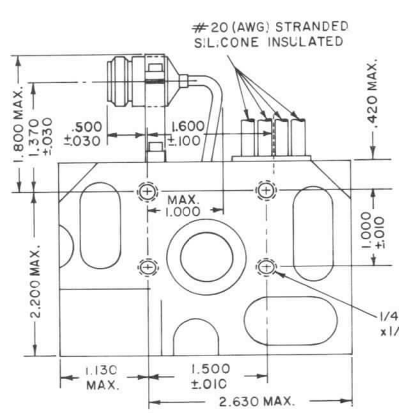
† Measured at point shown on the outline drawing.

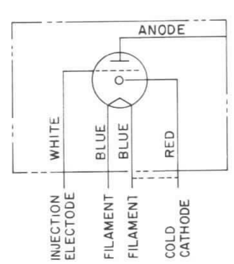
‡ Set to value marked on tube within ± 0.1 ampere.

¶ Set to give anode current marked on tube within ± 2 milliamperes.

*** Measured with load VSWR < 1.2; for loads between 1.2 and 2.0 VSWR the power output is diminished by the amount reflected, plus a positive or negative change due to residual pulling. At 2.0 VSWR the theoretical reduction at the worst load phase is down to 85 percent, and the guaranteed performance is not less than 75 percent of rated power.







NOTE - AN EXTERNAL CONNECTION IS REQUIRED BETWEEN THE COLD CATHODE AND ONE FILAMENT LEAD.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

MILITARY EQUIPMENT TYPES MANUAL

MET-16F

COAXIAL TRIODES AND TETRODES

Selection Chart

CAPABILITIES OF GENERAL ELECTRIC
VHF-UHF Metal-Ceramic Triodes and Tetrodes

The listing below includes power triodes and tetrodes of recent design, and types now in development, that are particularly applicable to systems being planned and built today.

Application	Tube Type	Service	Typical Capabilities	Cooling
Phased Array and Conventional Radar (200-1300 mcs, approx)	GL-7399 GL-51038	RF-Pulsed Amplifier	500 mcs; 10% Bandwidth 250 μsec; 0.005 Duty 30 KW, Peak; 10 db Gain	Forced-air
	GL-7399 GL-51038*	RF-Pulsed Amplifier	425 mcs; 11% Bandwidth 50 μsec; 0.010 Duty 10 KW, Peak; 9 db Gain	Forced-air
	GL-7399 GL-51038	RF-Pulsed Amplifier	425 mcs; 5% Bandwidth 20 μsec; 0.001 Duty 60 KW, Peak; 10 db Gain	Forced-air
	ZP-1034	RF-Pulsed Amplifier	1300 mcs; 10% Bandwidth 500 μsec; 0.060 Duty 5 KW, Peak; 10 db Gain	Liquid
	GL-51065	RF-Pulsed Amplifier	425 mcs; 20% Bandwidth 3.5 μsec; 0.005 Duty 10 KW, Peak; 7 db Gain	Forced-air
	GL-51025	RF-Pulsed Oscillator	1300 mcs; 25 KW, Peak 10 μsec; 0.001 Duty	Conduction
	GL-51074	RF-Pulsed Oscillator	425 mcs; 40 KW, Peak 10 μsec; 0.002 Duty	Conduction
AM and FM Transmitters (50-1250 mcs, approx)	GL-6283 GL-8500 GL-51070	RF Amplifier	225-440 mcs 440 Watts PEP; 13 db Gain 300 Watts CW; 13 db Gain	Forced-air
	GL-6942	RF Amplifier	1000 mcs 1 KW CW; 11 db Gain	Forced-air
	GL-6848	RF Amplifier	225-400 mcs 3.2 KW CW; 15 db Gain	Forced-air
	GL-7985	RF Amplifier	225-400 mcs 4.4 KW PEP; 17 db Gain	Liquid
	GL-8513 ZP-1039	RF Amplifier	225—400 mcs 6 KW PEP; 15 db Gain < 5% Distortion	Forced-air
	GL-51064	RF Amplifier	225-400 mcs 3 KW PEP; 16 db Gain 4 KW CW; 14 db Gain	Forced-air

* Liquid-Cooled Version Available (ZP-1079)

Application	Tube Type	Service	Typical Capabilities	Cooling
IFF Radar (1030 & 1090 mcs)	GL-7399 ZP-1015 GL-51065	RF-Pulsed Amplifier (Grid-Pulsed)	1030 mcs 10 μsec; 0.010 Duty 10 KW, Peak; 8.5 db Gain	Forced-air or Conduction
	GL-8866	RF-Pulsed Amplifier (Grid-Pulsed)	1030 mcs 10 μsec; 0.020 Duty 2 KW, Peak; 10 db Gain	Conduction
CW or Pulsed Signal Generators (200-2000 mcs, approx)	GL-51025 GL-51074	RF-Pulsed Oscillator	200-1300 mcs 5 μsec; 0.005 Duty 5 KW, Peak	Conduction
			200-1300 mcs 5 μsec; 0.001 Duty 20 KW, Peak	
	ZP-1057	RF CW Oscillator	200-1300 mcs 200 Watts	Forced-air
Electronic Voltage Regulators	GL-51038R	High-Voltage Series Regulator	10 KV DC Hold-Off 1000 Watts Dissipation	Circulating Oil
VHF-UHF Television	GL-6283 GL-8500 GL-51070	RF Amplifier	900 mcs 260 Watts, Synch Peak	Forced-air
	GL-6942	RF Amplifier	900 mcs 1000 Watts, Synch Peak	Forced-air
	GL-6251	RF Amplifier	216 mcs 25 KW, Synch Peak	Liquid

TUBE PRODUCTS DEPARTMENT
GENERAL ELECTRIC
Schenectady, N. Y. 12305

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1015

Tetrode

Grid-Pulsed Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1015 is a heat-sink-cooled version of the GL-7399 especially designed for pulsed-amplifier or oscillator service at L-band frequencies. This tetrode is particularly well suited for use in airborne IFF radar equipment.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the ZP-1015 include long life and reliability, long pulse width and high gain.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage	6.0	6.3	6.8	Volts
Heater Current	–	5.6	–	Amperes
Amplification Factor, G_2 to G_1	–	10.5	–	
E_{g2}=275 Volts DC, E_b=1000 Volts DC, I_b = 200 Milliamperes DC				
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances*				
Cathode to Plate †	–	0.012	–	$\mu\mu$f
Input	–	24	–	$\mu\mu$f
Output	–	9.3	–	$\mu\mu$f

MECHANICAL

Mounting Position – Any
Net Weight, approximately . . . . . 11 Ounces

THERMAL

Cooling – Heat-sink and Forced-Air ‡
Anode Temperature §, maximum . . . . . 250 C
Seals
Screen and Control Grid, approximate . . . . . 1 Cubic Foot per Minute
Heater and Cathode, approximate . . . . . 1 Cubic Foot per Minute
Ceramic Temperature at Any Point, maximum . . . . . 200 C

RADIO-FREQUENCY POWER AMPLIFIER – CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles

DC Plate Voltage**	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes

RADIO-FREQUENCY POWER AMPLIFIER - CLASS C (CONT'D)

Maximum Ratings (Cont'd)

Pulsed Drive, 1250 Megacycles (Cont'd)

Plate Dissipation	150	Watts
Pulse Width ♥ ◊	15	Microseconds
Duty Factor ♥ ϕ	0.01	

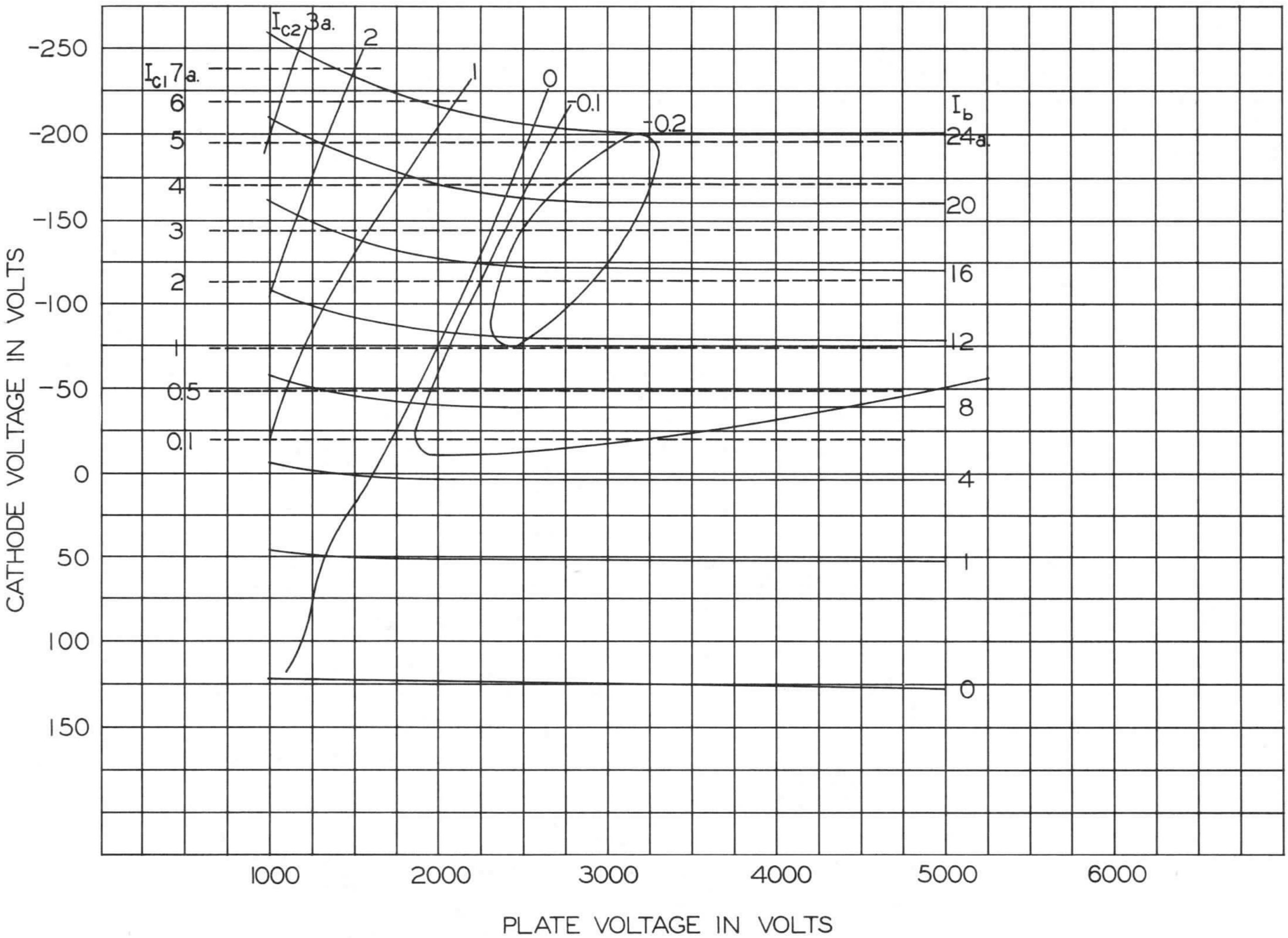
Typical Operation

Grounded-grid Service at 1100 Megacycles, 3/4λ Output Circuit

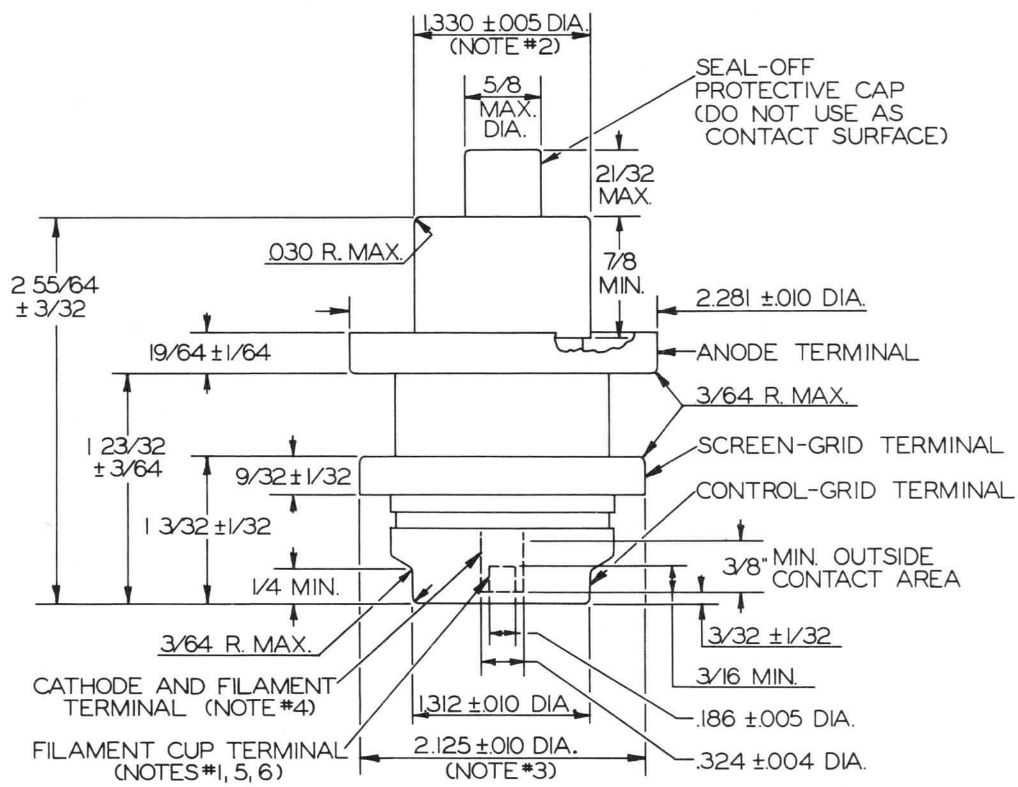
DC Plate Voltage	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	-200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width ◊	15	Microseconds
Duty Factor ϕ	0.01	

* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
‡ Forced-air cooling should be applied during the application of any voltages.
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified; the temperature is measured at the point indicated on the outline drawing.
**** A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.**
♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
◊ Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
ϕ Maximum ratio of on-time to elapsed time during any 15 millisecond period.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



NOTES:
1. Bottom of cup must not be used as a socket stop.
2. Max. eccentricity 0.015"
3. Max. eccentricity 0.008"
4. Max. eccentricity 0.018"
5. Max. eccentricity 0.021" with respect to centerline determined by centers of anode and control-grid terminals.
6. Max. eccentricity 0.008" with respect to cathode terminal.



GENERAL ELECTRIC
POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

OBJECTIVE
TECHNICAL INFORMATION

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ZP-1026

TRIODE

Grid-Pulsed Amplifier Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1026 is a heat-sink-cooled triode especially designed for grid-pulsed amplifier service in L-band. This tube is particularly well suited for use in navigational aid beacons (TACAN). Features include small size, high gain, long pulse width and high duty capability, long life and reliability.

ELECTRICAL

Heater Voltage*	6.3	Volts
Heater Current	3.8	Amperes
Cathode Heating Time, minimum	1	Minute
Direct Interelectrode Capacitances		
Input	15.5	μμf
Output	5.9	μμf
Plate-Cathode	0.13	μμf

MECHANICAL

Mounting Position - Any		
Net Weight, approximately	3 1/4	Ounces

THERMAL

Cooling - Heat-sink and Forced-air		
Anode Temperature §	250	C
Ceramic Temperature at Any Point	200	C

GRID-PULSED AMPLIFIER - CLASS AB_2

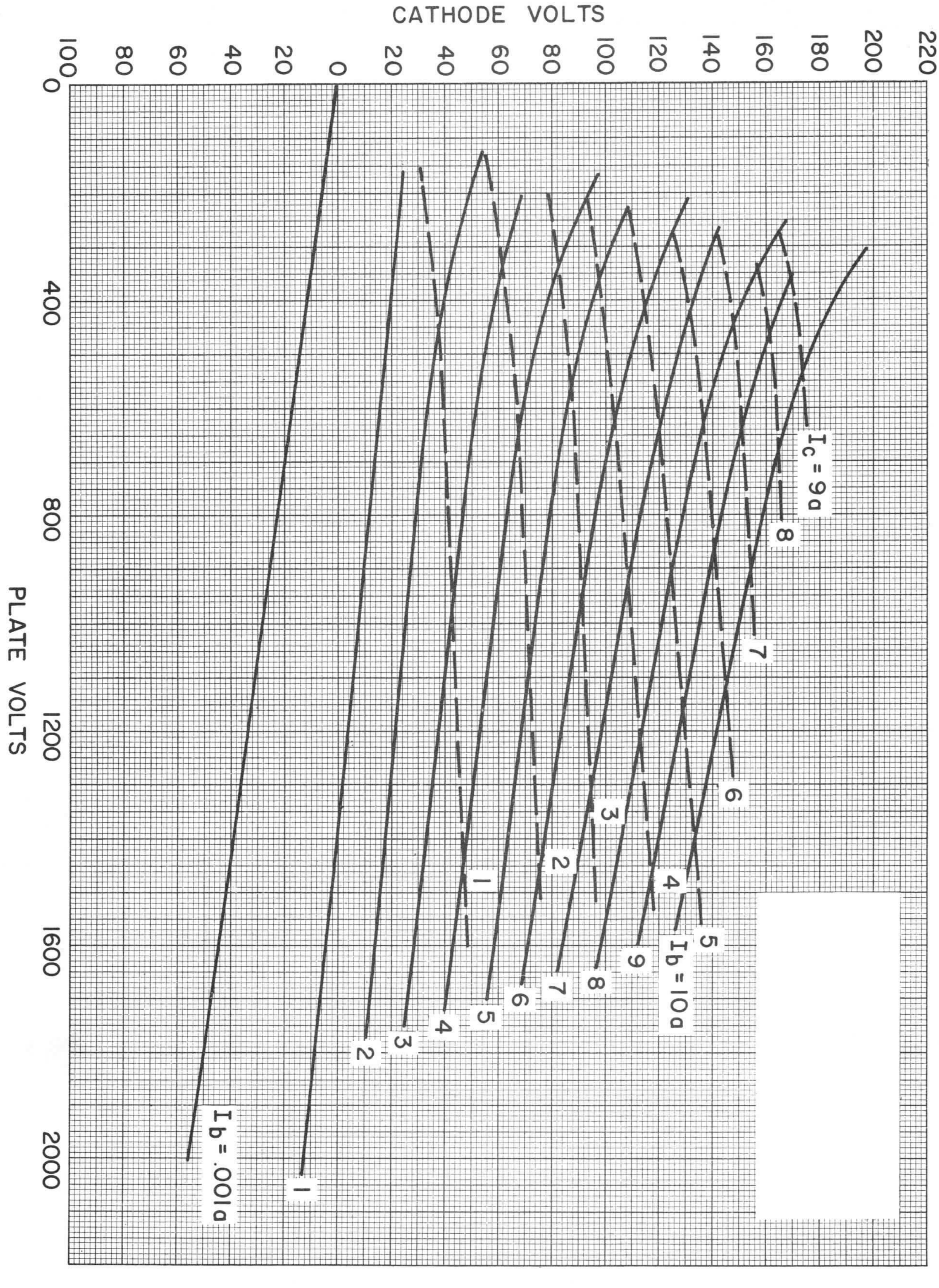
Maximum Ratings

DC Plate Voltage	2.5	Kilovolts
DC Plate Current, during pulse	2.0	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	110	Watts
Pulse Width	10	Microseconds
Duty Factor ø	.04	

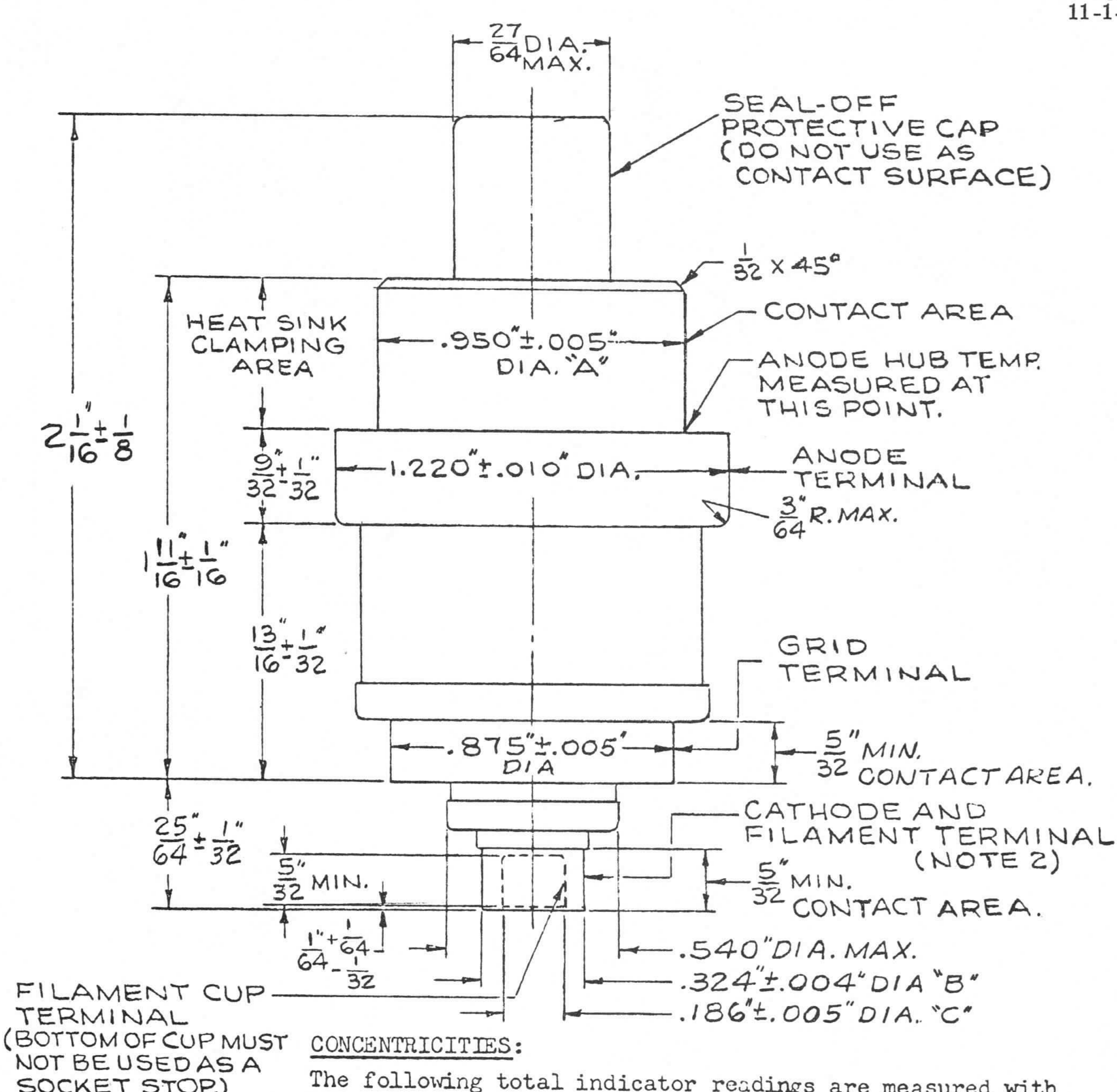
Typical Operation
Grounded-Grid Circuit at 1215 mcs, 3/4 λ Output

DC Plate Voltage	2000	Volts
DC Plate Current, during pulse	1.6	Amperes
DC Grid Voltage	-75	Volts
DC Grid Voltage, during pulse	0	Volts
DC Grid Current, during pulse	.5	Amperes
Power Output, during pulse (useful)	750	Watts
Drive Power, during pulse	95	Watts
Pulse Width ◊	8	Microseconds
Duty Factor	.03	

* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage.
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified.
ø Maximum ratio of on-time to elapsed time during any 250 microsecond period.
◊ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.



Voltages Referenced to Grid



CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.036 inches
Diameter C - 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) - 0.016 inches.

OBJECTIVE
TECHNICAL INFORMATION

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ZP-1034

TETRODE

Pulsed Service
Grounded-Grid Operation

Water Cooled
Metal and Ceramic

Integral Water Jacket

The ZP-1034 is a small-size, four-electrode transmitting tube especially designed for pulsed-amplifier service at L-band frequencies. This tetrode is particularly well suited for use in ground-based equipment such as steerable array radar.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the ZP-1034 include long life and reliability, long pulse width, high gain and broad-banding capability.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage	6.0	6.3	6.8	Volts
Heater Current	--	5.5	--	Amperes
Amplification Factor, G_2 to G_1	--	10.5	--	
E_{g2} = 275 Volts DC, E_b = 1000 Volts DC, I_b = 200 Milliamperes DC				
Cathode Heating Time	1	--	--	Minute
Direct Interelectrode Capacitances*				
Cathode to Plate †	--	0.012	--	uuf
Input	--	24.0	--	uuf
Output	--	9.8	--	uuf

MECHANICAL

Mounting Position – Any
Net Weight, approximate . . . . . 13 Ounces

THERMAL

Cooling – Water and Forced Air ø
Water Flow
Anode . . . . . 0.5 Minimum Gallons per Minute
Outlet Temperature . . . . . 70 Maximum C

THERMAL (Cont'd.)

Air Flow		
Anode Ceramic, approximate	1	Cubic Foot per Minute
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at any Point	200	Maximum C

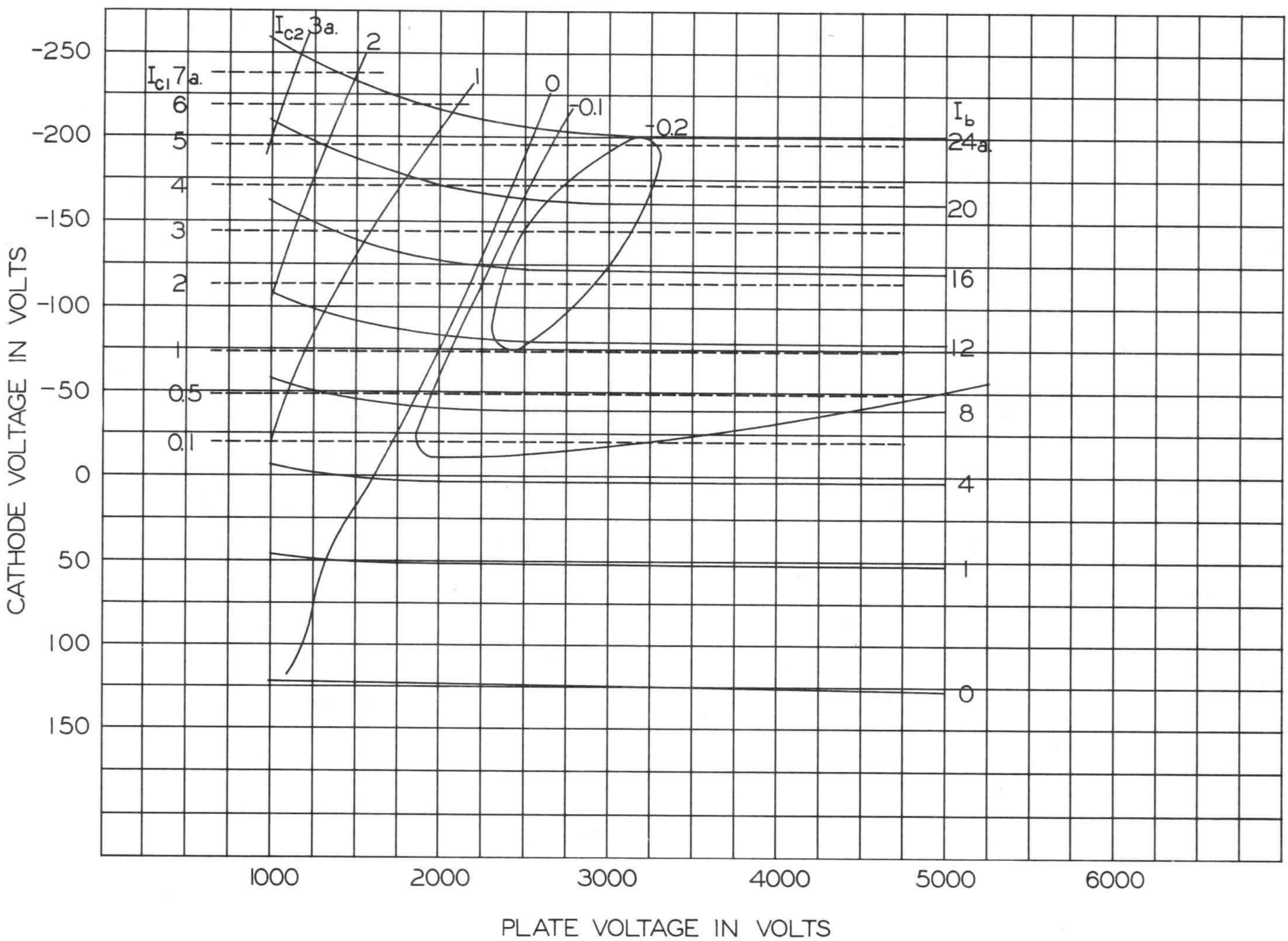
RADIO-FREQUENCY POWER AMPLIFIER - CLASS C

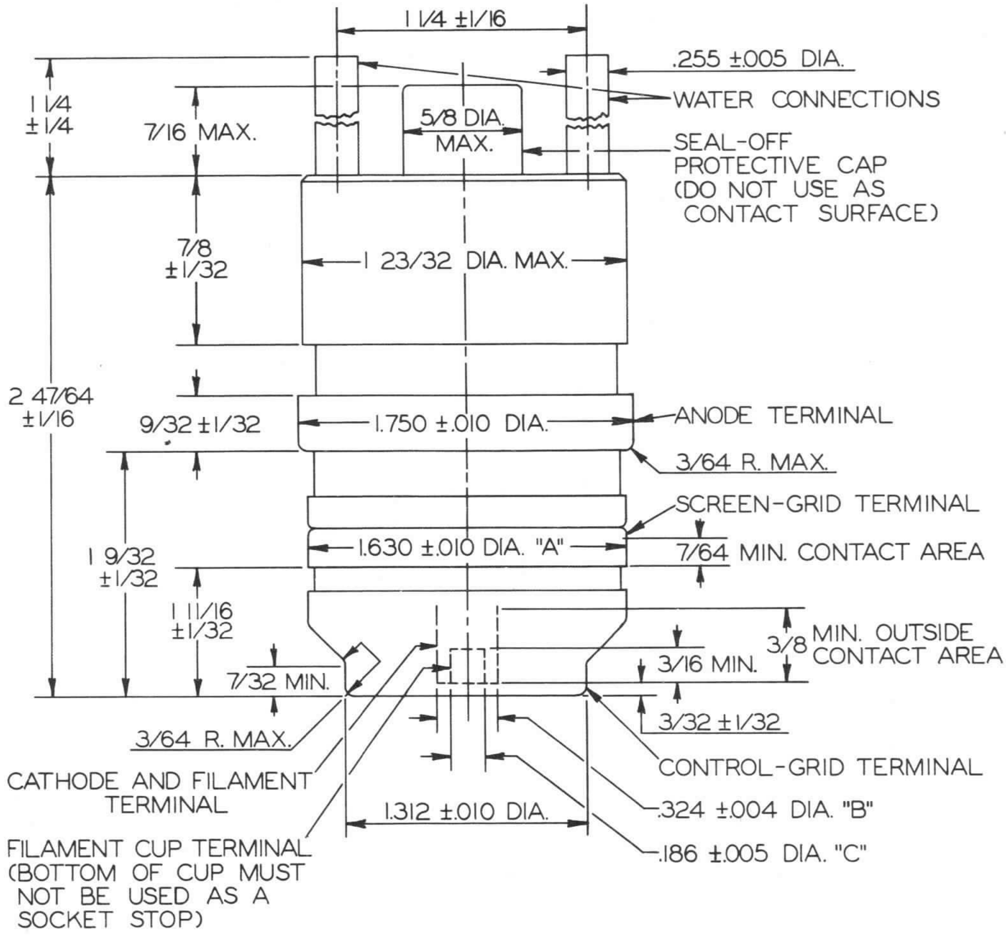
Maximum Ratings		
Pulsed Drive, 1300 Megacycles		
DC Plate Voltage	4	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input #	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation #	750	Watts
Pulse Width ** ††	15	Microseconds
Duty Factor ** øø	0.01	

Typical Operation		
Grounded-grid Circuit at 1300 Megacycles, $\lambda/4$ Output Circuit		
DC Plate Voltage ##	4.0	Kilovolts
DC Plate Current during pulse	3.5	Amperes
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 2 Current, during pulse	75	Milliamperes
DC Grid-No. 1 Voltage	-150	Volts
DC Grid-No. 1 Current, during pulse	150	Milliamperes
Driving Power at Tube, during pulse	750	Watts
Power Output, during pulse (useful)	7.5	Kilowatts
Pulse Width ††	15	Microseconds
Duty Factor	0.01	

* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
ø Water and forced air cooling to be applied during the application of any voltages.
\# Maximum average value.
** For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
†† Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
øø Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
\## A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





CONCENTRICITIES: The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A – 0.016 inches
Diameter B – 0.036 inches
Diameter C – 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) – 0.016 inches.

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1039

VHF-UHF Ring-Seal Construction	**TETRODE** Grounded-Grid Circuit	Forced-Air Cooled Metal and Ceramic

The ZP-1039 is a high-performance four-electrode tube for use as an RF power amplifier in grounded-grid circuits with both grids maintained at RF ground potential. This tube features a high-efficiency, axial-flow radiator for minimum forced-air-cooling requirements. The anode is capable of dissipating 5000 watts. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply to 800 megacycles, although higher-frequency operation is possible.

As a Class B linear power amplifier the tube will deliver 1500 watts at the carrier level with high power gain and high linearity.

In narrow band, plate-modulated Class C telephony service, the ZP-1039 has a useful carrier power output in excess of 1000 watts. In Class C telegraphy service, it has a useful power output in excess of 3000 watts of continuous power as an RF power amplifier or oscillator.

ELECTRICAL

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	–	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	–	14.5	–	Amperes
With 150 Watts Cathode Bombarding	–	13.5	–	Amperes
Heater Starting Current	–	–	25	Amperes
Heater Cold Resistance	–	0.041	–	Ohms
Cathode Bombarding Power*	–	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	–	650	–	Volts
For 195 Watts Bombarding Power	–	700	–	Volts
Cathode Heating Time	1	–	–	Minute
Amplification Factor, G_2 to G_1;				
E_b = 4000 Volts; I_b = 0.5 ampere	–	20	–	
Direct Interelectrode Capacitances				
Cathode to Plate §	–	0.01	–	$\mu\mu$f
Input, G_2 tied to G_1	–	27.8	–	$\mu\mu$f
Output, G_2 tied to G_1 ¶	–	6.7	–	$\mu\mu$f

MECHANICAL

Mounting Position – Vertical, Anode-end Up
Net Weight, approximate . . . . . 9.5 Pounds

THERMAL

Type of Cooling – Forced Air
Air Flow Through Radiator, at Sea Level

Plate Dissipation	Air Flow	Static Pressure
4.0 Kw	80 CFM	0.9 In.
5.0 Kw	150 CFM	2.5 In.

Seals

Screen-grid to Control-grid, minimum	15	Cubic Feet per Minute
Heater-to-cathode, minimum	7.5	Cubic Feet per Minute
Anode Ceramic, minimum	10	Cubic Feet per Minute

THERMAL (CONT'D)

Incoming Air Temperature, maximum	25	C
Anode Hub Temperature, maximum	250	C
Temperature of Anode Ceramic and Seals, maximum	250	C
Temperature at Any Other Point, maximum	200	C

Forced-air cooling to be applied before and during the application of any voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage. The radiator air ducting can be constructed so that air is forced along the anode seal and ceramic through the anode contact fingers and additional holes in the plate contact ring to accomplish the anode ceramic and anode seal cooling. The volume of cooling air indicated for the various seals is approximate only. Distribution of cooling air will vary with configuration of the cavity about the tube.

RADIO-FREQUENCY POWER AMPLIFIER - CLASS B

Carrier Conditions per Tube for Use with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	9000	Volts
DC Grid-No. 2 Voltage	800	Volts
DC Plate Current	0.800	Ampere
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	5.0	Kilowatts

Typical Operation

Grounded-grid Circuit, 225-400 Megacycles

DC Plate Voltage	8000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 1 Voltage, approximate	-50	Volts
DC Plate Current	0.600	Ampere
DC Grid-No. 2 Current	0.010	Ampere
DC Grid-No. 1 Current	0.060	Ampere
Driving Power, approximate	160	Watts
Measured at crest of audio-frequency cycle with modulation factor of 1.0		
Power Output #	1500	Watts
Circuit Efficiency	90	Percent
Plate Dissipation	2500	Watts
Cathode Bombarding Power *	170	Watts
Cathode Bombarding Voltage	650	Volts
Cathode Bombarding Current	0.260	Ampere

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER - CLASS C TELEPHONY

Carrier Conditions with a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	-120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	5.0	Kilowatts

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER - CLASS C TELEPHONY (CONT'D)

Carrier Conditions with a Maximum Modulation Factor of 1.0, Screen Modulation Required

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	-100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output #	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power *	165	Watts
Cathode Bombarding Voltage, approximate	630	Volts
Cathode Bombarding Current, approximate	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR - CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	5.0	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	-120	-100	Volts
Peak RF Plate Voltage, approximate	3000	-	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate #	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power *	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR - CLASS C TELEGRAPHY (CONT'D)

Key Down Conditions per Tube Without Amplitude Modulation

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	-120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate #	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power *	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

* The cathode of the ZP-1039, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

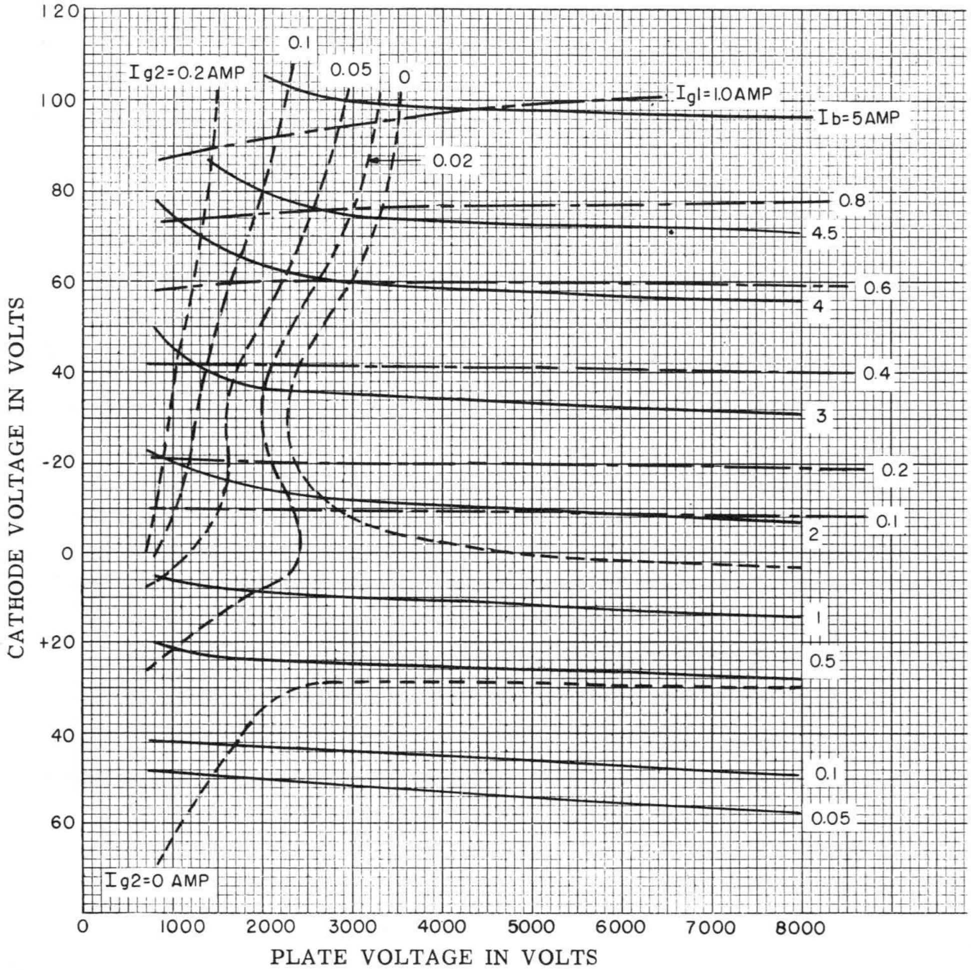
§ Measured with complete isolation between cathode and plate.

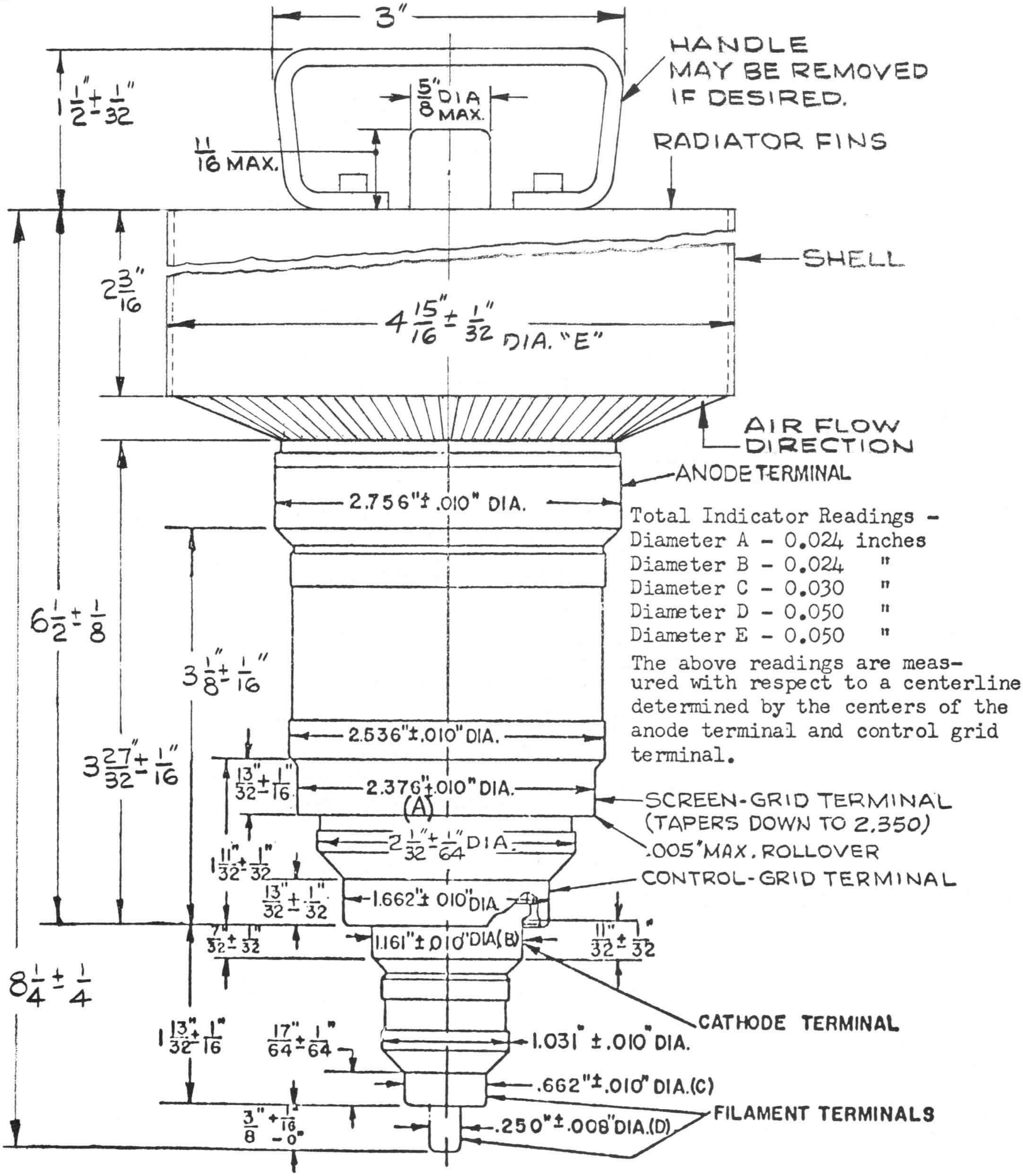
¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

Useful power output including power transferred from driver stage.

TYPICAL CHARACTERISTICS

Ef = 7 Volts AC
Eg2 = 750 Volts
Bombarding Power = 180 Watts
All Voltages Referenced to Grid





Total Indicator Readings -
Diameter A - 0.024 inches
Diameter B - 0.024 "
Diameter C - 0.030 "
Diameter D - 0.050 "
Diameter E - 0.050 "

The above readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

A-69087-72B120 (12-2-64)

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZP-1057
TRIODE

Internal Feedback for CW Oscillator Service
Grounded-Grid Operation

Forced-Air Cooled
Metal and Ceramic

The ZP-1057 is a forced-air cooled triode especially designed for CW oscillator service through approximately 2000 megacycles. This tube is particularly well suited for use in special applications such as high level microwave signal generators operating over an extremely wide frequency range.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service. This special feature greatly simplifies cavity design, construction and operation, particularly where very broad frequency coverage is required.

Other features include small size metal and ceramic construction, a high efficiency radiator, and an oxide-coated cathode with inherent long life.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage*	-	6.3	-	Volts
Heater Current	3.5	3.8	4.0	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances				
Input	-	15.5	-	μμf
Output	-	6.5	-	μμf

MECHANICAL

Mounting Position - Any
Net Weight, approximately .... 5 3/4 Ounces

THERMAL

Cooling - Forced Air
Through Radiator, at Sea Level
Plate Dissipation .... 300 Watts
Air Flow, 45 C Incoming Air Temperature, minimum .... 7 Cubic Feet per Minute
Static Pressure, approximate ..... 0.7 Inches-Water
Radiator Hub Temperature, at Point Adjacent to Anode Seal^{2} .... 250 C
Ceramic Temperature at Any Point, maximum 200 C

CW RADIO-FREQUENCY OSCILLATOR - CLASS C

Maximum Ratings

DC Plate Voltage	1750	Volts
DC Plate Current	0.300	Amperes
DC Grid Voltage	-150	Volts
DC Grid Current	0.050	Amperes
Plate Dissipation	300	Watts

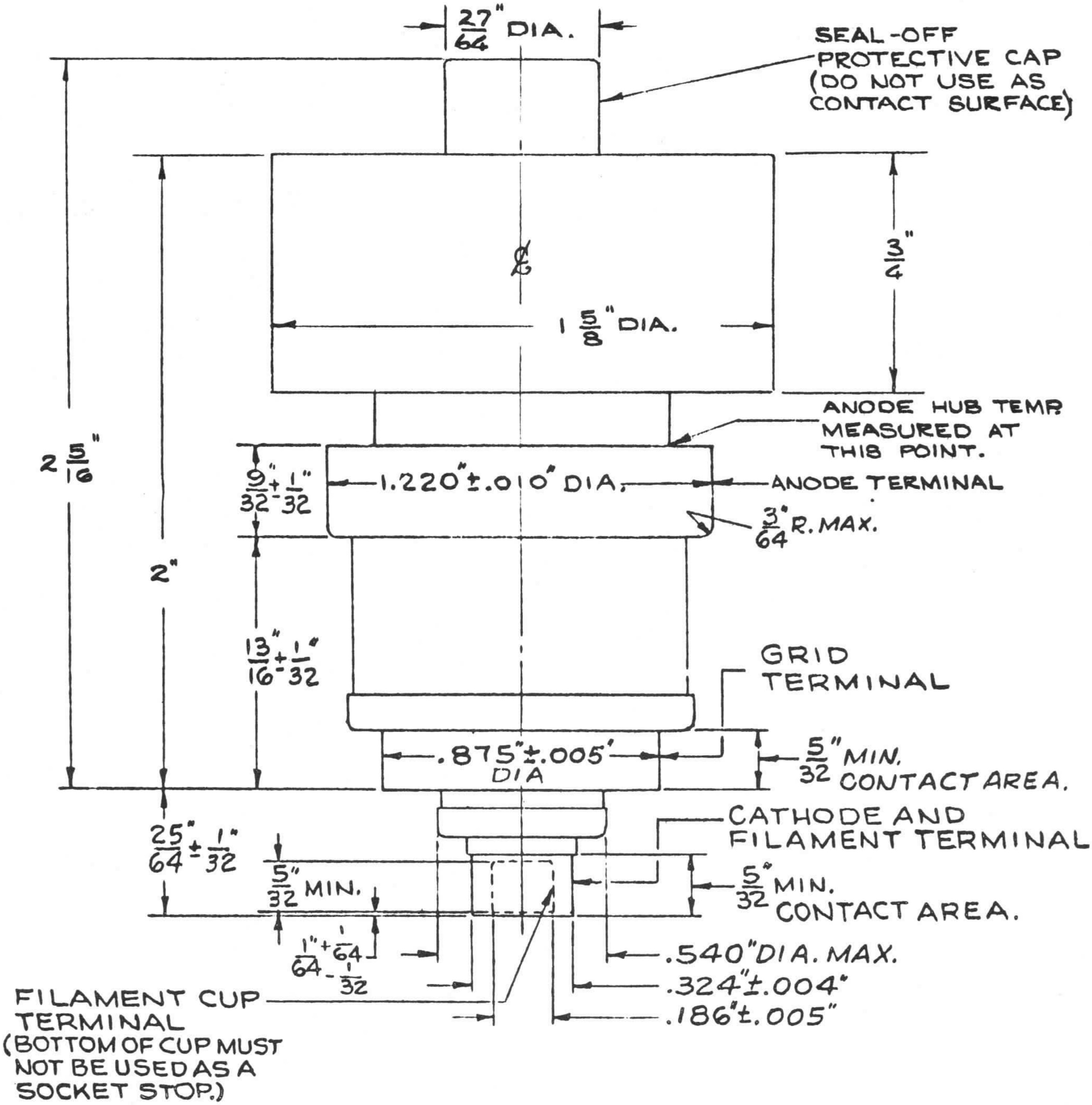
Typical Operation

Grounded-Grid Circuit at 1200 Megacycles, $3/4\lambda$ Output

DC Plate Voltage	1500	Volts
DC Plate Current	0.275	Amperes
DC Grid Voltage	-125	Volts
DC Grid Current	0.045	Amperes
Power Output, approximate (useful)	200	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

∂ Forced-air cooling to be provided before and during the application of any voltages to limit the anode hub temperature to the value specified.



A-69087-72B116

ELECTRONIC INNOVATIONS IN ACTION

TUBES

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

DEVELOPMENTAL TYPE

ZP-1079

TETRODE

Pulsed Service
Grounded-Grid Operation

Water Cooled
Metal and Ceramic

Integral Water Jacket

The ZP-1079 is a small-size, four-electrode transmitting tube especially designed for RF grid-pulsed or plate-and-screen pulsed amplifier service at VHF-UHF frequencies. This tetrode is particularly well suited for use in ground-based radar equipment such as steerable array radar.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

The features of the ZP-1079 include long life and reliability, long pulse width, high peak power, high gain and broad-banding capability.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where high performance and reliability are important.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage §	–	6.3	6.8	Volts
Heater Current	–	5.6	–	Amperes
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances*				
Input	–	24	–	μuf
Output	–	9	–	μuf

MECHANICAL

Mounting Position – Any
Net Weight . . . . . . 14 Ounces

THERMAL

Cooling – Water and Forced Air ‡

Water Flow		
Anode	0.5	Minimum Gallons per Minute
Pressure Drop at Rated Flow, approx	1	Pound per Square Inch
Outlet Temperature	70	Maximum C
Anode Hub Temperature Δ	250	Maximum C
Air Flow		
Anode Ceramic, approximate	1	Cubic Foot per Minute
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at any Point	200	Maximum C

RADIO-FREQUENCY POWER AMPLIFIER – Class B

Maximum Ratings
Plate-and Screen-Grid Pulsed, 500 Megacycles

DC Plate Voltage, during pulse	10	Kilovolts
DC Plate Current, during pulse	10	Amperes
DC Grid-No. 2 Voltage, during pulse	2000	Volts
DC Grid-No. 2 Input♣	15	Watts

RADIO-FREQUENCY POWER AMPLIFIER – Class B (Continued)

Plate Dissipation ♣	750	Watts
DC Grid-No. 1 Voltage, not pulsed	-175	Volts
DC Grid-No. 1 Current, during pulse	2.5	Amperes
Pulse Width ♡◇	15	Microseconds
Duty Factor ♡ ø	0.0012	

Typical Operation
Grounded-grid Circuit, 500 Megacycles, 1/4 λ Output Circuit

DC Plate Voltage, during pulse	9	Kilovolts
DC Grid-No. 2 Voltage, during pulse	1400	Volts
DC Grid-No. 1 Voltage, not pulsed	-125	Volts
Peak RF Plate Voltage	7000	Volts
Peak RF Grid Voltage	300	Volts
DC Plate Current, during pulse	9.2	Amperes
DC Grid-No. 1 Current, during pulse	1.1	Amperes
DC Grid-No. 2 Current, during pulse	0.47	Amperes
Driving Power at Tube, during pulse	2.6	Kilowatts
Power Output, during pulse (useful)	52	Kilowatts
Pulse Width ◇	15	Microseconds
Duty Factor	0.001	

RADIO-FREQUENCY POWER AMPLIFIER – Class C

Maximum Ratings
Pulsed Drive, 1250 Megacycles

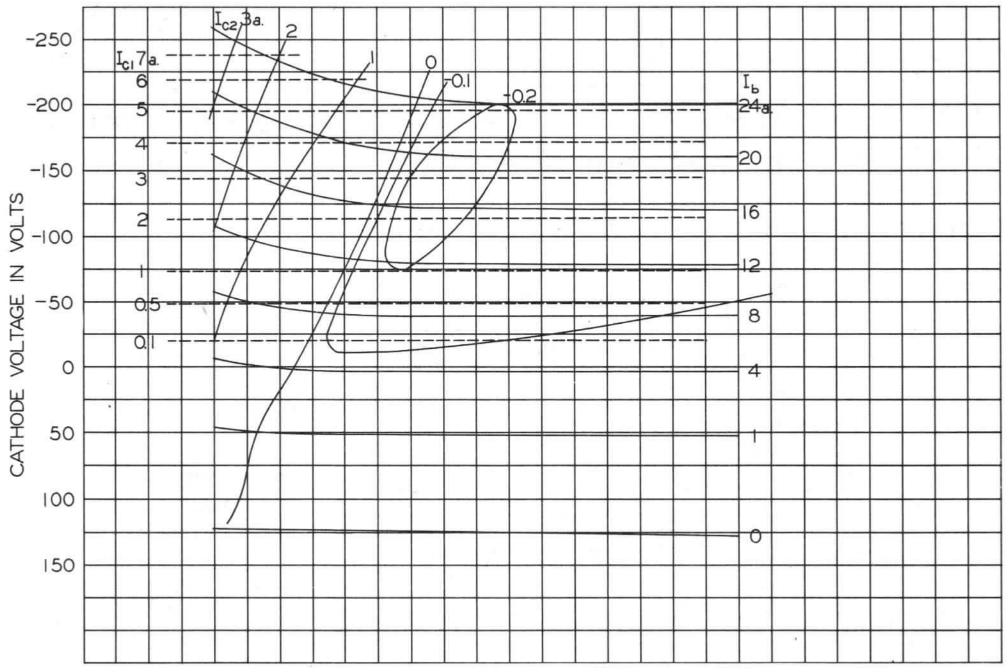
DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation	750	Watts
Pulse Width ♡ ◇	15	Microseconds
Duty Factor ♡ øø	0.01	

Typical Operation
Grounded-grid Circuit at 1100 Megacycles, 3/4 λ Output Circuit

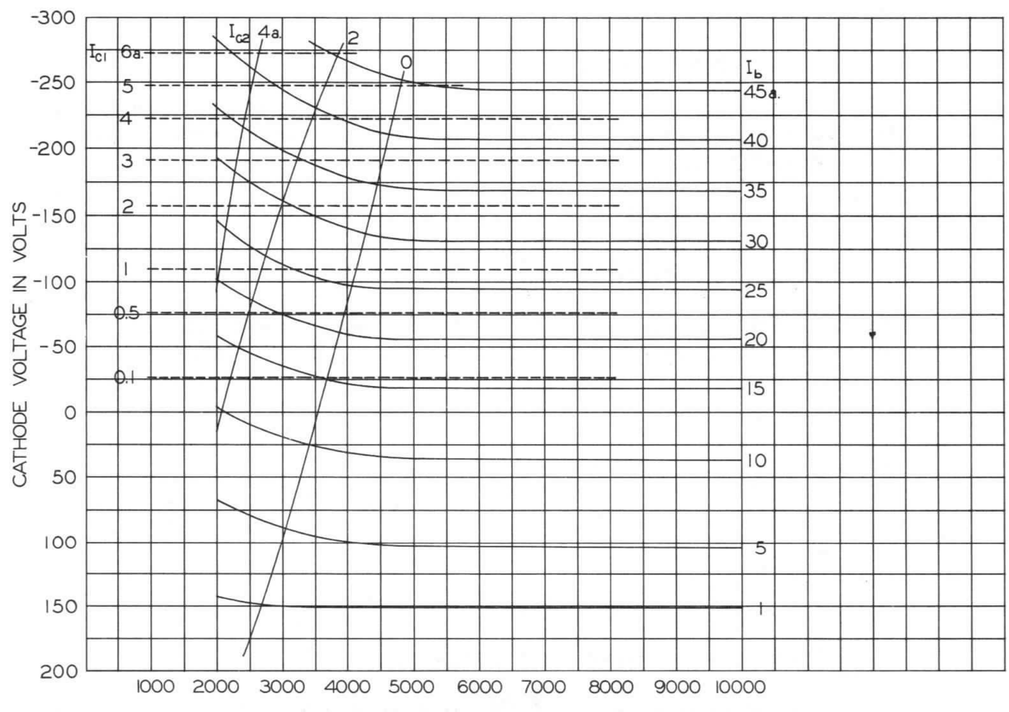
DC Plate Voltage**	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	-200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width ◇	15	Microseconds
Duty Factor	0.01	

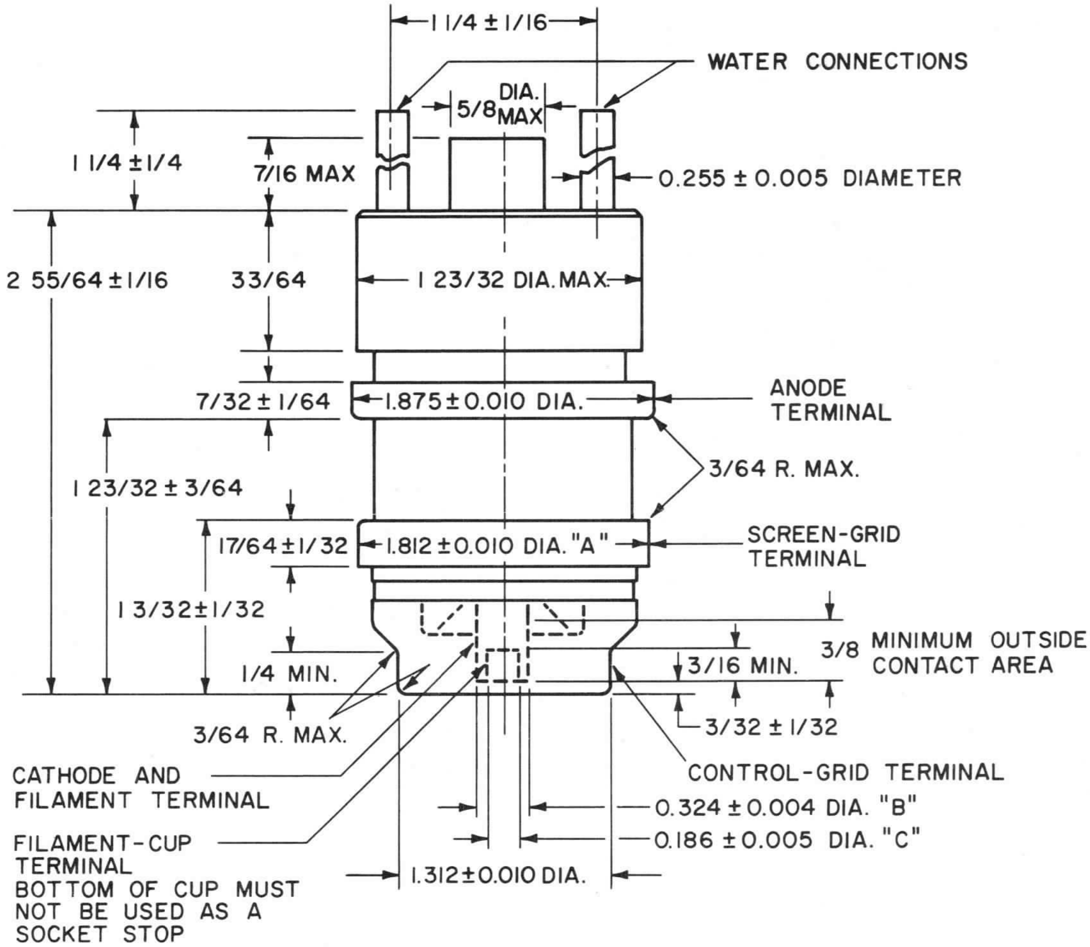
§ Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.
* Control grid connected directly to screen grid.
‡ Water and forced air cooling should be applied during the application of any voltages.
Δ Measured at the base of the water jacket and adjacent to the plate terminal.
♣ Maximum average value.
♡ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
◇ Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
ø Maximum ratio of on-time to elapsed time during any 12.5 millisecond period.
øø Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
** A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B^+ power supply at steady-state voltages greater than 3.5 kilovolts.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 2000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





CONCENTRICITIES:

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL.

DIAMETER A - 0.016 INCHES
DIAMETER B - 0.036 INCHES
DIAMETER C - 0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT-CUP-TERMINAL DIAMETER (C) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT-TERMINAL DIAMETER (B) = 0.016 INCHES.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

— PRODUCT INFORMATION —

GL-6251

Tetrode

25-KILOWATTS VHF TELEVISION OUTPUT
VHF TETRODE
GROUNDED-GRID CIRCUITS

WATER COOLED
METAL AND CERAMIC
GAIN IN EXCESS OF 10

The GL-6251 is a four-electrode, water-and-forced-air-cooled transmitting tube for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating twenty-five kilowatts. The cathode is a thoriated-tungsten filament. Maximum ratings apply up to 220 megacycles.

In Class B grounded-grid broadband television amplifier service this tube has a useful synchronizing peak-power output of twenty-five kilowatts at 220 megacycles. Because of its ratings, the tube is also well adapted to use in dielectric-heating equipment.

High operating efficiency is assured because of the close spacing of the tube electrodes, the ring-seal construction, and the low-loss factor due to the silver-plated external parts and the ceramic insulator. The ring-seal design permits quick plug-in installation. In addition, the grounded-grid construction eliminates the necessity for neutralization in a properly designed circuit.

Electrical

	Minimum	Bogey	Maximum	
⊕Filament Voltage	5.1	5.5	5.75	Volts
Filament Current at 5.5 Volts	..	190	...	Amperes
Filament Starting Current	..	...	360	Amperes
Filament Cold Resistance	..	0.004	...	Ohms
Filament Heating Time	30	...	...	Seconds
Amplification Factor, G_2 to G_1				
$E_b = 1000$ Volts, $I_b = 0.1$ Amps	..	20	...	
Peak Cathode Current*	..	...	30	Amperes
Direct Interelectrode Capacitances§				
Grounded-Grid Circuit				
Cathode-Plate†	..	0.06	...	$\mu\mu f$
Input	..	75	...	$\mu\mu f$
Output	..	27	...	$\mu\mu f$

Mechanical

Mounting Position	Vertical, anode down	
Net Weight, approximate	15	Pounds

Thermal

Type of Cooling—Water and Forced Air

Water Cooling		
Water Flow		
Anode	12 Min	Gallons per Minute
Water Pressure	80 Max	Pounds per Square Inch
Pressure Drop at Rated Flow, approximate	13	Pounds per Square Inch
Outlet Water Temperature	70 Max	C
Air Cooling		
Air Flow		
Anode Seal	30 Min	Cubic Feet per Minute
Filament Seal	15 Min	Cubic Feet per Minute
Grid-to-Grid Seal	10 Min	Cubic Feet per Minute
Ceramic Temperature	200 Max	C
□Seal and Terminal Temperature	180 Max	C

GENERAL ELECTRIC

RADIO-FREQUENCY AMPLIFIER—CLASS B TELEVISION SERVICE

Synchronizing-Level Conditions Per Tube Unless Otherwise Specified

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Max	Volts
⊕DC Grid-No. 2 Voltage	700	Max	Volts
DC Plate Current	8	Max	Amperes
Plate Input	50	Max	Kilowatts
Grid-No. 2 Input‡	350	Max	Watts
⊕DC Grid-No. 2 Current			
Pedestal Level	0.200	Max	Amperes
Plate Dissipation	25	Max	Kilowatts
Grid-No. 1 Dissipation	150	Max	Watts
⊕DC Grid-No. 1 Current	1.0	Max	Amperes

Typical Operation—Grounded-Grid Circuit up to 216 Megacycles

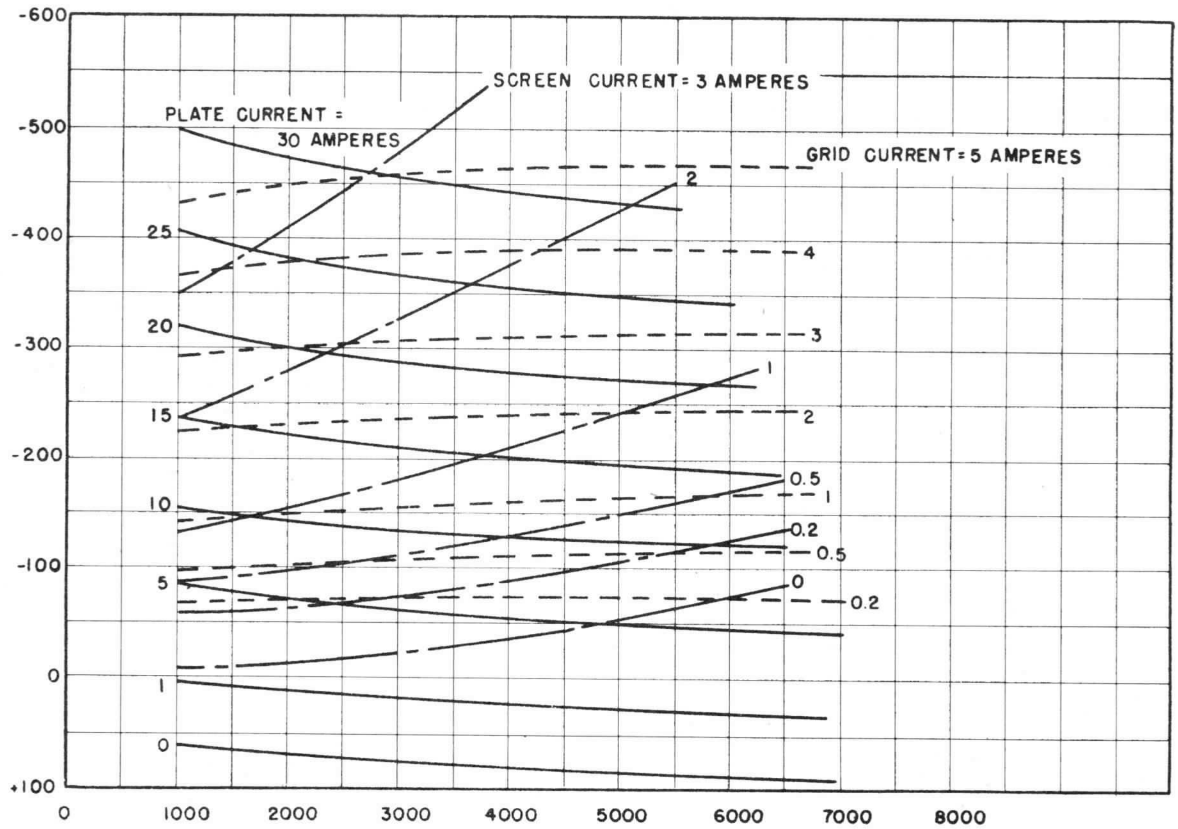
Bandwidth 7 Megacycles, 1 Decibel Voltage		
DC Plate Voltage	6800	Volts
⊕DC Grid-No. 2 Voltage//	600	Volts
DC Grid-No. 1 Voltage	—20	Volts
Peak RF Plate Voltage		
Synchronizing Level	4800	Volts
Pedestal Level	3600	Volts
Peak RF Driving Voltage		
Synchronizing Level	350	Volts
Pedestal Level	250	Volts
DC Plate Current		
Synchronizing Level	7.5	Amperes
Pedestal Level	5.8	Amperes
DC Grid-No. 2 Current//		
Pedestal Level	0.05	Amperes
DC Grid-No. 1 Current		
Synchronizing Level	0.90	Amperes
Pedestal Level	0.55	Amperes
Driving Power at Tube, approximate		
Synchronizing Level	2.3	Kilowatts
Pedestal Level	1.3	Kilowatts
Power Output, approximate¶		
Synchronlzing Level	25	Kilowatts
Pedestal Level	15	Kilowatts

* Maximum usable cathode current (plate current plus current to each grid) for any condition of operation.
§ Control grid and screened grid are connected together.
† Measured with 12-inch diameter flat metal disk attached to the screen-grid terminal and grounded.
‡ Calculated from characteristic curve only. This value includes dissipation transferred from driving power. Maximum allowable screen input as indicated by measured d-c current and voltage is much lower because of secondary screen emission.
//DC Grid-No. 2 voltage and current should be held at the minimum values consistent with proper circuit operation. Negative values of screen current are frequently encountered but are not detrimental.
¶ Useful power output including power transferred from driver stage.
⊕Denotes a change.
□ Denotes an addition.

CONSTANT CURRENT CHARACTERISTICS

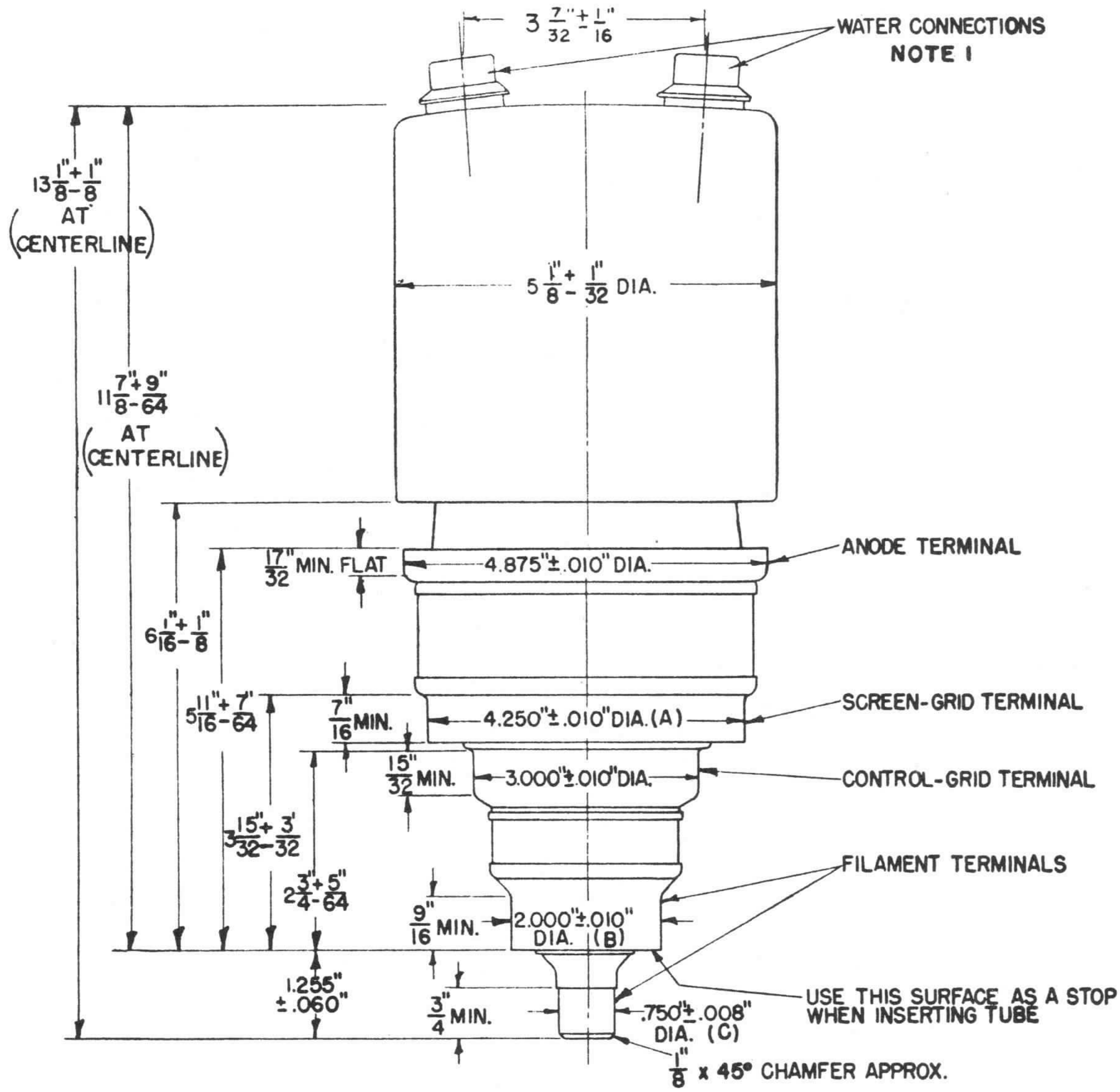
SCREEN VOLTAGE=700 VOLTS, CONTROL-GRID GROUNDED

ELECTRODE VOLTAGES MEASURED TO GROUND



K-69087-72A680 12-30-54

▲Supersedes pages 3 and 4 dated 9-57



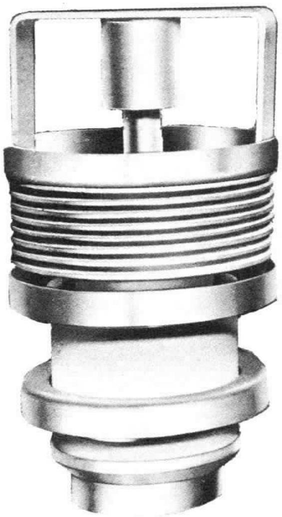
(A) MAX. ECCENTRICITY .040"
(B) MAX. ECCENTRICITY .040"
(C) MAX. ECCENTRICITY .050"
WITH RESPECT TO CENTERLINE DETERMINED BY CENTERS OF ANODE TERMINAL & CONTROL-GRID TERMINAL.

NOTE 1: MATES WITH WIGGINS SOCKET NO. BC-323B OR EQUIVALENT.
E. B. WIGGINS OIL TOOL COMPANY, INC., LOS ANGELES, CALIFORNIA

N-20726AZ

1-6-59

GL-6283
TETRODE



RADIO-FREQUENCY AMPLIFIER
CW SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC
INTEGRAL RADIATOR

The GL-6283 is a reliable power tetrode that delivers useful output to 1250 megacycles or higher. This tube is particularly suitable for application in the final output or driver stage of military-communications systems.

As a Class B linear amplifier in the 225–400-megacycle range, the tube will deliver 110 watts of carrier power modulated up to 100 percent. Since a power gain of 20 may be realized, drive requirements are low—approximately 5 watts at carrier level.

Operating as a Class C CW amplifier at 900 megacycles, the gain is approximately 15 at the 200-watt level.

Features of the GL-6283 include long life and reliability, high gain, high linearity, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	—	6.3	6.8	Volts
Heater Current	—	3.8	—	Amperes
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, $E_b=1000$V DC; $E_{g2}=275$V DC; $I_b=0.2$ A DC	—	14	—	
Peak Cathode Current†	—	—	1.75	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate‡	—	0.006	—	$\mu\mu f$
Input, G_2 tied to G_1	—	18.25	—	$\mu\mu f$
Output, G_2 tied to G_1♦	—	6.4	—	$\mu\mu f$

Mechanical

Mounting Position—Any
Net Weight, approximate . . . 1.0 Pounds

Thermal

Cooling—Forced Air§ Through Radiator, at Sea Level**				
Plate Dissipation	500	400	300	Watts
Air Flow, 45 C Incoming Air Temperature, minimum	17.0	12.0	6.5	Cubic Feet per Minute
Static Pressure, approximate	0.9	0.5	0.2	Inches-Water
Radiator Hub Temperature, at Point Adjacent to Anode Seal	—	—	250	C
Seals				
Screen-Grid to Control-Grid, approximate	—	—	1	Cubic Feet per Minute
Heater to Cathode, approximate	—	—	1	Cubic Feet per Minute
Ceramic Temperature at Any Point, maximum	—	—	200	C

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B LINEAR

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings

DC Plate Voltage	2000	Volts
DC Grid-No. 2 Voltage	320	Volts
DC Plate Current	0.250	Amperes
Plate Input	500	Watts
Grid-No. 2 Input	5	Watts
Plate Dissipation	500	Watts

Typical Operation

Grounded-Grid Circuit at 225–400 Megacycles

DC Plate Voltage	1750	Volts
DC Grid-No. 2 Voltage	250	Volts
DC Grid-No. 1 Voltage, approximate	−20	Volts
Peak RF Plate Voltage #, approximate	1250	Volts
Peak RF Grid-No. 1 Voltage #, approximate	40	Volts
DC Plate Current	0.200	Amperes
Zero Signal DC Plate Current (E_{c1} adjusted)	0.020	Amperes
DC Grid-No. 2 Current	0.005	Amperes
DC Grid-No. 1 Current	0.010	Amperes
Driving Power, approximate	5	Watts
Power Output♥	110	Watts

RADIO-FREQUENCY AMPLIFIER—CLASS B TELEVISION SERVICE

Synchronizing-Level Conditions Per Tube Unless Otherwise Specified

Maximum Ratings, Absolute Values

DC Plate Voltage	1600 Max	Volts
DC Grid-No. 2 Voltage	320 Max	Volts
DC Plate Current	0.400 Max	Amperes
Plate Input	600 Max	Watts
Grid-No. 2 Input	15 Max	Watts
Plate Dissipation	500 Max	Watts
Grid-No. 1 Dissipation	2 Max	Watts

Typical Operation—Grounded-Grid Circuit up to 900 Megacycles

Bandwidth 6 Megacycles		
DC Plate Voltage	1500	Volts
DC Grid-No. 2 Voltage	250	Volts
DC Grid-No. 1 Voltage	−25	Volts
Peak RF Plate Voltage		
Synchronizing Level	1100	Volts
Pedestal Level	825	Volts
Peak RF Driving Voltage		
Synchronizing Level	35	Volts
Pedestal Level	27	Volts
DC Plate Current		
Synchronizing Level	0.400	Amperes
Pedestal Level	0.295	Amperes
DC Grid-No. 2 Current (Pedestal Level)	0.007	Amperes
DC Grid-No. 1 Current		
Synchronizing Level	0.036	Amperes
Pedestal Level	0.016	Amperes
Driving Power at Tube, approximate		
Synchronizing Level	25	Watts
Pedestal Level	15	Watts
Power Output, approximate		
Synchronizing Level¶	260	Watts
Pedestal Level¶	145	Watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation△

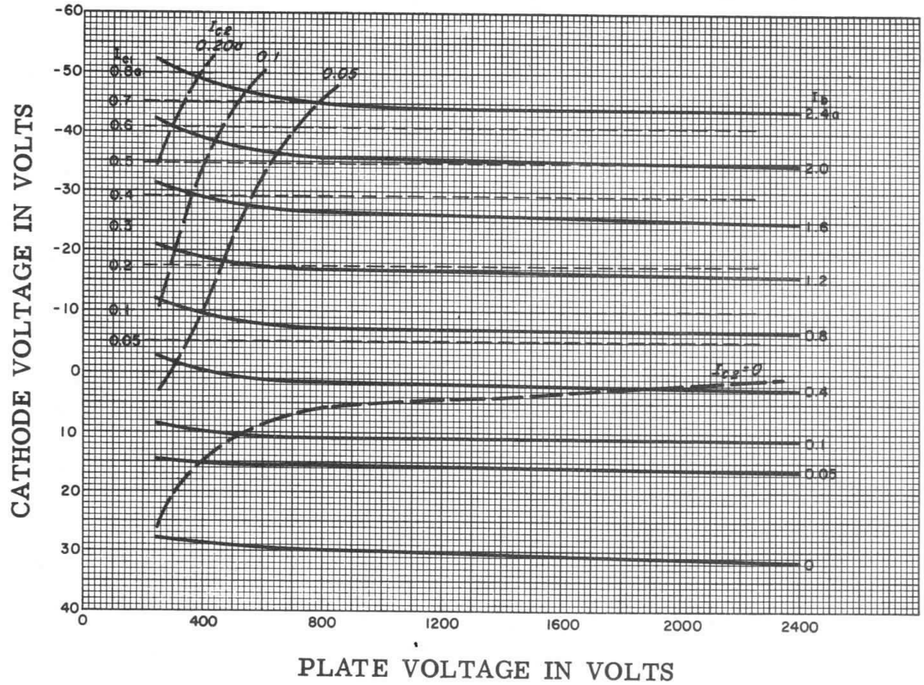
Maximum Ratings	**900 Megacycles**	**400 Megacycles**	
DC Plate Voltage	1600	2000	Volts
DC Grid-No. 2 Voltage	320	320	Volts
DC Grid-No. 1 Voltage	−100	−100	Volts
DC Plate Current	0.300	0.300	Ampere
DC Grid-No. 1 Current	0.050	0.050	Ampere
Plate Input	480	600	Watts
Grid-No. 2 Input	15	15	Watts
Plate Dissipation	500	500	Watts
Grid-No. 1 Dissipation	2	2	Watts

Typical Operation

Grounded-Grid Circuit at 900 Megacycles			
DC Plate Voltage	1500	2000	Volts
DC Grid-No. 2 Voltage	210	225	Volts
DC Grid-No. 1 Voltage	−40	−40	Volts
DC Plate Current	0.300	0.250	Ampere
DC Grid-No. 2 Current, approximate	0.010	0.010	Ampere
DC Grid-No. 1 Current, approximate	0.020	0.020	Ampere
Driving Power, approximate	14	15	Watts
Power Output, approximate¶	205	300	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.
† Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.
‡ Measured with a 6-inch minimum diameter flat metal disk attached to the screen-grid ring. Control grid connected to the screen grid.
♦ Output capacitances measured between anode and screen grid. Control grid connected directly to screen grid.
§ Forced-air cooling to be applied before and during the application of any voltages.
**Provision must be made for unobstructed passage of cooling air between radiator fins and between the anode terminal and adjacent radiator fin.
♥ Useful power output as measured in output-circuit load.
¶ Useful power output including power transferred from driver stage. Output circuit efficiency approximately 80 percent.
△ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 250 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



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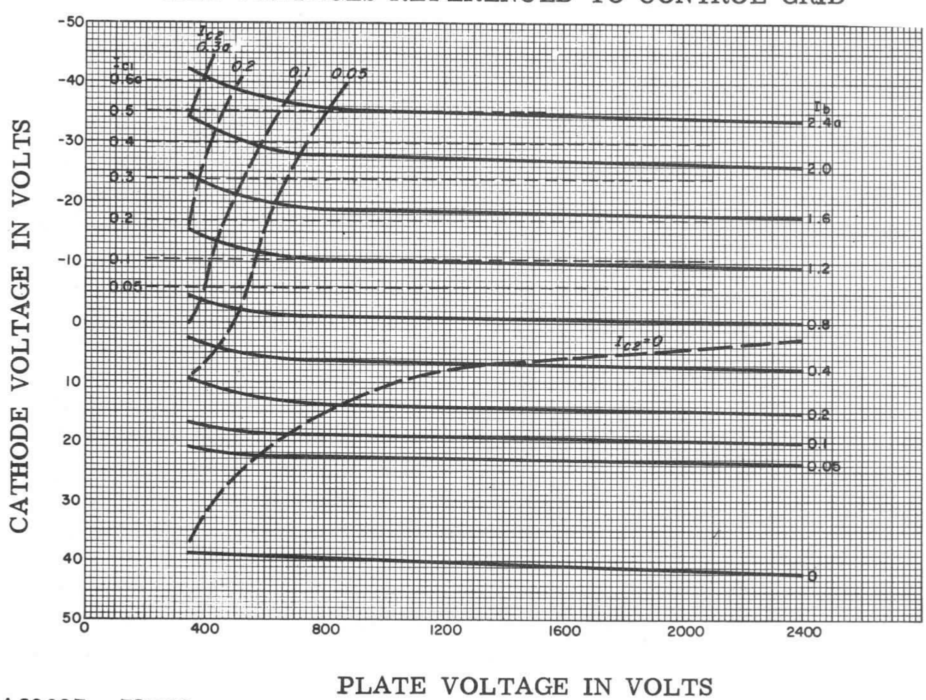
CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 350 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



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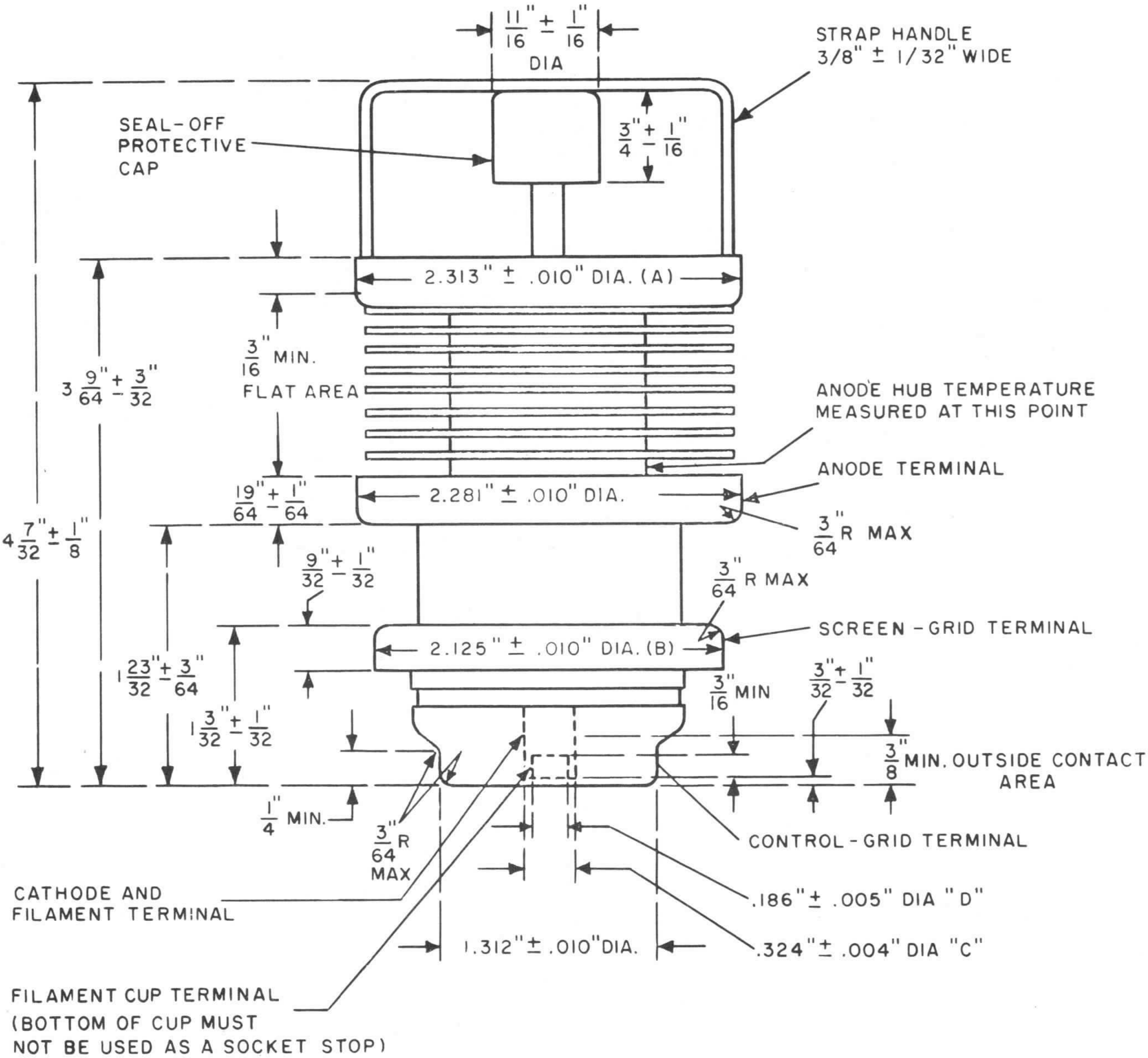


CONCENTRICITIES

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL GRID TERMINAL

DIAMETER A – 0.030 INCHES
DIAMETER B – 0.016 INCHES
DIAMETER C – 0.036 INCHES
DIAMETER D – 0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT CUP TERMINAL DIAMETER (D) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT TERMINAL DIAMETER (C) – 0.016 INCHES

K-69087-72A578 8-1-62

GL-6848
TETRODE

VHF-UHF | **FORCED-AIR COOLED**
RING-SEAL CONSTRUCTION | **METAL AND CERAMIC**
GROUNDED-GRID CIRCUIT

The GL-6848 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 2 kilowatts. Cooling is accomplished by forced air with the radiator an integral part of the anode. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply up to 800 megacycles, although higher frequency operation is possible.

In narrow band, Class C, grounded-grid, amplitude-modulated service, the GL-6848 has a useful carrier-power output in excess of one kilowatt. In Class C Telegraphy, it has a useful power output of 3.0 kilowatts of continuous power as an amplifier or oscillator.

Electrical

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	—	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	—	14.5	—	Amperes
With 150 Watts Cathode Bombarding	—	13.5	—	Amperes
Heater Starting Current	—	—	25	Amperes
Heater Cold Resistance	—	0.041	—	Ohms
Cathode Bombarding Power*	—	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	—	650	—	Volts
For 195 Watts Bombarding Power	—	700	—	Volts
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, $E_b = 4000$ volts, $I_b = 0.5$ Ampere	—	20	—	
Peak Cathode Current‡	—	—	6	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate§	—	0.01	—	$\mu\mu$f
Input, G_2 tied to G_1	—	27.8	—	$\mu\mu$f
Output, G_2 tied to G_1¶	—	6.4	—	$\mu\mu$f

Mechanical

Mounting Position—Vertical, Anode-end Up

Net Weight, approximate .... 6.0 Pounds

Thermal

Type of Cooling—Forced Air

Air Flow

Through Radiator				
Percentage Rated Plate Dissipation	100	80	60	Percent
Air Flow	120	70	48	Cubic Feet per Minute
Static Pressure	3.2	1.5	0.8	Inches
Screen-grid to Control-grid Seals			15	Min Cubic Feet per Minute
Heater-to-Cathode Seals			7.5	Min Cubic Feet per Minute
Anode Ceramic			10	Min Cubic Feet per Minute

Incoming Air Temperature	45	Max C
Anode Hub Temperature	180	Max C
Ceramic Temperature at Any Point	200	Max C
Temperature at Any Other Point	200	Max C

Forced-air cooling to be applied before and during the application of any voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage. The air duct can be constructed so that air is forced along the anode seal and ceramic through the anode contact fingers to accomplish the anode ceramic and anode seal cooling. The volume of cooling air indicated is approximate only. Distribution of cooling air will vary with configuration of the cavity about the tube.

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions With a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	2.0	Kilowatts

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output#	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power*	165	Watts
Cathode Bombarding Voltage, approx.	630	Volts
Cathode Bombarding Current, approx.	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	2.0	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	−120	−100	Volts
Peak RF Plate Voltage, approximate	3000	—	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate#	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power*	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	−120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate#	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power*	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

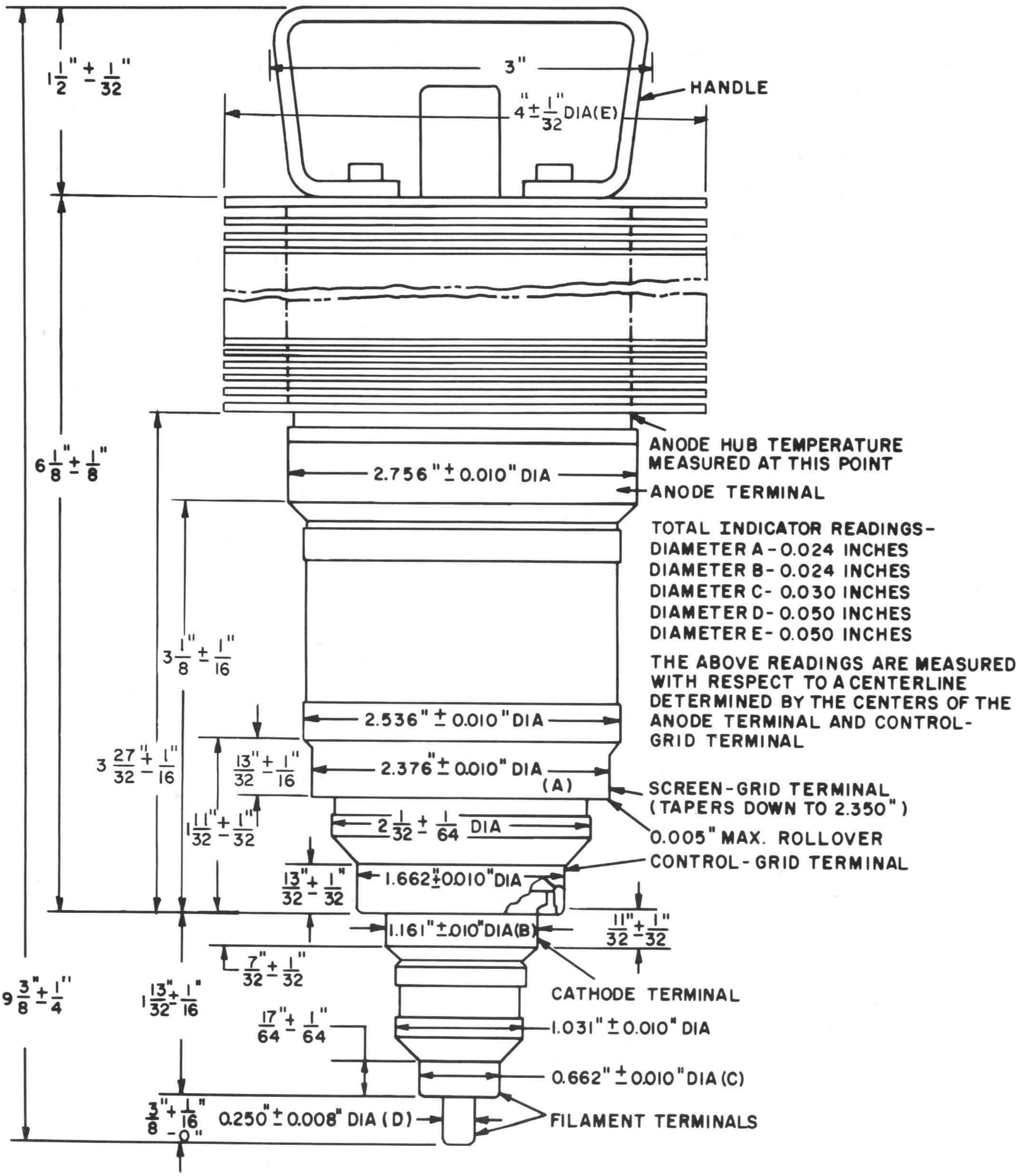
* The cathode of the GL-6848, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

‡ Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

§ Measured with complete isolation between cathode and plate.

¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

Useful power output including power transferred from driver stage.


HANDLE
3"
4" ± 1/32" DIA(E)
1 1/2" ± 1/32"
6 1/8" ± 1/8"
9 3/8" ± 1/4"
ANODE HUB TEMPERATURE MEASURED AT THIS POINT
2.756" ± 0.010" DIA
ANODE TERMINAL
TOTAL INDICATOR READINGS-
DIAMETER A - 0.024 INCHES
DIAMETER B - 0.024 INCHES
DIAMETER C - 0.030 INCHES
DIAMETER D - 0.050 INCHES
DIAMETER E - 0.050 INCHES
THE ABOVE READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL
3 1/8" ± 1/16"
2.536" ± 0.010" DIA
3 27/32" ± 1/16"
13/32" ± 1/16"
2.376" ± 0.010" DIA (A)
SCREEN-GRID TERMINAL (TAPERS DOWN TO 2.350")
1 1/32" ± 1/32"
2 1/32 ± 1/64 DIA
0.005" MAX. ROLLOVER
CONTROL-GRID TERMINAL
13/32" ± 1/32"
1.662" ± 0.010" DIA
1.161" ± .010" DIA (B)
11/32" ± 1/32"
7/32" ± 1/32"
1 13/32" ± 1/16"
CATHODE TERMINAL
17/64" ± 1/64"
1.031" ± 0.010" DIA
0.662" ± 0.010" DIA (C)
3/8" + 1/16" - 0"
0.250" ± 0.008" DIA (D)
FILAMENT TERMINALS

GL-6942

Tetrode

ONE KILOWATT UHF TELEVISION OUTPUT
UHF TETRODE
GROUNDED-GRID CIRCUITS
FORCED-AIR COOLED
METAL AND CERAMIC
INTEGRAL RADIATOR
THORIATED-TUNGSTEN CATHODE

The GL-6942 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope designed for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating one and one half kilowatts. Cooling is accomplished by forced air with the radiator an integral part of the anode. The cathode is indirectly heated thoriated tungsten. Maximum ratings apply up to 1000 megacycles.

When used as a Class B grounded-grid broadband television amplifier this tube has a useful synchronizing peak-power output of one kilowatt at 900 megacycles; in narrow band Class C service the output is one kilowatt of continuous power as an amplifier or oscillator. Because of its ratings, the tube is also well adapted to use in dielectric-heating equipment.

High operating efficiency is assured because of the small size and close spacing of the tube electrodes, the ring-seal construction, and the low-loss factor due to the silver-plated external parts and the ceramic insulators. In addition, the grounded-grid construction eliminates the necessity for neutralization in a properly designed circuit. The small size of the GL-6942 permits compact mounting, and the ring-seal construction allows quick plug-in installation.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	—	5.7	6.0	Volts
Heater Current at 5.7 Volts	22	24	26	Amperes
Heater Starting Current	—	—	36	Amperes
Heater Cold Resistance	—	0.02	—	Ohms
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, Eb = 2000 Volts, I_b = 0.200 Ampere, E_c2 = 475 Volts	12	17	22	
Peak Cathode Current†	—	—	3.0	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate‡	—	—	0.006	$\mu\mu f$
Input, G_2 tied to G_1	15.5	17.0	18.5	$\mu\mu f$
Output, G_2 tied to G_1§	5.0	5.5	6.0	$\mu\mu f$

Mechanical

Mounting Position . . . . . Any
Net Weight, approximate . . . . . 3.6 Pounds

Thermal

Air Flow¶		
Through Radiator—See drawing for air duct form on page 3.		
Plate Dissipation	1.5	Kilowatts
Air Flow	60 Min	Cubic Feet per Minute
Static Pressure	1.5	Inches Water
Heater-to-Cathode Seals	8 Min	Cubic Feet per Minute
Screen-Grid to Control-Grid Seals	4 Min	Cubic Feet per Minute
Anode to Screen-Grid Ceramic Insulator	6 Min	Cubic Feet per Minute
Incoming Air Temperature	45 Max	C
Radiator Hub Temperature at Fin Adjacent to Anode Seal	180 Max	C
Ceramic Temperature at Any Point	200 Max	C

Forced-air cooling to be applied before and during the application of any voltages. Forced-air cooling must be maintained for one minute after the removal of all voltages.

RADIO-FREQUENCY AMPLIFIER—CLASS B TELEVISION SERVICE

Synchronizing-Level Conditions per Tube Unless Otherwise Specified

Maximum Ratings, Absolute Values

DC Plate Voltage	4000 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Plate Current	0.7 Max	Amperes
Plate Input	2.5 Max	Kilowatts
Grid-No. 2 Input	25 Max	Watts
Plate Dissipation	1.5 Max	Kilowatts

Typical Operation—Grounded-Grid Circuit up to 900 Megacycles

Bandwidth 6 Megacycles, measured to 1 decibel point

DC Plate Voltage	3500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−40	Volts
Peak RF Plate Voltage		
Synchronizing Level	2500	Volts
Pedestal Level	1875	Volts
Peak RF Driving Voltage		
Synchronizing Level	110	Volts
Pedestal Level	70	Volts
DC Plate Current		
Synchronizing Level	0.520	Amperes
Pedestal Level	0.360	Amperes
DC Grid-No. 2		
Pedestal Level	0.035	Amperes
DC Grid-No. 1 Current		
Synchronizing Level	0.110	Amperes
Pedestal Level	0.035	Amperes
Driving Power at Tube, approximate		
Synchronizing Level	100	Watts
Pedestal Level	25	Watts
Power Output, approximateϕ		
Synchronizing Level	1000	Watts
Pedestal Level	560	Watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions with a Maximum Madulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	3200 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Grid-No. 1 Voltage	−120 Max	Volts
DC Plate Current	0.35 Max	Amperes
Dc Grid-No. 1 Current	0.10 Max	Amperes
Plate Input	1.12 Max	Kilowatts
Grid-No. 2 Input	10 Max	Watts
Plate Dissipation	1200 Max	Watts

Typical Operation, Grounded-Grid Circuit up to 900 Megacycles

DC Plate Voltage	3000	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2300	Volts
Peak RF Driving Voltage	137	Volts
DC Plate Current	0.25	Amperes
DC Grid-No. 2 Current	0.01	Amperes
DC Grid-No. 1 Current, approximate	0.047	Amperes
Driving Power, approximate♦	38	Watts
Power Outputϕ	565	Watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions per Tube without Amplitude Modulation▲

Maximum Ratings, Absolute Values

DC Plate Voltage	4000 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Grid-No. 1 Voltage	−150 Max	Volts
DC Plate Current	0.7 Max	Amperes
DC Grid-No. 1 Current	0.10 Max	Amperes
Plate Input	2.5 Max	Kilowatts
Grid-No. 2 Input	25 Max	Watts
Plate Dissipation	1.5 Max	Kilowatts

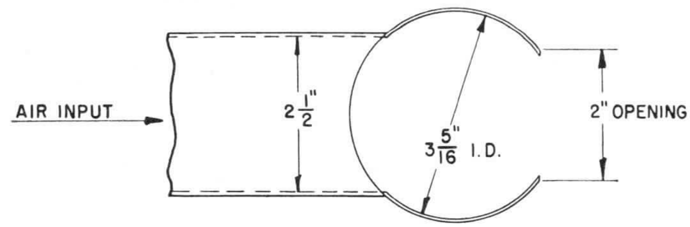
Typical Operation—Grounded-Grid Circuit at 1000 Megacycles, ¼λ Output

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−110	Volts
DC Plate Current	0.42	Amperes
DC Grid-No. 2 Current	0.011	Amperes
DC Grid-No. 1 Current, approximate	0.055	Amperes
Driving Power, approximate	65	Watts
Power Output, usefulϕ	1000	Watts

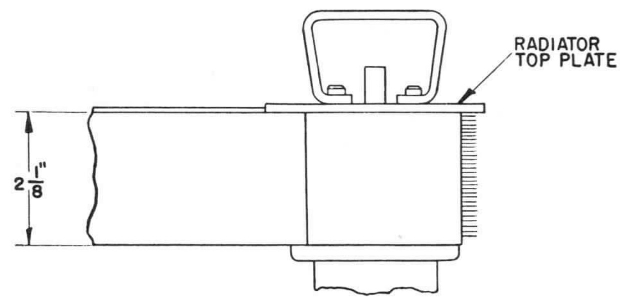
* The cathode of the GL-6942 because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the heater input to prevent overheating of the cathode with resulting short life. For long life, the GL-6942 should be put in operation with rated heater voltage. After the circuit has been adjusted for proper tube operation the heater voltage should be reduced to a value slightly above that at which circuit performance is affected. At a frequency of 900 megacycles and with typical operating conditions the heater voltage can be reduced to approximately 5.3 volts. At lower frequencies, the reduction will be less. Minor curcuit readjustment may be necessary after this adjustment.

† Represents maximum useable cathode current (plate current plus current to each grid) for any condition of operation.
‡ Measured with complete external shielding between cathode and anode.
§ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.
¶ The volume of cooling air indicated for the various seals is for sea-level conditions and approximate only. Distribution of cooling air will vary with the cavity configuration about the tube. For most staisfactory operation the maximum temperature of any point on the tube should be below 200 C.
ϕ Useful power output including power transferred from driver stage.
♦ The carrier of the driver modulated 100 percent.
▲Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

BLOWER DUCT



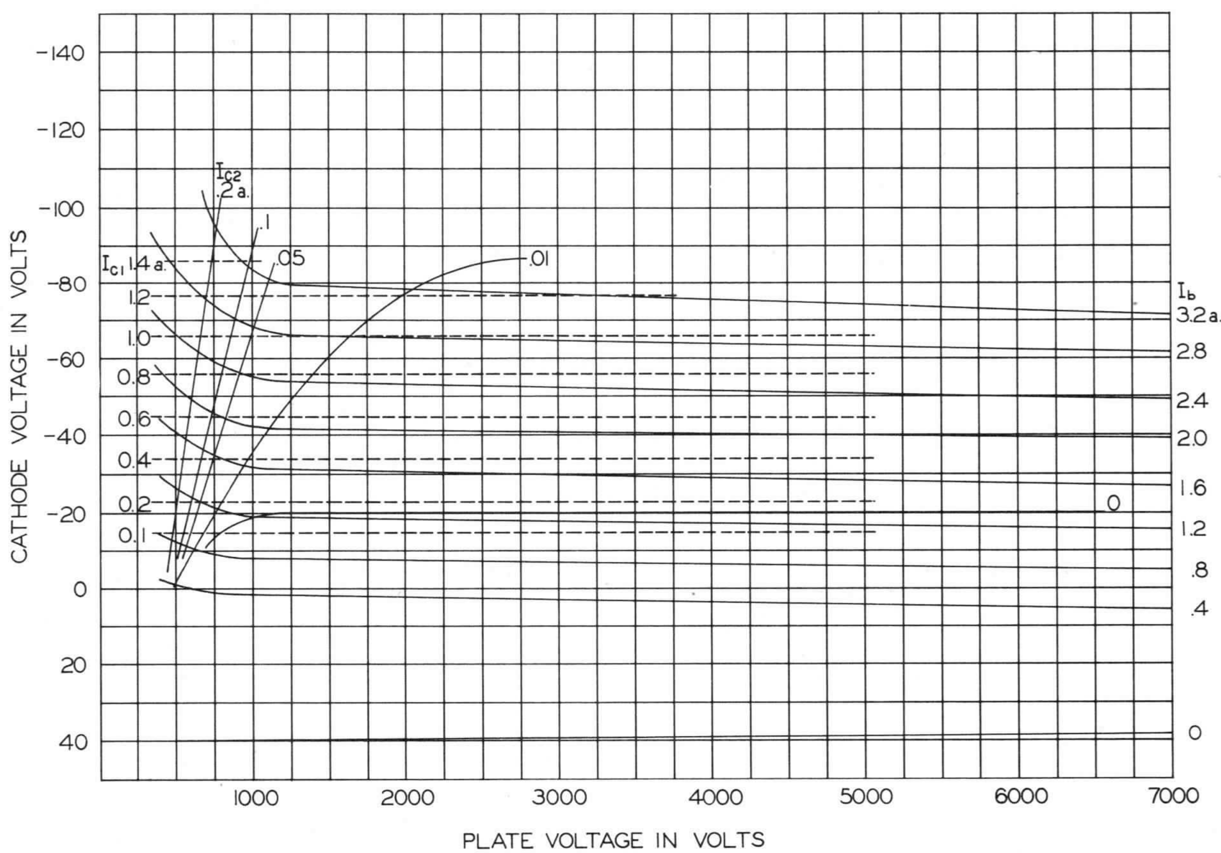
TOP VIEW

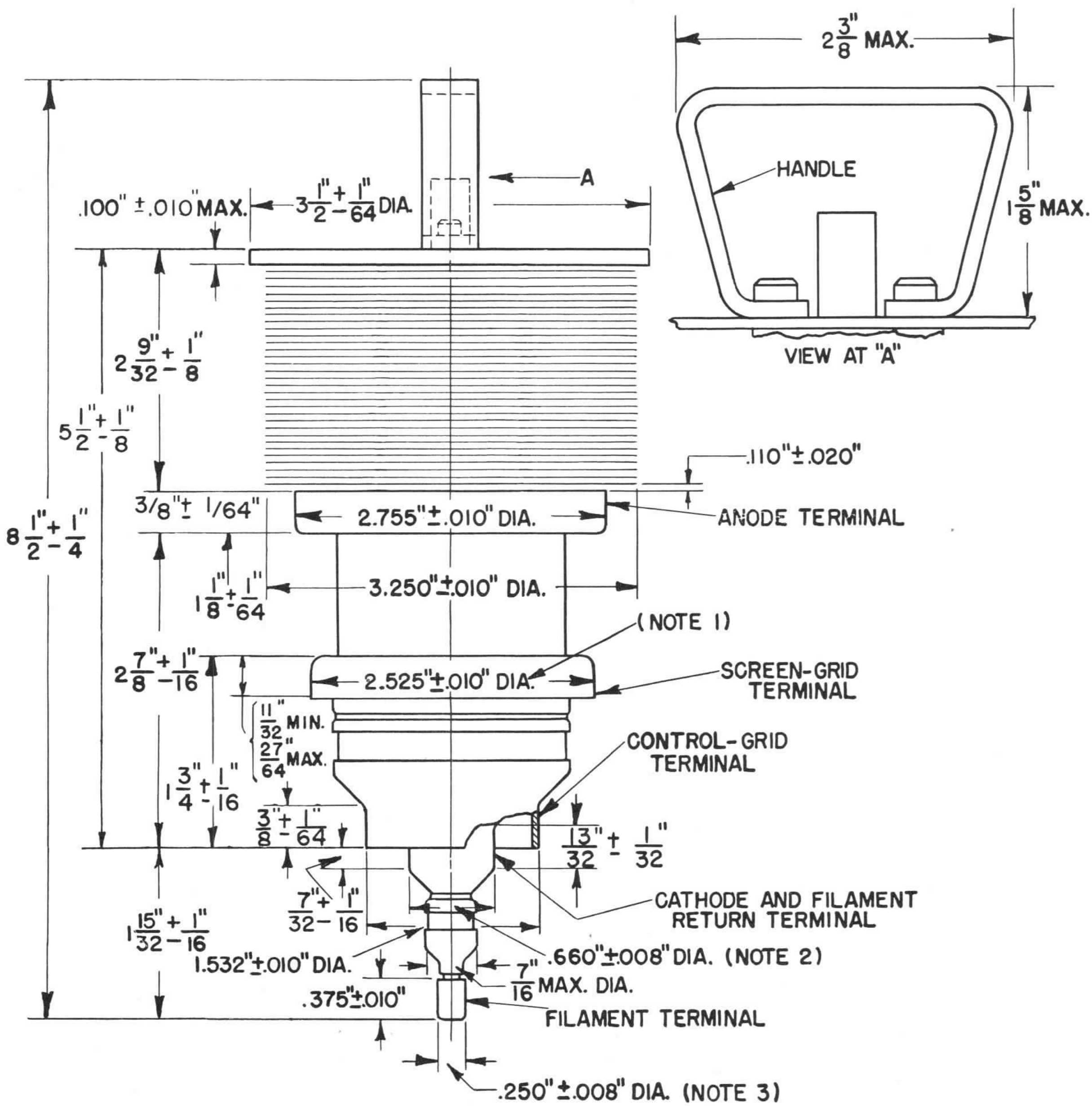


SIDE VIEW (WITH TUBE IN PLACE)

K-69087-72A592 8-29-56

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 500 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





TOTAL INDICATOR READINGS

NOTE 1: 0.020″
NOTE 2: 0.030″
NOTE 3: 0.060″

The above readings are measured with respect to a centerline determined by the centers of the anode terminal and control-grid terminal.

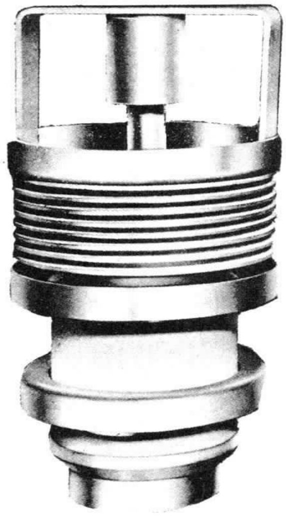
TUBE DEPARTMENT

GENERAL ELECTRIC

Schenectady, New York 12305

Tetrode

GL-7399



PULSED SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC

INTEGRAL RADIATOR

The GL-7399 is a small-size, four-electrode transmitting tube especially designed for pulsed-amplifier or -oscillator service at L-band frequencies. This tetrode is particularly well suited for use in airborne or ground-based radar equipment.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the GL-7399 include long life and reliability, long pulse width, high peak power and high gain, broad-banding capability, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage (See Note 1)	—	6.3	6.8	Volts
Heater Current		5.6		Amperes
Amplification Factor, G_2 to G_1		10.5		
$E_{g2} = 275$ Volts DC, $E_b = 1000$ Volts DC, $I_b = 200$ Milliamperes DC				
Cathode Heating Time	1			Minute
Direct Interelectrode Capacitances*				
Cathode to Plate†		0.012		μμf
Input		24.0		μμf
Output		9.3		μμf

Mechanical

Mounting Position—Any		
Net Weight	1.0	Pounds

Thermal

Cooling—Forced Air‡				
Radiator§				
Plate Dissipation	500	400	300	Watts
Air Flow, 45 C incoming air temperature	17.0	12.0	6.5	Min Cubic Feet per Minute
Static Pressure, approximate anode at room temperature	0.9	0.5	0.2	Inches-Water
Anode Hub Temperature▲			250	Max C
Seals				
Screen and Control Grid, approximate			1	Cubic Foot per Minute
Heater and Cathode, approximate			1	Cubic Foot per Minute
Ceramic Temperature at any Point			200	Max C

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

Maximum Ratings

Plate- and Screen-Grid Pulsed, 500 Megacycles

DC Plate Voltage, during pulse	10	Kilovolts
DC Plate Current, during pulse	10	Amperes
DC Grid-No. 2 Voltage, during pulse	2000	Volts
DC Grid-No. 2 Input♣	15	Watts
Plate Dissipation♣	500	Watts
DC Grid-No. 1 Voltage, not pulsed	−175	Volts
DC Grid-No. 1 Current, during pulse	2.5	Amperes
Pulse Width♥♦	15	Microseconds
Duty Factor♥ϕ	0.0012	

Typical Operation

Grounded-grid Circuit, 500 Megacycles

DC Plate Voltage, during pulse	9	Kilovolts
DC Grid-No. 2 Voltage, during pulse	1400	Volts
DC Grid-No. 1 Voltage, not pulsed	−125	Volts
Peak RF Plate Voltage	7000	Volts
Peak RF Grid Voltage	300	Volts
DC Plate Current, during pulse	9.2	Amperes
DC Grid-No. 1 Current, during pulse	1.1	Amperes
DC Grid-No. 2 Current, during pulse	0.47	Amperes
Driving Power at Tube, during pulse	2.6	Kilowatts
Power Output, during pulse (useful)	52	Kilowatts
Pulse Width♦	15	Microseconds
Duty Factor	0.001	

Note 1: Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles

DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	−225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation	500	Watts
Pulse Width ♥♦	15	Microseconds
Duty Factor ♥$\phi\phi$	0.01	

Typical Operation

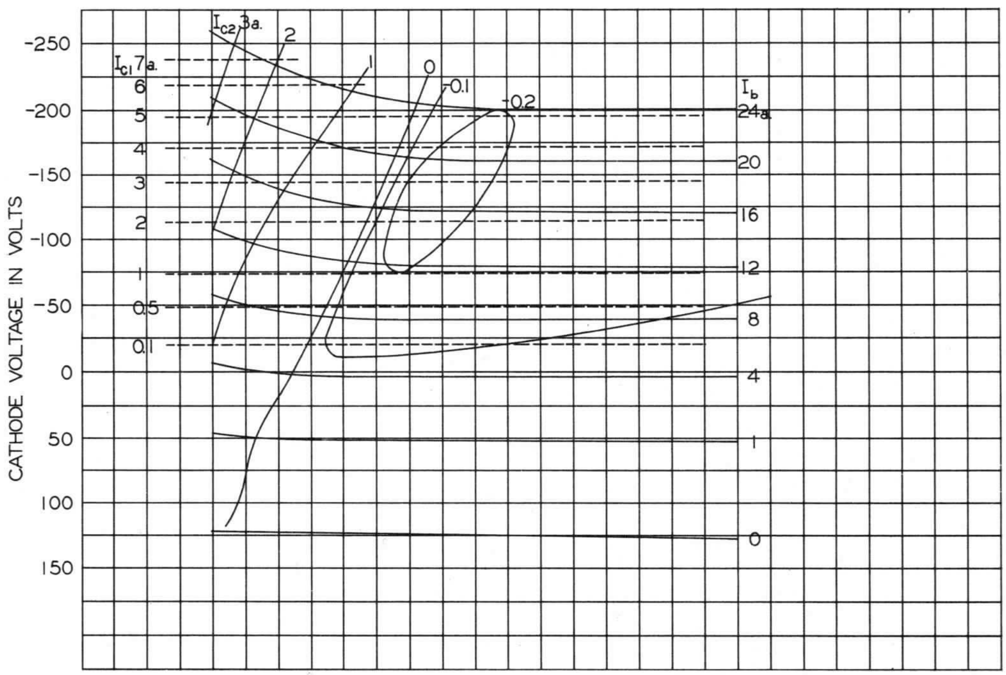
Grounded-grid Circuit at 1100 Megacycles, $\frac{3}{4}\lambda$ Output Circuit

DC Plate Voltage**	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	−200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width♦	15	Microseconds
Duty Factor	0.01	

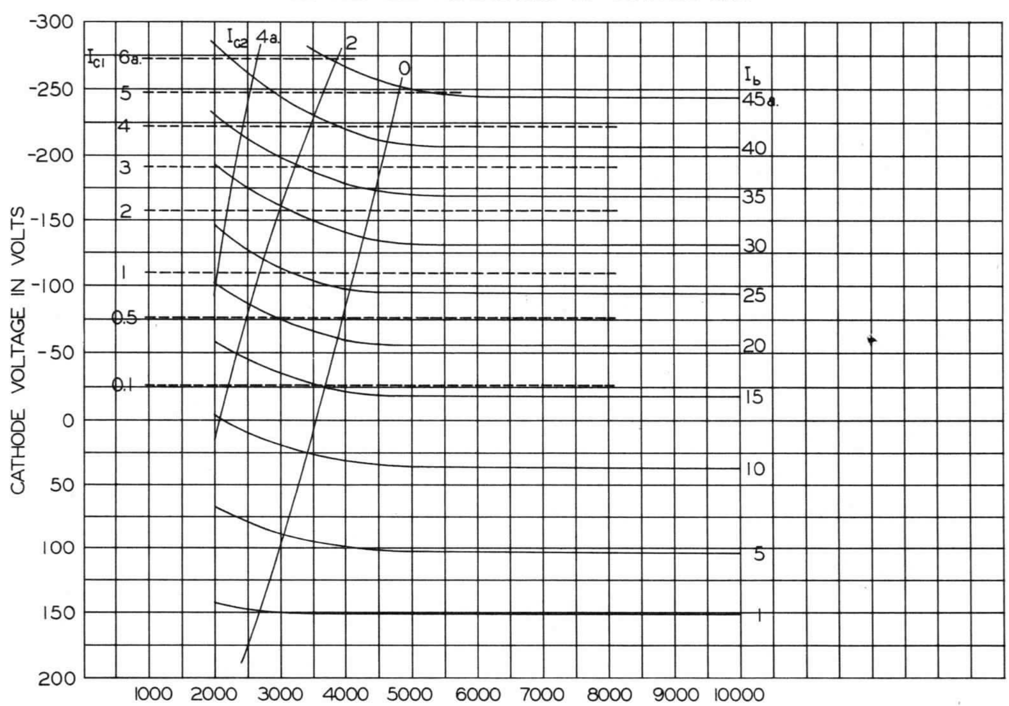
---

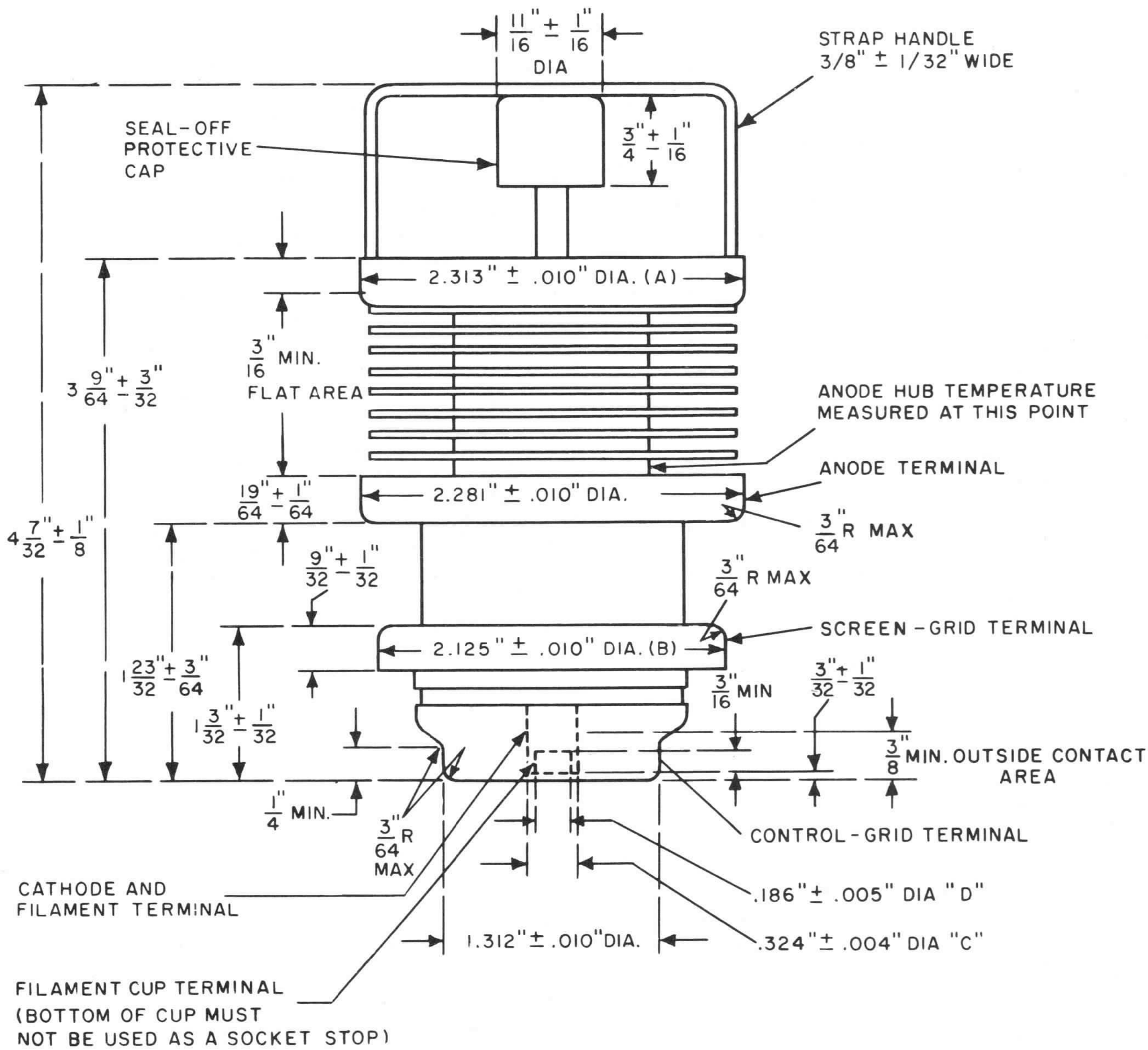
* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
‡ Forced air cooling should be applied during the application of any voltages.
§ Provision must be made for unobstructed passage of cooling air between radiator fins, and between the anode terminal and adjacent fins.
▲Measured at the base of the fin adjacent to the plate terminal. See outline drawing on page 4.
♣Maximum average value.
♥For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
♦ Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
ϕ Maximum ratio of on-time to elapsed time during any 12.5-millisecond period.
$\phi\phi$Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
**A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 2000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





CONCENTRICITIES

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL GRID TERMINAL

DIAMETER A – 0.030 INCHES
DIAMETER B – 0.016 INCHES
DIAMETER C – 0.036 INCHES
DIAMETER D – 0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT CUP TERMINAL DIAMETER (D) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT TERMINAL DIAMETER (C) – 0.016 INCHES

TUBE DEPARTMENT
GENERAL ELECTRIC
Schenectady, New York 12305
PRINTED IN U.S.A.

GL-7985
TETRODE

VHF-UHF
RING-SEAL CONSTRUCTION
GROUNDED-GRID CIRCUIT

WATER COOLED
METAL AND CERAMIC
INTEGRAL WATER JACKET

The GL-7985 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 3½ kilowatts. Cooling is accomplished by water and forced air with the water jacket an integral part of the anode. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply up to 800 megaycles, although higher frequency operation is possible.

In narrow band, Class C, grounded-grid, amplitude-modulated service, the GL-7985 has a useful carrier-power output in excess of one kilowatt. In Class C Telegraphy, it has a useful power output of 3.0 kilowatts of continuous power as an amplifier or oscillator.

As a Class B radio-frequency power amplifier, the tube is capable of delivering 1100 watts of power with 20 watts of drive at carrier level.

Electrical

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	—	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	—	14.5	—	Amperes
With 150 Watts Cathode Bombarding	—	13.5	—	Amperes
Heater Starting Current	—	—	25	Amperes
Heater Cold Resistance	—	0.041	—	Ohms
Cathode Bombarding Power*	—	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	—	650	—	Volts
For 195 Watts Bombarding Power	—	700	—	Volts
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, $E_b = 4000$ volts, $I_b = 0.5$ Ampere	—	20	—	
Peak Cathode Current‡	—	—	6	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate§	—	0.01	—	μμf
Input, G_2 tied to G_1	—	27.8	—	μμf
Output, G_2 tied to G_1¶	—	6.4	—	μμf

Mechanical

Mounting Position—Vertical, Anode-end Up
Net Weight, approximate . . . . . . 2.0 Pounds

Thermal

Type of Cooling—Water and Forced Air

Water Flow
- Anode . . . . . . 3.0 Min Gallons per Minute
- Pressure Drop at Rated Flow . . . . . . 20 Max Pounds per Square Inch
- Water Pressure . . . . . . 80 Max Pounds per Square Inch
- Outlet Water Temperature . 70 Max C

Air Flow
- Screen-grid to Control-grid Seals . . . . . . 15 Min Cubic Feet per Minute
- Heater-to-Cathode Seals . . . 7.5 Min Cubic Feet per Minute
- Anode Ceramic . . . . . . 10 Min Cubic Feet per Minute

Temperature at Any Point . . 200 Max C

Water and forced-air cooling to be applied before and during the application of any voltages. Water cooling may be discontinued with removal of all voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

Carrier Conditions per Tube for use with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	0.600	Ampere
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	3.5	Kilowatts

Typical Operation

Grounded-grid Circuit, 225–400 Megacycles

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage, approximate	−35	Volts
Peak RF Plate Voltage, approximate	5500	Volts
Peak RF Grid-No. 1 Voltage, approximate	105	Volts
DC Plate Current	0.475	Ampere
Zero Signal DC Plate Current	0.115	Ampere
$E_b = 7000$ volts, $E_{c2} = 600$ volts, E_{c1} adjusted for $I_b = 0.115$ amperes		
DC Grid-No. 2 Current	0.010	Ampere
DC Grid-No. 1 Current	0.025	Ampere
Driving Power, approximate	80	Watts
Measured at crest of audio-frequency cycle with modulation factor of 1.0		
Power Output#	1100	Watts
Circuit Efficiency	90	Percent
Plate Dissipation	2300	Watts
Cathode Bombarding Power*	160	Watts
Cathode Bombarding Voltage	610	Volts
Cathode Bombarding Current	0.260	Ampere

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions With a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	3.5	Kilowatts

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output#	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power*	165	Watts
Cathode Bombarding Voltage, approx.	630	Volts
Cathode Bombarding Current, approx.	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	3.5	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	−120	−100	Volts
Peak RF Plate Voltage, approximate	3000	—	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate#	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power*	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	−120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate#	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power*	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

* The cathode of the GL-7985, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

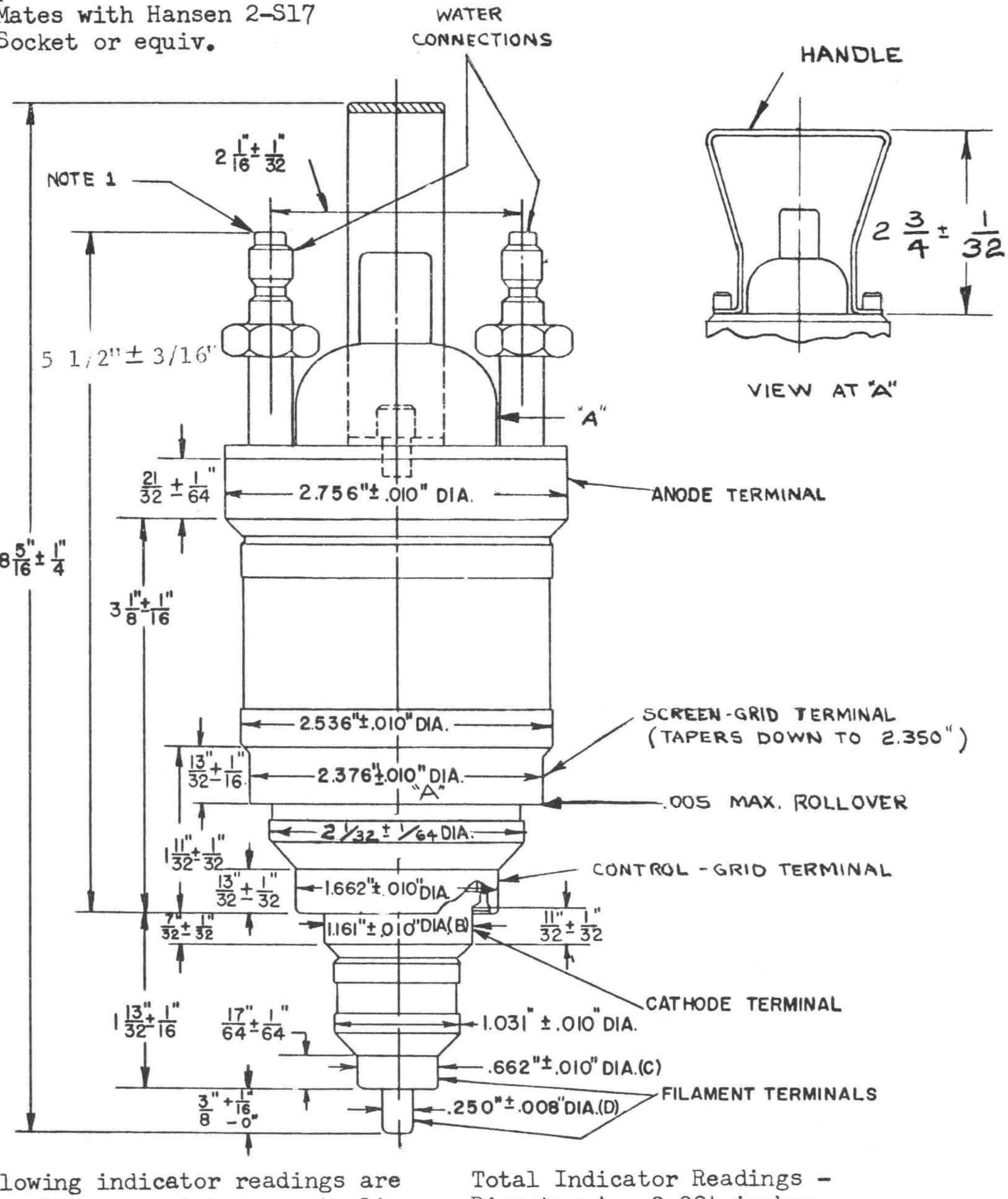
‡ Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

§ Measured with complete isolation between cathode and plate.

¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

\# Useful power output including power transferred from driver stage.

NOTE 1: Top portion same as top portion of Hansen B2T16 Mates with Hansen 2-S17 Socket or equiv.



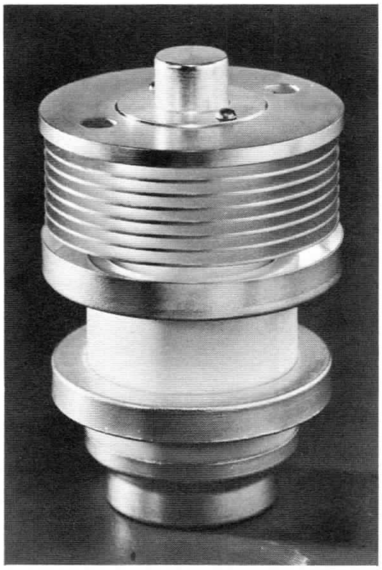
The following indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Total Indicator Readings -
Diameter A - 0.024 inches
Diameter B - 0.024 "
Diameter C - 0.030 "
Diameter D - 0.050 "

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky



GL-8500

TETRODE

RADIO-FREQUENCY AMPLIFIER
CW SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC
INTEGRAL RADIATOR

The GL-8500 is a reliable power tetrode that delivers useful output to 1250 megacycles or higher. This tube is particularly suitable for application in the final output or driver stage of military-communications systems.

As a Class B linear amplifier in the 225–400-megacycle range, the tube will deliver 110 watts of carrier power modulated up to 100 percent. Since a power gain of 20 may be realized, drive requirements are low—approximately 5 watts at carrier level.

Operating as a Class C CW amplifier at 900 megacycles, the gain is approximately 15 at the 200-watt level.

Features of the GL-8500 include long life and reliability, high gain, high linearity, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	—	6.3	6.8	Volts
Heater Current	—	3.8	—	Amperes
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, $E_b=1000V$ DC; $E_g2=275V$ DC; $I_b=0.2$ A DC	—	14	—	
Peak Cathode Current†	—	—	1.75	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate‡	—	0.006	—	μμf
Input, G_2 tied to G_1	—	19.5	—	μμf
Output, G_2 tied to G_1♦	—	6.4	—	μμf

Mechanical

Mounting Position—Any

Net Weight, approximate	1.0	Pounds

Thermal

Cooling—Forced Air§ Through Radiator, at Sea Level**				
Plate Dissipation	500	400	300	Watts
Air Flow, 45 C Incoming Air Temperature, minimum	17.0	12.0	6.5	Cubic Feet per Minute
Static Pressure, approximate	0.9	0.5	0.2	Inches-Water
Radiator Hub Temperature, at Point Adjacent to Anode Seal	—	—	250	C
Seals				
Screen-Grid to Control-Grid, approximate	—	—	1	Cubic Feet per Minute
Heater to Cathode, approximate	—	—	1	Cubic Feet per Minute
Ceramic Temperature at Any Point, maximum	—	—	200	C

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B LINEAR

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings

DC Plate Voltage	2000	Volts
DC Grid-No. 2 Voltage	320	Volts
DC Plate Current	0.250	Amperes
Plate Input	500	Watts
Grid-No. 2 Input	5	Watts
Plate Dissipation	500	Watts

Typical Operation

Grounded-Grid Circuit at 225–400 Megacycles

DC Plate Voltage	1750	Volts
DC Grid-No. 2 Voltage	250	Volts
DC Grid-No. 1 Voltage, approximate	−20	Volts
Peak RF Plate Voltage #, approximate	1250	Volts
Peak RF Grid-No. 1 Voltage #, approximate	40	Volts
DC Plate Current	0.200	Amperes
Zero Signal DC Plate Current (E_{c1} adjusted)	0.020	Amperes
DC Grid-No. 2 Current	0.005	Amperes
DC Grid-No. 1 Current	0.010	Amperes
Driving Power, approximate	5	Watts
Power Output ♥	110	Watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation△

Maximum Ratings	900 Megacycles	400 Megacycles	
DC Plate Voltage	1600	2000	Volts
DC Grid-No. 2 Voltage	320	320	Volts
DC Grid-No. 1 Voltage	−100	−100	Volts
DC Plate Current	0.300	0.300	Ampere
DC Grid-No. 1 Current	0.050	0.050	Ampere
Plate Input	480	600	Watts
Grid-No. 2 Input	15	15	Watts
Plate Dissipation	500	500	Watts
Grid-No. 1 Dissipation	2	2	Watts

Typical Operation

Grounded-Grid Circuit at 900 Megacycles

DC Plate Voltage	1500	2000	Volts
DC Grid-No. 2 Voltage	210	225	Volts
DC Grid-No. 1 Voltage	−40	−40	Volts
DC Plate Current	0.300	0.250	Ampere
DC Grid-No. 2 Current, approximate	0.010	0.010	Ampere
DC Grid-No. 1 Current, approximate	0.020	0.020	Ampere
Driving Power, approximate	14	15	Watts
Power Output, approximate¶	205	300	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

† Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

‡ Measured with a 6-inch minimum diameter flat metal disk attached to the screen-grid ring. Control grid connected to the screen grid.

♦ Output capacitances measured between anode and screen grid. Control grid connected directly to screen grid.

§ Forced-air cooling to be applied before and during the application of any voltages.

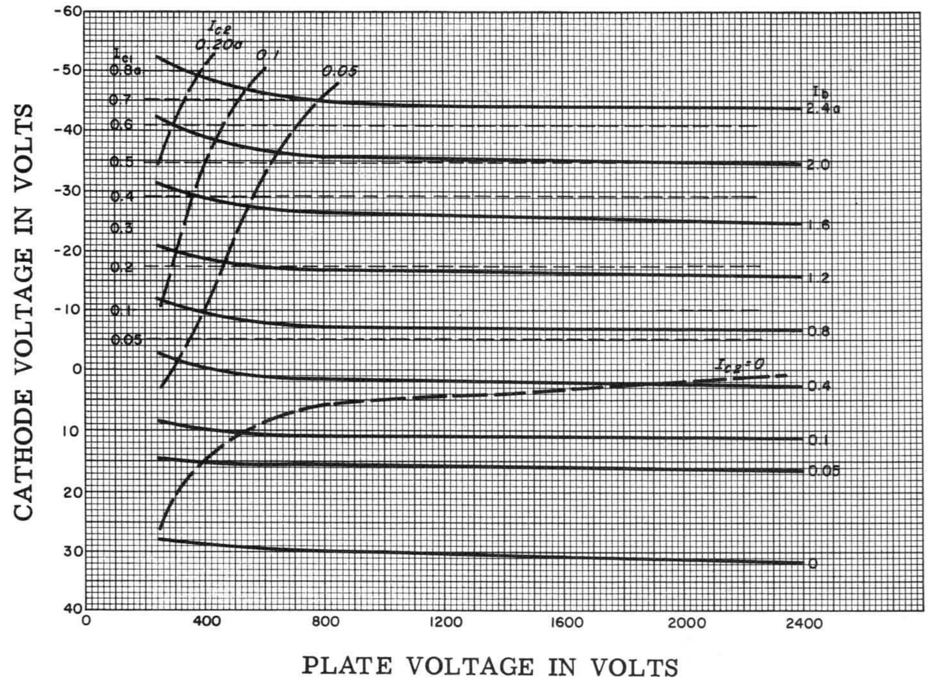
**Provision must be made for unobstructed passage of cooling air between radiator fins and between the anode terminal and adjacent radiator fin.

♥ Useful power output as measured in output-circuit load.

¶ Useful power output including power transferred from driver stage. Output circuit efficiency approximately 80 percent.

△ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 250 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



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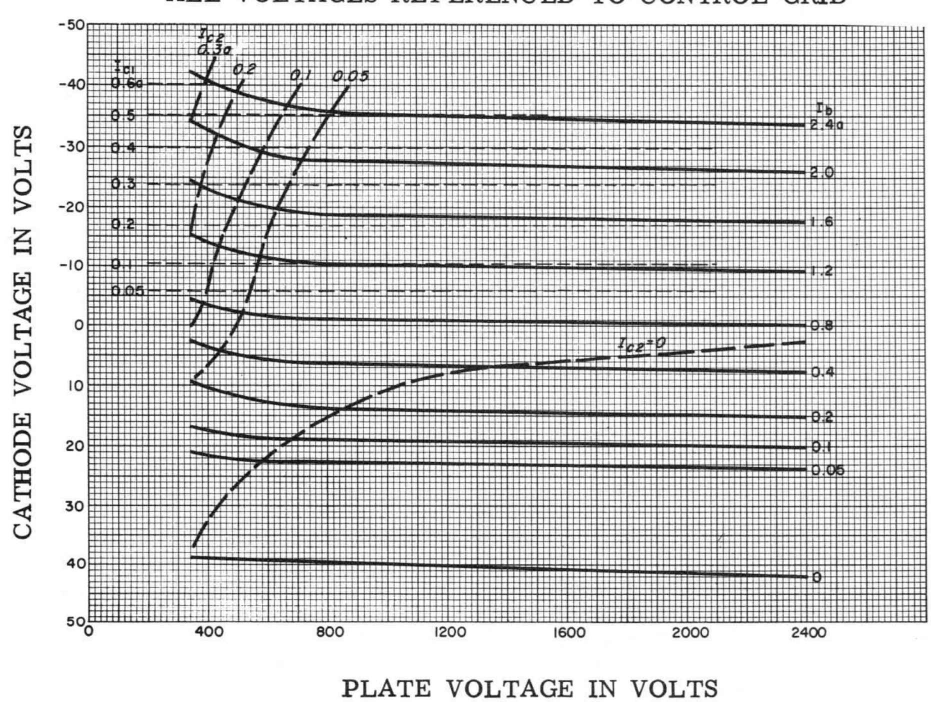
CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 350 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



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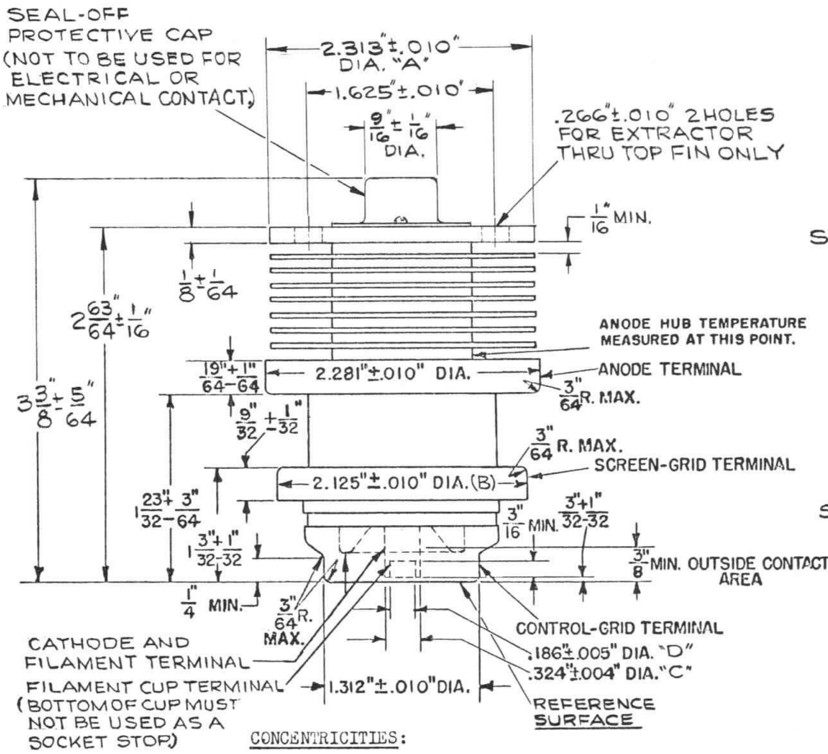
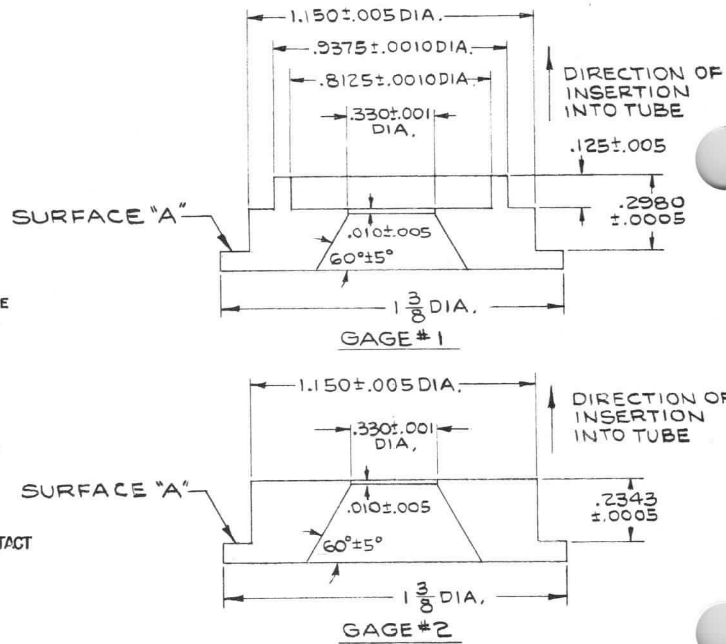


CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.016 inches
Diameter C - 0.036 inches
Diameter D - 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) - 0.016 inches.



ZP-1030
CATHODE AND FILAMENT TERMINAL GAGES

When inserted over the cathode and filament terminal, gage #1 <u>shall</u> <u>not</u> contact the tube REFERENCE SURFACE at gage SURFACE "A".

When inserted over the cathode and filament terminal, gage #2 <u>shall</u> contact the tube REFERENCE SURFACE at gage SURFACE "A".

A-69087 - 72B58

12-31-62

GL-8513
TETRODE

VHF-UHF
RING-SEAL CONSTRUCTION

GROUNDED-GRID CIRCUIT

FORCED-AIR COOLED
METAL AND CERAMIC

The GL-8513 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 4 kilowatts. Cooling is accomplished by forced air with the radiator an integral part of the anode. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply up to 800 megacycles, although higher frequency operation is possible.

As a Class B linear power amplifier the tube will deliver 1500 watts at carrier level.

In narrow band, Class C, grounded-grid, amplitude-modulated service, the GL-8513 has a useful carrier-power output in excess of one kilowatt. In Class C Telegraphy, it has a useful power output of 3 kilowatts of continuous power as an amplifier or oscillator.

Electrical

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	–	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	–	14.5	—	Amperes
With 150 Watts Cathode Bombarding	–	13.5	—	Amperes
Heater Starting Current	–	—	25	Amperes
Heater Cold Resistance	–	0.041	—	Ohms
Cathode Bombarding Power*	–	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	–	650	—	Volts
For 195 Watts Bombarding Power	–	700	—	Volts
Cathode Heating Time	1	—	—	Minute
Amplification Factor, G_2 to G_1; $E_b = 4000$ volts; $I_b = 0.5$ ampere	–	20	—	
Peak Cathode Current†	–	—	6	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate§	–	0.01	—	μμf
Input, G_2 tied to G_1	–	27.8	—	μμf
Output, G_2 tied to G_1¶	–	6.7	—	μμf

Mechanical

Mounting Position—Vertical, Anode-end Up
Net Weight, approximate .... 12.5 Pounds

Thermal

Type of Cooling—Forced Air

Air Flow Through Radiator, at Sea Level

Plate Dissipation	Air Flow	Static Pressure
4.0 Kw	135 CFM	2.8 In.

Seals		
Screen-grid to Control-grid, minimum	15	Cubic Feet per Minute
Heater-to-cathode, minimum	7.5	Cubic Feet per Minute
Anode Ceramic, minimum	10	Cubic Feet per Minute
Incoming Air Temperature, maximum	55	C
Anode Hub Temperature, maximum	250	C
Temperature of Anode Ceramic and Seals, maximum	250	C
Temperature at Any Other Point, maximum	200	C

Forced-air cooling to be applied before and during the application of any voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage. The radiator air ducting can be constructed so that air is forced along the anode seal and ceramic through the anode contact fingers and additional holes in the plate contact ring to accomplish the anode ceramic and anode seal cooling. The volume of cooling air indicated for the various seals is approximate only. Distribution of cooling air will vary with configuration of the cavity about the tube.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

Carrier Conditions per Tube for Use with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	9000	Volts
DC Grid-No. 2 Voltage	800	Volts
DC Plate Current	0.800	Ampere
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	4.0	Kilowatts

Typical Operation

Grounded-grid Circuit, 225–400 Megacycles

DC Plate Voltage	8000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 1 Voltage, approximate	−50	Volts
DC Plate Current	0.600	Ampere
DC Grid-No. 2 Current	0.010	Ampere
DC Grid-No. 1 Current	0.060	Ampere
Driving Power, approximate	160	Watts
Measured at crest of audio-frequency cycle with modulation factor of 1.0		
Power Output#	1500	Watts
Circuit Efficiency	90	Percent
Plate Dissipation	2500	Watts
Cathode Bombarding Power*	170	Watts
Cathode Bombarding Voltage	650	Volts
Cathode Bombarding Current	0.260	Ampere

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions with a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	4.0	Kilowatts

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output#	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power*	165	Watts
Cathode Bombarding Voltage, approximate	630	Volts
Cathode Bombarding Current, approximate	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	4.0	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	−120	−100	Volts
Peak RF Plate Voltage, approximate	3000	—	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate#	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power*	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	−120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate#	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power*	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

* The cathode of the GL-8513, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

† Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

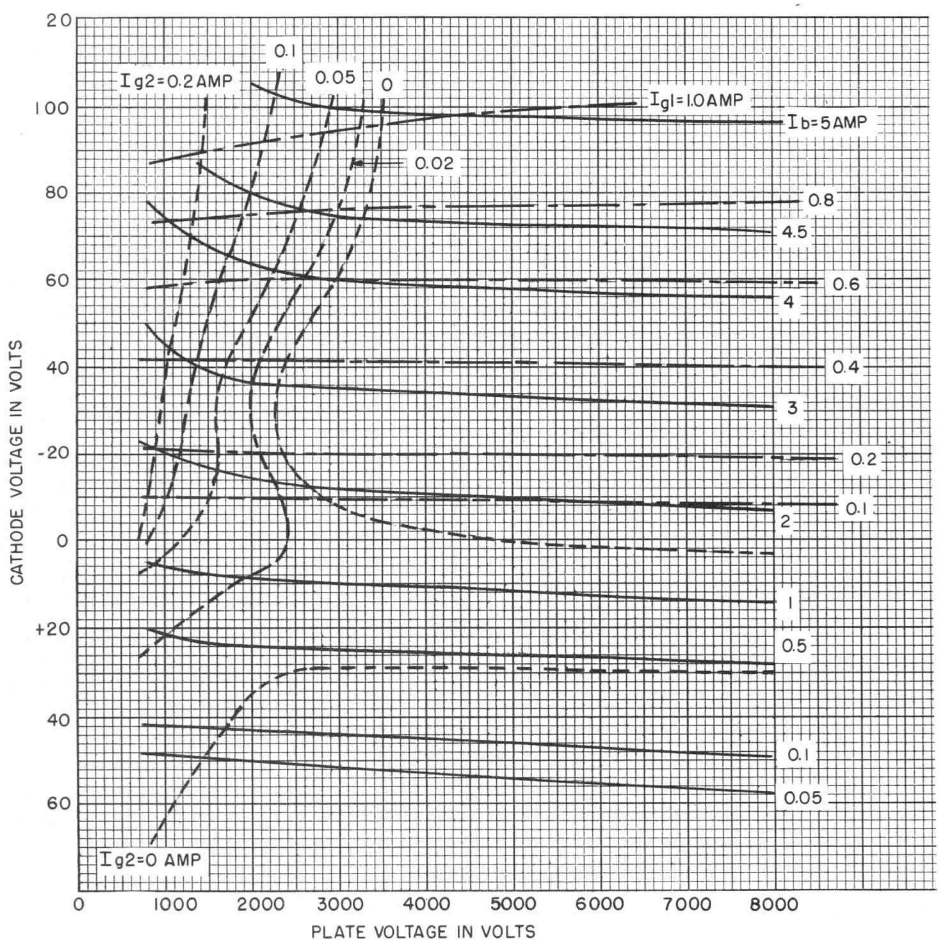
§ Measured with complete isolation between cathode and plate.

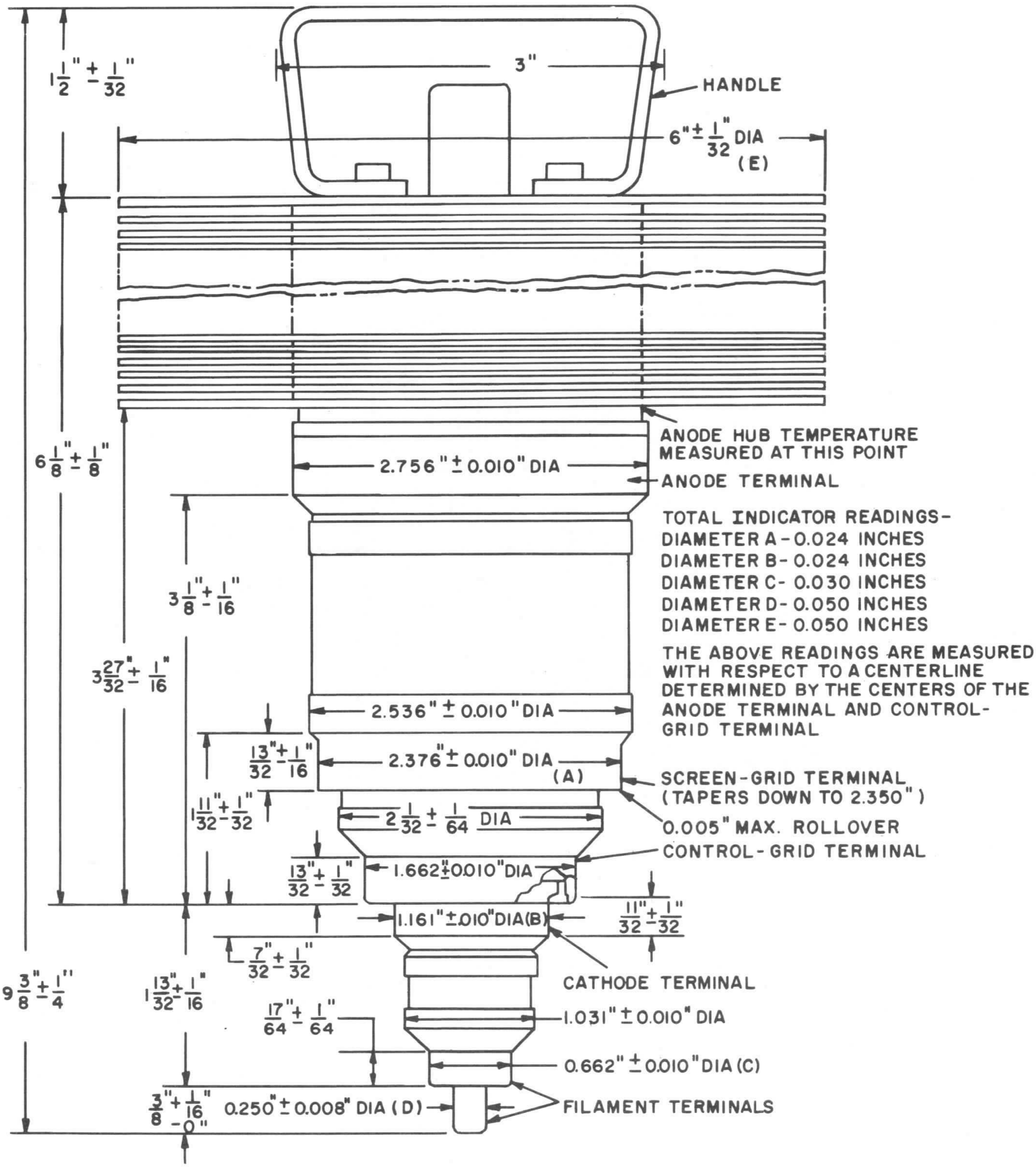
¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

\# Useful power output including power transferred from driver stage.

TYPICAL CHARACTERISTICS

Eg2 = 750 Volts, Ef = 7 Volts AC
Bombarding Power = 180 Watts
All Voltages Referenced to Grid




3"
HANDLE
6" ± 1/32" DIA (E)
1 1/2" ± 1/32"
6 1/8" ± 1/8"
2.756" ± 0.010" DIA
ANODE HUB TEMPERATURE MEASURED AT THIS POINT
ANODE TERMINAL
TOTAL INDICATOR READINGS-
DIAMETER A - 0.024 INCHES
DIAMETER B - 0.024 INCHES
DIAMETER C - 0.030 INCHES
DIAMETER D - 0.050 INCHES
DIAMETER E - 0.050 INCHES
THE ABOVE READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL
3 1/8" ± 1/16"
3 27/32" ± 1/16"
2.536" ± 0.010" DIA
13/32" ± 1/16"
2.376" ± 0.010" DIA (A)
SCREEN-GRID TERMINAL (TAPERS DOWN TO 2.350")
1 11/32" ± 1/32"
2 1/32 ± 1/64 DIA
0.005" MAX. ROLLOVER
CONTROL-GRID TERMINAL
13/32" ± 1/32"
1.662" ± 0.010" DIA
11/32" ± 1/32"
1.161" ± .010" DIA (B)
7/32" ± 1/32"
CATHODE TERMINAL
9 3/8" ± 1/4"
1 13/32" ± 1/16"
17/64" ± 1/64"
1.031" ± 0.010" DIA
0.662" ± 0.010" DIA (C)
3/8" + 1/16" - 0"
0.250" ± 0.008" DIA (D)
FILAMENT TERMINALS

ELECTRONIC INNOVATIONS IN ACTION

TUBES

— PRODUCT INFORMATION —

GL-8866

Tetrode

GRID-PULSED SERVICE
GROUNDED-GRID OPERATION

HEAT-SINK AND FORCED-AIR COOLED
METAL AND CERAMIC

The GL-8866 is a reduced-size heat-sink-cooled version of the GL-6283 especially designed for pulsed-amplifier or oscillator service at L-band frequencies. This tetrode is particularly well suited for use in airborne radar equipment such as IFF transponders.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the 8866 include long life and reliability, long pulse width and high gain.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage (See Note 1)	—	6.3	—	Volts
Heater Current	—	3.8	—	Amperes
Cathode Heating Time	1	—	—	Minute
Direct Interelectrode Capacitances*				
Cathode to Plate†	—	0.006	—	$\mu\mu$f
Input	—	20	—	$\mu\mu$f
Output	—	8.9	—	$\mu\mu$f

Mechanical

Mounting Position—Any		
Net weight, approximate	9	Ounces

Thermal

Cooling—Heat-sink and Forced-Air‡		
Anode Temperature§, maximum	250	C
Seals		
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at Any Point, aaximum	200	C

RADIO-FREQUENCY POWER AMPLIFIER—CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles		
DC Plate Voltage	3.5	Kilovolts
DC Plate Current, during pulse	5	Amperes
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	−200	Volts
Plate Dissipation	150	Watts
Pulse Width♥♦	15	Microseconds
Duty Factor♥ϕ	.02	

Typical Operation

Grounded-Grid Service at 1100 Megacycles, ¼λ Output Circuit			
DC Plate Voltage	2.5	2.5	Kilovolts
DC Plate Current, during pulse	1.4	1.0	Amperes
DC Grid-No. 2 Voltage	600	600	Volts
DC Grid-No. 2 Current, during pulse	50	0	Milliamperes
DC Grid-No. 1 Voltage	−70	−70	Volts
DC Grid-No. 1 Current, during pulse	90	80	Milliamperes
Driving Power at the Tube, during pulse	165	95	Watts
Power Output, during pulse (useful)	1.6	1.0	Kilowatts
Pulse Width	6	6	Microseconds
Duty Factor	.02	.02	

Note 1: Under the typical operating conditions shown the heater voltage should be reduced to approximately 6.0 volts because of back-heating resulting from transit-time effects.

* Control grid connected directly to screen grid.

† Complete external shielding between cathode and plate.

‡ Forced air cooling should be applied during the application of any voltages.

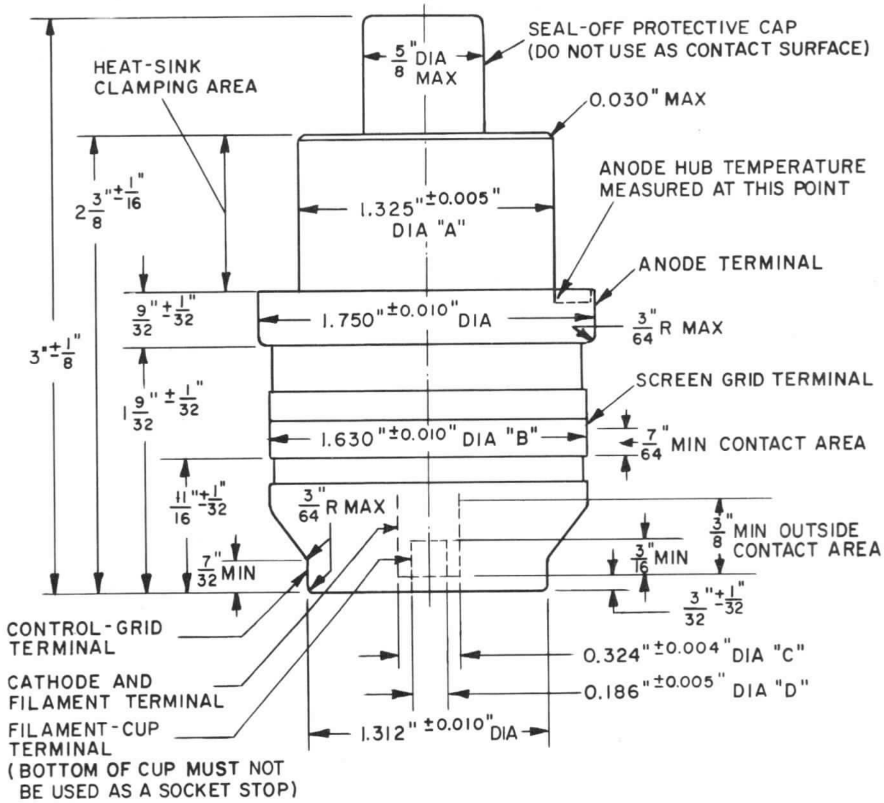
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified; the temperature is measured at the point indicated on the outline drawing.

♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.

♦ Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

ϕ Maximum ratio of on-time to elapsed time during any 7.5-millisecond period.

GENERAL ELECTRIC



CONCENTRICITIES:

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL.

DIAMETER "A" – 0.030 INCH
DIAMETER "B" – 0.016 INCH
DIAMETER "C" – 0.036 INCH
DIAMETER "D" – 0.042 INCH

TOTAL INDICATOR READING OF FILAMENT CUP-TERMINAL DIAMETER (D) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT-TERMINAL DIAMETER (C) 0.016 INCH.

Triode

GL-51025

INTERNAL FEEDBACK FOR OSCILLATOR SERVICE
GROUNDED-GRID OPERATION

METAL AND CERAMIC
HEAT-SINK AND FORCED-AIR COOLED

The GL-51025 is a heat-sink-cooled triode especially designed for pulsed oscillator service in L-band. This type is particularly well suited for use in airborne or ground-based radar equipment.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service.

Other features include small size, high peak power, long-pulse-width capability, long life and reliability.

	Minimum	Bogey	Maximum	
Electrical				
Heater Voltage*	-	6.3	-	Volts
Heater Current	3.5	3.8	4.0	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances				
Cathode to Plate	-	0.45	-	μμf
Input	-	15.5	-	μμf
Output	-	5.9	-	μμf

Mechanical

Mounting Position – Any

Net Weight, approximate	3 1/4	Ounces

Thermal

Cooling – Heat-Sink and Forced Air

Anode Temperature§	250	C
Ceramic Temperature at Any Point, maximum	200	C

PLATE-PULSED OSCILLATOR — CLASS C

Maximum Ratings

DC Plate Voltage, During Pulse	8.0	Kilovolts
DC Plate Current, During Pulse	10.0	Amperes
DC Grid Voltage, During Pulse	-400	Volts
DC Grid Current, During Pulse	5.0	Amperes
Plate Dissipation §	110	Watts
Grid Dissipation	3.5	Watts
Pulse Width ◇	10	Microseconds
Duty Factor ø	0.003	

Typical Operation

Grounded-Grid Service at 1300 Megacycles, 3/4 λ Output Circuit

DC Plate Voltage, During Pulse	8.0	6.0	Kilovolts
DC Plate Current, During Pulse	9.0	7.0	Amperes
DC Grid Current, During Pulse (Grid Resistor = 50 Ohms)	4.0	4.3	Amperes
Power Output, During Pulse (useful)	40.0	24.0	Kilowatts
Pulse Width	10	10	Microseconds
Duty Factor	0.003	0.001	

GRID-PULSED OSCILLATOR — CLASS C

Maximum Ratings

DC Plate Voltage	2.5	Kilovolts
DC Plate Current, During Pulse	3.0	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	100	Watts
Pulse Width ◇	15	Microseconds
Duty Factor øø	0.02	

Typical Operation

Grounded-Grid Circuit at 1100 Megacycles, 1/4 λ Output

DC Plate Voltage	1750	1950	2200	Volts
DC Plate Current, During Pulse	2.2	2.6	2.7	Amperes
DC Grid Voltage Supply**	-97	-104	-104	Volts
DC Grid Current, During Pulse	1.05	1.2	1.25	Amperes
Power Output, During Pulse (useful)	1.5	2.0	2.4	Kilowatts
Pulse Width	10	10	10	Microseconds
Duty Factor	0.02	0.02	0.02	

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* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage. For the 1100 mcs, 2 kw, 0.02 duty condition, the typical heater voltage is 5.5 volts. The optimum heater voltage for any application should be determined by RF performance testing.

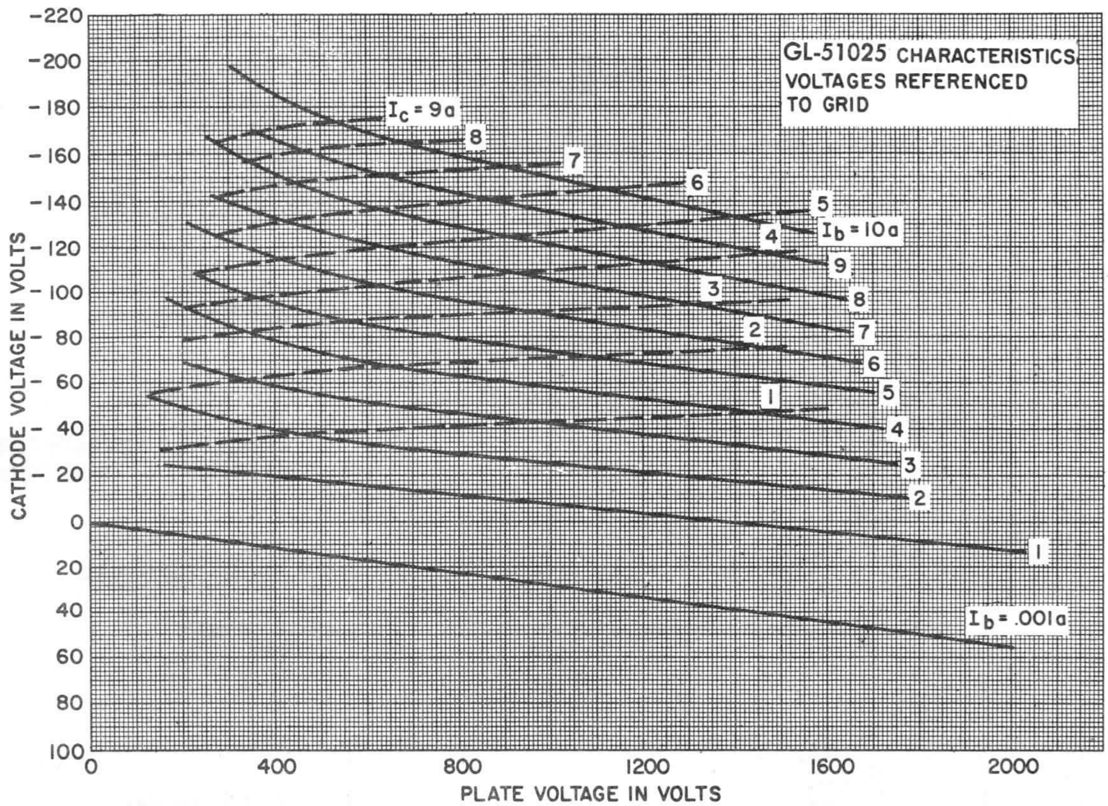
§ A suitable clamp-on radiator or heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified. Higher plate dissipation is allowable with provision for proper cooling.

◇ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse. For applications requiring longer pulses, refer to the tube manufacturer.

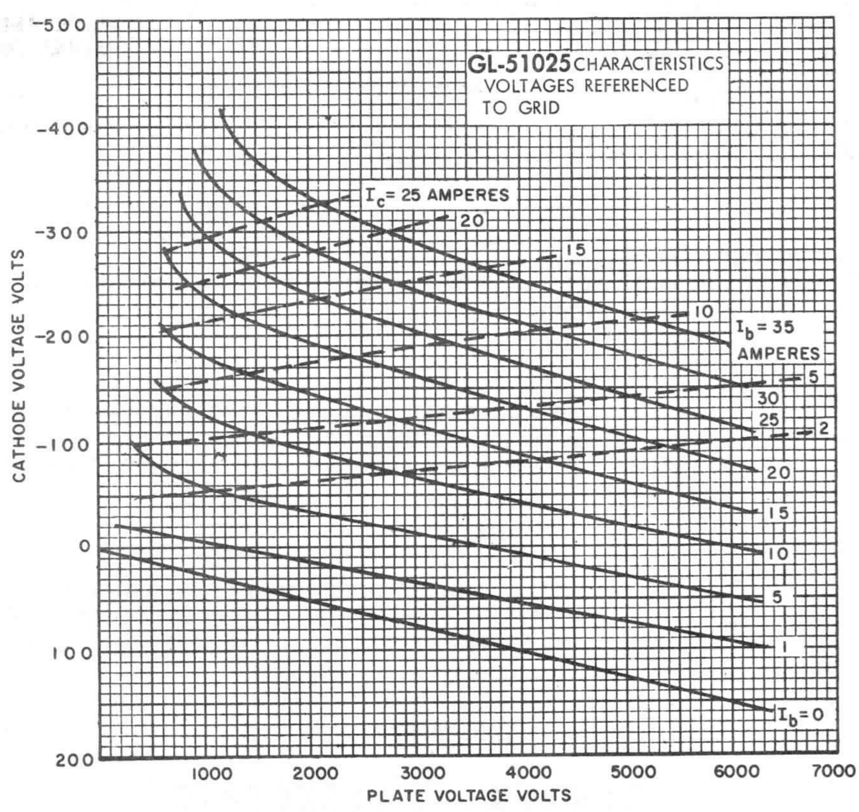
ø Maximum ratio of on-time to elapsed time during any 3.3-millisecond period.

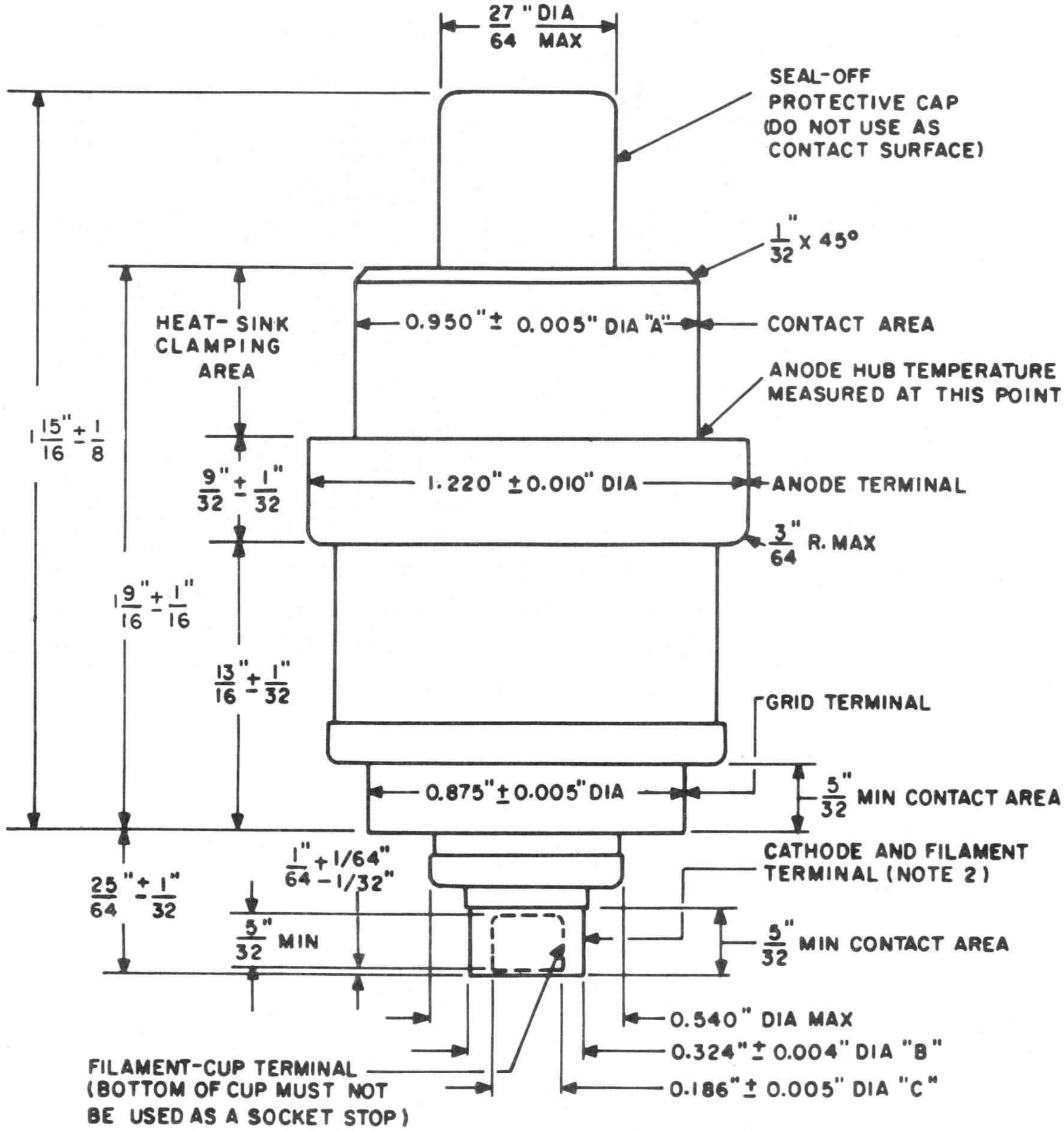
øø Maximum ratio of on-time to elapsed time during any 75-millisecond period.

** With a series grid resistance of 50 ohms.


GL-51025 CHARACTERISTICS
VOLTAGES REFERENCED
TO GRID
I_c = 9a
8
7
6
5
4
3
2
1
I_b = 10a
9
8
7
6
5
4
3
2
1
I_b = .001a
CATHODE VOLTAGE IN VOLTS
-220
-200
-180
-160
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
0
400
800
1200
1600
2000
PLATE VOLTAGE IN VOLTS

MIL-152


GL-51025 CHARACTERISTICS
VOLTAGES REFERENCED
TO GRID
I_c= 25 AMPERES
20
15
10
5
2
I_b = 35
AMPERES
30
25
20
15
10
5
1
I_b=0
CATHODE VOLTAGE VOLTS
-500
-400
-300
-200
-100
0
100
200
1000
2000
3000
4000
5000
6000
7000
PLATE VOLTAGE VOLTS



CONCENTRICITIES:

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL.

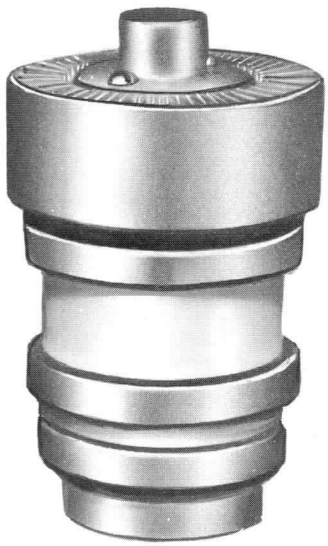
DIAMETER A-0.030 INCHES
DIAMETER B-0.036 INCHES
DIAMETER C-0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT-CUP TERMINAL DIAMETER (C) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT-TERMINAL DIAMETER (B)-0.016 INCHES.

—PRODUCT INFORMATION—

Tetrode

GL-51038



PULSED SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC

INTEGRAL RADIATOR

The GL-51038 is a small-size, four-electrode transmitting tube especially designed for RF grid-pulsed or plate-and-screen pulsed amplifier service at L-band frequencies. This tetrode is particularly well suited for use in airborne or ground-based radar equipment.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the GL-51038 include long life and reliability, long pulse width, high peak power and high gain, broad-banding capability, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where high performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage (See Note 1)	–	6.3	6.8	Volts
Heater Current	–	5.6	–	Amperes
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances*				
Input	–	24	–	$\mu\mu f$
Output	–	9	–	$\mu\mu f$

Mechanical

Mounting Position – Any		
Net Weight	0.8	Pounds

Thermal

Cooling – Forced Air‡				
Radiator§				
Plate Dissipation	600	400	–	Watts
Air Flow, 45 C incoming air temperature, at sea level	9	4.5	–	Min Cubic Feet per Minute
Static Pressure, approximate	0.5	0.2	–	Inches-Water
Anode Hub Temperature△			250	Max C
Seals				
Screen and Control Grid, approximate			1	Cubic Foot per Minute
Heater and Cathode, approximate			1	Cubic Foot per Minute
Ceramic Temperature at any Point			200	Max C

Note 1: Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

RADIO-FREQUENCY POWER AMPLIFIER – CLASS B

Maximum Ratings

Plate- and Screen-Grid Pulsed, 500 Megacycles

DC Plate Voltage, during pulse	10	Kilovolts
DC Plate Current, during pulse	10	Amperes
DC Grid-No. 2 Voltage, during pulse	2000	Volts
DC Grid-No. 2 Input♣	15	Watts
Plate Dissipation♣	500	Watts
DC Grid-No. 1 Voltage, not pulsed	-175	Volts
DC Grid-No. 1 Current, during pulse	2.5	Amperes
Pulse Width♥ ◊	15	Microseconds
Duty Factor♥ ø	0.0012	

Typical Operation

Grounded-grid Circuit, 500 Megacycles, 1/4 λ Output Circuit

DC Plate Voltage, during pulse	9	Kilovolts
DC Grid-No. 2 Voltage, during pulse	1400	Volts
DC Grid-No. 1 Voltage, not pulsed	-125	Volts
Peak RF Plate Voltage	7000	Volts
Peak RF Grid Voltage	300	Volts
DC Plate Current, during pulse	9.2	Amperes
DC Grid-No. 1 Current, during pulse	1.1	Amperes
DC Grid-No. 2 Current, during pulse	0.47	Amperes
Driving Power at Tube, during pulse	2.6	Kilowatts
Power Output, during pulse (useful)	52	Kilowatts
Pulse Width◊	15	Microseconds
Duty Factor	0.001	

RADIO-FREQUENCY POWER AMPLIFIER – CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles

DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation	500	Watts
Pulse Width♥ ◊	15	Microseconds
Duty Factor♥ øø	0.01	

Typical Operation

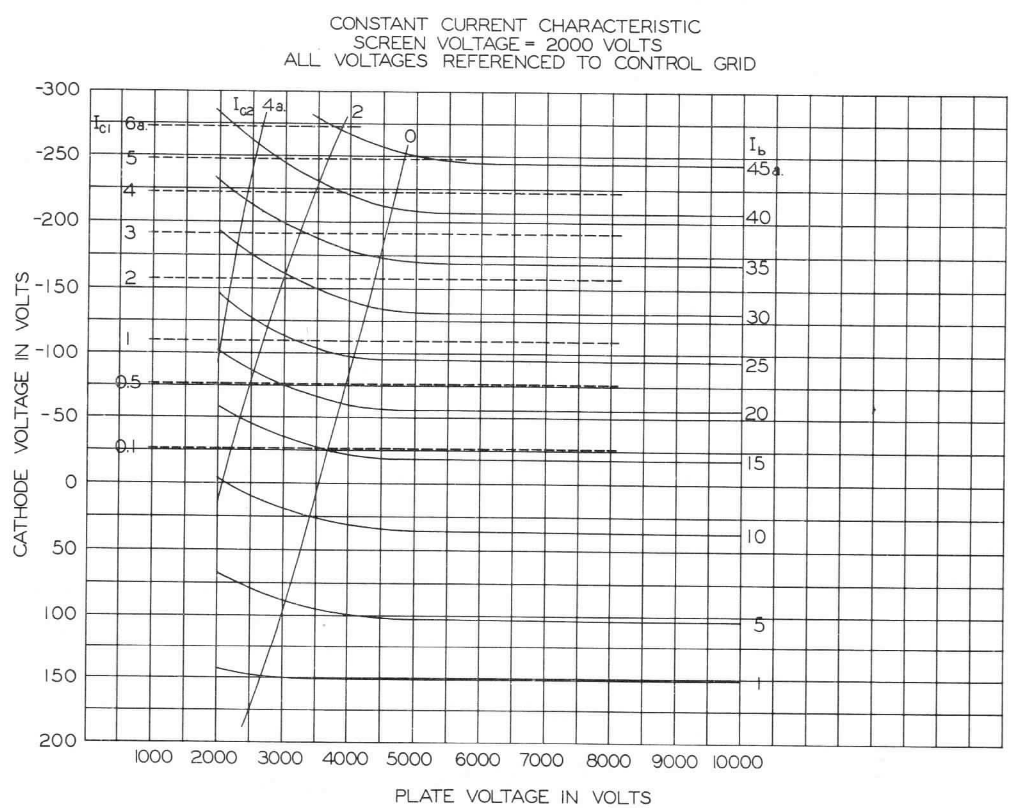
Grounded-grid Circuit at 1100 Megacycles, 3/4λ Output Circuit

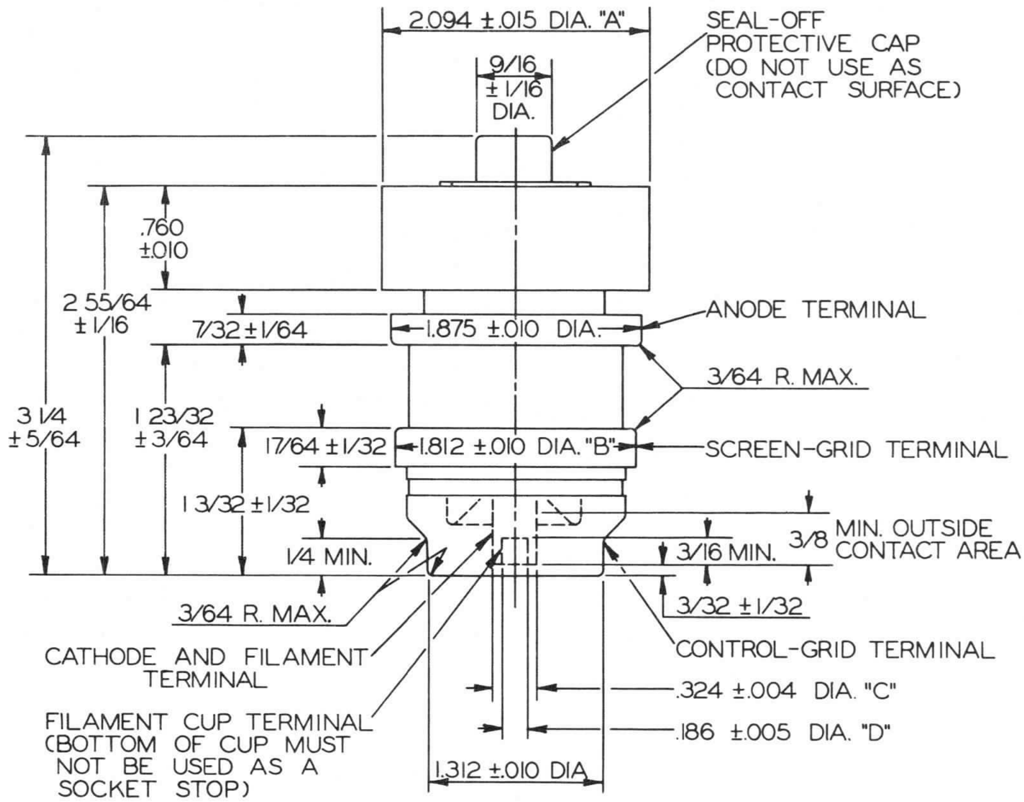
DC Plate Voltage **	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	-200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width◊	15	Microseconds
Duty Factor	0.01	

---

* Control grid connected directly to screen grid.
‡ Forced air cooling should be applied during the application of any voltages.
§ Provision must be made for unobstructed passage of cooling air through the radiator fins, and between the anode terminal and adjacent portion of the radiator.
△ Measured at the base of the radiator and adjacent to the plate terminal.
♣ Maximum average value.
♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
◊ Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
ø Maximum ratio of on-time to elapsed time during any 12.5-millisecond period.
øø Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
** A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.


CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID
CATHODE VOLTAGE IN VOLTS
PLATE VOLTAGE IN VOLTS
I_{c2} 3a.
I_{c1} 7a.
I_b 24a.


CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 2000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID
CATHODE VOLTAGE IN VOLTS
PLATE VOLTAGE IN VOLTS
I_{c2} 4a.
I_{c1} 6a.
I_b 45a.



CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A – 0.030 inches
Diameter B – 0.016 inches
Diameter C – 0.036 inches
Diameter D – 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) – 0.016 inches.

GL-51038R

Tetrode

PULSED SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC

INTEGRAL RADIATOR

The GL-51038R is a small-size, four-electrode transmitting tube especially designed for RF grid-pulsed or plate-and-screen pulsed amplifier service at L-band frequencies. This tetrode is particularly well suited for use in airborne or ground-based radar equipment.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the GL-51038R include long life and reliability, long pulse width, high peak power and high gain, broad-banding capability, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where high performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage (See Note 1)	–	6.3	6.8	Volts
Heater Current	–	5.6	..	Amperes
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances*				
Input	–	24	–	$\mu\mu$f
Output	–	9	–	$\mu\mu$f

Mechanical

Mounting Position – Any		
Net Weight	0.8	Pounds

Thermal

	Minimum	Bogey	Maximum	
Cooling – Forced Air‡				
Radiator§				
Plate Dissipation	600	400	–	Watts
Air Flow, 45 C incoming air temperature, at sea level	9	4.5	–	Min Cubic Feet per Minute
Static Pressure, approximate	0.5	0.2	–	Inches-Water
Anode Hub Temperature △			250	Max C
Seals				
Screen and Control Grid, approximate			1	Cubic Foot per Minute
Heater and Cathode, approximate			1	Cubic Foot per Minute
Ceramic Temperature at any Point			200	Max C

Note 1: Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

RADIO-FREQUENCY POWER AMPLIFIER – CLASS B

Maximum Ratings

Plate- and Screen-Grid Pulsed, 500 Megacycles

DC Plate Voltage, during pulse	10	Kilovolts
DC Plate Current, during pulse	10	Amperes
DC Grid-No. 2 Voltage, during pulse	2000	Volts
DC Grid-No. 2 Input♣	15	Watts
Plate Dissipation♣	500	Watts
DC Grid-No. 1 Voltage, not pulsed	-175	Volts
DC Grid-No. 1 Current, during pulse	2.5	Amperes
Pulse Width♥ ◊	15	Microseconds
Duty Factor♥ ø	0.0012	

Typical Operation

Grounded-grid Circuit, 500 Megacycles, 1/4 λ Output Circuit

DC Plate Voltage, during pulse	9	Kilovolts
DC Grid-No. 2 Voltage, during pulse	1400	Volts
DC Grid-No. 1 Voltage, not pulsed	-125	Volts
Peak RF Plate Voltage	7000	Volts
Peak RF Grid Voltage	300	Volts
DC Plate Current, during pulse	9.2	Amperes
DC Grid-No. 1 Current, during pulse	1.1	Amperes
DC Grid-No. 2 Current, during pulse	0.47	Amperes
Driving Power at Tube, during pulse	2.6	Kilowatts
Power Output, during pulse (useful)	52	Kilowatts
Pulse Width◊	15	Microseconds
Duty Factor	0.001	

RADIO-FREQUENCY POWER AMPLIFIER – CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles

DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation	500	Watts
Pulse Width♥ ◊	15	Microseconds
Duty Factor♥ øø	0.01	

Typical Operation

Grounded-grid Circuit at 1100 Megacycles, 3/4λ Output Circuit

DC Plate Voltage **	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	-200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width◊	15	Microseconds
Duty Factor	0.01	

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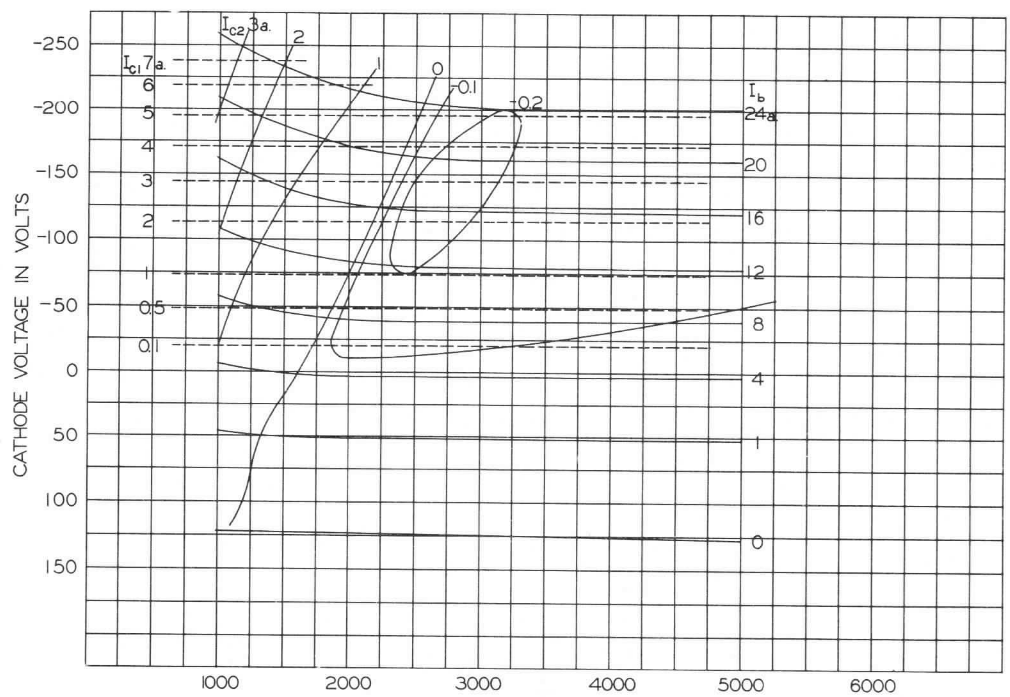
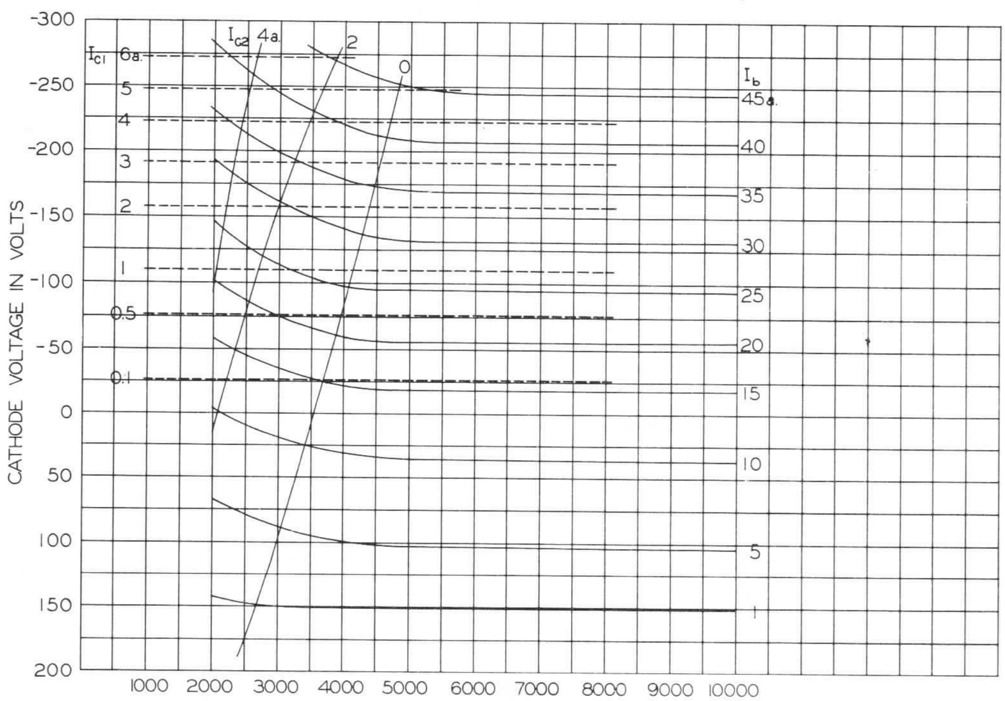
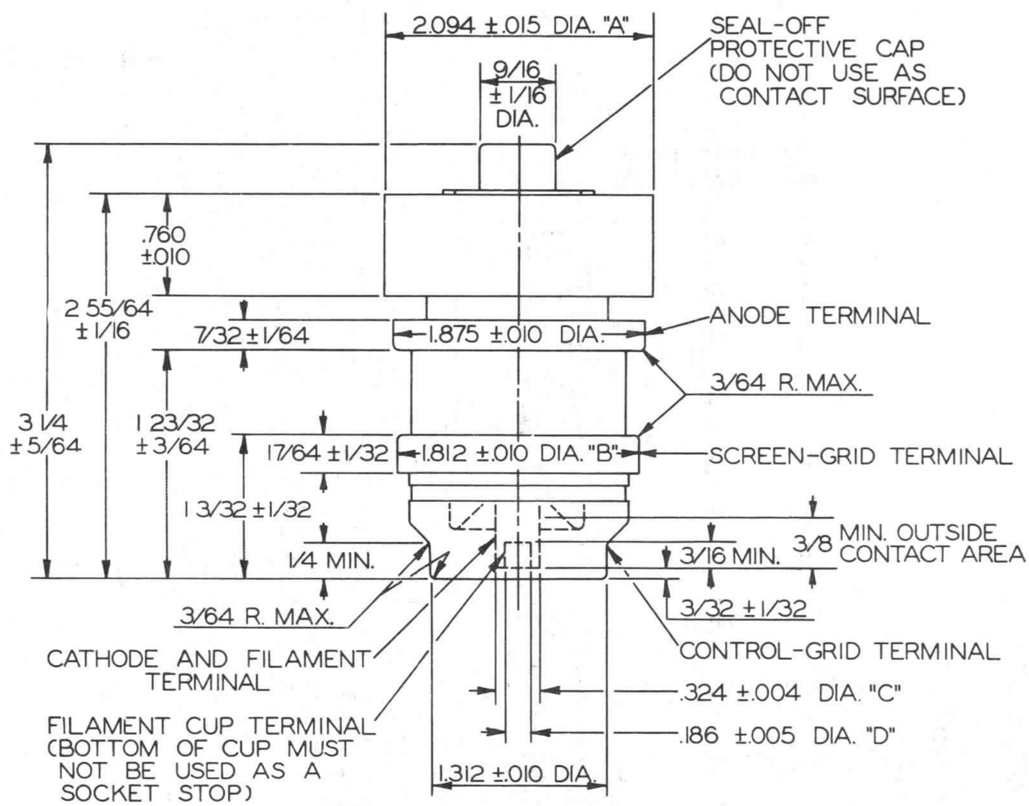
* Control grid connected directly to screen grid.
‡ Forced air cooling should be applied during the application of any voltages.
§ Provision must be made for unobstructed passage of cooling air through the radiator fins, and between the anode terminal and adjacent portion of the radiator.
△ Measured at the base of the radiator and adjacent to the plate terminal.
♣ Maximum average value.
♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
◊ Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
ø Maximum ratio of on-time to elapsed time during any 12.5-millisecond period.
øø Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
** A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 2000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A – 0.030 inches
Diameter B – 0.016 inches
Diameter C – 0.036 inches
Diameter D – 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) – 0.016 inches.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

— PRODUCT INFORMATION —

GL-51064

Tetrode

VHF-UHF METAL CERAMIC TETRODE
4 KILOWATTS USEFUL CW OUTPUT
750 WATTS CLASS B LINEAR OUTPUT

FORCED AIR COOLED
INTEGRAL RADIATOR
THORIATED-TUNGSTEN CATHODE

The GL-51064 is a forced-air cooled power tetrode that delivers useful output to approximately 1250 megacycles. This tube is particularly suitable for application as an AM or FM power amplifier in the final output or driver stage of VHF-UHF military communications systems.

The tube features high power gain, as much as 14 db, while delivering up to 4000 watts of useful CW power as a grounded-grid Class C amplifier at 400 megacycles. An output capacitance of only 6.0 $\mu\mu$f, which is significantly low for a tube of its power handling capability, makes the GL-51064 well suited for application in equipments requiring broad electronic bandwidth.

Other features include metal-ceramic construction, a high efficiency axial flow radiator capable of dissipating 2750 watts, and an indirectly heated thoriated tungsten cathode.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage *	...	5.7	...	Volts
Heater Current at 5.7 Volts	22	24	26	Amperes
Heater Starting Current	...	...	36	Amperes
Heater Cold Resistance	...	0.02	...	Ohms
Cathode Heating Time	1	...	...	Minute
Amplification Factor, G_2 to G_1				
Eb = 2000 Volts, I_b = 0.200 Ampere, E_{c2} = 475 Volts	12	17	22	
Direct Interelectrode Capacitances				
Cathode to Plate ‡	...	...	0.006	$\mu\mu$f
Input, G_2 tied to G_1	15.5	17.0	18.5	$\mu\mu$f
Output, G_2 tied to G_1 §	...	6.0	...	$\mu\mu$f

Mechanical

Mounting Position		Vertical
Net Weight, approximate	5.0	Pounds

Thermal

Cooling-Forced Air ¶

Through Radiator, at Sea Level

Plate Dissipation	Air Flow	Static Pressure
2.75 Kilowatts	140 Min CFM	1.9 Inches Water
2.0 Kilowatts	90 Min CFM	0.8 Inches Water
1.5 Kilowatts	55 Min CFM	0.4 Inches Water

Seals	
Screen-Grid to Control-Grid	4 Min CFM
Heater-to-Cathode	8 Min CFM
Anode to Screen-Grid Ceramic Insulator	6 Min CFM
Incoming Air Temperature	25 Max C
Radiator Hub Temperature (Adjacent to Anode Seal)	180 Max C
Temperature at Any Other Point	200 Max C

Forced-air cooling to be applied before and during the application of any voltages. Forced-air cooling must be maintained for one minute after the removal of all voltages.

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR – CLASS C

Maximum Ratings, Absolute Values

	420 mcs	1000 mcs	
DC Plate Voltage	8000	6000	Max Volts
DC Grid-No. 2 Voltage	650	650	Max Volts
DC Grid-No. 1 Voltage	-175	-175	Max Volts
DC Plate Current	0.700	0.700	Max Amperes
DC Grid-No. 1 Current	0.175	0.175	Max Amperes
Plate Input	5.6	4.2	Max Kilowatts
Grid-No. 2 Input	25	25	Max Watts
Plate Dissipation	2.75	2.75	Max Kilowatts

Typical Operation – Grounded-Grid Circuit @ 400 mcs

DC Plate Voltage	5500	7500	Volts
DC Grid-No. 2 Voltage	600	600	Volts
DC Grid-No. 1 Voltage	-100	-100	Volts
DC Plate Current	0.450	0.650	Amperes
DC Grid-No. 2 Current	0.012	0.016	Amperes
DC Grid-No. 1 Current	0.085	0.155	Amperes
Driving Power, approx	90	150	Watts
Power Output, useful ø	2000	4000	Watts
Power Gain, approx	13.5	14.3	db

RADIO-FREQUENCY POWER AMPLIFIER – CLASS B LINEAR SERVICE

Maximum Ratings at 420 Megacycles, Absolute Values

DC Plate Voltage	8000	Max Volts
DC Grid-No. 2 Voltage	650	Max Volts
DC Plate Current	585	Max Milliamperes
Plate Input	4150	Max Watts
Grid-No. 2 Input	16	Max Watts
Plate Dissipation	2750	Max Watts

Typical Operation at 400 Mcs, Carrier Conditions for Maximum Modulation Factor of 1.0

DC Plate Voltage	7500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage, approx	-50	Volts
DC Plate Current	330	Milliamperes
DC Grid-No. 2 Current	5	Milliamperes
DC Grid-No. 1 Current	30	Milliamperes
Driving Power, approx	17.5	Watts
Power Output, useful ø	750	Watts
Power Gain, approx	16	db

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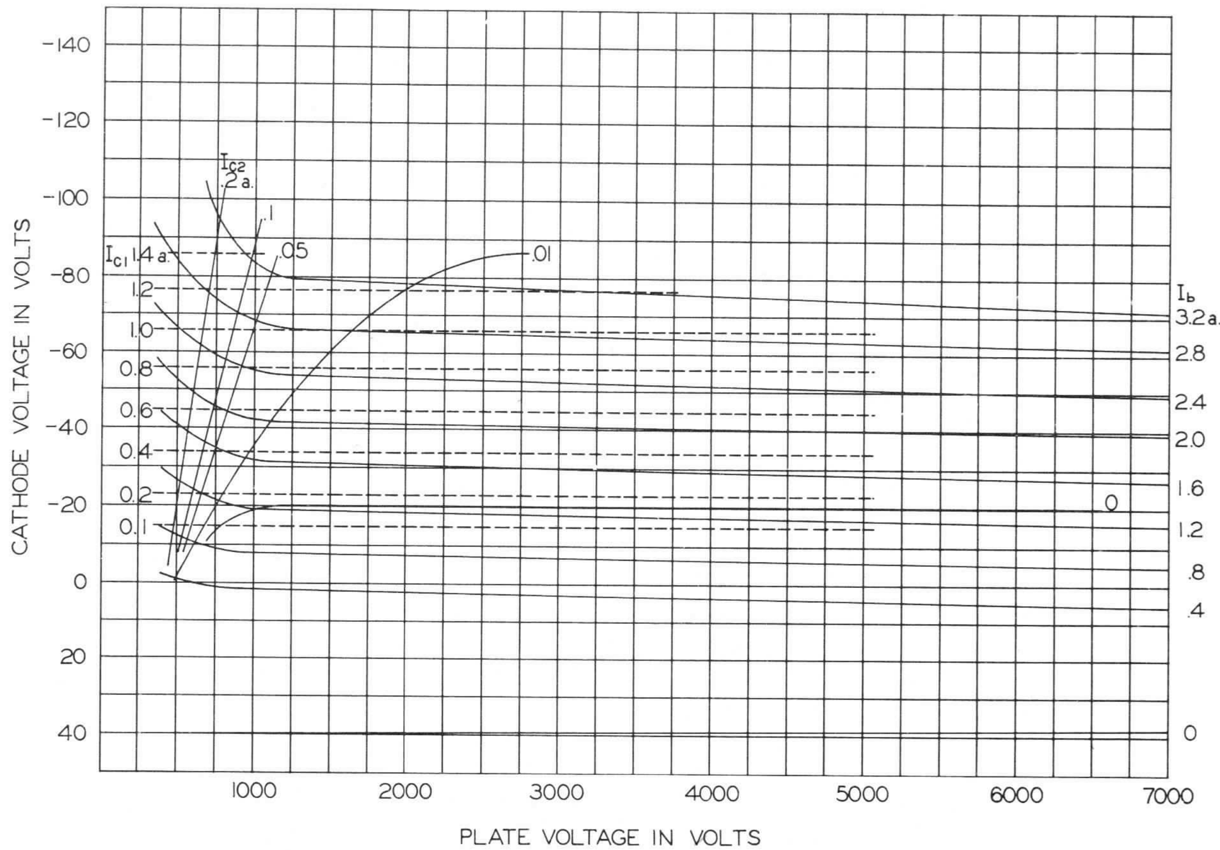
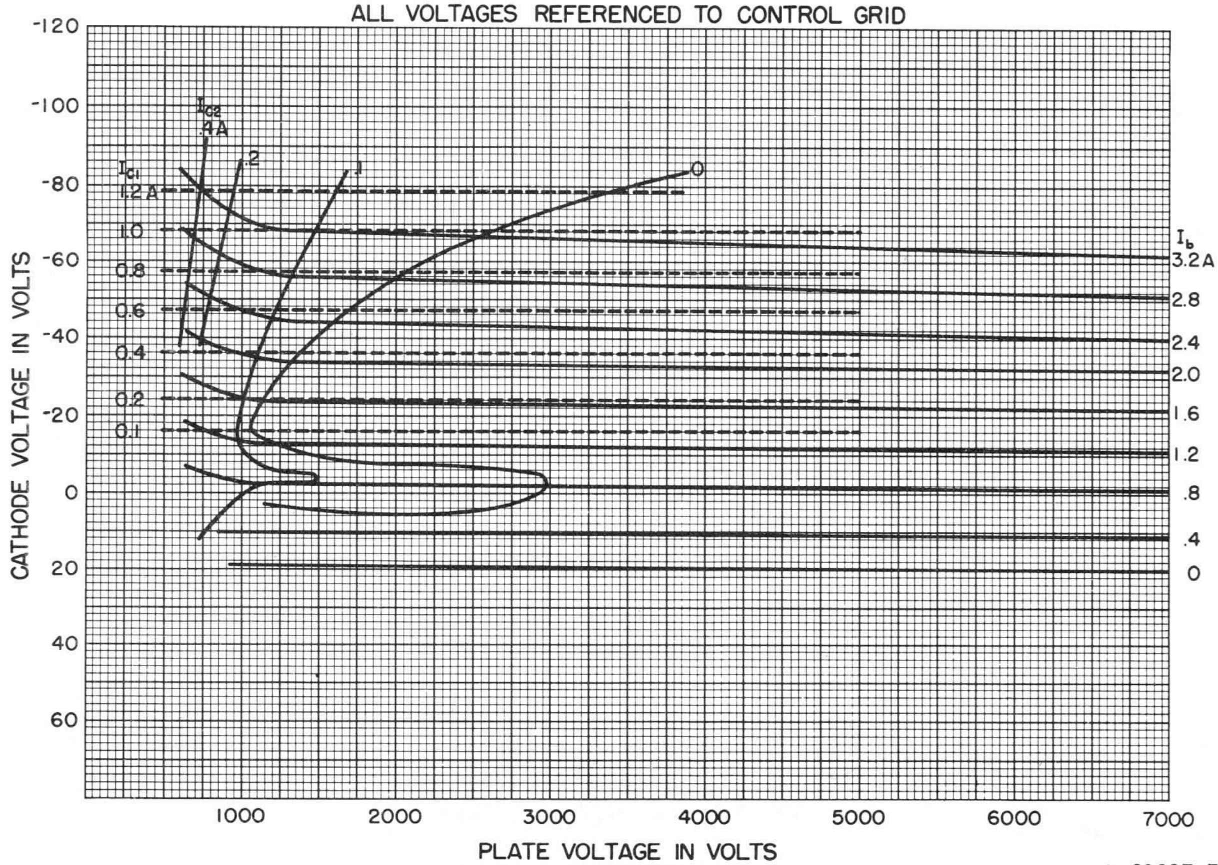
* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater voltage reduction is dependent on operating conditions.

‡ Measured with complete external shielding between cathode and anode.
§ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.
¶ The volume of cooling air indicated for the various seals is for sea-level conditions and approximate only. Distribution of cooling air will vary with the cavity configuration about the tube. For most satisfactory operation the maximum temperature of any point on the tube should be below specified limits.
ø Useful power output including power transferred from driver stage.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 500 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 650 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



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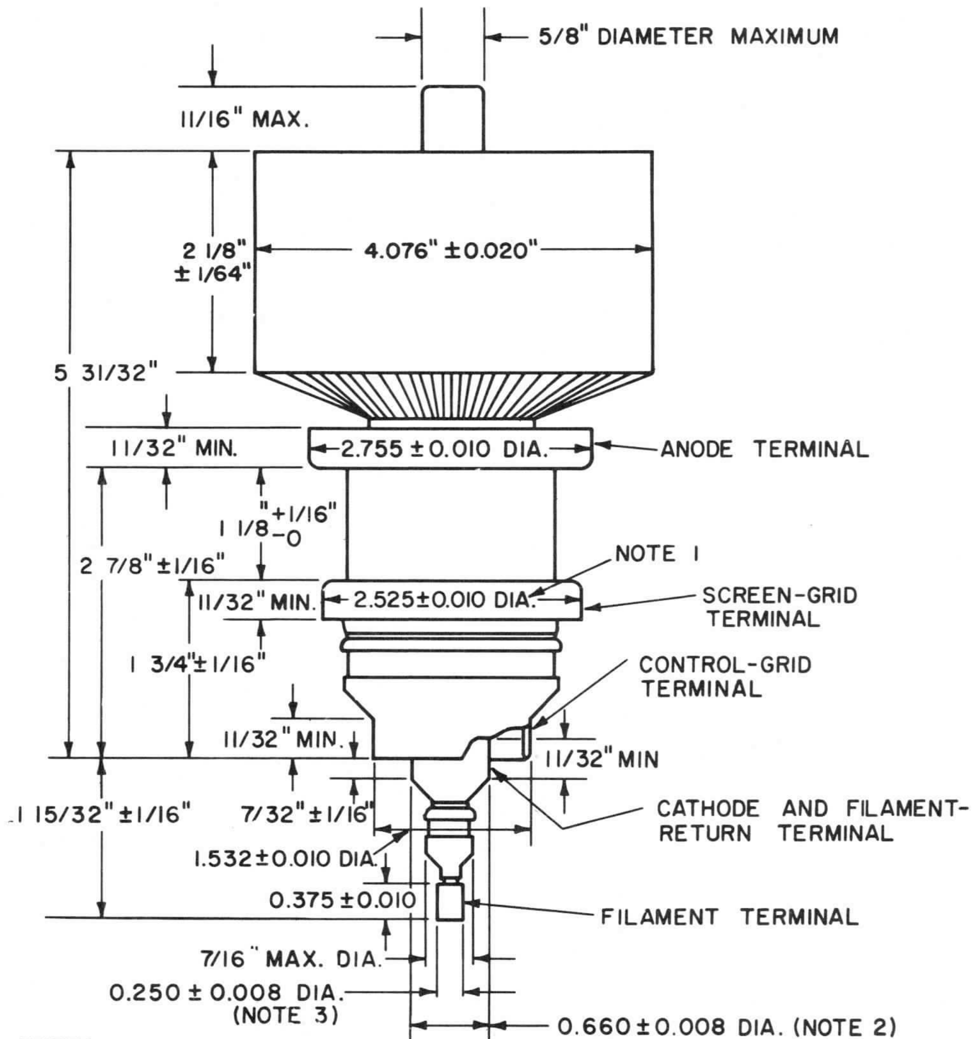


NOTES
1 MAXIMUM ECCENTRICITY 0.010
2. MAXIMUM ECCENTRICITY 0.015
3. MAXIMUM ECCENTRICITY 0.030
WITH RESPECT TO CENTERLINE DETERMINED BY CENTERS OF ANODE TERMINAL AND CONTROL-GRID TERMINAL

ELECTRONIC INNOVATIONS IN ACTION

TUBES

— PRODUCT INFORMATION —

GL-51065

Tetrode

GRID-PULSED SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC

The GL-51065 is a high-performance, forced-air cooled, metal-ceramic tetrode especially designed for grid-pulsed amplifier service (pulsed RF drive only) at L-band frequencies. This tetrode is particularly well suited for use in radar equipment such as advanced ground-based, ship-board or airborne IFF interrogators. It is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the GL-51065 include long life and reliability, high gain with pulsed RF drive only, long pulse width, and high-duty capability.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	-	6.3	-	Volts
Heater Current	-	3.8	-	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances**				
Cathode to Plate †	-	0.006	-	$\mu\mu$f
Input	-	20	-	$\mu\mu$f
Output	-	7.5	-	$\mu\mu$f

Mechanical

Mounting Position		Any
Net Weight, approximate	13	Ounces

Thermal

Cooling – Forced-Air‡			
Through Radiator, at Sea Level			
Plate Dissipation	600	400	Watts
Air Flow, 45 C Incoming Air Temperature, minimum	9	4.5	Cubic Feet per Minute
Static Pressure, approximate	0.5	0.2	Inches Water
Radiator Hub Temperature at Point Adjacent to Anode Seal, maximum§		250	C
Seals			
Screen and Control Grid, approximate		1	Cubic Feet per Minute
Heater and Cathode, approximate		1	Cubic Feet per Minute
Ceramic Temperature at Any Point, maximum		200	C

RADIO-FREQUENCY POWER AMPLIFIER

Maximum Ratings

Pulsed Drive, 1250 Megacycles		
DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-200	Volts
Plate Dissipation	600	Watts
Pulse Width ◊	10	Microseconds
Duty Factor ø	0.01	

RADIO-FREQUENCY POWER AMPLIFIER (CONT'D)

Typical Operation

Grounded-Grid Service at 1030 Megacycles, 1/4λ Output Circuit

DC Plate Voltage øø	4.5	3.5	Kilovolts
DC Plate Current, during pulse	5.3	3.0	Amperes
DC Grid-No. 2 Voltage	750	750	Volts
DC Grid-No. 2 Current, during pulse	0.110	0.065	Amperes
DC Grid-No. 1 Voltage, approximate	-115	-75	Volts
DC Grid-No. 1 Current, during pulse	0.850	0.400	Amperes
Driving Power at the Tube, during pulse	1.5	0.5	Kilowatts
Power Output, during pulse (useful)	11.0	4.5	Kilowatts
Pulse Width	10	10	Microseconds
Duty Factor	0.01	0.03	

* Under the typical operating conditions shown the filament voltage should be reduced to approximately 6.0 volts because of back-heating resulting from transit time effects.

** Control grid connected directly to screen grid.

† Complete external shielding between cathode and plate.

‡ Forced-air cooling should be applied during the application of any voltages.

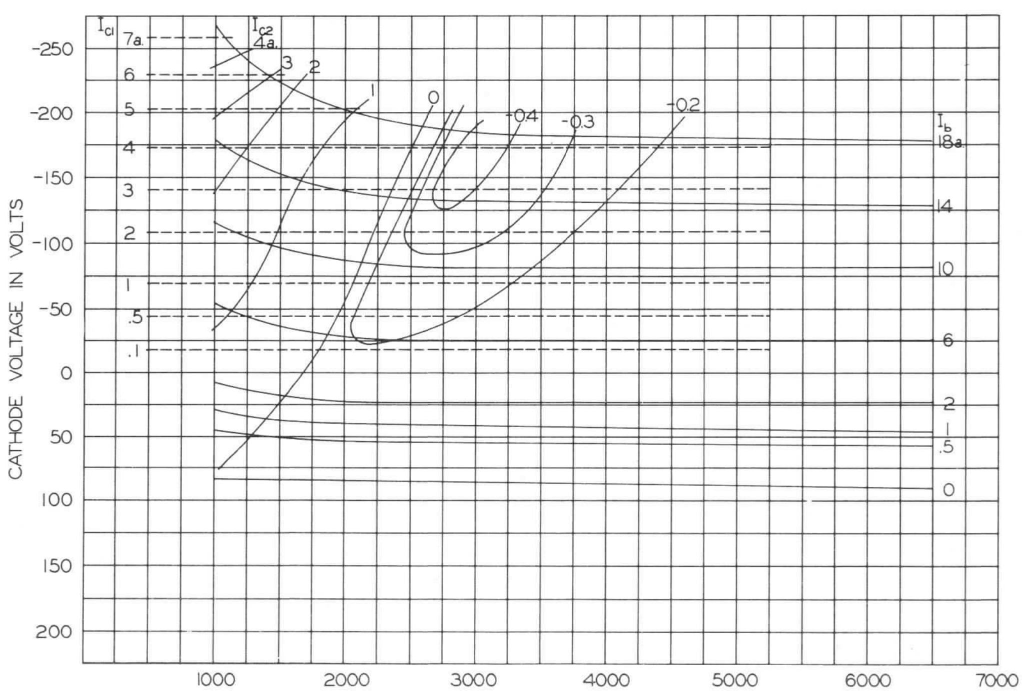
§ Provision must be made for unobstructed passage of cooling air to limit the anode hub temperature to the value specified.

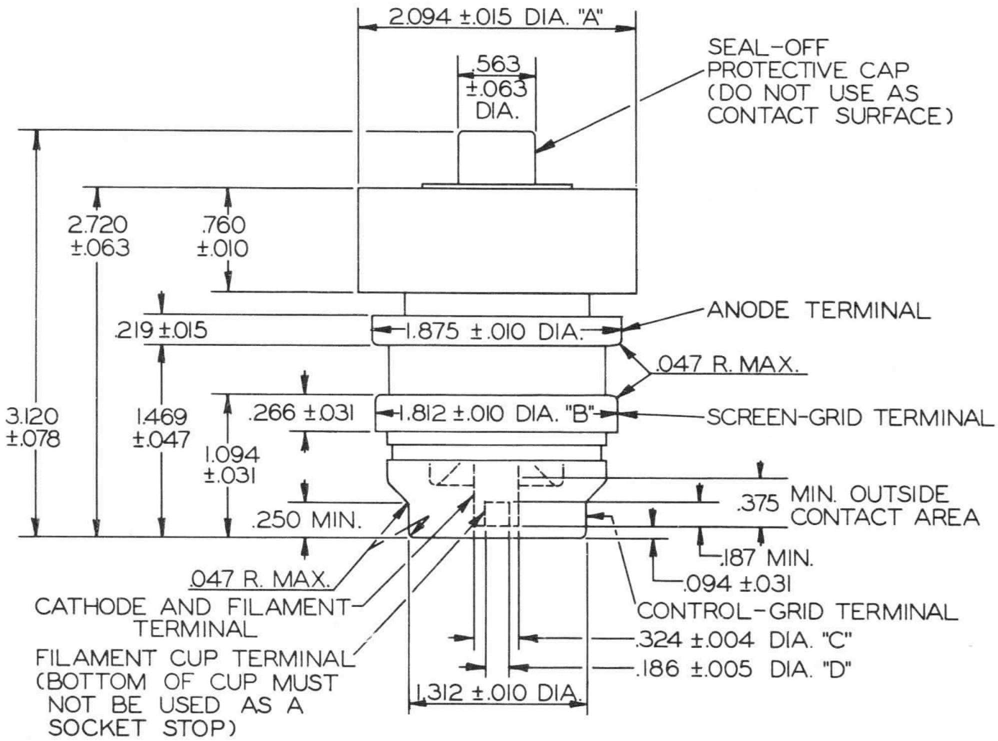
◊ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

ø Maximum ratio of on-time to elapsed time during any 1-millisecond period. Higher duty may be allowed with lower tube input as indicated under typical operation at 0.03 duty. For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.

øø A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 1000 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID





CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.016 inches
Diameter C - 0.036 inches
Diameter D - 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) - 0.016 inches.

ELECTRONIC INNOVATIONS IN ACTION

TUBES

— PRODUCT INFORMATION —

GL-51070

Tetrode

RADIO–FREQUENCY AMPLIFIER
CW SERVICE
GROUNDED–GRID OPERATION
FORCED–AIR COOLED
METAL AND CERAMIC
INTEGRAL RADIATOR

The GL-51070 is a reliable power tetrode that delivers useful output to 1250 megacycles or higher. This tube is particularly suitable for application in the final output or driver stage of military-communications systems.

As a Class B linear amplifier in the 225-400 megacycle range, the tube will deliver 110 watts of carrier power modulated up to 100 percent. Since a power gain of 20 may be realized, drive requirements are low - approximately 5 watts at carrier level.

Operating as a Class C CW amplifier at 900 megacycles, the gain is approximately 15 at the 200-watt level.

Features of the GL-51070 include long life and reliability, high gain, high linearity, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage *	–	6.3	6.8	Volts
Heater Current	–	3.8	–	Amperes
Cathode Heating Time	1	–	–	Minutes
Amplification Factor, G_2 to G_1, E_b = 1000 Volts DC; E_{g2}=275 Volts DC; I_b = 0.2 A DC	–	14	–	
Direct Interelectrode Capacitances				
Cathode to Plate ‡	–	0.006	–	$\mu\mu$f
Input, G_2 tied to G_1	–	20	–	$\mu\mu$f
Output, G_2 tied to G_1 ◊	–	7.5	–	$\mu\mu$f

Mechanical

Mounting Position – Any		
Net Weight, approximate	13	Ounces

Thermal

Cooling – Forced Air §				
Through Radiator, at Sea Level **				
Plate Dissipation	600	400		Watts
Air Flow, 45 C Incoming Air Temperature, minimum	9	4.5		Cubic Feet per Minute
Static Pressure, approximate	0.5	0.2		Inches-Water
Radiator Hub Temperature at Point Adjacent to Anode Seal	–	–	250	C

Thermal (cont'd)

Seals				
Screen-Grid to Control-Grid, approximate	-	-	1	Cubic Foot per Minute
Heater to Cathode, approximate	-	-	1	Cubic Foot per Minute
Ceramic Temperature at Any Point, maximum	-	-	200	C

RADIO—FREQUENCY POWER AMPLIFIER — CLASS B LINEAR

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings

DC Plate Voltage	2000	Volts
DC Grid-No. 2 Voltage	320	Volts
DC Plate Current	0.250	Ampere
Plate Input	500	Watts
Grid-No. 2 Input	5	Watts
Plate Dissipation	600	Watts

Typical Operation

Grounded-Grid Circuit at 225-400 Megacycles

DC Plate Voltage	1750	Volts
DC Grid-No. 2 Voltage	250	Volts
DC Grid-No. 1 Voltage, approximate	-20	Volts
Peak RF Plate Voltage #, approximate	1250	Volts
Peak RF Grid-No. 1 Voltage #, approximate	40	Volts
DC Plate Current	0.200	Ampere
Zero Signal DC Plate Current (E_{c1} adjusted)	0.020	Ampere
DC Grid-No. 2 Current	0.005	Ampere
DC Grid-No. 1 Current	0.010	Ampere
Driving Power, approximate	5	Watts
Power Output♥	110	Watts

RADIO—FREQUENCY POWER AMPLIFIER AND OSCILLATOR — CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation△

Maximum Ratings

	900 Megacycles	400 Megacycles	
DC Plate Voltage	1600	2000	Volts
DC Grid-No. 2 Voltage	320	320	Volts
DC Grid-No. 1 Voltage	-100	-100	Volts
DC Plate Current	0.300	0.300	Ampere
DC Grid-No. 1 Current	0.050	0.050	Ampere
Plate Input	480	600	Watts
Grid-No. 2 Input	15	15	Watts
Plate Dissipation	600	600	Watts
Grid-No. 1 Dissipation	2	2	Watts

Typical Operation

Grounded-Grid Circuit at 900 Megacycles			
DC Plate Voltage	1500	2000	Volts
DC Grid-No. 2 Voltage	210	225	Volts
DC Grid-No. 1 Voltage	-40	-40	Volts
DC Plate Current	0.300	0.250	Ampere
DC Grid-No. 2 Current, approximate	0.010	0.010	Ampere
DC Grid-No. 1 Current, approximate	0.020	0.020	Ampere
Driving Power, approximate	14	15	Watts
Power Output, approximate ¶	205	300	Watts

*Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

‡ Measured with a 6-inch minimum diameter flat metal disk attached to the screen-grid ring. Control grid connected to the screen grid.

◊ Output capacitances measured between anode and screen grid. Control grid connected directly to screen grid.

§ Forced-air cooling to be applied before and during the application of any voltages.

** Provision must be made for unobstructed passage of cooling air between radiator fins and between the anode terminal and adjacent radiator fin.

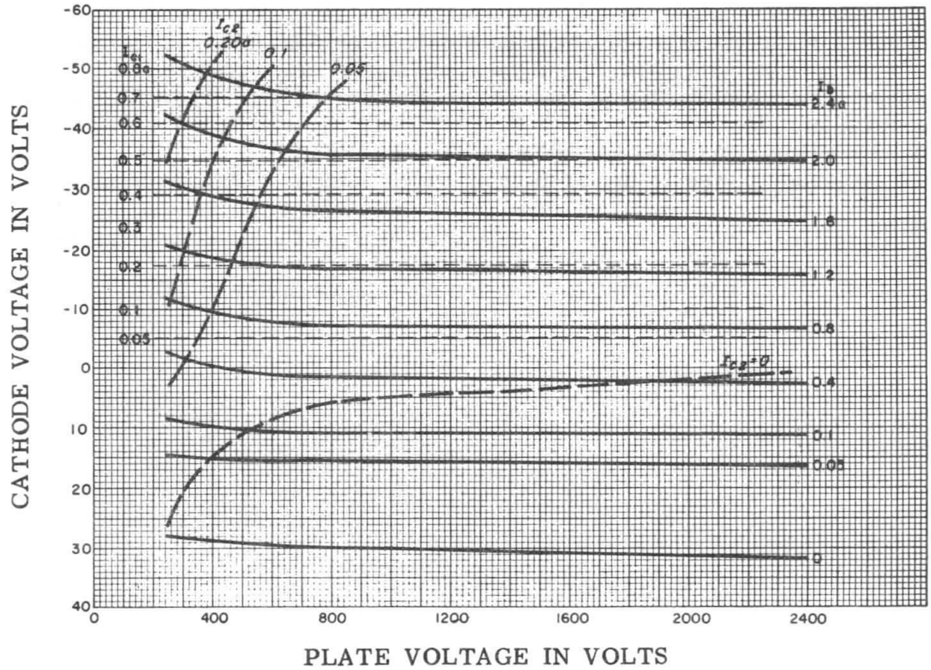
♥ Useful power output as measured in output-circuit load.

¶ Useful power output including power transferred from driver stage. Output circuit efficiency approximately 80 percent.

Δ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

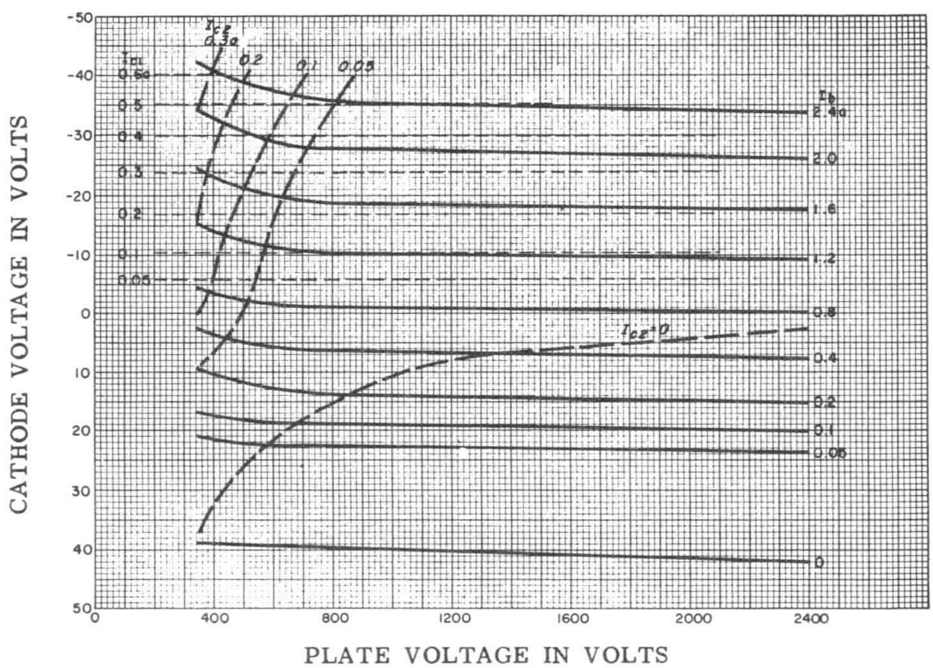
Measured at the crest of the audio-frequency cycle with a modulation factor of 1.0.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 250 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID

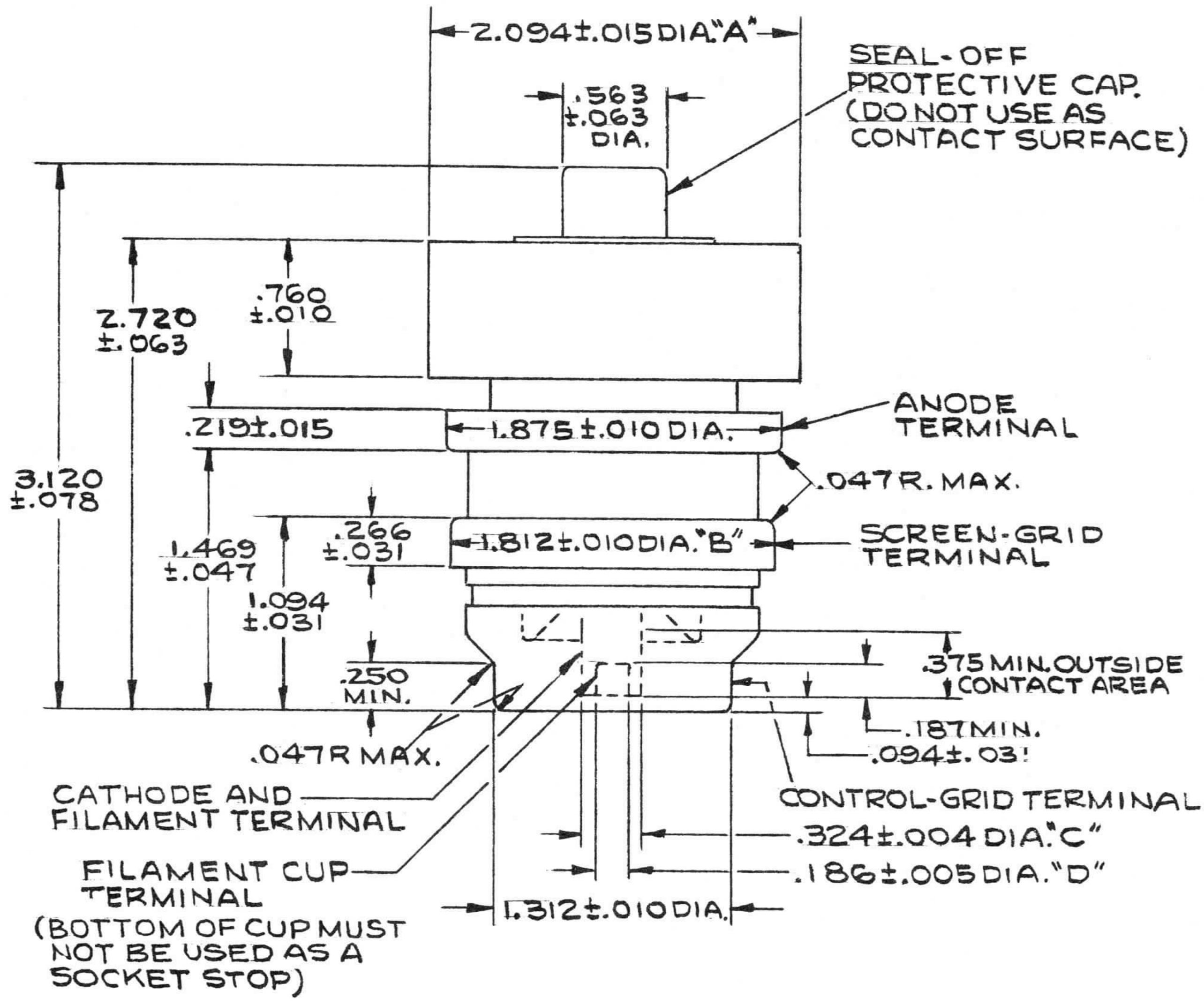


A69087 - 72B67 (1-30-62)

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 350 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



A69087 - 72B68 (1-30-63)



CONCENTRICITIES:
The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

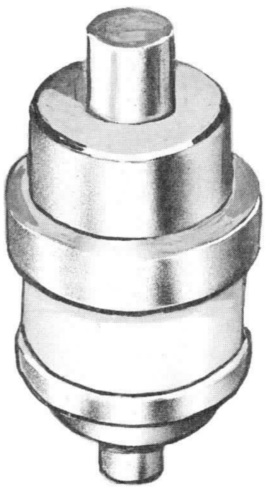
Diameter A - 0.030 inches
Diameter B - 0.016 inches
Diameter C - 0.036 inches
Diameter D - 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) - 0.016 inches.

A69087-72B126 (2-3-65)

Triode

GL-51074



INTERNAL FEEDBACK FOR OSCILLATOR SERVICE
GROUNDED–GRID OPERATION
HEAT–SINK AND FORCED–AIR COOLED
METAL AND CERAMIC

The GL-51074 is a heat-sink-cooled triode that features internal feedback. It is especially designed for pulsed oscillator service in L-band. Applications for which it is particularly well suited include airborne or ground-based radar, and high level signal generators.

The GL-51074 is a higher-voltage version of the GL-51025. Ratings include a DC plate voltage of 3500 volts under grid-pulsed-oscillator service for 5 kilowatts of peak power output at 0.005 duty.

Other features include small size, high peak power as a plate-pulsed oscillator, long-pulse-width capability, long life and reliability.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	-	6.3	-	Volts
Heater Current	3.5	3.8	4.0	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances				
Cathode to Plate	-	0.5	-	$\mu\mu$f
Input	-	15.5	-	$\mu\mu$f
Output	-	5.9	-	$\mu\mu$f

Mechanical

Mounting Position – Any

Net Weight, approximate	3 1/4	Ounces

Thermal

Cooling – Heat-Sink and Forced Air

Anode Temperature§	250	C
Ceramic Temperature at Any Point, maximum	200	C

PLATE–PULSED OSCILLATOR – CLASS C

Maximum Ratings

DC Plate Voltage, During Pulse	8.0	Kilovolts
DC Plate Current, During Pulse	10.0	Amperes
DC Grid Voltage, During Pulse	-400	Volts
DC Grid Current, During Pulse	5.0	Amperes
Plate Dissipation§	110	Watts
Grid Dissipation	3.5	Watts
Pulse Width ◊	10	Microseconds
Duty Factor ø	0.003	

Typical Operation

Grounded-Grid Service at 1300 Megacycles, 3/4λ Output Circuit

DC Plate Voltage, During Pulse	8.0	6.0	Kilovolts
DC Plate Current, During Pulse	9.0	7.0	Amperes
DC Grid Current, During Pulse (Grid Resistor = 50 Ohms)	4.0	4.3	Amperes
Power Output, During Pulse (useful)	40.0	24.0	Kilowatts
Pulse Width	10	10	Microseconds
Duty Factor	0.003	0.001	

GRID–PULSED OSCILLATOR – CLASS C

Maximum Ratings

DC Plate Voltage	3.75	Kilovolts
DC Plate Current, During Pulse	3.7	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	110	Watts
Pulse Width ◇	15	Microseconds
Duty Factor øø	0.02	

Typical Operation

Grounded-Grid Circuit at 1100 Megacycles, 1/4 λ Output

DC Plate Voltage	3500	2200	Volts
DC Plate Current, During Pulse	3.5	2.7	Amperes
DC Grid Voltage Supply**	-110	-104	Volts
DC Grid Current, During Pulse	1.7	1.25	Amperes
Power Output, During Pulse (useful)	5.0	2.4	Kilowatts
Pulse Width	10	10	Microseconds
Duty Factor	0.005	0.02	

---

* Because of back-heating due to transit-time effects, it may be necessary to reduce the heater voltage. For the 1100 mcs, 2 kw, 0.02 duty condition, the typical heater voltage is 5.5 volts. The optimum heater voltage for any application should be determined by RF performance testing.

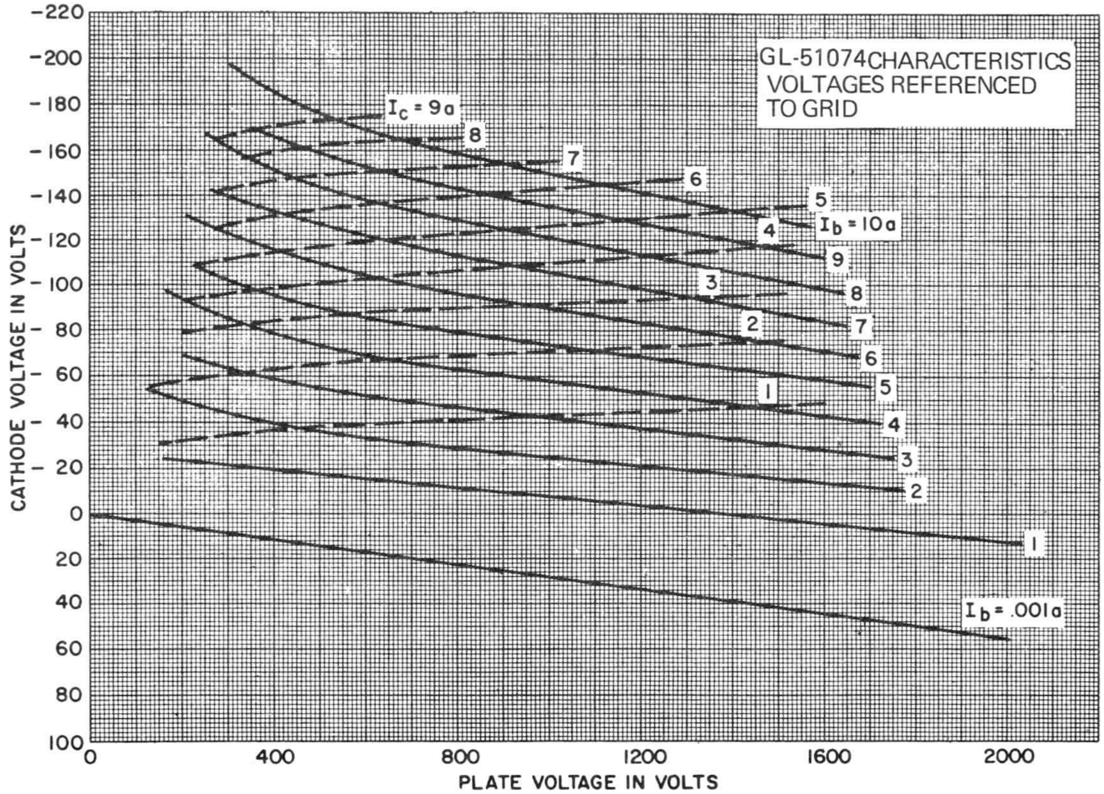
§ A suitable clamp-on radiator or heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified. Higher plate dissipation is allowable with provision for proper cooling.

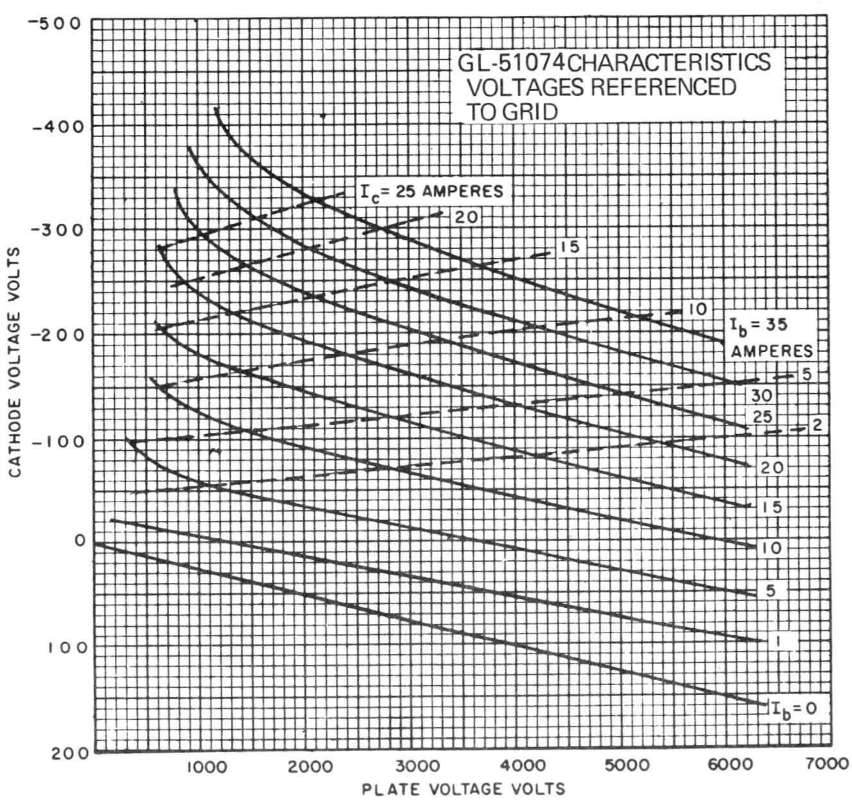
◇ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse. For applications requiring longer pulses, refer to the tube manufacturer.

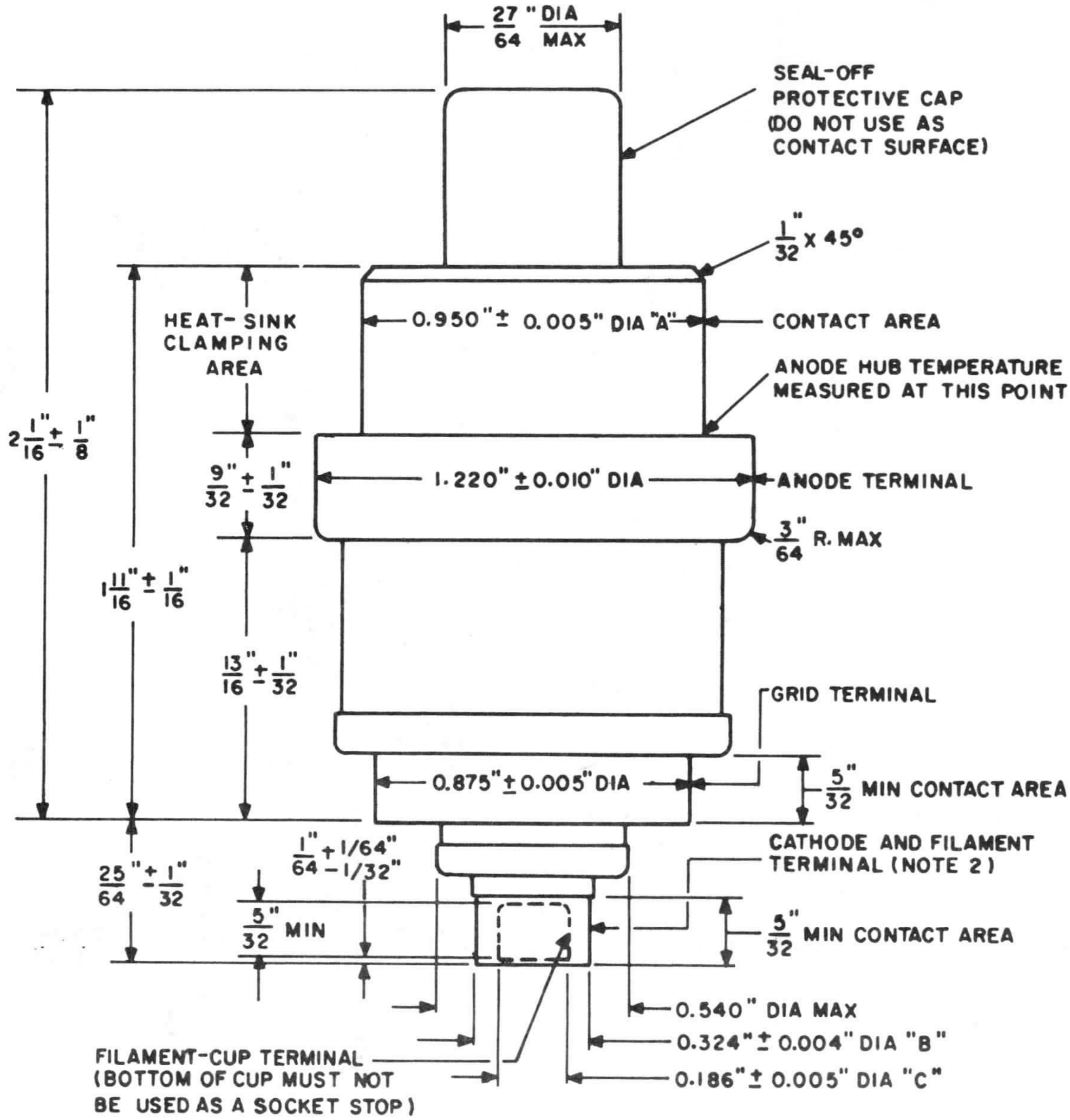
ø Maximum ratio of on-time to elapsed time during any 3.3-millisecond period.

øø Maximum ratio of on-time to elapsed time during any 75-millisecond period.

** With a series grid resistance of 50 ohms.


GL-51074 CHARACTERISTICS
VOLTAGES REFERENCED
TO GRID
CATHODE VOLTAGE IN VOLTS
PLATE VOLTAGE IN VOLTS
I_c = 9a
I_b = 10a
I_b = .001a


GL-51074 CHARACTERISTICS
VOLTAGES REFERENCED
TO GRID
CATHODE VOLTAGE VOLTS
PLATE VOLTAGE VOLTS
I_c= 25 AMPERES
I_b = 35
AMPERES
I_b=0



CONCENTRICITIES:

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL.

DIAMETER A-0.030 INCHES
DIAMETER B-0.036 INCHES
DIAMETER C-0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT-CUP TERMINAL DIAMETER (C) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT-TERMINAL DIAMETER (B)-0.016 INCHES.

FILE THIS PAGE AS THE VERY FIRST PAGE IN YOUR MANUAL

ELECTRONIC INNOVATIONS IN ACTION

TUBES

INDUSTRIAL EQUIPMENT TYPES TUBE MANUAL

REGISTRATION PAGE

3-BCD ET-11-E00-00
12-28-65
599

Mr. P. G. Durham
Chief of Technical Pub. Dept.
English Electric Valve Co., Ltd.
Chelmsford Essex, England

This tube manual is recorded in the name and at the address shown above. To assure prompt receipt of the revised and new data that are issued in regular supplemental mailings, will you please notify us immediately of any changes of address or transfer of the manual to another person. If you should move, or if you transfer this manual to another person, *RETURN THIS PAGE TO US WITH YOUR NEW ADDRESS OR WITH THE NEW OWNER (AND ADDRESS) OF THE MANUAL INDICATED IN THE ABOVE SQUARE.*

WE CANNOT CHANGE YOUR ADDRESS OR TRANSFER ANY MANUAL UNLESS YOU RETURN THIS PAGE WITH THE NECESSARY CHANGES INDICATED TO:

GENERAL ELECTRIC COMPANY
Tube Products Department, A. & S. P.
316 East Ninth Street
Owensboro, Kentucky 42301

We will apply this change, if you have more than one manual, to all those recorded in your name.

Date change requested______________________________

TUBE PRODUCTS DEPARTMENT

GENERAL ELECTRIC

SCHENECTADY, NEW YORK 12305, U. S. A.

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ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

INDUSTRIAL EQUIPMENT TYPES MANUAL

IET-1E

TABLE OF CONTENTS

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

ECSO PRODUCT LISTING AND SALES OFFICES

ET-F20B

The General Electric Electronic Component Sales Operation offers a complete electronic components "market basket" of products. A listing follows:

TUBE PRODUCTS

1. Transmitter tubes
1A. Camera tubes
2. Klystrons
3. VTM's
4. Ignitrons
4A. Vacuum gaps
4B. Hydrogen thyratrons
5. Ceramic tubes
6. Photocells
7. Reed switches
8. Compactrons
9. Conventional receiving tubes

SEMICONDUCTOR PRODUCTS

10. Germanium rectifiers
    low current (0 to 1.4 amp)
11. Silicon rectifiers
    low current (0 to 1.4 amp)
    medium current (1.5 to 35.0 amp)
    high current (over 35 amp)
12. SCR's
    low current (0 to 7.5 amp)
    high current (over 35 amp)
    light activated
13. Silicon controlled combination stacks
14. AC controlled switches
15. Rectifier stacks (Germanium, silicon, potted blocks)
16. Assemblies (thyratron replacements, specials)
17. Selenium and copper oxide rectifiers
18. Functional components
19. Silicon controlled switches
20. Unijunction transistors
21. Silicon grown-diffused passivated NPN transistor
22. Tunnel diodes and back diodes
23. Reference amplifiers
24. Silicon planar epitaxial passivated amplifiers and switches
25. Active discrete pellet functional devices
26. Signal diodes
27. Matched pairs and quads
28. Silicon mesa NPN passivated power transistors

CAPACITOR PRODUCTS

29. Film capacitors
30. Large D-c capacitors
31. Energy Storage capacitors
32. Network capacitors
33. D-c specialty capacitors
34. A-c specialty capacitors
35. Aluminum electrolytic capacitors
36. Tantalum electrolytic capacitors

VACUUM PROCUCTS

37. Vacuum system
38. Triode ion pumps
39. Trigger gages
40. Mercury diffusion pumps
41. Ion gages
42. Leak detectors
43. Partial pressure analyzers
44. Permeation leak-gas purifiers
45. Sublimation pumps
46. Vacuum accessories

OTHER PRODUCTS

47. Adjustable speed drives
48. Appliance controls
49. Ballasts (fluorescent)
50. Circuit protective devices
51. General purpose control
52. Magnets
53. Nickel cadmium rechargeable batteries
54. Sealed relays
55. Soldering Irons
56. Thermistors
57. Varistor
58. Volt Pac® specialty transformers

INSTRUMENTS

59. Panel Meters
60. Time Meters
61. Meter Relays
62. Shunts
63. Switchboard Indicators
64. Recorders (Direct Acting)
65. Transducers

RECORDING INSTRUMENTS

66. Direct - operated, strip - chart recorders (inking, inkless, hook-on)
67. Miniature (4-inch) servo-operated recorders
68. Servo-operated (12-inch) strip and round chart recorders/recorder controllers (one, two or multi-point pen)

MOTORS

69. A-C Tri-Clad '55'® induction 1-125 HP
70. A-c fractional
71. D-c integral
72. D-c fractional
73. Specialty motors
74. DCM&G sets

Electronic Components Sales Operation Offices on Page 2.

ELECTRONIC COMPONENT SALES OPERATION OFFICES

ARIZONA

Phoenix 85012
Guaranty Bank Bldg., Suite 712
3550 N. Central Ave.
Phone A/C 602 264-1751

CALIFORNIA

***Los Angeles 90064**
11840 W. Olympic Blvd.
Phone: A/C 213 479-7763
A/C 213 272-8566
A/C 213 879-1350

Portola Valley 94025
3210 Alpine Road
Phone: A/C 415 854-4010

COLORADO

Denver 80206
201 University Blvd.
P.O. Box 2331
Phone: A/C 303 388-5771

CONNECTICUT

Bridgeport 06602
1285 Boston Ave.,
Phone: A/C 203 334-1012

DISTRICT OF COLUMBIA

Washington 20005
777 - 14th St., N.W.
Phone: A/C 202 393-3600

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North Palm Beach 33403
321 North Lake Blvd., Room 201
Phone: A/C 305 844-5202

Tampa 33609
P.O. Box 10577
2104 S. Lois Ave.
Phone: A/C 813 877-8311

Winter Park 32789
John Hancock Bldg., Suite 250
370 Wymore Rd.
Phone: A/C 305 425-8634

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***Chicago 60641**
3800 N. Milwaukee Ave.
Phone: A/C 312 777-1600

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Fort Wayne 46806
6001 S. Anthony
Phone: A/C 219 447-1511

Indianapolis 46208
3750 N. Meridian St.
Phone: A/C 317 923-7221

IOWA

Cedar Rapids 52401
210 2nd St., S.E.
303 Dows Bldg.
Phone: A/C 319 364-9149

KENTUCKY

Owensboro 42301
316 E. 9th St.
Phone: A/C 502 683-2401
Ext. 482 (Receiving Tubes)
Ext. 422 (I&M Tubes)

MASSACHUSETTS

Wellesley 02181
1 Washington St.
Phone: A/C 617 237-2050

MICHIGAN

***Detroit 48237**
15160 W. Eight Mile Rd.
Phone: A/C 313 564-5228

MINNESOTA

Minneapolis 55424
4900 Viking Dr., Rm. 108
Phone: A/C 612 927-5458

MISSOURI

Kansas City 64199
911 Main St., Suite 518
P.O. Box 13566
Phone: A/C 816 221-4033

NEW JERSEY

***Clifton 07014**
200 Main Ave.
Phone: A/C 201 472-8100

NEW YORK

Albany 12205
11 Computer Drive West
(518) 869-3576

New York City
(*Great Neck 11021)
425 Northern Blvd.
Phone: A/C 516 466-8800

***North Syracuse 13212**
Northern Concourse Office Bldg.
Room 102
315-456-3412

Rochester 14624
35 Deep Rock Rd.
(716) 436-3480

NORTH CAROLINA

Greensboro 27408
1828 Banking St.
Phone: A/C 919 273-6982

OHIO

***Cleveland 44117**
25000 Euclid Ave.
Phone: A/C 216 266-2900

Dayton 45429
3430 S. Dixie Hwy.
P.O. Box 2143
Kettering Branch
Phone: A/C 513 298-0311

OKLAHOMA

Oklahoma City 73112
3022 N.W. Expressway
May-Ex Building, Room 412
Phone: A/C 405 943-9015

PENNSYLVANIA

Erie 16505
2318 W. 8th Street
Phone: A/C 814 455-8377

***Philadelphia 19102**
3 Penn Center Plaza
Phone: A/C 215 568-1800

Pittsburgh 15220
875 Greentree Rd. - Room 304
3 Parkway Center
Phone: A/C 412 921-4134

TEXAS

Dallas 75205
4447 N. Central Expressway,
Phone: A/C 214 521-1931

Houston 77006
3110 S.W. Freeway
Room 220
Phone: A/C 713 524-3061

VIRGINIA

Charlottesville 22902
2007 Earhart St.
P.O. Box 319
Phone: A/C 703 296-8118

Portsmouth 23707
3205 King St.
P.O. Box 7175
Phone: A/C 703 393-6780

WASHINGTON

Seattle 98188
225 Tukwila Pky.
Phone: A/C 206 244-7750

WISCONSIN

***Milwaukee 53202**
615 East Michigan St.
Phone: A/C 414 271-5000

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Electronic Sales
IGE Export Division
159 Madison Avenue
New York, N.Y. 10016
Phone: A/C 212 751-1311

IN CANADA, ADDRESS INQUIRIES TO:

Canadian General Electric Co.
189 Dufferin Street
Toronto, Ontario, Canada
Phone: A/C 416 537-4481

GOVERNMENT PROGRAMS OPERATION OFFICES

ALABAMA

Huntsville 35801
3322 Memorial Parkway South,
Suite 13
Phone: A/C 205 883-3131

DISTRICT OF COLUMBIA

***Washington 20005**
777 - 14th St., N.W.
Phone: A/C 202 393-3600

OHIO

Dayton 45439
3430 S. Dixie Hwy.
P.O. Box 2143
Kettering Branch 45529
Phone: A/C 513 298-0311

CALIFORNIA

Los Angeles 90064
11840 W. Olympic Blvd.
Phone: A/C 213 479-7763
A/C 213 272-8566
A/C 213 879-1350

*Region Office

—PRODUCT INFORMATION—

INDUSTRIAL EQUIPMENT TYPES MANUAL

NUMERICAL LISTING OF TYPES

This lists the types included in this manual and the family to which each belongs. For detailed technical information refer to the section indicated.

TYPE	CLASSIFICATION
FG-172	Special Purpose Rectifiers and Thyratrons
FG-280	Special Purpose Rectifiers and Thyratrons
GL-414	Special Purpose Rectifiers and Thyratrons
GL-857-B	Special Purpose Rectifiers and Thyratrons
GL-869-B	Special Purpose Rectifiers and Thyratrons
GL-870-A	Special Purpose Rectifiers and Thyratrons
2050A	Special Purpose Rectifiers and Thyratrons
GL-5550	Welding Control Ignitrons
GL-5551-A	Welding Control Ignitrons
GL-5552-A	Welding Control Ignitrons
GL-5553-B	Welding Control Ignitrons
GL-5554	Rectifier Ignitrons
GL-5555	Rectifier Ignitrons
GL-5564	Rectifier Ignitrons
GL-5630	Rectifier Ignitrons
GL-5779	Rectifier Ignitrons
GL-5788	Rectifier Ignitrons
GL-5822-A	Welding Control Ignitrons
GL-5830	Special Purpose Rectifiers and Thyratrons
6011/710, 7518/710L, 7725, 7726	Special Purpose Rectifiers and Thyratrons
GL-6228	Rectifier Ignitrons
ZM-6287	Industrial Heating Magnetron
GL-6504	Rectifier Ignitrons
GL-6509	Rectifier Ignitrons
GL-6512	Rectifier Ignitrons
GL-6513	Rectifier Ignitrons
GL-6514	Rectifier Ignitrons
GL-6515	Rectifier Ignitrons
GL-6878	Rectifier Ignitrons
GL-6958	Rectifier Ignitrons
GL-7042	Rectifier Ignitrons
GL-7151	Rectifier Ignitrons
GL-7171	Pulse Ignitrons
GL-7669	Welding Control Ignitrons
GL-7670	Welding Control Ignitrons
GL-7671	Welding Control Ignitrons
GL-7672	Welding Control Ignitrons
GL-7673	Welding Control Ignitrons
GL-7681	Welding Control Ignitrons
GL-7703	Pulse Ignitrons
GL-7736	Rectifier Ignitrons
GL-7998	Welding Control Ignitrons
GL-8205	Welding Control Ignitrons
GL-8360	Welding Control Ignitrons
GL-8420	Rectifier Ignitrons
GL-8465	Rectifier Ignitrons
GL-8466	Rectifier Ignitrons
GL-37207	Pulse Ignitrons
GL-37248	Pulse Ignitrons

—PRODUCT INFORMATION—

ELECTRONIC TUBE

MANUAL INDEX

This tabulation lists all tubes and devices in the current tube manuals and the manual in which each component may be located. Type numbers are arranged in alpha-numerical order.

There is duplication of type numbers in the four-digit series of designations. In this numbering sequence, particularly in the 6000 and higher series, the developmental type-number system employed by the Microwave Tube Business Section parallels the standardized Electron Industries Association (EIA) industry-wide numbering system for tubes other than home-entertainment and television picture types. Microwave Tube Business Section developmental numbers use the prefix "Z" followed by another letter: e.g., ZG, ZM, ZP (EIA standardized MTBS designations have the prefix "GL", a few old thyratrons use the prefix "FG").

The receiving tube component of the Tube Products Department does not employ prefix letters except in the case of reed switches, and a few types transferred from other components where prefixes were used. For this reason designations in the four-digit series without prefixes represent standardized EIA designations, whereas those with prefixes (other than "GL") as mentioned in the foregoing paragraph are MTBS developmental types.

TYPE	MANUAL*				
1AY2-A				R-2	
1BC2-A				R-2	
1BH2-A				R-2	
1BY2-A				R-1	
1DG-3				R-2	
1G3-GTA				R-2	
1K3A				R-2	
1V2				R-2	
1X2-C				R-2	
2AS2-A				R-1	
2AV2				R-2	
2B22	FS				
2BU2				R-1	
2C39-B	FS				
2C40	FS				
2C40-A	FS				
2C43	FS				
2CN3-B				R-2	
2CY5				R-2	
2D21	FS				
2DF4	FS				
2GK5				R-2	
3A3-C				R-2	
3AT2-B				R-1	
3AW2-A				R-1	
3BN2-A				R-1	
3BW2				R-1	
3BZ6				R-2	
3C23	FS				
3CB6				R-2	
3CN3-B				R-2	
3CS6				R-2	
3CU3-A				R-2	
3CX100A5	FS				
3DK6				R-2	
3DA3				R-2	
3DB3				R-2	
3DC3				R-2	
3DF3				R-2	
3DH3				R-2	
3DJ3				R-2	
3DT6				R-2	
3GK5				R-2	
3HA5				R-2	
3HM5				R-2	
3HS8				R-2	
3JC6A				R-2	
4AU6				R-2	
4BZ6				R-2	
4CB6				R-2	
4CS6				R-2	
4DE6				R-2	
4DK6				R-2	
4DT6				R-2	
4GK5				R-2	
4HS8				R-2	
4JC6A				R-2	
4JD6				R-2	
4JH6				R-2	
4LU6				R-2	
5AQ5				R-2	
5AR4				R-2	
5CG8				R-2	
5EW6				R-2	
5GH8				R-2	
5KZ8				R-2	
5R4-GYA	FS				
5U4-GB				R-2	
5Y3-GT				R-2	
6AB4				R-2	
6AC10				R-1	
6AD10				R-1	
6AF11				R-1	
6AG9				R-1	
6AH9				R-1	
6AK6	FS				
6AK9				R-1	
6AK10				R-1	
6AL5				R-2	
6AM4				R-2	
6AQ5-A				R-2	
6AR11				R-1	
6AS7-GS	FS				
6AU6-A				R-2	
6AU8-A				R-2	
6AV6				R-2	
6AV11				R-1	
6AW8-A				R-2	
6AX3				R-1	
6AY3-B				R-2	
6B10				R-1	
6BA6				R-2	
6BA10				R-1	
6BD11				R-1	
6BE3				R-2	
6BE6				R-2	
6BF11				R-1	
6BH6				R-2	
6BH11				R-1	
6BK7-B				R-2	
6BN6				R-2	
6BN11				R-1	
6BQ5				R-2	
6BQ7-A				R-2	
6BV10				R-1	
6BW3				R-1	
6BW11				R-1	
6BZ3				R-1	
6BZ6				R-2	
6C4				R-2	
6CA11				R-1	
6CB6-A				R-2	
6CG3				R-1	
6CG8-A				R-2	
6CJ3				R-2	
6CL8-A				R-2	
6CS6				R-2	
6CU5				R-2	
6CY5				R-2	
6DJ8	FS				

*FS = Special Products and Microwave Devices for Industry Manual.
I = Industrial Equipment Types Manual.
RS = Reed Switches and Photoconductive Cells Manual.
M = Military Equipment Types Manual.
R-1 = Receiving Types Manual, Vol 1, Compactrons.
R-2 = Receiving Types Manual, Vol. 2, Conventional Types.

If a customer holds the single-volume combined Industrial and Military Equipment Types Manual, designations listed above in the I and M columns will be in that book following tab divider "Industrial," "Military."

TYPE	MANUAL*	TYPE		MANUAL*	TYPE	MANUAL*
6DK6	R-2	6SN7-GTA		R-2	12GE5	R-1
6DT6	R-2	6SN7-GTB		R-2	12GN7-A	R-2
6DT8	R-2	6T8-A		R-2	12HG7	R-2
6EA8	R-2	6T10		R-1	12HL7	R-2
6EF4	R-1	6U10		R-1	12JN6	R-1
6EH4-A	R-1	6V6-GTA		R-2	12JN8	R-2
6EJ4A	R-1	6X4		R-2	12SL7-GT	R-2
6EL4-A	R-2	6Z10		R-1	12SN7-GTA	R-2
6EW6	R-2	7KY6		R-2	13JZ8	R-1
6EZ8	R-2	8AC10		R-1	13V10	R-1
6FM7	R-1	8AL9		R-1	13Z10	R-1
6FQ7	R-2	8AR11		R-1	14BL11	R-1
6FY7	R-1	8AW8-A		R-2	14BR11	R-1
6GE5	R-1	8B10		R-1	15AF11	R-1
6GK5	R-2	8BA11		R-1	15BD11	R-1
6GK6	R-2	8BM11		R-1	15FM7	R-1
6GM6	R-2	8BN11		R-1	15FY7	R-1
6GN8	R-2	8BQ11		R-1	15MF8	R-1
6GU7	R-2	8BU11		R-1	16AK9	R-1
6GV5	R-1	8CB11		R-1	16BQ11	R-1
6GX6	R-2	8FQ7		R-2	16BX11	R-1
6GY5	R-1	8GN8		R-2	16GY5	R-1
6GY6	R-2	8JU8-A		R-2	16LU8-A	R-1
6GY8	R-2	8JV8		R-2	17AB10	R-1
6HA5	R-2	8LT8		R-2	17AX3	R-1
6HB5	R-1	9AH9		R-1	17AY3-A	R-2
6HB6	R-2	9AK10		R-1	17BE3	R-1
6HE5	R-1	9MN8		R-1	17BF11	R-1
6HM5	R-2	10GK6		R-2	17BF11-A	R-1
6HS8	R-2	10GN8		R-2	17BW3	R-1
6HZ6	R-2	10JY8		R-2	17BZ3	R-1
6HV5-A	R-1	10KR8		R-2	17CU5	R-2
6J6-A	R-2	10LW8		R-2	17GE5	R-1
6JB5	R-1	10LZ81		R-2	17GV5	R-1
6JH6	R-2	10T10		R-1	17JM6	R-1
6JC6-A	R-2	10Z10		R-1	17JN6	R-1
6JD5	R-1	11AR11		R-1	17JZ8	R-1
6JD6	R-2	11BQ11		R-1	18AJ10	R-1
6JM6	R-1	11BT11		R-1	19CG3	R-1
6JN6	R-1	11CA11		R-1	19DE3	R-1
6JN8	R-2	11CF11		R-1	19JN8	R-2
6JU8-A	R-2	11FY7		R-1	19T8	R-2
6JV8	R-2	11LT8		R-2	21GY5	R-1
6JZ6	R-1	12AE10		R-1	21HB5-A	R-1
6JZ8	R-1	12AL5		R-2	21JZ6	R-1
6KD6	R-1	12AT7		R-2	21LU8	R-1
6KR8-A	R-2	12AU6		R-2	22BW3	R-1
6KS6	R-2	12AU7		R-2	23Z9	R-1
6KT8	R-2	12AU7-A		R-2	24BF11	R-1
6L6-GC	R-2	12AV6		R-2	24JZ8	R-1
6LB6	R-1	12AV7		R-2	25C5	R-2
6LE8	R-2	12AX3		R-1	25CG3	R-1
6LG6	R-1	12AX7		R-2	25EH5	R-2
6LJ6-A	R-2	12AX7-A		R-2	25JZ8	R-1
6LJ8	R-2	12AY7	FS	R-2	26LX6	R-1
6LT8	R-2	12BA6		R-2	31AL10	R-1
6LU8	R-1	12BE3		R-1	30JZ6	R-1
6LY8	R-2	12BE6		R-2	32HO7	R-1
6M11	R-1	12BF11		R-1	33GY7A	R-1
6MD8	R-2	12BV11		R-1	34CE3	R-1
6MJ8	R-1	12BY7-A		R-2	35C5	R-2
6MK8A	R-2	12C5		R-2	35W4	R-2
6MN8	R-1	12CU5		R-2	36KD6	R-1
6MV8	R-2	12DQ7		R-2	38HE7	R-1
6SL7-GT	R-2	12FQ7		R-2	38HK7	R-1

TYPE	MANUAL*				
50C5				R-2	
50DC4				R-2	
50EH5				R-2	
53HK7				R-1	
FG-81-A	FS				
FG-97	FS				
FG-98-A	FS				
DR100	FS				RS
DR101	FS				RS
DR103	FS				RS
DR104	FS				RS
FG-105	FS				
DR113	FS				RS
DRV120	FS				RS
DR121	FS				RS
DR123	FS				RS
DR125	FS				RS
DR-138	FS				RS
DR-145	FS				RS
DR-157	FS				
DR-158	FS				
DR-159	FS				
FG-172		I			
FG-280		I			
393-A	FS				
GL-414		I			
502-A	FS				
807	FS				
GL-857-B		I			
GL-869-B		I			
GL-870-A		I			
ZP-1015			M		
ZP-1026			M		
ZP-1034			M		
Y-1938	FS				
ZP-1039			M		
ZP-1065			M		
ZP-1079			M		
C-2002A	FS				
C-2003C	FS				
C-2006C	FS				
C-2007	FS				
C-2013	FS				
C-2014	FS				
C-2015	FS				
C-2020A	FS				
C-2035C	FS				
2050-A	FS				
C-2062	FS				
5544	FS				
GL-5550		I			
GL-5551-A		I			
GL-5552-A		I			
GL-5553-B		I			
GL-5554		I			
GL-5555		I			
5557	FS				
5558	FS				
5559	FS				
5560	FS				
5561	FS				
GL-5564		I			
GL-5630		I	M		
5654	FS				
5663	FS				

TYPE	MANUAL*				
5670	FS				
5686	FS				
5687	FS				
5696-A	FS				
5720	FS				
5725	FS				
5726	FS				
5727	FS				
5749	FS				
5750	FS				
5751	FS				
GL-5779		I			
GL-5788		I			
5814-A	FS				
GL-5822-A		I			
5824	FS				
GL-5830		I			
5844	FS				
5855	FS				
5963	FS				
5965	FS				
5965-A	FS				
5998-A	FS				
6005	FS				
6011/710	FS				
6046	FS				
ZM-6046			M		
ZM-6047			M		
ZM-6051			M		
6072-A	FS				
6080	FS				
ZM-6085			M		
ZM-6086			M		
6087	FS				
ZM-6087			M		
6135	FS				
6136	FS				
6146	FS				
6146-A	FS				
6189	FS				
6197	FS				
6201	FS				
6202	FS				
6203	FS				
ZM-6203			M		
ZM-6205			M		
6211-A	FS				
ZM-6211-A			M		
ZM-6215			M		
6216	FS				
ZM-6220			M		
ZM-6222			M		
ZM-6231			M		
GL-6228		I	M		
ZM-6238			M		
ZM-6239			M		
ZM-6240			M		
ZM-6242			M		
ZM-6243			M		
ZM-6246			M		
GL-6251			M		
ZM-6257			M		
6265	FS				
ZM-6276			M		
ZM-6277			M		

TYPE	MANUAL*				
GL-6283			M		
ZM-6287		I			
6299	FS				
6350	FS				
6386	FS				
6414	FS				
ZM-6287		I			
6442	FS				
6463	FS				
6485	FS				
GL-6504		I			
GL-6509		I			
GL-6512		I			
GL-6513		I			
GL-6514		I			
GL-6515		I			
6660	FS				
6661	FS				
6662	FS				
6663	FS				
6664	FS				
6669	FS				
6676	FS				
6677	FS				
6678	FS				
6679	FS				
6680	FS				
6681	FS				
6688	FS				
6771	FS				
ZM-6802			M		
6807	FS				
6808	FS				
6809	FS				
6829	FS				
GL-6848			M		
GL-6878		I			
6897	FS				
6919	FS				
GL-6942			M		
GL-6958		I			
ZT-7004			M		
7025	FS			R-2	
7036	FS				
GL-7042		I			
7044	FS				
7077	FS				
GL-7151		I			
7167	FS				
GL-7171		I	M		
7189-A	FS			R-2	
7233	FS				
7239	FS				
7247	FS			R-2	
7266	FS				
7289	FS				
7296	FS				
7355	FS			R-2	
7370	FS				
GL-7390			M		
GL-7390-A			M		
7391	FS				
GL-7399			M		
7408	FS			R-2	
7462	FS				

TYPE	MANUAL*				
7486	FS				
ZR-7512			M		
ZR-7513			M		
ZR-7516			M		
ZR-7517			M		
7518/710L	FS				
7581-A	FS			R-2	
7588	FS				
GL-7669		I			
GL-7670		I			
GL-7671		I			
GL-7672		I			
GL-7673		I			
GL-7681		I			
7701	FS				
GL-7703		I	M		
7716	FS				
7717	FS				
7720	FS				
7724	FS				
7725	FS				
7726	FS				
7734	FS				
GL-7736		I			
7768	FS				
7784	FS				
7815	FS				
7815R	FS				
7841	FS				
7861	FS				
GL-7890			M		
7910	FS				
7911	FS				
7913	FS				
GL-7964			M		
GL-7964-1			M		
7984	FS			R-1	
GL-7985			M		
GL-7998		I			
8068	FS				
8102	FS				
8106	FS				
8113	FS				
8136	FS				
8156	FS				
GL-8205		I			
GL-8326			M		
GL-8360		I			
GL-8420		I			
GL-8465		I			
GL-8466		I			
GL-8500			M		
GL-8513			M		
GL-8559			M		
GL-8866			M		
GL-37207		I	M		
GL-37248		I	M		
GL-51025			M		
GL-51038			M		
GL-51038R			M		
GL-51064			M		
GL-51065			M		
GL-51070			M		
GL-51074			M		

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—

MILITARY EQUIPMENT TYPES MANUAL

MET-10A

IGNITRONS

Selection Chart

CAPACITOR-DISCHARGE AND DC-SHORT-CIRCUITING-SWITCH SERVICE

Capacitor Discharge			DC Short-Circuiting Switch			
Maximum Peak Current in Amperes	Peak Inverse and Forward Anode Volts	Type	Current-Amperes RMS	Current-Amperes Peak	Peak Inverse Volts	Type
35,000	10,000	GL-7171	–	10,000	50,000	ZG-7248
60,000 *	50,000	ZG-7219	15	35,000	10,000	GL-7171
100,000	20,000	GL-7703	15	35,000	20,000	GL-7703
300,000	25,000	ZG-7207	175	20,000	30,000	GL-5630
			500	30,000	45,000	GL-6228
			–	300,000	25,000	ZG-7207

* 1/2 cycle of 5 microseconds.

SAFETY PRECAUTIONS

WARNING: WITHOUT PROPER AND ADEQUATE PRECAUTIONS, THE OPERATION, HANDLING, OR SHIPMENT OF MICROWAVE AND HIGH-VOLTAGE ELECTRONIC TUBES CAN BE HAZARDOUS TO PERSONNEL AND PROPERTY. READ THE FOLLOWING INFORMATION. TAKE ALL REQUIRED PRECAUTIONS.

GENERAL

This information is provided to alert the purchaser of high-voltage tubes and microwave tubes to the potential hazards which may be created by improper operation, handling or shipment of these devices. All persons responsible for the operation, handling and shipping of these tubes should familiarize themselves with the potential hazards, and suitable safety precautions should be established and followed for the protection of personnel and equipment.

Do not operate high-voltage and microwave tubes except in accordance with adequate understanding of the potential hazards and with proper equipment-operating instructions and safety precautions.

Questions regarding proper and safe use of such tubes should be addressed to:

General Electric Company
Microwave Tube Operation
Building 269 – Application Engineering
1 River Road
Schenectady, New York 12305

Several of the potential hazards are defined and regulated by state or federal governmental agencies and bureaus. Since the documentation and specifications of such agencies and bureaus are frequently revised, it is not feasible to make full or precise reference to their content in this publication. If current governmental information is desired or if there are questions, the appropriate agency should be consulted.

HIGH VOLTAGE

The voltages used to operate microwave and high-voltage electronic tubes can cause death or serious injury due to electric shock and burns. Depending on the device and equipment designs, and considering the possibility of malfunctions in either, part or all of the exterior tube surfaces may be at, or may quickly reach, dangerous voltages. Equipment design and laboratory testing must take this into account by following design and operating precautions so that contact with, and proximity to, high-voltage circuits is not possible under operating conditions. High-voltage circuits should be enclosed in protective housings, and interlock circuits should be provided so that primary power is removed, and high-voltage terminals and capacitors are quickly grounded, whenever the enclosure is open. It is always dangerous and unsafe practice to defeat or avoid the proper safety devices and safety procedures (as bypassing an interlock circuit) while operating or testing the equipment.

GROUNDS

Many microwave tubes are operated in a grounded electrode mode in which the envelope and output cables are operated at ground potential. Care must be taken to be certain that the tube envelope is properly grounded before the operating voltages are applied. The grounding should never be done through the output cables since a break in the cable will then result in the tube envelope being raised to high voltage.

X-RADIATION

X-radiation is produced by the impact of high energy electrons on electron tube surfaces. Such high-energy electrons are produced when accelerated by the applied electrode voltages. Depending on the construction of the electron tube and the materials involved, X-radiation may be produced at voltages as low as 5 kilovolts. The production of highly penetrating X-radiation and energy increases to relatively more dangerous proportions as the electrode voltages and currents are increased. All electron tubes operating in high-voltage ranges constitute potential hazards, and applications of such tubes should be carefully reviewed before operation.

When X-radiation shielding is required, it should be provided with proper interlocks to prevent accidental exposure of personnel to X-radiation. Where hazards are high, periodic X-radiation level surveys should be made. Furhter, when continuous operation is in effect, personnel-monitoring devices should be worn by the personnel and controlled access to the area implemented.

Most high-voltage and microwave electronic devices are not designed, nor intended, to be fully self-shielded to X-radiation under all possible conditions of their application and use. External radiation shielding will usually be necessary. This shielding should be designed by the equipment manufacturer as a part of the user's equipment to protect the user against possible personal injury. It is the responsibility of the manufacturer of the equipment using such tubes to provide any and all enclosures required, and to provide the instructions and maintenance procedures for the proper use of the equipment.

Generally, the spatial distribution of X–radiation from power tubes is complex and changes from tube to tube. The same tube does not radiate the same 360^{o} around. Also, the surrounding metallic construction will tend to prevent, distort, or further filter the passage of X–radiation to regions external to the tube. Of major concern are the areas in which materials used in tube construction present the least attenuation of X–radiation.

The search for possible X–radiation is not to be confined to those directions in which emission may be expected; unintended emissions in high power tubes have sometimes caused X–radiation in unexpected directions. A thorough search in all directions around the tube is necessary to ensure that the regions of emissions is correctly determined.

Tubes presenting X–radiation hazards or other possible hazards will have radiation precaution labels or tags affixed to the device at the time of shipment. These should not be removed at any time. If these labels or tags are removed by the user, they should be prominently displayed in close visual proximity to the device.

MICROWAVE RADIATION

The radio-frequency output power of many electron tubes may exceed those power densities considered safe for human exposure. The design, operating instructions, and maintenance procedures of equipment utilizing such tubes must ensure that the radio-frequency energy is properly restricted to and contained in the circuits, transmission lines, waveguides, or cavity resonators and that these are frequently monitored to ensure that the radiation of radio-frequency energy from joints or connectors is below the hazardous limit. Antenna systems should also be frequently monitored for stray or indirect radiation. Operating and service personnel should be advised of exposure hazards and arrangements made to prevent accidental exposure.

MERCURY

Some devices contain mercury as a necessary constituent to their operation. Under certain circumstances, the presence of free mercury may generate air contamination or other pollution that is considered toxic. Disposal of tubes or handling of damaged tubes must be done with adequate precaution given to this possible hazard. If disposal presents questions, these questions should be directed in writing to the General Electric Company, Microwave Tube Operation, at the address shown on the front side of this sheet.

Air shipment regulations allow air transportation of devices containing mercury only under special packing and marking requirements. The current requirements should be obtained directly from the airline.

The packing containers of devices containing mercury will be marked accordingly when they are shipped from the tube manufacturer.

IMPLOSION

Most electronic tubes and devices operate with their internal volumes under high vacuum, and many gas-filled tubes also have their internal volumes considerably below atmospheric pressure. In the event that the envelope of some of these tubes is punctured or broken, the inrush of air can be violent under certain conditions. Tubes with large glass envelopes should be handled and stored with particular care, and implosion-proof shields should be installed in operating equipments. Particular care should also be given to shielding of the eyes and face.

MAGNETIC FORCES

The attractive force between magnetic and feromagnetic objects increases rapidly as separation between the objects is decreased and the objects will be accelerated toward one another, meeting with considerable impact. When handling or working near large permanent magnets, care must be taken to prevent injury which could result from this hazard.

Air shipment regulations allow air transportation of devices containing magnetized materials only under special packing and marking requirements. The current requirements should be obtained directly from the airline.

TUBE PRODUCTS DEPARTMENT
GENERAL ELECTRIC
Schenectady, New York 12305

ELECTRONIC INNOVATIONS IN ACTION

TUBES

—PRODUCT INFORMATION—
INDUSTRIAL EQUIPMENT TYPES MANUAL

ET-T1507D

IGNITRONS
Selection Chart

RESISTANCE-WELDING-CONTROL
Standard Welding-control Service

Size	Type	Maximum Dimensions in Inches: Length	Maximum Dimensions in Inches: Diameter	Description	Minimum Ignitor Firing Requirements: Pk. Volts	Pk. Amp	Starting Time (μs)	Water Flow Normal Gal/min	Water Temp °C: Inlet Min	Outlet Max	Supply Volts RMS	Maximum Demand KVA	Corresponding Average Anode Current Amp	Maximum Average Anode Current Amp	Corresponding Demand KVA	Maximum Fault Current (Peak Amp): @250 V	@600 V	Maximum Averaging Time (Sec): @250 V	@600 V
A	GL-5550	9 1/16	2 9/64	Two tubes in inverse-parallel control 300 kva at 250–600 volts; ratings per tube.				(1)	10	75	250–600	150	4.86	9.0	50	1680	700	27.8	11.6
					200	30	100	(1A)	10	50	250–600	300	12.1	22.4	100	3360	1400	22	9.2
B	GL-5551-A	13	2 3/4	Two tubes in inverse-parallel control 600 kva at 250–600 volts; ratings per tube.	200	30	100	1.0	0	40	250–600	600	30.2	56.0	200	6720	2800	18	7.5
B	GL-7669	13	3 1/4	Coaxial version of GL-5551-A.															
C	GL-5552-A	14	4 1/4	Two tubes in inverse-parallel control 1200 kva at 250–600 volts; ratings per tube.	200	30	100	1.5	0	40	250–600	1200	75.6	140	400	13,450	5600	14	5.8
C	GL-7671	14 1/4	4 5/8	Coaxial version of GL-5552-A.															
J-C(2)	GL-7681	17 1/2	4 1/4	Two tubes in inverse-parallel control 1800 kva at 250–600 volts; ratings per tube.	200	30	100	2.0	6	45	250–600	1800	113 5	210	600	20,040	8400	9.5	7.1
J-C(2)	GL-7998	16	4	Coaxial version of GL-7681.															
D	GL-5553-B	19 1/2	5 5/8	Two tubes in inverse-parallel control 2400 kva at 250–600 volts; ratings per tube.	200	30	100	3.0	0	40	250–600	2400	192	355	800	27,000	11,200	11.0	4.6
D	GL-7673	12 13/16	5 5/8	Coaxial version of GL-5553-B.															
E	GL-7151	19 3/4	9 1/8	Two tubes in inverse-parallel control 4800 kva at 250–600 volts; ratings per tube.	200	30	100	10	0	40	250–600	4800(3)	486	900	1600	54,000	22,400	8.9	3.8
E	GL-8205	20 1/2	9 1/2	Coaxial version of GL-7151.															
—	GL-5554	17	4 1/8	Two tubes in inverse-parallel control 1200 kva at 2400 volts; ratings per tube.	450	45	100	1.5	6	30	2400	1200	75	113	600	3000@2400V		1.50@2400V	
—	GL-5555	17 15/16	5 1/2	Two tubes in inverse-parallel control 2400 kva at 2400 volts; ratings per tube.	150	40	100	3	6	30	2400	2400	135	207	1105	6000@2400V		1.66@2400V	
—	GL-5564	27 11/16	9 1/8	Two tubes in inverse-parallel control 3600 kva at 600 volts and 4800 kva at 2400 volts; ratings per tube.	450	45	100	6	0	45	600	3600	530	850	1600	34,000@600V		3.4@600V	
											2400	4800	270	414	2210	12,000@2400V		1.66@2400V	
—	GL-6512	Integral thermostat control arrangement version of GL-5554. Same ratings apply.																	
—	GL-6513	Integral thermostat control arrangement version of GL-5555. Same ratings apply.																	
—	GL-6515	Integral thermostat control arrangement version of GL-5564. Same ratings apply.																	

(1)—Air-cooled ratings.
(1A)—Water-cooled ratings.
(2)—J-C indicates Jumbo C type.
(3)—Maximum demand current below 500 volts should not exceed 9600 amperes RMS.

Frequency range for all ratings is 25–60 cycles per second.
Sizes B through E equipped with mounting pad for demountable thermostat (see Ignitron Accessories Section).
Sizes B through D available with plastic coating.

Supersedes ET-T1507C dated 11-65

IGNITRONS—SELECTION CHART

Frequency-Changer Welding-Control Service

Size	Type	Maximum Dimensions in Inches		Description	Minimum Ignitor Firing Requirements			Water Flow Normal Gal per Min	Water Temp (°C)		Peak Inverse Voltage Volts	Max Peak Anode Current Amp	Corre-sponding Average Anode Current Amp	Max Average Anode Current Amp	Corre-sponding Peak Anode Current Amp	Max Fault(1) Peak Current Amp
		Length	Diameter		Pk. Volts	Pk. Amp	Starting Time (μs)		Inlet Min	Outlet Max						
B	GL-5551-A	13	2¾		200	30	100	1.0	0	40	1200	600	5	22.5	135	7500
B	GL-7669	13	3¼	Coaxial version of GL-5551-A.							1500	480	4	18	108	6000
C	GL-5822-A	14	4¼		200	30	100	1.5	10	35	1200	1500	20	70	420	18,750
C	GL-7672	14¼	4⅝	Coaxial version of GL-5822-A.							1500	1200	16	56	336	15,000
J-C(2)	GL-7681	17½	4¼		200	30	100	2.0	6	45	1200	2250	30	105	630	28,000
J-C(2)	GL-7998	16	4	Coaxial version of GL-7681.							1500	1800	24	84	502	22,500
D	GL-5553-B	19½	5⅝		200	30	100	3.0	0	40	1200	3000	40	140	840	37,500
D	GL-7673	12 13/16	5⅝	Coaxial version of GL-5553-B.							1500	2400	32	112	672	30,000

(1)—Maximum duration of fault current for all tubes is 0.15 second.

Frequency range for all ratings is 25–60 cycles per second. All above types available with plastic coating.

Pulse-Welding-Control Service

Size	Type	Maximum Dimensions in Inches		Description	Minimum Ignitor Firing Requirements			Water Flow Gal/min	Water Temp °C		Peak Inverse Voltage Volts	Initial Peak Inverse Volts	Peak Anode Current Amp	Average Anode Current Amp	Averag-ing Time Sec.	Anode Current Repeti-tion Rate (pps)	Anode Current Pulse Width (μs)
		Length	Diam-eter		Pk. Volts	Pk. Amp	Starting Time (μs)		Inlet Min	Outlet Max							
B	GL-7670	13	2¾	Coaxial type. Two tubes in inverse-parallel control 2000 peak amperes at 2500 volts peak.	200	30	100	1.0	10	35	2500	1250	2000	10	2	60	1000
B	GL-8360	13	2¾	Same as GL-7670 except larger coaxial mounting plate.													

Capacitor-Discharge and DC-Short-Circuiting-Switch Service

Capacitor Discharge					DC Short-Circuiting Switch			
Maximum Peak Current in Amperes	Inductance in Nanohenrys Approx	Peak Inverse and Forward Anode Volts	Repetition Rate per Minute Max	Type	Current-Amperes RMS	Current-Amperes Peak	Peak Inverse Volts	Type
35,000	30	10,000	1	GL-7171	—	10,000	50,000	ZG-7248
60,000*	—	50,000	2	ZG-7219	15	35,000	10,000	GL-7171
100,000	30	20,000	2	GL-7703	15	35,000	20,000	GL-7703
300,000	90	25,000	500	ZG-7207	175	20,000	30,000	GL-5630
300,000	15	15,000	500	ZG-7247	500	30,000	45,000	GL-6228
				ZG-7247Aψ	—	300,000	25,000	ZG-7207

*½ cycle of 5 microseconds
ψZG-7247 requires a clamp for cathode connection and cooling. The A version includes a water jacket and coaxial cathode connection.

IGNITRONS—SELECTION CHART

POWER-RECTIFIER SERVICE

Average Current Amperes	Type	Maximum Dimensions in Inches		Description	Minimum Ignitor Firing Requirements			Water Flow Gal/min	Water Temp °C		Peak Anode Voltage in Volts		Anode Current in Amperes				
		Length	Diameter		Pk. Volts	Peak Amp	Firing Time (μs)		Inlet Min	Outlet Max	Forward	Inverse	Peak	Average	2-hour(1)	1-minute(2)	Fault(3)
10	GL-5779	8¼	2½	Small glass air-cooled type for demonstrating the operating principles of ignitors and ignitrons.	150	40	100	. . .	. . .	. . .	350	350	30	10	. . . .	. . .	300
50	GL-5630	22³⁄₁₆	5¾	For high voltage power-rectifier and inverter service. Also used as capacitor discharge or DC short-circuiting switch.	450	45	100	3	35	45	20,000	20,000	200	50	50	50	2000
100	GL-5554	17	4⅛	For continuous-duty power rectifier service at 100 amperes at 900 volts peak forward and inverse. Has holding anode and two ignitors.	450	45	100	1.5	6	60	900	900	900	100	150	200	6000
100	GL-6512			Same as GL-5554. Contains integral thermostat control arrangement.						45	2100	2100	600	75	112.5	150	4500
150	GL-6228	42	9	For high voltage power-rectifier and inverter service. Also used in capacitor discharge and DC short-circuiting switch service.	450	45	. . .	5	35	45	20,000	20,000	900	150	200	300	6000
150	GL-5788	19¼	5¾	Similar to GL-5555. Features reliable operation at higher water temperatures and phase-retard operation; has larger diameter ignitor terminals.	450	45	150	3	6	60	900	900	1800	150	225	300	12,000
150	GL-6514			Same as GL-5788. Contains integral thermostat control arrangement.						55	2100	2100	1200	150	225	300	9000
200	GL-5555	17¹⁵⁄₁₆	5¾	For continuous-duty power rectifier service at 200 amperes at 900 volts peak forward and inverse. Has holding anode and two ignitors.	450	45	100	3	6	60	900	900	1800	200	300	400	12,000
200	GL-6513			Same as GL-5555. Contains integral thermostat control arrangement.						45	2100	2100	1200	150	225	300	9000
200	GL-6509	17¹⁵⁄₁₆	5¾	Similar to GL-5555. For auxiliary power in rectifier locomotives. Has three ignitors.	450	45	100	3	30	60	900	900	1800	200	300	400	12,000
										45	2100	2100	1200	150	225	300	9000
200	GL-8465	17¹⁵⁄₁₆	5¾	For continuous-duty power rectifier service at 200 amperes at 900 volts peak forward and inverse. Has holding anode and two ignitors.	450	45	100	3	6	40	2100	2100	1200	150	225	300	9000
200	GL-8466			Same as GL-8465. Contains integral thermostat control arrangement.													

(1)—Two-hour rating averaged over any two-minute interval.
(2)—One-minute rating averaged over any one-minute interval.
(3)—Maximum duration of fault current for all tubes is 0.15 second.

Frequency range for all ratings is 25–60 cycles per second.

(OVER)

POWER-RECTIFIER SERVICE (Cont'd)

Average Current Amperes	Type	Maximum Dimensions in Inches		Description	Minimum Ignitor Firing Requirements			Water Flow Gal/min	Water Temp °C		Peak Anode Voltage in Volts		Anode Current in Amperes				
		Length	Diam-eter		Pk. Volts	Peak Amp	Firing Time (μs)		Inlet Min	Outlet Max	Forward	Inverse	Peak	Average	2-hour(1)	1-minute(2)	Fault(3)
200	GL-8420	20 7/8	10 11/16	Forced-air-cooled type for locomotive electronic contactor service. Features coaxial cathode connection to reduce magnetic field effects; integral thermostat control.	450	45	...	Air Flow—750 CFM			1000	1000	....	200	130	325	.....
275	GL-6958	27 3/8	9	Double-grid type for industrial power rectifier and inverter service. Especially suited for phase retard operation. Features coaxial cathode connection to reduce magnetic field effects.	450	45	150	10	30	55	4000	4000	2000	275	350	570	30,000
275	GL-7042			Same as GL-6958. Contains integral thermostat control arrangement.													
350	GL-6504	27 1/4	12	Double-grid type with three ignitors for locomotive rectifier service. Twelve tubes will supply DC power for 4000 HP locomotive.	450	45	150	10	30	55	100	4000	2000	350	440	...	30,000
400	GL-5564	27 11/16	9 1/8	For continuous-duty power rectifier service at 400 amperes at 900 volts peak forward and inverse. Has holding anode and two ignitors.	450	45	100	6	0	60	900	900	3600	400	600	800	25,000
400	GL-6515			Same as GL-5564. Contains integral thermostat control arrangement.						50	2100	2100	2400	300	450	600	19,000
400	GL-7736	25 15/16	9 1/8	Similar to GL-5564. Features reliable operation at high voltage and with phase-retard operation.	450	45	100	6	35	60	900	2100	3600	400	600	800	15,000
										50	900	2100	2400	300	450	600	15,000
675	GL-6878	30 1/2	13 1/8	Double-grid type for locomotive rectifier service. Features coaxial cathode connection to reduce magnetic field effects.	450	45	...	10	30	55	100	4000	2500	675	...	...	40,000

(1)—Two-hour rating averaged over any two-minute interval.
(2)—One-minute rating averaged over any one-minute interval.
(3)—Maximum duration of fault current for all tubes is 0.15 second.

Frequency range for all ratings is 25–60 cycles per second.

GENERAL ELECTRIC

TUBE DEPARTMENT

Schenectady 5, N. Y.

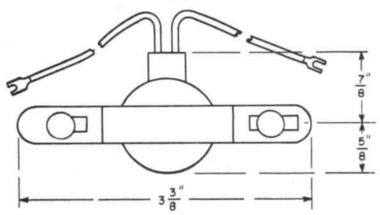
IGNITRON ACCESSORIES

THERMOSTATIC SWITCHES

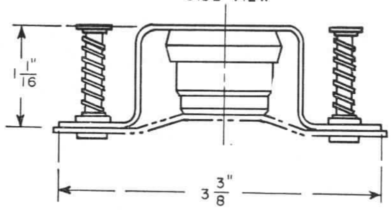
Welding-control ignitrons are provided with brackets for demountable thermostats to control the tube temperature and the cooling-water flow. The data sheets for these types carry a reference to the General Electric catalog numbers of these control thermostats, which are illustrated below. They are available in either flying-lead or terminal-block versions.

Kit includes thermostat and spring-loaded fastener in a captive assembly for connection to mounting pad located on ignitron water jacket. Single-pole contacts perform control functions as shown.

TOP VIEW



SIDE VIEW



FLYING LEAD TYPE

(36-inch leads with spade terminals)

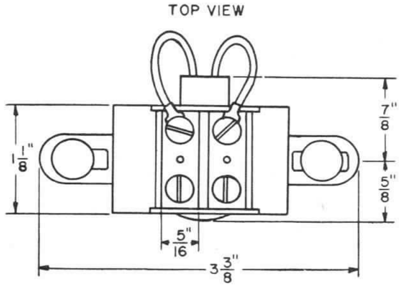
G-E Cat. No. N15272AA
Water-Control—Contacts normally open
Temperature

Open	86 F
Closed	96 F

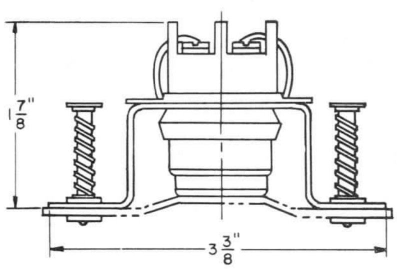
G-E Cat. No. N15273AA
Over-Temperature Control—Contacts normally closed
Temperature

Open	125 F
Closed	105 F

TOP VIEW



SIDE VIEW



TERMINAL-BLOCK TYPE

G-E Cat. No. N15286AA
Water-Control—Contacts normally open
Temperature

Open	86 F
Closed	96 F

G-E Cat. No. N15287AA
Over-Temperature Control—Contacts normally closed
Temperature

Open	125 F
Closed	105 F

Contact Ratings

Voltage	125	250	440	600	Volts AC
Current	3	1.5	0.75	0.50	Amperes AC

The voltage between the switch contacts and the tube envelope should not exceed 600 volts a-c.

ORDERING INSTRUCTIONS—Order by catalog number from regular tube supply source.

SOLENOID VALVES

The following solenoid valves are recommended for supplying the cooling water required by welding ignitrons.

½-inch Pipe Size—Cat. No. 8210A2
Automatic Switch Company
391 Lakeside Avenue
Orange, New Jersey
Specify coil voltage when ordering this valve.

½-inch Pipe Size—Type A or B. Alike except Type B has manual controls.
J. D. Gould Company
730 East Washington Street
Indianapolis 2, Indiana
Specify coil voltage when ordering this valve.

⅜-inch Pipe Size—Type K-25EW
General Controls Company
31 Thomson Avenue
Long Island City 1, New York
Specify coil voltage when ordering this valve.

⅜-inch Pipe Size—Hays Electroflow
Cat. No. 2100-1011; 115 v, 60 CPS
Cat. No. 2100-1111; 230 v, 60 CPS
Cat. No. 2100-1211; 440 v, 60 CPS
Hays Manufacturing Company
Erie, Pennsylvania

⅜-inch Pipe Size—Type M2-200
Skinner Electric Valve Division
Skinner Chuck Company
New Britain, Connecticut
Specify coil voltage when ordering this valve.

To insure reliable valve operation a 40 by 36 mesh screen strainer should be installed ahead of the valve in the water-supply line.

ORDERING INSTRUCTIONS—Order by catalog or type number from the manufacturers listed.

IGNITOR-TERMINAL CONNECTING LEADS

Insulated leads for connecting to 0.250-inch diameter ignitor terminals:

Cat. No. N22006LC— 7¾ inches long
Cat. No. N22007LC—13½ inches long

ORDERING INSTRUCTIONS—Order by catalog number from regular tube supply source.

COOLING CLAMPS

A removable clamp, listed below, is required to accomplish cathode connection and liquid cooling of the GL-5550, GL-7171 and GL-7703 ignitrons. The water circulates through this clamp, which surrounds the tube.

Cat. No. L6922259-G5, right-hand position.

ORDERING INSTRUCTIONS—Order by catalog number from District Industrial Sales Operation office.

QUICK-CHANGE WATER CONNECTORS

Quick-change, brass, water-hose connectors are available for joining water lines to welding-control ignitrons. Two sets are required for each tube, one set for connecting to the inlet water terminal and one set for connecting to the outlet terminal. Each set consists of a socket and a plug. These connectors and the tubes with which they are used are listed below.

Ignitron Type	Connector Cat. No.
GL-5551-A GL-5552-A GL-5822-A GL-7669 GL-7670 GL-7671 GL-7672 GL-7681 GL-7998 GL-8360	B1H11—Socket B1K11—Plug
GL-5553-B GL-5554 GL-5555 GL-6512 GL-6513 GL-7673	B2H16—Socket B2K16—Plug

ORDERING INSTRUCTIONS—Order by catalog number from regular tube supply source.

—PRODUCT INFORMATION—
INDUSTRIAL EQUIPMENT TYPES MANUAL
IGNITRONS—SERVICE NOTES

The anode of an ignitron operates at red heat under normal loads. To prevent overheating of the inner-envelope walls at shutdown periods, cooling-water flow should be continued after anode power is removed.

For some types this information appears on the tube data sheets. It does not now appear on the sheets for the types below.

Ignitron Type	After Removal of Anode Voltage Continue Water Flow for
GL-5551-A	15 Minutes
GL-5552-A	15 Minutes
GL-5553-B	30 Minutes
GL-5554	15 Minutes
GL-5555	30 Minutes
GL-5564	1 Hour
GL-5630	30 Minutes
GL-5822-A	15 Minutes
GL-6228	1 Hour
GL-6509	30 Minutes
GL-6512	15 Minutes

Ignitron Type	After Removal of Anode Voltage Continue Water Flow for
GL-6513	30 Minutes
GL-6514	30 Minutes
GL-6515	1 Hour
GL-6878	1 Hour
GL-7669	15 Minutes
GL-7670	15 Minutes
GL-7671	15 Minutes
GL-7672	15 Minutes
GL-7673	30 Minutes
GL-7736	1 Hour
GL-8360	15 Minutes

INDUSTRIAL EQUIPMENT TYPES MANUAL

IGNITRONS

Data Arrangement

Technical data on ignitrons is arranged by class of service, "Pulse Ignitrons," "Rectifier Ignitrons," and "Welding Control Ignitrons."

When a tube can be used in more than one application, complete, detailed technical data is included in the section covering the major use to which the tube is usually applied. Cross-reference sheets to guide the reader to complete data are provided in the other sections.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-5630

Technical data on tube type GL-5630 is filed in the "Rectifier Ignitrons" section of this manual.

INDUSTRIAL EQUIPMENT TYPES MANUAL

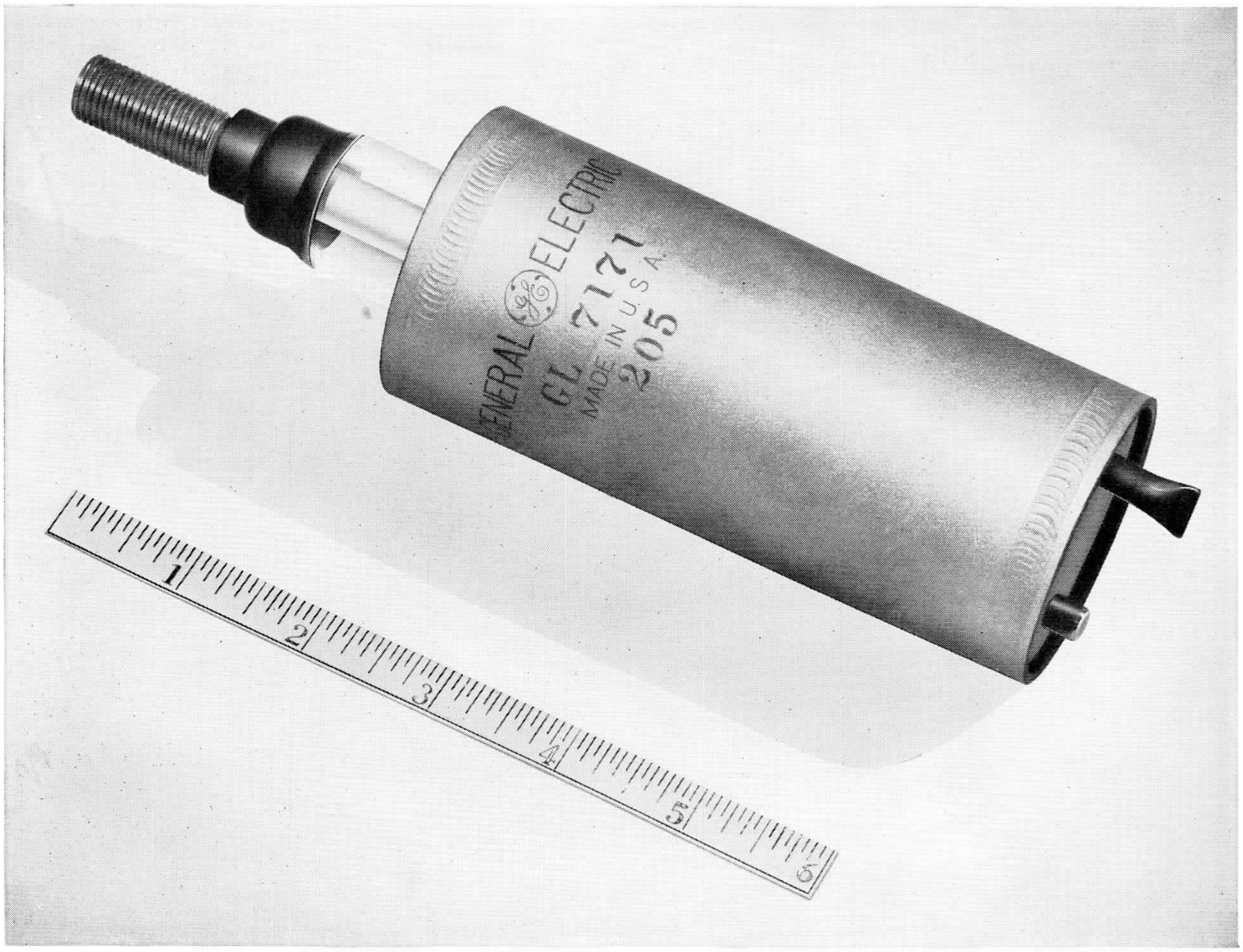
GL-5630

Technical data on tube type GL-5630 is filed in the "Rectifier Ignitrons" section of this manual.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-6228

Technical data on tube type GL-6228 is filed in the "Rectifier Ignitrons" section of this manual.



IGNITRON

CAPACITOR-DISCHARGE SERVICE **DC SHORT-CIRCUITING-SWITCH SERVICE**
35,000 AMPERES PEAK

The GL-7171 is a sealed, stainless-steel jacketed ignitron for use as a switch in capacitor-discharge circuits operating up to 10,000 volts. In this service the tube will carry peak currents up to 35,000 amperes.

GENERAL

Electrical

Cathode Excitation—Cyclic		
Cathode Spot Starting—Ignitor		
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Ignitors	1	
Arc Drop		
At 4000 Amperes	20	Volts
At 30,000 Amperes	55	Volts
Peak Inverse Voltage, maximum	10,000	Volts

Mechanical

Envelope Material—Stainless Steel		
Mounting Position—Axis Vertical, Anode Lead Up		
Net Weight	2	Pounds

Thermal

Type of Cooling—Convection		
Ambient Temperature, minimum	25	C
Cathode Temperature, maximum	35	C
Anode-Header Temperature, maximum*	55	C

GENERAL ELECTRIC

Supersedes ET-T1512 dated 12-58

MAXIMUM RATINGS AND TYPICAL OPERATION

Capacitor-Discharge Service, Pulse Duty, Sinusoidal Current

Peak Anode Voltage		
Forward	10,000	Volts
Inverse	10,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts
Anode Current (See Curve K-69087-72A858 for Details)		
Peak†	35,000	Amperes
Average	0.1	Amperes
Maximum Averaging Time	1	Cycle
Fault	35,000	Amperes
Maximum Duration	0.002	Seconds
Rate of Rise of Current		
Maximum	5600	Amperes per Microsecond
Minimum	1400	Amperes per Microsecond
Frequency of Current Conduction Periods, maximum	1	Per Minute
Ionization Time	0.5	Microseconds

DC Short-Circuiting-Switch Service

Peak Anode Voltage		
Forward	10,000	Volts
Inverse	10,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts
Anode Current (See Curve K-69087-72A858 for Details)		
Peak‡	35,000	Amperes
Average	0.25	Amperes
Maximum Averaging Time	1	Cycle
Fault	35,000	Amperes
Maximum Duration	0.002	Seconds
Rate of Rise of Current		
Maximum	5600	Amperes per Microsecond
Minimum	1400	Amperes per Microsecond
Frequency of Current Conduction Periods, maximum	1	Per Minute
Ionization Time	0.5	Microseconds

Ignitor Ratings	Minimum	Maximum	
Separate Excitation			
Ignitor Voltage			
Forward Open Circuit	1500	3000	Volts
Inverse, maximum	—	5	Volts
Ignitor Current Short Circuit	200	250	Amperes
Length of Firing Pulse, sine wave	5	10	Microseconds
Anode Firing			
Ignitor Voltage			
Forward, maximum		3000	Volts
Inverse, maximum		5	Volts
Peak Ignitor Current	200	250	Amperes

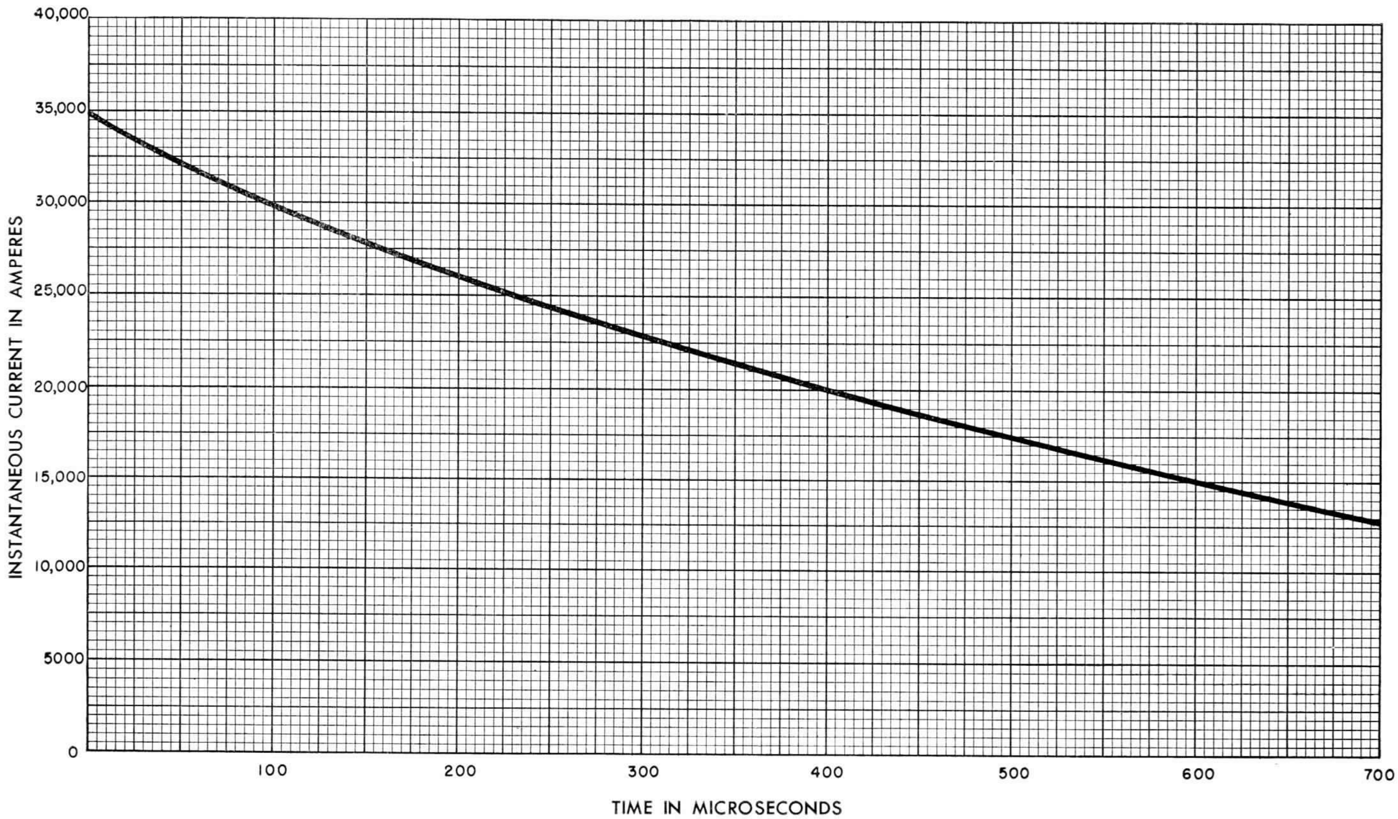
*To prevent mercury condensation, the anode-header temperature should be higher than the cathode temperature at all times. Mercury must be kept away from the anode and anode seals. Before tube operation, the anode seals must be warmed, with respect to the cathode, long enough to vaporize all mercury from the seal area.

†Dampened oscillations are permissible provided the dampening coefficient is less than the value shown on the current-waveform curve. The peak of the oscillation must not exceed 48,000 amperes.

‡Tube must be operated within the area specified on the current-waveform curve.

CURRENT-WAVEFORM CURVE

MAXIMUM PERMISSIBLE CURRENT



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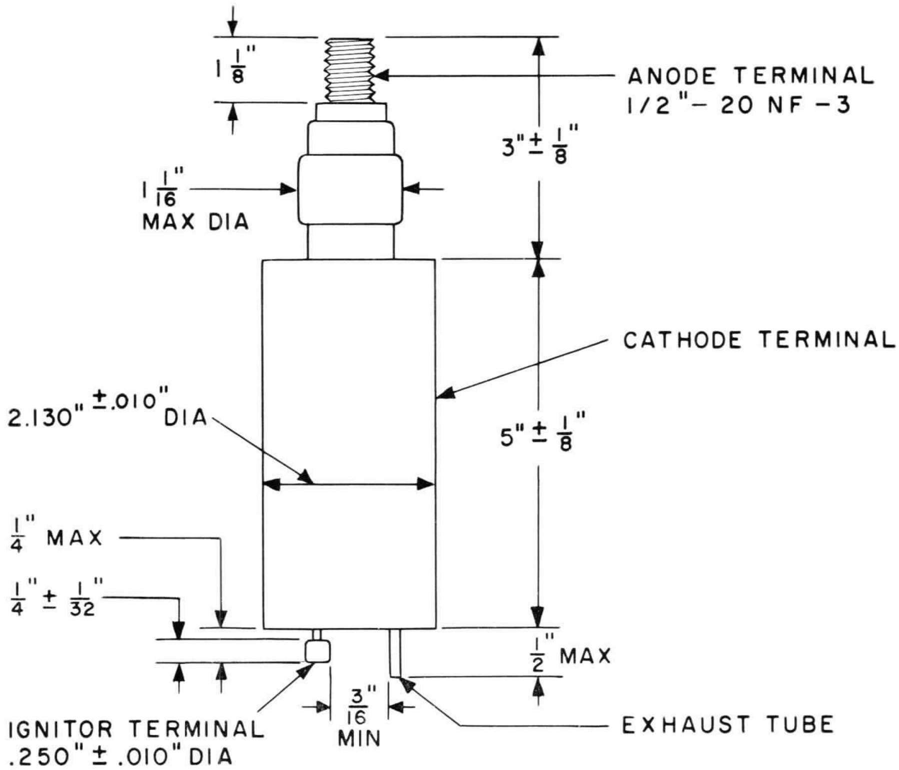
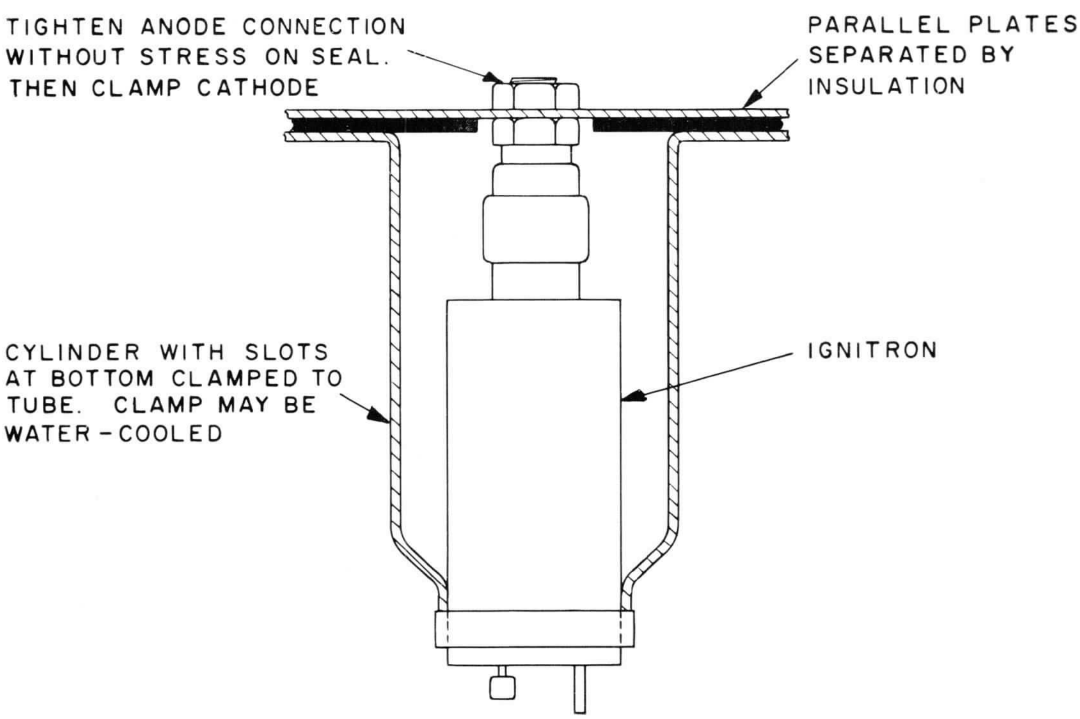
12-6-60



COAXIAL MOUNTING



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OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

DEVELOPMENTAL TYPE

IGNITRON
ZG-7219

The ZG-7219 is an ignitron for capacitor-discharge service. Features of the tube include a potential-dividing grid to improve reliability for high voltage hold-off.

GENERAL

Electrical

Cathode Excitation	Cyclic
Cathode Spot Starting	Ignitor
Number of Electrodes	
Main Anode	1
Main Cathode	1
Ignitors	1

Mechanical

Envelope	Encapsulated Glass and Fernico
Mounting Position	Axis Vertical, Anode Terminal Up
Net Weight	14 Pounds

Thermal

Type of Cooling	Forced Air or Water
Cathode Temperature, Maximum	35 C
Insulating Compound Temperature, Maximum	70 C*

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Capacitor-Discharge Service, Intermittent Pulse Duty

Peak Anode Voltage	50,000 Volts
Peak Anode Current	
1/2 cycle of 75 μsec	30,000 Amperes
1/2 cycle of 5 μsec	60,000 Amperes
Discharge Rate	2 Per Minute

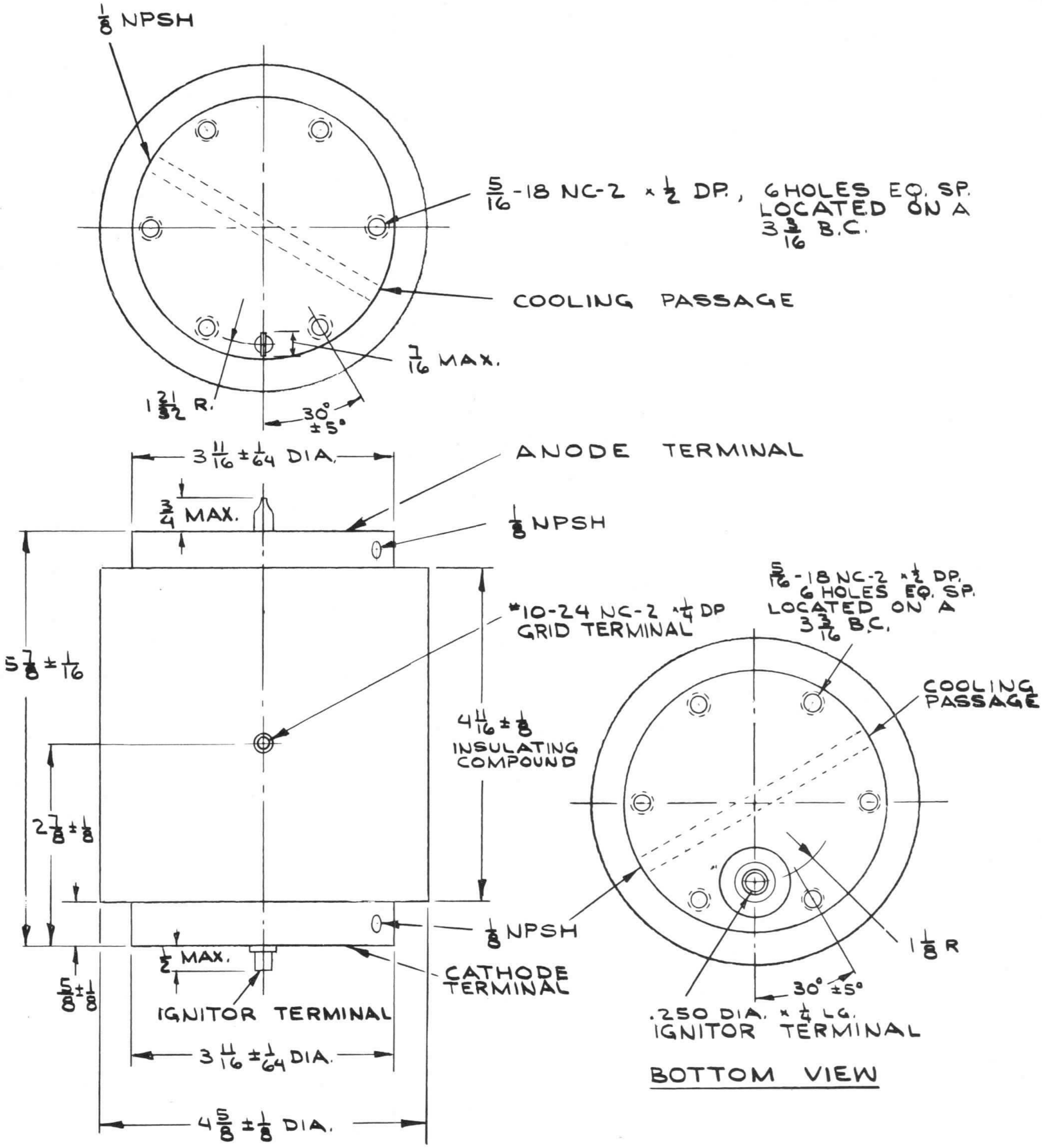
DC Short-Circuiting-Switch (Crowbar) Service

Peak Anode Voltage	50,000 Volts
Peak Anode Current	15,000 Amperes

IGNITOR CIRCUIT RATINGS

	Minimum	Maximum
Ignitor Voltage		
Forward Open-Circuit (Ignitor +)	1500	3000 Volts
Inverse (Ignitor -)	-	5 Volts
Ignitor Short-Circuit Current	100	250 Amperes
Length of Firing Pulse, sine wave	5	Microseconds

* The temperature of the anode end of the tube must be kept higher than that of the cathode end to prevent mercury condensation on the anode and anode seal, which in turn can cause failures to hold off voltage. Before operation the top of the tube must be heated while the bottom kept cool to vaporize all mercury which may have been condensed or splashed into the top during handling.



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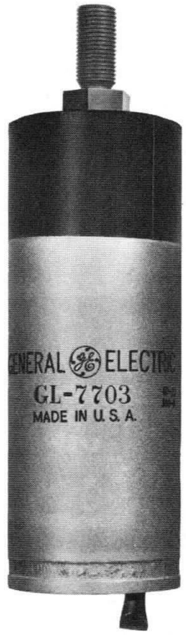


GL-7703
IGNITRON

CAPACITOR-DISCHARGE SERVICE — 20,000 VOLTS PEAK
DC SHORT-CIRCUITING-SWITCH SERVICE — 100,000 AMPERES PEAK

The GL-7703 is a sealed, stainless-steel-jacketed ignitron for use as a switch in capacitor-discharge circuits operating up to 20,000 volts. In this service the tube will carry peak currents up to 100,000 amperes. The anode seal is enclosed in an insulating compound to prevent external voltage flashover.

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1
Main Cathodes	1
Ignitors	1

Mechanical

Envelope—Stainless Steel
Mounting Position—Axis Vertical, Anode Terminal Up
Net Weight . . . . . 2 Pounds

Thermal

Type of Cooling—Air or Liquid, by clamp around lower portion of tube

Clamp Temperature	10 to 30	C
Cathode Temperature, maximum	35	C
Anode Insulating-Compound Temperature*, maximum	70	C

Capacitor-Discharge Service, Intermittent Pulse Duty, Sinusoidal Current†

Peak Anode Voltage‡

Forward	20,000	Volts
Inverse	20,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts

Anode Current¶

Peak, for ½ cycle of 120 microseconds	60,000	Amperes
Peak, for ½ cycle of 20 microseconds	100,000	Amperes
Maximum Discharge Rate	2	Per Minute
Rate of Rise of Current§, tube inductance approx.	0.04	Microhenrys
Ionization Time	0.5	Microseconds

DC Short-Circuiting-Switch Service

Peak Anode Voltage‡

Forward	20,000	Volts
Inverse	20,000	Volts
Critical Anode Starting Voltage, minimum	100	Volts

Anode Current

Peak	35,000	Amperes
Average	0.25	Amperes
Maximum Averaging Time	1	Cycle
Rate of Rise of Current§, tube inductance approx.	0.04	Microhenrys
Ionization Time	0.5	Microseconds

Ignitor Ratings

	Minimum	Maximum	
Separate Excitation			
Ignitor Voltage			
Forward Open Circuit	1500	3000	Volts
Inverse, maximum	—	5	Volts
Ignitor Short-Circuit Current	200	250	Amperes
Length of Firing Pulse, sine wave	5	10	Microseconds

	Minimum	Maximum	
Anode Firing			
Ignitor Voltage			
Forward, maximum	—	3000	Volts
Inverse, maximum	—	5	Volts
Peak Ignitor Current	200	250	Amperes

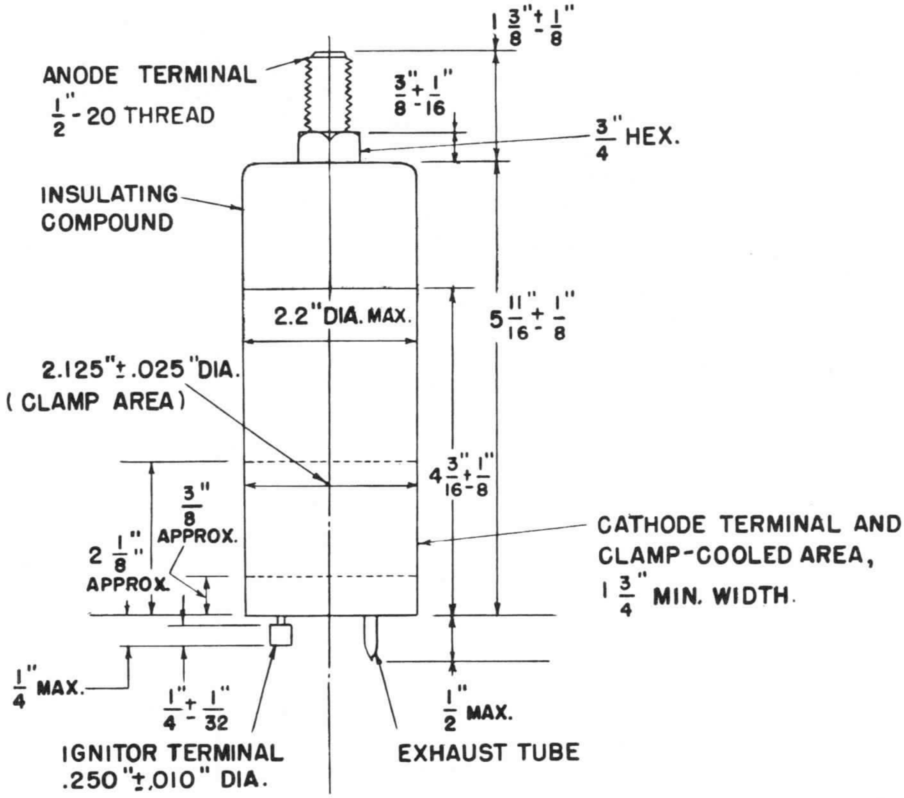
* Anode-seal, insulating-compound temperature must always be higher than the cathode temperature to prevent mercury condensation on the anode and anode seal. Before tube operation, the anode seals must be heated long enough to vaporize all mercury from the seal area.

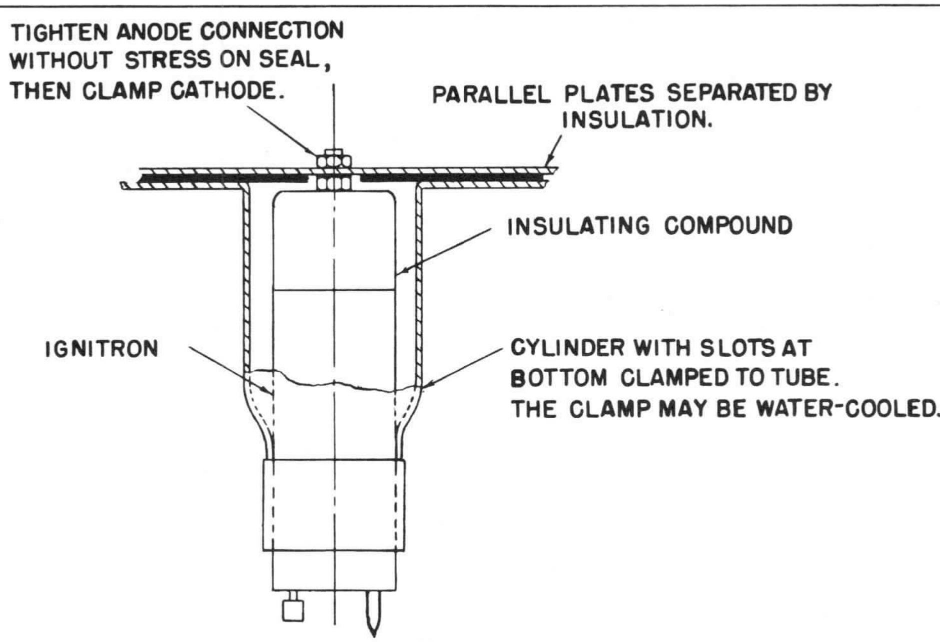
† The tube may become a closed switch (does not open) carrying current in both directions until the current dampens out.

‡ The tube cannot hold off this voltage immediately after conduction. A 1-to-10-second delay may be required before reapplication of voltage.

¶ Dampened oscillations are permissible provided the oscillating cycles do not exceed 20. The peak current value for one-half cycle must not be exceeded.

§ Rate of rise depends on circuit.





SUGGESTED METHOD FOR PROVIDING MOUNTING FOR COAXIAL CONNECTION

K-69087-72A948 8-60

GENERAL ELECTRIC
POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

PRINTED IN U.S.A.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-8465, -8466

Technical data on these types is filed in the "Power Rectification" section of this manual.

—PRODUCT INFORMATION—

IGNITRON

GL-37207

The GL-37207 is a stainless-steel-water-jacketed ignitron for use as a switch in capacitor-discharge circuits, or for DC short-circuiting-switch (crowbar) protective service.

GENERAL

Electrical

Cathode Excitation	Cyclic
Cathode Spot Starting	Ignitor
Number of Electrodes	
Main Anode	1
Main Cathode	1
Ignitors	3

Mechanical

Envelope	Stainless Steel
Mounting Position	Axis Vertical-Anode Terminal Up
Net Weight	20 Pounds
Length (excluding flexible anode cable)	18-3/4 Inches
Diameter (excluding water nipples)	5-1/2 Inches

Thermal

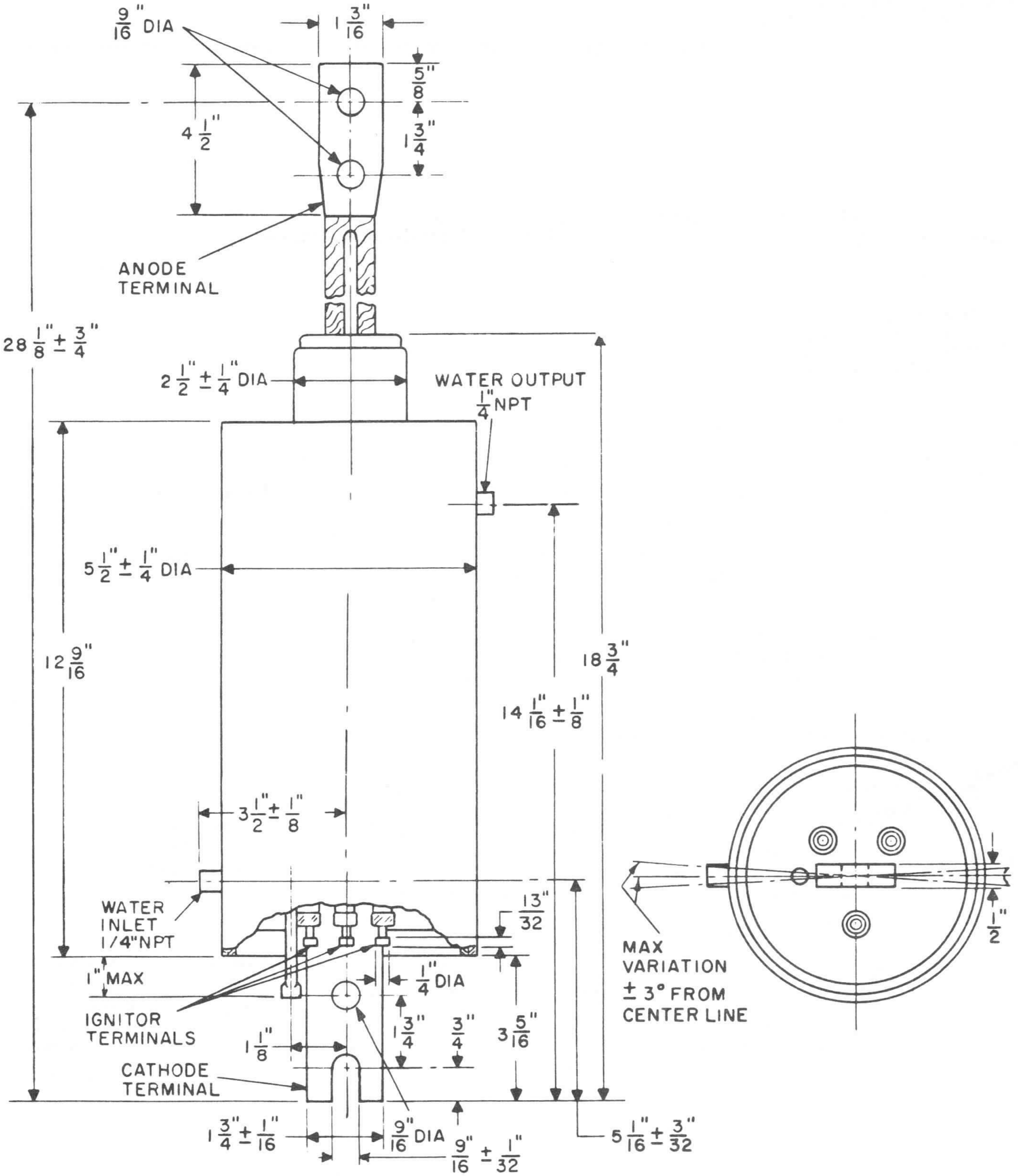
Type of Cooling — Water	
Inlet Water Temperature, minimum	6 C
Inlet Water Temperature, maximum	30 C
Nominal Water Flow	1.5 Gallons Per Minute

MAXIMUM RATINGS (Not simultaneous conditions)

Peak Anode Voltage	25,000 Volts
Peak Anode Current	300,000 Amperes
Length of Conduction	10 Milliseconds
Repetition Rate	500 Per Minute
Maximum Coulombs per Discharge	200 Amp-Sec.
Maximum Coulombs per Minute	200 Amp-Sec/Min.
Maximum Voltage Reversal	10 Percent

IGNITOR-CIRCUIT RATINGS

	Minimum	Maximum
Ignitor Voltage		
Forward Open-Circuit (ignitor +)	1500	3000 Volts
Inverse (ignitor −)	—	5 Volts
Ignitor Short-Circuit Current	100	250 Amperes
Length of Firing Pulse, 1/2 sine wave	5	10 Microseconds



NOTE: ONE IGNITOR USED AT A TIME

69087-72B63

—PRODUCT INFORMATION—

IGNITRON

GL-37248

The GL-37248 ignitron is designed primarily for DC short-circuiting-switch (crowbar) protective service. Features of the tube include a holding anode which provides a means for keeping the tube ionized should voltage reversals occur during the discharge.

GENERAL

Electrical

Cathode Excitation	Cyclic
Cathode Spot Starting	Ignitor
Number of Electrodes	
Main Anode	1
Auxiliary Anode	1
Ignitors	1
Main Cathode	1
Approximate Inductance	30 Nanohenrys

Mechanical

Envelope	Stainless Steel
Mounting Position	Axis Vertical-Anode Terminal Up
Net Weight	2 Pounds
Diameter	2-1/8 Inches
Height	7-1/2 Inches

Thermal

Type of Cooling — Clamp around lower half of cylinder which also serves as cathode connection*

Clamp Temperature	10-30 C
Cathode Temperature, Max.	35 C
Anode Insulating-Compound Temperature and anode-Lead Temperature, maximum	70 C*

MAXIMUM RATINGS

Peak Anode Voltage	50,000 Volts
Peak Anode Current	10,000 Amperes
Length of Conduction	20 Milliseconds
Repetition Rate	6 Per Hour*
Voltage Reversal	50 Percent

IGNITOR-CIRCUIT RATINGS

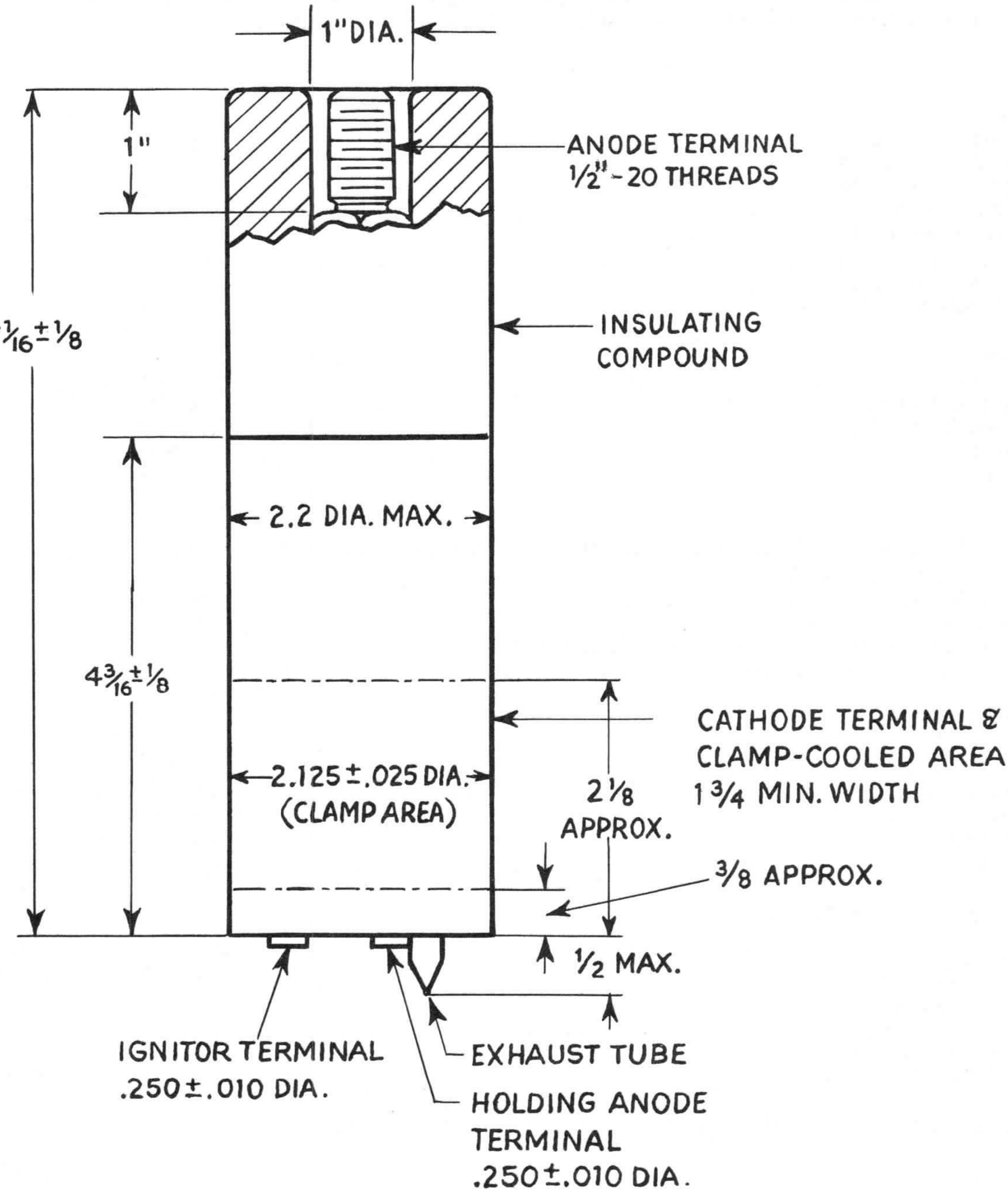
	Minimum	Maximum
Ignitor Voltage		
Forward Open Circuit (ignitor +)	1500	3000 Volts
Inverse (ignitor —)	—	5 Volts
Ignitor Short-Circuit Current	100	250 Amperes
Length of Firing Pulse, sine wave	5	10 Microseconds

HOLDING-ANODE CIRCUIT RATINGS†

Holding-Anode Voltage (Positive d-c)	80	150 Volts
Holding-Anode Current	5	10 Amperes

* The temperature of the anode end of the tube must be kept higher than that of the cathode end to prevent mercury condensation on the anode and anode seal. Before operation the top of the tube must be heated sufficiently to vaporize all mercury from the anode area. The repetition rate may be increased by a factor of ten by water cooling the clamp around the lower half of the cylinder.

† It is anticipated that a holding-anode rectifier will be provided to supply the required power and that its supply will drop to zero at the end of the crowbar operation so the ignitron will regain control. An alternate method is to discharge a large capacitor into the holding anode with a time constant longer than the crowbar time.



IGNITRON

RECTIFIER SERVICE—100 AMPERES
AC CONTROL SERVICE—1200 KILOVOLT-AMPERES

HOLDING ANODE
TWO IGNITORS

The GL-5554 ignitron is a sealed, steel-jacketed, water-cooled, mercury-pool tube designed for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. It is suitable for use in rectifiers rated up to 200 kilowatts output, depending on the number of ignitrons used, the output voltage, and the circuit. It has a continuous average current rating of 100 amperes per tube in rectifiers rated up to 300 volts d-c. The tube is also designed for 2400-volt a-c control service where it has a capacity of 1200 kilovolt-amperes.

The GL-5554 has a holding anode and two ignitors. Excitation of the holding anode permits stabilizing the cathode spot for very small anode currents. The two ignitors assure long life since only one is used at a time. Phase control of the ignitor impulses permits voltage control of the rectified output. In common with other ignitrons arc losses in the GL-5554 are low, and design and construction features such as a complete stainless-steel-water jacket assure ease of installation, economical use of space, and reliability of operation.

GENERAL ELECTRIC

Supersedes ET-T1129 dated 1-55

GENERAL

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Holding Anodes	1	
Ignitors	2	
Arc Drop at 100 Peak Amperes	12.6±0.5	Volts
Arc Drop at 300 Peak Amperes	14.4±0.5	Volts
Arc Drop at 600 Peak Amperes	17.3±0.5	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire (See curve K-9033883 for details)	450	Volts
Ignitor Current Required to Fire (See curve K-9033883 for details)	45	Amperes
Starting Time at Required Voltage or Current	100	Microseconds

Mechanical

Envelope Material—Stainless Steel

Over-all Length	17	Inches
Over-all Width	4	Inches
Net Weight, approximate	13.5	Pounds

Thermal

Type of Cooling—Water

Inlet Water Temperature, minimum	6	C
Outlet Water Temperature, maximum		
Power-Rectifier Service		
Peak Inverse Anode Voltage = 900 Volts	60	C
Peak Inverse Anode Voltage = 2100 Volts	45	C
AC Control Service		
Voltage = 2400 Volts RMS	30	C
Water Flow, minimum		
At No Load	0.5	Gallons per Minute
At Continuous Rated Average Current	1.5	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	6	C
Pressure Drop at 3 Gallons per Minute	5	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

AC Control Service*

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	2400	Volts RMS
Maximum Demand	1200	Kilovolt-Amperes
Average Current at Maximum Demand	75	Amperes
Maximum Average Current	113	Amperes
Demand at Maximum Average Current	600	Kilovolt-Amperes
Maximum Averaging Time at 2400 Volts RMS	1.50	Seconds
Maximum Peak Fault Current	3000	Amperes
Frequency Range	25–60	Cycles per Second

Power-Rectifier Service, Continuous Duty

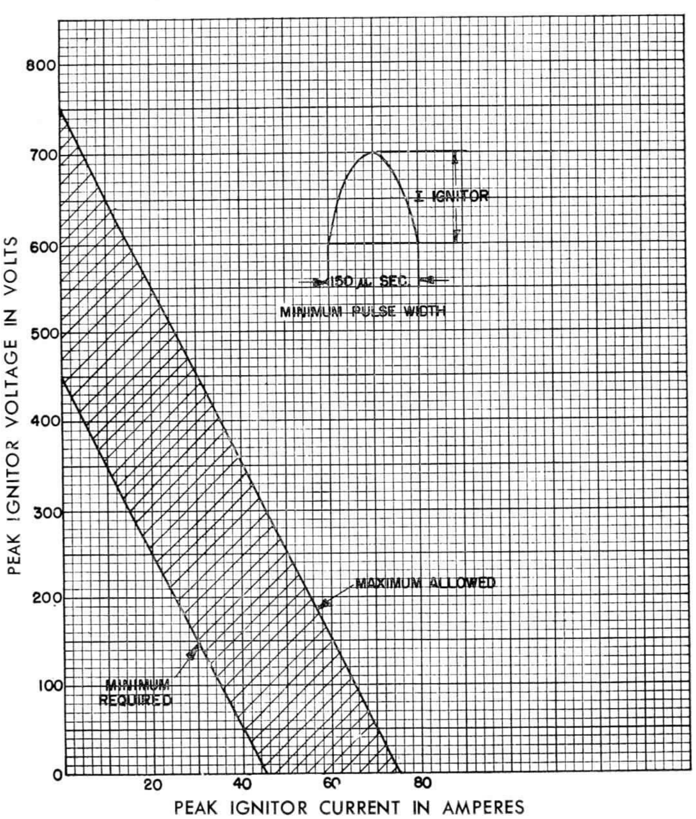
Ratings are for Zero-Phase-Control—See Curves K-69087-72A182 and K-69087-72A183 for details.

Maximum Peak Anode Voltage			
Inverse	900	2100	Volts
Forward	900	2100	Volts
Maximum Anode Current			
Peak	900	600	Amperes
Average			
Continuous	100	75	Amperes
Two-Hours—Averaged Over Any Two-Minute Interval	150	112.5	Amperes
One-Minute—Averaged Over Any One-Minute Interval	200	150	Amperes
Fault	6000	4500	Amperes
Maximum Duration of Fault Current	0.15	0.15	Seconds
Frequency Range	25–60	25–60	Cycles per Second

Ignitor		
Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
Root Mean Square	15	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds
Typical Resistance Added to Ignitor Circuit for Anode Firing		
At Anode Voltage of 600 Volts or Less	4	Ohms
At Anode Voltage of 601 Volts to 1000 Volts	10	Ohms
At Anode Voltage of 1001 Volts to 1500 Volts	20	Ohms
At Anode Voltage of 1501 Volts to 2000 Volts	35	Ohms
At Anode Voltage of 2001 Volts to 2400 Volts	50	Ohms
Holding Anode		
Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Root Mean Square	15	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds

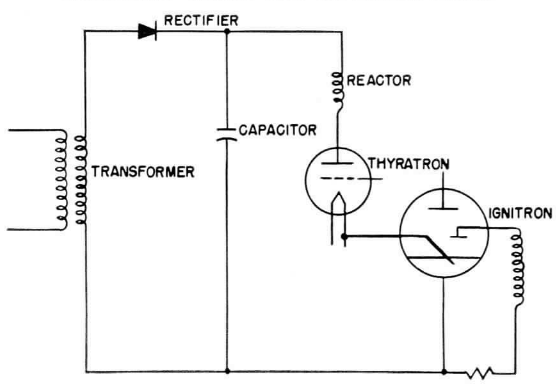
* RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used.

IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS
THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA.



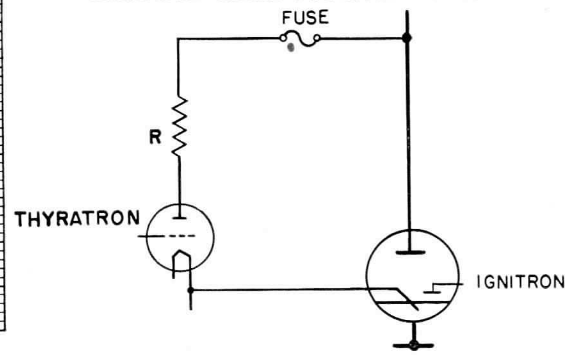
K-9033883 5-25-54

ELEMENTARY CIRCUIT FOR CAPACITOR FIRING



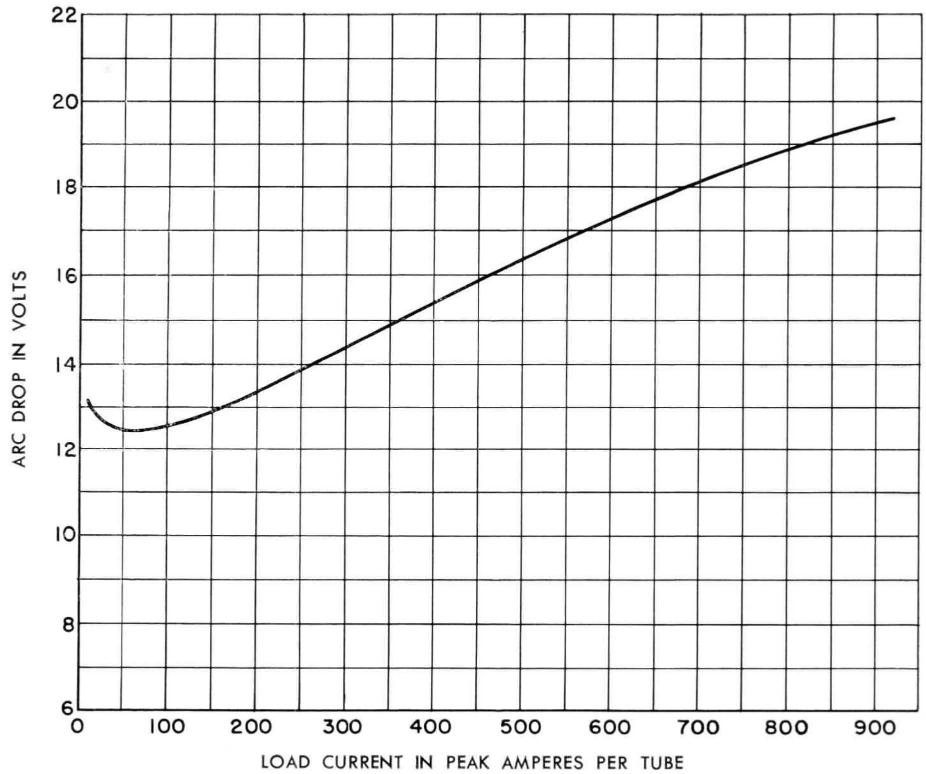
K-9033525 5-25-54

ELEMENTARY CIRCUIT FOR ANODE FIRING



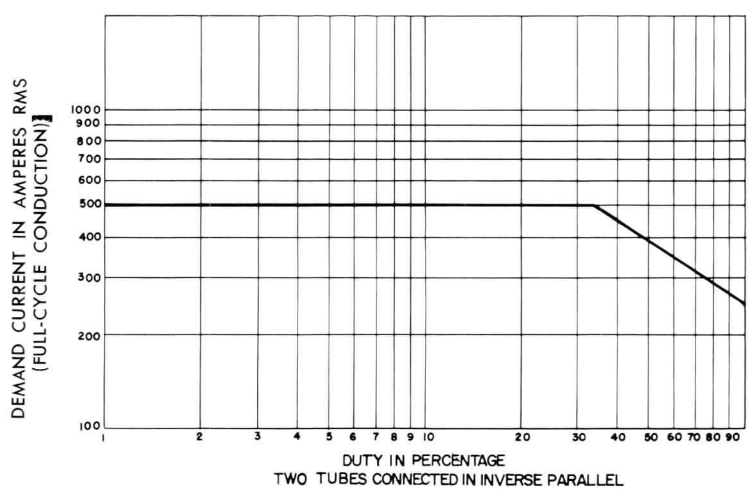
K-9033528 5-25-54

ARC DROP



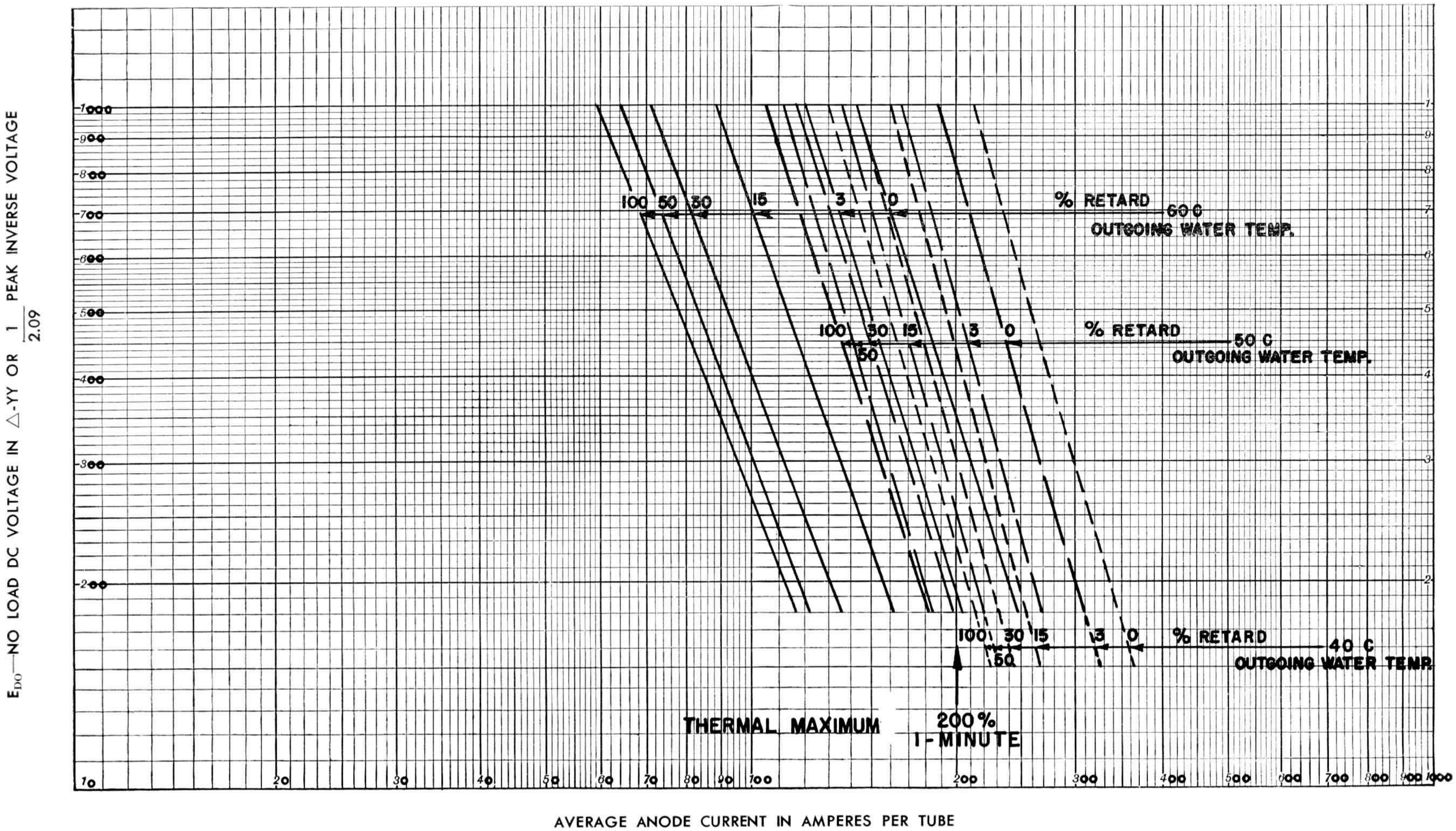
K-6917493 10-20-54

DEMAND CURRENT VS PERCENTAGE DUTY
AT 2400 VOLTS RMS



AVERAGING TIME = 1.5 SECONDS

K-69087-72A859 6-20-58

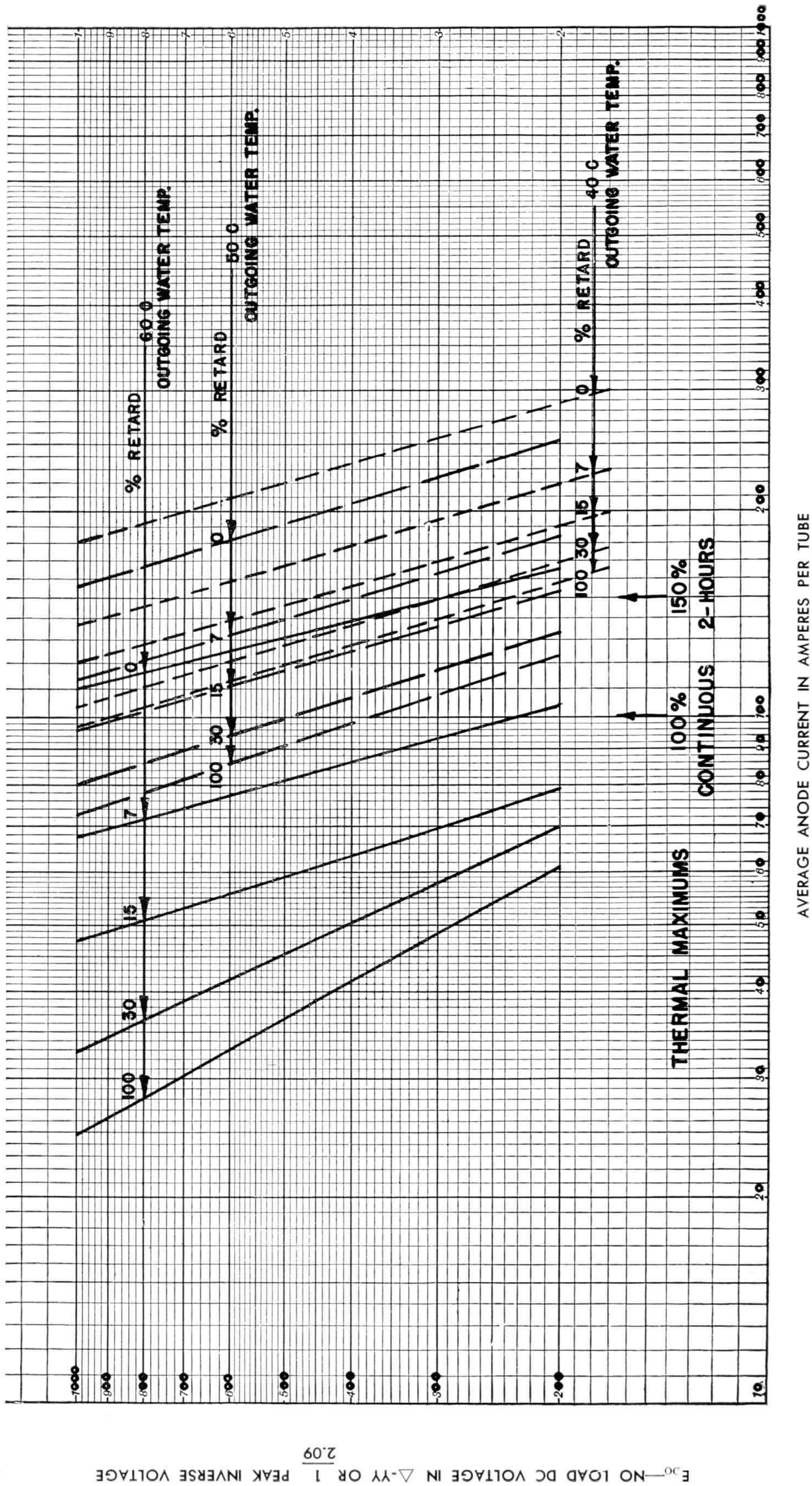


K-69087-72A182

10-20-54

COMMUTATION LIMITS
1-MINUTE LOADS

DELTA, SIX-PHASE, DOUBLE-WYE CIRCUIT OR EQUIVALENT
RATIO OF PEAK-TO-AVERAGE ANODE CURRENT = 3:1
REACTANCE FACTOR, $\frac{I_c X_c}{E_s} = .075$ AT $I_c = 450$ AMPERES



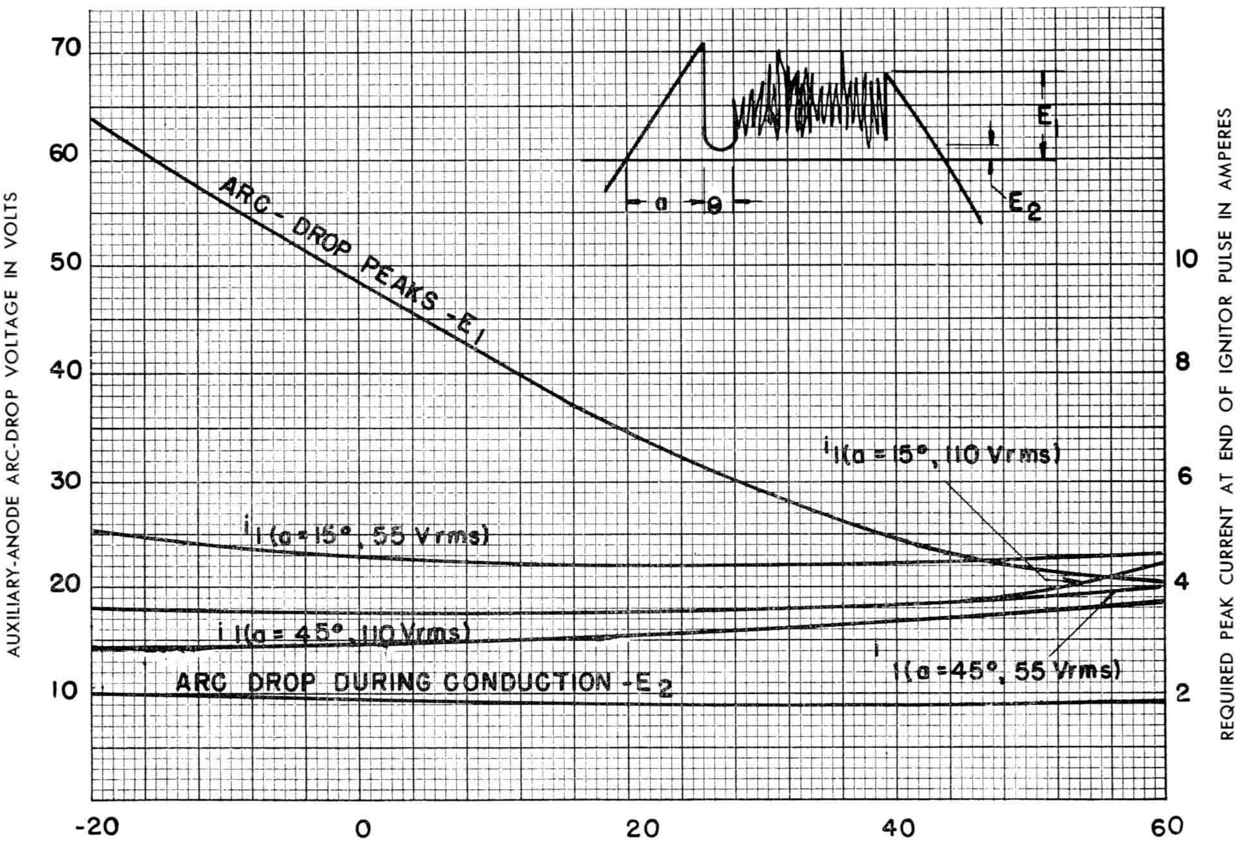
10-20-54

COMMUTATION LIMITS
2-HOUR LOADS

DELTA, SIX-PHASE, DOUBLE-WYE CIRCUIT OR EQUIVALENT
RATIO OF PEAK-TO-AVERAGE ANODE CURRENT = 3:1
REACTANCE FACTOR, $\frac{I_c X_c}{E_s} = .075$ AT $I_c = 450$ AMPERES

K-69087-72A183

HOLDING ANODE REQUIREMENTS



INLET WATER TEMPERATURE IN C

K-69087-72A437 12-1-54

$$I_{max} = \frac{\sqrt{2}\ \text{Erms-arc drop}}{R} = \frac{I_1}{\sin(a+\theta)}$$

WHERE I_{max} = MAXIMUM VALUE OF AUXILIARY ANODE CURRENT TO PREVENT ARC FROM BEING EXTINGUISHED AT END OF IGNITOR PULSE MORE THAN ONCE PER MINUTE WITH MAIN ANODE NOT CONDUCTING. INCREASE APPROXIMATELY 40 PERCENT TO MAINTAIN ARC EVERY CYCLE.

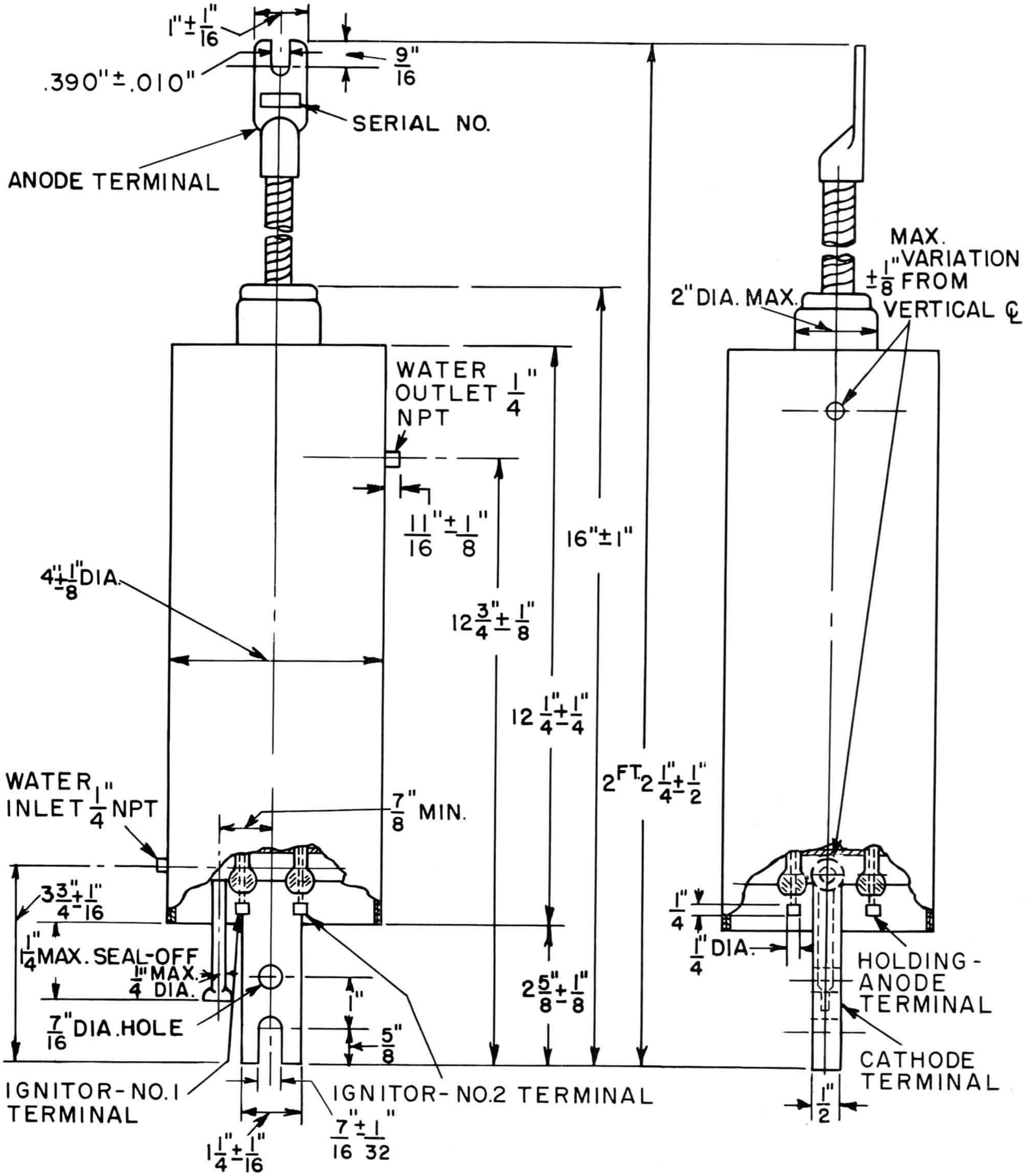
I_1 = INSTANTANEOUS VALUE OF AUXILIARY ANODE CURRENT AT TIME IGNITOR CURRENT DECAYS (FROM CURVES SHOWN FOR TWO VALUES OF a AND TWO VALUES OF SUPPLY VOLTAGE).

a = IGNITOR RETARD ANGLE WITH RESPECT TO HOLD:NG ANODE VOLTAGE.

θ = WIDTH OF IGNITOR PULSE (DEGREES).

Erms = SUPPLY VOLTAGE.

R = TOTAL CIRCUIT RESISTANCE.



K-5344767

3-8-63

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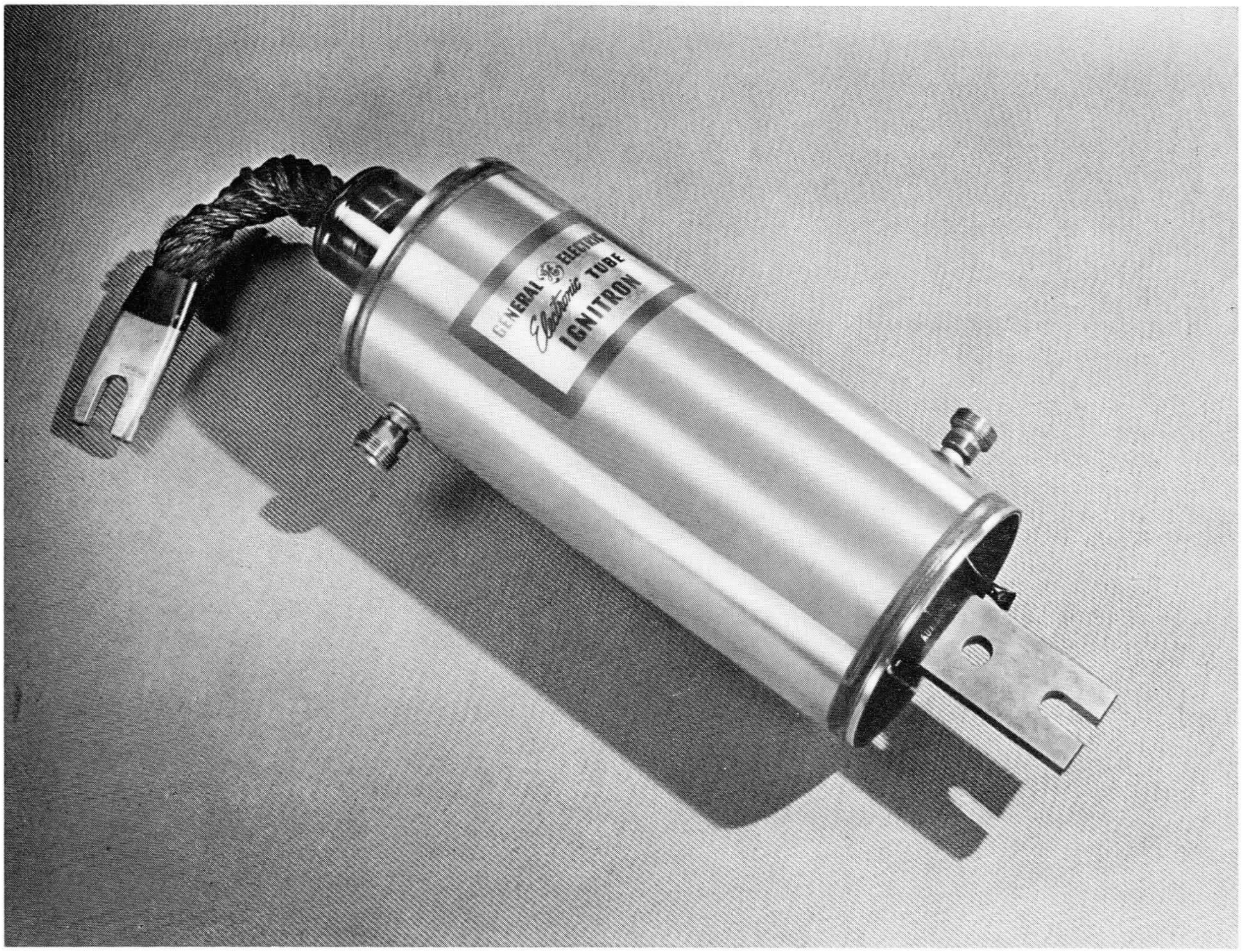


IGNITRON

RECTIFIER SERVICE—200 AMPERES
AC CONTROL SERVICE—2400 KILOVOLT-AMPERES

HOLDING ANODE
TWO IGNITORS

The GL-5555 is a steel-jacketed ignitron designed for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. It is used for rectifiers rated up to 1000 kilowatts depending on the number of ignitrons used, the output voltage, and the circuit.

This tube is also rated for 2400-volt resistance-welder-control service and has a capacity of 2400 kilovolt-amperes in this service. Continuous average current rating is 200 amperes per tube in rectifiers rated up to 1000 kilowatts.

Arc losses are low. Phase control of the ignitron impulses permits voltage control of the rectified output. Excitation of the small holding anode stabilizes the cathode spot for very low anode currents. Two ignitors, only one of which is used at a time, assure long life.

GENERAL ELECTRIC

Supersedes ET-T1573 dated 8-59

GENERAL

Electrical

Cathode Excitation		Cyclic
Cathode Spot Starting		Ignitor
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Holding Anodes	1	
Ignitors	2	
Arc Drop at 600 Peak Amperes	16.2 ± 0.5	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	150	Volts
Ignitor Current Required to Fire	40	Amperes
(See curve K-9033883 for details)		
Excitation Arc Current Required, minimum	8	Amperes
Excitation Arc-Drop Voltage	9 ± 0.5	Volts
Excitation Arc Open-Circuit Voltage, minimum	55	Volts AC

Mechanical

Envelope Material		Metal
Over-all Length	$17\frac{15}{16}$	Inches
Over-all Width	$5\frac{1}{2}$	Inches
Net Weight	25	Pounds

Thermal

Type of Cooling		Water
Characteristics for Water Cooling		
Water Temperature Rise, maximum	4.5	C
Pressure Drop at 3 Gallons per Minute, maximum	6	Pounds per Square Inch
Maximum Outlet Water Temperature		
Peak Inverse Anode Voltage = 900	60	C
Peak Inverse Anode Voltage = 2100	45	C
Minimum Inlet Water Temperature†	6	C
Minimum Water Flow at Continuous Rated Average Current	3	Gallons per Minute
Minimum Water Flow at no Load	1	Gallons per Minute

†Dependent upon load conditions. For substantially constant loads 6 C is satisfactory. For widely fluctuating loads, 25 C is required.

MAXIMUM RATINGS

As AC Control Tube

Two Tubes in Inverse Parallel		
Voltage	2400	RMS Volts
Maximum Demand	2400	Kilovolt-Amperes
Average Current at Maximum Demand	135	Amperes
Maximum Average Current	207	Amperes
Demand at Maximum Average Current	1105	Kilovolt-Amperes
Maximum Averaging Time at 2400 Volts RMS	1.66	Seconds
Maximum Surge Current	6000	Peak Amperes

As Power Rectifier Tube

Ratings are for zero phase-control angle.

Maximum Peak Anode Voltage			
Inverse	900	2100	Volts
Forward	900	2100	Volts
Maximum Anode Current			
Peak	1800	1200	Amperes
Average			
Continuous	200	150	Amperes
2 hours	300	225	Amperes
1 minute	400	300	Amperes
Surge	12000	9000	Amperes
Maximum Duration of Surge Current		0.15	Seconds
Frequency Range		25 to 60	Cycles per Second

Ignitor

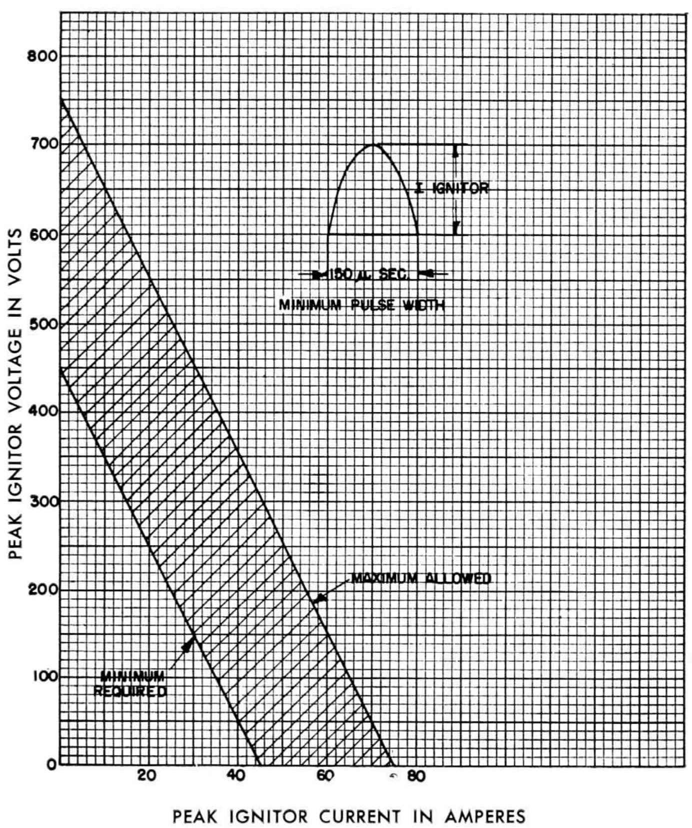
Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
Root Mean Square	15	Amperes
Average	2.0	Amperes
Maximum Averaging Time	10	Seconds
Starting Time at Required Voltage or Current	100	Microseconds

Holding Anode

Maximum Current		
Peak	20	Amperes
Average	5	Amperes
Maximum Averaging Time	10	Seconds
Rms	10	Amperes
Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode not Conducting	160	Volts

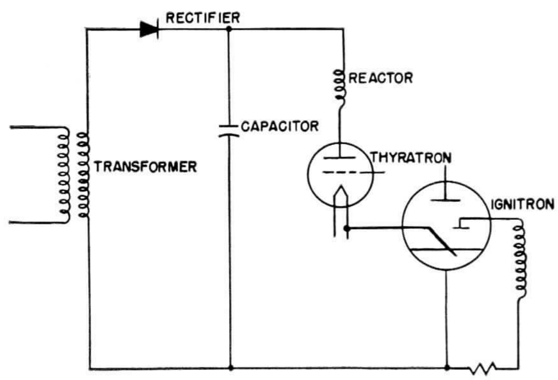
IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA.



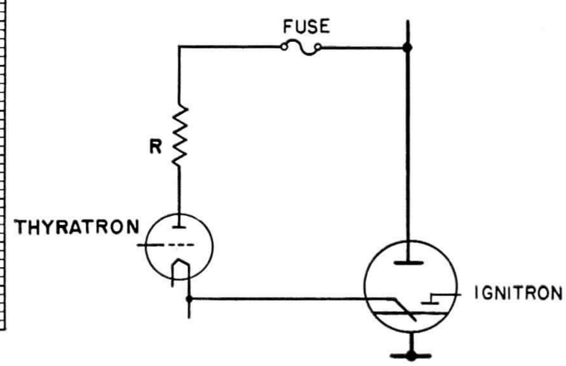
K-9033883 5-25-54

ELEMENTARY CIRCUIT FOR CAPACITOR FIRING



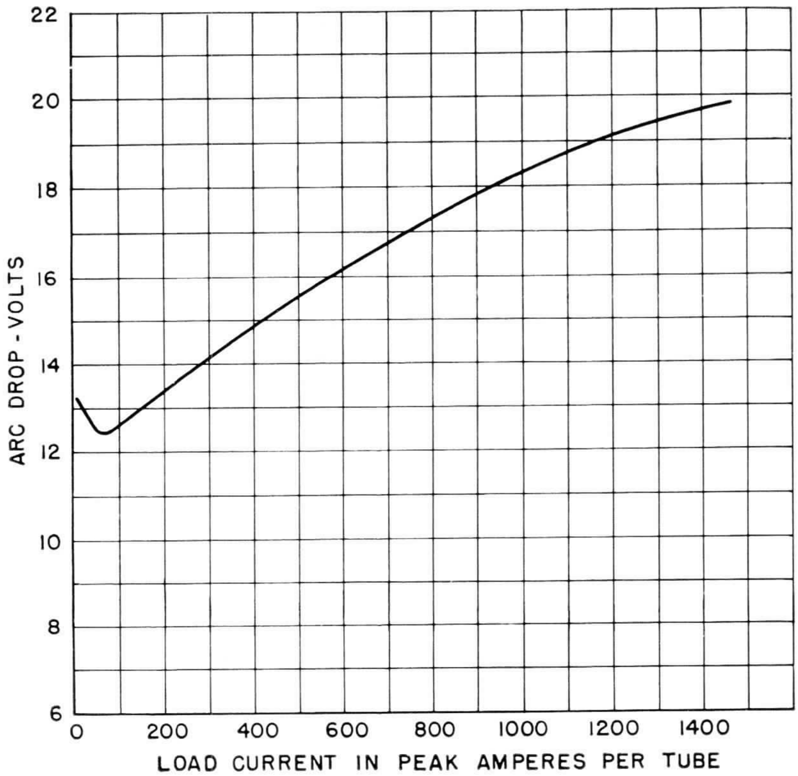
K-9033525 5-25-54

ELEMENTARY CIRCUIT FOR ANODE FIRING



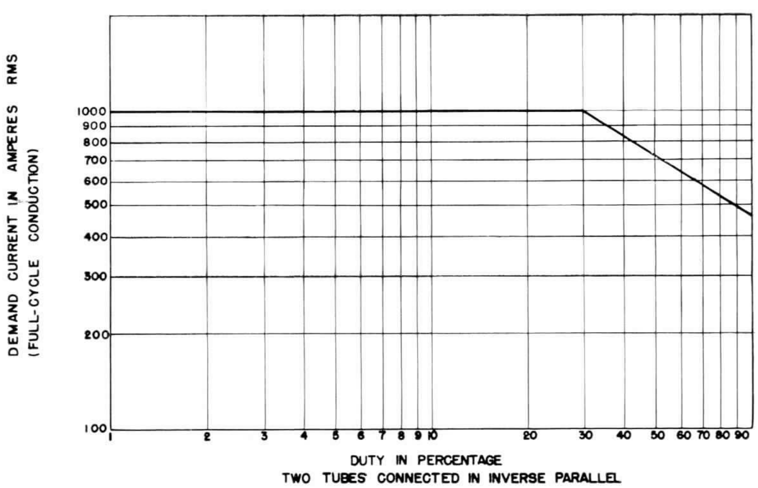
K-9033528 5-25-54

ARC DROP
OUTLET WATER TEMPERATURE—40 C TO 60 C, WATER FLOW—3 GPM



K-6917495 2-14-55

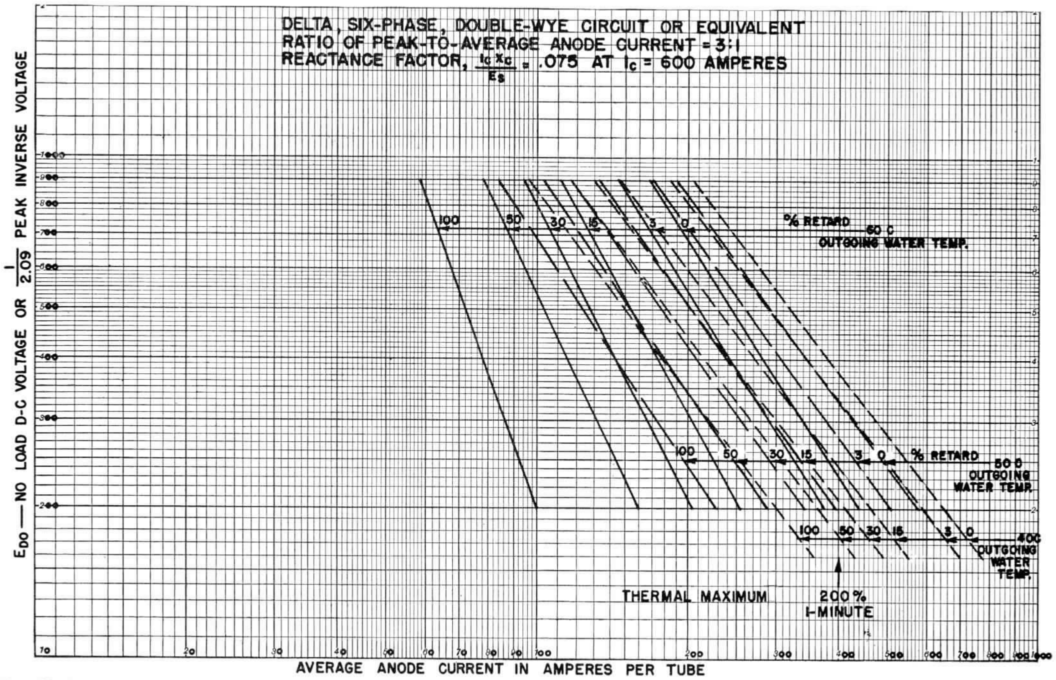
DEMAND CURRENT VS PERCENTAGE DUTY AT 2400 VOLTS RMS



AVERAGING TIME = 1.66 SECONDS

K-8074661 6-20-58

COMMUTATION LIMITS—1-MINUTE LOADS



K-69087-72A180

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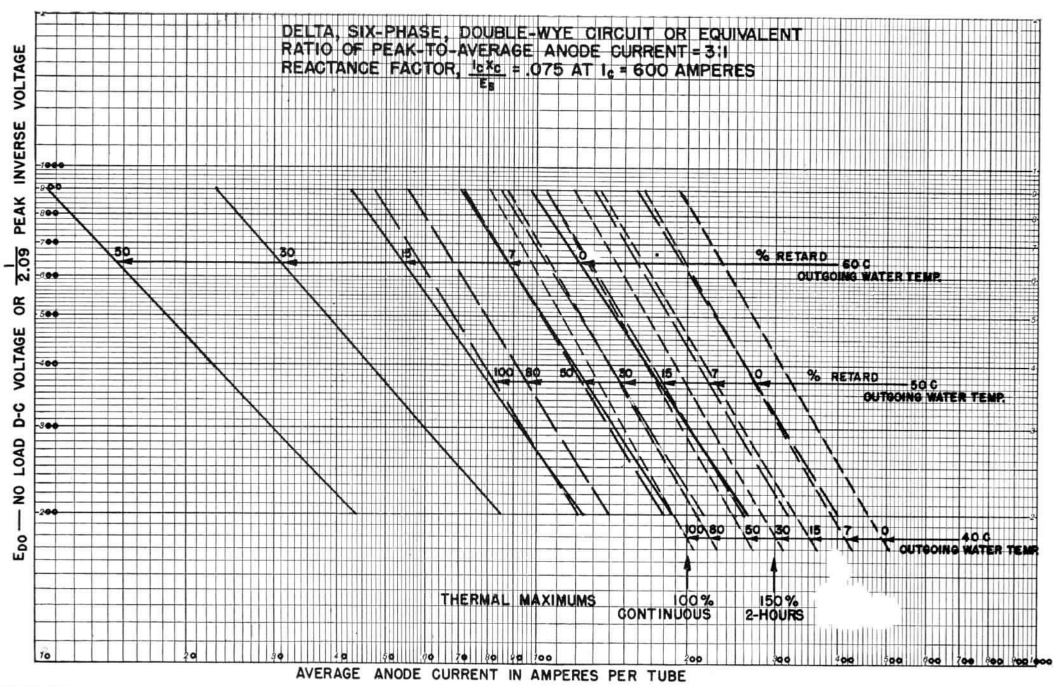
COMMUTATION LIMITS—2-HOUR LOADS



K-69087-72A181

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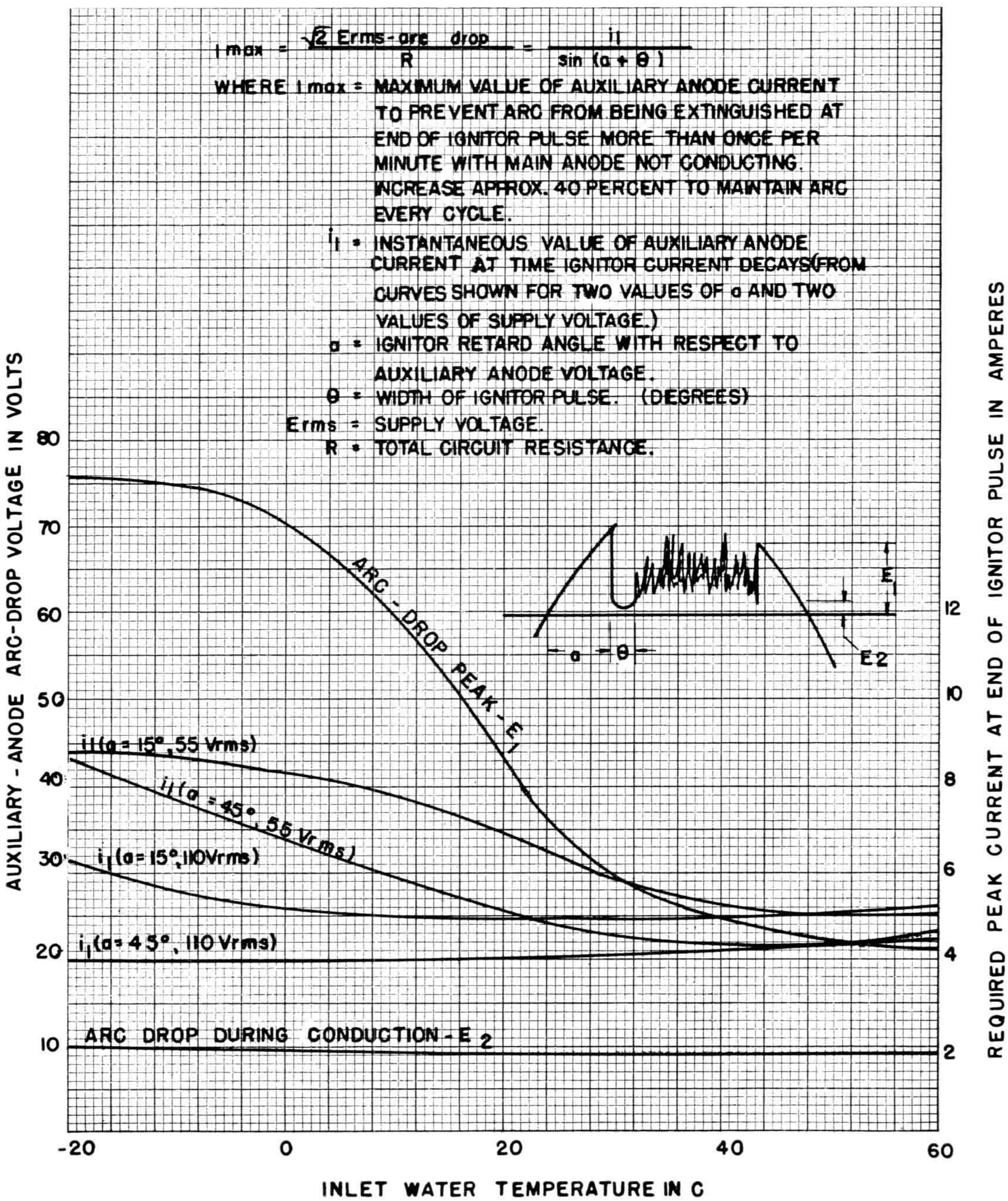
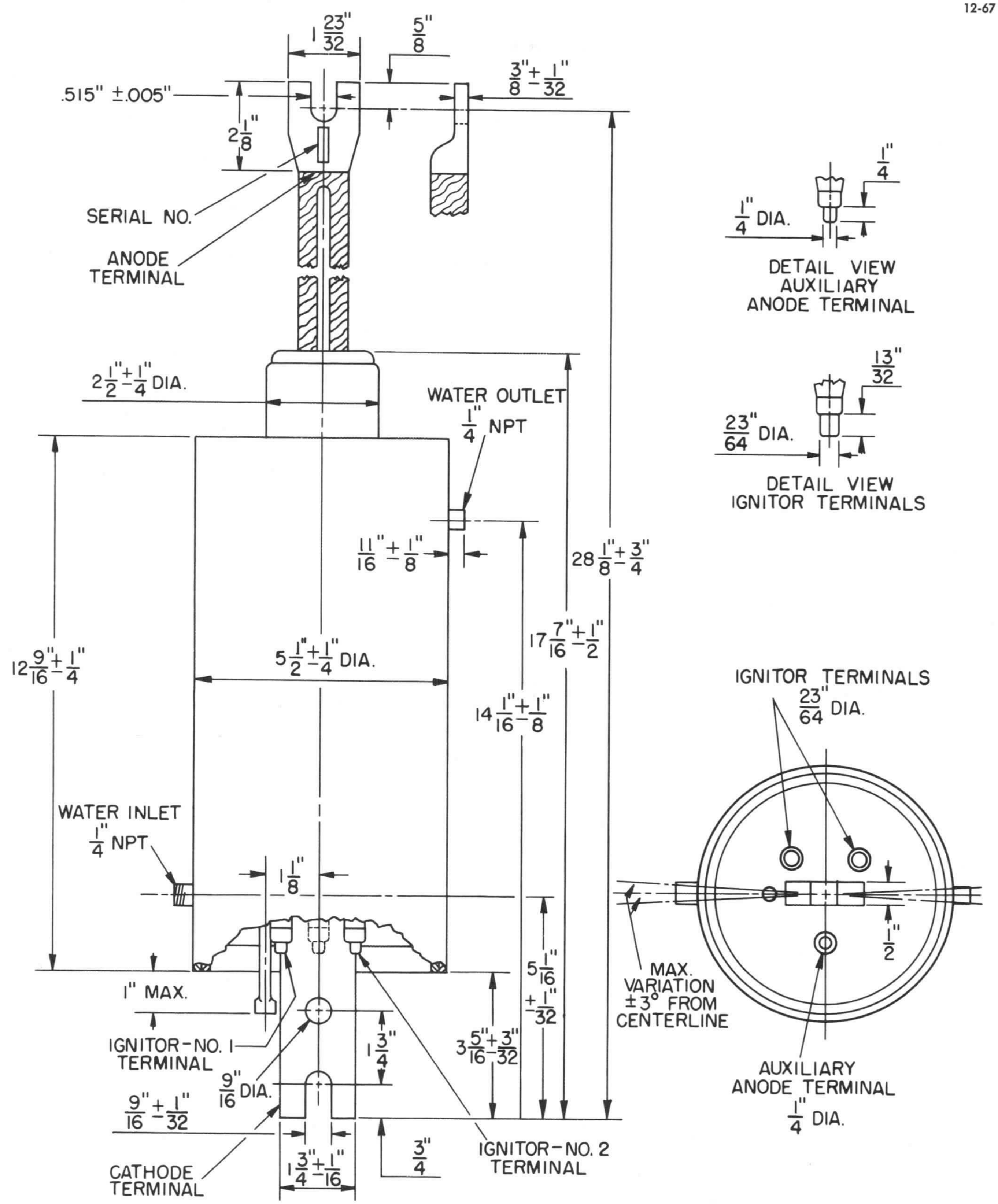
HOLDING ANODE REQUIREMENTS



K-69037-72A438 12-1-54



.515" ±.005"
$1\frac{23}{32}$"
$\frac{5}{8}$"
$\frac{3}{8}$" $+ -$ $\frac{1}{32}$"
$2\frac{1}{8}$"
SERIAL NO.
ANODE TERMINAL
$2\frac{1}{2}$" $+ -$ $\frac{1}{4}$" DIA.
WATER OUTLET $\frac{1}{4}$" NPT
$\frac{11}{16}$" $+ -$ $\frac{1}{8}$"
$28\frac{1}{8}$" $+ -$ $\frac{3}{4}$"
$17\frac{7}{16}$" $+ -$ $\frac{1}{2}$"
$12\frac{9}{16}$" $+ -$ $\frac{1}{4}$"
$5\frac{1}{2}$" $+ -$ $\frac{1}{4}$" DIA.
$14\frac{1}{16}$" $+ -$ $\frac{1}{8}$"
WATER INLET $\frac{1}{4}$" NPT
$1\frac{1}{8}$"
1" MAX.
$5\frac{1}{16}$" $+ -$ $\frac{1}{32}$"
$3\frac{5}{16}$" $+ -$ $\frac{3}{32}$"
$1\frac{3}{4}$"
IGNITOR-NO. 1 TERMINAL
$\frac{9}{16}$" DIA.
$\frac{9}{16}$" $+ -$ $\frac{1}{32}$"
CATHODE TERMINAL
$1\frac{3}{4}$" $+ -$ $\frac{1}{16}$"
$\frac{3}{4}$"
IGNITOR-NO. 2 TERMINAL
$\frac{1}{4}$"
$\frac{1}{4}$" DIA.
DETAIL VIEW AUXILIARY ANODE TERMINAL
$\frac{13}{32}$"
$\frac{23}{64}$" DIA.
DETAIL VIEW IGNITOR TERMINALS
IGNITOR TERMINALS $\frac{23}{64}$" DIA.
$\frac{1}{2}$"
MAX. VARIATION ±3° FROM CENTERLINE
AUXILIARY ANODE TERMINAL $\frac{1}{4}$" DIA.

IGNITRON

RECTIFIER SERVICE—400 AMPERES
AC CONTROL SERVICE—4800 KILOVOLT-AMPERES

HOLDING ANODE
TWO IGNITORS

The GL-5564 ignitron is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube designed for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. It is suitable for use in rectifiers rated up to 1000 kilowatts output, depending upon the number of ignitrons used, the output voltage, and the circuit. Continuous average current rating is 400 amperes per tube in rectifiers rated up to 300 volts d-c. The tube is also designed for 2400-volt a-c control service where it has a rating of 4800 kilovolt-amperes.

The GL-5564 has a holding anode and two ignitors. Excitation of the holding anode permits stabilizing the cathode spot for very small anode currents. The two ignitors assure long life since only one is used at a time. Phase control of the ignitor impulses permits voltage control of the rectified output. In common with other ignitrons arc losses in the GL-5564 are low, and design and construction features, such as a complete stainless-steel-water jacket, assure ease of installation, economical use of space, and reliability of operation.

Supersedes ET-T1130 dated 1-55

GENERAL

Electrical

Cathode-Excitation—Cyclic		
Cathode Spot Starting—Ignitor		
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Holding Anodes	1	
Ignitors	2	
Control Grids	1	
Arc Drop at 1200 Peak Amperes	18.2 ±0.1	Volts
Arc Drop at 8000 Peak Amperes	35 ±0.1	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	450	Volts
(See curve K-69087-72A982 for details)		
Ignitor Current Required to Fire	45	Amperes
(See curve K-69087-72A982 for details)		
Starting Time at Required Voltage or Current	100	Microseconds
Peak Excitation Arc Current Required, minimum	6	Amperes
(See curve K-69087-72A387 for details)		
Excitation Arc-Drop Voltage	12	Volts
Grid Requirements*		
Minimum Voltage To Establish Conduction	50	Volts
Minimum Voltage to Prevent Conduction	100	Volts
Positive Current to Establish Conduction	0.1	Amperes

Mechanical

Envelope Material—Stainless Steel		
Over-all Length	27 7/16	Inches
Over-all Width	9 1/8	Inches
Net Weight, approximate	90	Pounds

Thermal

Type of Cooling—Water		
Inlet Water Temperature†, minimum	25	C
Outlet Water Temperature, maximum		
Power-Rectifier Service		
Peak Inverse Anode Voltage = 750 Volts	50	C
AC Control Service		
Voltage = 250 Volts RMS	45	C
Voltage = 600 Volts RMS	45	C
Voltage = 2400 Volts RMS	45	C
Water Flow, minimum		
At No Load**	2	Gallons per Minute
At Continuous Rated Average Current	6	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	19	C
Pressure Drop at 6 Gallons per Minute, maximum	1	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

AC Control Service‡

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	2400	Volts RMS
Maximum Demand	4800	Kilovolt-Amperes
Average Current at Maximum Demand	270	Amperes
Maximum Average Current	414	Amperes
Demand at Maximum Average Current	2210	Kilovolt-Amperes
Maximum Averaging Time	1.66	Seconds
Maximum Peak Fault Current	12,000	Amperes
Frequency Range	25–60	Cycles Per Second

Power-Rectifier Service, Continuous Duty

Ratings are for Zero-Phase-Control Angle—See Curves K-69087-72A178 and K-69087-72A179 for details.

Maximum Peak Anode Voltage		
Inverse	750	Volts
Forward	750	Volts
Maximum Anode Current		
Peak	3600	Amperes
Average		
Continuous	400	Amperes
Two-Hours—Averaged Over Any Two-Minute Interval	600	Amperes
One-Minute—Averaged Over Any One-Minute Interval	800	Amperes

Fault	15,000	Amperes
Maximum Duration of Fault Current	0.15	Seconds
Frequency Range	25–60	Cycles per Second

Ignitor

Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
Root Mean Square	15	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds
Typical Resistance Added to Ignitor Circuit for Anode Firing		
At Anode Voltage of 600 Volts or Less	4	Ohms
At Anode Voltage of 601 Volts to 1000 Volts	10	Ohms
At Anode Voltage of 1001 Volts to 1500 Volts	20	Ohms
At Anode Voltage of 1501 Volts to 2000 Volts	35	Ohms
At Anode Voltage of 2001 Volts to 2400 Volts	50	Ohms

Holding Anode

Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Grid*

Maximum Peak Forward Voltage	250	Volts
Maximum Peak Inverse Voltage	300	Volts
Maximum Grid-Current		
Peak Positive	1.5	Amperes
Peak Negative	0.5	Amperes
Average	0.5	Amperes
Root Mean Square	1.0	Amperes

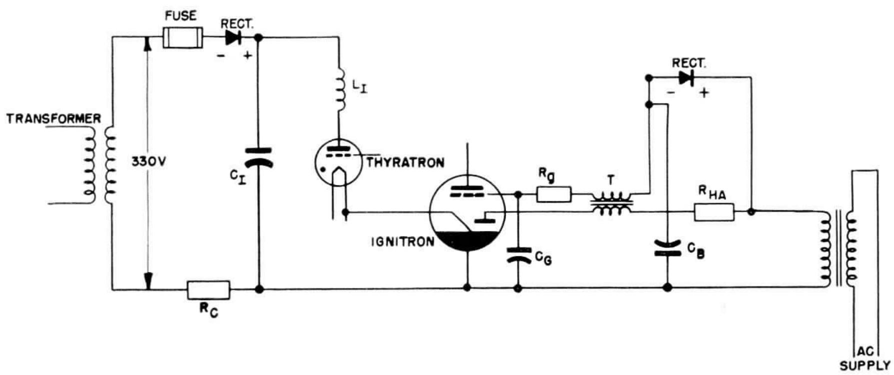
* At main anode voltages of 500 volts and over, the grid circuit should provide a negative d-c bias of 100 volts and a suitable turn-on voltage to swing the grid positive at the time the ignitor is fired. At lower anode voltages, it is sufficient to connect the grid to the main anode through a resistor. In either case, the grid circuit resistance should be 500 to 1000 ohms.

† Dependent upon load conditions. For substantially constant load 0 C is satisfactory. For widely fluctuating loads 25 C is required.

‡ RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. For voltages below the minimum, the minimum-voltage current rating applies. With the use of log-log paper straight-line interpolation between tabulated points may be used for other detailed ratings of: Demand kva vs average anode current, and maximum averaging time vs anode voltage.

**Water flow should be continued for one hour after removal of anode power.

ELEMENTARY CIRCUIT FOR CAPACITOR FIRING



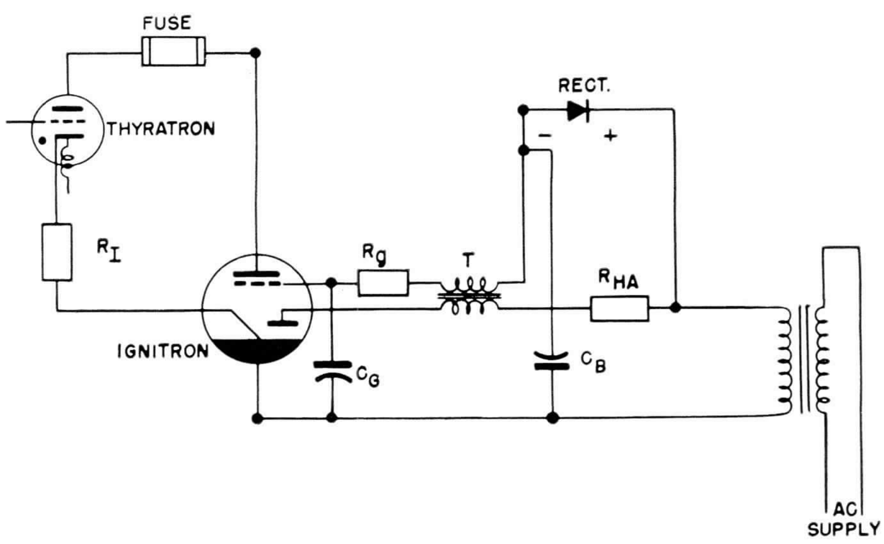
K-69087-72A672 10-22-54

TYPICAL VALUES

C_B = 8 MFD
C_G = 0.1 MFD
C_I = 15–20 MFD
L_I = 1–1.5 mh
R_c = 10 OHMS

R_g = 500 OHMS
R_{HA} = PROPER RESISTANCE TO PROVIDE NECESSARY STABILIZING CURRENT CALLED FOR ON K-69087-72A387
FUSE = 5 AMPERES

ELEMENTARY CIRCUIT FOR ANODE FIRING



K 69087-72A673 10-22-54

TYPICAL VALUES

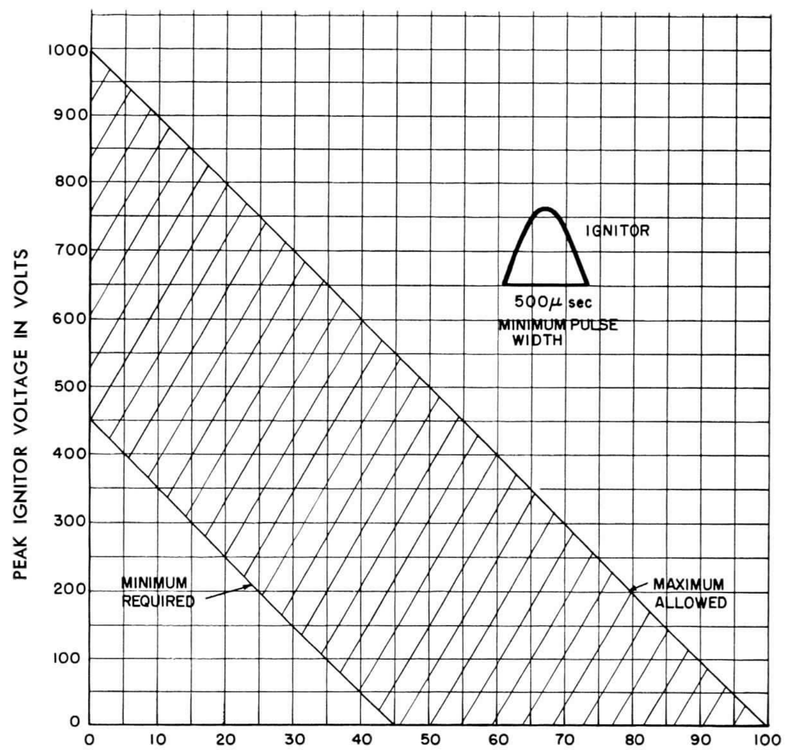
R_I:
- ANODE VOLTAGE = 600 VOLTS OR LESS—4 OHMS
- ANODE VOLTAGE = 601 VOLTS TO 1000 VOLTS—10 OHMS
- ANODE VOLTAGE = 1001 VOLTS TO 1500 VOLTS—20 OHMS
- ANODE VOLTAGE = 1501 VOLTS TO 2000 VOLTS—35 OHMS
- ANODE VOLTAGE = 2001 VOLTS TO 2400 VOLTS—50 OHMS

R_g = 500 OHMS
C_B = 8 MFD
C_G = 0.1 MFD
FUSE = 6 AMPERES

R_{HA} = PROPER RESISTANCE TO PROVIDE NECESSARY STABILIZING CURRENT CALLED FOR ON K-69087-72A387

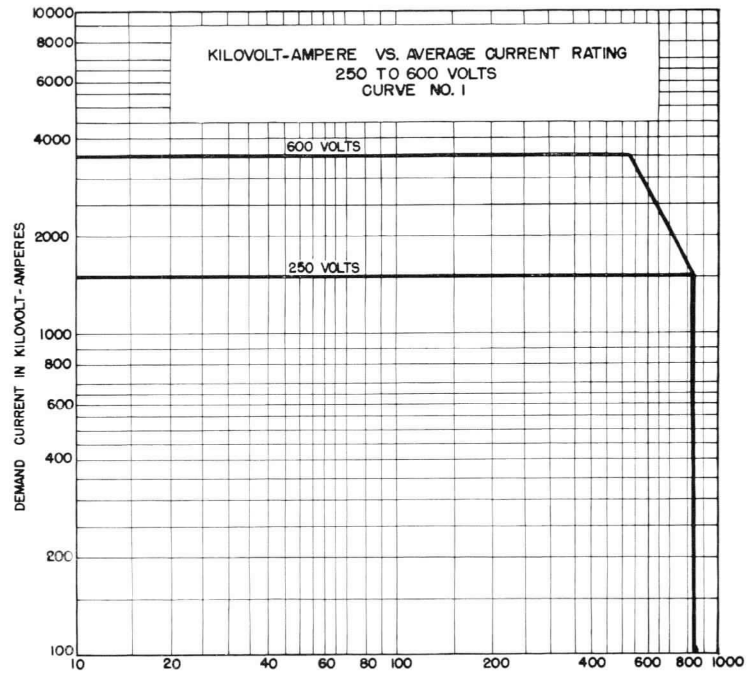
IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED
TO OPERATE WITHIN THE SHADED AREA



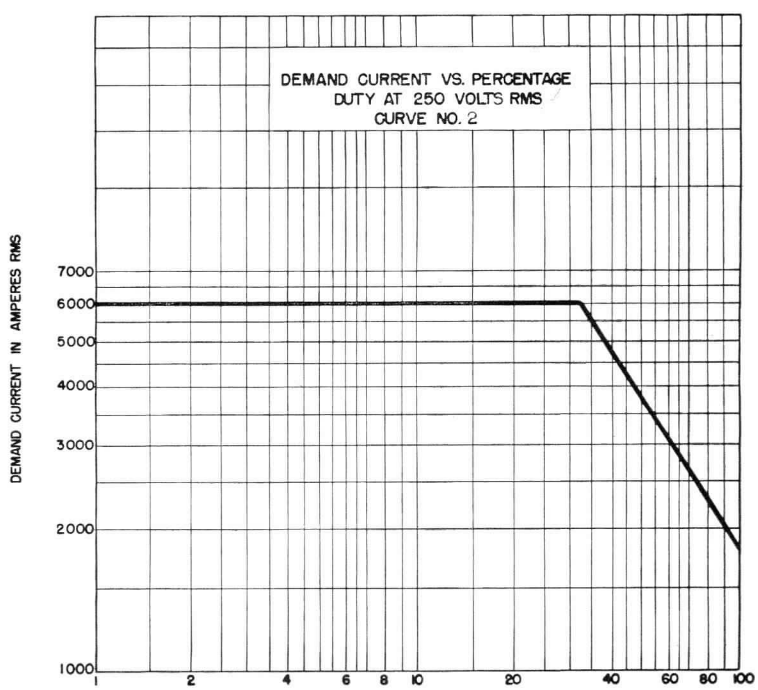
PEAK IGNITOR CURRENT IN AMPERES

K-69087-72A982 9-2-60



AVERAGE ANODE CURRENT IN AMPERES PER TUBE

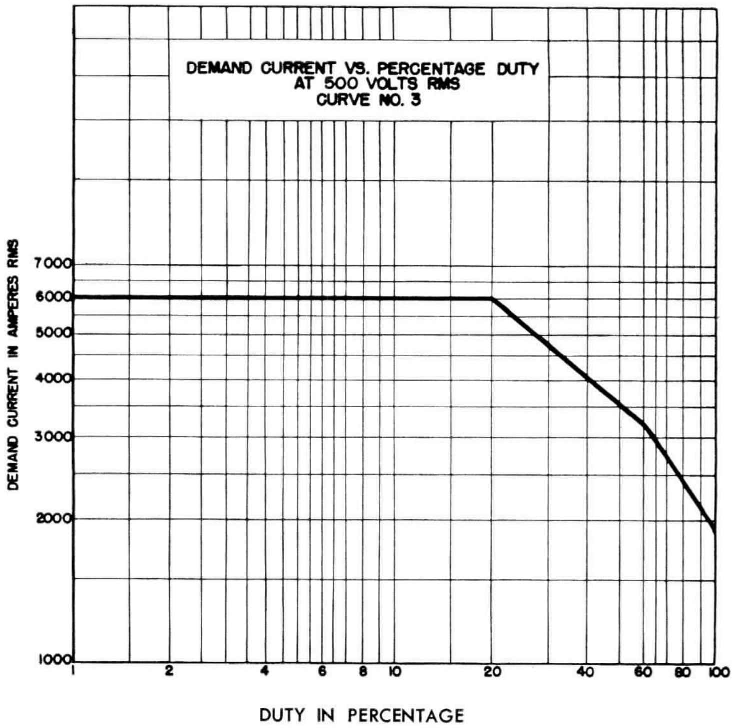
K-69087-72A666 6-20-58



DUTY IN PERCENTAGE
2 TUBES CONNECTED IN INVERSE PARALLEL

AVERAGING TIME = 9 SECONDS

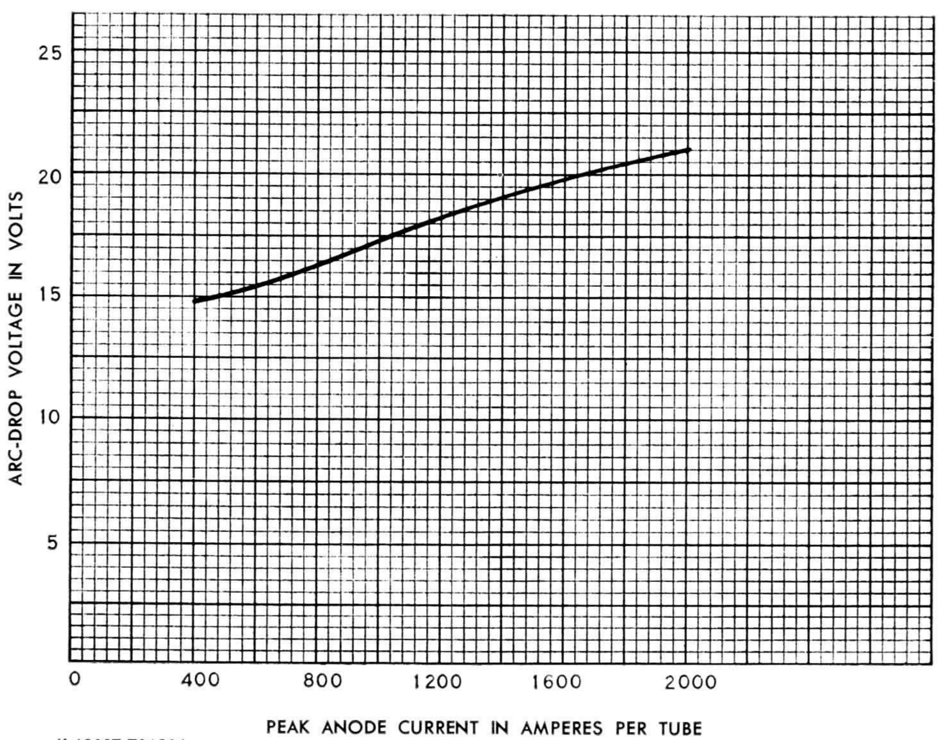
K-69087-72A667 6-20-58



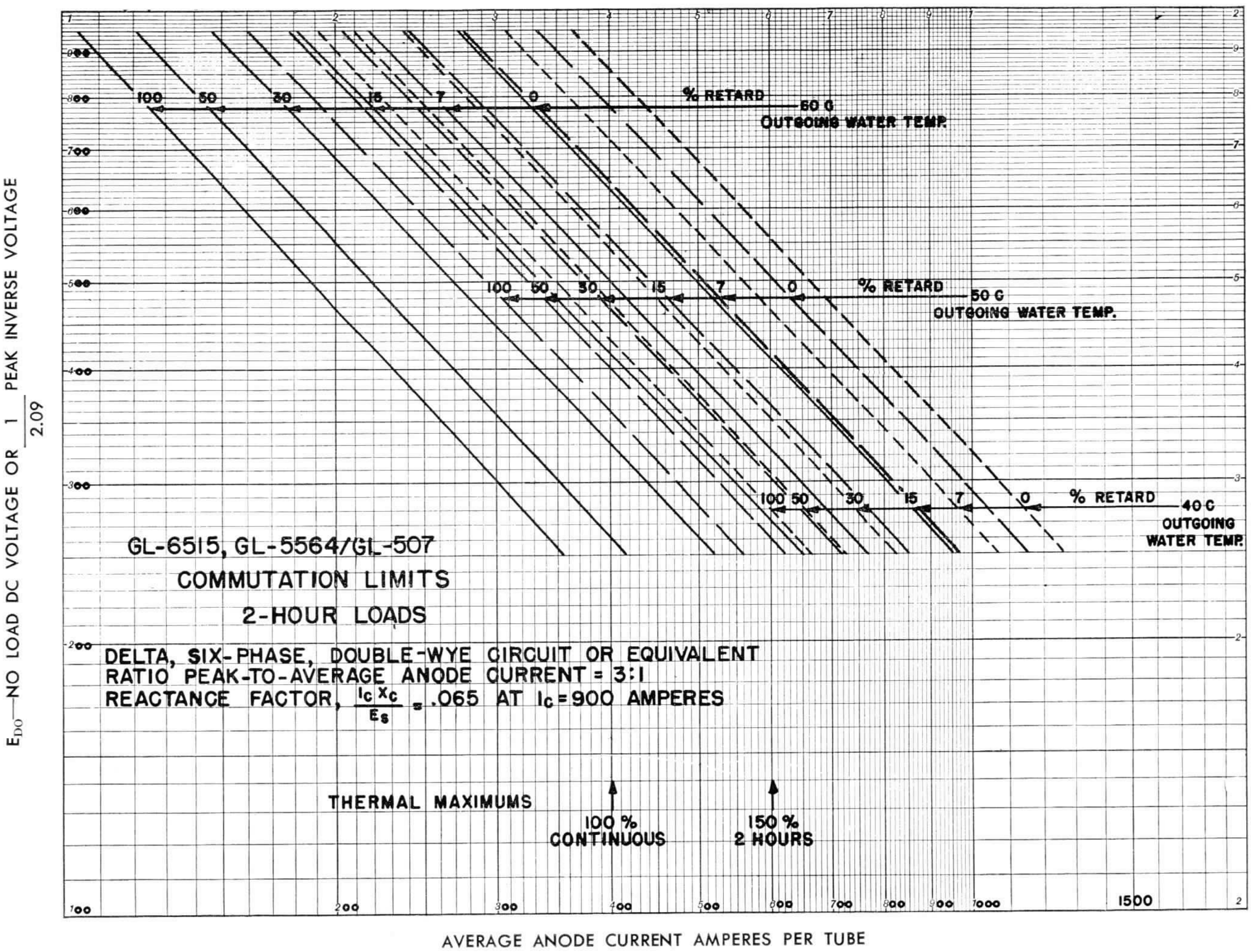
2 TUBES CONNECTED IN INVERSE PARALLEL

K-69087-72A668 6-20-58

ARC-DROP CHARACTERISTIC

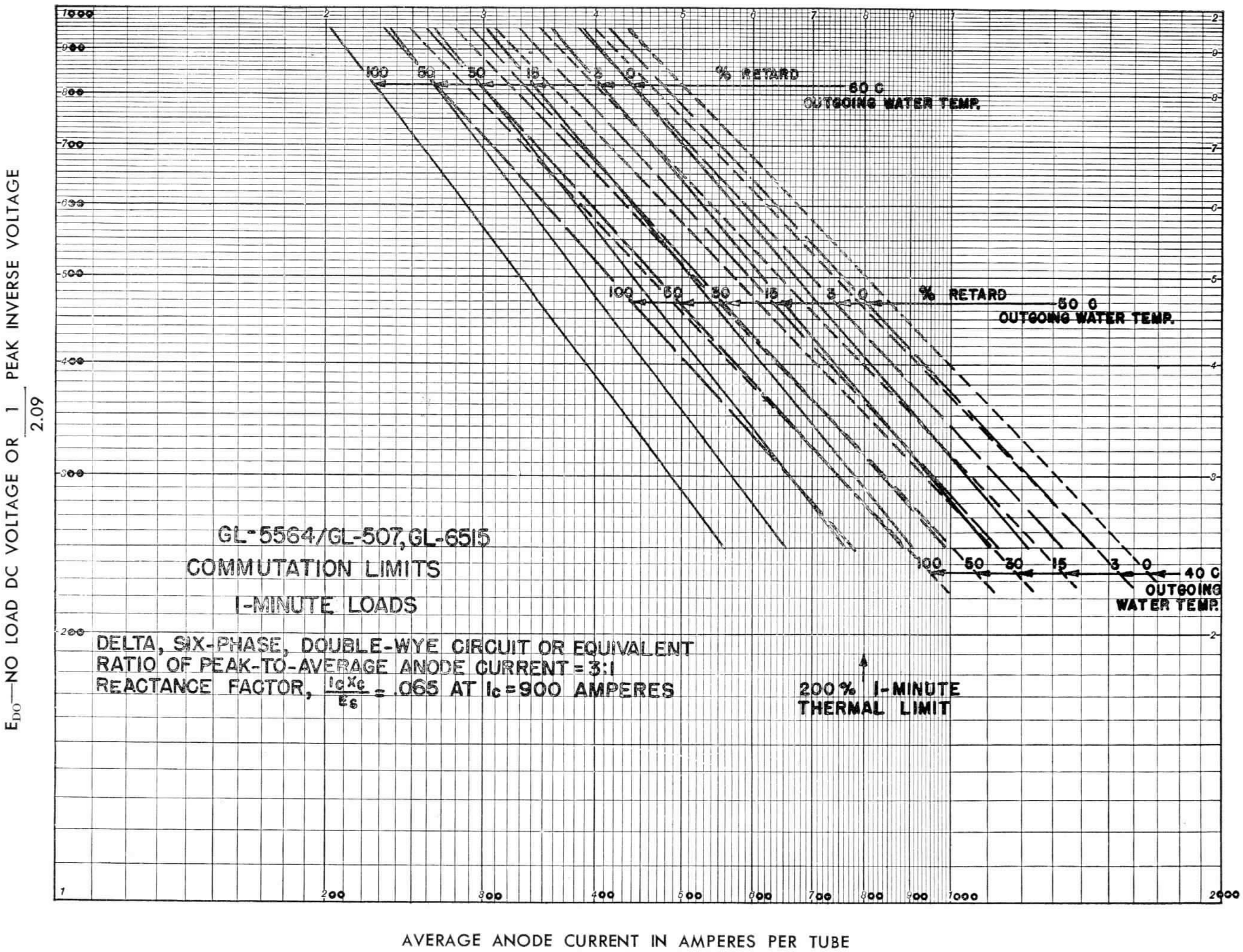


K-69087-72A324 12-8-54



K-69087-72A178

10-20-54



K-69087-72A179

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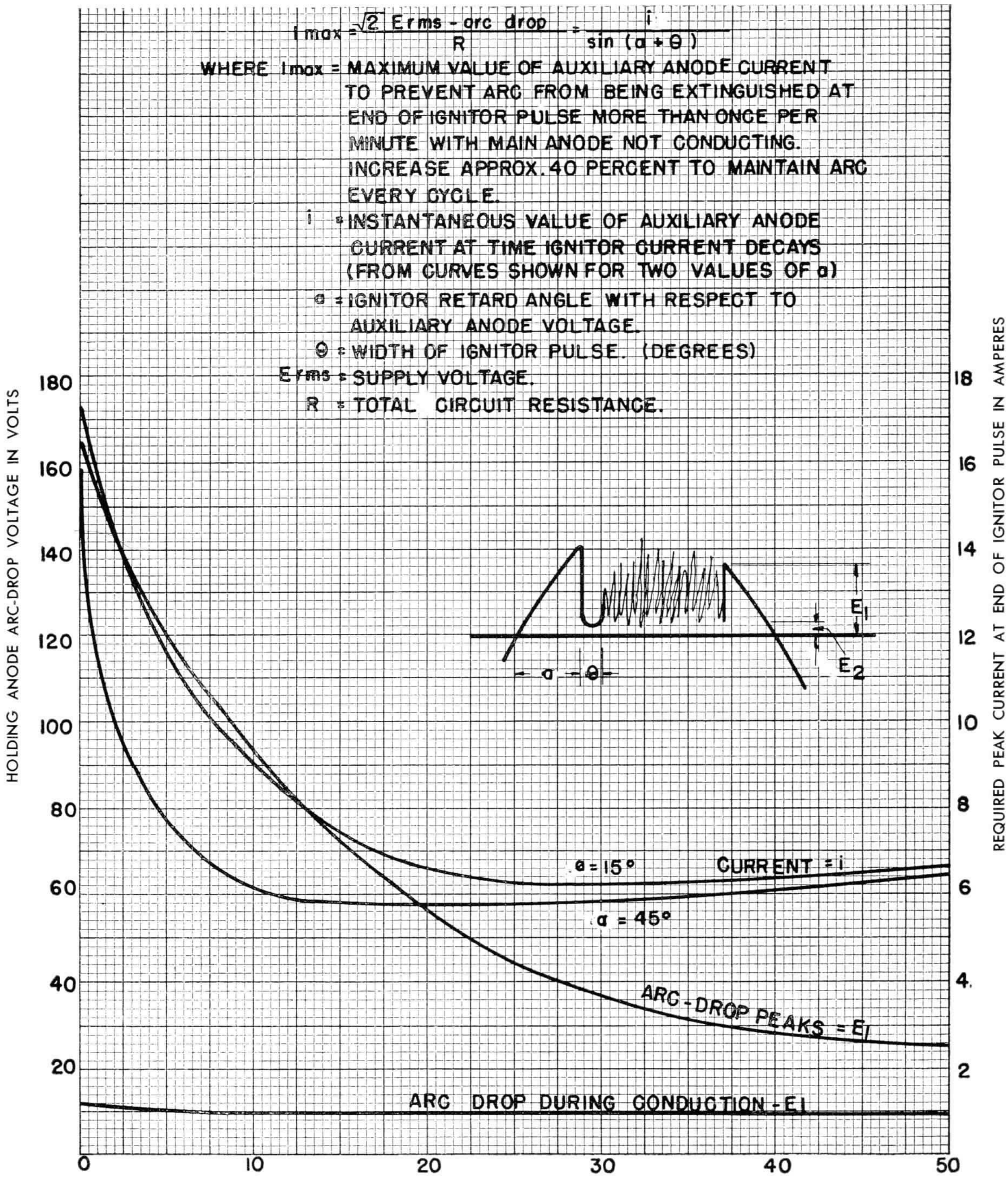
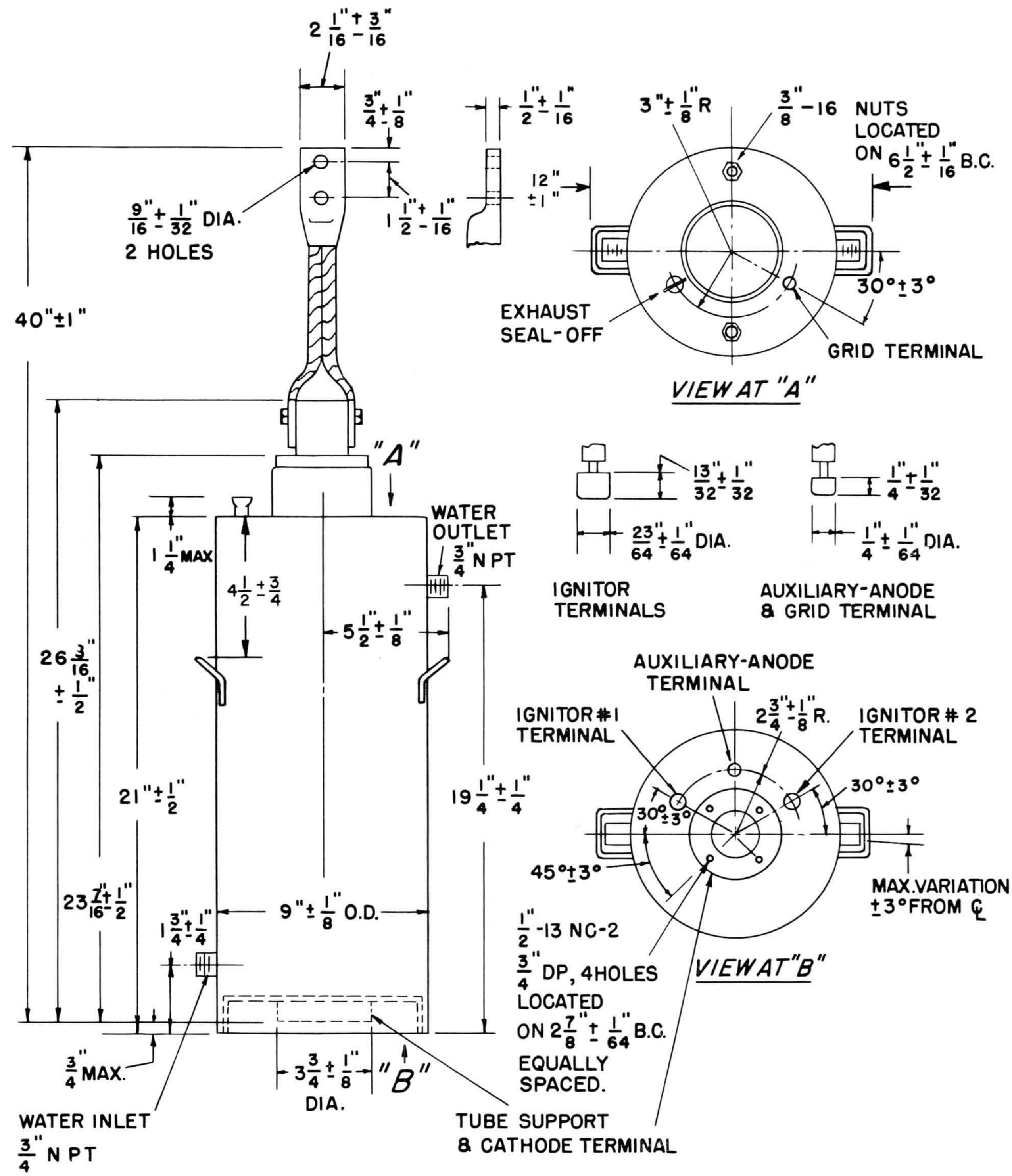
HOLDING ANODE REQUIREMENTS



K-69087-72A387

12-1-54



K-69087-72A956

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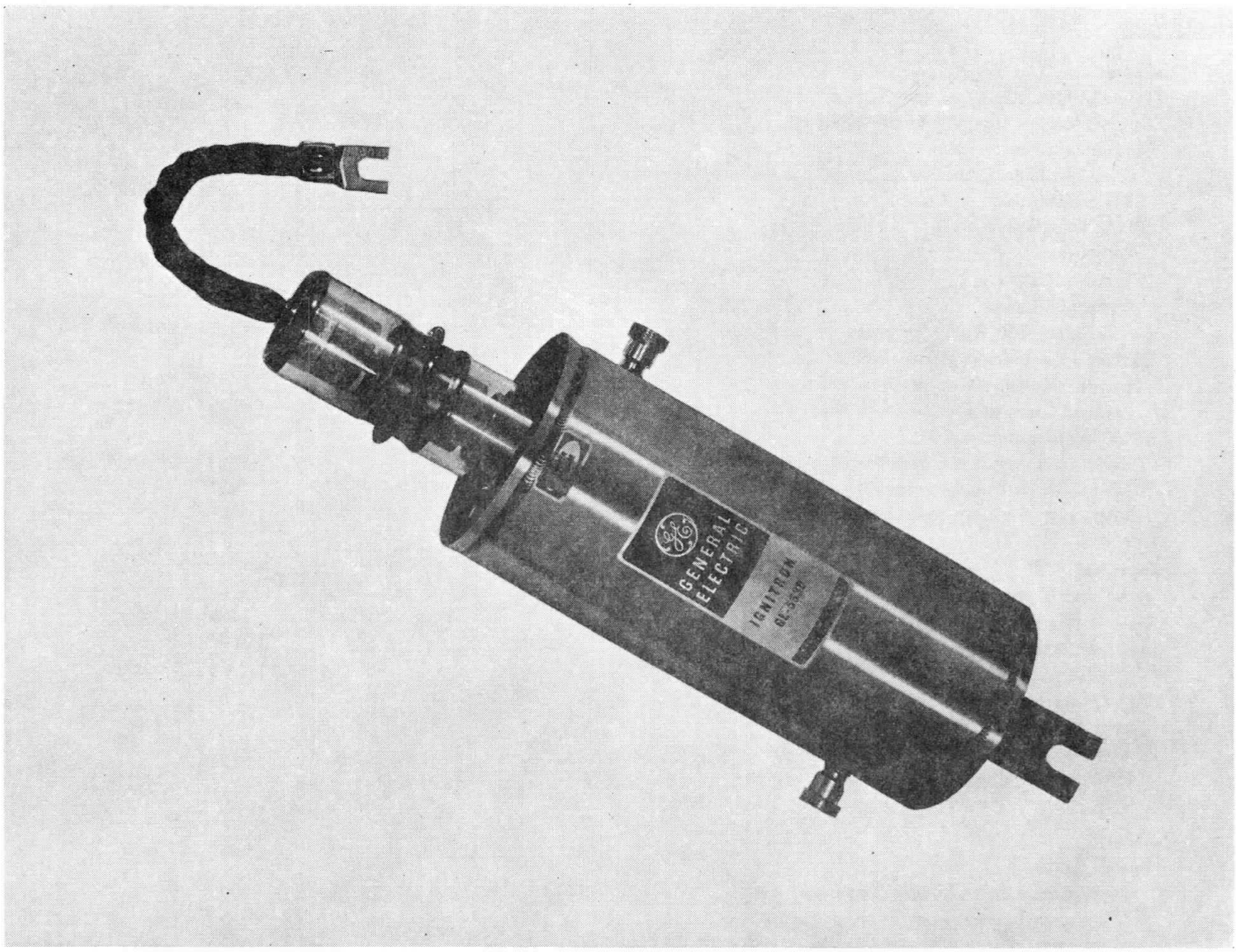
GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.

PRINTED IN U.S.A.



IGNITRON

The GL-5630 ignitron is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube designed primarily for use in radio-transmitter power supplies. In this service 6 tubes will rectify up to 2500 kilowatts at 17,000 volts. Use of the grid to prevent conduction gives one-cycle circuit-breaker action.

X-RAY WARNING NOTICE

This device may produce X-rays when energized. X-ray warning signs or labels should be permanently attached to the equipment.

Precautions must be exercised during the service and operation of equipment to assure that any shielding components are replaced to their intended position before the equipment is operated.

GENERAL

Electrical

Type Cathode Excitation—Cyclic
Type Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Holding Anodes	1	
Ignitors	2	
Control Grids	1	
Gradient Grids	1	
Arc Drop at 150 Peak Amperes	18 ± 1	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	450	Volts
Ignitor Current Required to Fire	42	Amperes
Grid Requirements		
Positive Current to Establish Conduction	0.200	Amperes
Minimum Voltage to Establish Conduction	+100	Volts
Minimum Voltage to Prevent Conduction	−50	Volts

Mechanical

Envelope Material—Metal

Over-all Length, maximum	$22\frac{3}{16}$	Inches
Over-all Width, maximum	$5\frac{3}{4}$	Inches
Net Weight	23 ± 2	Pounds

Type Cooling—water
Characteristics for Water Cooling

Water Temperature Rise, maximum	2	C
Pressure Drop at 3 Gallons per Minute	4	Pounds per Square Inch

Thermal

Water Cooling

Maximum Outlet Water Temperature	45	C
Minimum Inlet Water Temperature	35	C
Minimum Water Flow at Continuous Rated Average Current	3	Gallons per Minute
Minimum Water Flow at no Load	3	Gallons per Minute

MAXIMUM RATINGS

AS POWER RECTIFIER TUBE

Ratings are for zero phase-control angle.

Maximum Peak Anode Voltage		
Inverse	20,000	Volts
Forward	20,000	Volts
Main Anode Current		
Peak	200	Amperes
Average		
Continuous	50	Amperes
2 Hours	50	Amperes
1 Minute	50	Amperes
Surge	2000	Amperes
Maximum Duration of Surge Current	0.15	Seconds
Frequency Range	25–60	Cycles per Second

IGNITOR

Maximum Voltage		
Positive	1000	Volts
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
RMS	17.5	Amperes
Average	2.5	Amperes
Maximum Averaging Time	10.0	Seconds
Starting Time at Required Voltage or Current	100	Microseconds

HOLDING ANODE

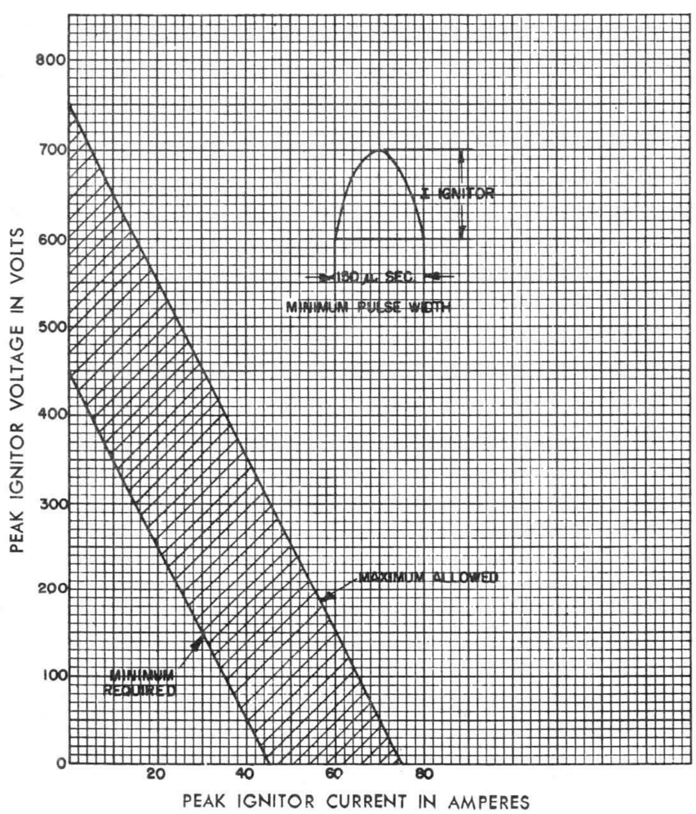
Maximum Current		
Peak	20	Amperes
Average	5	Amperes
Maximum Averaging Time	1	Second
RMS	10	Amperes
Maximum Peak Forward Voltage	200	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode not Conducting	150	Volts

CONTROL GRID

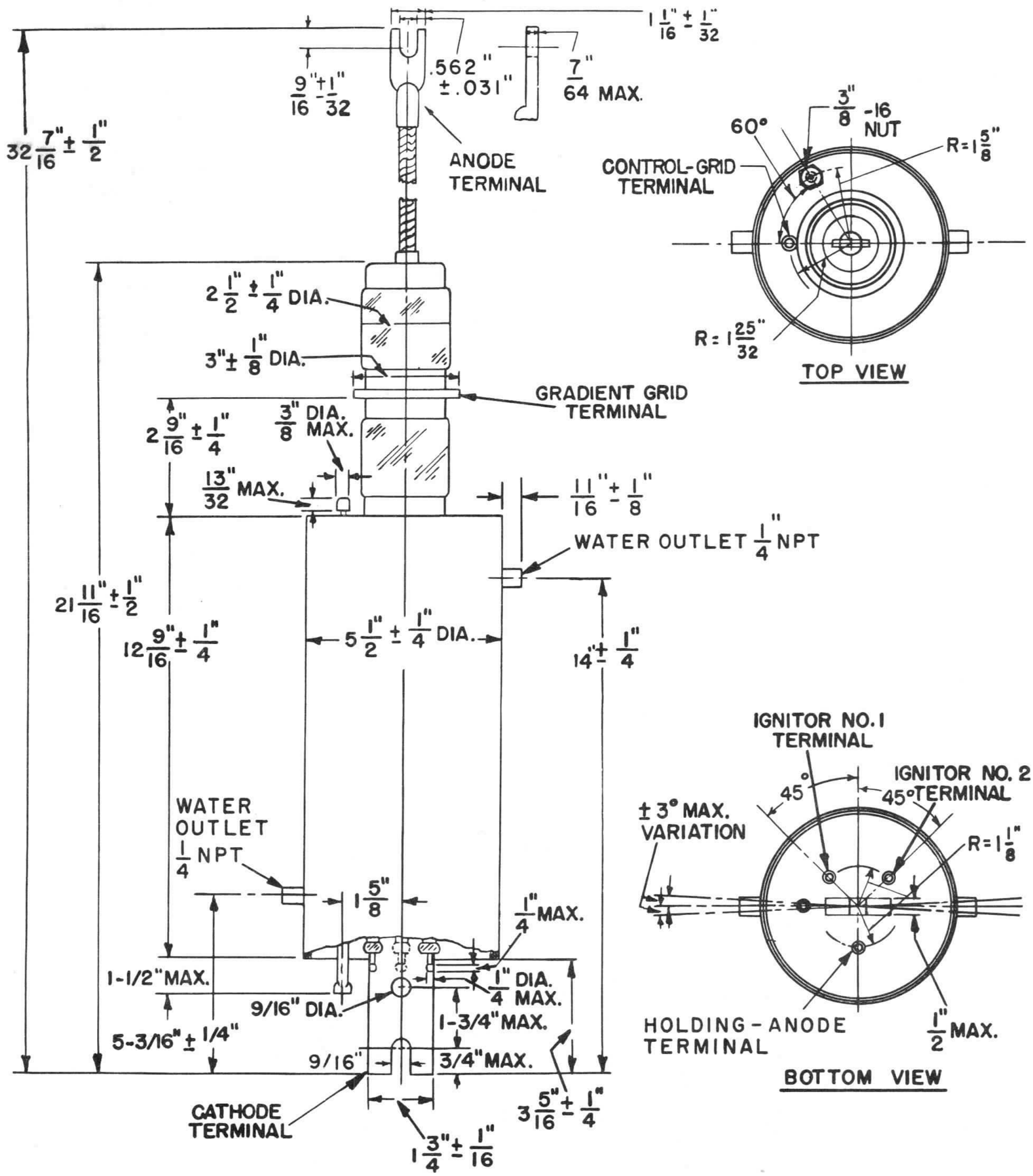
Maximum Peak Forward Voltage	500	Volts
Maximum Peak Inverse Voltage	200	Volts
Maximum Grid-Current		
Peak Positive	5.0	Amperes
Peak Negative	0.1	Amperes
Average	1.0	Amperes
RMS	2.0	Amperes

IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA.

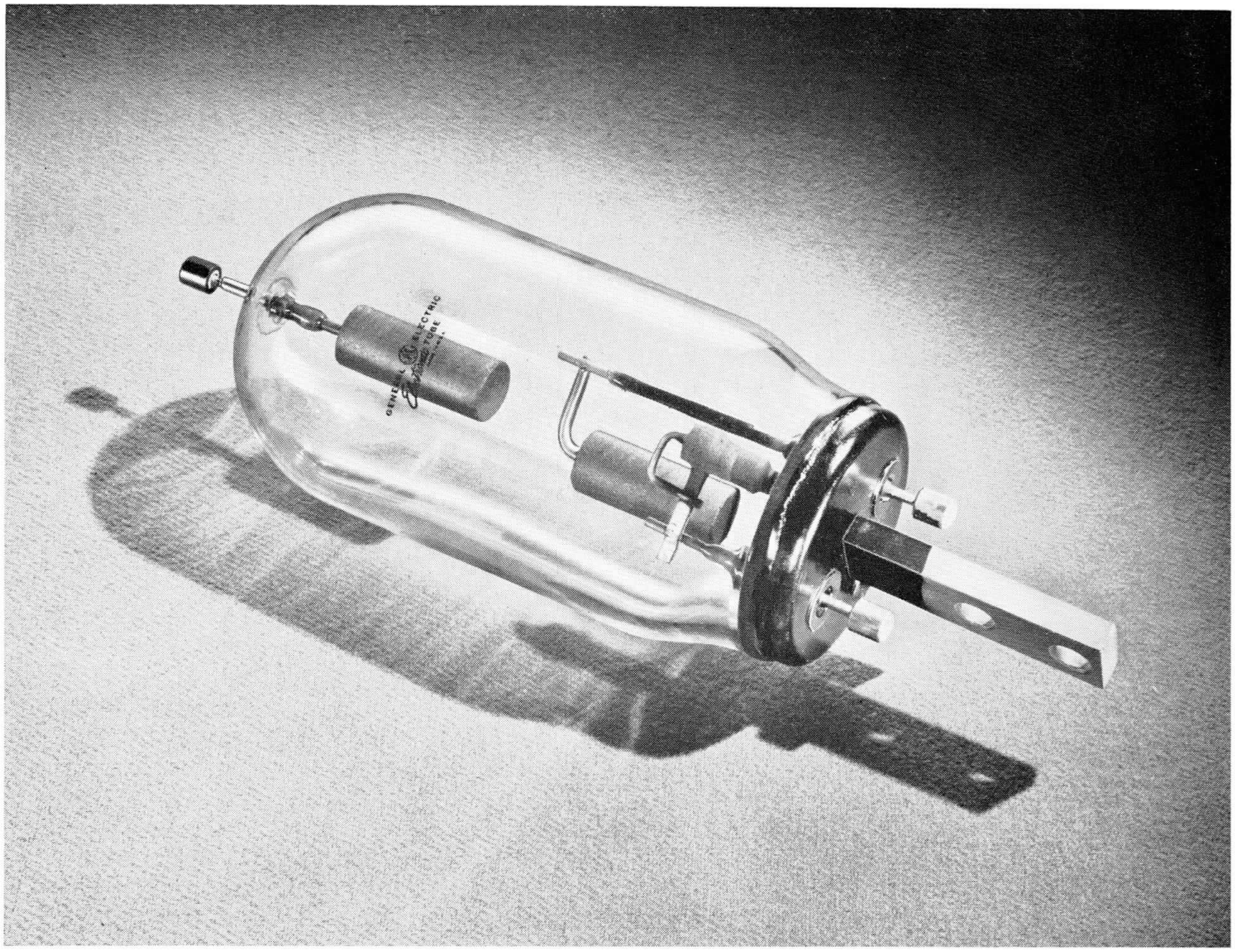


K-9033883 5-25-54



N-22003AZ

3-8-63



IGNITRON

DEMONSTRATION TYPE **10 AMPERES**

The GL-5779 is a small glass, air-cooled ignitron tube designed primarily for demonstrating the operating principles of ignitors and ignitron tubes.

GENERAL

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Auxiliary Anodes	1	
Ignitors	1	
Control Grids	0	
Auxiliary Grids	0	
Arc Drop at 15 Peak Amperes	13±2	Volts

Cathode Excitation Requirements

Ignitor Voltage Required to Fire	150	Volts
Ignitor Current Required to Fire	40	Amperes

(See Curve 9033883 for Ignitor Circuit Requirements)

Starting Time at Required Voltage or Current	100	Microseconds

GENERAL ELECTRIC

Supersedes ET-T1376 dated 12-56

Mechanical

Envelope Material—Glass

Over-all Length	8¼	Inches
Over-all Width	2½	Inches
Net Weight	1½	Pounds

Thermal

Type of Cooling—Air*

Maximum Average Tube Temperature	100	C
Minimum Average Tube Temperature	10	C

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier Service

Ratings are for Zero-Phase-Control Angle

Maximum Peak Anode Voltage		
Inverse	350	Volts
Forward	350	Volts
Maximum Anode Current		
Peak	30	Amperes
Average		
Continuous	10	Amperes
Fault	300	Amperes
Maximum Duration of Fault Current	0.03	Seconds
Frequency Range	25–60	Cycles per Second

Ignitor

Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
Root Mean Square	15	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds

Holding Anode

Maximum Current		
Peak	20	Amperes
Average	5	Amperes
Maximum Averaging Time	1.0	Seconds
Root Mean Square	10	Amperes
Maximum Peak Forward Voltage	150	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	150	Volts

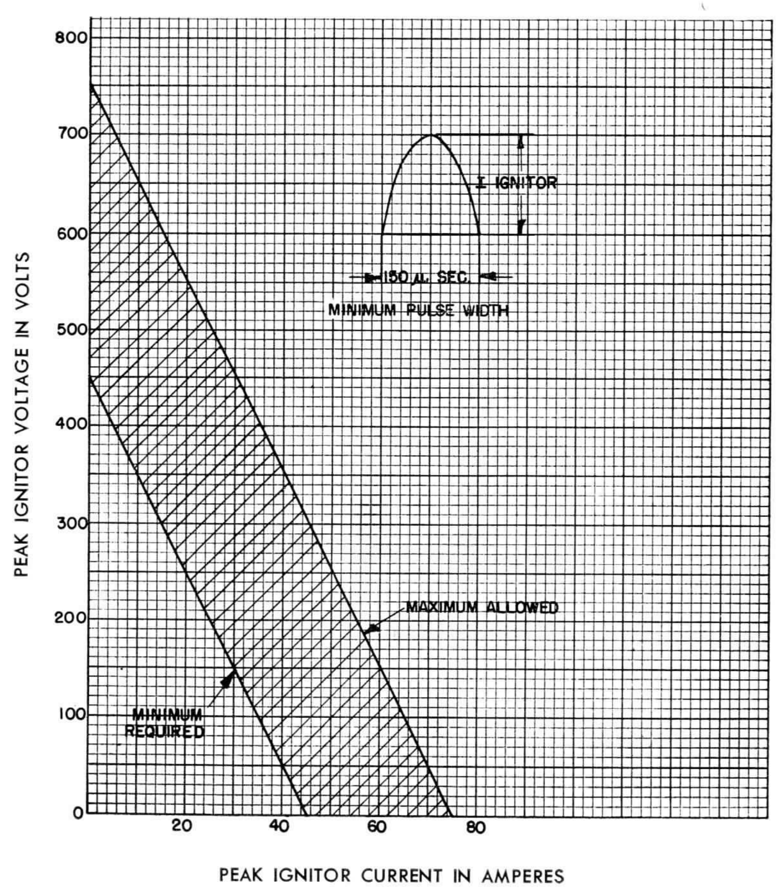
Cathode

Maximum Average Current	10	Amperes

* An ordinary desk fan will provide sufficient cooling for most purposes.

IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



K-9033883

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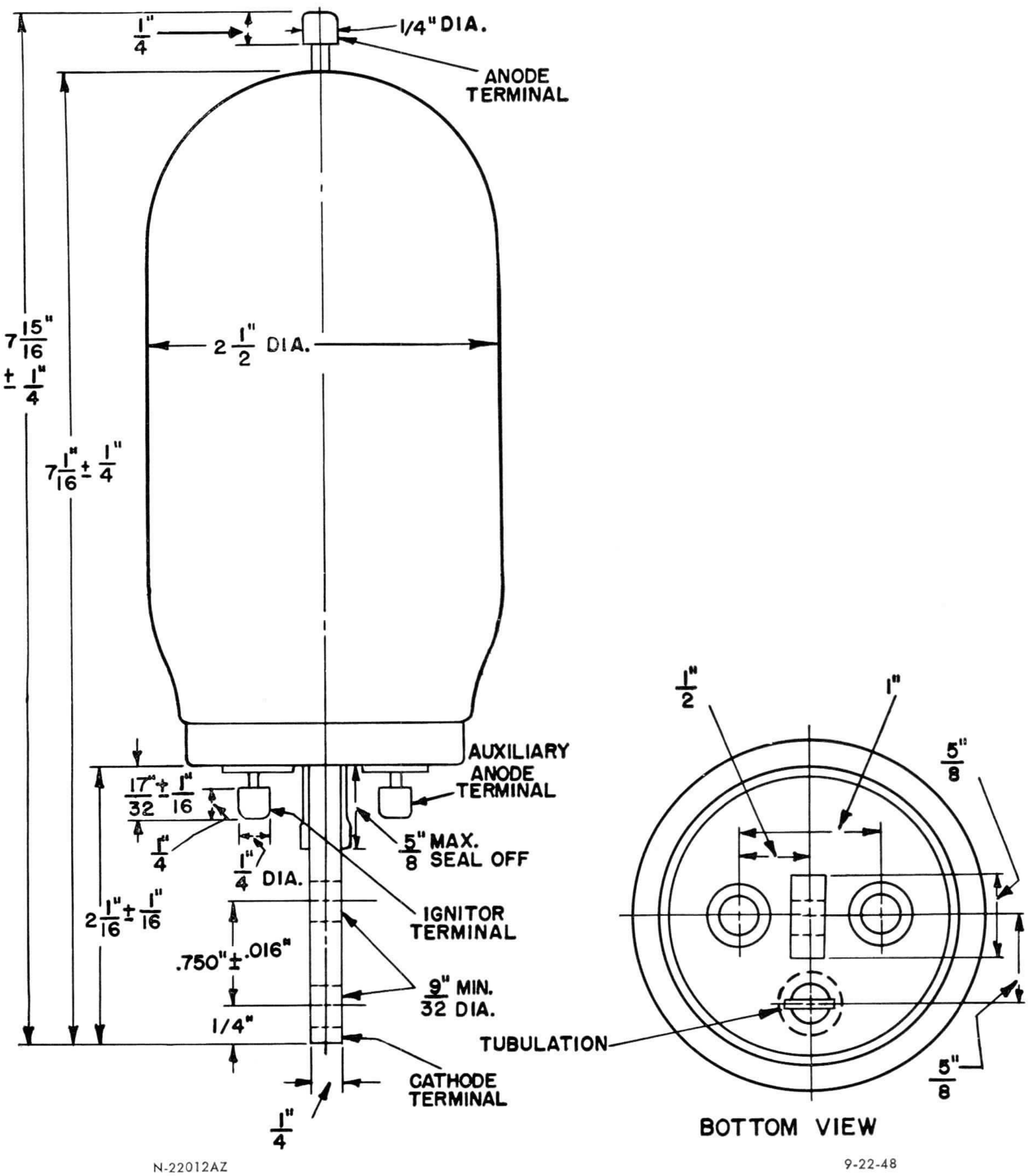


N-22012AZ

9-22-48

PRODUCT INFORMATION

IGNITRON

GL-5788

GL-5788

RECTIFIER SERVICE—150 AMPERES
AC CONTROL SERVICE—2400 KILOVOLT-AMPERES
HOLDING ANODE — TWO IGNITORS

The GL-5788 is a permanently sealed, water-cooled, rectifier ignitron similar in construction and rating to the GL-5555. Special features are reliable operation at higher water temperature and lower water-pressure drop than are possible with that tube, and distinctive (larger diameter) ignitor terminals. These features make possible the use of economical water-to-air heat exchangers at higher ambient temperatures than are possible with the other tube and assure the user against premature ignitor failures caused by connecting the holding-anode lead to an ignitor terminal. The tube is designed for operation in 300-, 600-, and 900-volt d-c industrial-rectifier circuits. The continuous average anode current rating is 150 amperes per tube.

ELECTRICAL

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes
- Main Anodes 1
- Main Cathodes 1
- Holding Anodes 1
- Ignitors 2

Arc Drop at 600 Amperes Peak . . . . . 16.2 ± 0.5 Volts
See Curve "Arc Drop"

MECHANICAL

Envelope Material—Stainless Steel
Net Weight, approximate . . . . . 25 Pounds

THERMAL

Type of Cooling—Water
Operating Range* . . . . . 40–60 C
Outlet Water Temperature, maximum
- Power-Rectifier Service
  - Peak Inverse Anode Voltage = 900 Volts and Below . . . . . 60 C
  - Peak Inverse Anode Voltage = 2100 Volts and Below . . . . . 55 C
- AC Control Service
  - Voltage = 2400 Volts RMS . . . . . 45 C

Water Flow, minimum, solenoid water valve open
- At No Load† . . . . . 1 Gallon per Minute
- At Continuous Rated Average Current . . . . . 3 Gallons per Minute

Characteristics for Water Cooling at Rated Minimum Flow
- Water Temperature Rise, maximum . . . . . 4.5 C
- Pressure Drop at 3 Gallons per Minute, maximum . . . . . 3 Pounds per Square Inch

* With heat-exchanger systems the tube may be started at the usual ambient temperatures, 20 to 30 C, minimum 6 C; and the losses in the tube allowed to bring the heat exchanger to the controlled temperature setting. With direct (once through) water cooling and the companion GL-6514 temperature-controlled ignitron, automatic control of the water-outlet temperature is practicable for operation with provision for the recommended cooling period after shut-down, provided that not more than three tubes are connected in series.

† Water flow should be continued for at least thirty minutes after removal of anode power.

MAXIMUM RATINGS

Power-Rectifier Service, Continuous Duty

Ratings are for Zero-Phase-Control Angle—See Curves "Commutation Limits"

Maximum Peak Anode Voltage
- Inverse . . . . . 900–2100 Volts
- Forward . . . . . 2100 Volts

Maximum Anode Current
- Peak . . . . . 1200 Amperes
- Average
  - Continuous . . . . . 150 Amperes
  - Two-Hours—Averaged Over Any Two-Minute Interval . . . . . 225 Amperes
  - One-Minute—Averaged Over Any One-Minute Interval . . . . . 300 Amperes
- Fault . . . . . 9000 Amperes
  - Maximum Duration of Fault Current . . 0.15 Seconds

Frequency Range . . . . . 25–60 Cycles per Second

AC Control Service

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage . . . . . 2400 Volts RMS
Maximum Demand . . . . . 2400 Kilovolt-Amperes
- Average Current at Maximum Demand . . . 135 Amperes

Maximum Average Current . . . . . 207 Amperes
- Demand at Maximum Average Current . . 1105 Kilovolt-Amperes

Maximum Averaging Time at 2400 Volts RMS . . . . . 1.66 Seconds
Maximum Peak Fault Current . . . . . 6000 Amperes
Frequency Range . . . . . 25–60 Cycles per Second

MAXIMUM RATINGS (Cont'd)

Holding Anode

See Curve "Holding Anode Requirements"

Maximum Peak Voltage

Forward	160	Volts
Inverse		
Main Anode Conducting	25	Volts
Main Anode Non-Conducting	160	Volts

Maximum Current

Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Cathode Excitation Requirements

Peak Excitation Arc Current Required, minimum	8	Amperes

See Curve "Holding Anode Requirements"

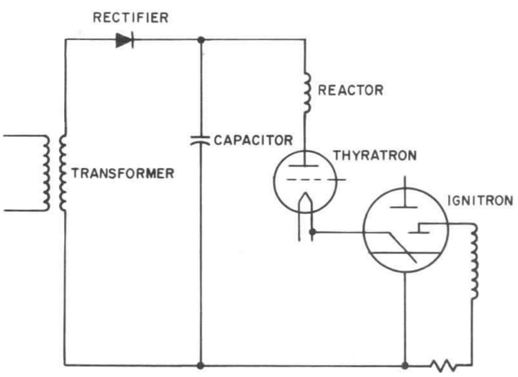
Excitation Arc-Drop Voltage	9±0.5	Volts
Excitation Arc Open-Circuit Voltage, minimum	55	Volts

Ignitor

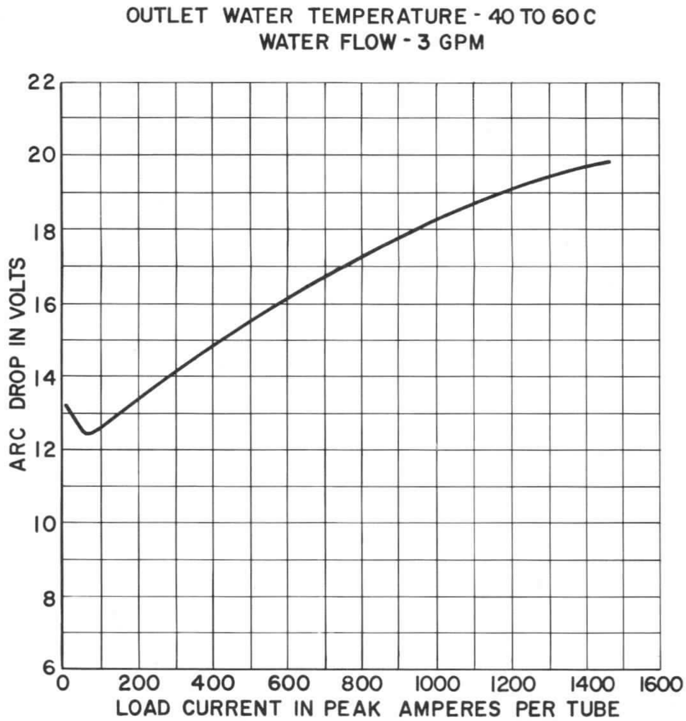
Maximum Inverse Voltage	5	Volts
Recommended Pulse Length	800	Microseconds
Minimum Pulse Length, for average anode currents greater than 5 amperes	150	Microseconds
Maximum Pulse Length	4000	Microseconds

Volt-Ampere Characteristics—See Curve "Ignitor Volt-Ampere Characteristics"

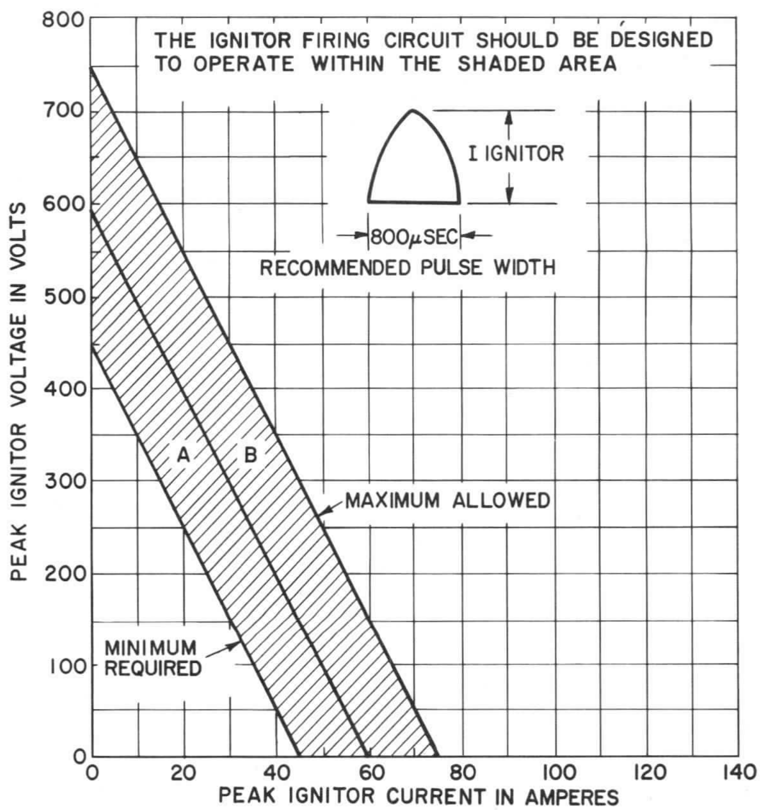
IGNITRONS
ELEMENTARY CIRCUIT FOR CAPACITOR FIRING



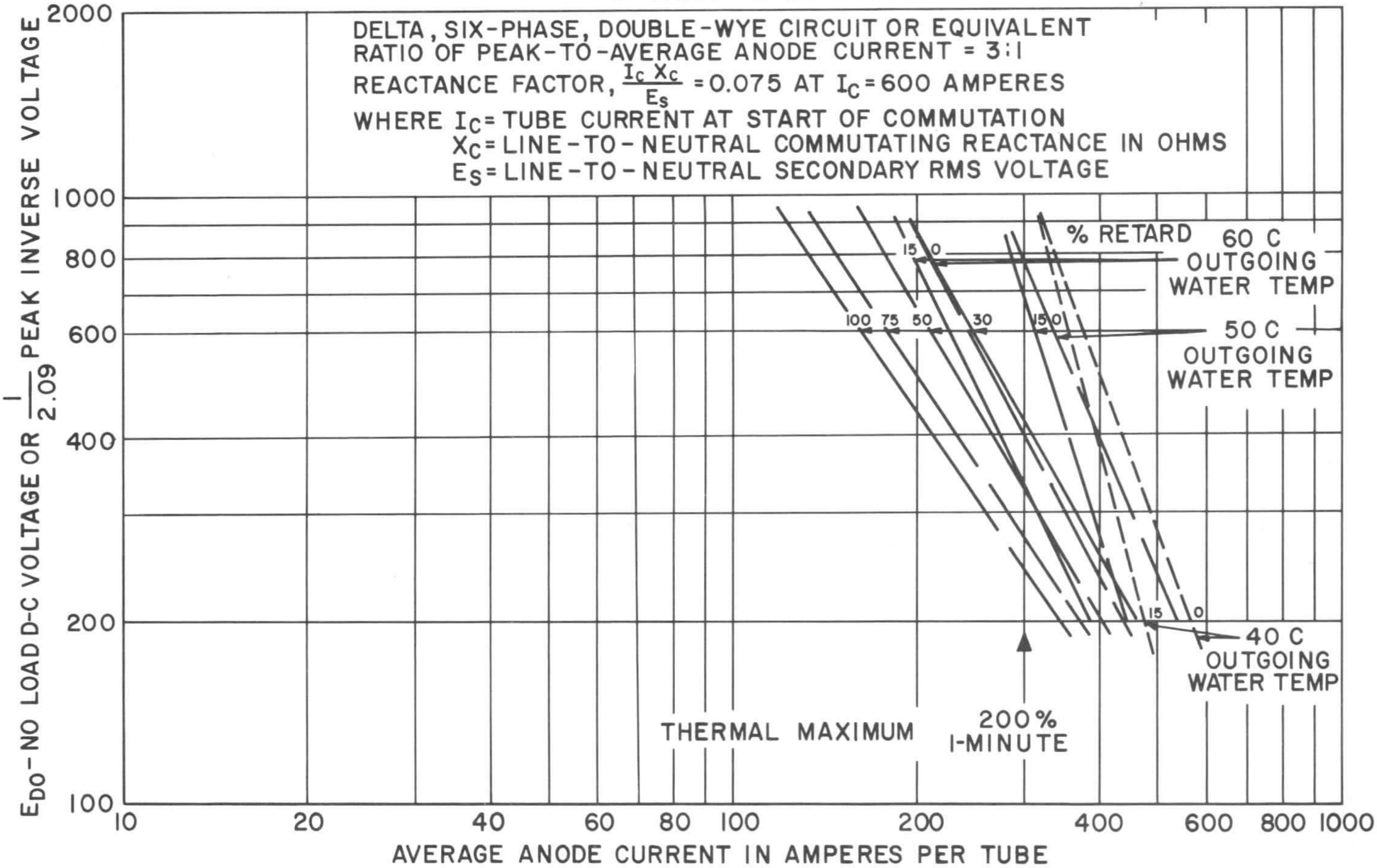
ARC DROP



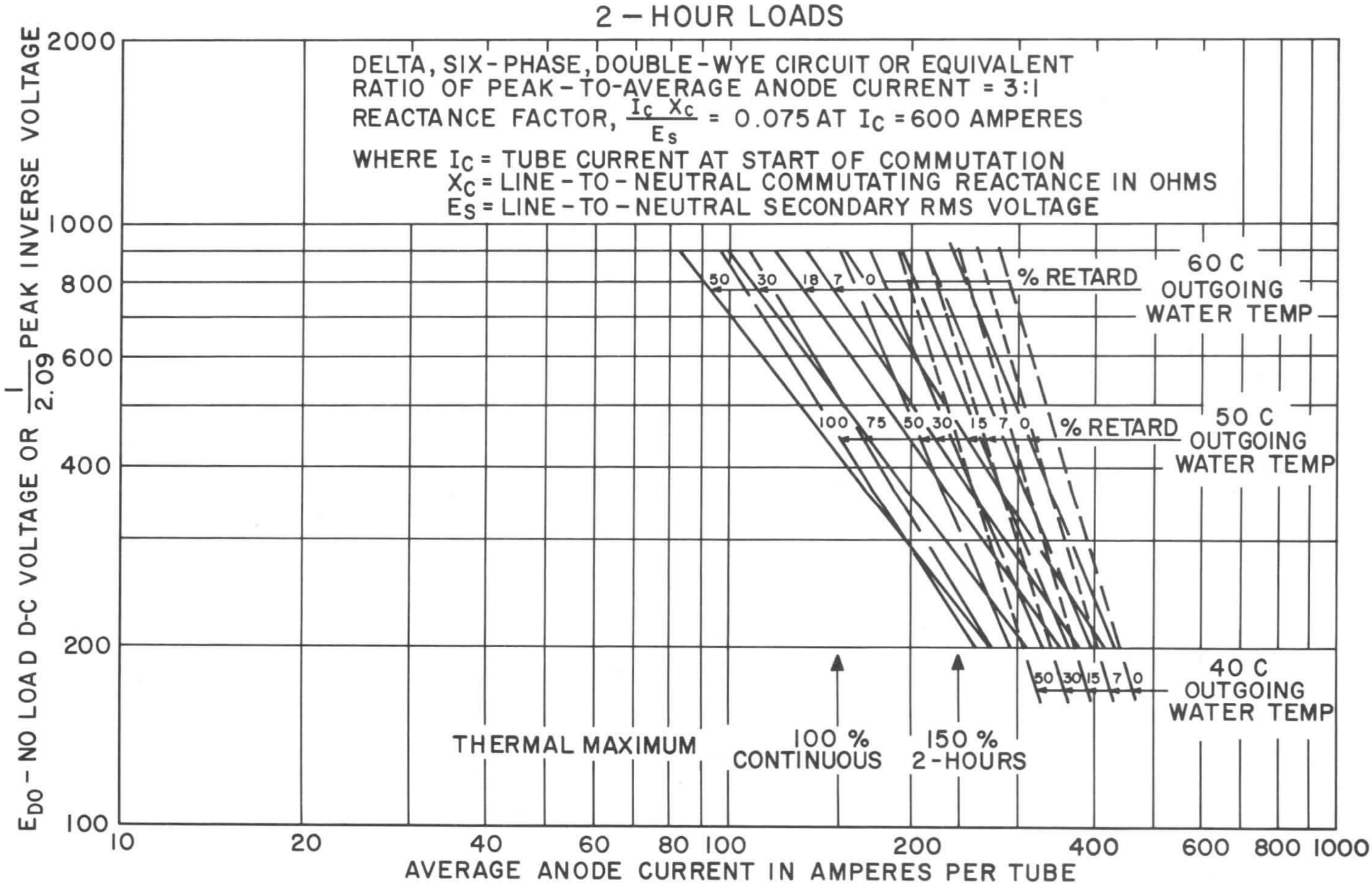
IGNITOR VOLT-AMPERE REQUIREMENTS



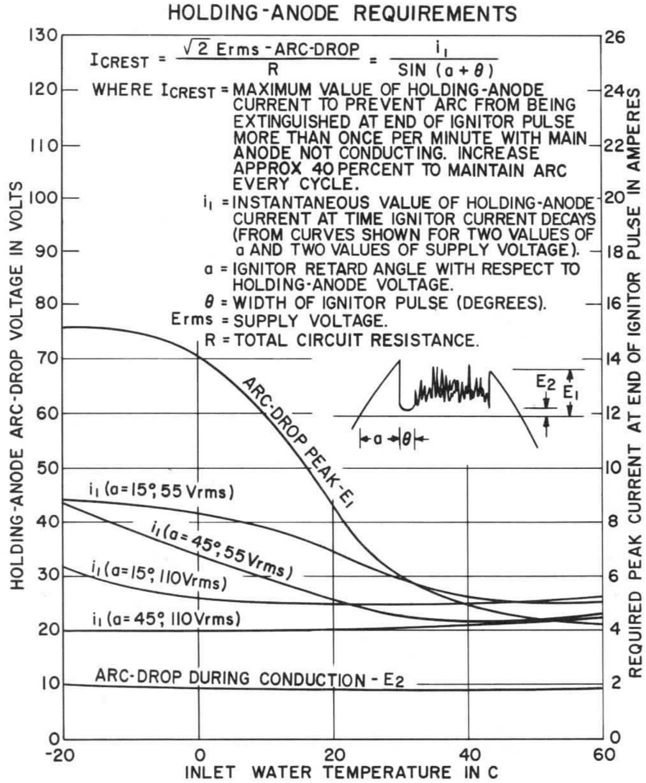
COMMUTATION LIMITS
1-MINUTE LOADS

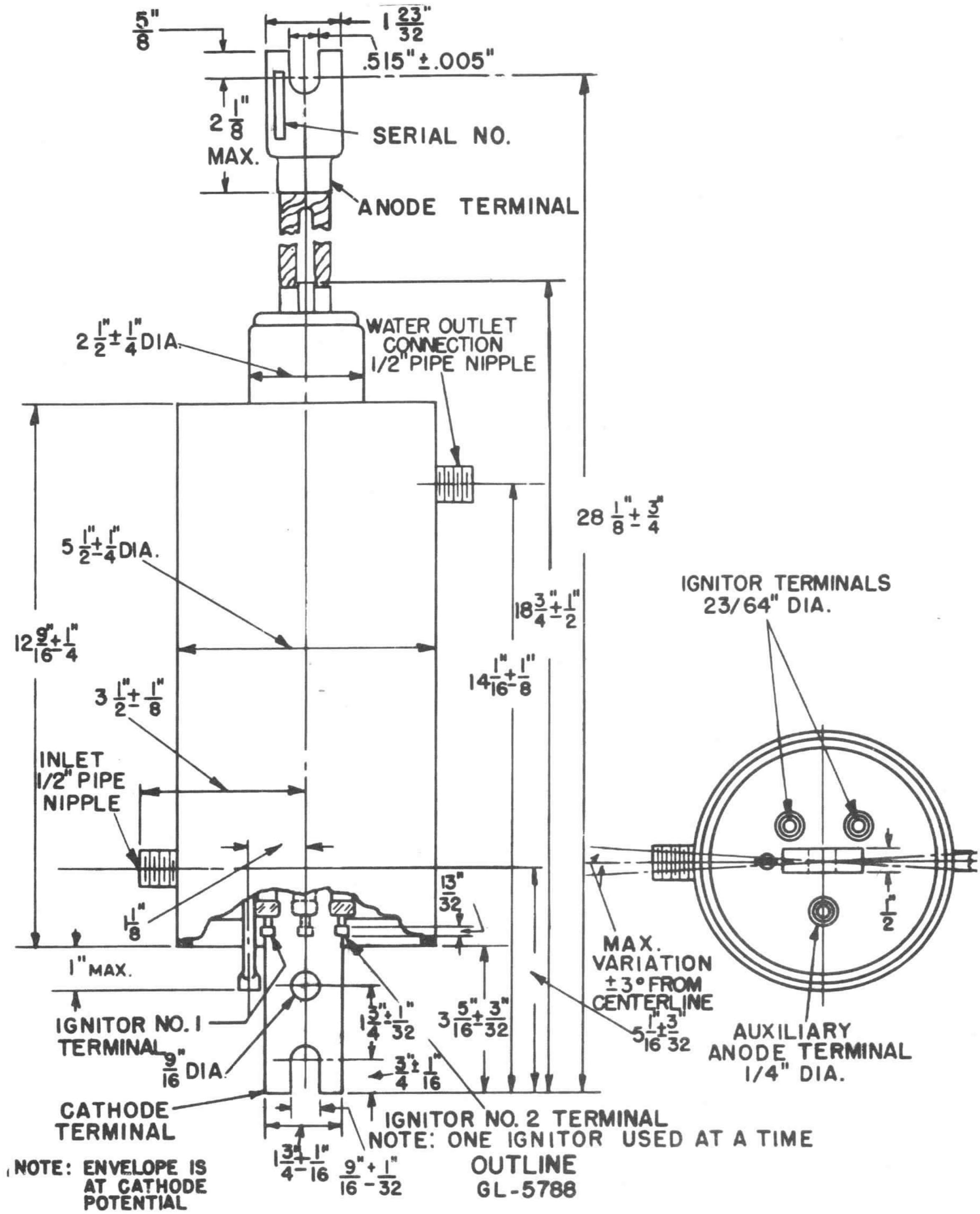


COMMUTATION LIMITS
2 — HOUR LOADS

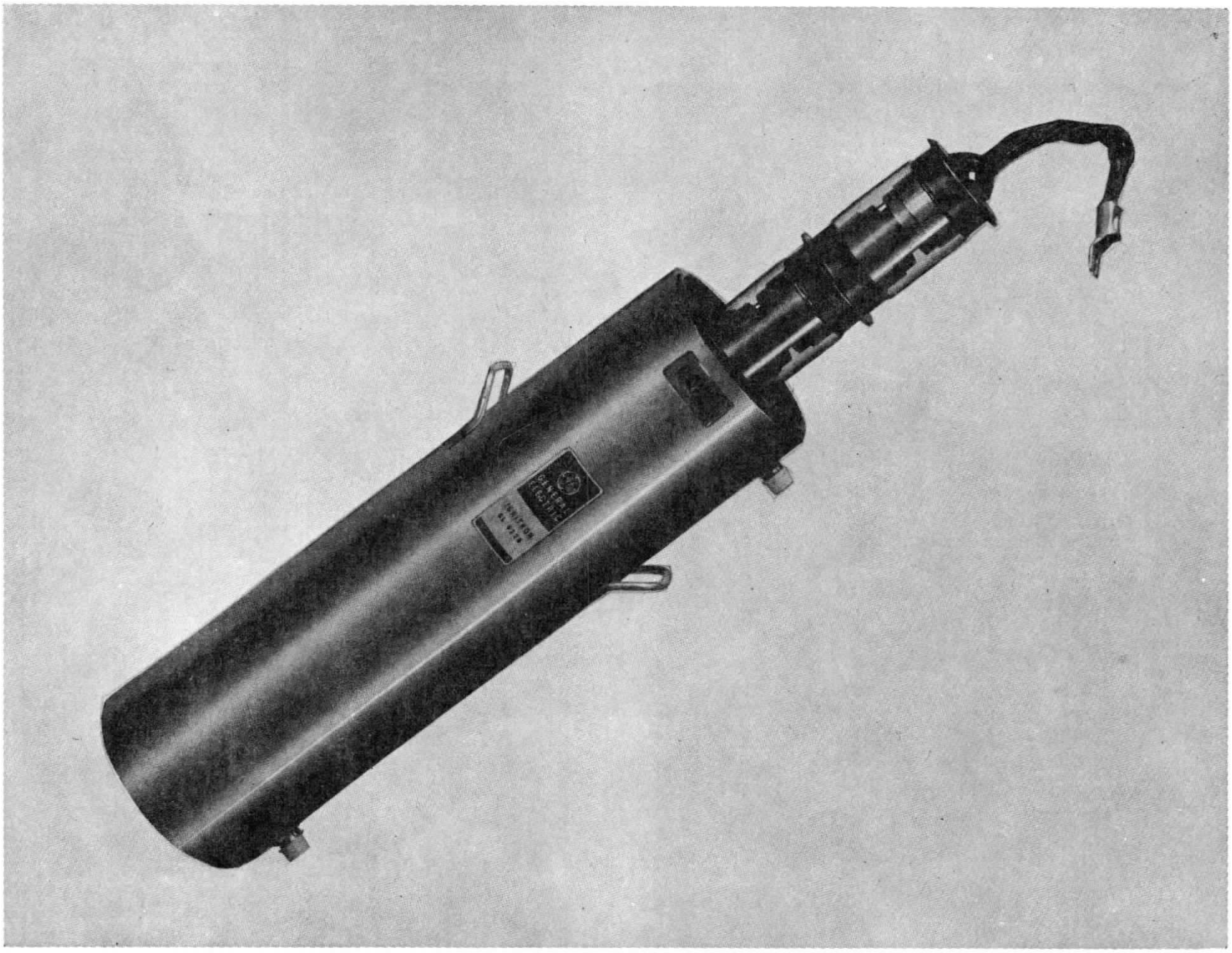


HOLDING-ANODE REQUIREMENTS





OUTLINE
GL-5788



IGNITRON

PENTODE TYPE FREQUENCY-CHANGER SERVICE

The GL-6228 ignitron is a sealed, stainless-steel-jacketed, water-cooled mercury-pool tube designed primarily for use in electronic frequency changers. In this service, six tubes will rectify or invert up to 7500 kilowatts at 17,000 volts. The tube is also designed for use in intermittent-rectifier service, capacitor-discharge service, and as a d-c short-circuiting switch.

GENERAL

Electrical

Type cathode excitation—Cyclic

Type cathode-spot starting—Ignitor

Number of electrodes

Main anodes	1	
Main cathode	1	
Ignitors	3	
Holding anodes	2	
Shield grids	1	
Control grids	1	
Gradient grids	1	

Arc drop

At 600 amperes peak	20 ± 2	volts
At 2000 amperes peak	30 ± 2	volts

GENERAL (CONT'D)

Electrical (Cont'd)

Cathode-excitation requirements
See specific class of service
Grid-excitation requirements
See specific class of service

Mechanical

Envelope material—metal
Net weight . . . 100±10 pounds

Thermal

Type of cooling—water
Characteristics for water cooling

Water temperature rise	4	C
Pressure drop at 5 gallons per minute, maximum	4	pounds per square inch
Inlet water temperature, minimum	35	C
Outlet water temperature, maximum	45	C
Water flow, minimum	5	gallons per minute
Recommended temperature range	40 to 45	C

MAXIMUM RATINGS

POWER-RECTIFIER SERVICE

	Minimum	Maximum	
ASA (See ASA Standards C34.1-1949)			
Peak anode voltage			
Inverse	—	20,000	volts
Forward	—	20,000	volts
Anode current*			
Peak	—	900	amperes
Average			
Continuous	—	150	amperes
2 hours	—	200	amperes
1 minute	—	300	amperes
Fault	—	6000	amperes
Duration of fault current ‡		0.15	second
Peak control-grid voltage			
Forward	200	500	volts
Inverse	100	200	volts
Peak shield-grid voltage			
Forward	200	500	volts
Inverse	50	200	volts
Peak control-grid current			
Forward	—	5	amperes
Inverse	—	0.4	amperes
Peak shield-grid current			
Forward	—	5	amperes
Inverse	—	0.2	amperes
Peak gradient-grid voltage			
Forward	1/2	1/2	anode-cathode voltage
Inverse	1/2	1/2	anode-cathode voltage
Peak gradient-grid current			
Forward	0.010	0.020	amperes
Inverse	0.010	0.020	amperes
Ignitor ratings			
Peak ignitor voltage			
Forward, open-circuit voltage	450	750	volts
Inverse	0	5	volts
Width of current pulse, sinusoidal waveshape			
At 60 cycles	500	1500	microseconds
At 25 cycles	500	4000	microseconds
Peak ignitor current, short-circuit current	45	75	amperes

MAXIMUM RATINGS (CONT'D)

POWER-RECTIFIER SERVICE (CONT'D)

	Minimum	Maximum	
Holding anode ratings			
Available instantaneous holding anode voltage during desired conduction period	40	—	volts
Peak holding-anode voltage			
Forward	—	200	volts
Inverse	—	25	volts
Peak holding-anode current			
Forward	—	20	amperes
Inverse	—	0.100	amperes
Average	—	5	amperes
RMS	—	10	amperes
Minimum			
Forward current during desired conduction period	7	—	amperes

Continuous Duty, No Overloads

	Minimum	Maximum	
Peak anode voltage			
Inverse	—	20,000	volts
Forward	—	20,000	volts
Anode current*			
Peak	—	600	amperes
Average	—	200	amperes
Fault	—	6000	amperes
Duration of fault current‡	—	0.15	second
Product of inverse or forward voltage and average current	—	3	megavolt-amperes
Peak control-grid voltage			
Forward	200	500	volts
Inverse	100	200	volts
Peak shield-grid voltage			
Forward	200	500	volts
Inverse	50	200	volts
Peak control-grid current			
Forward	—	5	amperes
Inverse	—	0.4	amperes
Peak shield-grid current			
Forward	—	5	amperes
Inverse	—	0.2	amperes
Peak gradient-grid voltage			
Forward	1/2	1/2	anode-cathode voltage
Inverse	1/2	1/2	anode-cathode voltage
Peak gradient-grid current			
Forward	0.010	0.020	amperes
Inverse	0.010	0.020	amperes
Ignitor ratings			
Peak ignitor voltage			
Forward	450	750	volts
Inverse	0	5	volts
Width of current pulse, sinusoidal waveshape	500	—	microseconds
At 60 cycles	—	1500	microseconds
At 25 cycles	—	9000	microseconds
Peak ignitor current	45	75	amperes
Holding anode ratings			
Available instantaneous holding anode Voltage during desired conduction period	40	—	volts
Peak holding-anode voltage			
Forward	—	200	volts
Inverse	—	25	volts
Peak holding-anode current			
Forward	—	20	amperes
Inverse	—	0.100	amperes

MAXIMUM RATINGS (CONT'D)

POWER-RECTIFIER SERVICE (CONT'D)

	Minimum	Maximum	
Average	—	5	amperes
Rms	—	10	amperes
Minimum			
Forward current during desired conduction period	7	—	amperes
Intermittent Duty†			
Peak anode voltage			
Inverse	—	20,000	volts
Forward	—	20,000	volts
Anode current*			
Peak	—	1500	amperes
Average	—	150	amperes
Averaging time	—	0.15	second
Rms	—	500	amperes
Averaging time	—	0.15	second
Fault	—	6000	amperes
Duration of fault current ‡	—	0.15	second
Product of inverse or forward voltage and peak anode current	—	22.5	megavolt-amperes
Peak control-grid voltage			
Forward	200	500	volts
Inverse	100	200	volts
Peak shield-grid voltage			
Forward	200	500	volts
Inverse	50	200	volts
Peak control-grid current			
Forward	—	5	amperes
Inverse	—	0.4	amperes
Peak shield-grid current			
Forward	—	5	amperes
Inverse	—	0.2	amperes
Peak gradient-grid voltage			
Forward	1/2	1/2	anode-cathode voltage
Inverse	1/2	1/2	anode-cathode voltage
Peak gradient-grid current			
Forward	0.010	0.020	amperes
Inverse	0.010	0.020	amperes
Ignitor ratings			
Peak ignitor voltage			
Forward	450	750	volts
Inverse	0	5	volts
Width of current pulse, sinusoidal waveshape	500	—	microseconds
At 60 cycles	—	1500	microseconds
At 25 cycles	—	9000	microseconds
Peak ignitor current	45	75	amperes
Holding anode ratings			
Available instantaneous holding anode voltage during desired conduction period	40	—	volts
Peak holding-anode voltage			
Forward	—	200	volts
Inverse	—	25	volts
Peak holding-anode current			
Forward	—	20	amperes
Inverse	—	0.100	amperes
Average	—	5	amperes
Rms	—	10	amperes
Minimum			
Forward current during desired conduction period	7	—	amperes

AC CONTROL OR CAPACITOR-DISCHARGE SERVICE—SINUSOIDAL CURRENT, PULSE DUTY†

	Minimum	Maximum	
Peak anode voltage			
Inverse	—	20,000	volts
Forward	—	20,000	volts
Anode current			
Peak	—	2000	amperes
Average	—	200	amperes
Maximum averaging time—one conduction pulse plus one nonconducting period			
Rms	—	500	amperes
Maximum averaging time—one conduction pulse plus one nonconducting period			
Fault	—	2000	amperes
Duration of fault current	—	0.15	second
Product of inverse or forward voltage and average current	—	3	megavolt-amperes
Equivalent frequency—25 to 60 cycles			
Above 60 cycles use commutating reactors			
Current at start of commutation period	—	60	amperes
Current at end of commutation period	—	0	amperes
Length of commutation period	200	—	microseconds

DC SHORT-CIRCUITING SWITCH†

	Minimum	Maximum	
Anode voltage			
Peak	—	20,000	volts
Forward	100	—	volts
Anode current			
Peak	—	6000	amperes
Average	—	90	amperes
Averaging time	—	10	seconds
Frequency of current-conduction periods	—	100	per hour
Ionization time	—	10	microseconds
Control-grid open-circuit voltage	1500	2500	volts
Control-grid short-circuit current	5	10	amperes
Shield-grid open-circuit voltage	1500	2500	volts
Shield-grid short-circuit current	2.5	5.0	amperes
Time constant of shield- and control-grid circuits	50	100	microseconds
Peak gradient-grid voltage			
Forward	1/2	1/2	anode-cathode voltage
Inverse	1/2	1/2	anode-cathode voltage
Peak gradient-grid current			
Forward	0.010	0.020	amperes
Inverse	0.010	0.020	amperes
Ignitor ratings			
Ignitor voltage			
Forward open-circuit voltage	1500	2500	volts
Negative voltage	—	5	volts
Ignitor current			
Short-circuit current	200	250	amperes
Time constant of ignitor circuit	50	100	microseconds

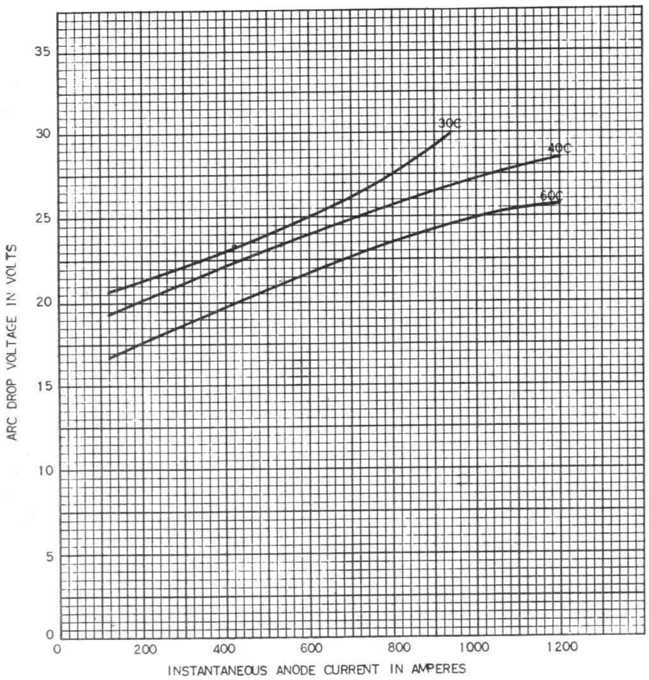
* Ratings are for zero-phase-control angle—See curve K-69087-72A513 for ratings at other phase-control angles.
‡ Reduce duration of fault current by suppressing rectifier by removing ignitor and grid excitation.
† Precautions should be taken to assure that magnetic fields of adjacent conductors do not deflect the arc in the tube.

X-RAY WARNING NOTICE

This device may produce X-rays when energized. X-ray warning signs or labels should be permanently attached to the equipment.

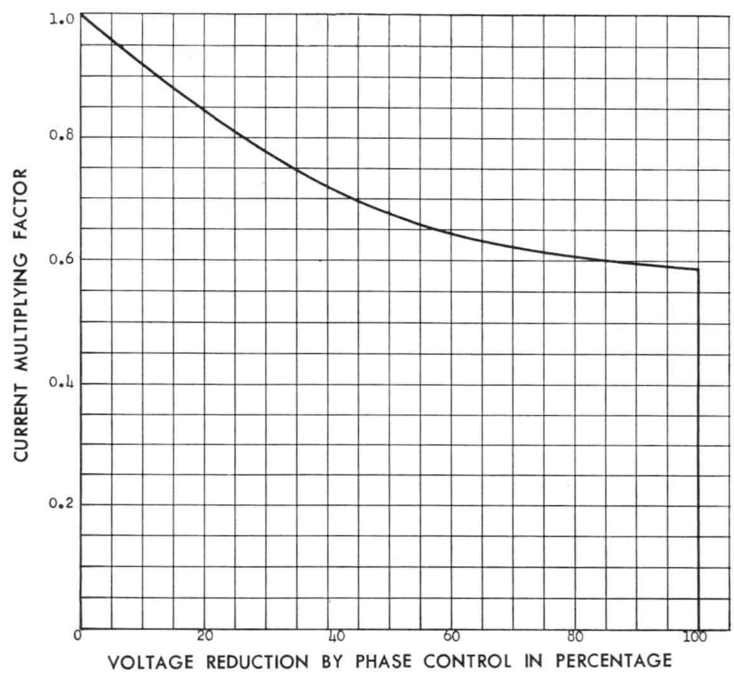
Precautions must be exercised during the service and operation of equipment to assure that any shielding components are replaced to their intended position before the equipment is operated.

ARC-DROP CHARACTERISTIC
FOR COOLING-WATER TEMPERATURES OF
30–60 C



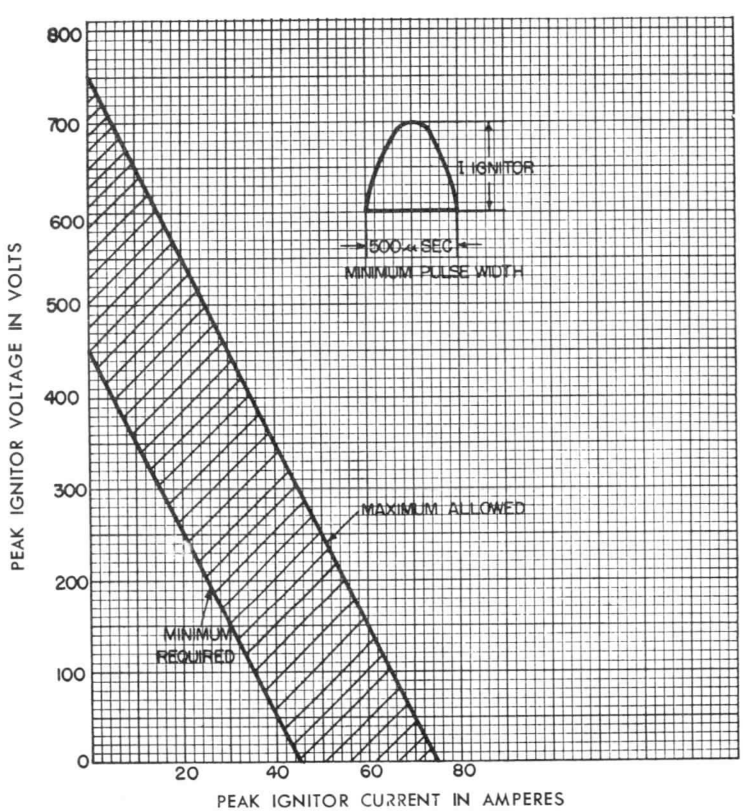
K 69087-72A196 5-2-49

PHASE CONTROL
THREE-PHASE SINGLE-WAY
DOUBLE-WAY CIRCUITS

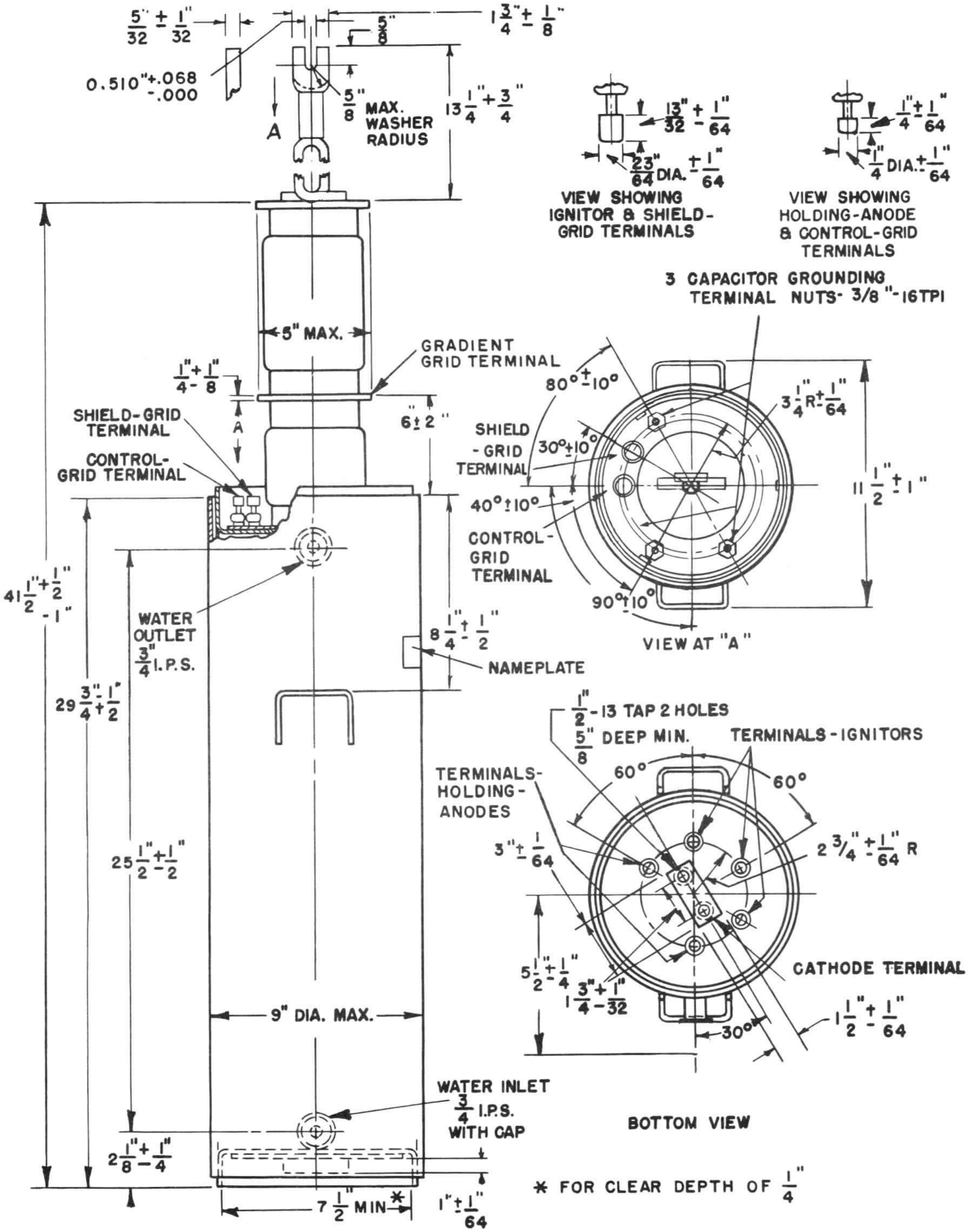


K-69087-72A513 8-21-53

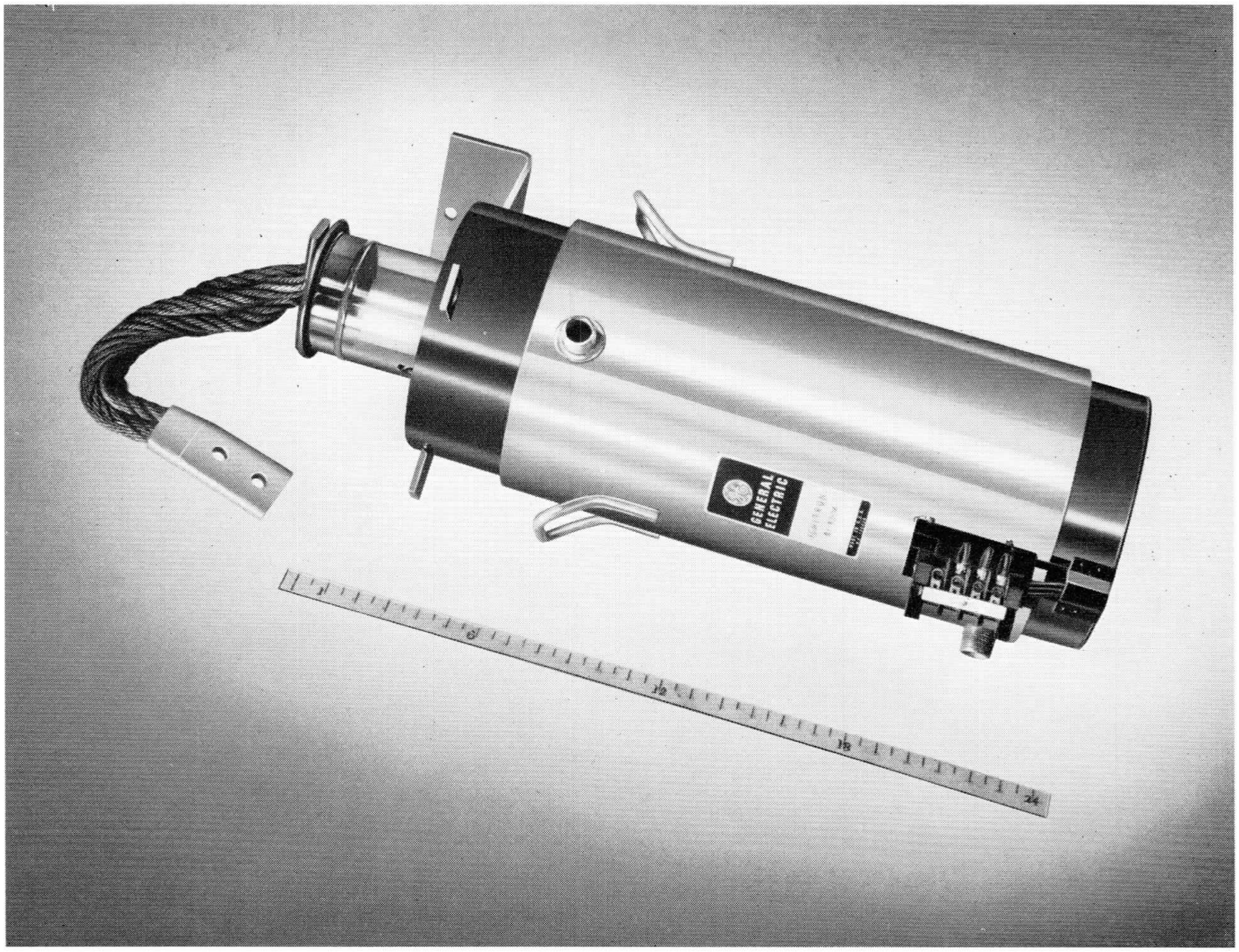
IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION SEALED-IGNITRON RECTIFIERS
THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



K-69087-72A741 12-9-55



N-22002AZ 4-2-63



IGNITRON

LOCOMOTIVE RECTIFIER SERVICE—350 AMPERES THREE IGNITORS

The GL-6504 is a double-grid ignitron designed for railroad locomotive rectifier service. In this service twelve tubes will supply d-c power for a 4000-horsepower locomotive.

A coaxial cathode-current return reduces magnetic fields due to tube currents. The tube also features baffles in the mercury pool to assure contact between the mercury and the ignitor points during swaying of the equipment.

A companion tube, the GL-6509 ignitron, is available to supply the auxiliary power requirements of applications which use the GL-6504 as the main power source.

GENERAL

Electrical

Cathode Excitation—Cyclic

Cathode Spot Starting—Ignitor

Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Ignitors	3	
Shield Grids	1	
Control Grids	1	
Arc Drop at 1000 Amperes, peak	20.5 ± 2	Volts
Arc Drop at 2000 Amperes, peak	24 ± 2	Volts

(See Curve K-69087-72A709 for details)

GENERAL ELECTRIC

Supersedes ET-T1131A dated 11-57

GENERAL (Cont'd)

Mechanical

Envelope Material—Stainless Steel		
Over-all Length	$27\frac{3}{8}$	Inches
Over-all Width	12	Inches
Net Weight, approximate	95	Pounds

Thermal

Type of Cooling—Water		
Inlet Water Temperature, minimum	30	C
Outlet Water Temperature, maximum	55	C
Water Flow, minimum		
At Continuous Rated Average Current	10	Gallons per Minute
At No Load§	1	Gallons per Minute
Temperature Range	40 to 45	C
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	6.5	C
Pressure Drop at 10 Gallons per Minute, maximum	1.5	Pounds per Square Inch
Maximum Working Water Pressure—Non Shock	100	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier Service, Continuous Duty

Ratings are for Zero-Phase-Control Angle

Maximum Peak Anode Voltage			
Inverse		4000	Volts
Forward		100	Volts
Maximum Anode Current*			
Peak		2000	Amperes
Average	**Passenger†**	**Freight‡**	
Continuous	350	300	Amperes
Two Hours	440	380	Amperes
Fifty Minutes	490	420	Amperes
Twelve Minutes	560	490	Amperes
Six Minutes	660	520	Amperes
Four Minutes	720	540	Amperes
Fault			
Forward Direction		15,000	Amperes
Reverse Direction		30,000	Amperes
Maximum Duration of Fault Current		0.15	Seconds
Frequency Range		25–60	Cycles per Second

Ignitor Characteristics

Maximum Inverse Voltage	5	Volts
Recommended Pulse Length	800	Microseconds
Minimum Pulse Length, for average anode currents greater than 8 amperes	150	Microseconds
Maximum Pulse Length	4000	Microseconds

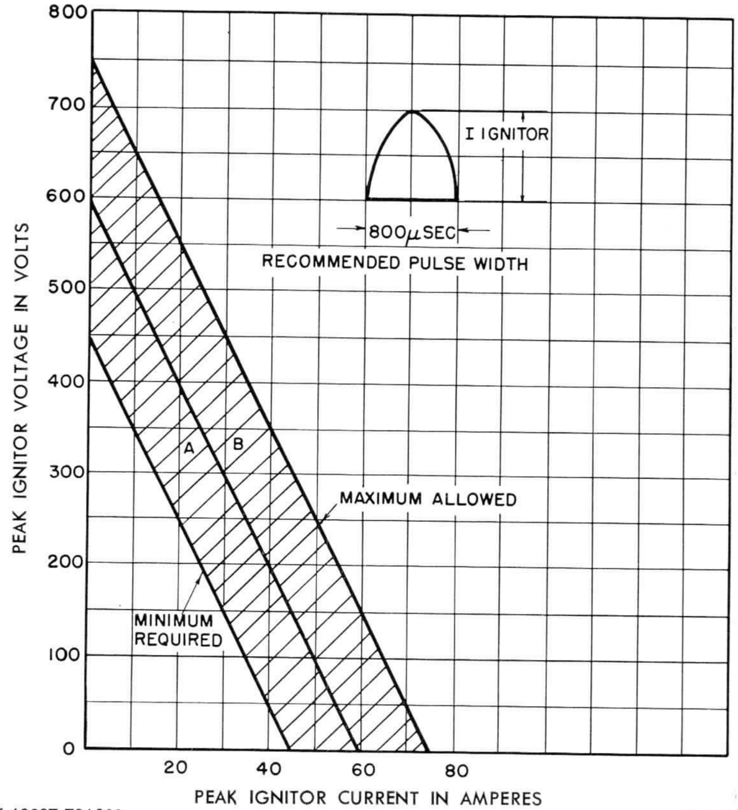
Volt-Ampere Characteristics—See Curve K69087-72A803 for details.

	Minimum	**Maximum**	
Shield-Grid Voltage			
Peak Forward	200	500	Volts
Peak Inverse	—	200	Volts
Shield-Grid Current			
Peak Forward	0.2	5	Amperes
Peak Inverse	—	0.2	Amperes
Control-Grid Voltage			
Peak Forward	200	500	Volts
Peak Inverse	100	200	Volts
Control-Grid Current			
Peak Forward	0.4	5	Amperes
Peak Inverse	0.4	1	Amperes

* Service Factors Energized—50 percent of annual hours
Passenger Service—80 percent
Freight Service—80 percent
† Short time loads applied following light load.
‡ Short time loads applied following continuous operation at full load.
§ Water flow should be continued for at least one hour after removal of anode power.

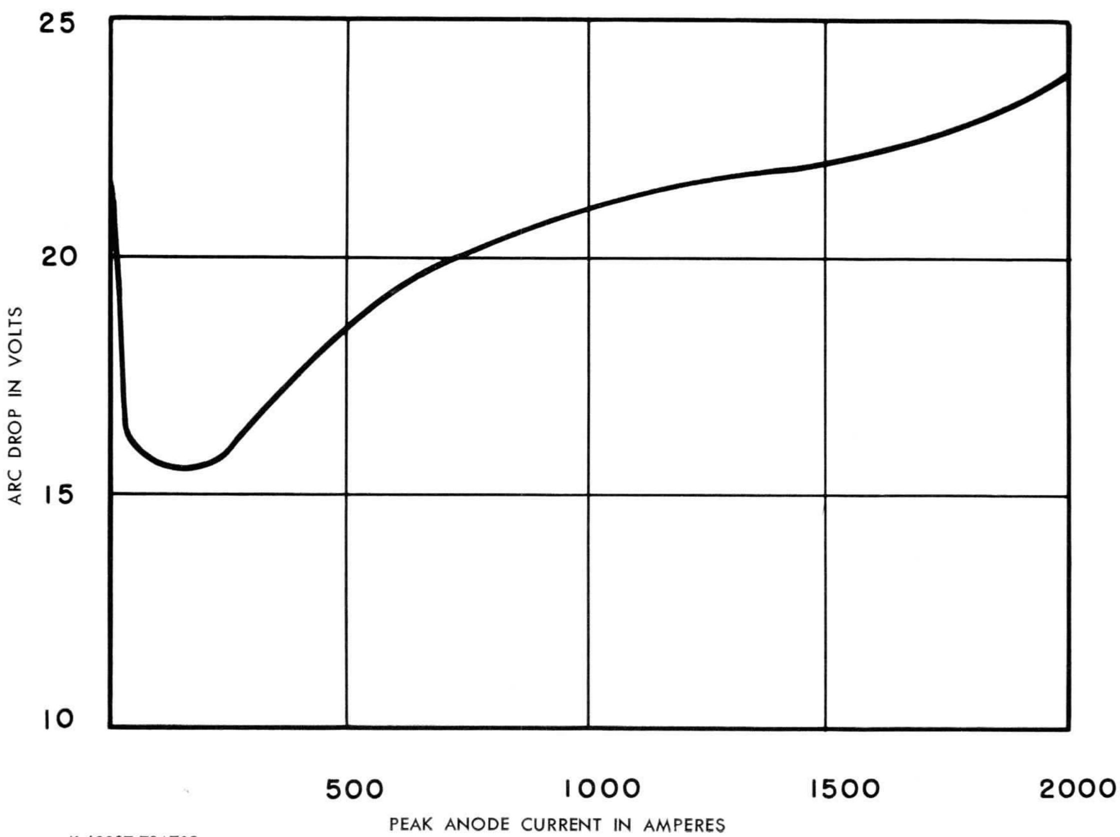
IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION
SEALED-IGNITRON RECTIFIER

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA

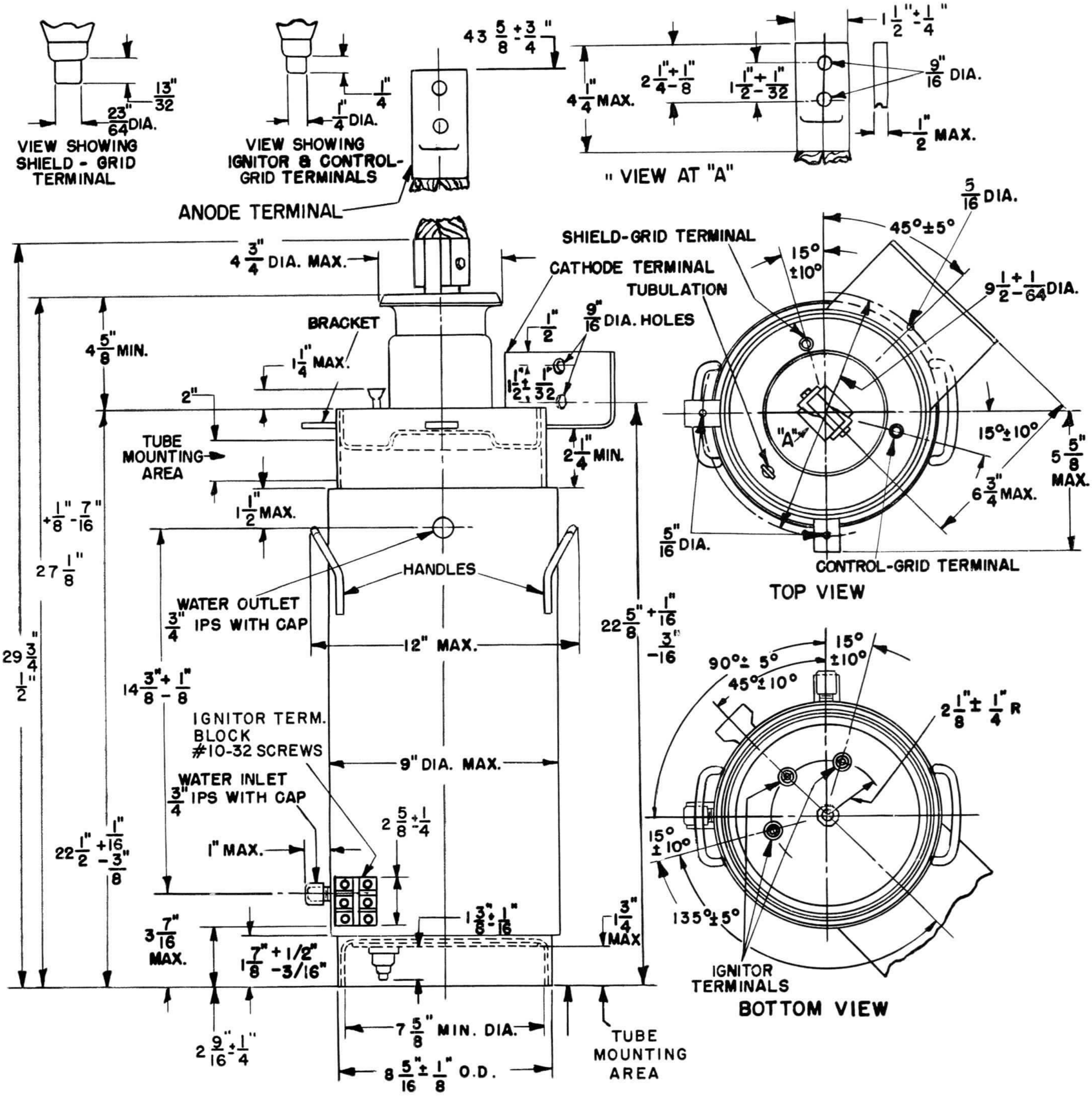


K-69087-72A803 11-6-58

ARC DROP

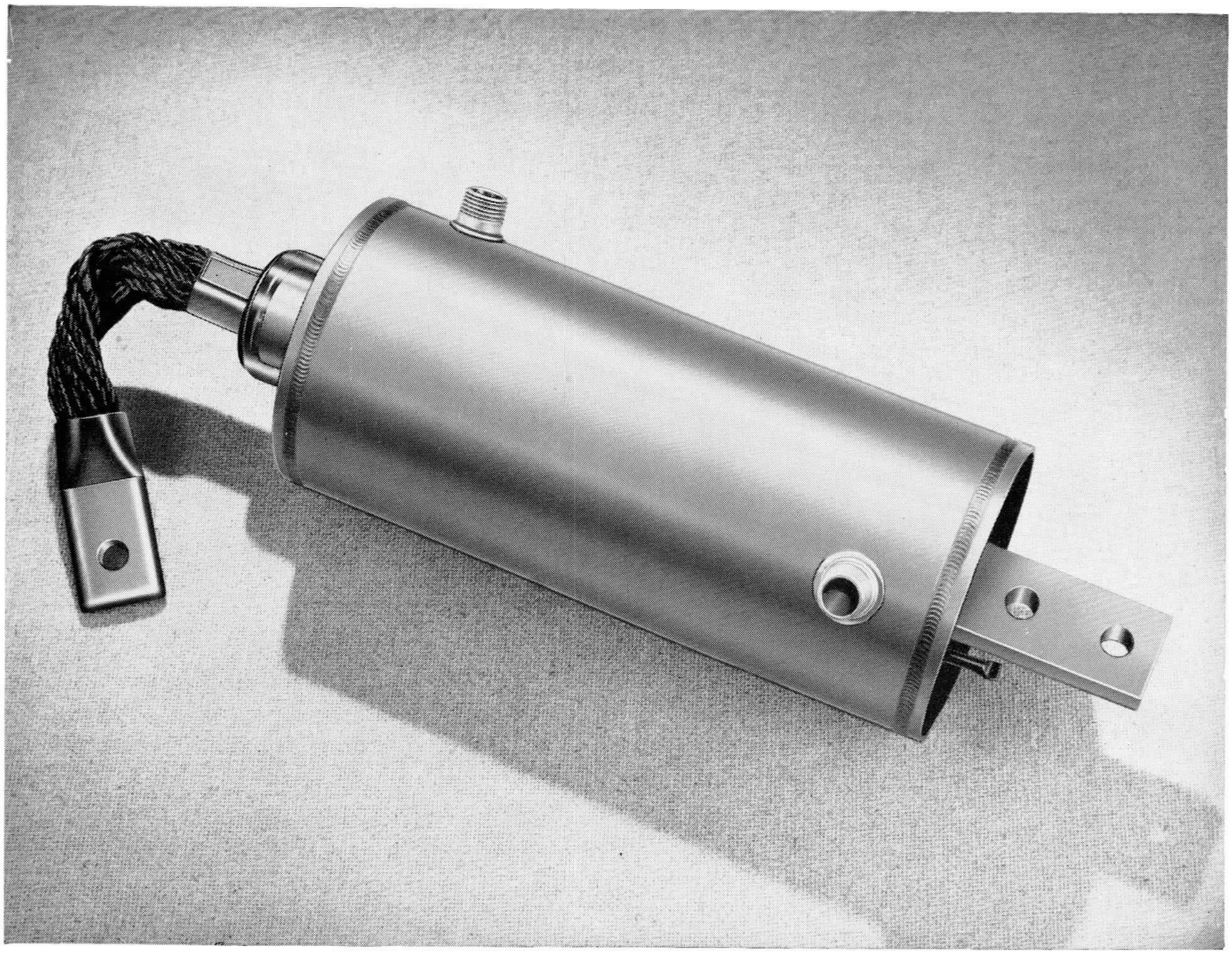


K-69087-72A709 11-6-58



N-22020AZ

4-5-61



IGNITRON

LOCOMOTIVE RECTIFIER SERVICE—200 AMPERES **THREE IGNITORS**

The GL-6509 is an ignitron for railroad locomotive rectifier service. This tube is designed to supply the auxiliary power requirements in those locomotives that utilize the GL-6504 ignitron as the main power supply. In addition to this service the GL-6509 ratings also make the tube particularly suitable for use as the main power source in multiple-unit car installations.

The tube is similar in construction to the GL-5555 ignitron but has the additional feature of baffles in the mercury pool to assure contact between the mercury and the ignitor points during swaying of the equipment.

GENERAL

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes
Main Anodes 1
Main Cathodes 1
Ignitors 3
Arc Drop at 600 Peak Amperes . . . . 16.2±0.5 Volts
(See Curve K-69087-246A8 for details)

GENERAL ELECTRIC

Supersedes ET-T1132 dated 12-56

GENERAL (Cont'd)

Mechanical

Envelope Material—Stainless Steel

Over-all Length	$17\frac{15}{16}$	Inches
Over-all Width	$5\frac{3}{4}$	Inches
Net Weight, approximate	25	Pounds

Thermal

Type of Cooling—Water

Inlet Water Temperature, minimum	30	C
Outlet Water Temperature, maximum		
Peak Inverse Anode Voltage = 900 Volts	60	C
Peak Inverse Anode Voltage = 2100 Volts	45	C
Water Flow, minimum		
At No Load	1	Gallons per Minute
At Continuous Rated Average Current	3	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	4.5	C
Pressure Drop at 3 Gallons per Minute, maximum	2	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier Service, Continuous Duty

Ratings are for Zero-Phase-Control Angle—See Curves K-69087-72A654 and K-69087-72A653 for details.

Maximum Peak Anode Voltage			
Inverse	900	2100	Volts
Forward	900	2100	Volts
Maximum Anode Current			
Peak	1800	1200	Amperes
Average			
Continuous	200	150	Amperes
Two-Hours-Averaged Over Any Two-Minute Interval	300	225	Amperes
One-Minute-Averaged Over Any One-Minute Interval	400	300	Amperes
Fault	12,000	9000	Amperes
Maximum Duration of Fault Current	0.15	0.15	Seconds
Frequency Range	25–60	25–60	Cycles per Second

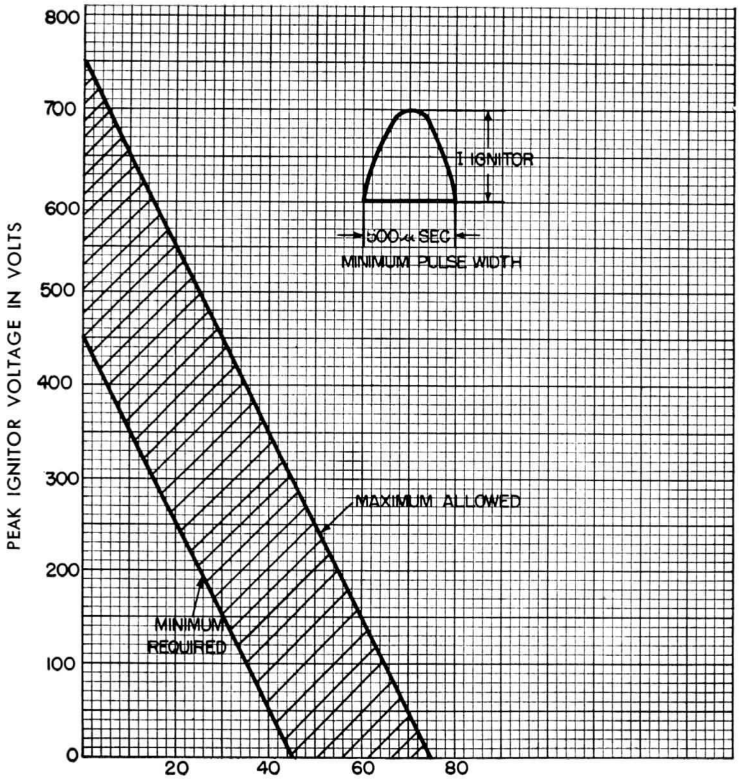
Ignitor

Volt-Ampere-Time Requirements—See Curve K-69087-72A741 for Ignitor Circuit Requirements.

Maximum Inverse Voltage	5	Volts
Maximum Current		
Root Mean Square	15	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds

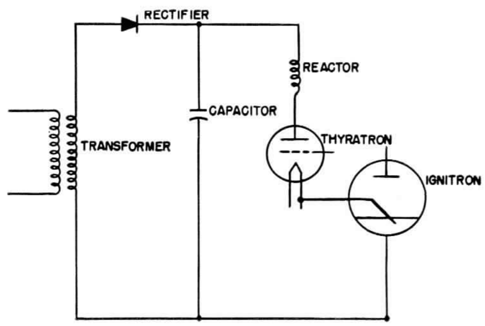
IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION SEALED-IGNITRON RECTIFIERS

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



K-69087-72A741 PEAK IGNITOR CURRENT IN AMPERES 12-9-55

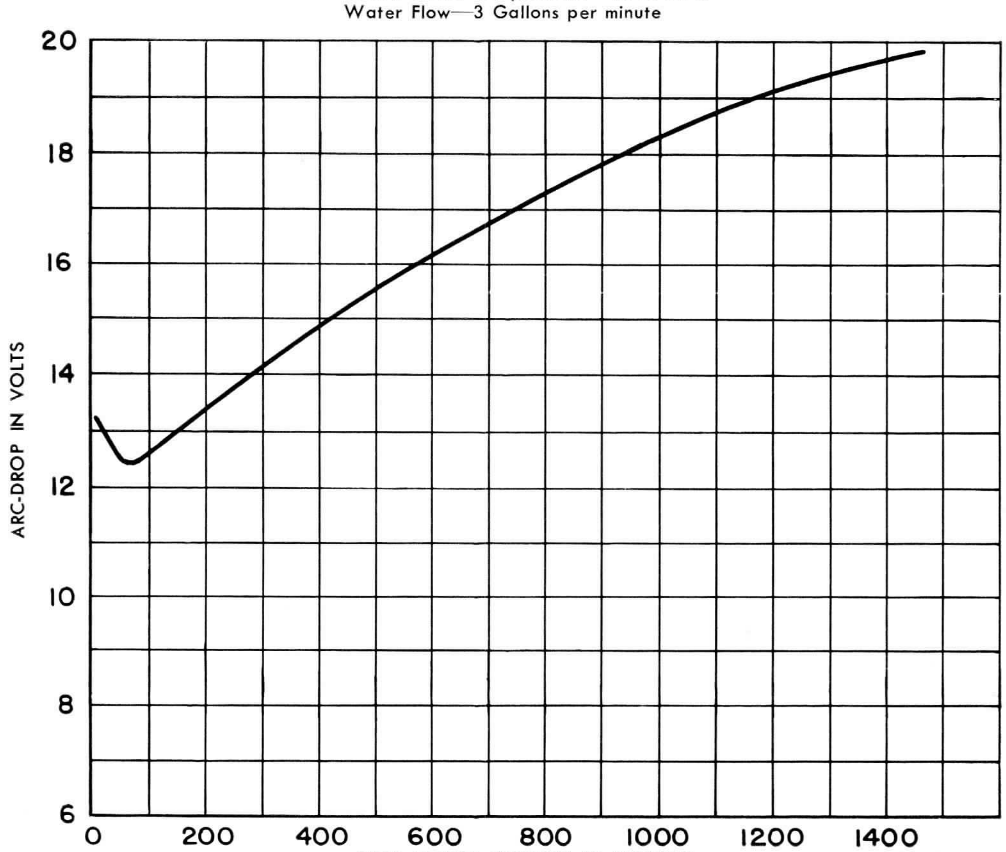
ELEMENTARY CIRCUIT FOR CAPACITOR FIRING



K-9033525 5-25-54

ARC DROP

Outlet Water Temperature—40 to 60 C
Water Flow—3 Gallons per minute

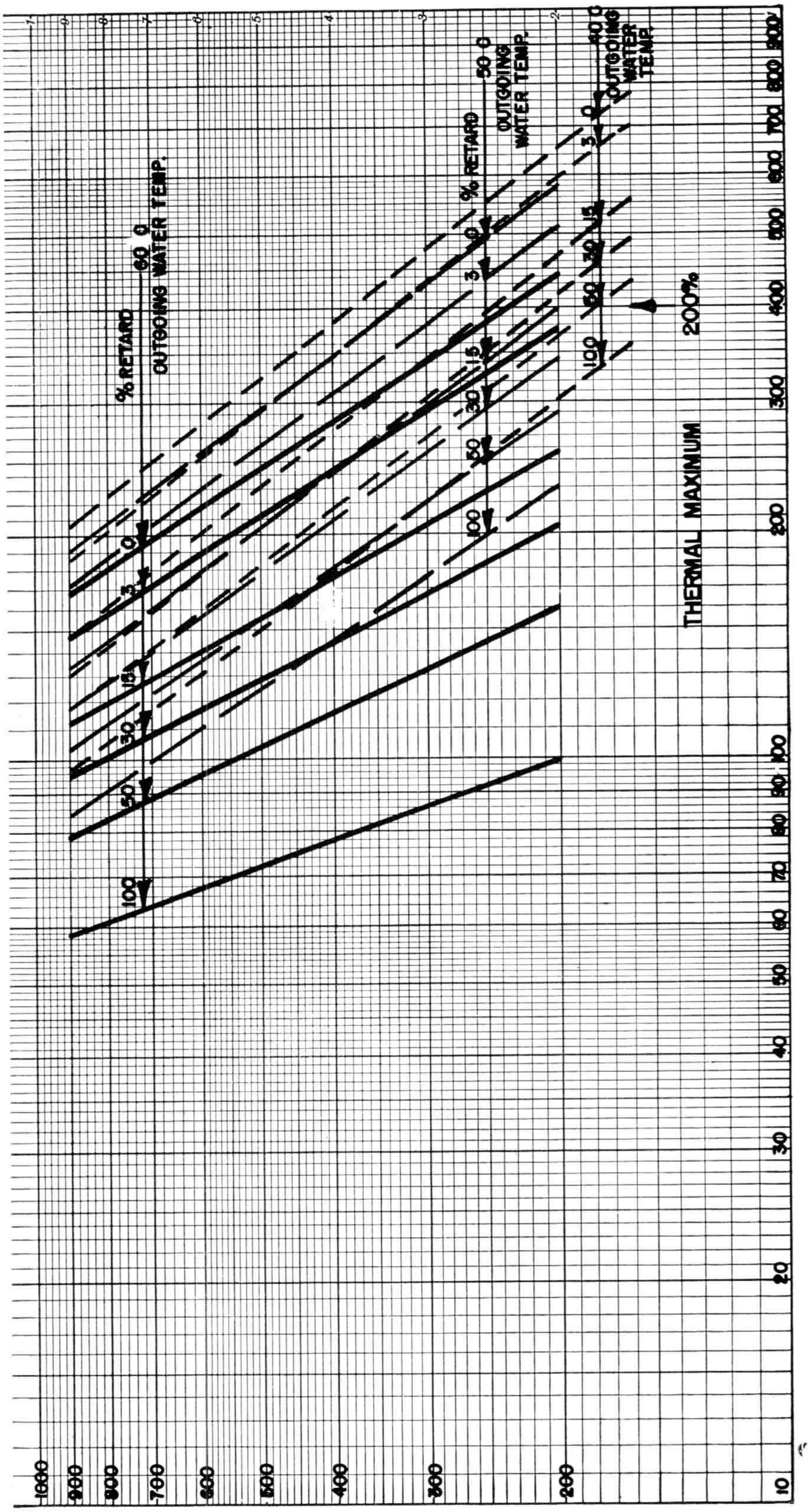


K-69087-246A8 PEAK ANODE CURRENT IN AMPERES 6-16-54

COMMUTATION LIMITS
1-MINUTE LOADS

DELTA, SIX-PHASE, DOUBLE-WYE CIRCUIT OR EQUIVALENT
RATIO OF PEAK-TO-AVERAGE ANODE CURRENT = 3:1

REACTANCE FACTOR, $\frac{I_c X_c}{E_s} = .075$ AT $I_c = 600$ AMPERES



AVERAGE ANODE CURRENT IN AMPERES PER TUBE

E_{DO}—NO LOAD DC VOLTAGE OR $\frac{1}{2.09}$ PEAK INVERSE VOLTAGE

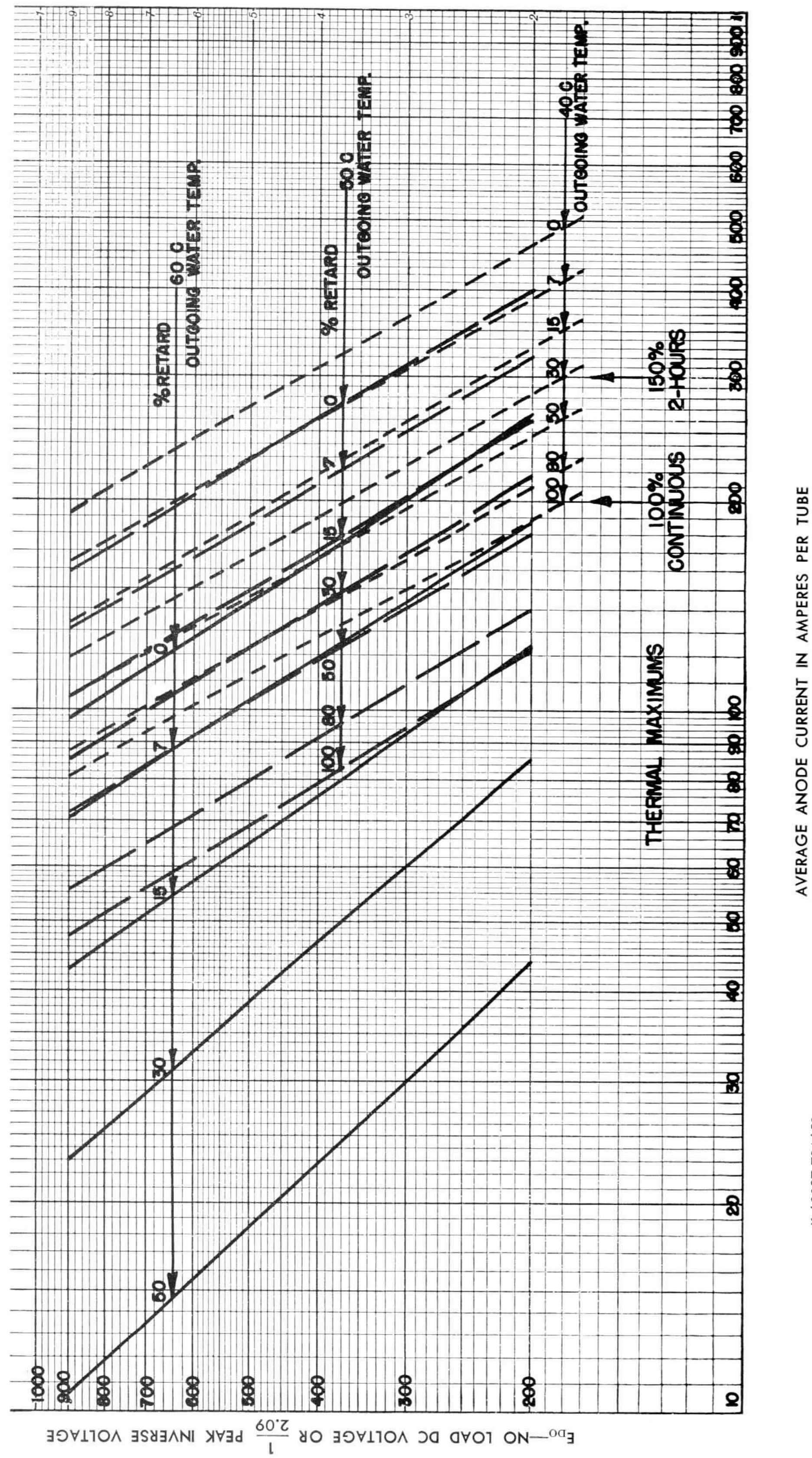
6-16-54

K-69087-72A654

COMMUTATION LIMITS
2-HOUR LOADS

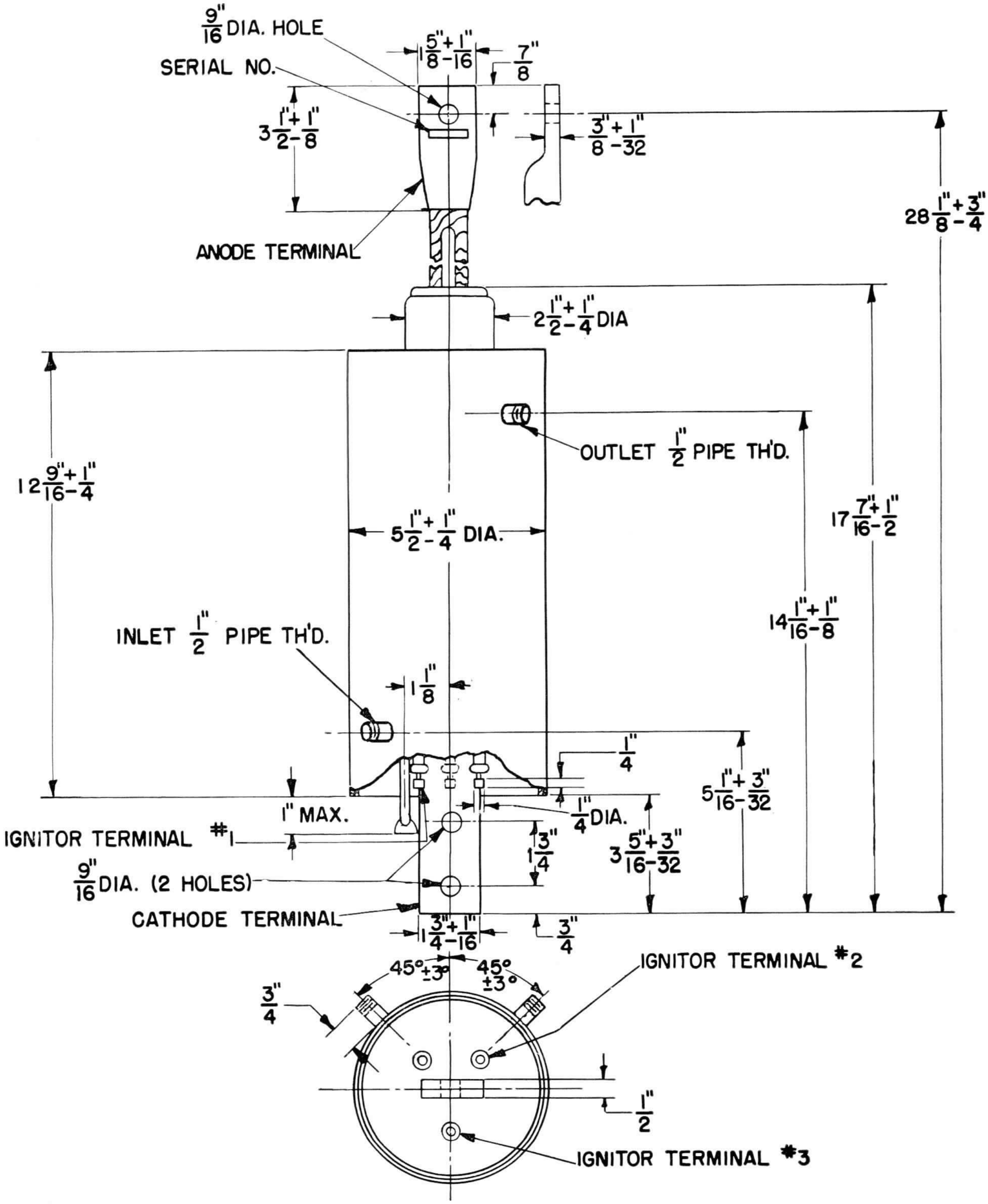
DELTA, SIX-PHASE, DOUBLE-WYE CIRCUIT OR EQUIVALENT RATIO OF PEAK-TO-AVERAGE ANODE CURRENT = 3:1

REACTANCE FACTOR, $\frac{I_c X_c}{E_s} = .075$ AT $I_c = 600$ AMPERES

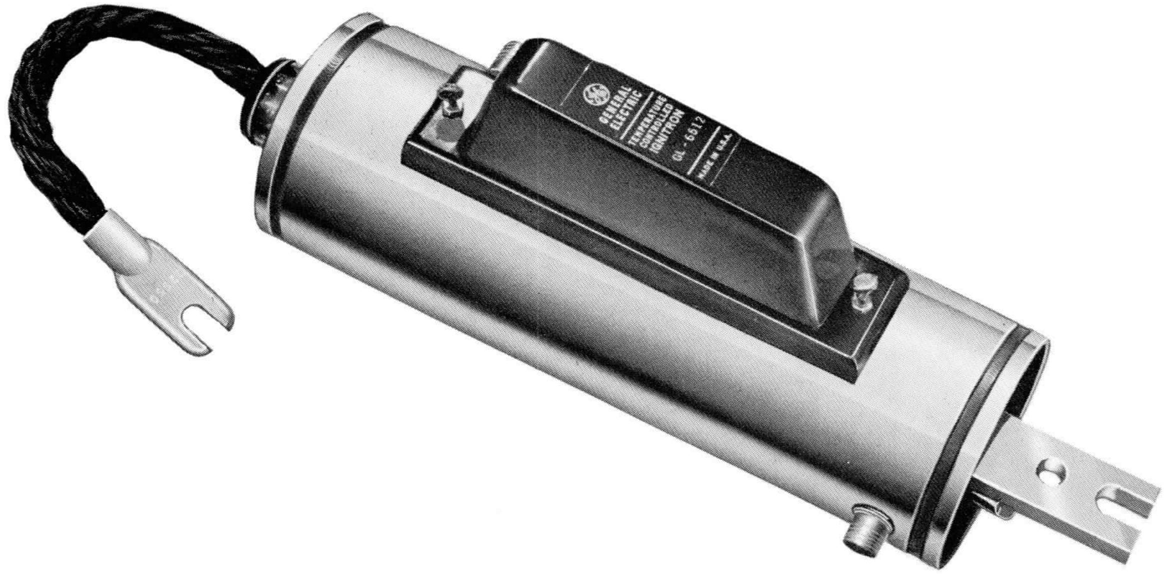


K-59087-72A653

6-16-54


9/16" DIA. HOLE
SERIAL NO.
1 5/8" + 1/16" -
7/8"
3 1/2" + 1/8" -
3/8" + 1/32" -
ANODE TERMINAL
28 1/8" + 3/4" -
2 1/2" + 1/4" - DIA
12 9/16" + 1/4" -
OUTLET 1/2" PIPE TH'D.
5 1/2" + 1/4" - DIA.
17 7/16" + 1/2" -
INLET 1/2" PIPE TH'D.
14 1/16" + 1/8" -
1 1/8"
1/4"
5 1/16" + 3/32" -
1" MAX.
1/4" DIA.
IGNITOR TERMINAL #1
1 3/4"
3 5/16" + 3/32" -
9/16" DIA. (2 HOLES)
CATHODE TERMINAL
1 3/4" + 1/16" -
3/4"
45° ±3°
45° ±3°
IGNITOR TERMINAL #2
3/4"
1/2"
IGNITOR TERMINAL #3

N-22021AZ



IGNITRON

RECTIFIER SERVICE—100 AMPERES
AC CONTROL SERVICE—1200 KILOVOLT-AMPERES
TEMPERATURE CONTROLLED

HOLDING ANODE
TWO IGNITORS

The GL-6512 ignitron is a sealed, steel-jacketed, water-cooled, mercury-pool tube designed for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. It is suitable for use in rectifiers rated up to 200 kilowatts output, depending on the number of ignitrons used, the output voltage, and the circuit. It has a continuous average current rating of 100 amperes per tube in rectifiers rated up to 300 volts d-c. The tube is also designed for 2400-volt a-c control service where it has a rating of 1200 kilovolt-amperes.

This tube is identical in ratings and characteristics to the GL-5554. Mechanically, it has the additional feature of an integral thermostatic arrangement with protective features. The arrangement includes a switch which controls a solenoid valve in the water-supply line to the tube in response to increasing and decreasing tube temperature, thus maintaining the amount of cooling water to the minimum required by the operating conditions. It also includes an over-temperature switch which may be used to remove power from the ignitron when its temperature exceeds a safe value.

This new design has several advantages. It eliminates the need for heat exchangers and recirculating water systems where they have been required to ensure safe operation of the older non-temperature-controlled ignitrons when the available cooling water temperature is too low to provide the minimum reliable mercury vapor pressure in the tubes. It eliminates the usual safety devices required with the older design tubes, such as water-flow relays, water over-temperature relays and water-pressure interlocks which have required considerable maintenance in the past. Another advantage is the prevention of excessive moisture condensation over the external parts of the tube under conditions of high humidity.

Like its prototype, the GL-6512 has a holding anode and two ignitors. Excitation of this anode permits stabilizing the cathode spot for very small anode currents. The two ignitors assure long life since only one is used at a time. Phase control of the ignitor impulses permits voltage control of the rectified output. In common with other ignitrons arc losses in the GL-6512 are low, and design and construction features, such as a complete stainless-steel-water jacket, assure ease of installation, economical use of space, and reliability of operation.

GENERAL

Electrical

Cathode Excitation—Cyclic		
Cathode Spot Starting—Ignitor		
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Holding Anodes	1	
Ignitors	2	
Arc Drop at 100 Peak Amperes	12.6±0.5	Volts
Arc Drop at 300 Peak Amperes	14.4±0.5	Volts
Arc Drop at 600 Peak Amperes	17.3±0.5	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	450	Volts
(See Curve K-9033883 for details)		
Ignitor Current Required to Fire	45	Amperes
(See Curve K-9033883 for details)		
Starting Time at Required Voltage or Current	100	Microseconds

Mechanical

Envelope Material—Stainless Steel		
Over-all Length	17	Inches
Over-all Width	4⅛	Inches
Net Weight, approximate	13.5	Pounds

Thermal

Type of Cooling—Water		
Inlet Water Temperature, minimum	−15	C
Inlet Water Temperature*, maximum		
Power-Rectifier Service		
Peak Inverse Anode Voltage = 900 Volts	50	C
Peak Inverse Anode Voltage = 2100 Volts	35	C
AC Control Service		
Voltage = 2400 Volts RMS	30	C
Water Flow, minimum		
At Continuous Rated Average Current	1.5	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	6	C
Pressure Drop at 3 Gallons per Minute, maximum	5	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier Service, Continuous Duty

Ratings are for Zero-Phase-Control—See Curves K-69087-72A182 and K-69087-72A183 for details.

Maximum Peak Anode Voltage			
Inverse	900	2100	Volts
Forward	900	2100	Volts
Maximum Anode Current			
Peak	900	600	Amperes
Average			
Continuous	100	75	Amperes
Two-Hours—Averaged Over Any Two-Minute Interval	150	112.5	Amperes
One-Minute—Averaged Over Any One-Minute Interval	200	150	Amperes
Fault	6000	4500	Amperes
Maximum Duration of Fault Current	0.15	0.15	Seconds
Frequency Range	25–60	25–60	Cycles per Second

AC Control Service†

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	2400	Volts RMS
Maximum Demand	1200	Kilovolt-Amperes
Average Current at Maximum Demand	75	Amperes
Maximum Average Current	113	Amperes
Demand at Maximum Average Current	600	Kilovolt-Amperes
Maximum Averaging Time at 2400 Volts RMS	1.50	Seconds
Maximum Peak Fault Current	3000	Amperes
Frequency Range	25–60	Cycles per Second

MAXIMUM RATINGS (CONT'D)

Ignitor

Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
Root Mean Square	15	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds
Typical Resistance Added to Ignitor Circuit for Anode Firing		
At Anode Voltage of 600 Volts or Less	4	Ohms
At Anode Voltage of 601 Volts to 1000 Volts	10	Ohms
At Anode Voltage of 1001 Volts to 1500 Volts	20	Ohms
At Anode Voltage of 1501 Volts to 2000 Volts	35	Ohms
At Anode Voltage of 2001 Volts to 2400 Volts	50	Ohms

Holding Anode

Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Temperature-Control-Switch Ratings‡

Maximum Voltage	575	Volts
Maximum Current		
Over-Temperature Switch	6	Amperes
Water-Control Switch	1.5	Amperes
Maximum Peak Potential Difference Between Switch Circuit and Tube Water Cylinder	1500	Volts
Switch Contact Arrangement		
Over-Temperature Switch—Normally Closed		
(Contacts Open on Temperature Rise)		
Water-Control Switch—Normally Open		
(Contacts Close on Temperature Rise)		

* When two or more tubes are connected in series for water flow, the temperature of the incoming water to the warmest tube in the series must be within the rated limit.

† RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used.

The switching circuit must be insulated to prevent excessive voltage between the tube cylinder and the switches.

‡ Suitable fuses should be provided in the switch circuits to prevent a power arc should a ground occur in the switch or wiring.

INSTALLATION AND OPERATION NOTES

In order to realize the advantage of safe tube operation on low-temperature cooling water, water must be supplied to the tube through a rapid-closing solenoid valve controlled by the water-control switch on the tube. The valve must completely stop the water flow to the tube except when the water-control switch is closed. The number of tubes connected in series for water from a single valve must be restricted for the lower temperatures. Placing fewer tubes in series with a solenoid valve will allow the use of lower incoming water temperatures without resulting in arcbacks caused by low tube temperatures.

If the water-supply temperature will never be below +10 C, six tubes may be connected in series for water flow, providing the temperature is not high enough to cause over-temperature on the last tube for the flow available and the load expected on the rectifier. If six tubes are connected in series, only one solenoid valve is required for a six-tube rectifier. It is possible to operate with only one temperature-controlled tube (installed in the outgoing end of the series group). For more complete protection, two temperature-controlled ignitrons are usually installed in the last two positions on the outgoing water end with their water-control switches in parallel and their over-temperature switches in series.

If the water-supply temperature will be less than +10 C, but never less than 0 C, a series-parallel system should be used connecting three tubes in series for water flow. Water to each series group should be supplied through a solenoid water valve controlled by the water-control switch on the last tube receiving water in that group. In this arrangement, one temperature-controlled tube in the outgoing end of each series group may be used to protect two non-temperature-controlled ignitrons in the remaining positions of the group.

If the water-supply temperature is expected to

INSTALLATION AND OPERATION NOTES (CONT'D)

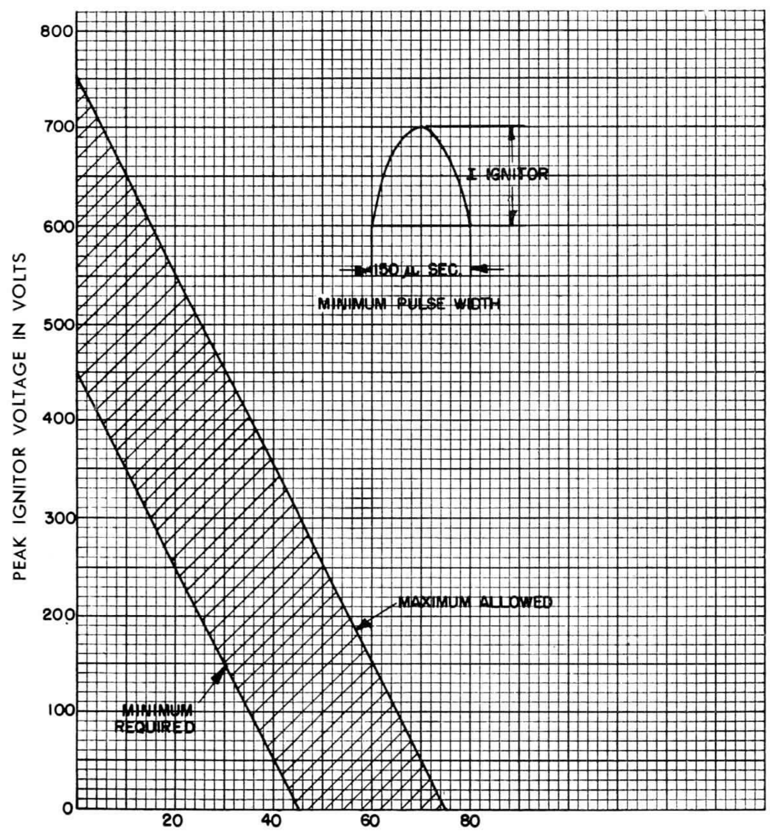
drop below 0 C, all tubes in the rectifier must be temperature-controlled, be connected in parallel for water flow and have individual solenoid water valves which prevent water from circulating through any tube until its water-control switch closes. If the tubes themselves are at this low temperature initially, a low load (such as ¼ load) should be applied to the rectifier long enough to cause one operation of the solenoid valves. After this initial warming, the rectifier should be in condition to handle safely normal loads unless it is idle in a cold atmosphere long enough for the tube again to become cold.

The minimum allowable temperature for the series and series-parallel connections is based on normal industrial loads on the rectifier. For some special conditions of loading it is possible to lower these temperatures.

In some applications, for example, where the rectifier has only intermittent low loads which are not sufficient to heat the anode end of the tubes to normal temperature, there may be a tendency for mercury to accumulate on the inside of the anode glass insulating bushing. Small amounts of mercury here are not serious. If the entire surface becomes covered, however, it will cause an arc over the inside of the glass which may permanently damage the tube. If this type of service is anticipated, large accumulations of mercury over the glass can easily be prevented by applying external heat to the glass with small radiant heaters or heat lamps. The glass temperature should be raised to approximately 50 C, but may go to 200 C without damage when the tubes are loaded.

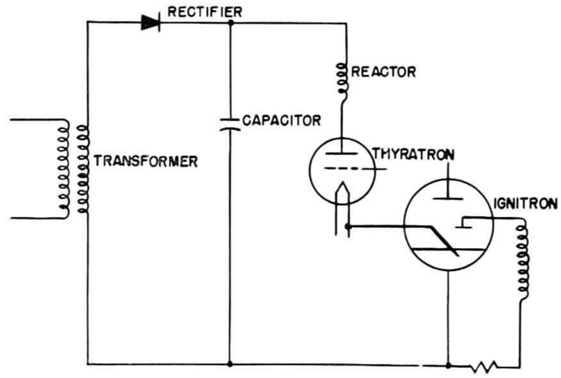
IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



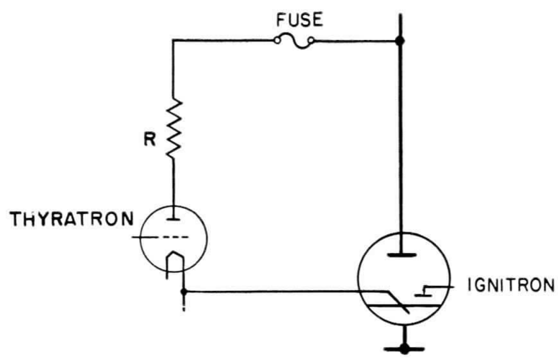
PEAK IGNITOR CURRENT IN AMPERES

K-9033883 5-25-54



ELEMENTARY CIRCUIT FOR CAPACITOR FIRING

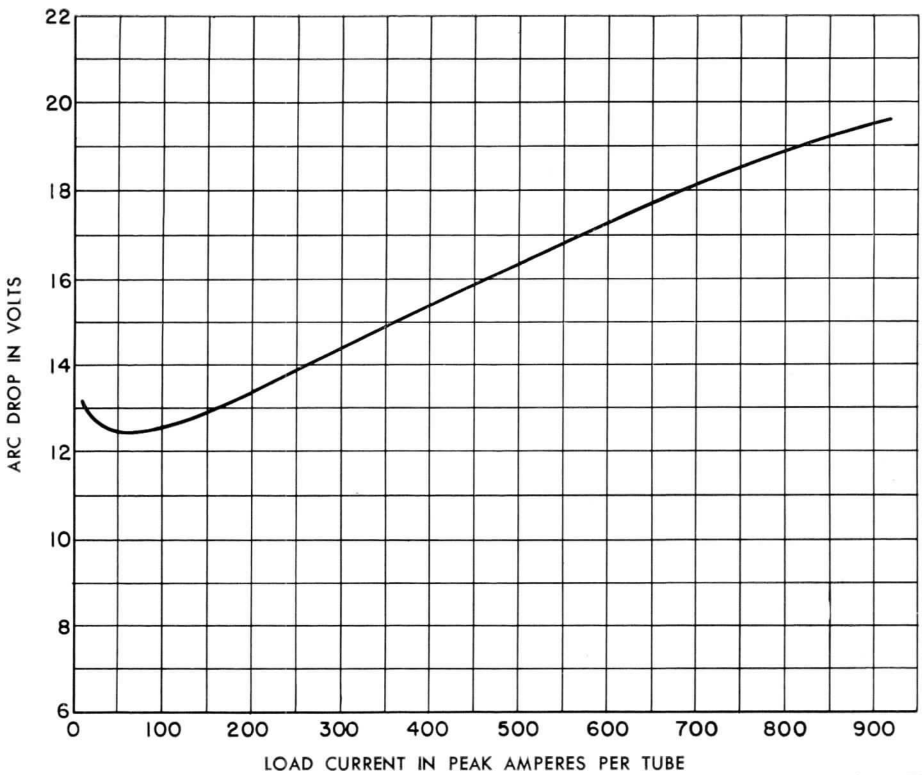
K-9033525 5-25-54



ELEMENTARY CIRCUIT FOR ANODE FIRING

K-9033528 5-25-54

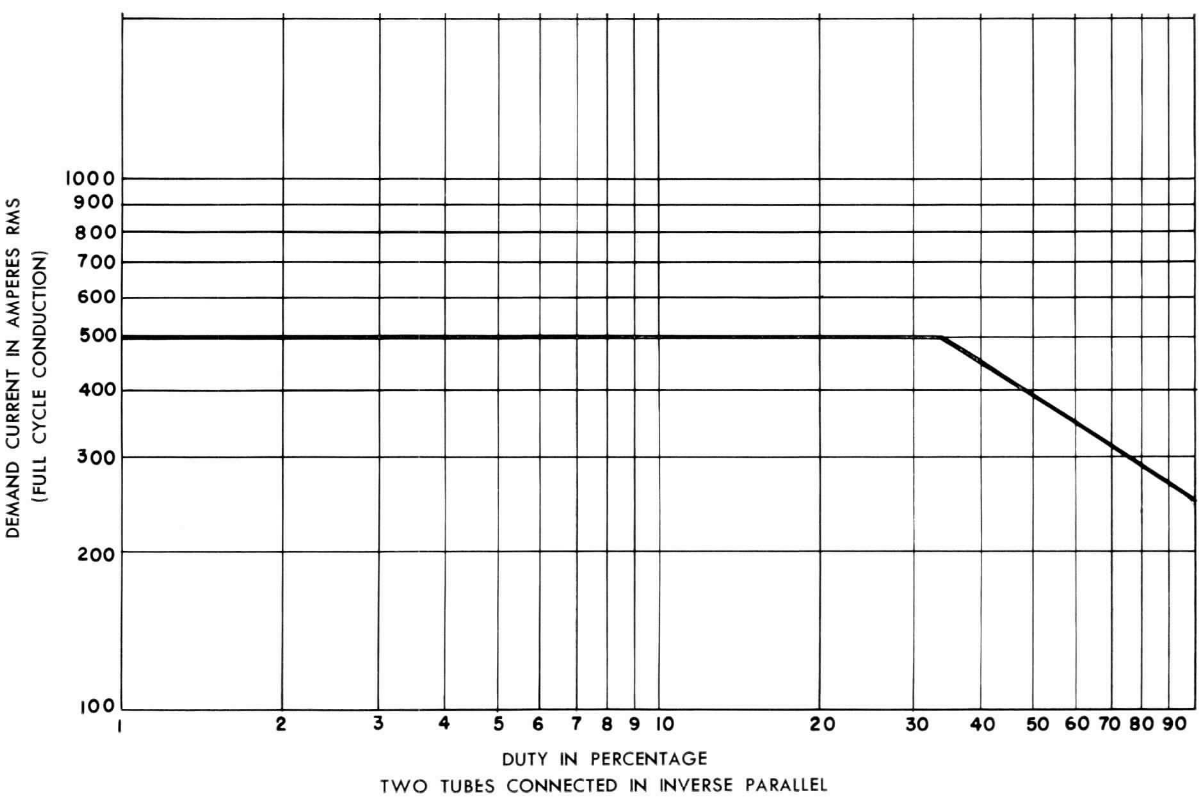
ARC DROP



K-6917493

10-20-54

DEMAND CURRENT VS PERCENTAGE DUTY
AT 2400 VOLTS RMS



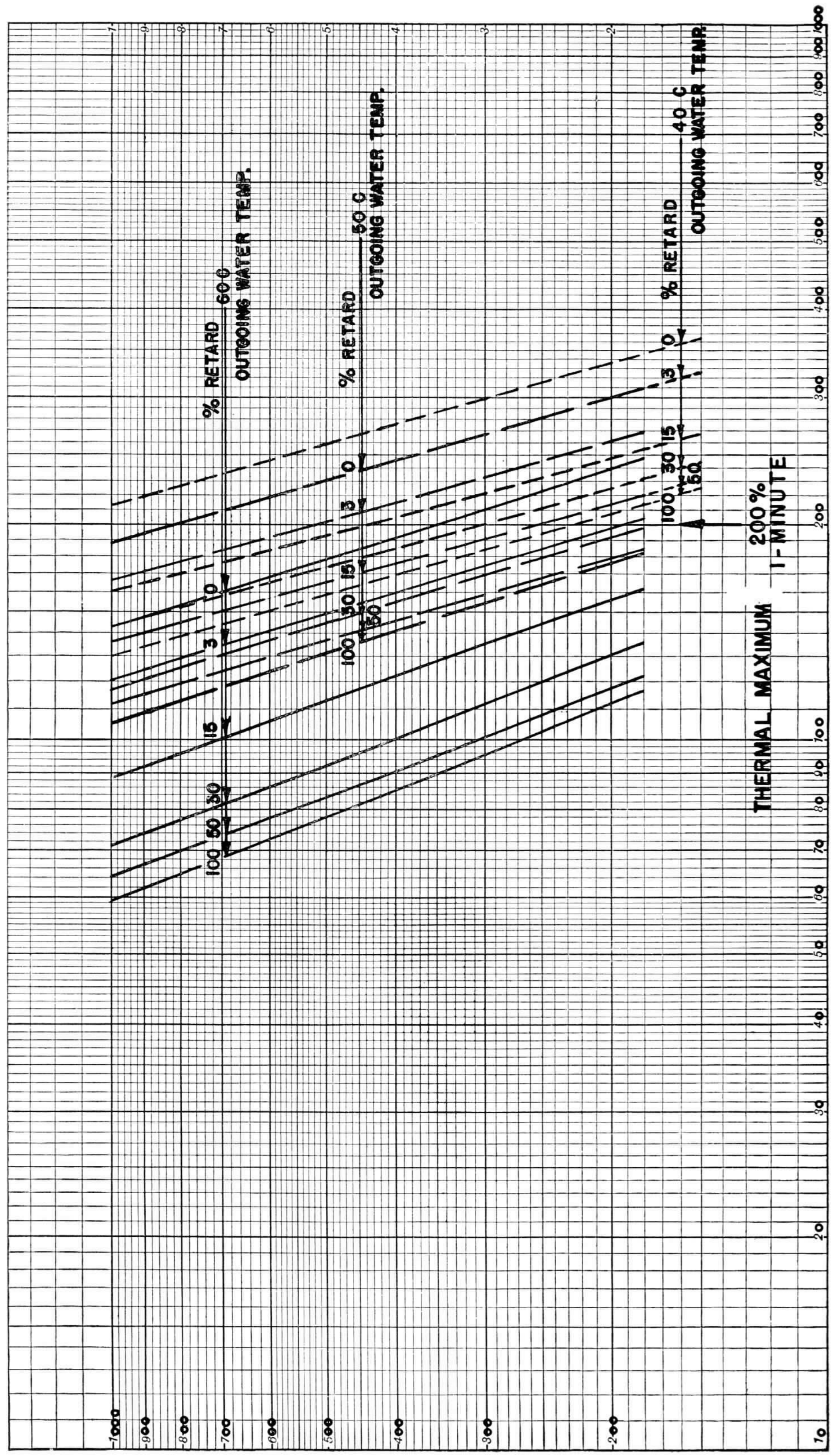
AVERAGING TIME = 1.5 SECONDS

K-69087-72A859

6-20-58

COMMUTATION LIMITS
1-MINUTE LOADS

DELTA, SIX-PHASE, DOUBLE-WYE CIRCUIT OR EQUIVALENT
RATIO OF PEAK-TO-AVERAGE ANODE CURRENT = 3:1
REACTANCE FACTOR, $\frac{I_C X_C}{E_S} = .075$ AT $I_C = 450$ AMPERES



AVERAGE ANODE CURRENT IN AMPERES PER TUBE

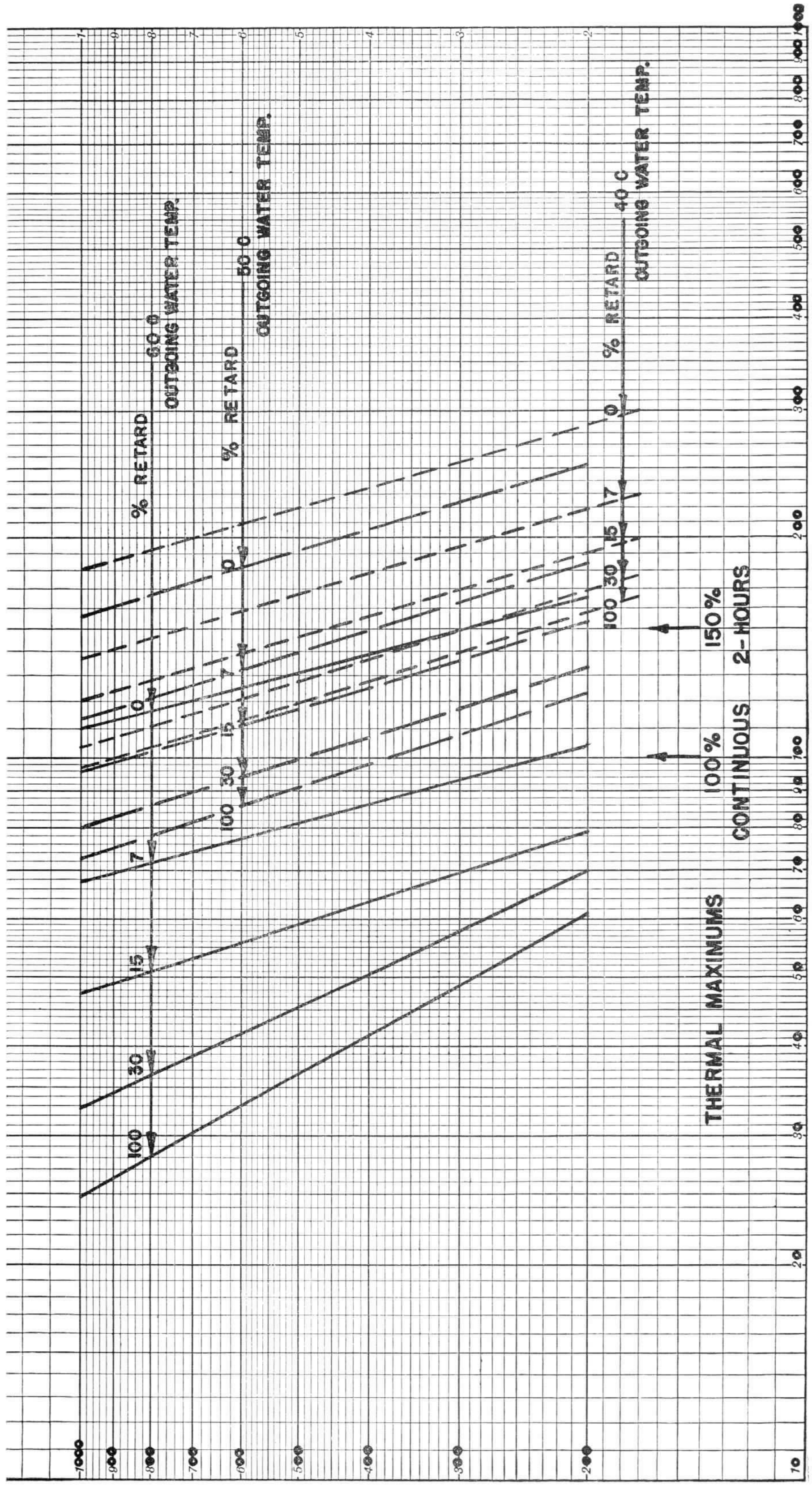
E_{DO}—NO LOAD DC VOLTAGE IN Δ-YY OR $\frac{1}{2.09}$ PEAK INVERSE VOLTAGE

10-20-54

K-69087-72A182

COMMUTATION LIMITS
2-HOUR LOADS

DELTA, SIX-PHASE, DOUBLE-WYE CIRCUIT OR EQUIVALENT
RATIO OF PEAK-TO-AVERAGE ANODE CURRENT = 3:1
REACTANCE FACTOR, $\frac{I_C X_C}{E_S}$ = .075 AT I_C = 450 AMPERES



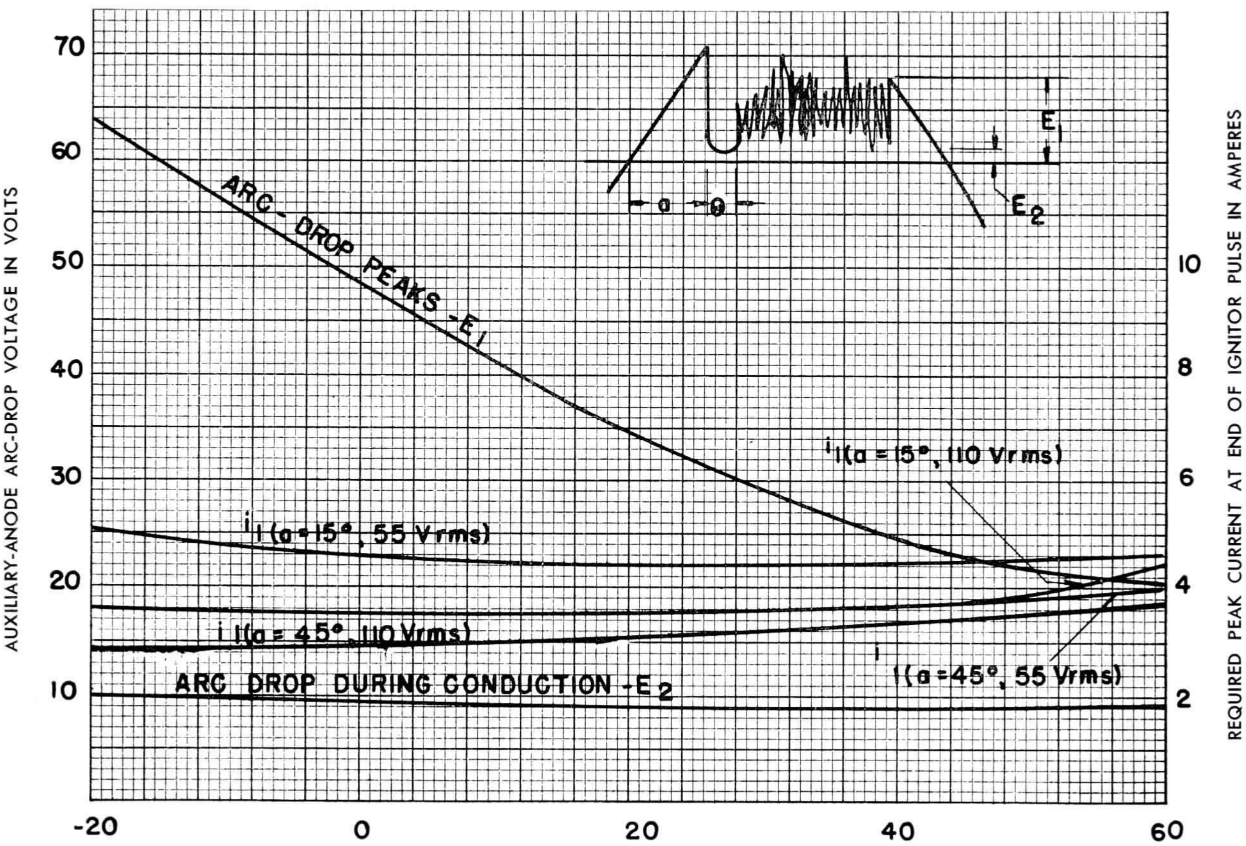
AVERAGE ANODE CURRENT IN AMPERES PER TUBE

E_{DO}—NO LOAD DC VOLTAGE IN $\triangle$-YY OR $\frac{1}{2.09}$ PEAK INVERSE VOLTAGE

10-20-54

K-69087-72A183

HOLDING ANODE REQUIREMENTS



INLET WATER TEMPERATURE IN C

K-69087-72A437 3-7-58

$$I_{max} = \frac{\sqrt{2}\ \text{Erms-arc drop}}{R} = \frac{I_1}{\sin(a+\theta)}$$

WHERE I_{max} = MAXIMUM VALUE OF AUXILIARY ANODE CURRENT TO PREVENT ARC FROM BEING EXTINGUISHED AT END OF IGNITOR PULSE MORE THAN ONCE PER MINUTE WITH MAIN ANODE NOT CONDUCTING. INCREASE APPROXIMATELY 40 PERCENT TO MAINTAIN ARC EVERY CYCLE.

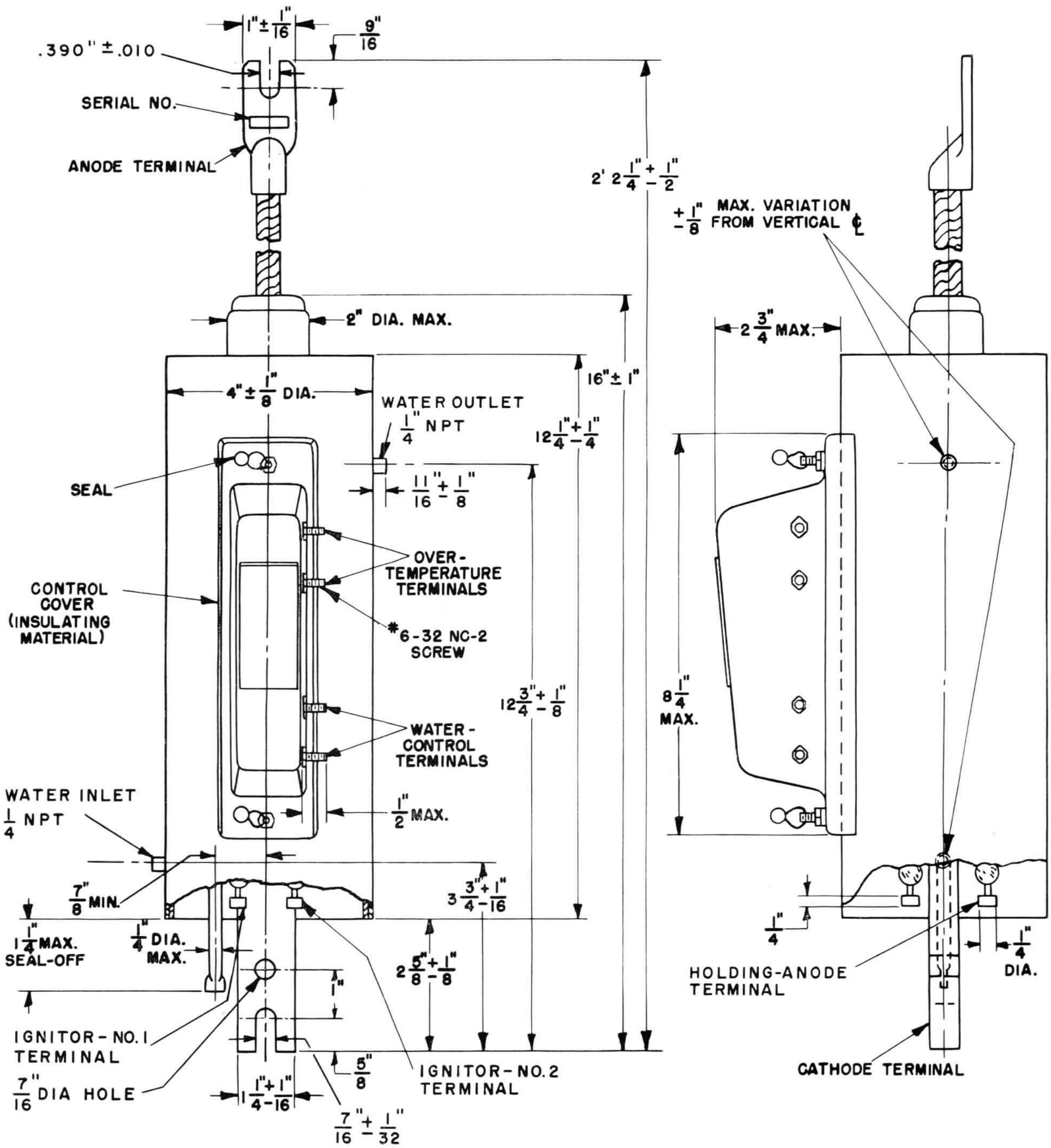
I_1 = INSTANTANEOUS VALUE OF AUXILIARY ANODE CURRENT AT TIME IGNITOR CURRENT DECAYS (FROM CURVES SHOWN FOR TWO VALUES OF a AND TWO VALUES OF SUPPLY VOLTAGE).

a = IGNITOR RETARD ANGLE WITH RESPECT TO AUXILIARY ANODE VOLTAGE.

θ = WIDTH OF IGNITOR PULSE (DEGREES).

E_{rms} = SUPPLY VOLTAGE.

R = TOTAL CIRCUIT RESISTANCE.



N-22022AZ

3-8-63

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.

IGNITRON

RECTIFIER SERVICE—200 AMPERES
AC CONTROL SERVICE—2400 KILOVOLT-AMPERES
TEMPERATURE CONTROLLED

HOLDING ANODE
TWO IGNITORS

The GL-6513 ignitron is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube designed for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. It is suitable for use in rectifiers rated up to 500 kilowatts output, depending on the number of ignitrons used, the output voltage, and the circuit. Continuous average current rating is 200 amperes per tube in rectifiers rated up to 300 volts d-c. The tube is also designed for 2400-volt a-c control service where it has a rating of 2400 kilovolt-amperes.

This tube is identical in ratings and characteristics to the GL-5555. Mechanically, it has the additional feature of an integral thermostatic arrangement with protective features. The arrangement includes a switch which controls a solenoid valve in the water-supply line to the tube in response to increasing and decreasing tube temperature, thus maintaining the amount of cooling water to the minimum required by the operating conditions. It also includes an over-temperature switch which may be used to remove power from the ignitron when its temperature exceeds a safe value.

This new design has several advantages. It eliminates the need for heat exchangers and recirculating water systems where they have been required to ensure safe operation of the older non-temperature-controlled ignitrons when the available cooling water temperature is too low to provide the minimum reliable mercury vapor pressure in the tubes. It eliminates the usual safety devices required with the older design tubes, such as water-flow relays, water over-temperature relays and water-pressure interlocks which have required considerable maintenance in the past. Another advantage is the pre-

Supersedes ET-T1134 dated 1-55

vention of excessive moisture condensation over the external parts of the tube under conditions of high humidity.

Like its prototype, the GL-6513 has a holding anode and two ignitors. Excitation of this anode permits stabilizing the cathode spot for very small anode currents. The two ignitors assure long life since only one is used at a time. Phase control of the ignitor impulses permits voltage control of the rectified output. In common with other ignitrons arc losses in the GL-6513 are low, and design and construction features, such as a complete stainless-steel-water jacket, assure ease of installation, economical use of space, and reliability of operation.

GENERAL

Electrical

Cathode Excitation—Cyclic		
Cathode Spot Starting—Ignitor		
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Auxiliary Anodes	1	
Ignitors	2	
Arc Drop at 600 Peak Amperes	16.2 ± 0.5	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	450	Volts
(See Curve K-9033883 for details)		
Ignitor Current Required to Fire	45	Amperes
(See Curve K-9033883 for details)		
Starting Time at Required Voltage or Current	100	Microseconds

Mechanical

Envelope Material—Stainless Steel		
Over-all Length	$17\frac{15}{16}$	Inches
Over-all Width	$5\frac{3}{4}$	Inches
Net Weight, approximate	25	Pounds

Thermal

Type of Cooling—Water		
Inlet Water Temperature, minimum	−15	C
Inlet Water Temperature,* maximum		
Power-Rectifier Service		
Peak Inverse Anode Voltage = 900 Volts	50	C
Peak Inverse Anode Voltage = 2100 Volts	35	C
AC Control Service		
Voltage = 2400 Volts RMS	25	C
Water Flow, minimum		
At Continuous Rated Average Current	3	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	7	C
Pressure Drop at 3 Gallons per Minute, maximum	6	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier Service, Continuous Duty

Ratings are for Zero-Phase-Control—See Curves K-69087-72A180 and K-69087-72A181 for details.

Maximum Peak Anode Voltage			
Inverse	900	2100	Volts
Forward	900	2100	Volts
Maximum Anode Current			
Peak	1800	1200	Amperes
Average			
Continuous	200	150	Amperes
Two-Hours—Averaged Over Any Two-Minute Interval	300	225	Amperes
One-Minute—Averaged Over Any One-Minute Interval	400	300	Amperes
Fault	12,000	9000	Amperes
Maximum Duration of Fault Current	0.15	0.15	Seconds
Frequency Range	25–60	25–60	Cycles per Second

MAXIMUM RATINGS (CONT'D)

AC Control Service†

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	2400	Volts RMS
Maximum Demand	2400	Kilovolt-Amperes
Average Current at Maximum Demand	135	Amperes
Maximum Average Current	207	Amperes
Demand at Maximum Average Current	1105	Kilovolt-Amperes
Maximum Averaging Time at 2400 Volts RMS	1.66	Seconds
Maximum Peak Fault Current	6000	Amperes
Frequency Range	25–60	Cycles per Second

Ignitor

Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
Root Mean Square	15	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds
Typical Resistance Added to Ignitor Circuit for Anode Firing		
At Anode Voltage of 600 Volts or Less	4	Ohms
At Anode Voltage of 601 Volts to 1000 Volts	10	Ohms
At Anode Voltage of 1001 Volts to 1500 Volts	20	Ohms
At Anode Voltage of 1501 Volts to 2000 Volts	35	Ohms
At Anode Voltage of 2001 Volts to 2400 Volts	50	Ohms

Holding Anode

Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Temperature-Control-Switch Ratings‡

Maximum Voltage	575	Volts
Maximum Current		
Over-Temperature Switch	6	Amperes
Water-Control Switch	1.5	Amperes
Maximum Peak Potential Difference Between Switch Circuit and Tube Water Cylinder	1500	Volts
Switch-Contact Arrangement		
Over-Temperature Switch—Normally Closed (Contacts Open on Temperature Rise)		
Water-Control Switch—Normally Open (Contacts Close on Temperature Rise)		

* When two or more tubes are connected in series for water flow, the temperature of the incoming water to the warmest tube in the series must be within the rated limit.

† RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used.

The switching circuit must be insulated to prevent excessive voltage between tube cylinder and switches.

‡ Suitable fuses should be provided in the switch circuits to prevent a power arc should a ground occur in the switch or wiring.

INSTALLATION AND OPERATION NOTES

In order to realize the advantage of safe tube operation on low-temperature cooling water, water must be supplied to the tube through a rapid-closing solenoid valve controlled by the water-control switch on the tube. The valve must completely stop the water flow to the tube except when the water-control switch is closed. The number of tubes connected in series for water from a single valve must be restricted for the lower temperatures. Placing fewer tubes in series with a solenoid valve

INSTALLATION AND OPERATION NOTES (CONT'D)

will allow the use of lower incoming water temperatures without resulting in arcbacks caused by low tube temperatures.

If the water-supply temperature will never be below +10 C, six tubes may be connected in series for water flow, providing the temperature is not high enough to cause over-temperature on the last tube for the flow available and the load expected on the rectifier. If six tubes are connected in series, only one solenoid valve is required for a six-tube rectifier. It is possible to operate with only one temperature-controlled tube (installed in the outgoing end of the series group). For more complete protection, two temperature-controlled ignitrons are usually installed in the last two positions on the outgoing water end with their water-control switches in parallel and their over-temperature switches in series.

If the water-supply temperature will be less than +10 C, but never less than 0 C, a series-parallel system should be used connecting three tubes in series for water flow. Water to each series group should be supplied through a solenoid water valve controlled by the water-control switch on the last tube receiving water in that group. In this arrangement, one temperature-controlled tube in the outgoing end of each series group may be used to protect two non-temperature-controlled ignitrons in the remaining positions of the group.

If the water-supply temperature is expected to drop below 0 C, all tubes in the rectifier must be temperature-controlled, be connected in parallel for water flow, and have individual solenoid water valves which prevent water from circulating through any tube until its water-control switch closes. If the tubes themselves are at this low temperature initially, a low load (such as ¼ load) should be applied to the rectifier long enough to cause one operation of the solenoid valves. After this initial warming, the rectifier should be in condition to handle safely normal loads unless it is idle in a cold atmosphere long enough for the tubes again to become cold.

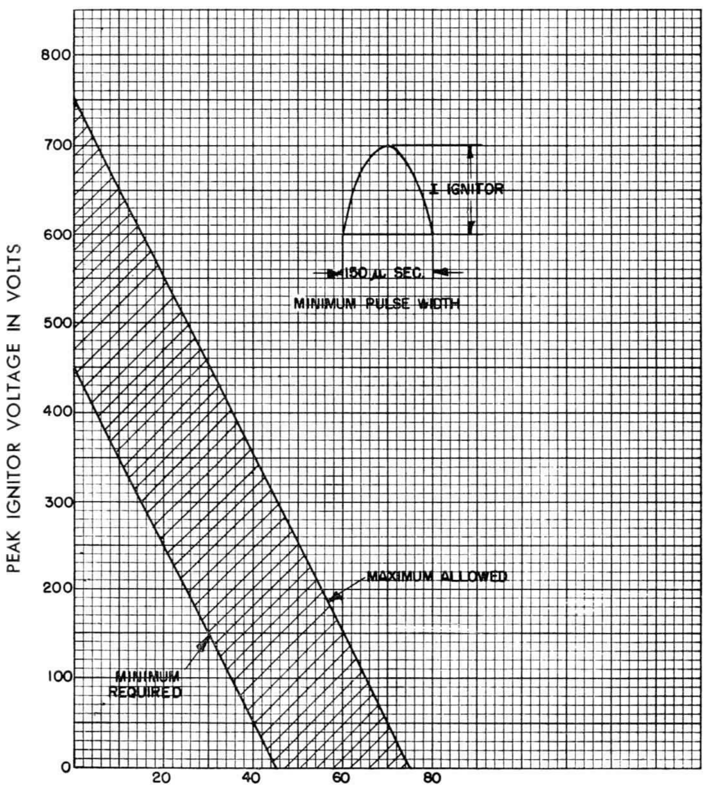
The minimum allowable temperature for the series and series-parallel connections is based on normal industrial loads on the rectifier. For some special conditions of loading it is possible to lower these temperatures.

In some applications, for example, where the rectifier has only intermittent low loads which are not sufficient to heat the anode end of the tubes to normal temperature, there may be a tendency for mercury to accumulate on the inside of the anode glass insulating bushing. Small amounts of mercury here are not serious. If the entire surface becomes covered, however, it will cause an arc over the inside of the glass which may permanently damage the tube. If this type of service is anticipated, large accumulations of mercury over the glass can easily be prevented by applying external heat to the glass with small radiant heaters or heat lamps. The glass temperature should be raised to approximately 50 C, but may go to 200 C without damage when the tubes are loaded.

IGNITOR VOLT-AMPERE REQUIREMENTS

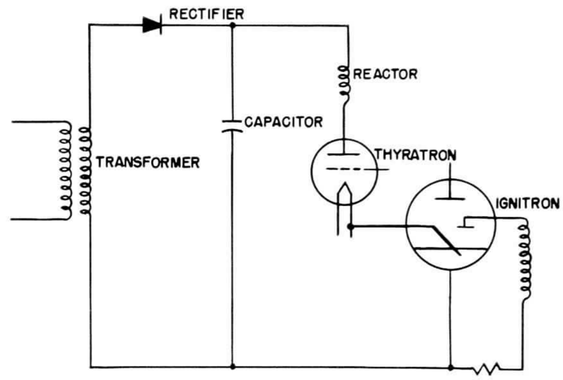
SEALED-IGNITRON RECTIFIERS

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



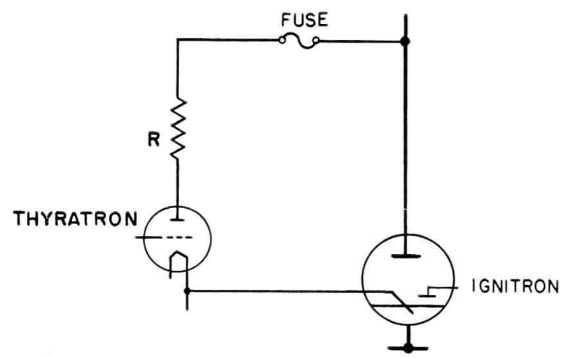
PEAK IGNITOR CURRENT IN AMPERES

K-9033883 5-25-54



ELEMENTARY CIRCUIT FOR CAPACITOR FIRING

K-9033525 5-25-54

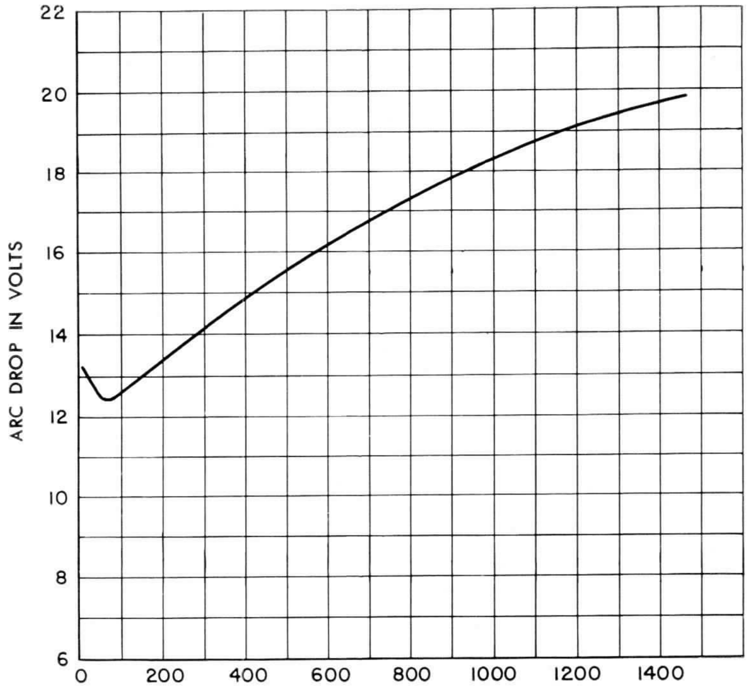


ELEMENTARY CIRCUIT FOR ANODE FIRING

K-9033528 5-25-54

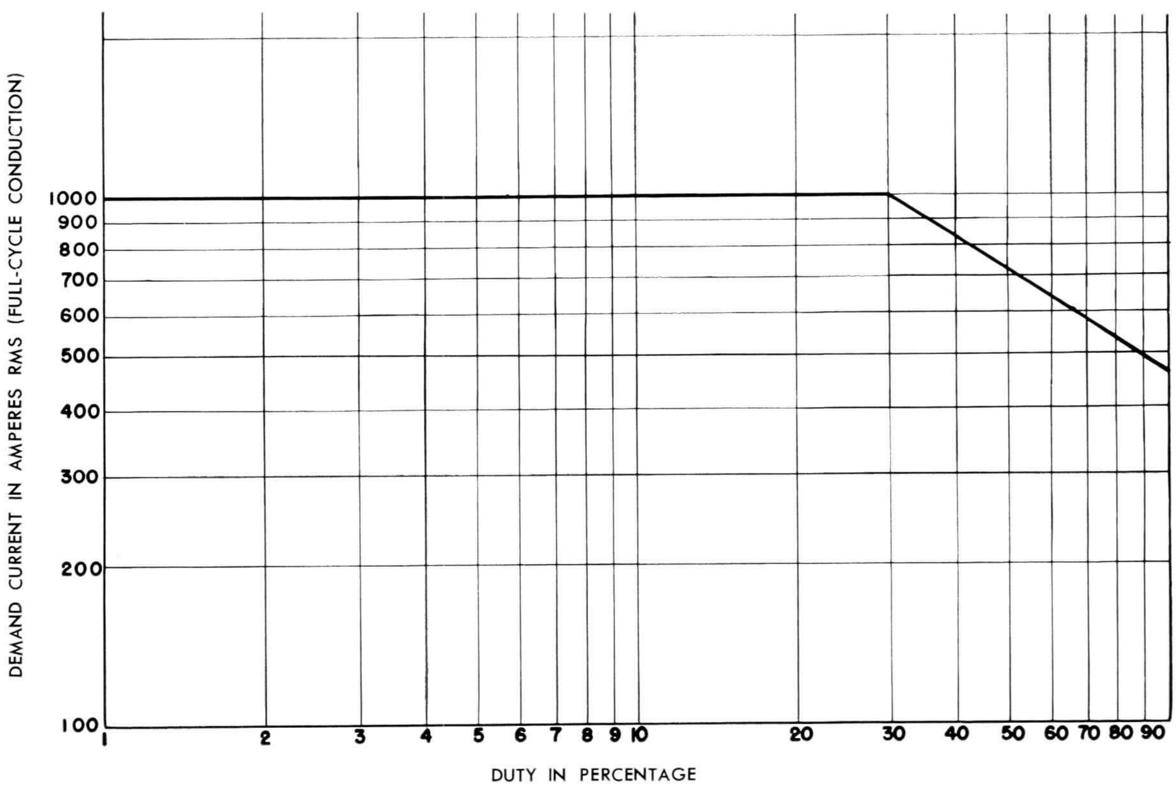
ARC DROP

OUTLET WATER TEMPERATURE—40 TO 60 C
WATER FLOW—3 GPM



K-6917495 2-14-55

DEMAND CURRENT VS PERCENTAGE DUTY AT 2400 VOLTS RMS



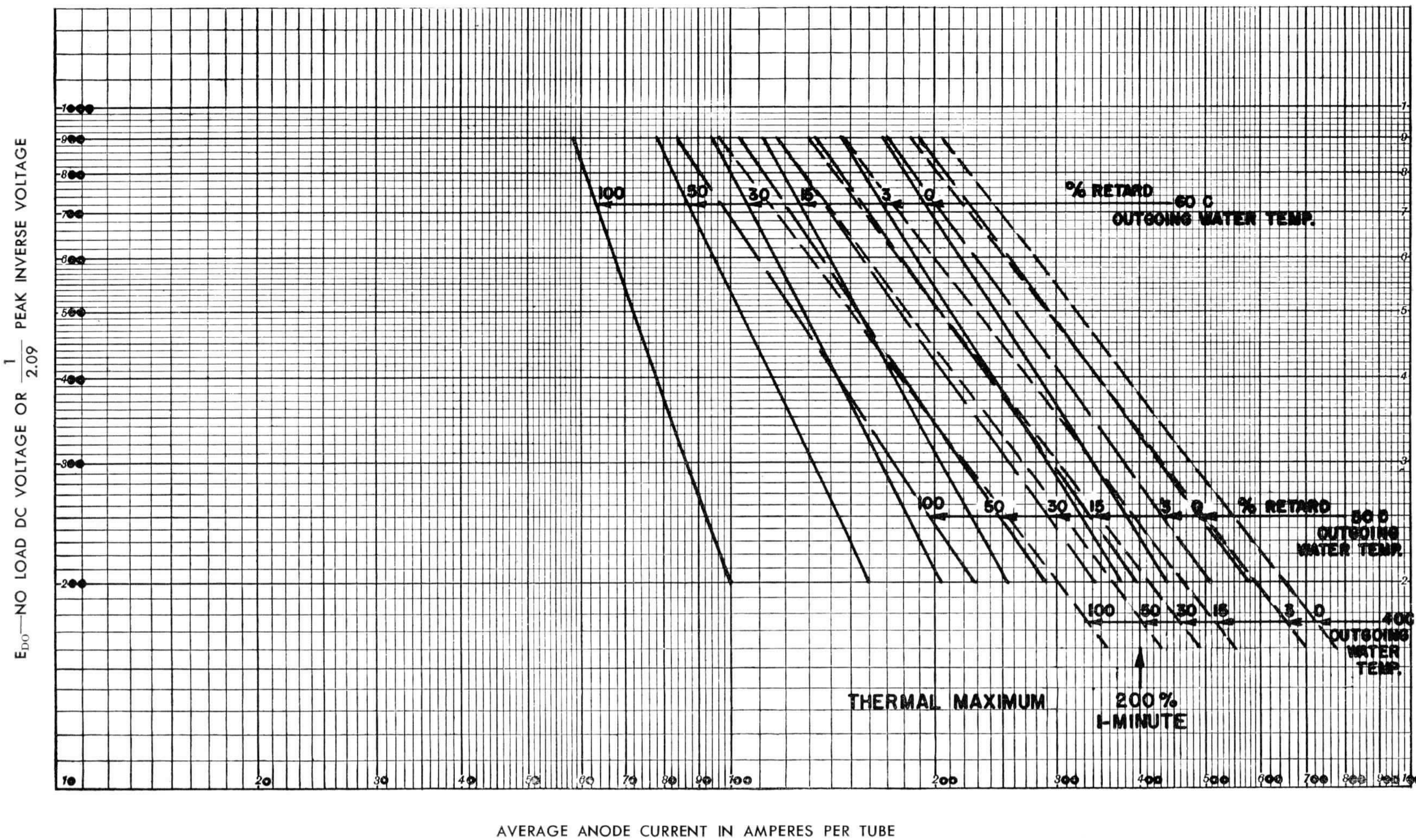
TWO TUBES CONNECTED IN INVERSE PARALLEL

K-8074661 6-20-58

AVERAGING TIME = 1.66 SECONDS

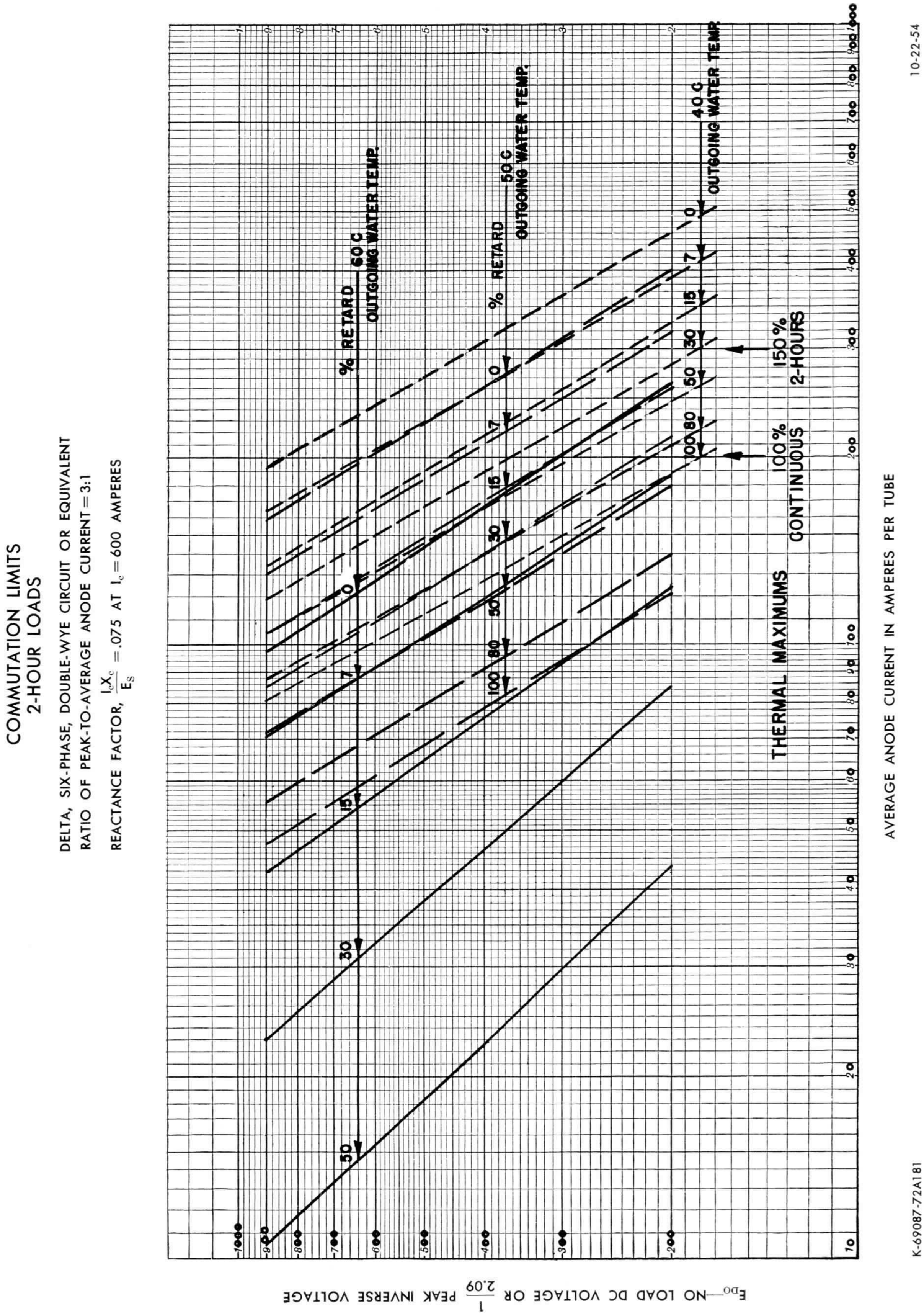
COMMUTATION LIMITS
1-MINUTE LOADS

DELTA, SIX-PHASE, DOUBLE-WYE CIRCUIT OR EQUIVALENT
RATIO OF PEAK-TO-AVERAGE ANODE CURRENT = 3:1
REACTANCE FACTOR, $\frac{I_c X_c}{E_S} = .075$ AT $I_c = 600$ AMPERES



K-69087-72A180

10-22-54


COMMUTATION LIMITS
2-HOUR LOADS
DELTA, SIX-PHASE, DOUBLE-WYE CIRCUIT OR EQUIVALENT
RATIO OF PEAK-TO-AVERAGE ANODE CURRENT = 3:1
REACTANCE FACTOR, $\frac{I_c X_c}{E_S}$ = .075 AT I_c = 600 AMPERES
% RETARD
60 C
OUTGOING WATER TEMP.
% RETARD
50 C
OUTGOING WATER TEMP.
40 C
OUTGOING WATER TEMP.
0
7
15
30
50
80
100
150%
2-HOURS
100%
CONTINUOUS
THERMAL MAXIMUMS
AVERAGE ANODE CURRENT IN AMPERES PER TUBE
E_{DO}—NO LOAD DC VOLTAGE OR $\frac{1}{2.09}$ PEAK INVERSE VOLTAGE
10
20
30
40
50
60
70
80
90
100
200
300
400
500
600
700
800
900
1000
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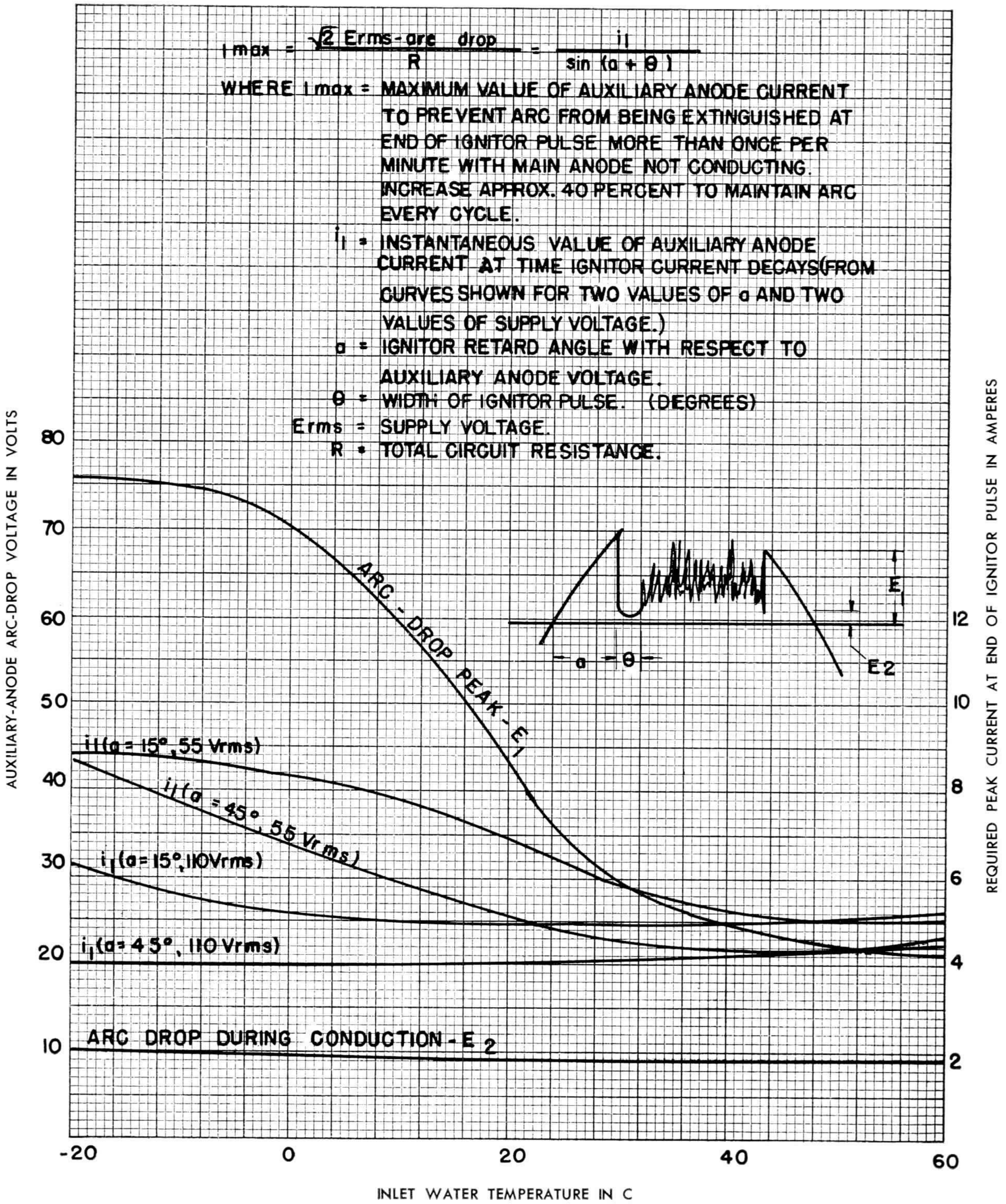
K-69087-72A181

HOLDING ANODE REQUIREMENTS



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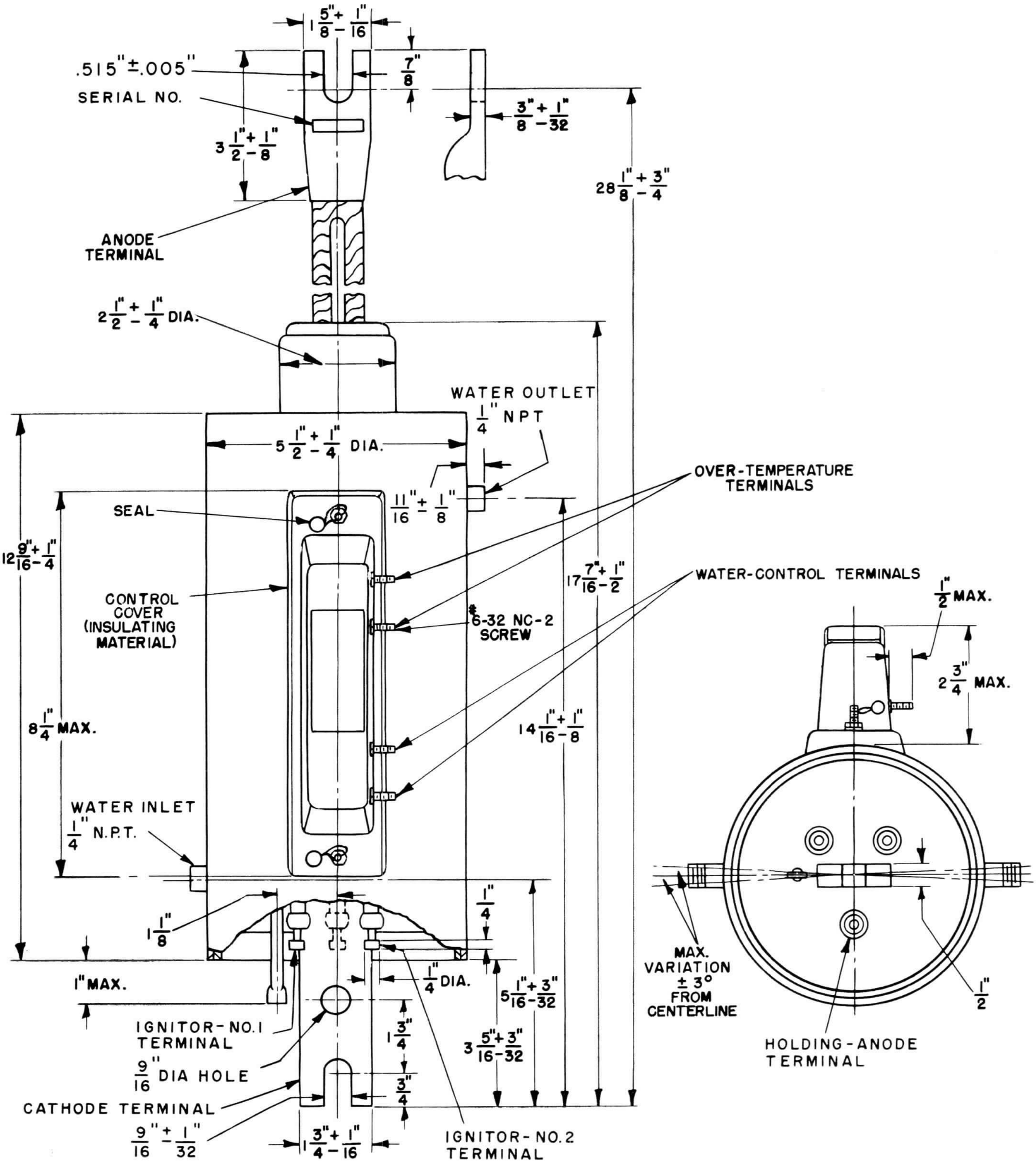

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PRODUCT INFORMATION

IGNITRON

GL-6514

GL-6514

RECTIFIER SERVICE—150 AMPERES
AC CONTROL SERVICE—2400 KILOVOLT-AMPERES
HOLDING ANODE TEMPERATURE-CONTROLLED TWO IGNITORS

The GL-6514 is a permanently sealed water-cooled rectifier ignitron similar in construction and rating to the GL-5788. Special features are the addition of an integral temperature-control device with protective features, and low water-pressure drop. The tube is designed for operation in 300-, 600-, and 900-volt d-c industrial rectifier circuits. The continuous average anode current rating is 150 amperes per tube in rectifiers rated up to 400 volts d-c. The control includes a switch which operates a solenoid valve in the water-supply line to the tube in response to increasing and decreasing tube temperature, thus maintaining the amount of cooling water to the minimum required by the operating conditions. It also includes an over-temperature switch which may be used to remove power from the ignitron when its temperature exceeds a safe value.

This design eliminates the need for heat exchangers and recirculating water systems required to ensure safe operation of the non-temperature-controlled tube when the available cooling water temperature is too low to provide the minimum reliable mercury-vapor pressure in the tubes. Another advantage is that temperature-controlled tubes replace the usual safety devices, such as, water-flow relays, water over-temperature relays, and water-pressure interlocks, which require considerable maintenance. These tubes prevent excessive moisture condensation over their external parts under conditions of high humidity.

ELECTRICAL

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes
- Main Anodes 1
- Main Cathodes 1
- Holding Anodes 1
- Ignitors 2

Arc Drop at 600 Amperes Peak . . . . . 16.2±0.5 Volts
See Curve "Arc Drop"

MECHANICAL

Envelope Material—Stainless Steel
Net Weight, approximate . . . . . 25 Pounds

THERMAL

Type of Cooling—Water
Inlet Water Temperature*, minimum . . . . . −10C

Inlet Water Temperature, maximum
- Power-Rectifier Service
  - Peak Inverse Anode Voltage = 900 Volts and Below . . . . . 55 C
  - Peak Inverse Anode Voltage = 2100 Volts and Below . . . . . 50 C
- AC Control Service
  - Voltage = 2400 Volts RMS . . . . . 45 C

Water Flow, minimum, solenoid water valve open†
- At Continuous Rated Average Current . . . . . 3 Gallons per Minute

Characteristics for Water Cooling at Rated Minimum Flow
- Water Temperature Rise, maximum . . . . . 4.5 C
- Pressure Drop at 3 Gallons per Minute, maximum . . . . . 3 Pounds per Square Inch

* See "Installation and Operation Notes"

† Water flow should be continued for at least thirty minutes after removal of anode power.

MAXIMUM RATINGS

Power-Rectifier Service, Continuous Duty

Ratings are for Zero-Phase-Control Angle—See Curves "Commutation Limits"

Maximum Peak Anode Voltage		
Inverse	900–2100	Volts
Forward	2100	Volts
Maximum Anode Current		
Peak	1200	Amperes
Average		
Continuous	150	Amperes
Two-Hours—Averaged Over Any Two-Minute Interval	225	Amperes
One-Minute—Averaged Over Any One-Minute Interval	300	Amperes
Fault	9000	Amperes
Maximum Duration of Fault Current	0.15	Seconds
Frequency Range	25–60	Cycles per Second

AC Control Service

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	2400	Volts RMS
Maximum Demand	2400	Kilovolt-Amperes
Average Current at Maximum Demand	135	Amperes
Maximum Average Current	207	Amperes
Demand at Maximum Average Current	1105	Kilovolt-Amperes
Maximum Averaging Time at 2400 Volts RMS	1.66	Seconds
Maximum Peak Fault Current	6000	Amperes
Frequency Range	25–60	Cycles per Second

MAXIMUM RATINGS (Cont'd)

Holding Anode

See Curve "Holding Anode Requirements"

Maximum Peak Voltage		
Forward	160	Volts
Inverse		
Main Anode Conducting	25	Volts
Main Anode Non-Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Cathode Excitation Requirements

Ignitor Voltage Required to Fire	450	Volts
See Curve "Ignitor Volt-Ampere Requirements"		
Ignitor Current Required to Fire	45	Amperes
See Curve "Ignitor Volt-Ampere Requirements"		
Starting Time at Required Voltage or Current	100	Microseconds
Peak Excitation Arc Current Required, minimum	8	Amperes
See Curve "Holding Anode Requirements"		
Excitation Arc-Drop Voltage	9 ± 0.5	Volts
Excitation Arc Open-Circuit Voltage, minimum	55	Volts Ac

Ignitor

Maximum Voltage		
Positive—Anode Voltage		
Inverse	5	Volts
Maximum Current		
Peak	100	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Temperature-Control-Switch Ratings‡

Maximum Voltage	575	Volts
Maximum Current		
Over-Temperature Switch	6	Amperes
Water-Control Switch	1.5	Amperes
Maximum Peak Potential Difference Between Tube Water Cylinder and Switch Circuit	1500	Volts

Switch-Contact Arrangement
- Over-Temperature Switch—Normally Closed (Contacts Open on Temperature Rise)
- Water-Control Switch—Normally Open (Contacts Close on Temperature Rise)

‡ Suitable fuses should be provided in the switch circuits to prevent a power arc should a ground occur in the switch or wiring.

INSTALLATION AND OPERATION NOTES

In order to realize the advantage of safe tube operation on low-temperature cooling water, water must be supplied to the tube through a rapid-closing solenoid valve controlled by the water-control switch on the tube. The valve must completely stop the water flow to the tube except when the water-control switch is closed. The number of tubes connected in series for water from a single valve must be restricted for the lower temperatures. Placing fewer tubes in series with a solenoid valve will allow the use of lower incoming water temperatures without resulting in arcbacks caused by low tube temperatures.

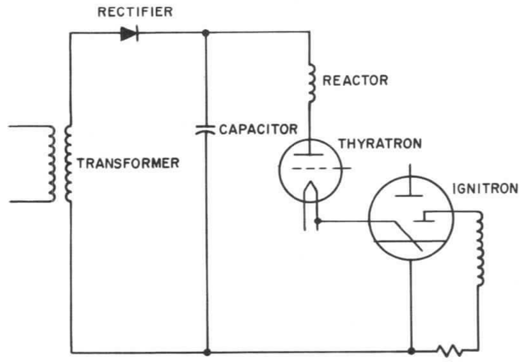
If the water-supply temperatures will never be below +5 C, three tubes may be connected in series for water flow, provided the temperature is not high enough to cause over-temperature on the last tube for the flow available and the load expected on the rectifier. If three tubes are connected in series, only one solenoid valve is required for the series group, and only the last tube in the group requires the temperature-control switches.

If the water-supply temperature may sometimes drop below +5 C, all tubes in the rectifier must be temperature-controlled, be connected in parallel for water flow, and have individual solenoid water valves which prevent water from circulating through any tube until its water-control switch closes. If the tubes themselves are at this low temperature initially, a low load (such as ¼ load) should be applied to the rectifier long enough to cause one operation of the solenoid valves. After this initial warming, the rectifier should be in condition to handle safely normal loads unless it is idle in a cold atmosphere long enough for the tube again to become cold.

The minimum allowable temperature for the series-parallel connection is based on normal industrial loads on the rectifier. For some special conditions of loading it is possible to lower these temperatures.

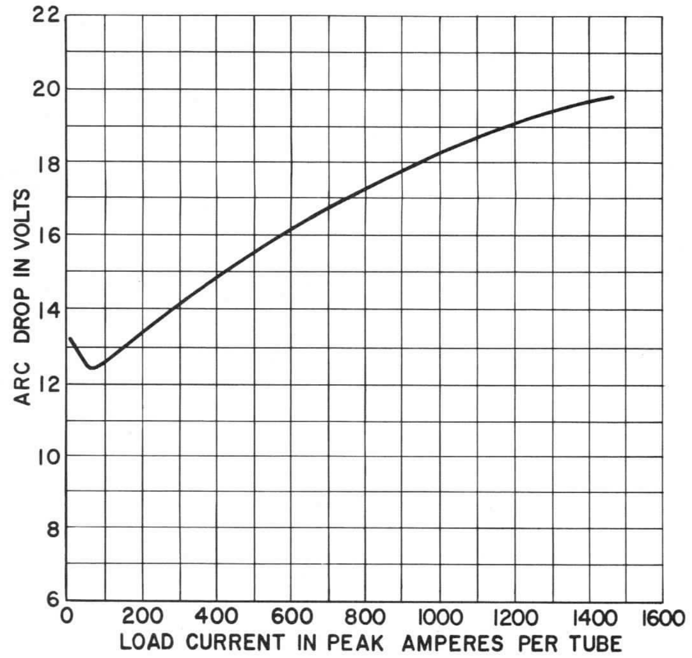
In some applications, for example, where the rectifier has only intermittent low loads which are not sufficient to heat the anode end of the tubes to normal temperature, there may be a tendency for mercury to accumulate on the inside of the anode glass insulating bushing. Small amounts of mercury here are not serious. If the entire surface becomes covered, however, it will cause an arc over the inside of the glass which may permanently damage the tube. If this type of service is anticipated, large accumulations of mercury over the glass can easily be prevented by applying external heat to the glass with small radiant heaters or heat lamps. The glass temperature should be raised to approximately 50 C, but may go to 200 C without damage when the tubes are loaded.

IGNITRONS
ELEMENTARY CIRCUIT FOR CAPACITOR FIRING

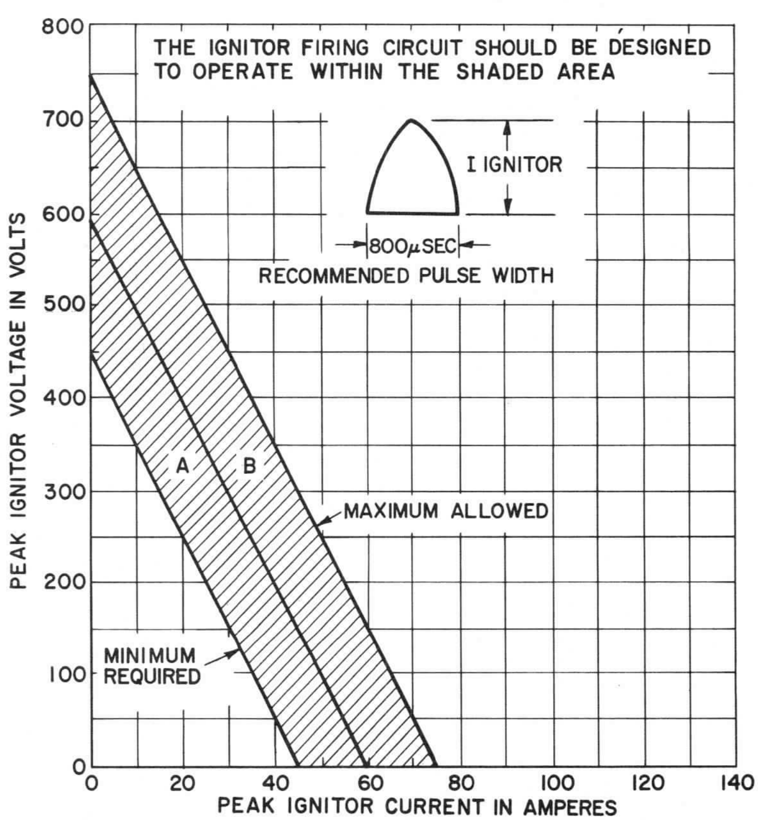


ARC DROP

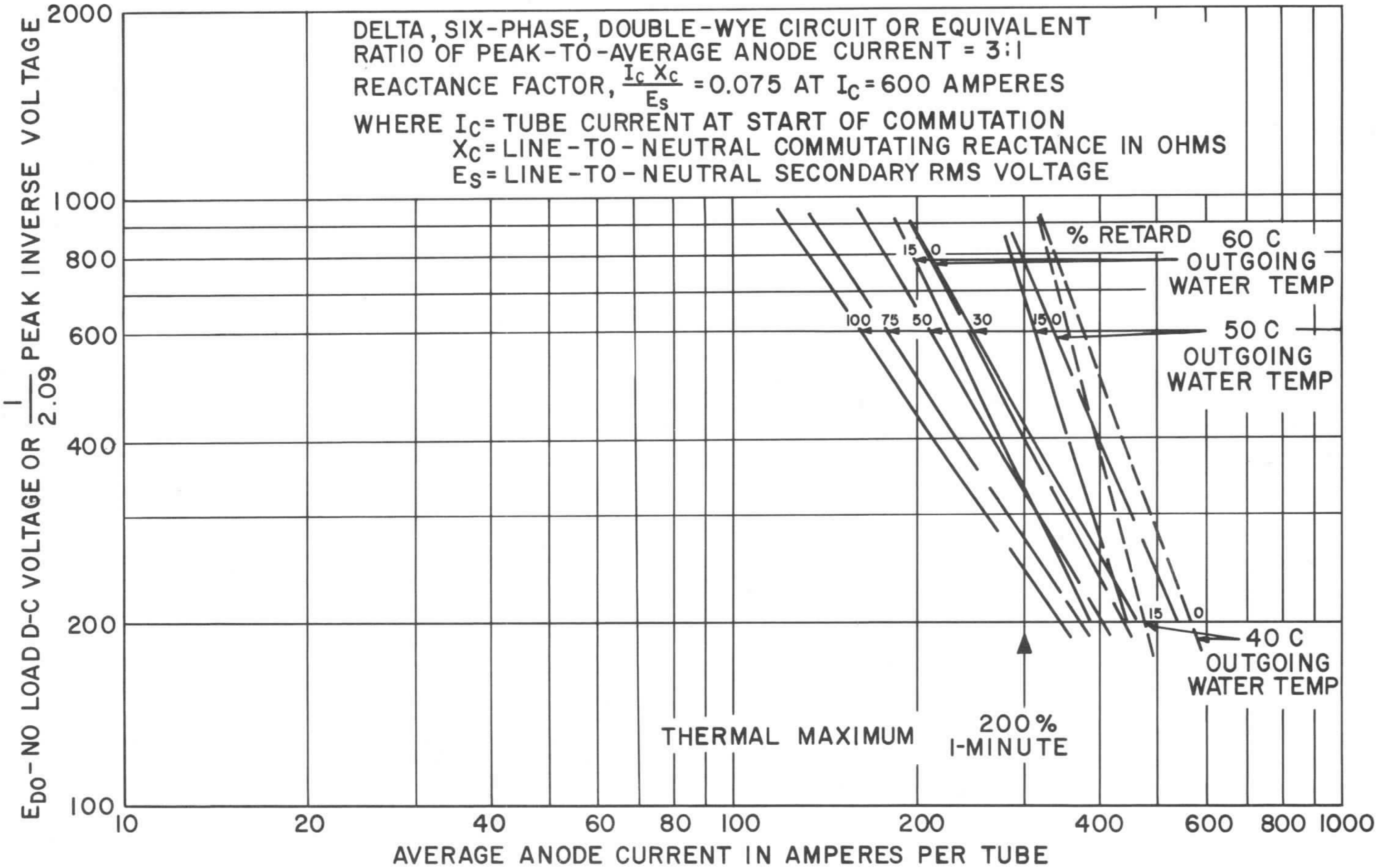
OUTLET WATER TEMPERATURE - 40 TO 60 C
WATER FLOW - 3 GPM



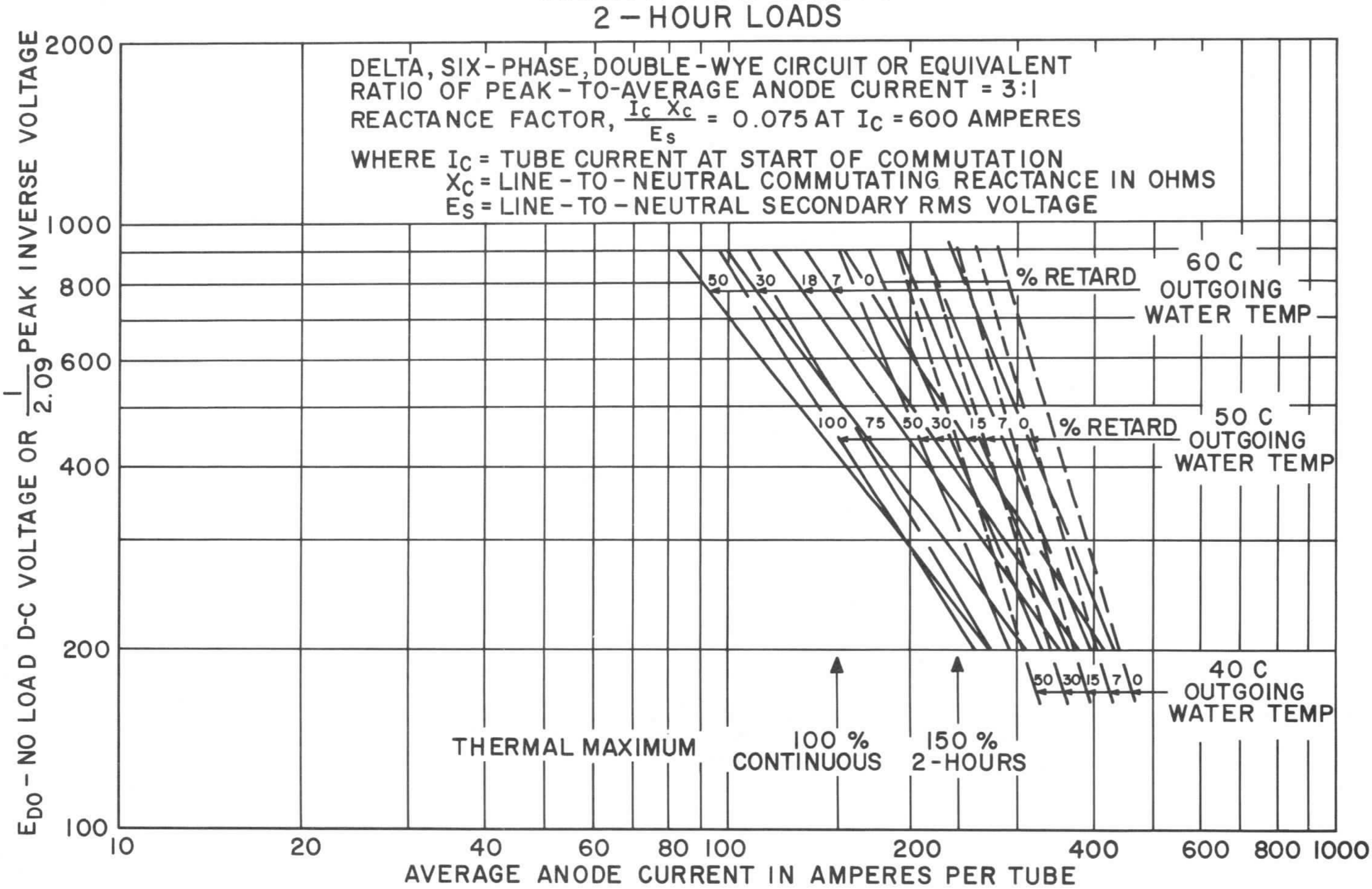
IGNITOR VOLT-AMPERE REQUIREMENTS



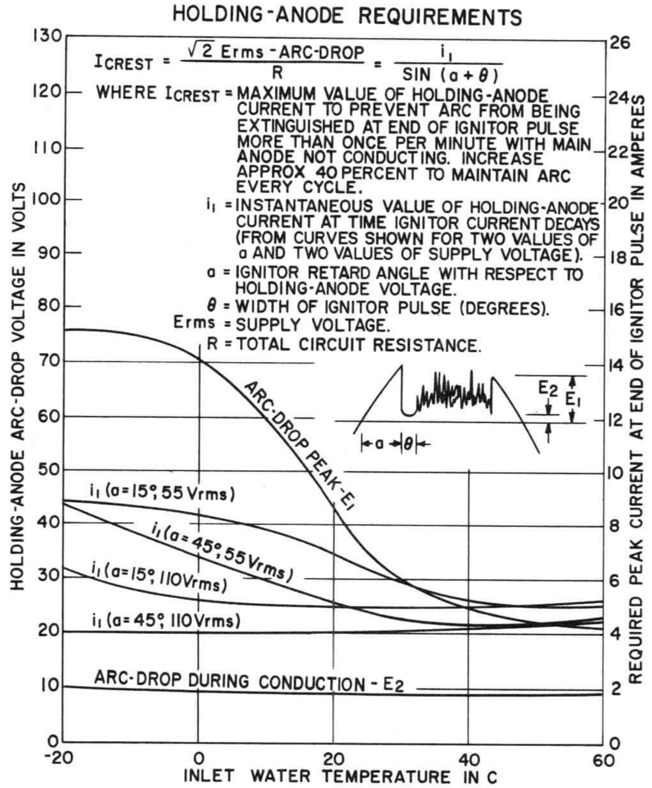
COMMUTATION LIMITS
1-MINUTE LOADS

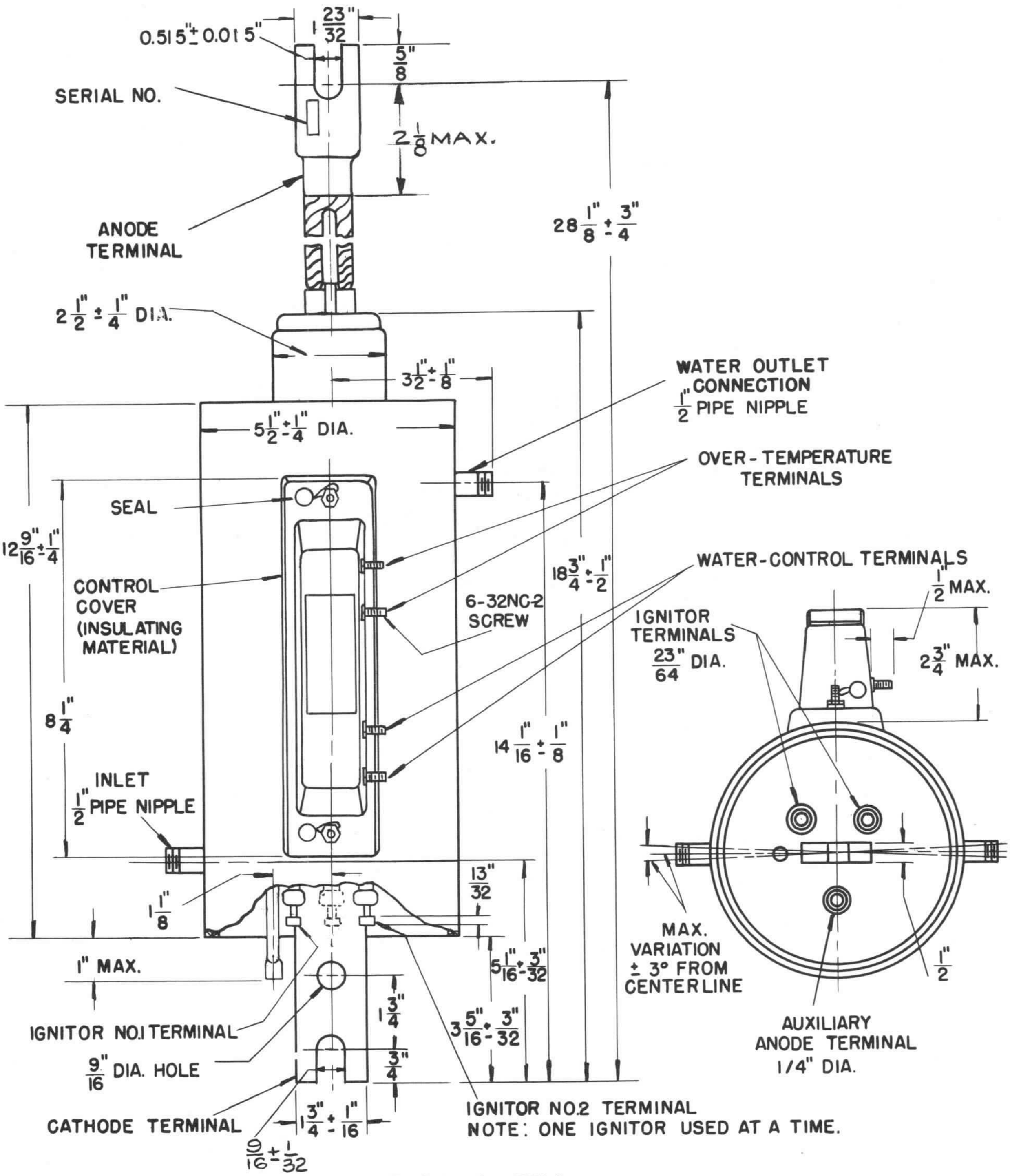


COMMUTATION LIMITS
2-HOUR LOADS



HOLDING-ANODE REQUIREMENTS





OUTLINE GL-6514

IGNITRON

RECTIFIER SERVICE—400 AMPERES **HOLDING ANODE**

AC CONTROL SERVICE—4800 KILOVOLT-AMPERES **TWO IGNITORS**

TEMPERATURE CONTROLLED

The GL-6515 ignitron is a sealed, stainless-steel jacketed, water-cooled mercury-pool tube for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. It is suitable for use in rectifiers rated up to 1000 kilowatts output, depending on the number of ignitrons used, the output voltage, and the circuit. Continuous average current rating is 400 amperes per tube in rectifiers rated up to 300 volts d-c. The tube is also designed for 2400-volt a-c control service where it has a rating of 4800 kilovolt-amperes.

This tube is identical in ratings and characteristics to the GL-5564. Mechanically, it has the additional feature of an integral thermostatic arrangement with protective features. The arrangement includes a switch which controls a solenoid valve in the water-supply line to the tube in response to increasing and decreasing tube temperature, thus maintaining the amount of cooling water to the minimum required by the operating conditions. It also includes an over-temperature switch which may be used to remove power from the ignitron when its temperature exceeds a safe value.

This new design has several advantages. It eliminates the need for heat exchangers and recirculating water systems where they have been required to ensure safe operation of the older non-temperature-controlled ignitrons when the available cooling water temperature is too low to provide the minimum reliable mercury vapor pressure in the tubes. It eliminates the usual safety devices required with the older design tubes, such as water-flow relays, water over-temperature relays and water-pressure interlocks which have required considerable maintenance in the past. Another advantage is the prevention of excessive moisture condensation over the external parts of the tube under conditions of high humidity.

Like its prototype, the GL-6515 has a holding anode and two ignitors. Excitation of this anode permits stabilizing the cathode spot for very small anode currents. The two ignitors assure long life since only one is used at a time. Phase control of the ignitor impulses permits voltage control of the rectified output. In common with other ignitrons arc losses in the GL-6515 are low, and design and construction features, such as a complete stainless-steel-water jacket, assure ease of installation, economical use of space, and reliability of operation.

GENERAL

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Holding Anodes	1	
Ignitors	2	
Control Grids	1	
Arc Drop at 1200 Peak Amperes	18.2 ± 0.1	Volts
Arc Drop at 8000 Peak Amperes	35 ± 0.1	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	450	Volts
(See curve K-9033883 for details)		
Ignitor Current Required to Fire	45	Amperes
(See curve K-9033883 for details)		
Starting Time at Required Voltage or Current	100	Microseconds
Peak Excitation Arc Current Required, minimum	6	Amperes
(See curve K-69087-72A387 for details)		
Excitation Arc-Drop Voltage	12	Volts
Grid Requirements*		
Minimum Voltage to Establish Conduction	50	Volts
Minimum Voltage to Prevent Conduction	100	Volts
Positive Current to Establish Conduction	0.1	Amperes

Mechanical

Envelope Material—Stainless Steel

Over-all Length	$27\frac{11}{16}$	Inches
Over-all Width	$9\frac{1}{8}$	Inches
Net Weight, approximate	90	Pounds

Thermal

Type of Cooling—Water

Inlet Water Temperature†, minimum	25	C
Inlet Water Temperature‡, maximum		
Power-Rectifier Service		
Peak Inverse Anode Voltage = 900 Volts	50	C
Peak Inverse Anode Voltage = 2100 Volts	40	C
AC Control Service		
Voltage = 250 Volts RMS	30	C
Voltage = 600 Volts RMS	30	C
Voltage = 2400 Volts RMS	30	C
Water Flow, minimum		
At Continuous Rated Average Current	6	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	19	C
Pressure Drop at 6 Gallons per Minute, maximum	1	Pound per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier Service, Continuous Duty

Ratings are for Zero Phase-Control Angle—See curves K-69087-72A178 and K-69087-72A179 for details.

Maximum Peak Anode Voltage

Inverse	900	Volts
Forward	900	Volts

MAXIMUM RATINGS (CONT'D)

Power Rectifier Service (Cont'd)

Maximum Anode Current		
Peak	3600	Amperes
Average		
Continuous	400	Amperes
Two-Hours—Averaged Over Any Two-Minute Interval	600	Amperes
One-Minute—Averaged Over Any One-Minute Interval	800	Amperes
Fault	15,000	Amperes
Maximum Duration of Fault Current	0.15	Seconds
Frequency Range	25–60	Cycles per Second

AC Control Service§

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	2400	Volts RMS
Maximum Demand	4800	Kilovolt-Amperes
Average Current at Maximum Demand	270	Amperes
Maximum Average Current	414	Amperes
Demand at Maximum Average Current	2210	Kilovolt-Amperes
Maximum Averaging Time	1.66	Seconds
Maximum Peak Fault Current	12,000	Amperes
Frequency Range	25–60	Cycles per Second

Ignitor

Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
Root Mean Square	15	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds
Typical Resistance Added to Ignitor Circuit for Anode Firing		
At Anode Voltage of 600 Volts or Less	4	Ohms
At Anode Voltage of 601 Volts to 1000 Volts	10	Ohms
At Anode Voltage of 1001 Volts to 1500 Volts	20	Ohms
At Anode Voltage of 1501 to 2000 Volts	35	Ohms
At Anode Voltage of 2001 to 2400 Volts	50	Ohms

Holding Anode

Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Grid*

Maximum Peak Forward Voltage	250	Volts
Maximum Peak Inverse Voltage	300	Volts
Maximum Grid-Current		
Peak Positive	1.5	Amperes
Peak Negative	0.5	Amperes
Average	0.5	Amperes
Root Mean Square	1.0	Amperes

Temperature-Control-Switch Ratings π

Maximum Voltage	575	Volts
Maximum Current		
Over-Temperature Switch	6	Amperes
Water-Control Switch	1.5	Amperes
Maximum Peak Potential Difference Between Switch Circuit and Tube Water Cylinder	1500	Volts

Switch-Contact Arrangement
Over-Temperature Switch—Normally Closed
(Contacts Open on Temperature Rise)
Water-Control Switch—Normally Open
(Contacts Close on Temperature Rise)

* At main anode voltages of 500 volts and over, the grid circuits should provide a negative d-c bias of 100 volts and a suitable turn-on voltage to swing the grid positive at the time the ignitor is fired. At lower anode voltages, it is sufficient to connect the grid to the main anode through a resistor. In either case, the grid-circuit resistance should be 500 to 1000 ohms.

† Dependent upon load conditions. For substantially constant load 0 C is satisfactory. For widely fluctuating loads 25 C is required.

‡ When two or more tubes are connected in series for water flow the temperature of the incoming water to the warmest tube in the series must be within the rated limit.

§ RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. For voltages below the minimum, the minimum-voltage current rating applies. With the use of log-log paper straight-line interpolation between tabulated points may be used for other detailed ratings of: Demand kva vs average anode current, and maximum averaging time vs anode voltage.

At higher voltage ratings, the switching circuit must be insulated to prevent excessive voltage between the tube cylinder and switches.

π Suitable fuses should be provided in the switch circuits to prevent a power arc should a ground occur in the switch or wiring.

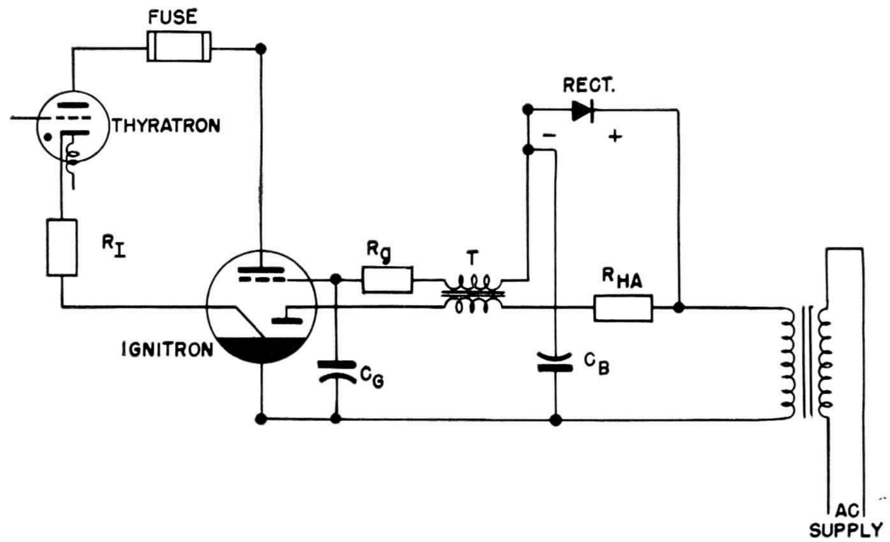
NOTE: This tube is not recommended for applications requiring continuous voltage control greater than 15 percent voltage reduction.

INSTALLATION AND OPERATION NOTES

In order to realize the advantage of safe tube operation on low-temperature cooling water, water must be supplied to the tube through a rapid-closing solenoid valve controlled by the water-control switch on the tube. The valve must completely stop the water flow to the tube except when the water-control switch is closed.

All tubes in the rectifier must be temperature controlled, be connected in parallel for water flow with an individual solenoid water valve for each tube. If the tubes themselves are at temperatures below 3 C before a period of operation, a low load (such as 1/4 load) should be applied to the rectifier long enough to cause one operation of the valves. After this initial warming, the rectifier should be in condition to handle safely normal loads unless it is idle in a cold atmosphere long enough for the tubes again to become cold.

In some applications, for example, where the rectifier has only intermittent low loads which are not sufficient to heat the anode end of the tubes to normal temperature, there may be a tendency for mercury to accumulate on the inside of the anode glass insulating bushing. Small amounts of mercury here are not serious. If the entire surface becomes covered, however, it will cause an arc over the inside of the glass which may permanently damage the tube. If this type of service is anticipated, large accumulations of mercury over the glass can easily be prevented by applying external heat to the glass with small radiant heaters or heat lamps. The glass temperature should be raised to approximately 100 C, but may go to 200 C without damage when the tubes are loaded.



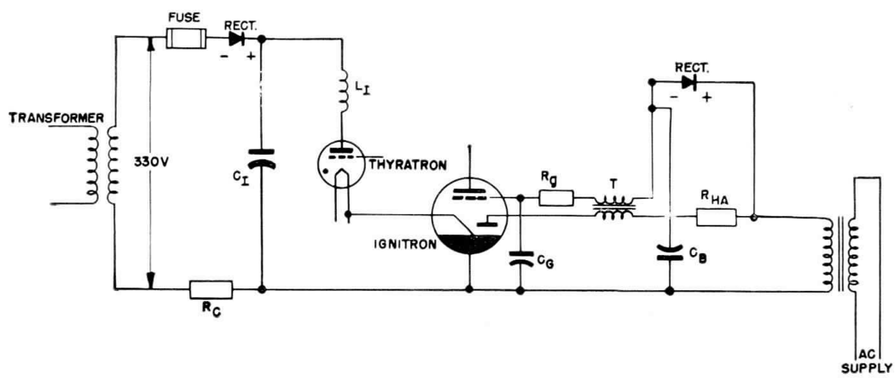
K-69087-72A673 10-22-54

ELEMENTARY CIRCUIT FOR ANODE FIRING
TYPICAL VALUES

R_I:
- ANODE VOLTAGE = 600 VOLTS OR LESS—4 OHMS
- ANODE VOLTAGE = 601 VOLTS TO 1000 VOLTS—10 OHMS
- ANODE VOLTAGE = 1001 VOLTS TO 1500 VOLTS—20 OHMS
- ANODE VOLTAGE = 1501 VOLTS TO 2000 VOLTS—35 OHMS
- ANODE VOLTAGE = 2001 VOLTS TO 2400 VOLTS—50 OHMS

R_g = 500 OHMS
C_B = 8 MFD
C_G = 0.1 MFD
FUSE = 6 AMPERES

R_{HA} = PROPER RESISTANCE TO PROVIDE NECESSARY STABILIZING CURRENT CALLED FOR ON K-69087-72A387



K-69087-72A672 10-22-54

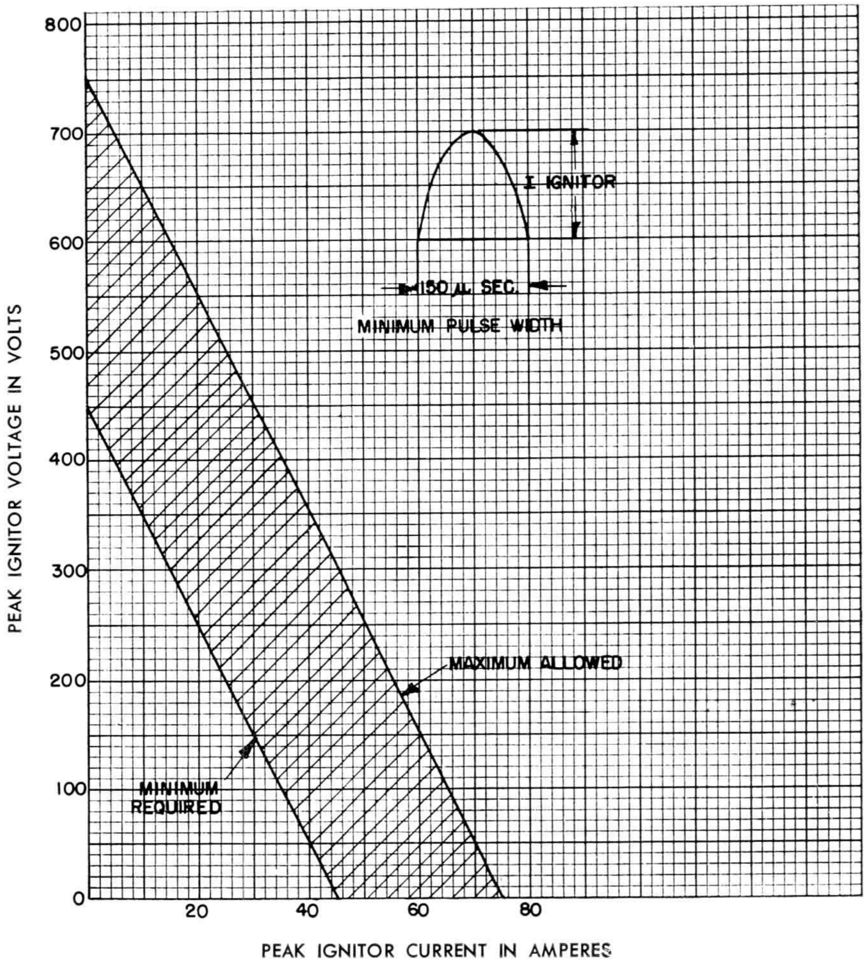
ELEMENTARY CIRCUIT FOR CAPACITOR FIRING
TYPICAL VALUES

C_B = 8 MFD
C_G = 0.1 MFD
C_I = 15–20 MFD
L_I = 1–1.5 mh
R_C = 10 OHMS

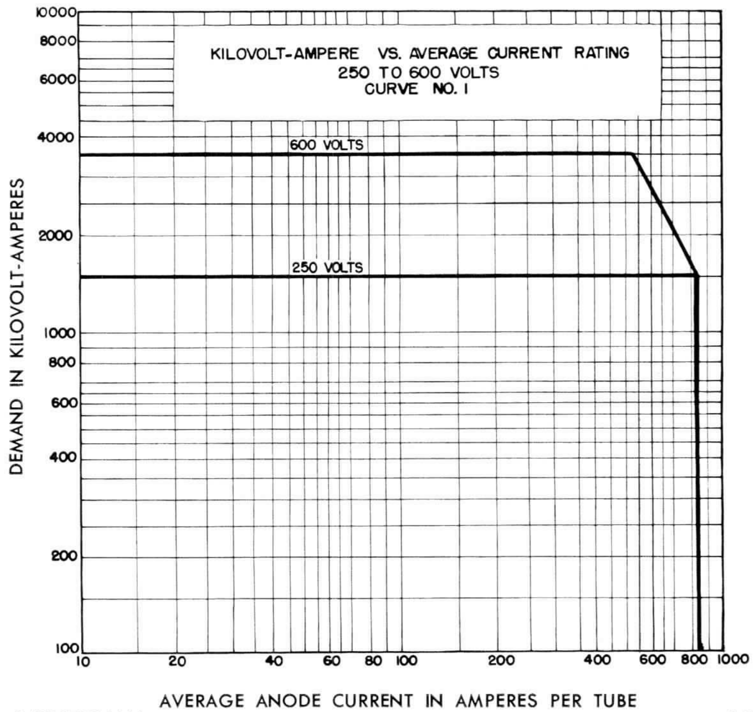
R_g = 500 OHMS
R_{HA} = PROPER RESISTANCE TO PROVIDE NECESSARY STABILIZING CURRENT CALLED FOR ON K-69087-72A387
FUSE = 5 AMPERES

IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS

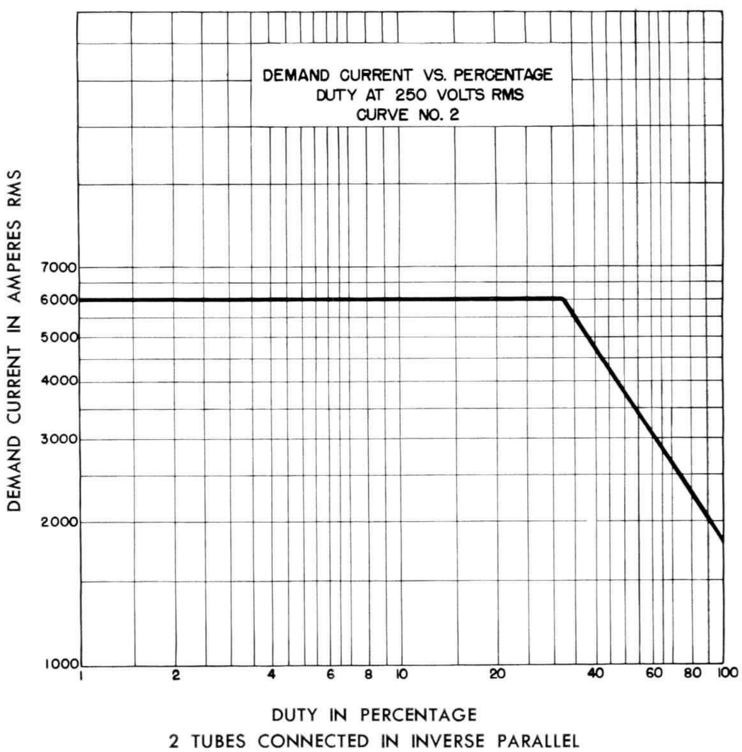
THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



K-9033883 5-25-54



K-69087-72A666 6-20-58



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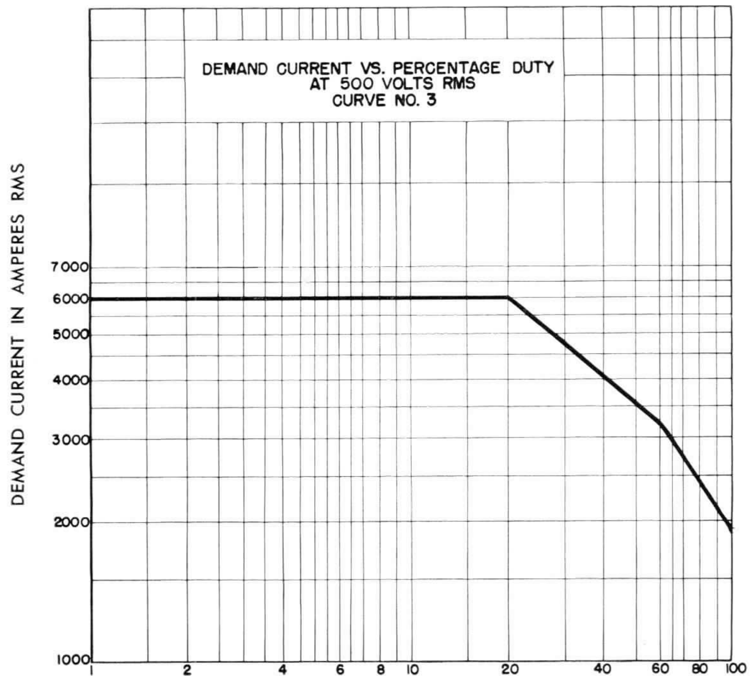
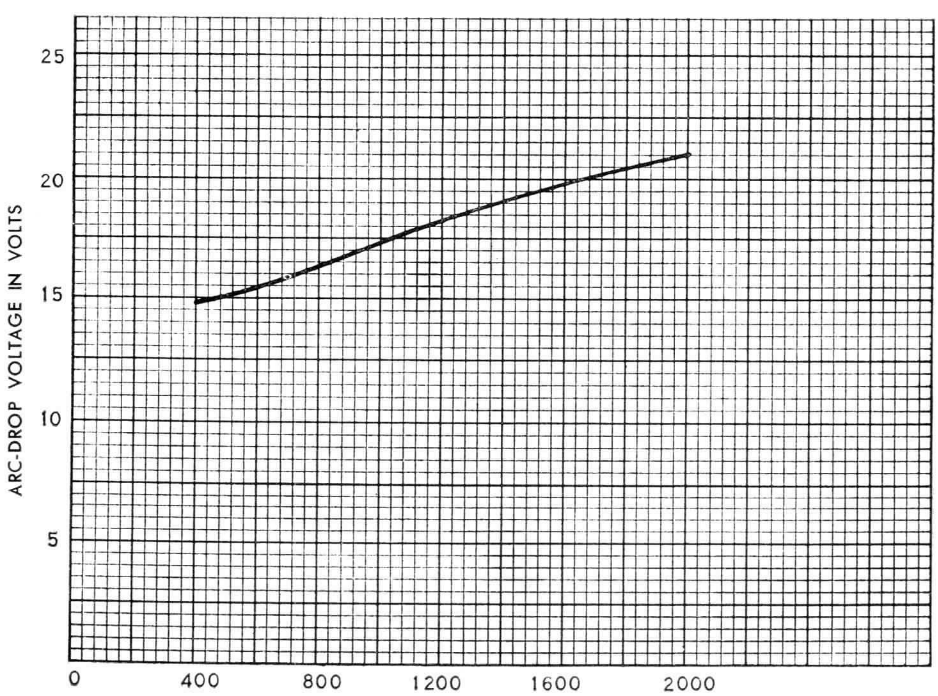


DUTY IN PERCENTAGE
2 TUBES CONNECTED IN INVERSE PARALLEL

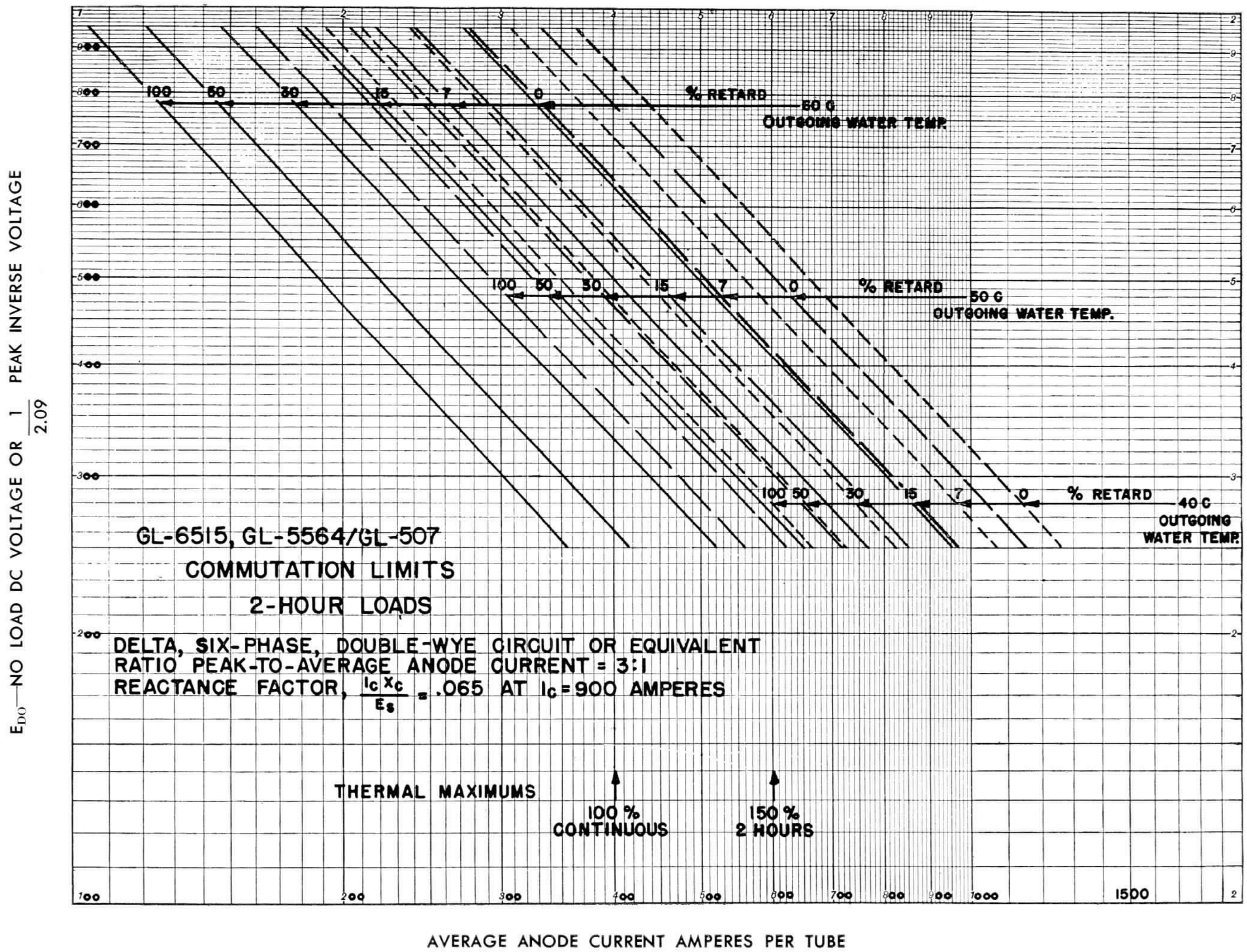
K-69087-72A668 6-20-58

ARC-DROP CHARACTERISTIC



PEAK ANODE CURRENT IN AMPERES PER TUBE

K-69087-72A324 12-8-54



K-69087-72A178

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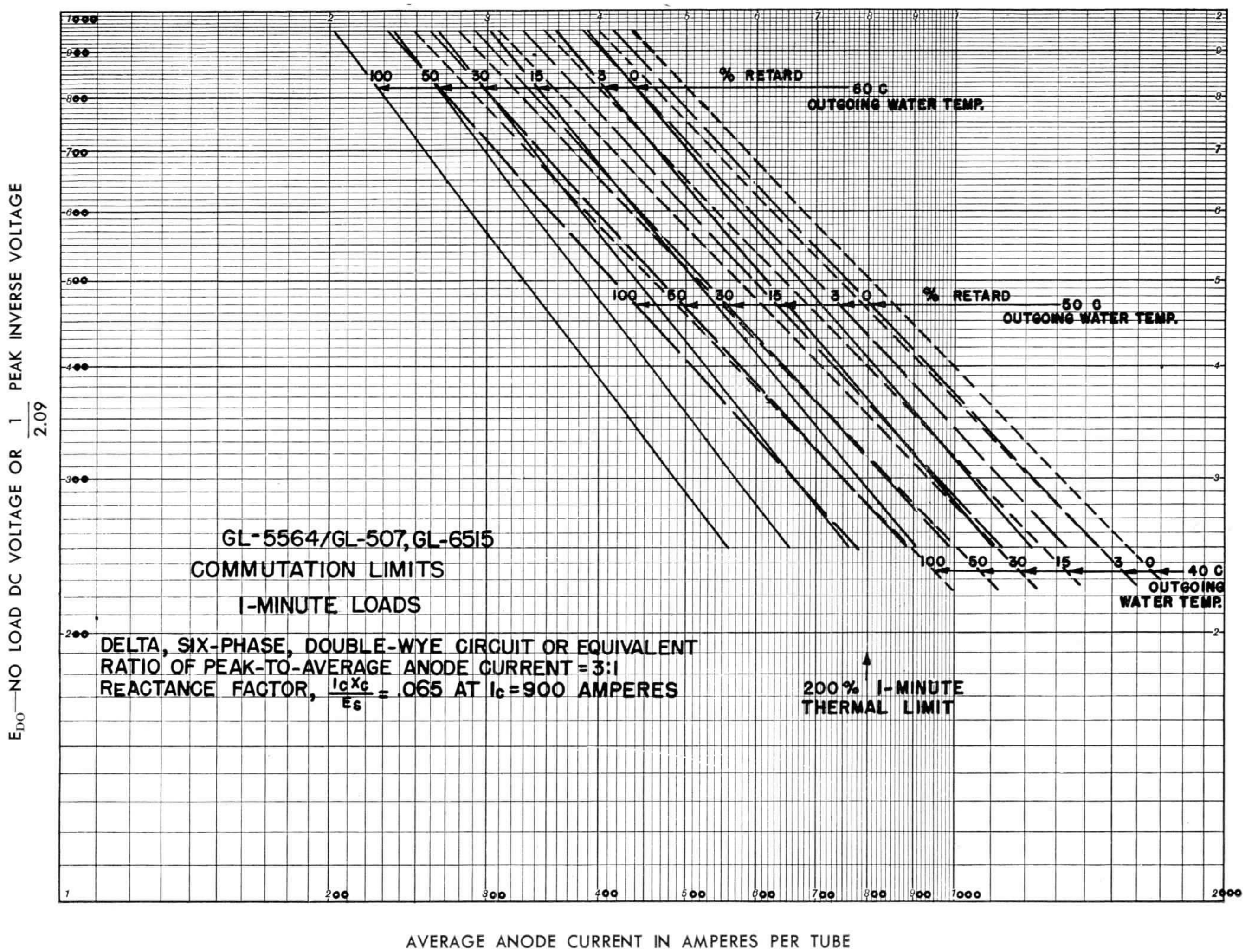
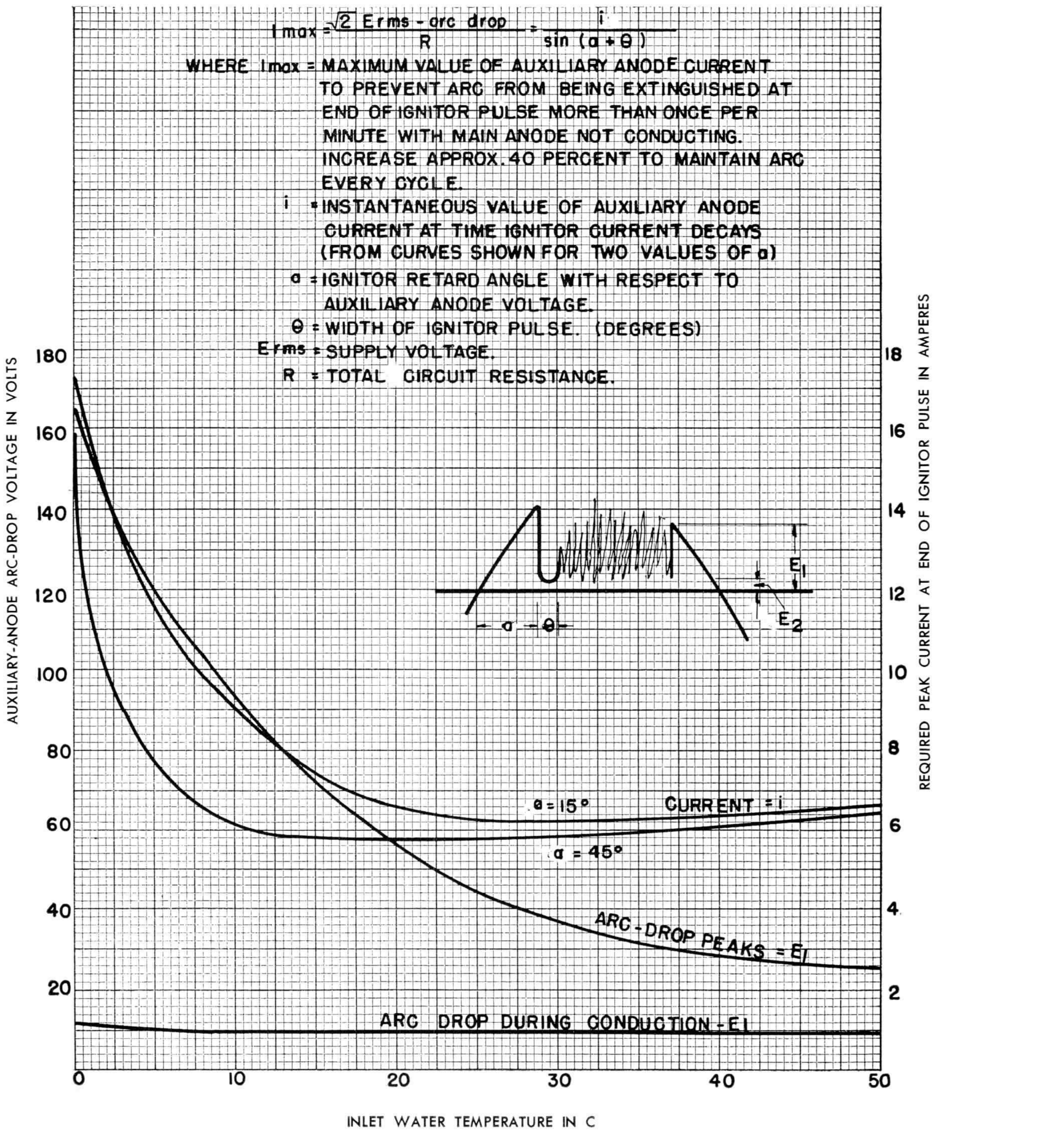

GL-5564/GL-507, GL-6515
COMMUTATION LIMITS
1-MINUTE LOADS
DELTA, SIX-PHASE, DOUBLE-WYE CIRCUIT OR EQUIVALENT
RATIO OF PEAK-TO-AVERAGE ANODE CURRENT = 3:1
REACTANCE FACTOR, $\frac{I_C X_C}{E_S}$ = .065 AT I_C = 900 AMPERES
% RETARD
60 C OUTGOING WATER TEMP.
50 C OUTGOING WATER TEMP.
40 C OUTGOING WATER TEMP.
100
50
30
15
3
0
200 % 1-MINUTE THERMAL LIMIT
E_{DO}—NO LOAD DC VOLTAGE OR $\frac{1}{2.09}$ PEAK INVERSE VOLTAGE
AVERAGE ANODE CURRENT IN AMPERES PER TUBE
1000
900
800
700
600
500
400
300
200
2000

HOLDING ANODE REQUIREMENTS



K-69087-72A387

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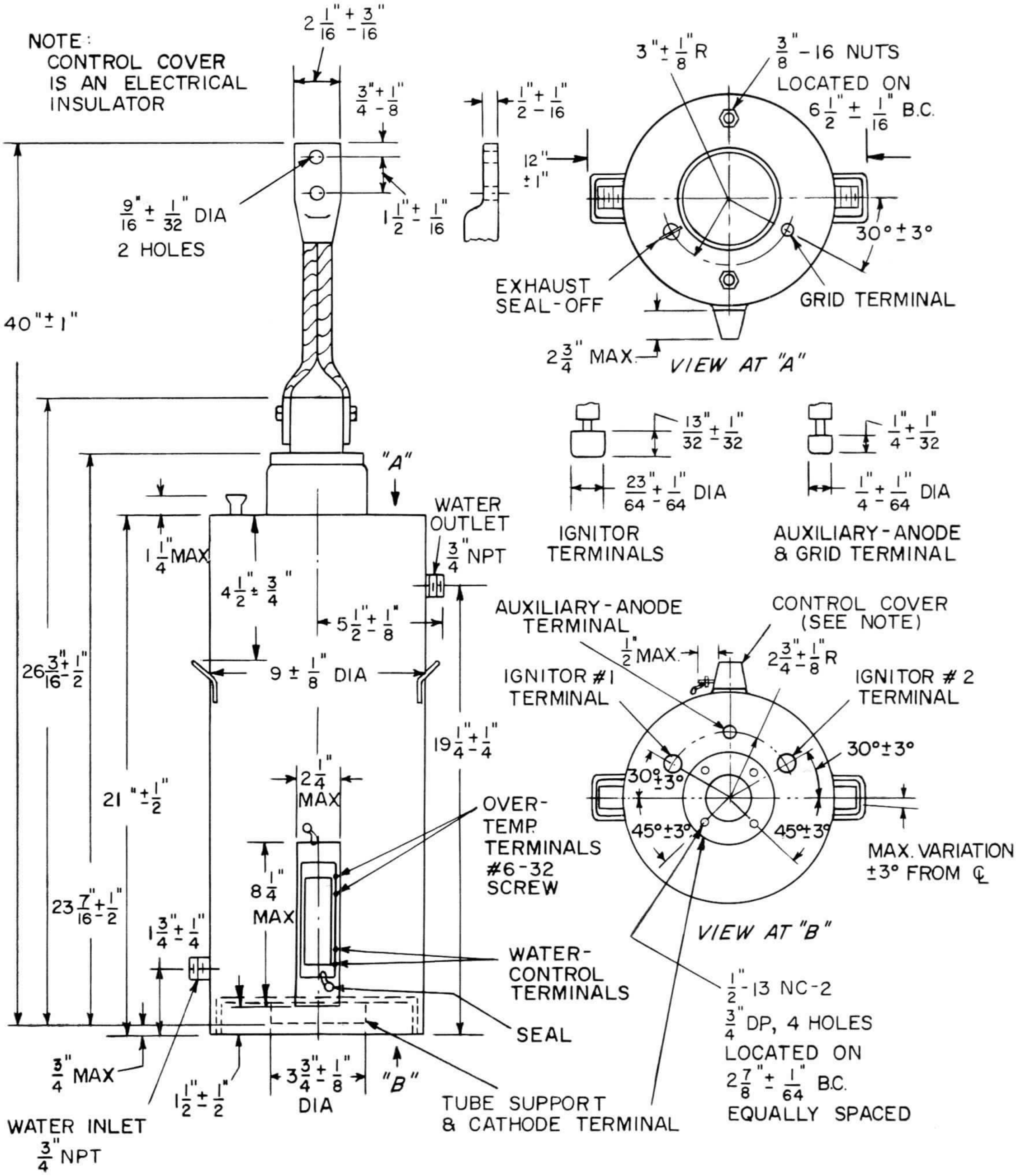


K-69087-72B5

4-61

IGNITRON

LOCOMOTIVE RECTIFIER SERVICE—675 AMPERES **TWO IGNITORS**

The GL-6878 is a double-grid ignitron designed for railroad locomotive rectifier service.

A coaxial cathode-current return reduces magnetic fields due to tube currents. The tube also features baffles in the mercury pool to assure contact between the mercury and the ignitor points during swaying of the equipment.

A companion tube, the GL-6509 ignitron, is available to supply the auxiliary power requirements of applications which use the GL-6878 as the main power source.

GENERAL

Electrical

Cathode Excitation—Cyclic
Cathode-Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Holding Anode	1	
Ignitors	2	
Shield Grids	1	
Control Grids	1	
Arc Drop at 2000 Peak Amperes	21 ± 1	Volts
Arc Drop at 4000 Peak Amperes	26 ± 1	Volts

(See Curve K-69087-72A764 for Details)

GENERAL ELECTRIC

Supersedes ET-T1284A dated 12-56

Mechanical

Envelope Material—Stainless Steel		
Over-all Length	30½	Inches
Over-all Width	13⅛	Inches
Net Weight	190	Pounds

Thermal

Type of Cooling—Water		
Inlet Water Temperature, minimum	30	C
Outlet Water Temperature, maximum	55	C
Water Flow, minimum		
At Continuous Rated Average Current	10	Gallons per Minute
At No Load	1	Gallons per Minute
Recommended Outlet Water Temperature Range	40 to 45	C
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	10	C
Pressure Drop at 10 Gallons per Minute, maximum	2.5	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier Service, Continuous Duty, Single Phase

Ratings are for Zero-Phase-Control Angle

Maximum Peak Anode Voltage		
Inverse	4000	Volts
Forward	100	Volts
Maximum Anode Current		
Peak	2500	Amperes
Average*		
Continuous	675	Amperes
Fifty Minutes	675	Amperes
Twelve Minutes	750	Amperes
Six Minutes	810	Amperes
Four Minutes	875	Amperes
Fault		
Peak, Forward Direction	20,000	Amperes
Peak, Reverse Direction	40,000	Amperes
Maximum Duration of Fault Current	0.15	Seconds
Frequency	25	Cycles per Second

Ignitor

Volt-Ampere-Time Requirements—See Curve K-69087-72A741 for Details

Maximum Inverse Voltage	5	Volts
Maximum Current		
Root Mean Square	15	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds

Holding Anode

Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Shield Grid

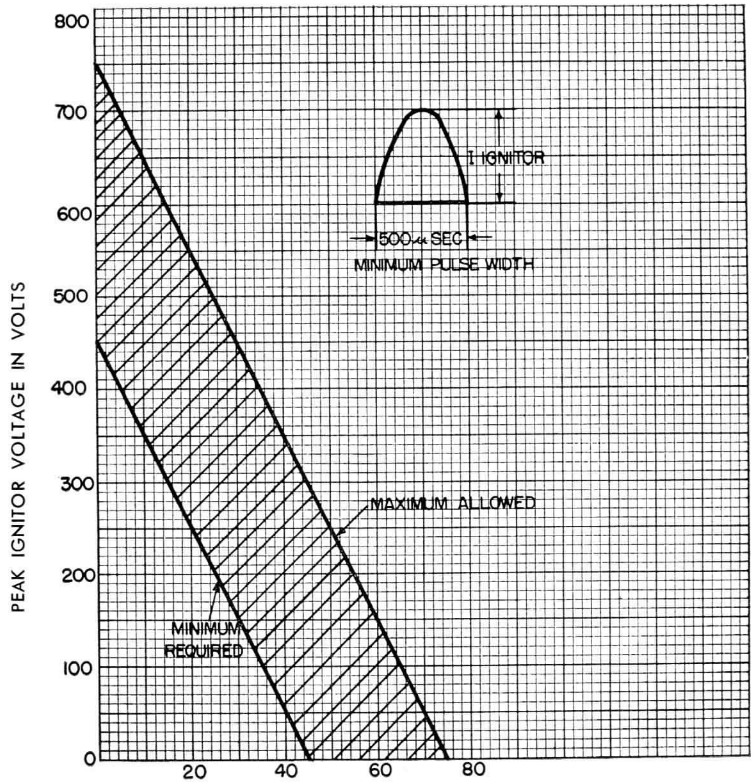
	Minimum	Maximum	
Shield-Grid Voltage			
Peak Forward	200	500	Volts
Peak Inverse	...	200	Volts

Control Grid

	Minimum	Maximum	
Shield-Grid Current			
Peak Forward	0.2	5	Amperes
Peak Inverse	...	0.2	Amperes
Control-Grid Voltage			
Peak Forward	200	500	Volts
Peak Inverse	100	200	Volts
Control-Grid Current			
Peak Forward	0.4	5	Amperes
Peak Inverse	0.4	1	Amperes

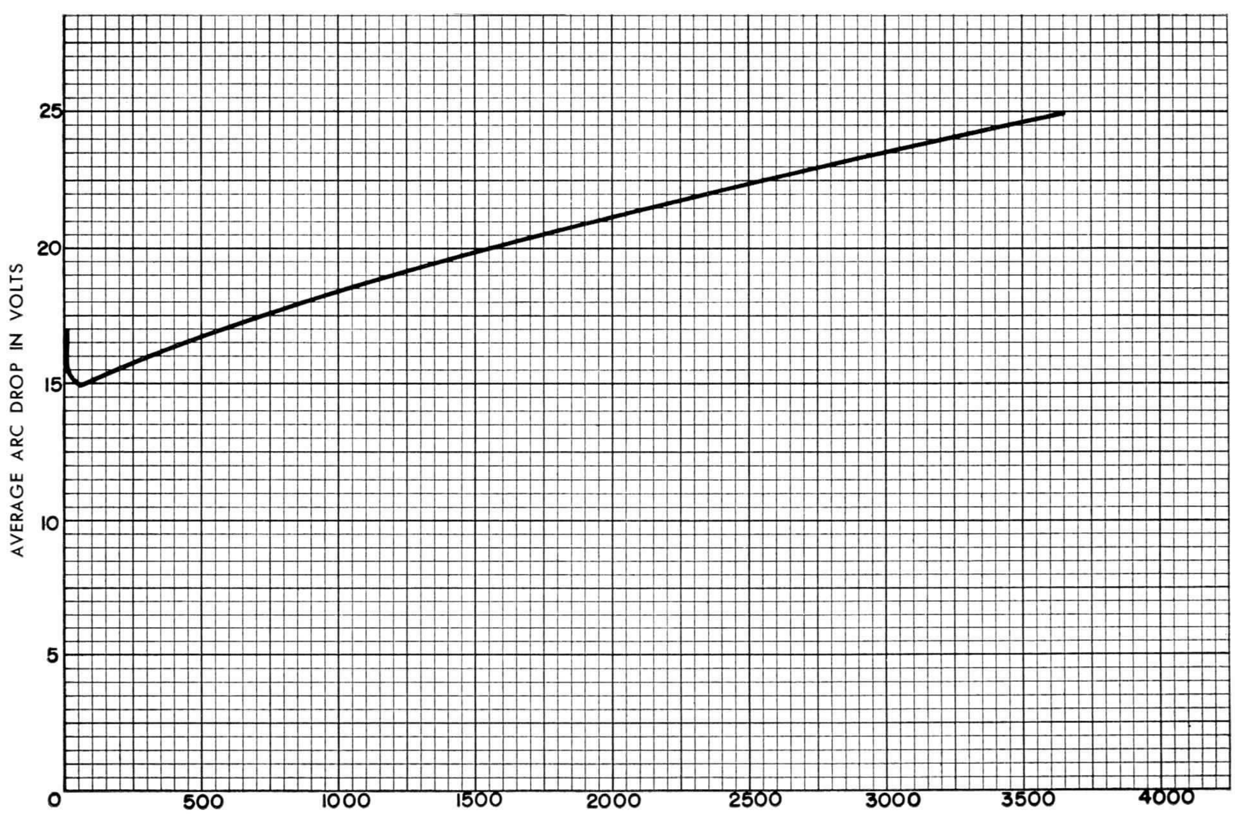
* Short time loads applied following light load.

IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION
SEALED-IGNITRON RECTIFIERS
THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



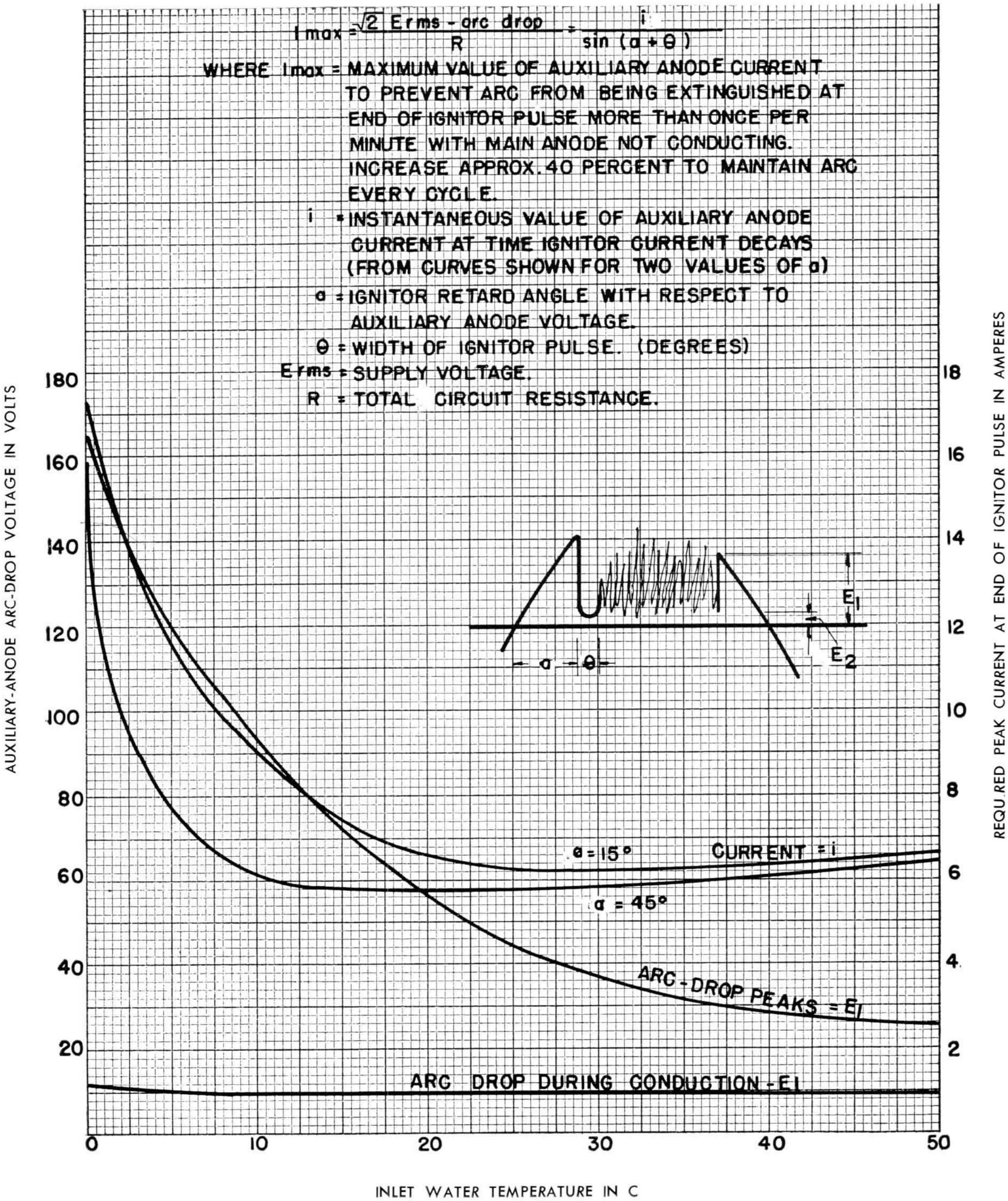
K-69087-72A741 PEAK IGNITOR CURRENT IN AMPERES 12-9-55

ARC DROP

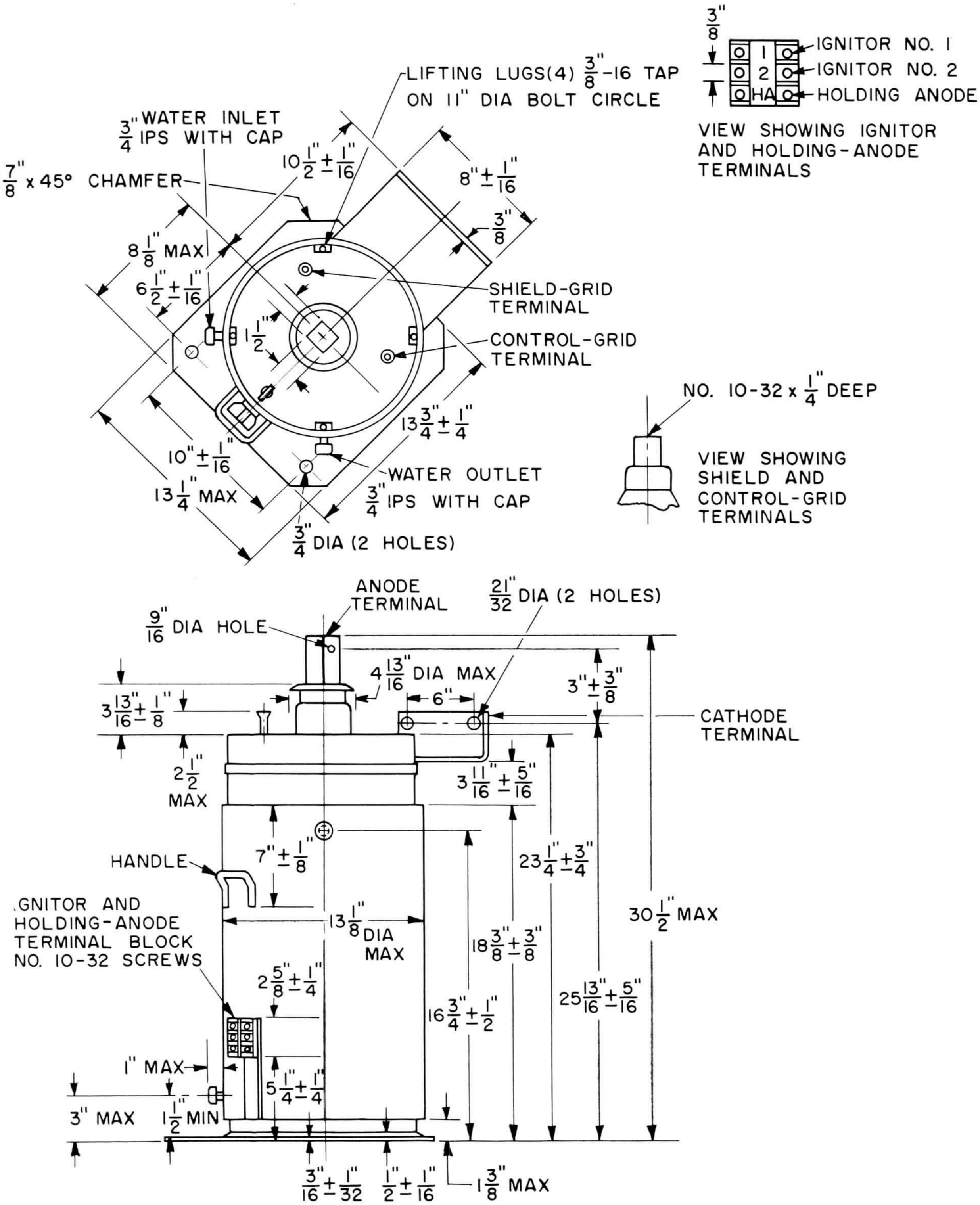


K-69087-72A764 PEAK ANODE CURRENT IN AMPERES 4-10-56

HOLDING-ANODE REQUIREMENTS



K-69087-72A387 12-1-54



K-69087-72A740

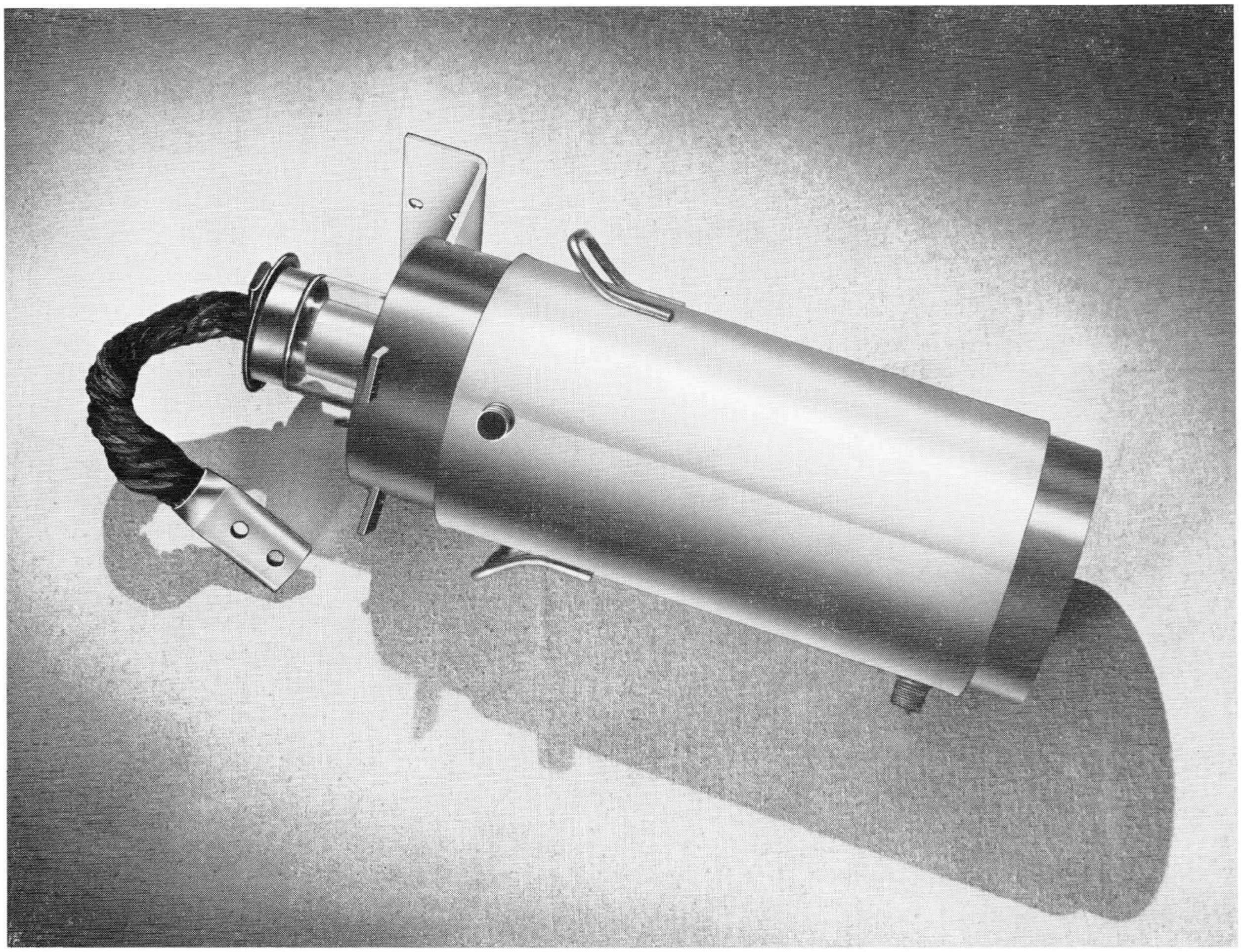
3-15-61

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.

PRINTED IN U.S.A.



IGNITRON

POWER-RECTIFIER SERVICE **INVERTER SERVICE**

TWO IGNITORS

The GL-6958 is a double-grid ignitron designed for industrial rectifier or inverter applications where it will operate at peak inverse voltages as high as 4000 volts. In such applications six tubes will supply 3000 kilowatts at voltages of 1800 or 3600 volts d-c, depending upon the circuit used.

This tube is particularly suitable when more than usual amounts of voltage control by phase retard are required. In addition, the tube features a coaxial cathode current return which reduces magnetic fields caused by the tube currents.

GENERAL

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1
Holding Anode	1
Main Cathodes	1
Ignitors	2
Shield Grids	1
Control Grids	1

Arc Drop

At 1000 Peak Amperes	20.5 ±2 Volts
At 2000 Peak Amperes	24.0 ±2 Volts

(See curve K-69087-72A709 for details)

GENERAL ELECTRIC

Supersedes ET-T1479 dated 11-57

GENERAL (CONT'D)

Mechanical

Envelope Material—Stainless Steel	
Over-all Length	27⅜ Inches
Over-all Width	9 Inches
Net Weight	95 Pounds

Thermal

Type of Cooling—Water	
Inlet Water Temperature, minimum	30 C
Outlet Water Temperature, maximum	55 C
Water Flow	
At Continuous Rated Average Current, minimum	10 Gallons per Minute
At No Load, *minimum	1 Gallons per Minute
Temperature Range	40 to 45 C
Characteristics for Water Cooling at 10 Gallons per Minute	
Water Temperature Rise, maximum	6.5 C
Pressure Drop, maximum	1.5 Pounds per Square Inch
Working Water Pressure—Non Shock, maximum	100 Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier or Inverter Service, Continuous Duty

Ratings Are for Zero-Phase-Control Angle

Maximum Peak Anode Voltage	
Inverse	4000 Volts
Forward	4000 Volts
Maximum Anode Current	
Peak	2000 Amperes
Average	
Continuous	275 Amperes
Two Hours	350 Amperes
One Minute	570 Amperes
Fault	
Forward Direction	15,000 Amperes
Reverse Direction	30,000 Amperes
Maximum Duration of Fault Current	0.15 Seconds
Frequency Range	25 to 60 Cycles per Second

Ignitor Characteristics

Maximum Inverse Voltage	5 Volts
Recommended Pulse Length	800 Microseconds
Minimum Pulse Length, average anode current greater than 8 amperes	150 Microseconds
Maximum Pulse Length	4000 Microseconds
Volt-Ampere Characteristics—See curve K-69087-72A803 for details.	

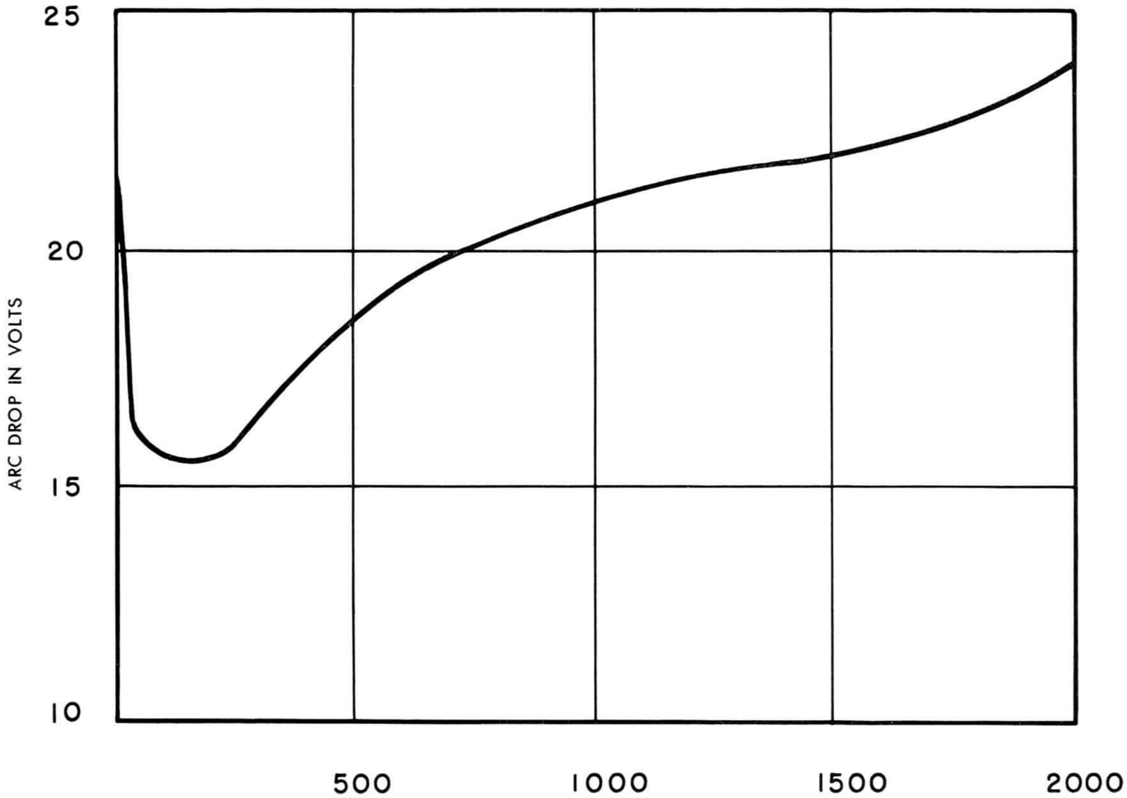
Holding Anode

Maximum Peak Forward Voltage	160 Volts
Maximum Peak Inverse Voltage	
Main Anode Conducting	25 Volts
Main Anode Not Conducting	160 Volts
Maximum Current	
Peak	30 Amperes
Average	9 Amperes
Maximum Averaging Time	10 Seconds
Root Mean Square	15 Amperes

	Minimum	Maximum
Shield-Grid Characteristics		
Voltage		
Peak Forward	200	500 Volts
Peak Inverse	....	200 Volts
Current		
Peak Forward	0.2	5.0 Amperes
Peak Inverse	....	0.2 Amperes
Control-Grid Characteristics		
Voltage		
Peak Forward	200	500 Volts
Peak Inverse	100	200 Volts
Current		
Peak Forward	0.4	5.0 Amperes
Peak Inverse	0.4	1.0 Amperes
DC Bias	−90	−110 Volts

* Water flow should be continued for one hour after removal of anode power.

ARC DROP



K-69087-72A709

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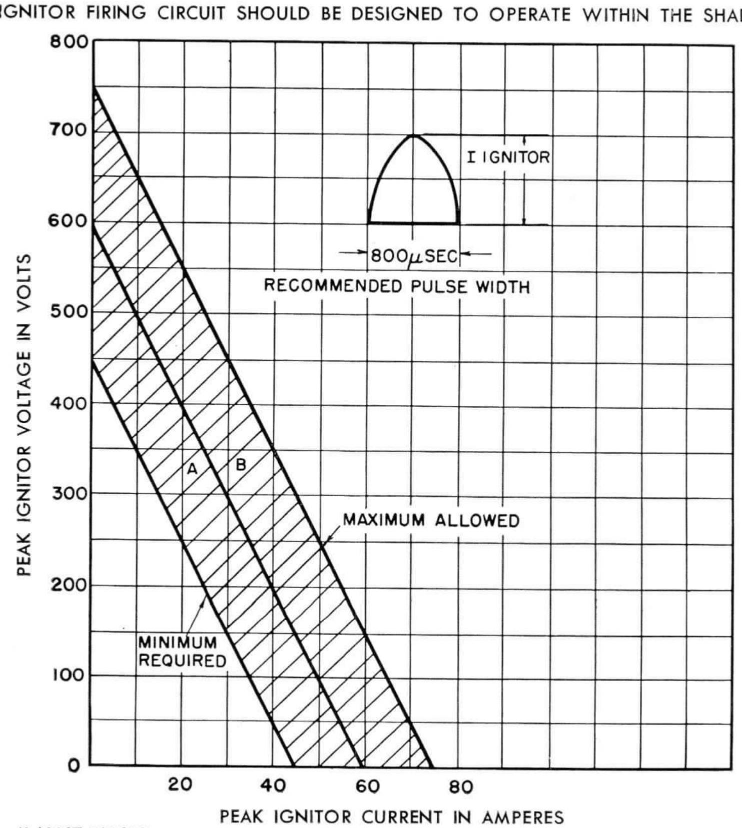
IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION
SEALED-IGNITRON RECTIFIER

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



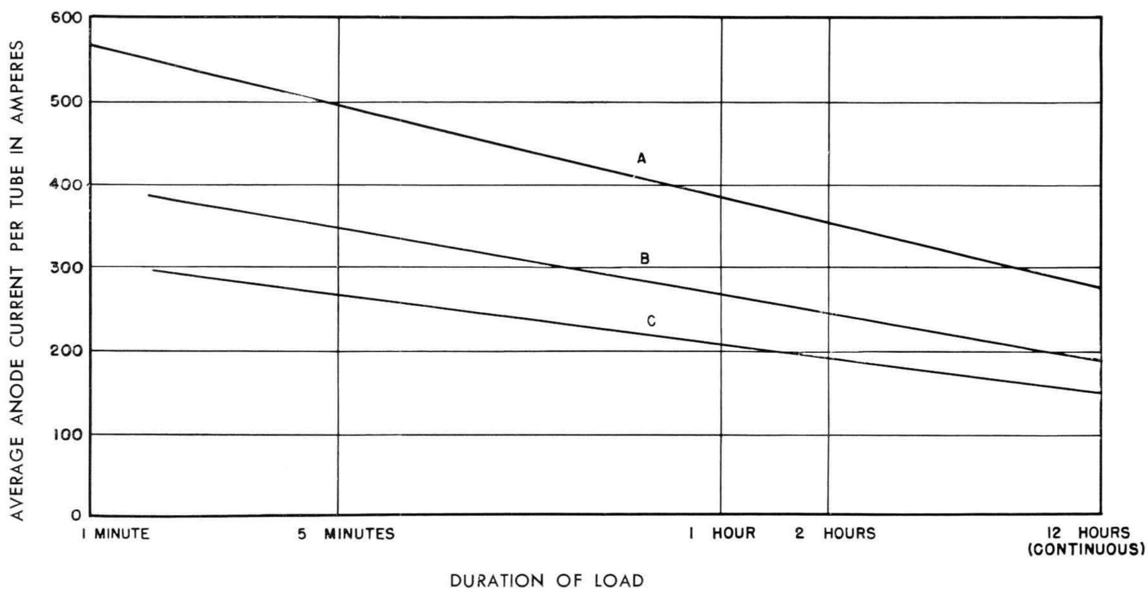
K-69087-72A803

11-8-57

SHORT PERIOD OPERATION RATINGS

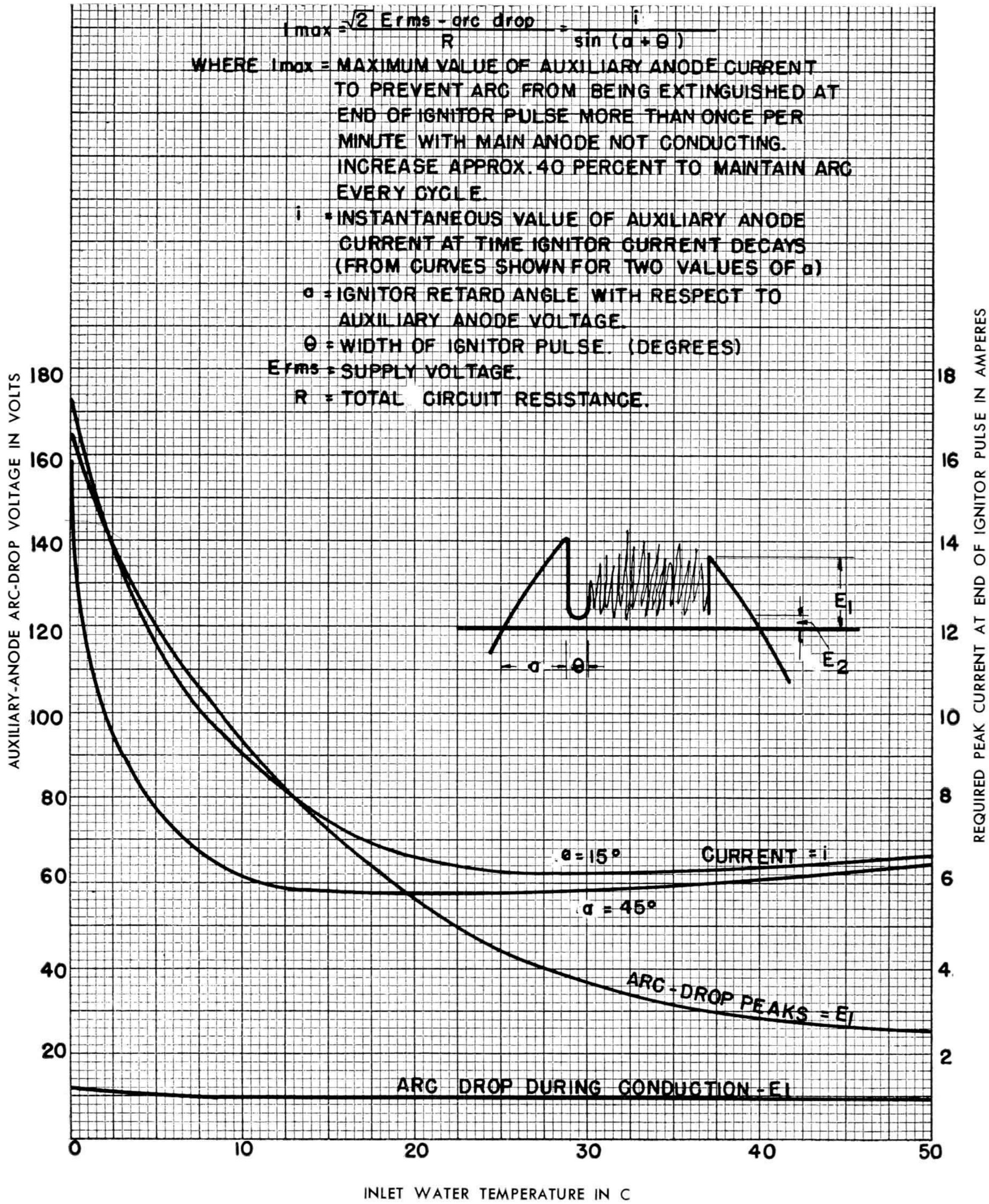
PEAK INVERSE VOLTAGE = 4000 VOLTS
INLET WATER TEMPERATURE = 45 C

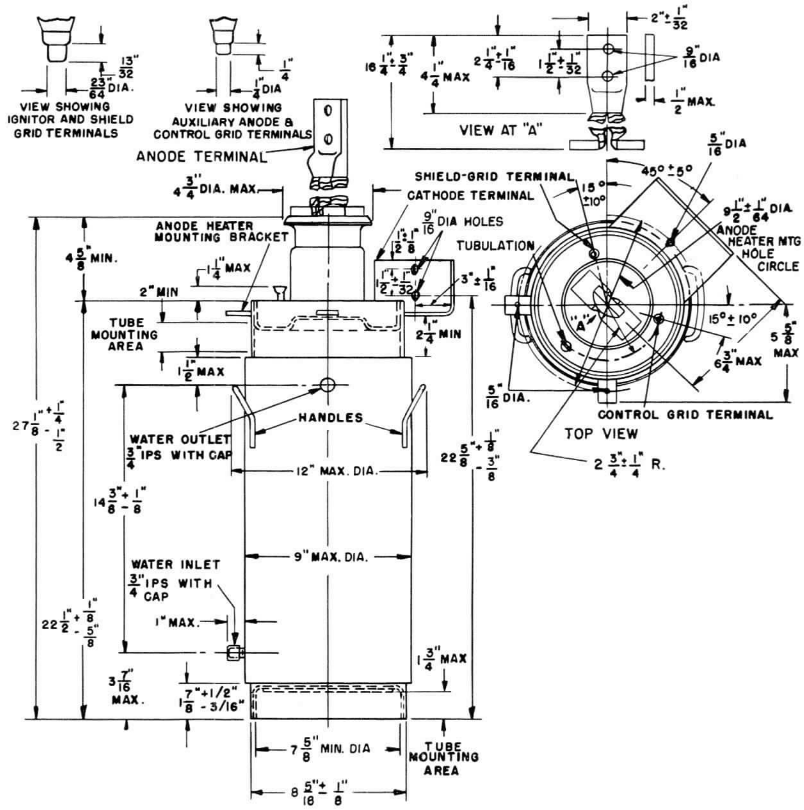
A—PHASE RETARD = ZERO
B—PHASE RETARD = 15% (ESTIMATED)
C—PHASE RETARD = 50% (ESTIMATED)

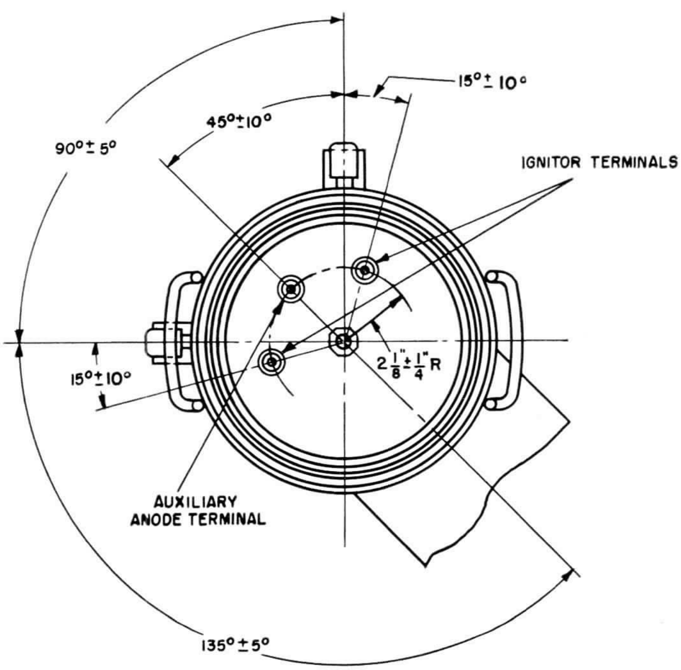


K-69087-72A809 1-29-58

HOLDING ANODE REQUIREMENTS







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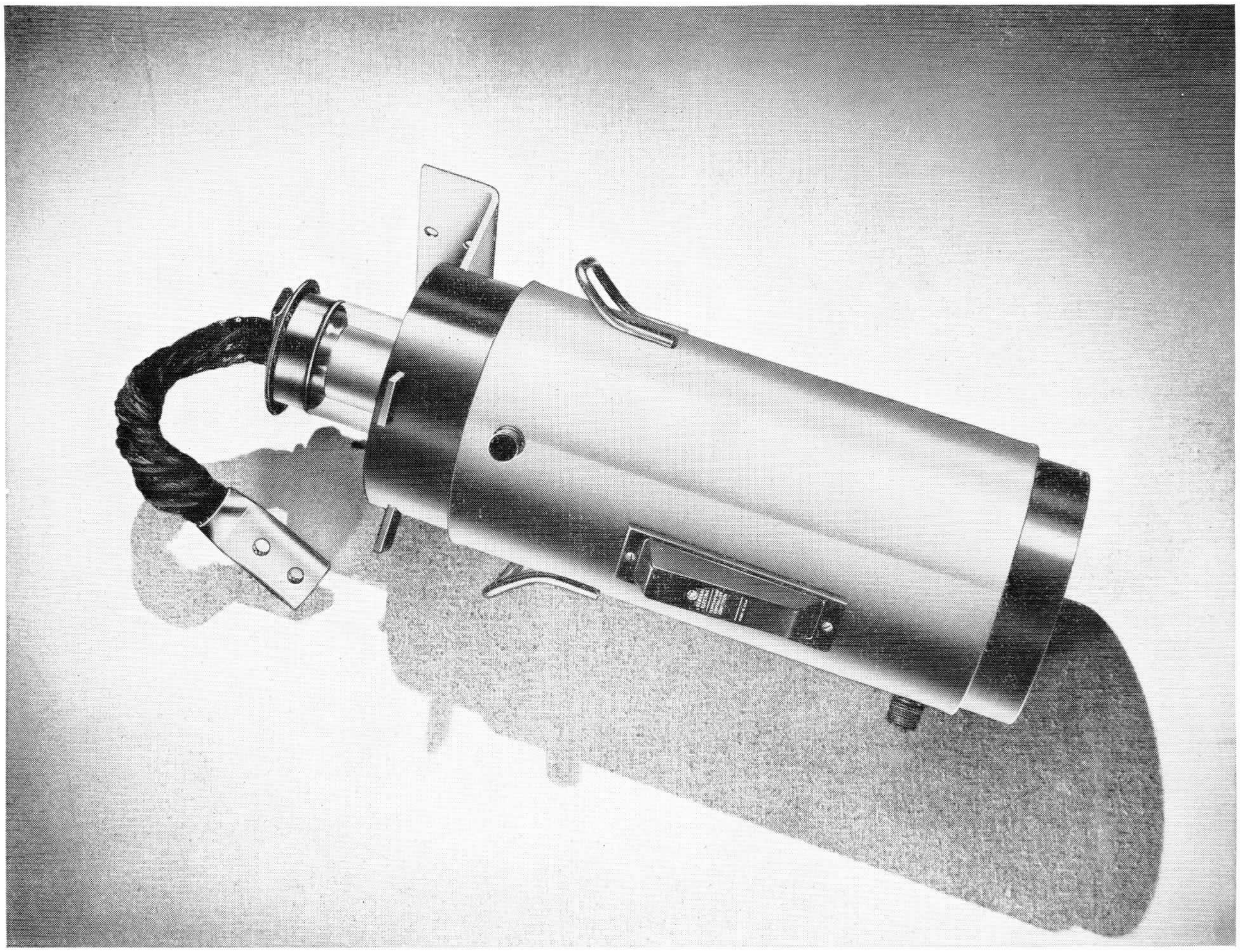


IGNITRON

POWER RECTIFIER SERVICE **INVERTER SERVICE**
TWO IGNITORS **TEMPERATURE CONTROLLED**
2000 AMPERES PEAK

The GL-7042 is a double-grid ignitron for industrial rectifier or inverter service at voltage levels up to 4000 volts peak inverse. This tube is particularly suitable when more than usual amounts of voltage control by phase retard are required.

The GL-7042 is identical in ratings and characteristics to the GL-6958 but it has the additional advantage of an integral thermostatic control arrangement with protective features. The arrangement includes a switch which controls a solenoid valve in the water-supply line to the tube in response to increasing and decreasing tube temperature, thus maintaining the minimum amount of cooling water required by the operating conditions. It also includes an over-temperature switch which may be used to remove power from the ignitron if its temperature should ever exceed a safe value.

GENERAL

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Holding Anode	1	
Main Cathodes	1	
Ignitors	2	
Shield Grids	1	
Control Grids	1	
Arc Drop		
At 1000 Peak Amperes	20.5 ± 2	Volts
At 2000 Peak Amperes	24.0 ± 2	Volts

(See Curve K-69087-72A709 for Details)

GENERAL ELECTRIC

Supersedes ET-T1510 dated 12-58

GENERAL (CONT'D)

Mechanical

Envelope Material—Stainless Steel		
Over-all Length	27⅜	Inches
Over-all Width	9	Inches
Net Weight, approximate	95	Pounds
Mounting Position—Vertical, Anode Terminal Up		

Thermal

Type of Cooling—Water		
Inlet Water Temperature, minimum*	10	C
Inlet Water Temperature, maximum†	45	C
Outlet Water Temperature, maximum	55	C
Water Flow, water valve open‡		
At Continuous Rated Average Current, minimum	10	Gallons per Minute
Water flow should be continued for at least one hour after removal of anode power.		
Characteristics at 10 Gallons per Minute		
Water Temperature Rise, maximum	6.5	C
Pressure Drop, maximum	1.5	Pounds per Square Inch
Working Water Pressure—Non-Shock, maximum	100	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier or Inverter Service, Continuous Duty

Ratings are for Zero-Phase-Control Angle

Maximum Peak Anode Voltage		
Inverse	4000	Volts
Forward	4000	Volts
Maximum Anode Current		
Peak	2000	Amperes
Average		
Continuous	275	Amperes
Two Hours	350	Amperes
One Minute	570	Amperes
Fault		
Forward Direction	15,000	Amperes
Reverse Direction	30,000	Amperes
Maximum Duration of Fault Current	0.15	Seconds
Frequency Range	25 to 60	Cycles per Second

Ignitor Ratings, Separate Excitation

Maximum Inverse Voltage	5	Volts
Recommended Pulse Length	800	Microseconds
Minimum Pulse Length		
Average Anode Current Greater than 8 Amperes	150	Microseconds
Maximum Pulse Length	4000	Microseconds
Volt-Ampere Requirements (See Curve K-69087-72A803 for Details.)		

Holding Anode

Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Shield-Grid Characteristics	Minimum	Maximum	
Voltage			
Peak Forward	200	500	Volts
Peak Inverse	....	200	Volts
Current			
Peak Forward	0.2	5.0	Amperes
Peak Inverse	....	0.2	Amperes

Control-Grid Characteristics			
Voltage			
Peak Forward	200	500	Volts
Peak Inverse	100	200	Volts
Current			
Peak Forward	0.4	5.0	Amperes
Peak Inverse	0.4	1.0	Amperes
DC Bias	−90	−110	Volts

MAXIMUM RATINGS AND TYPICAL OPERATION (CONT'D)

Temperature-Control Switch Ratings§

Maximum Voltage	575	Volts
Maximum Current		
Over-Temperature Switch	6	Amperes
Water-Control Switch	1.5	Amperes
Maximum Peak Potential difference between Switch Circuit and Tube Water Cylinder	1500	Volts

Switch-Contact Arrangement
Over-Temperature Switch—Normally Closed
(Contacts Open on Temperature Rise)
Water-Control Switch—Normally Open
(Contacts Close on Temperature Rise)

*This value assumes that the water will be supplied through a rapid-closing solenoid valve which prevents all water flow except when the water-control switch closes.

†If two tubes are cooled in series this value must be low enough to prevent the maximum outlet water temperature from being exceeded.

‡Water flow should be continued for one hour after removal of anode power.

§Suitable fuses should be provided in the switch circuits to prevent a power arc should a ground occur in the switch or wiring.

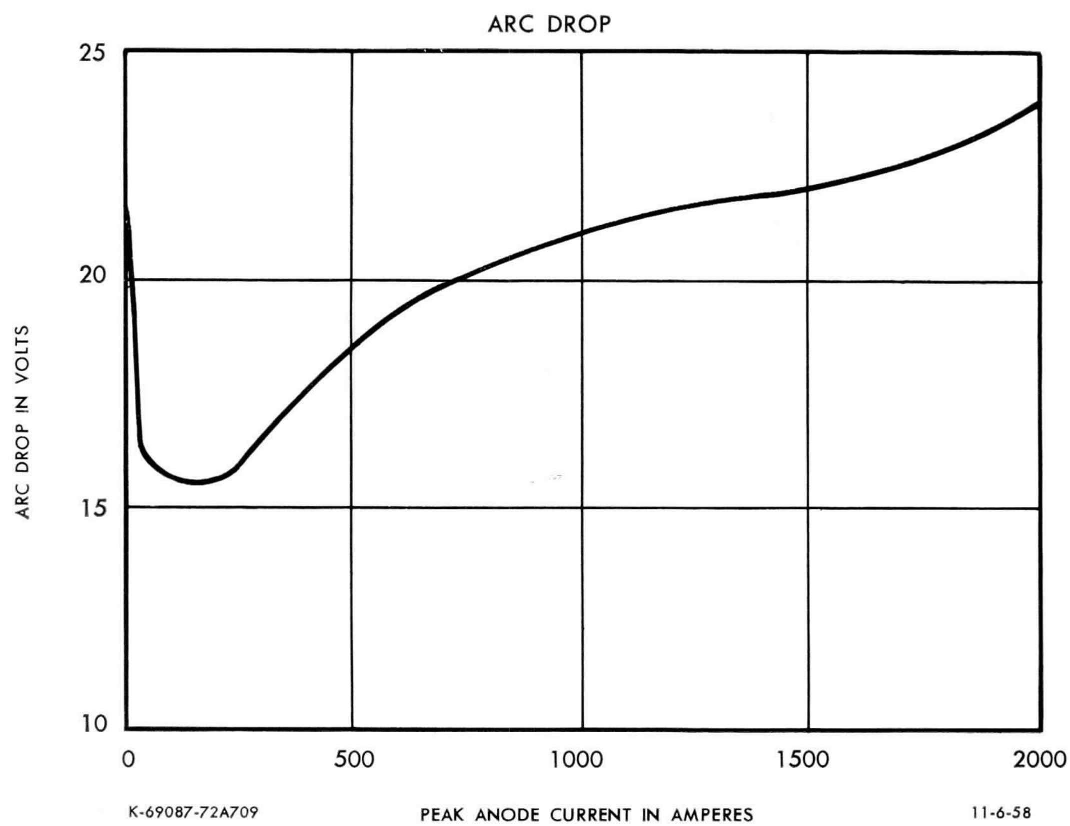
APPLICATION NOTES

In order to realize the advantage of safe tube operation on low temperature cooling water, water must be supplied to the tube through a rapid closing solenoid valve controlled by the water-control switch on the tube. The valve must completely stop the water flow to the tube except when the water-control switch is closed.

The cooling water for two tubes may be connected in series provided the inlet water at the first tube is above +20 C and the outlet water of the second tube is below 55 C. If two tubes are connected in series only one solenoid valve is required for each pair of tubes and it is only necessary to use the thermostat on the tube installed in the outgoing end of the series pair. For more complete protection two temperature-controlled tubes should be used with their over-temperature switches in series and their water-control switches in parallel.

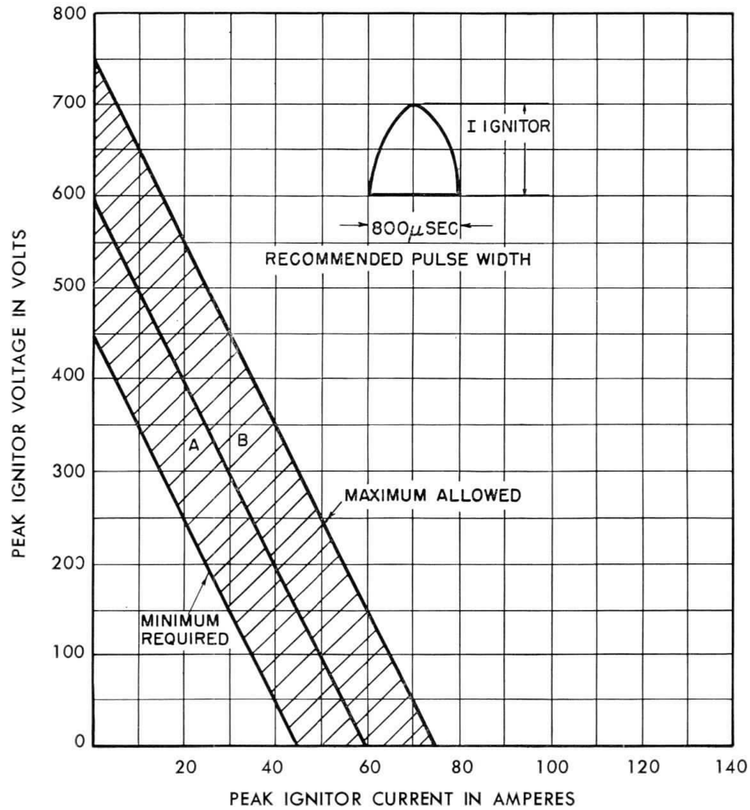
For inlet water temperatures below 20 C, each tube should be connected to the water supply through a rapid-closing solenoid valve controlled by the water-control switch on the tube thermostat.

To prevent excessive condensation of mercury on the inside of the glass, heat should be externally applied to the anode glass-seal area.



IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION SEALED-IGNITRON RECTIFIER

THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



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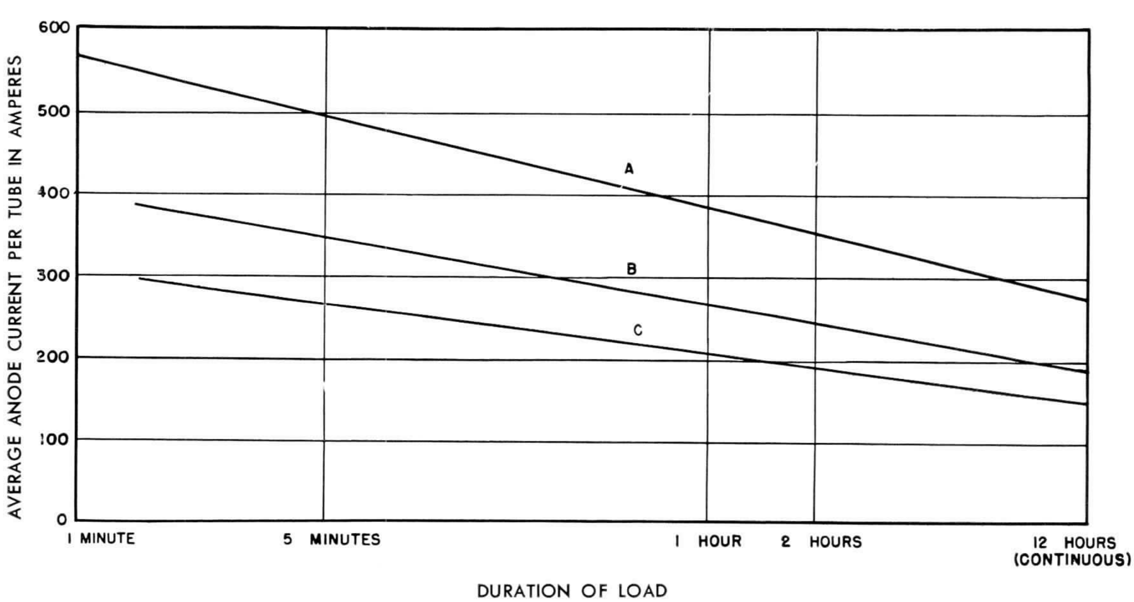
SHORT-PERIOD OPERATION RATINGS

PEAK INVERSE VOLTAGE = 4000 VOLTS
INLET WATER TEMPERATURE = 45 C

PHASE RETARD
A = ZERO
B = 15%, ESTIMATED
C = 50%, ESTIMATED



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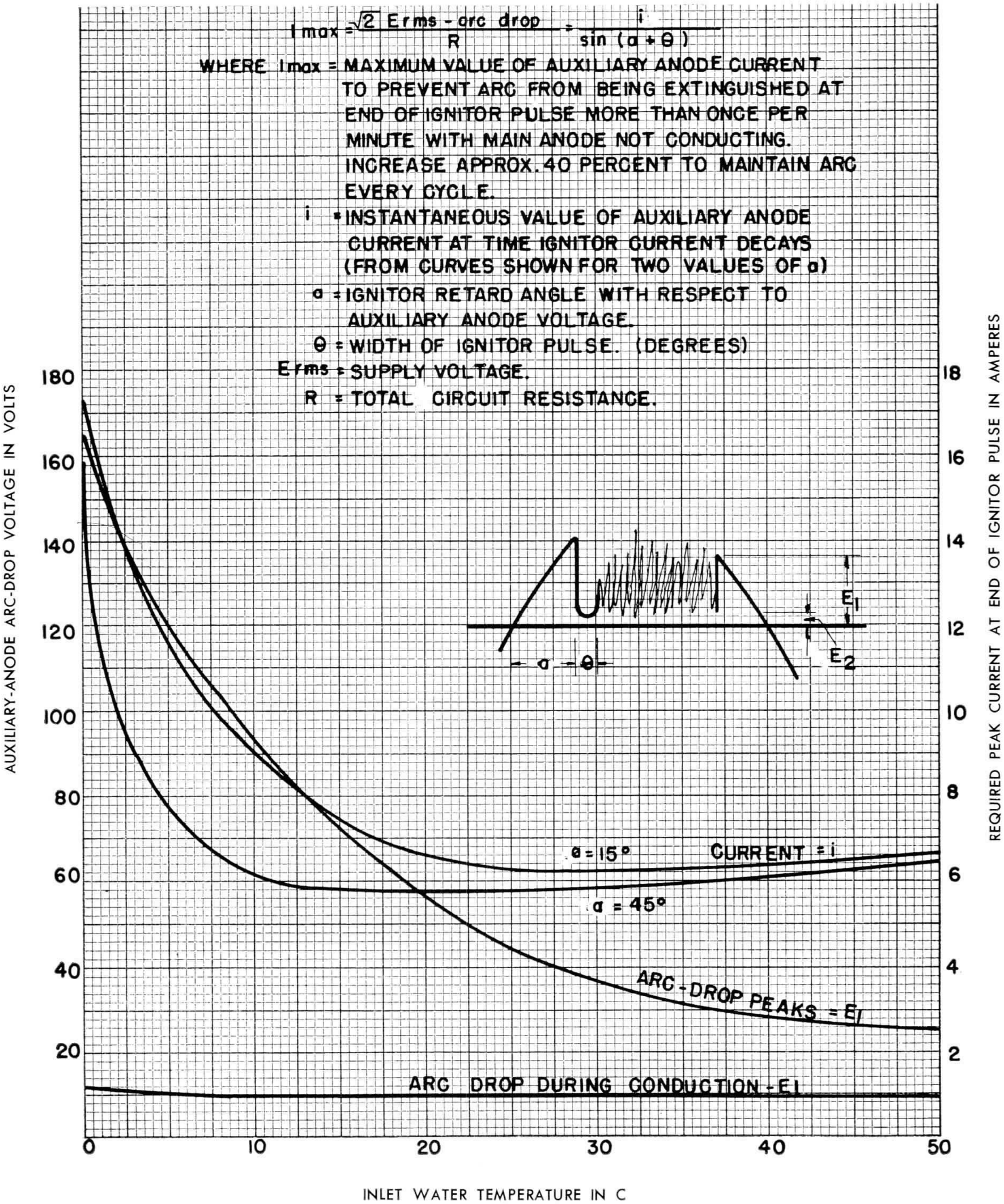
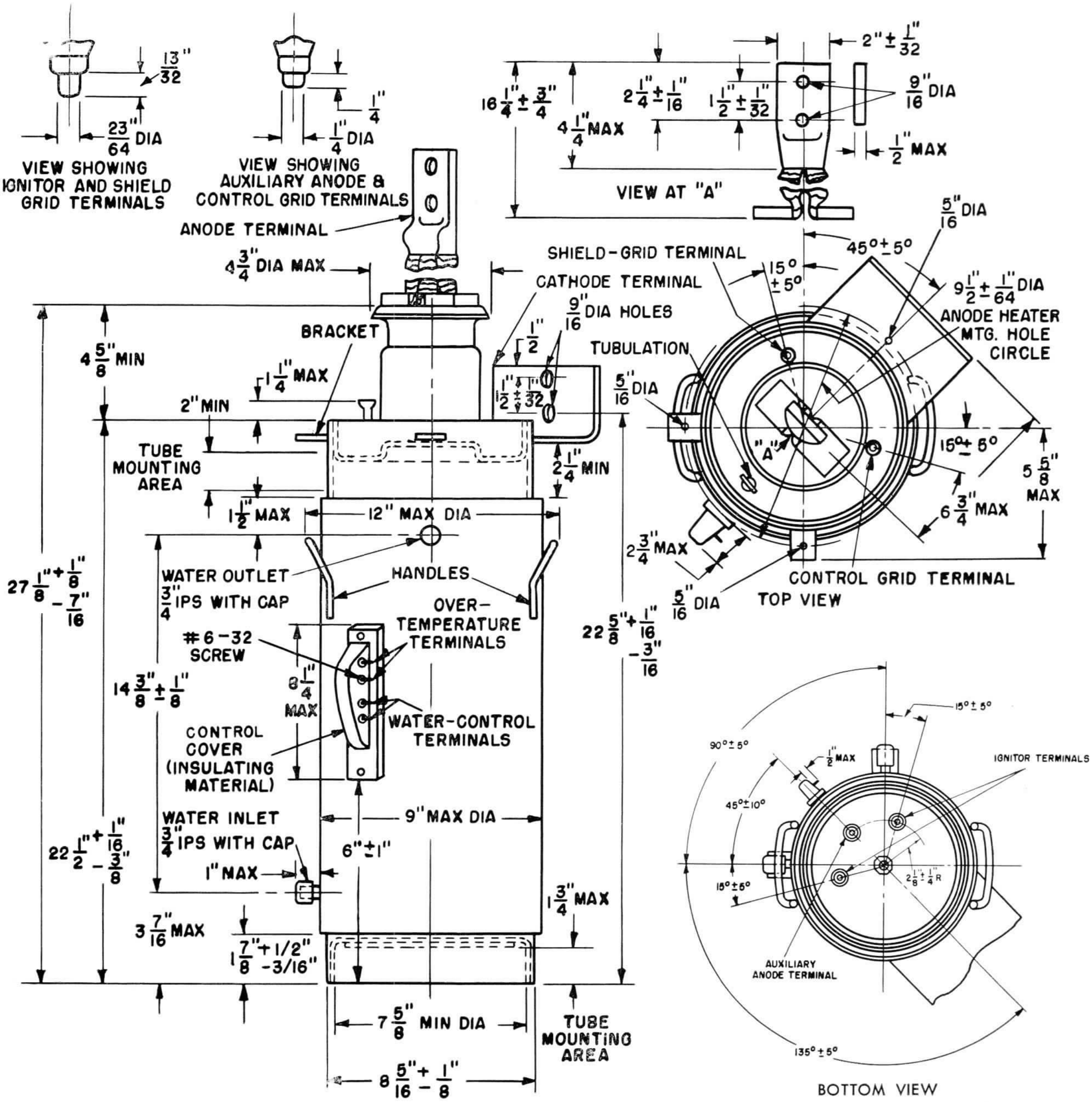
HOLDING REQUIREMENTS





K-69087-72A815

2-26-58

GL-7736

IGNITRON

RECTIFIER SERVICE—400 AMPERES

HOLDING ANODE **TWO IGNITORS**

The GL-7736 ignitron is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube designed for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. It is suitable for use in rectifiers rated up to 1000 kilowatts output, depending upon the number of ignitrons used, the output voltage, and the circuit. Continuous average current rating is 400 amperes per tube in rectifiers rated up to 300 volts d-c.

The GL-7736 has a holding anode and two ignitors. Excitation of the auxiliary anode permits stabilizing the cathode spot for very small anode currents. The two ignitors assure long life since only one is used at a time. Phase control of the ignitor impulses permits voltage control of the rectified output. In common with other ignitrons arc losses in the 7736 are low, and design and construction features, such as a complete stainless-steel-water jacket, assure ease of installation, economical use of space, and reliability of operation.

ELECTRICAL

Cathode-Excitation—Cyclic		
Cathode Spot Starting—Ignitor		
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Holding Anode	1	
Ignitors	2	
Control Grids	1	
Arc Drop at 1200 Peak Amperes	18.2 ± 0.1	Volts
Arc Drop at 8000 Peak Amperes	35 ± 0.1	Volts

MECHANICAL

Envelope Material—Stainless Steel		
Net Weight, approximate	90	Pounds

THERMAL

Type of Cooling—Water		
Inlet Water Temperature, minimum	35	C
Outlet Water Temperature, maximum		
Power-Rectifier Service		
Peak Inverse Anode Voltage = 900 Volts	60	C
Peak Inverse Anode Voltage = 2100 Volts	50	C
Water Flow, minimum*		
At No Load	2	Gallons per Minute
At Continuous Rated Average Current	6	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	19	C
Pressure Drop at 6 Gallons per Minute, maximum	1	Pound per Square Inch

MAXIMUM RATINGS

Power-Rectifier Service, Continuous Duty

(Ratings are for Zero-Phase-Control Angle)

Maximum Peak Anode Voltage			
Inverse	900	2100	Volts
Forward	900	2100	Volts
Maximum Anode Current			
Peak	3600	2400	Amperes
Average			
Continuous	400	300	Amperes
Two-Hours—Averaged Over Any Two-Minute Interval	600	450	Amperes
One-Minute—Averaged Over Any One-Minute Interval	800	600	Amperes
Fault	16,000	16,000	Amperes
Maximum Duration of Fault Current	0.15	0.15	Second
Frequency Range	25–60	25–60	Cycles per Second

Grid Requirements†		
Minimum Voltage to Establish Conduction	50	Volts
Minimum Voltage to Prevent Conduction	100	Volts
Positive Current to Establish Conduction	0.1	Ampere

Holding Anode		
Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Seconds
Grid†		
Maximum Peak Forward Voltage	250	Volts
Maximum Peak Inverse Voltage	300	Volts
Maximum Grid-Current		
Peak Positive	1.5	Amperes
Peak Negative	0.5	Ampere
Average	0.5	Ampere
Root Mean Square	1.0	Amperes

MAXIMUM RATINGS (Cont'd)

Cathode Excitation Requirements

Ignitor Voltage Required to Fire	450 Volts
Ignitor Current Required to Fire	45 Amperes
Starting Time at Required Voltage or Current	100 Microseconds
Peak Excitation Arc Current Required, minimum	6 Amperes
Excitation Arc-Drop Voltage	12 Volts

Ignitor

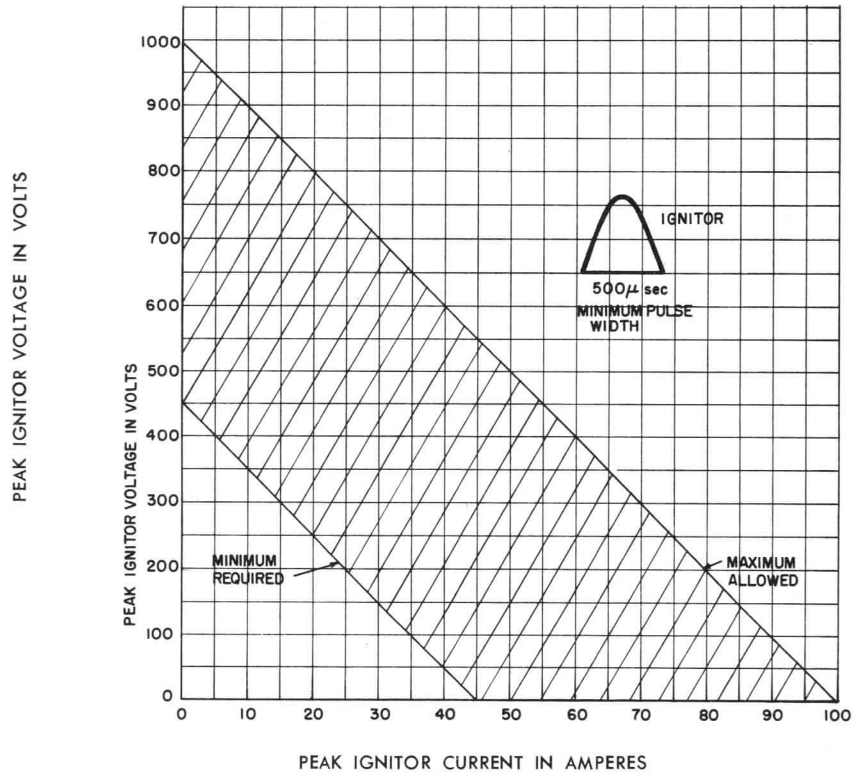
Maximum Inverse Voltage	5 Volts
Maximum Current	
Peak	100 Amperes
Root Mean Square	15 Amperes
Average	2 Amperes
Maximum Averaging Time	10 Seconds

* Water flow should be continued for one hour after removal of anode power.
Recirculating cooling system recommended. Other systems possible depending on application.
Anode heaters recommended.

† At main anode voltages of 500 volts and over, the grid circuit should provide a negative d-c bias of 100 volts and a suitable turn-on voltage to swing the grid positive at the time the ignitor is fired. At lower anode voltages, it is sufficient to connect the grid to the main anode through a resistor. In either case, the grid circuit resistance should be 500 to 1000 ohms.

IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION SEALED-IGNITRON RECTIFIERS

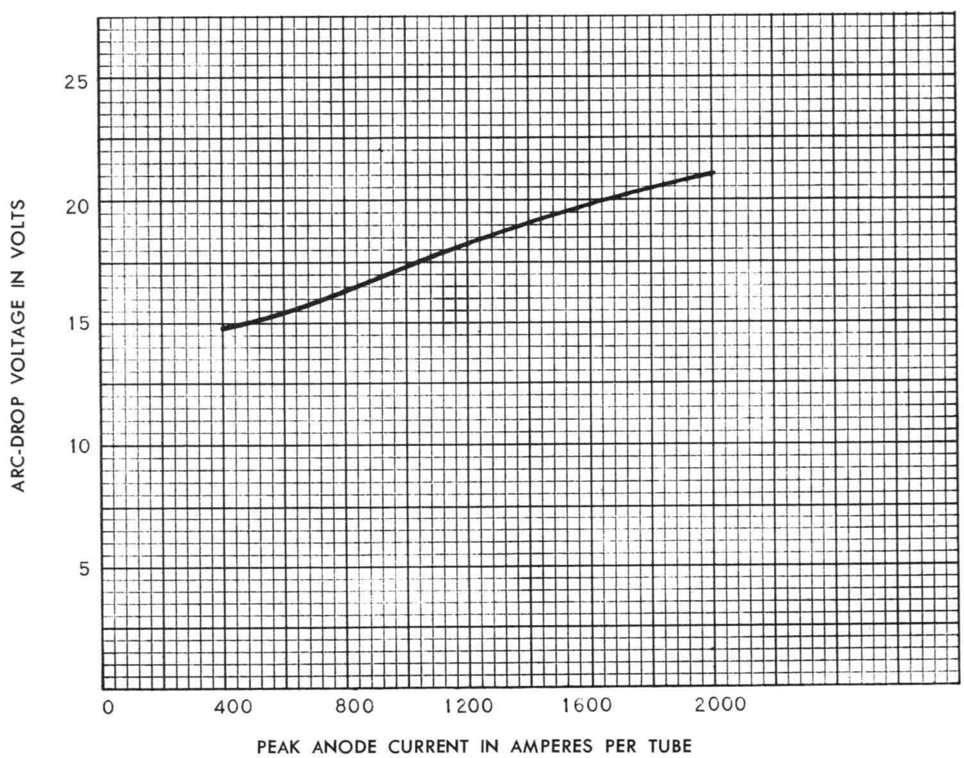
THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



K-69087-72A982 9-2-60

ARC-DROP CHARACTERISTIC

COOLING WATER TEMPERATURE—50 TO 60 C
WATER FLOW—6 GPM



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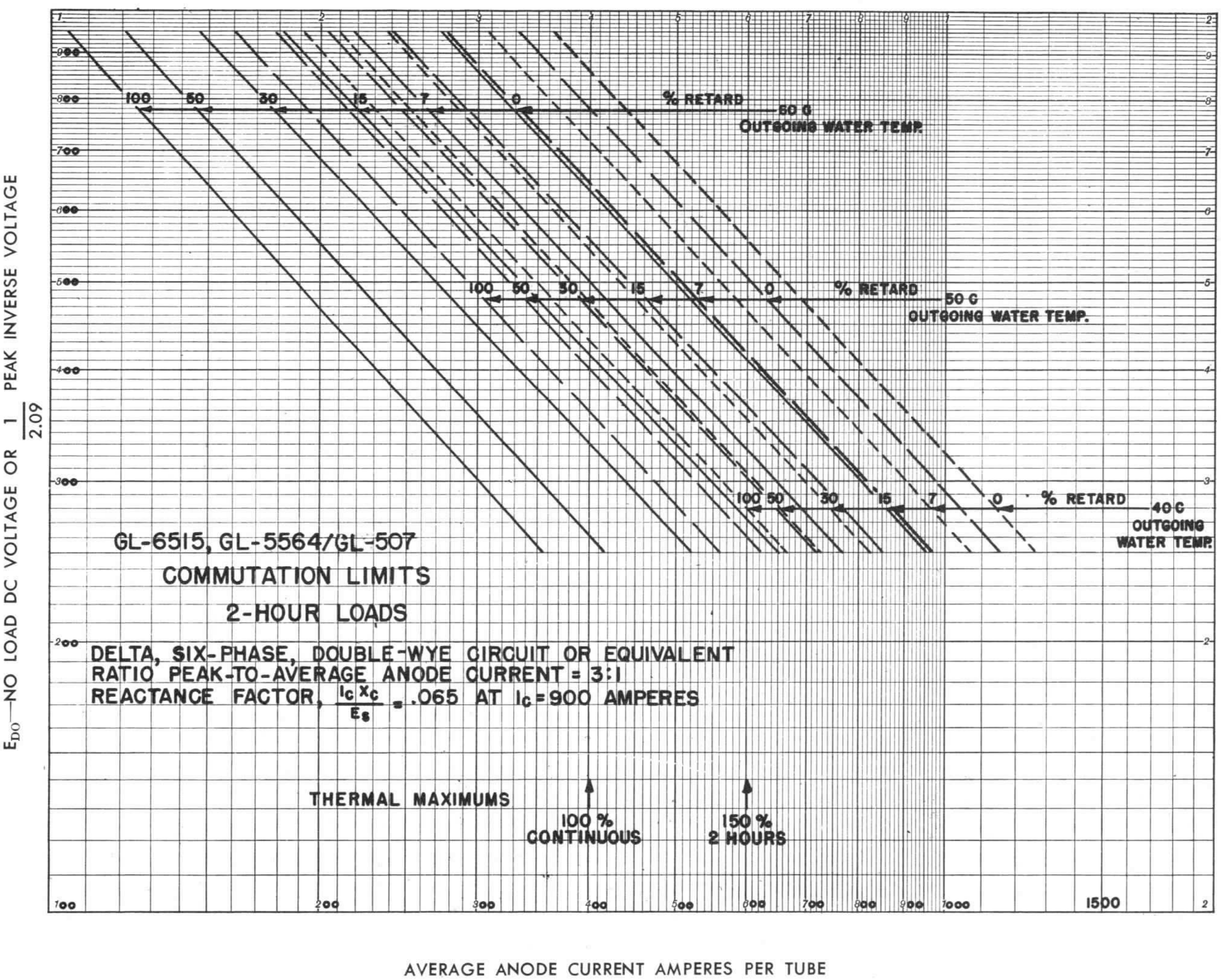
GL-7736
COMMUTATION LIMITS
2-HOUR LOADS



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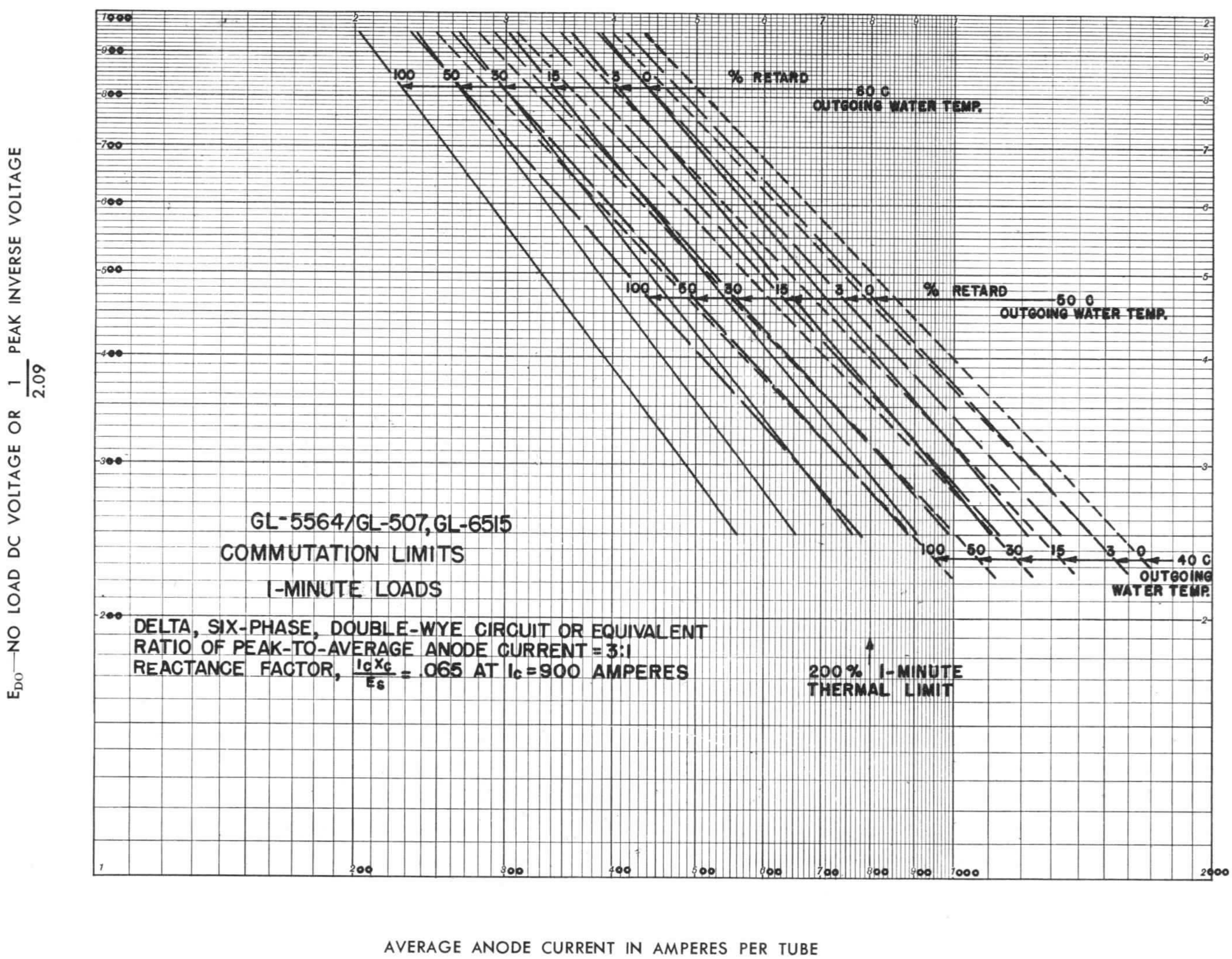
GL-7736

COMMUTATION LIMITS

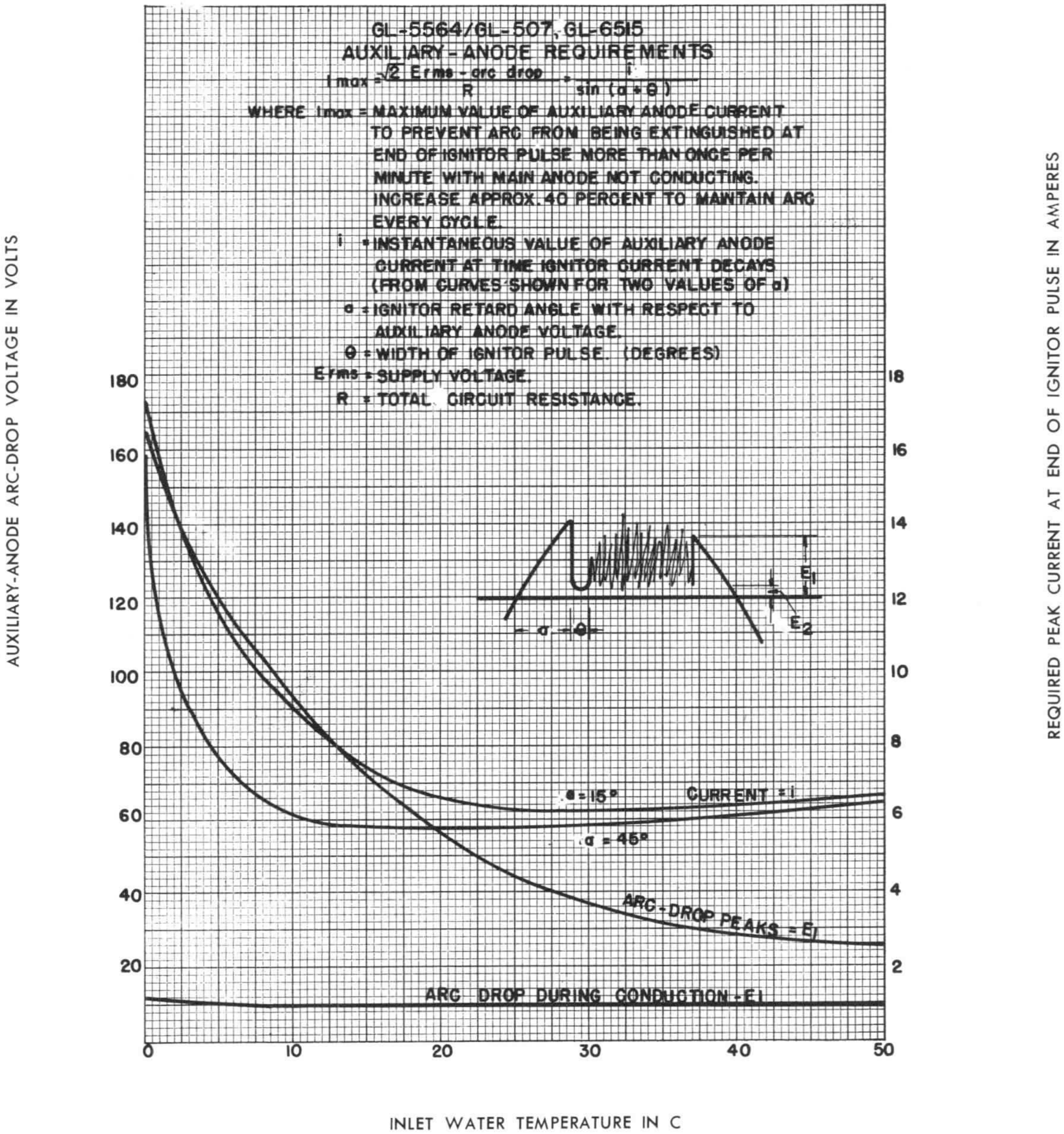
1-MINUTE LOADS



K-69087-72A179

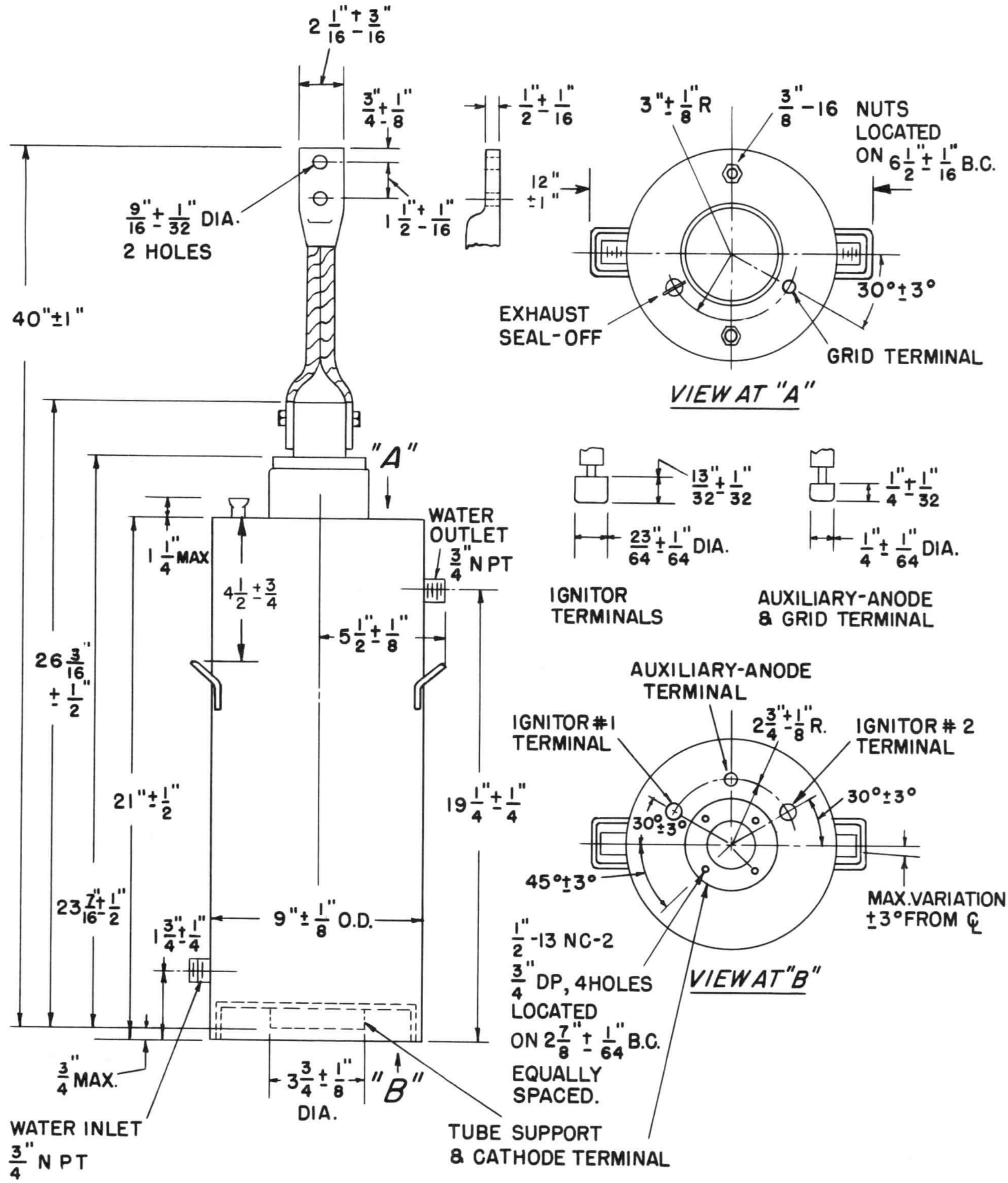
10-20-54

HOLDING-ANODE REQUIREMENTS



K-69087-72A387

12-1-54


2 1/16" + 3/16 − 3/16
3/4" + 1/8 − 1/8
1/2" + 1/16 − 1/16
9/16" + 1/32 − 1/32 DIA.
2 HOLES
1 1/2" + 1/16 − 1/16
12"
±1"
3" ± 1/8" R
3/8" −16 NUTS
LOCATED
ON 6 1/2" ± 1/16" B.C.
30° ± 3°
EXHAUST
SEAL-OFF
GRID TERMINAL
VIEW AT "A"
40" ± 1"
"A"
WATER
OUTLET
3/4" N PT
1 1/4" MAX
4 1/2 + 3/4 − 3/4
5 1/2" ± 1/8"
26 3/16"
± 1/2"
13/32" ± 1/32"
23/64" ± 1/64" DIA.
IGNITOR
TERMINALS
1/4" ± 1/32"
1/4" ± 1/64" DIA.
AUXILIARY-ANODE
& GRID TERMINAL
AUXILIARY-ANODE
TERMINAL
IGNITOR #1
TERMINAL
2 3/4" + 1/8 − 1/8 R.
IGNITOR # 2
TERMINAL
30° ± 3°
30° ± 3°
21" ± 1/2"
19 1/4" ± 1/4"
45° ± 3°
MAX.VARIATION
±3° FROM ℄
23 7/16" ± 1/2"
1 3/4" ± 1/4"
9" ± 1/8" O.D.
1/2" -13 NC-2
3/4" DP, 4 HOLES
LOCATED
ON 2 7/8" ± 1/64" B.C.
EQUALLY
SPACED.
VIEW AT "B"
3/4" MAX.
3 3/4 ± 1/8"
DIA.
"B"
WATER INLET
3/4" N PT
TUBE SUPPORT
& CATHODE TERMINAL

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.

PRINTED IN U.S.A.

PRODUCT INFORMATION

IGNITRON

GL-8420

GL-8420

AC CONTACTOR SERVICE—2000 AMPERES

FORCED-AIR COOLED **TWO IGNITORS**

The GL-8420 is a forced-air-cooled ignitron for use in railroad locomotive service as an electronic contactor. In such application two tubes in an inverse-parallel connection control the a-c voltage input to a semiconductor rectifier.

Features include a coaxial construction in which current flows from anode to cathode, then up the tube wall to a coaxial cathode terminal. Coaxial current flow minimizes arc deflection caused by high peak currents. A removable thermostat provides protection against excessive temperature and loss of cooling air. An ignitor terminal block on the periphery of the tube facilitates connecting to the ignitor.

ELECTRICAL

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Ignitors	2	
Arc Drop at 1100 Amperes Peak	19	Volts

See Curve "Arc Drop"

MECHANICAL

Envelope Material—Steel

Net Weight, approximate	130	Pounds

Mounting Position—Vertical Anode Terminal Up

THERMAL

Type of Cooling—Forced Air
Cooling Air Temperature

Maximum	45	C
Minimum	−25	C
Air Flow	600, 750	Cubic Feet per Minute
Static Incoming Air Pressure	6	Inches—Water

Incoming Air Enters Beneath Tube—See Outline Drawing

MAXIMUM RATINGS

AC Contactor Service

Two Tubes in Inverse Parallel, Ratings per Tube

Air Flow, minimum	600	750	Cubic Feet per Minute
Peak Forward and Inverse Anode Voltage	1000	1000	Volts
Peak Anode Current	2500	2500	Amperes
Average Anode Current			
5 Cycles	1000	2000	Amperes
3 Minutes	130	325	Amperes
Continuous	80	200	Amperes
Frequency Range	25–60		Cycles per Second

Ignitor

Maximum Voltage		
Positive—Anode Voltage		
Inverse	5	Volts
Maximum Current		
Peak	100	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Volt-Ampere Time Requirements—See Curve on page 2

Over-Temperature Thermostat Rating

Maximum Peak Potential Difference Between Tube Cylinder and Thermostat Contacts	4000	Volts
Maximum Current (220 Volts AC, Resistive)	15	Amperes

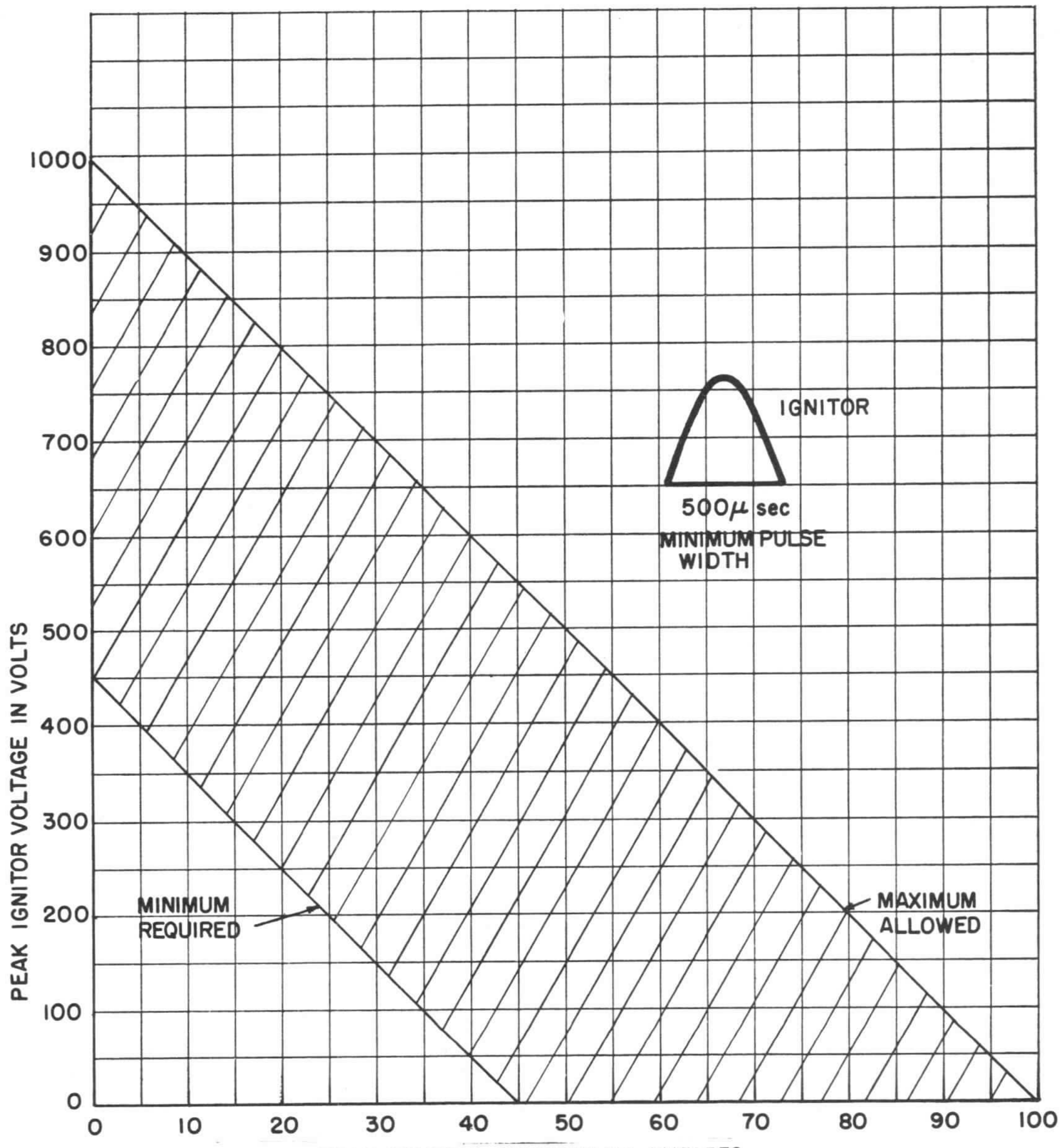
OPERATING NOTE

For railway and similar service the tube must be shock-mounted to maintain the resonant frequency of the shock-mounted assembly at less than five cycles per second at normal operating temperatures. The resonant frequency of all internal parts of the tube is above thirty-five cycles per second.

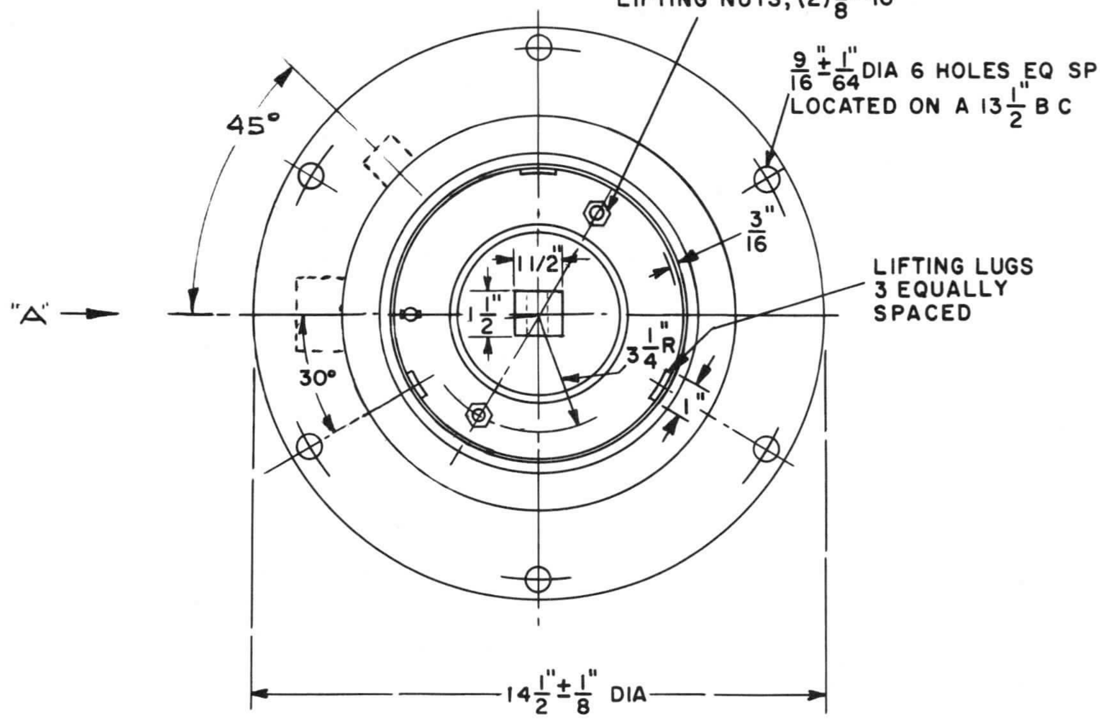
The center of gravity of the tube is approximately three inches below the cathode terminal and mounting ring of the tube.

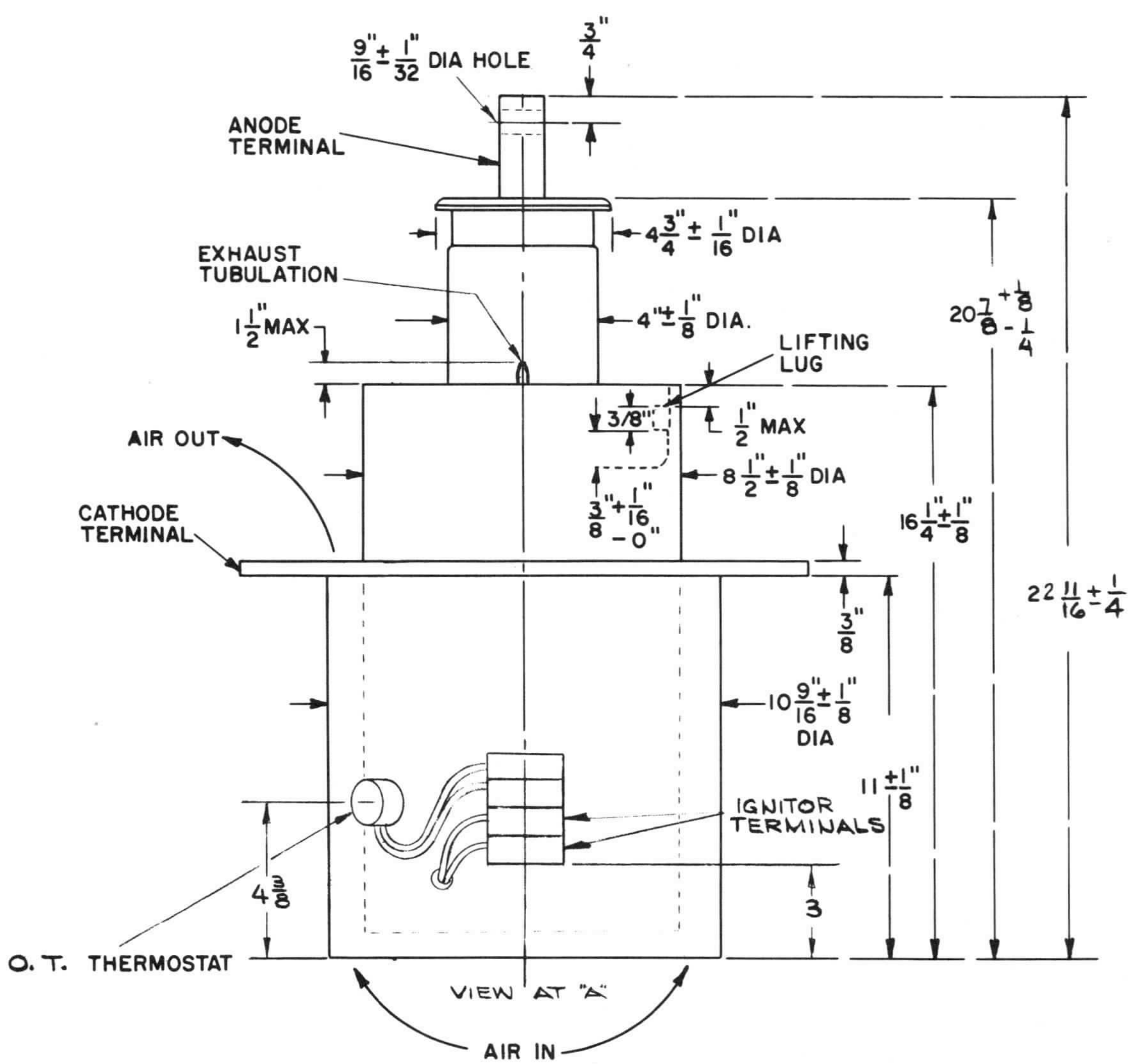
For best operation the tube should be mounted with the ignitor seals in line with the length of the car or locomotive. The maximum effective tip of the tube should not exceed ten degrees. "Effective tip" is the actual tip in any direction plus the simulated tip in that direction caused by acceleration of the car or locomotive.

IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION



THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA





OUTLINE GL-8420

GENERAL ELECTRIC
TUBE DEPARTMENT
Schenectady, N. Y. 12025

ELECTRONIC INNOVATIONS IN ACTION

TUBES

PRODUCT INFORMATION

GL-8465
GL-8466

IGNITRONS

GL-8465, GL-8466

RECTIFIER SERVICE—400 AMPERES

HOLDING ANODE — TWO IGNITORS

The GL-8465 and -8466 are sealed, stainless-steel jacketed, water-cooled, mercury-pool tubes for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. The tubes are suitable for use in rectifiers rated up to 500 kilowatts output, depending on the number used, the output voltage, and the circuit. Continuous average current rating is 200 amperes per tube in rectifiers rated up to 300 volts d-c.

These ignitrons can also be used in 2400-volt a-c control service. In this application their rating is 2400 kilovolt-amperes.

The GL-8466 features an integral thermostatic arrangement with protective elements. With this exception the tubes are identical in ratings and characteristics.

The thermostatic arrangement includes a switch which controls a solenoid valve in the water-supply line in response to increasing and decreasing tube temperature, thus maintaining the amount of cooling water to the minimum required by the operating conditions. An over-temperature switch permits removal of power when ignitron temperature exceeds a safe value.

The temperature-controlled design has several advantages over the non-temperature-controlled types. It eliminates heat exchangers and recirculating water systems required to ensure safe operation when the water temperature is too low to maintain the minimum reliable mercury-vapor pressure in the tubes. It eliminates the usual safety devices such as water-flow and water-over-temperature relays, and water-pressure interlocks, all of which require considerable maintenance. The control feature also prevents excessive moisture condensation on the external parts of the tube under conditions of high humidity.

Both the 8465 and 8466 have a holding anode and two ignitors. Excitation of this anode stabilizes the cathode spot for very small anode currents. Two ignitors assure long life since only one is used at a time. Phase control of the ignitor impulses permits voltage control of the rectified output.

ELECTRICAL

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor

Numbers of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Holding Anodes	1	
Ignitors	2	
Arc Drop at 600 Amperes Peak	16.2 ± 0.5	Volts

See Curve "Arc Drop"

MECHANICAL

Envelope Material—Stainless Steel

Over-all Length, excluding anode lead	17 15/16	Inches
Over-all Diameter	5 3/4	Inches
Net Weight, approximate	25	Pounds

THERMAL

Type of Cooling—Water

Inlet Water Temperature*, minimum	6	C
Outlet Water Temperature, maximum		
Power-Rectifier Service		
Peak Inverse Anode Voltage = 900 Volts	55	C
Peak Inverse Anode Voltage = 2100 Volts	40	C
AC Control Service Voltage = 2400 Volts RMS	35	C
Water Flow, minimum, solenoid water valve open		
At No Load†	1	Gallon per Minute
At Continuous Rated Average Current	3	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	4.5	C
Pressure Drop at 3 Gallons per Minute, maximum	3	Pounds per Square Inch

* Dependent upon load conditions. For substantially constant load 6 C is satisfactory. For widely fluctuating loads 20 C is required

† Water flow should be continued for at least thirty minutes after removal of anode power.

MAXIMUM RATINGS

Power-Rectifier Service, Continuous Duty

Ratings are for Zero-Phase-Control Angle—See Curves "Commutation Limits"

Maximum Peak Anode Voltage			
Inverse	900	2100	Volts
Forward	900	2100	Volts
Maximum Anode Current			
Peak	1800	1200	Amperes
Average			
Continuous	200	150	Amperes
Two-Hours—Averaged Over Any Two-Minute Interval	300	225	Amperes
One-Minute—Averaged Over Any One-Minute Interval	400	300	Amperes
Fault	12,000	9000	Amperes
Maximum Duration of Fault Current	0.15	0.15	Seconds
Frequency Range	25–60	25–60	Cycles per Second

AC Control Service △

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	2400	Volts RMS
Maximum Demand	2400	Kilovolt-Amperes
Average Current at Maximum Demand	135	Amperes
Maximum Average Current	207	Amperes
Demand at Maximum Average Current	1105	Kilovolt-Amperes
Maximum Averaging Time at 2400 Volts RMS	1.66	Seconds
Maximum Peak Fault Current	6000	Amperes
Frequency Range	25–60	Cycles per Second

MAXIMUM RATINGS (Cont'd)

Holding Anode

See Curve "Holding Anode Requirements"

Maximum Peak Voltage		
Forward	160	Volts
Inverse		
Main Anode Conducting	25	Volts
Main Anode Non-Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

Cathode Excitation Requirements

Ignitor Voltage Required to Fire	450	Volts
See Curve "Ignitor Volt-Ampere Requirements"		
Ignitor Current Required to Fire	45	Amperes
See Curve "Ignitor Volt-Ampere Requirements"		
Starting Time at Required Voltage or Current	100	Microseconds
Peak Excitation Arc Current Required, minimum	8	Amperes
See Curve "Holding Anode Requirements"		
Excitation Arc-Drop Voltage	9±0.5	Volts
Excitation Arc Open-Circuit Voltage, minimum	55	Volts

Ignitor

Maximum Voltage		
Positive—Anode Voltage		
Inverse	5	Volts
Maximum Current		
Peak	100	Amperes
Average	2	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

GL-8466

Temperature-Control-Switch Ratings‡

Maximum Voltage	575	Volts
Maximum Current		
Over-Temperature Switch	6	Amperes
Water-Control Switch	1.5	Amperes
Maximum Peak Potential Difference Between Tube Water Cylinder and Switch Circuit	1500	Volts

Switch-Contact Arrangement
Over-Temperature Switch—Normally Closed (Contacts Open on Temperature Rise)
Water-Control Switch—Normally Open (Contacts Close on Temperature Rise)

△RMS demand voltage, current and KVA demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used.

‡ Suitable fuses should be provided in the switch circuits to prevent a power arc should a ground occur in the switch or wiring.

INSTALLATION AND OPERATION GL-8466

To realize the advantage of safe tube operation on low-temperature cooling water, water must be supplied to the tube through a rapid-closing solenoid valve controlled by the water-control switch on the tube. The valve must completely stop the water flow to the tube except when the water-control switch is closed. The number of tubes connected in series for water from a single valve must be restricted for the lower temperatures. Placing fewer tubes in series with a solenoid valve will permit the use of lower incoming water temperatures without resulting in arcbacks caused by low tube temperatures.

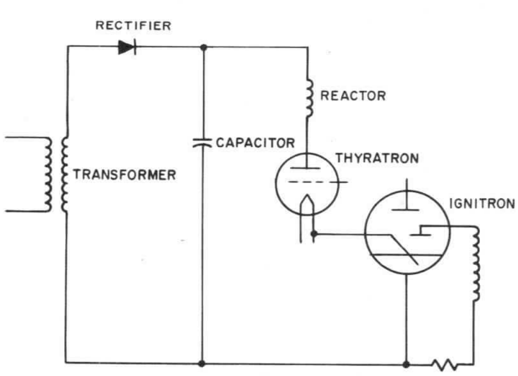
If the water-supply temperature will never be below plus 5 C, three tubes may be connected in series for water flow, provided the temperature is not so high as to cause over-temperature on the last tube for the flow available and the load expected on the rectifier. If three tubes are connected in series, only one solenoid valve is required for the series group, and only the last tube in the group requires the temperature-control switch.

If the water-supply may sometimes drop below plus 5 C, all tubes in the rectifier must be temperature-controlled, be connected in parallel for water flow, and have individual solenoid water valves to prevent water from circulating through any tube until its water-control switch closes. If the tubes themselves are at this low temperature initially, a low load (such as one-quarter load) should be applied to the rectifier long enough to cause one operation of the solenoid valves. After this initial warming, the rectifier should be in condition to handle safely normal loads unless it is idle in a cold atmosphere long enough for the tube again to become cold.

The minimum allowable temperature for the series-parallel connection is based on normal industrial loads on the rectifier. For some special conditions of loading it is possible to lower these temperatures.

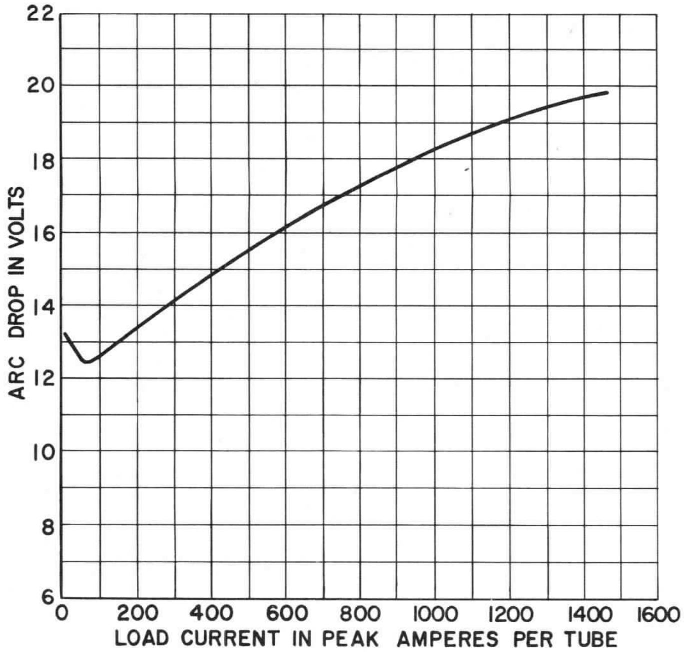
In some applications, for example where the rectifier has only intermittent low loads which are insufficient to heat the anode end of the tubes to normal temperature, there may be a tendency for mercury to accumulate on the inside of the anode-glass-insulating bushing. Small amounts of mercury here are not serious. However, if the entire surface becomes covered, an arc will form over the inside of the glass which may permanently damage the tube. If this type of service is anticipated, large accumulations of mercury over the glass can be prevented by applying external heat to the glass with small radiant heaters or heat lamps. The glass temperature should be raised to approximately 50 C, but may go to 200 C without damage when the tubes are loaded.

IGNITRONS
ELEMENTARY CIRCUIT FOR CAPACITOR FIRING

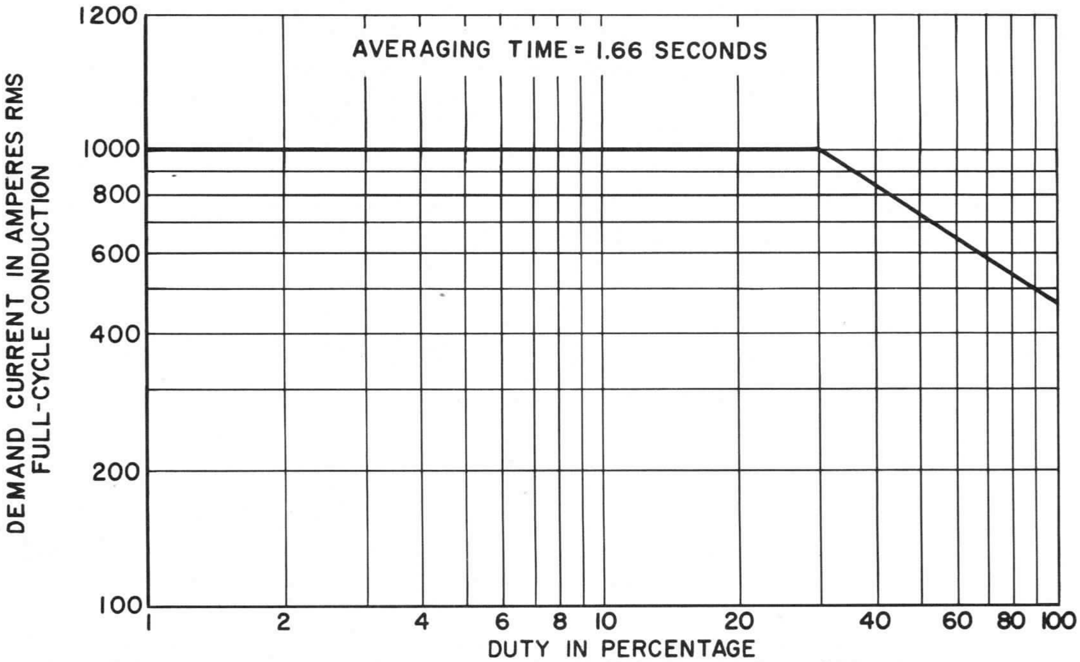


ARC DROP

OUTLET WATER TEMPERATURE - 40 TO 60 C
WATER FLOW - 3 GPM

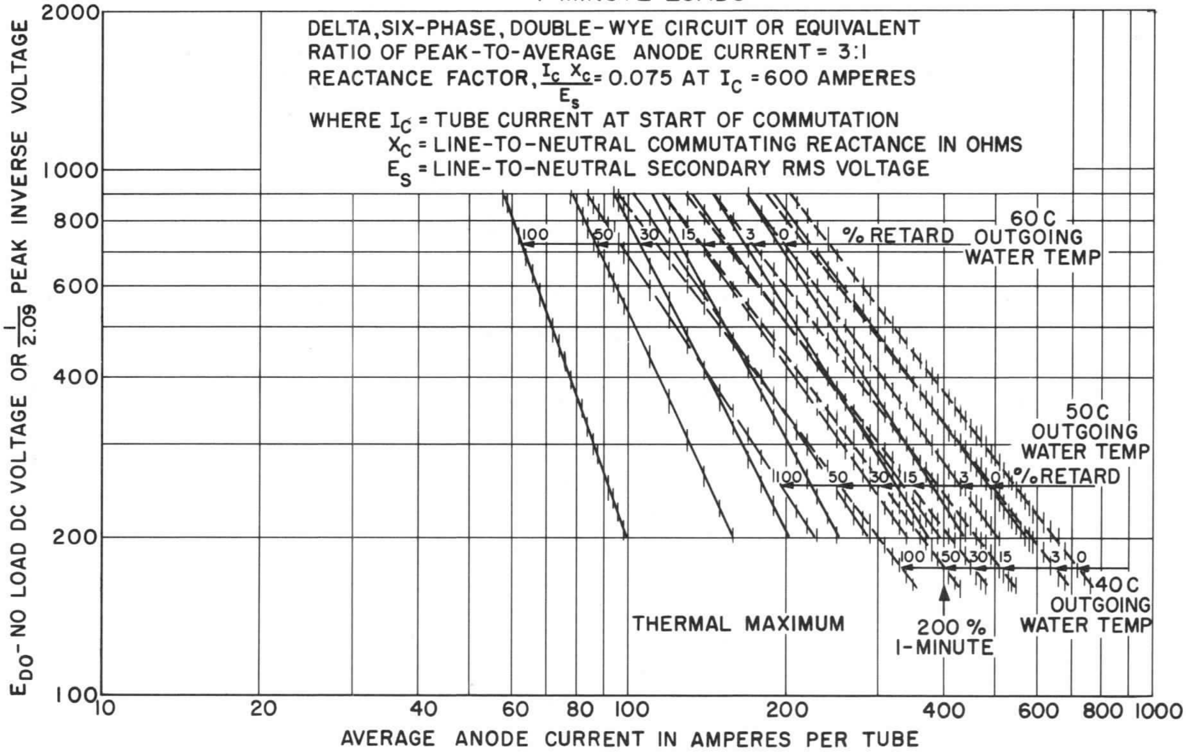


DEMAND CURRENT VS PERCENTAGE DUTY
AT 2400 VOLTS RMS

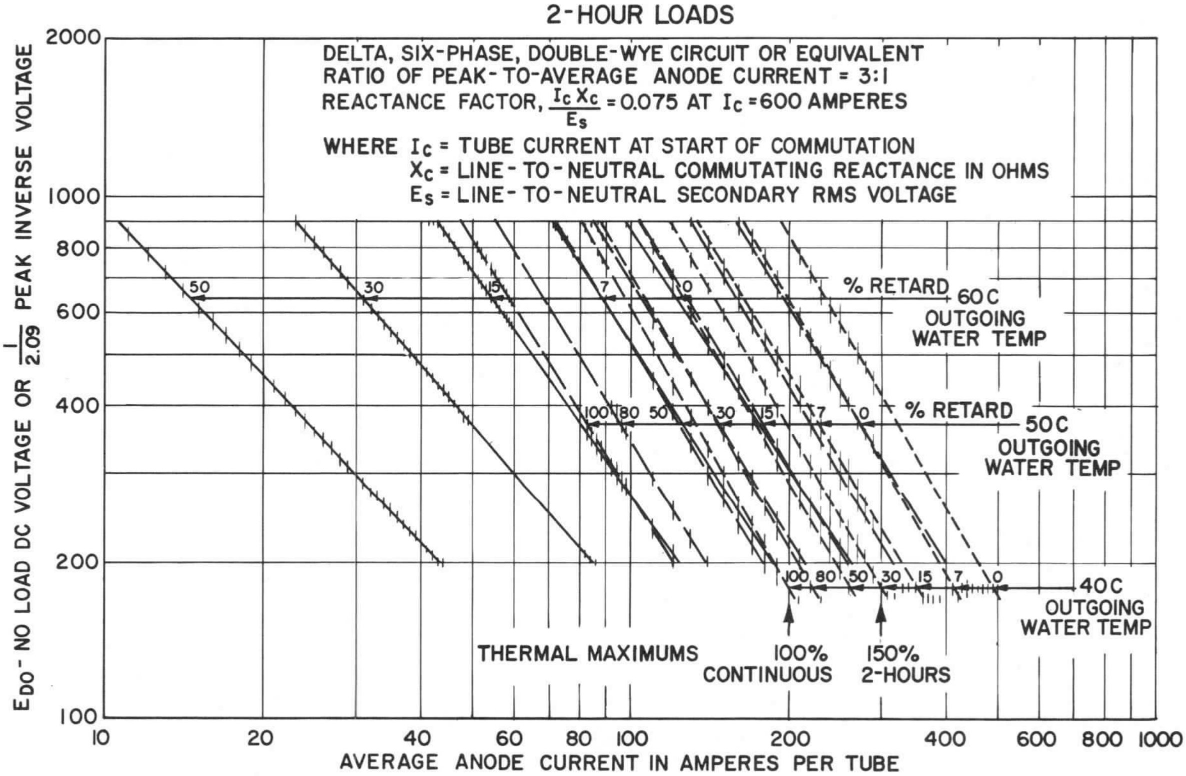


TWO TUBES CONNECTED IN INVERSE PARALLEL

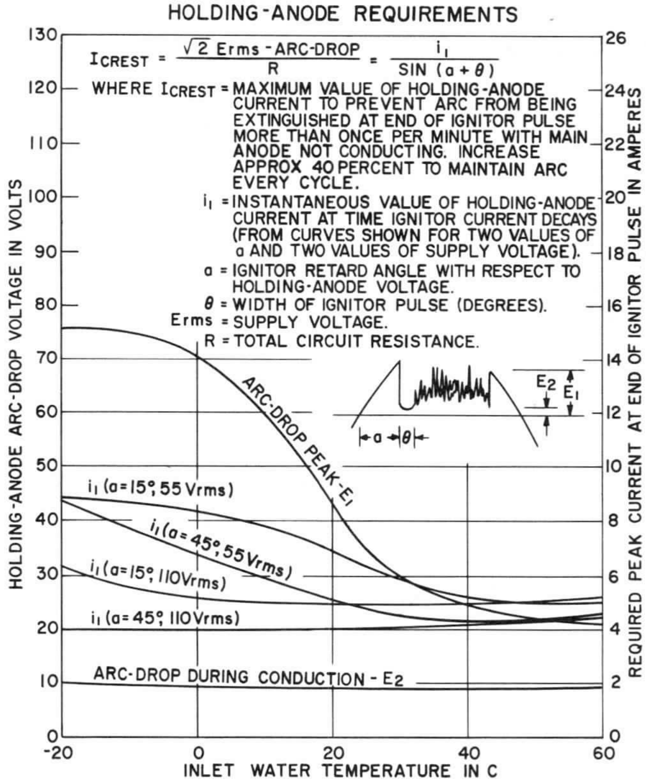
COMMUTATION LIMITS
1-MINUTE LOADS



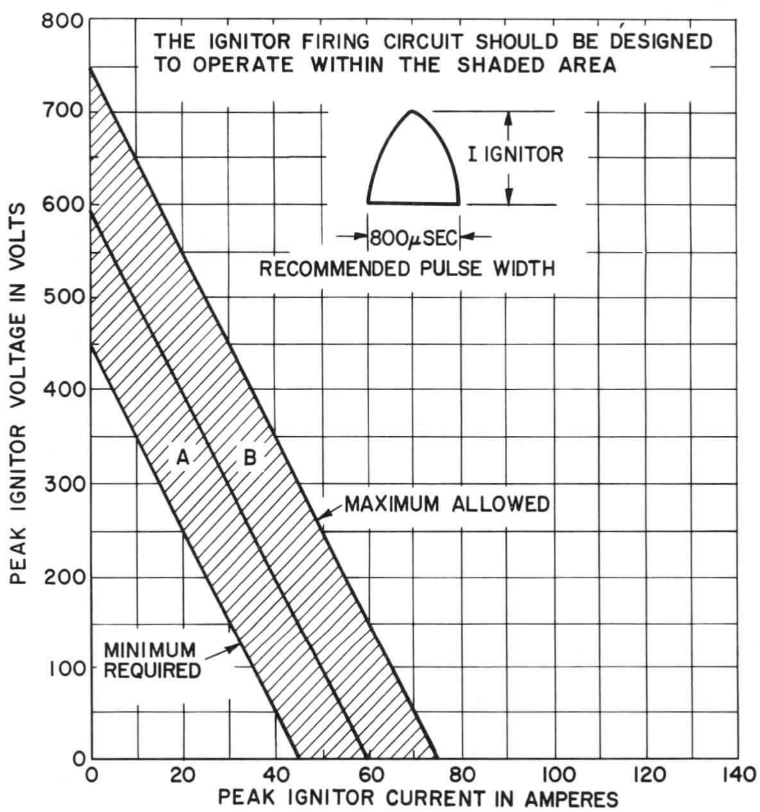
COMMUTATION LIMITS
2-HOUR LOADS

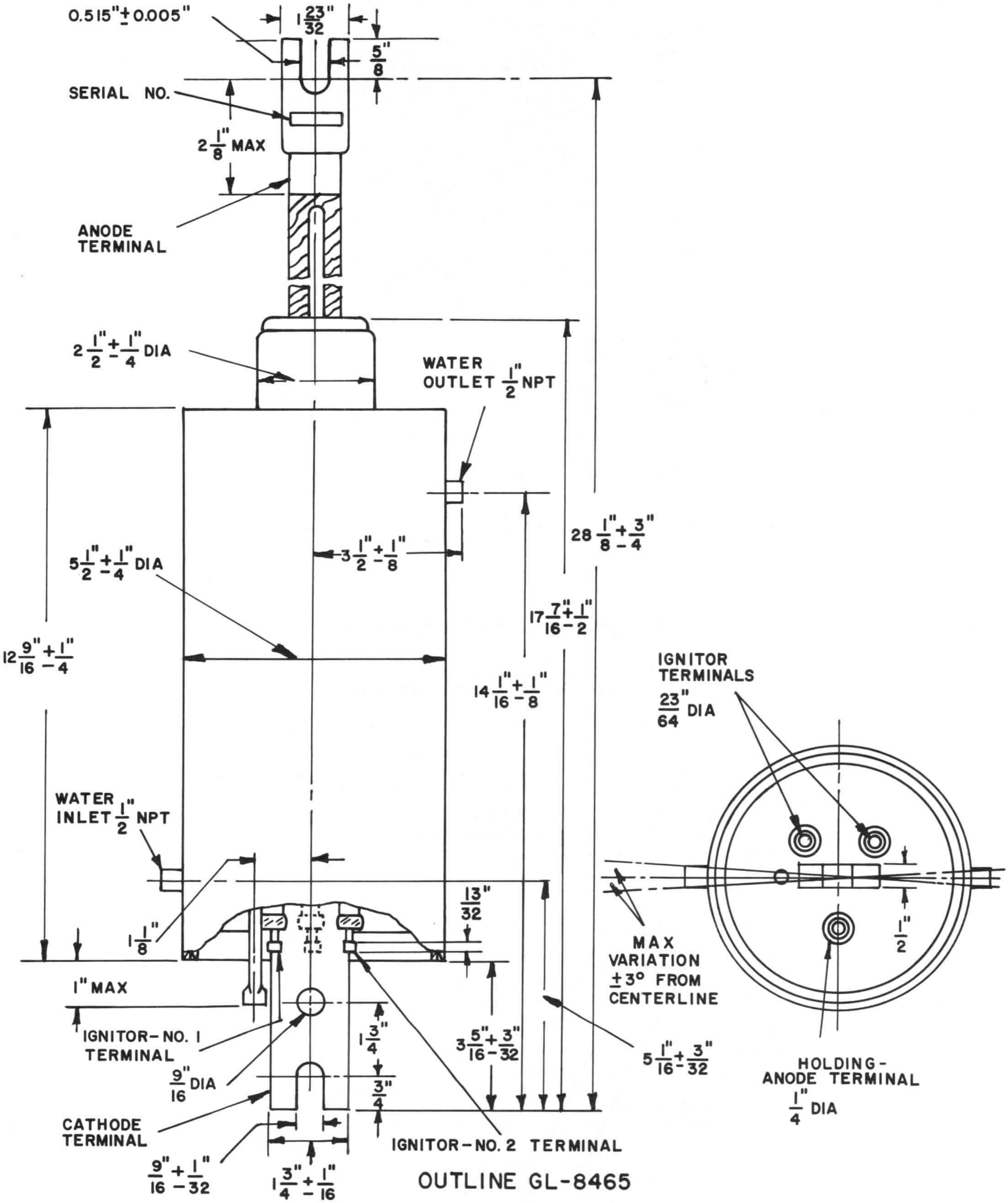


HOLDING-ANODE REQUIREMENTS

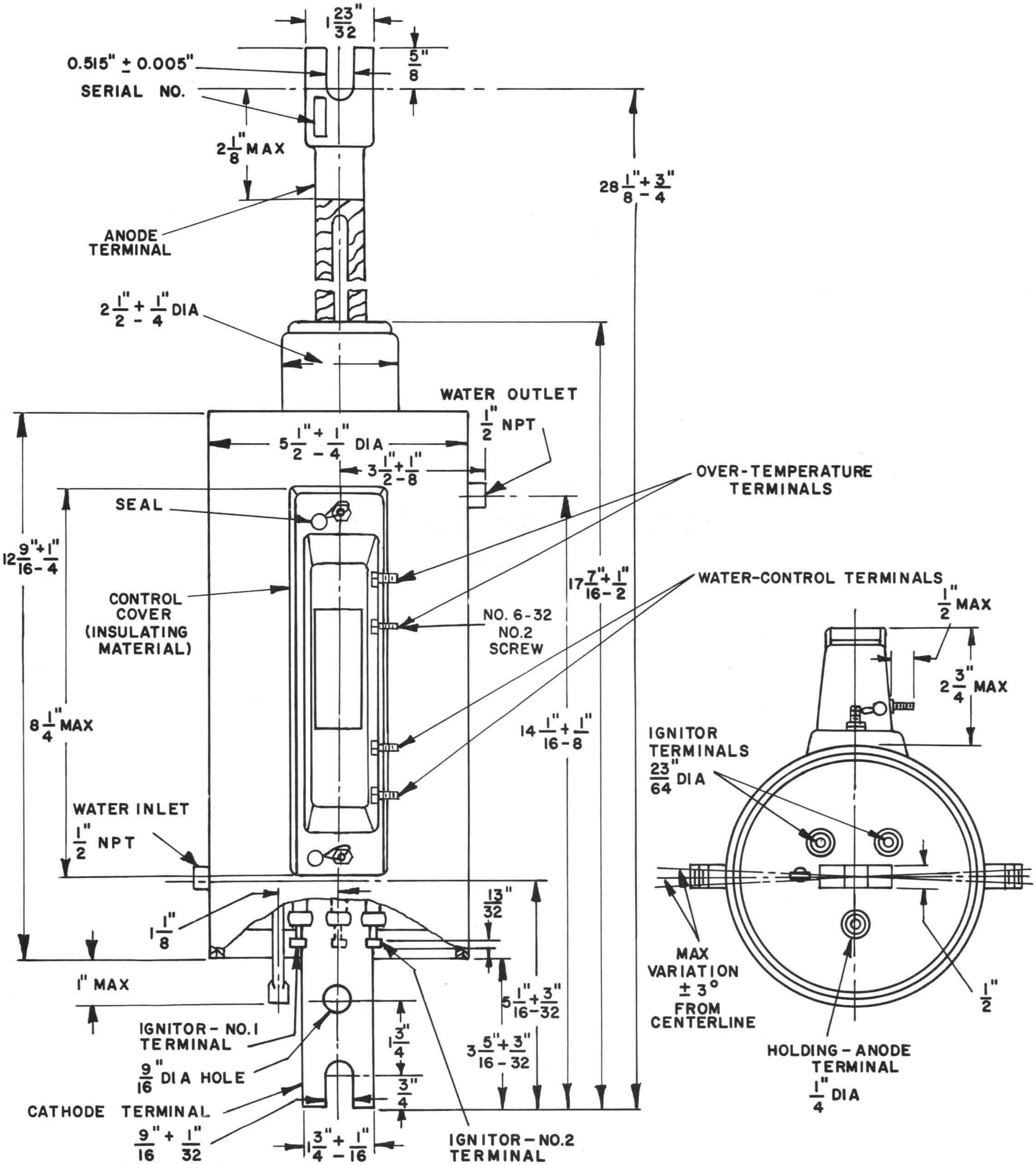


IGNITOR VOLT-AMPERE REQUIREMENTS



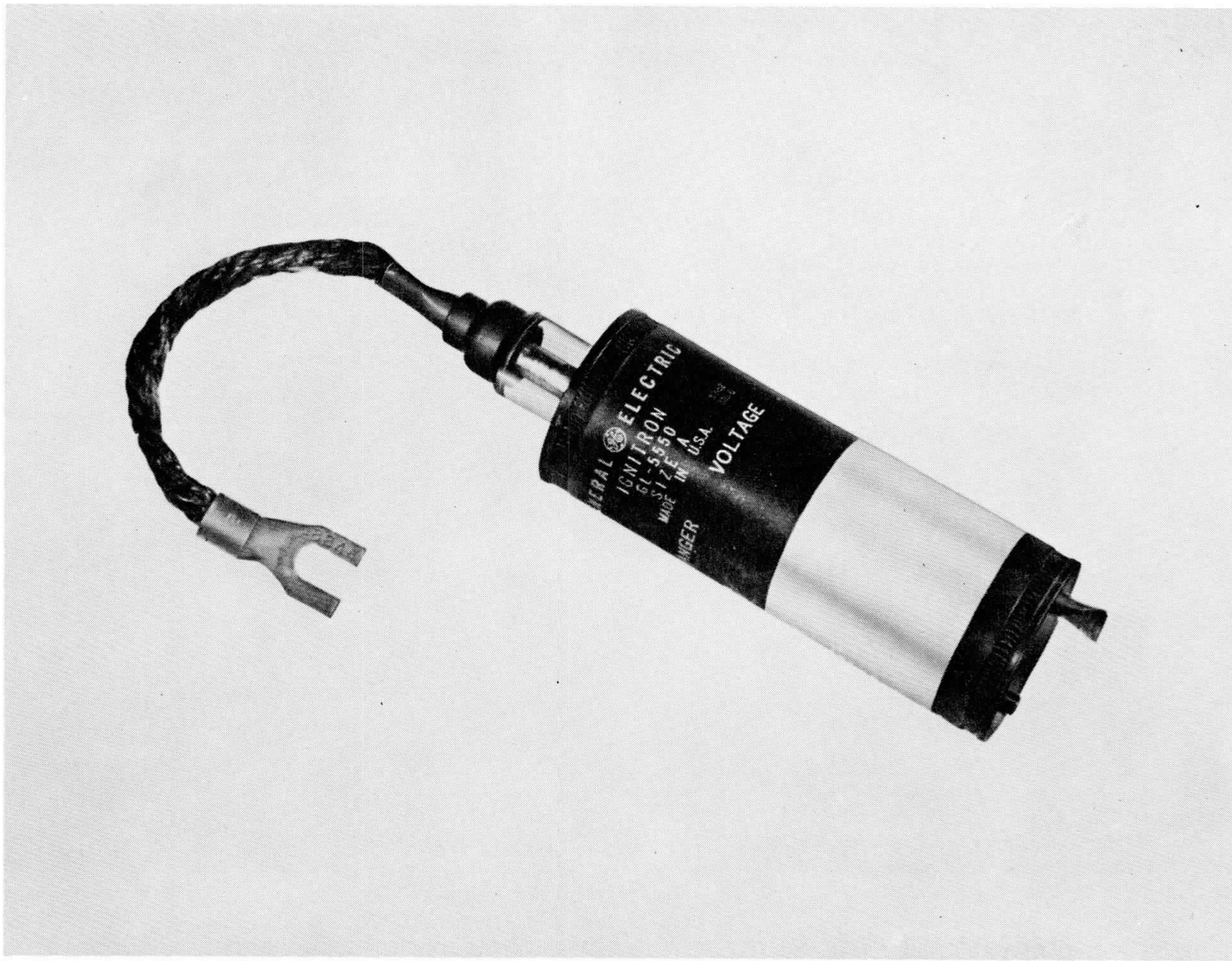


OUTLINE GL-8465



OUTLINE
GL-8466

TUBE DEPARTMENT
GENERAL ELECTRIC
Schenectady, New York 12305



IGNITRON

The GL-5550 ignitron is a sealed, clamp-cooled, mercury-pool tube designed primarily for resistance welding control. In this service, two tubes in the inverse-parallel connection will control 300 kilovolt-amperes at voltages of 250 to 600 volts and over the frequency range of 25-60 cycles. The tubes are also used in electrostatic energy storage types of resistance welding equipment to control the capacitor discharge.

Supersedes ET-T1574 dated 5-49

GENERAL

Electrical

Cathode Excitation—Cyclic	
Cathode Spot Starting—Ignitor	
Number of Electrodes	
Main Anodes	1
Main Cathodes	1
Ignitors	1
Arc Drop at 1697 Peak Amperes	30 Volts
Arc Drop at 70.4 Peak Amperes	12 Volts
Cathode Excitation Requirements	
Ignitor Voltage Required to Fire	200 Volts
Ignitor Current Required to Fire	30 Amperes
Starting Time at Required Voltage or Current	100 Microseconds

Mechanical

Envelope Material—Metal	
Over-all Length	$9\frac{1}{16}$ Inches
Over-all Width	$2\frac{9}{64}$ Inches
Net Weight	1.5 Pounds
Type of Cooling—Removable Clamp	
Clamp Contact Width	$1\frac{7}{8} \pm \frac{1}{8}$ Inches
Clamp Contact Area	9.4 Square Inches

MAXIMUM RATINGS

As AC Control Tube

Two Tubes in Inverse Parallel			
Maximum Clamp Temperature	75	50	C
Minimum Clamp Temperature	10	10	C
Voltage Range	250 to 600 RMS Volts		
Maximum Demand	150	300	Kilovolt-Amperes
Average Current at Maximum Demand	4.86	12.1	Amperes
Maximum Average Current	9.0	22.4	Amperes
Demand at Maximum Average Current	50.0	100	Kilovolt-Amperes
Maximum Averaging Time at 250 Volts RMS	27.8	22	Seconds
Maximum Averaging Time at 600 Volts RMS	11.6	9.2	Seconds
Maximum Surge Current at 250 Volts RMS	1680	3360	Peak Amperes
Maximum Surge Current at 600 Volts RMS	700	1400	Peak Amperes

Note 1—RMS demand voltage, current and kva are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used.

Note 2—For voltages below the minimum, the minimum-voltage current rating applies.

Note 3—With the use of log-log paper straight line interpolation between tabulated points may be used for other detailed ratings of:

1. Demand kva vs. average anode current.
2. Maximum averaging time vs. anode voltage and temperature.
3. Demand kva and average anode current vs. temperature.

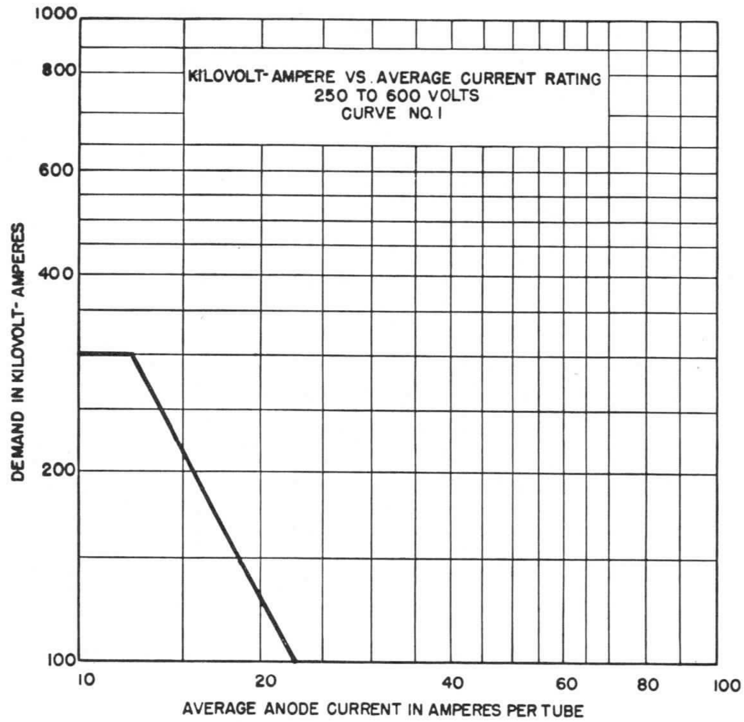
As Capacitor Discharge Tube

Maximum Number of Discharges per Second	60		60		
Maximum Peak Forward Anode Voltage	3000		6000		Volts
Maximum Peak Inverse Anode Voltage	3000		3000		Volts
Maximum Peak Anode Current	500		500		Amperes
Maximum Temperature of Cooling Clamp	70	40	60	40	C
Corresponding Maximum Average Anode Current	3	15	2.5	8	Amperes
Maximum Time of Averaging Anode Current	3.3	0.66	4.0	1.25	Seconds

Note 1—With the use of log-log paper straight line interpolation between tabulated points may be used for other detailed ratings of average anode current and maximum averaging time vs. temperature.

Ignitor

Maximum Voltage	
Positive	900 Volts
Negative	5 Volts
Maximum Current	
Peak	100 Amperes
Root Mean Square	10 Amperes
Average	1 Ampere
Maximum Averaging Time	5 Seconds



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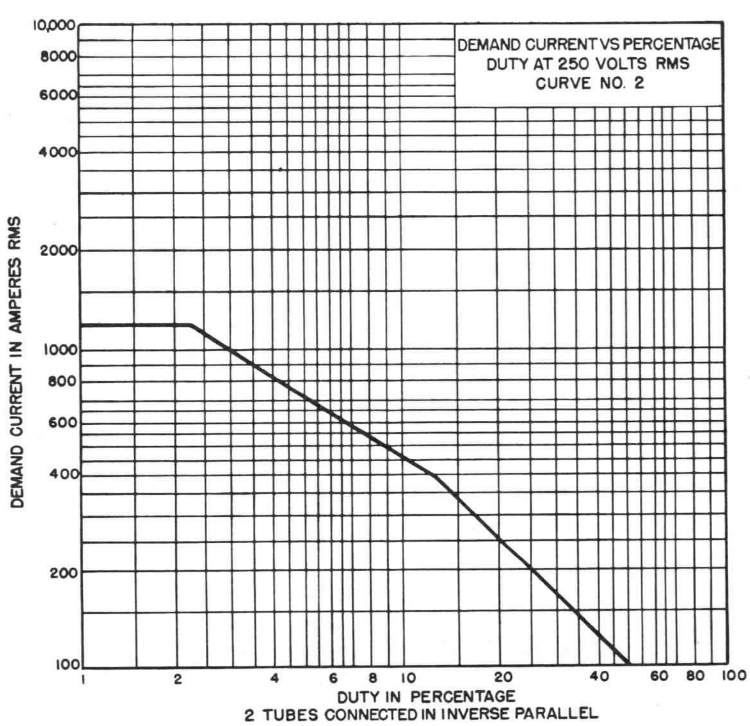
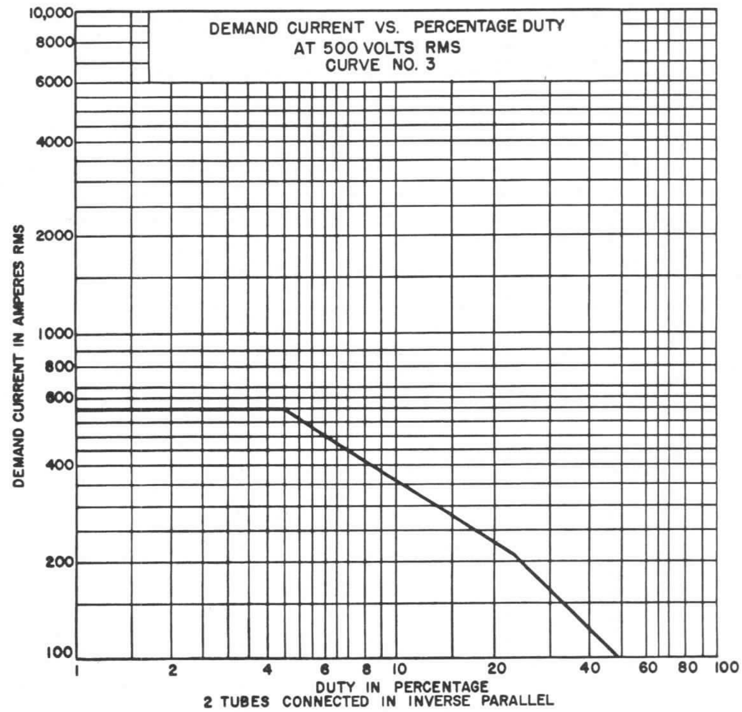


AVERAGING TIME = 22 SECONDS

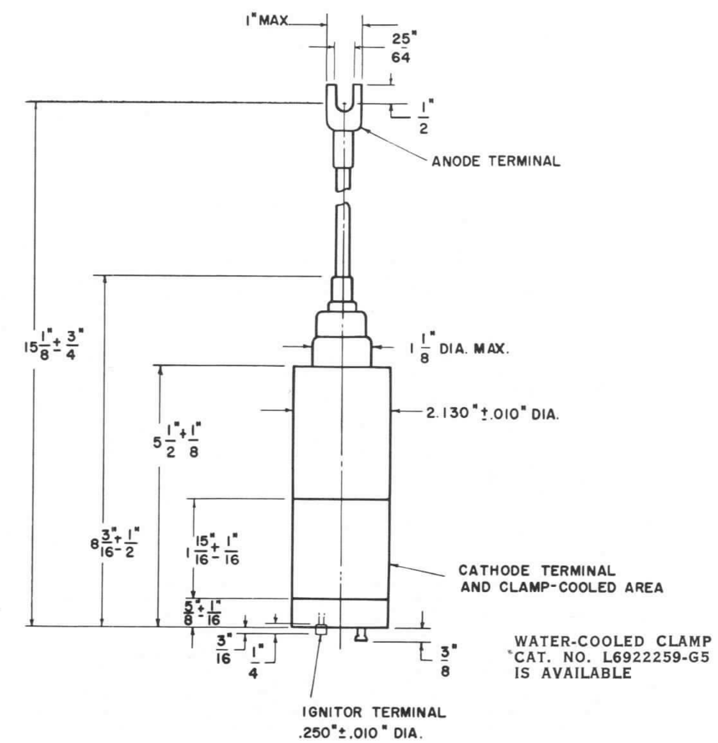
K-69087-72A863

7-11-58



AVERAGING TIME = 11 SECONDS

K-69087-72A866 7-11-58



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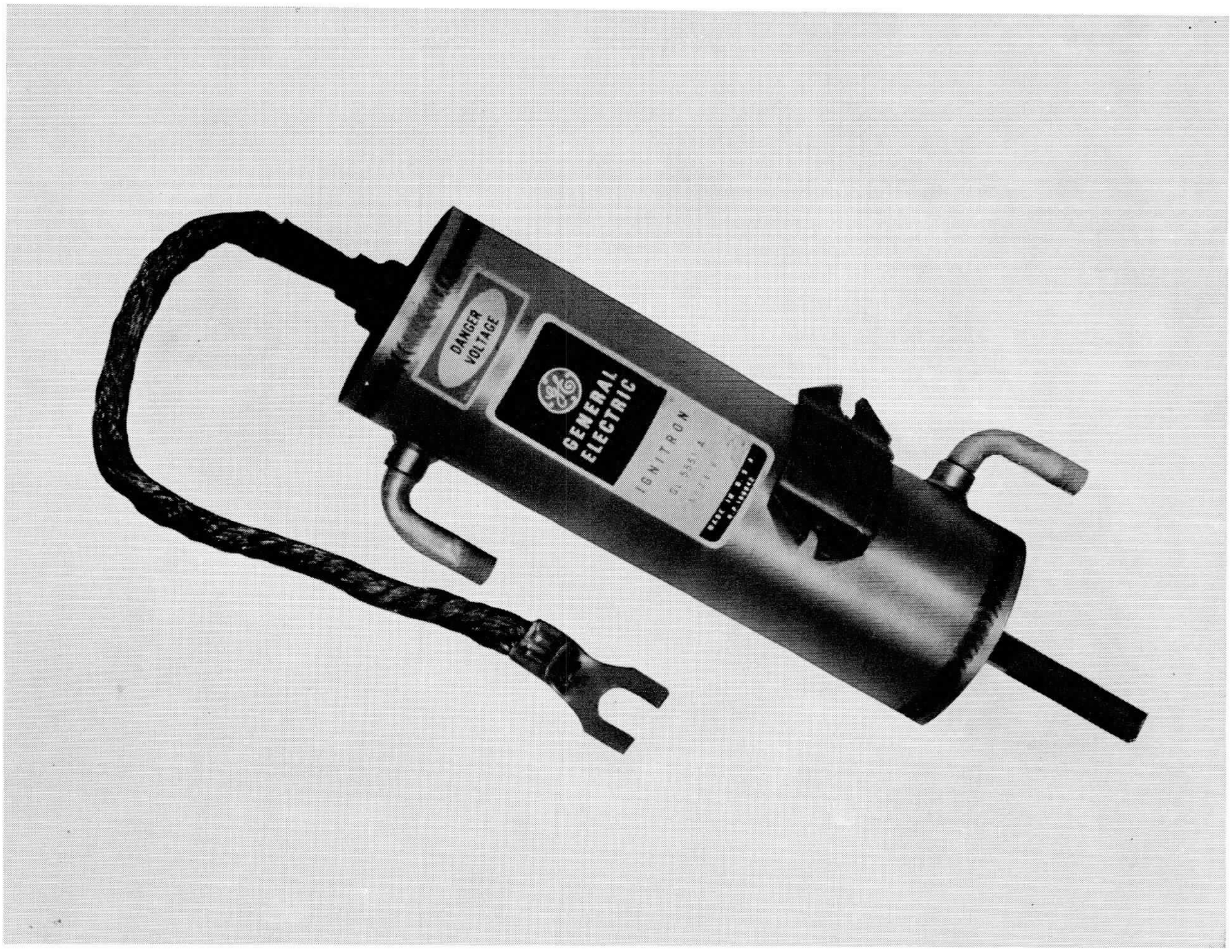


IGNITRON

ADAPTED TO WATER-FLOW CONTROL
RECTIFIER SERVICE—40 AMPERES

ADAPTED TO TEMPERATURE CONTROL
AC CONTROL SERVICE—56 AMPERES

The GL-5551-A is a sealed, stainless-steel jacketed, water-cooled ignitron for a-c control service. In such application two tubes in inverse-parallel connection will control 600 kilovolt-amperes at voltages of 250 to 600 over a frequency range of 25 to 60 cycles.

The tube is identical in rating and size to the GL-5551/FG-271 for which it is a direct replacement. The new tube, however, has the advantage of providing for simple, economical, and effective control of tube temperature and cooling-water flow. A copper plate on the tube envelope in thermal contact with the inner cylinder of the tube is maintained at substantially the same temperature as the inner cylinder. This plate is slotted to permit convenient mounting of a thermostat which on a single tube will either provide over-temperature protection or temperature control through regulation of the water flow.

Thermostats mounted on two tubes will provide both protection against excessive temperature and regulation of water flow. Advantages of the control feature include reduction of condensation on the tube walls during hot weather, protection against overloads, elimination of water supply as a limiting factor in equipment location, and appreciable savings in water consumption.

Supersedes ET-T1219A dated 12-56

GENERAL

Electrical

Cathode Excitation—Cyclic		
Cathode Spot Starting—Ignitor		
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Ignitors	1	
Arc Drop at 3400 Peak Amperes	26	Volts
Arc Drop at 176 Peak Amperes	13	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	200	Volts
Ignitor Current Required to Fire	30	Amperes
Starting Time at Required Voltage or Current	100	Microseconds

Mechanical

Envelope Material—Stainless Steel		
Over-all Length	13	Inches
Over-all Width	$2\frac{3}{4}$	Inches
Net Weight	3.6	Pounds

Thermal

Type of Cooling—Water		
Inlet Water Temperature, minimum	0	C
Inlet Water Temperature, maximum	30	C
Outlet Water Temperature, maximum	40	C
Water Flow, minimum, solenoid water valve open	1.0	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	4	C
Pressure Drop at 1 Gallon per Minute	1.8	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

AC Control Service*

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	250 to 600	Volts RMS
Maximum Demand	600	Kilovolt-Amperes
Average Current at Maximum Demand	30.2	Amperes
Maximum Average Current	56.0	Amperes
Demand at Maximum Average Current	200	Kilovolt-Amperes
Maximum Averaging Time at 250 Volts RMS	18	Seconds
Maximum Averaging Time at 600 Volts RMS	7.5	Seconds
Maximum Peak Fault Current at 250 Volts	6720	Amperes
Maximum Peak Fault Current at 600 Volts	2800	Amperes
Frequency Range	25–60	Cycles per Second

Power-Rectifier Service, Intermittent Duty

Ratings are for Zero Phase-Control Angle
(See Curve K-69087-72A310 for details)
Ratings Apply only at Inlet Water Temperatures up to 40 C

Maximum Peak Anode Voltage				
Inverse	500	1200	1500	Volts
Forward	500	1200	1500	Volts
Maximum Anode Current				
Peak	700	600	480	Amperes
Corresponding Average	—	5	4	Amperes
Average	40	22.5	18	Amperes
Corresponding Peak	—	135	108	Amperes
Maximum Averaging Time	6	10	10	Seconds
Fault	8000	8000	8000	Amperes
Maximum Duration of Fault Current	0.15	0.15	0.15	Seconds
Ratio of Average to Peak Current, maximum				
Averaging Time 0.2 Second	—	0.166	0.166	
Ratio of Fault to Maximum Peak Current	12.5	12.5	12.5	
Frequency Range	50–60	50–60	50–60	Cycles per Second

Ignitor

Maximum Voltage
  Positive—Anode Voltage
  Negative . . . . . 5 Volts
Maximum Current
  Peak . . . . . 100 Amperes
  Root Mean Square . . . . . 10 Amperes
  Average . . . . . 1 Amperes
    Maximum Averaging Time . . . . . 5 Seconds

* RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. For voltages below the minimum, the minimum-voltage current rating applies. With the use of log-log paper straight-line interpolation between tabulated points may be used for other detailed ratings of: Demand kva vs average anode current, and maximum averaging time vs anode voltage.

Control thermostats, with mounting brackets, are available through regular tube supply channels under the following catalog numbers:

AC Control Service
  Flying-Lead Type
    Water-Control Thermostat—N15272AA
    Over-Temperature Thermostat—N15273AA
  Terminal-Block Type
    Water-Control Thermostat—N15286AA
    Over-Temperature Thermostat—N15287AA

See Ignitron Accessories publication in front of Ignitron section for details.

APPLICATION DATA

Since two thermostats are required to achieve both temperature and water control, these features can be obtained in combination only when two or more tubes are used.

The water-flow thermostat should be mounted on the tube receiving water from the water-supply line; the over-temperature thermostat should be mounted on the other tube in a-c control service and on the last tube in the series in power-rectifier service.

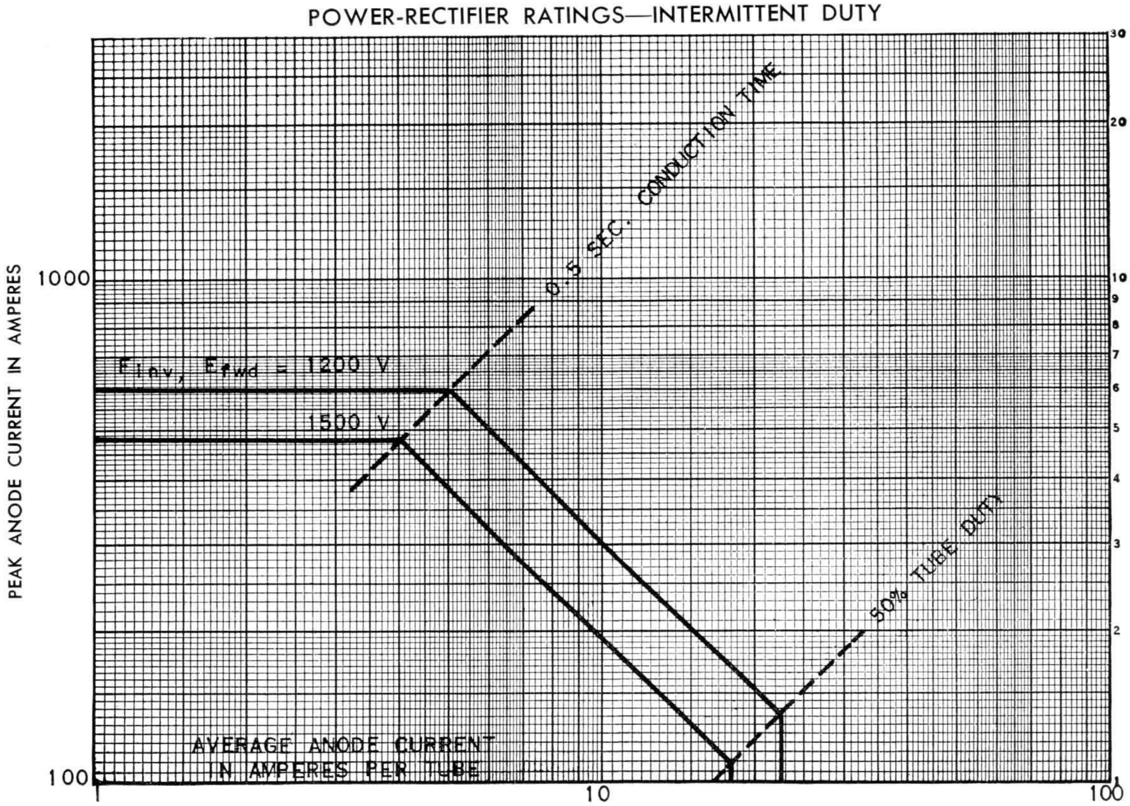
The water-control thermostat, whose contacts are set to close at 35 C, should be mounted on the tube and connected in series with the electric water valve that provides the cooling water. As long as the tube temperature remains below this value the valve remains closed, preventing water from flowing through the tube. When current is passed through the ignitron its temperature rises and at 35 C the thermostat contacts close, opening the water valve and allowing water to flow. Should the current be reduced, the water will cause the temperature to fall below the 35 C value, and the valve will close and stop the water flow.

The over-temperature thermostat provides an additional protection should the water flow be interrupted or the water-supply valve fail to open. It operates under emergency conditions to remove power from the ignitrons before they reach an excessive temperature. This thermostat is set to open its contacts at 52 C.

Appreciable time is required for the mechanism of the thermostats to reach the temperature of the copper plate on the tube. Heavy currents at high percentage duty passing through the tubes will cause their temperatures to rise more rapidly than the action of the thermostat. Where heavy loads are likely to exist, an auxiliary contact should be provided to start water flow as soon as current flows. The curve on page four shows the region of operation where this precaution must be provided for.

When the control thermostats are used with this tube, care must be taken that the cooling water has completely filled the tube before it is operated. This will prevent damage to the tube by arc-backs caused by rapid heating before the thermostats can function.

POWER-RECTIFIER RATINGS—INTERMITTENT DUTY

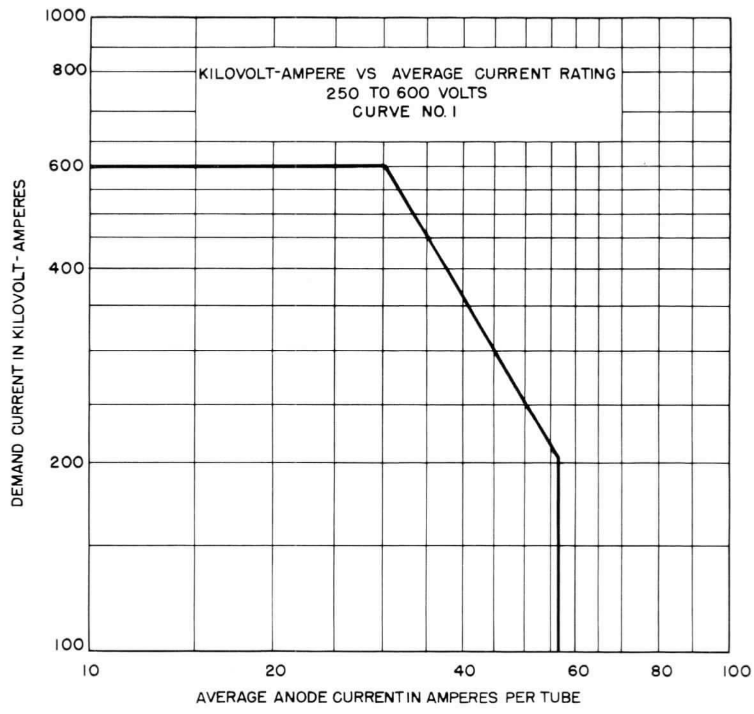


K-69087-72A310 AVERAGE ANODE CURRENT IN AMPERES PER TUBE 9-21-55

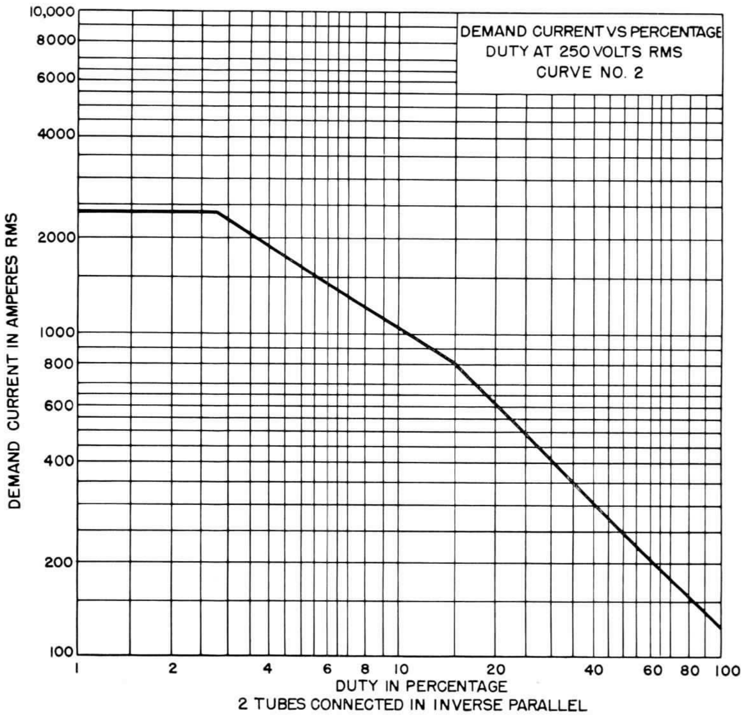
MAXIMUM AVERAGING TIME = 10 SECONDS

$\frac{\text{I AVERAGE}}{\text{I PEAK}}$ MAXIMUM AVERAGING TIME 0.2 SECOND = 0.66 MAXIMUM

$\frac{\text{I FAULT}}{\text{I PEAK MAX}}$ MAXIMUM DURATION OF FAULT CURRENT 0.15 SECOND = 12.5 MAXIMUM

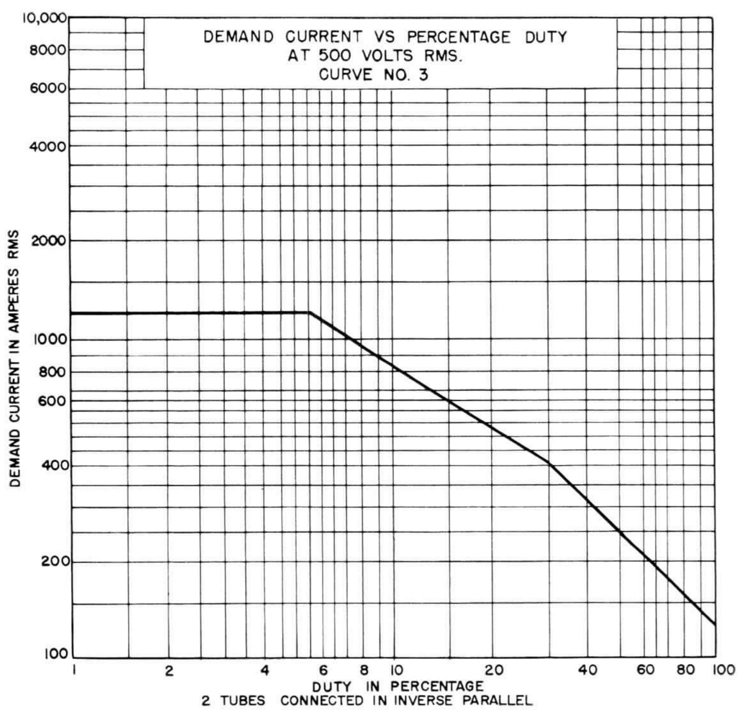


K-69087-72A861 7-11-58



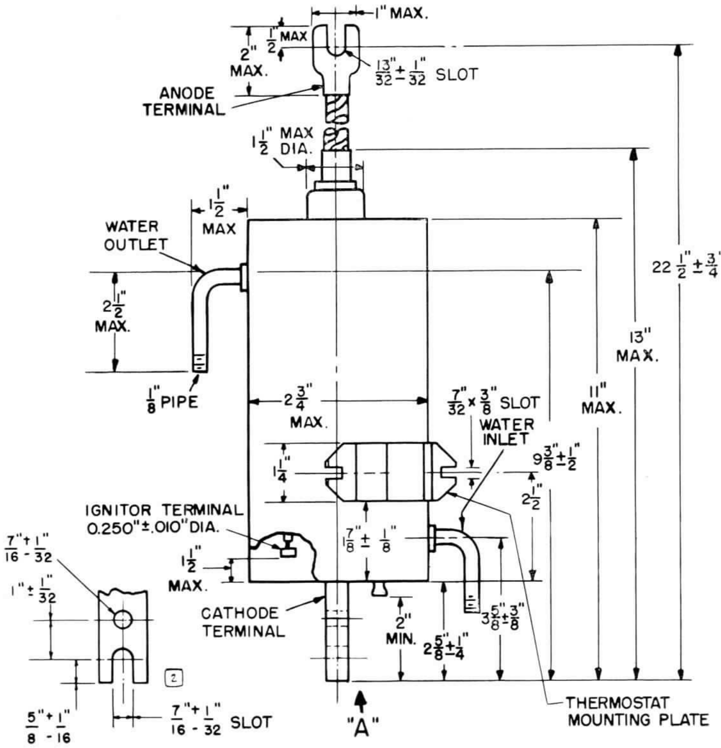
AVERAGING TIME = 18 SECONDS

K-69087-72A864 7-11-58

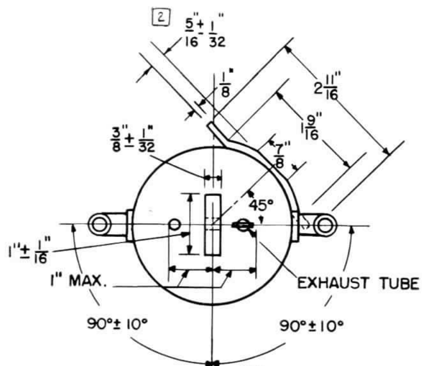


AVERAGING TIME = 9 SECONDS

K-69087-72A867 7-11-58



NOTE: ENVELOPE IS AT CATHODE POTENTIAL



VIEW AT "A"

N-22005-AZ

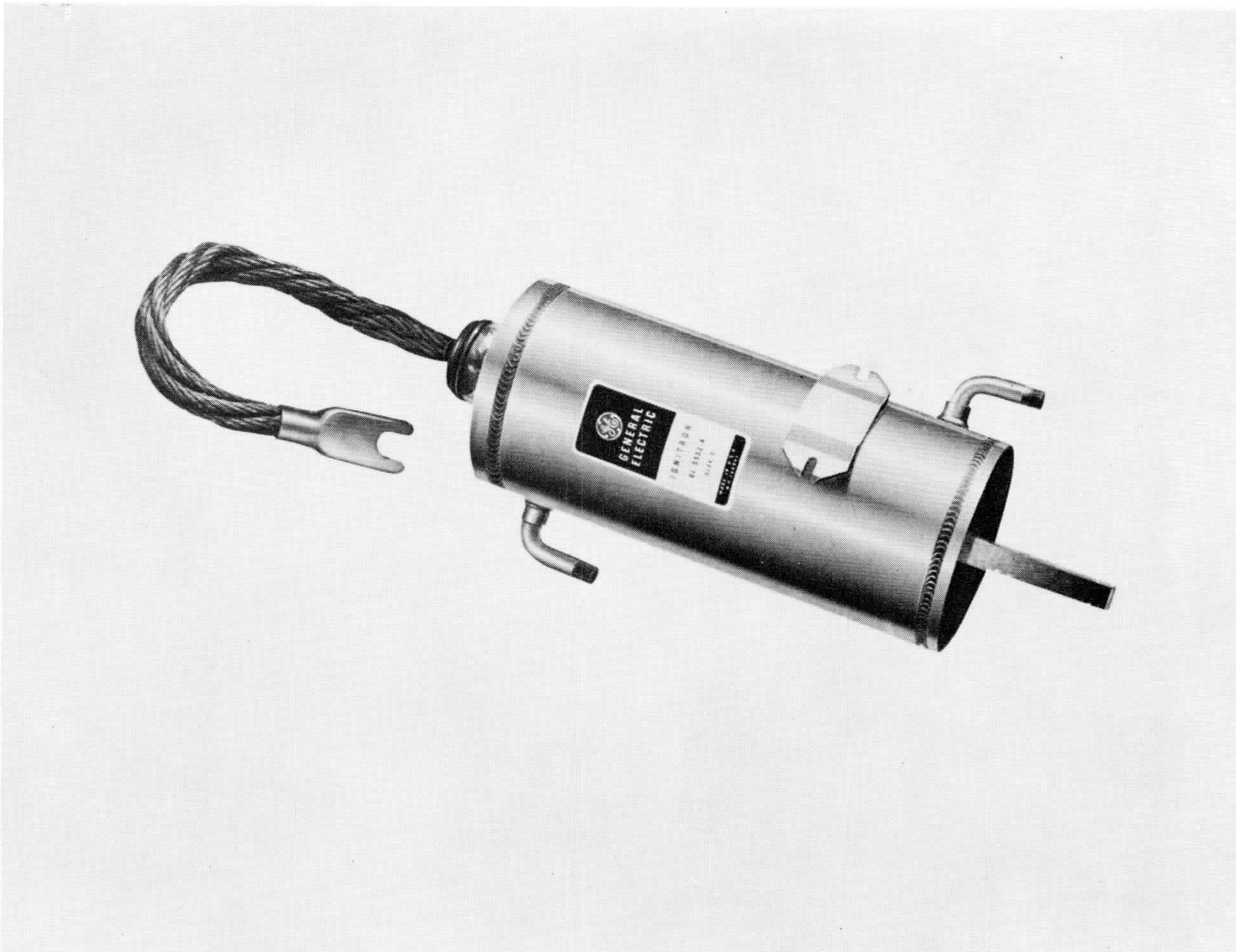
7-28-60

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.

PRINTED IN U.S.A.



IGNITRON

ADAPTED TO WATER-FLOW CONTROL
RECTIFIER SERVICE—100 AMPERES

ADAPTED TO TEMPERATURE CONTROL
AC CONTROL SERVICE—140 AMPERES

The GL-5552-A is a sealed, stainless-steel-jacketed, water-cooled ignitron for a-c control service. In such application two tubes in inverse-parallel connection will control 1200 kilovolt-amperes at voltages of 250 to 600 over a frequency range of 25 to 60 cycles.

The tube is identical in rating and size to the GL-5552/FG-235-A for which it is a direct replacement. The new tube, however, has the advantage of providing for simple, economical, and effective control of tube temperature and cooling-water flow. A copper plate on the tube envelope in thermal contact with the inner cylinder of the tube is maintained at substantially the same temperature as the inner cylinder. This plate is slotted to permit convenient mounting of a thermostat which on a single tube will either provide over-temperature protection or temperature control through regulation of the water flow.

Since the tubes are used in pairs, thermostats mounted on both tubes will provide both protection against excessive temperature and regulation of water flow. Advantages of the control feature include reduction of condensation on the tube walls during hot weather, protection against overloads, elimination of water supply as a limiting factor in equipment location, and appreciable savings in water consumption.

GENERAL ELECTRIC

Supersedes ET-T1220A dated 12-56

GENERAL

Electrical

Cathode Excitation—Cyclic		
Cathode Spot Starting—Ignitor		
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Ignitors	1	
Arc Drop at 6800 Peak Amperes	28	Volts
Arc Drop at 440 Peak Amperes	14	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	200	Volts
Ignitor Current Required to Fire	30	Amperes
Starting Time at Required Voltage or Current	100	Microseconds

Mechanical

Envelope Material—Stainless Steel		
Over-all Length	14	Inches
Over-all Width	4¼	Inches
Net Weight	8	Pounds

Thermal

Type of Cooling—Water		
Inlet Water Temperature		
Maximum	30	C
Minimum	0	C
Outlet Water Temperature, maximum	40	C
Water Flow, minimum, solenoid water valve open	1.5	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	6	C
Pressure Drop at 1.5 Gallons per Minute, maximum	4.5	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

AC Control Service*

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	250 to 600	Volts RMS
Maximum Demand	1200	Kilovolt-Amperes
Average Current at Maximum Demand	75.6	Amperes
Maximum Average Current	140	Amperes
Demand at Maximum Average Current	400	Kilovolt-Amperes
Maximum Averaging Time at 250 Volts RMS	14	Seconds
Maximum Averaging Time at 600 Volts RMS	5.8	Seconds
Maximum Peak Fault Current at 250 Volts	13,450	Amperes
Maximum Peak Fault Current at 600 Volts	5600	Amperes
Frequency Range	25–60	Cycles per Second

Power-Rectifier Service, Intermittent Duty

Ratings are for Zero Phase-Control Angle

Ratings Apply Only at Inlet Water Temperatures Up to 30 C

Maximum Peak Anode Voltage		
Inverse	500	Volts
Forward	500	Volts
Maximum Anode Current		
Peak	1600	Amperes
Average	100	Amperes
Maximum Averaging Time	6	Seconds
Fault	6000	Amperes
Maximum Duration of Fault Current	0.15	Seconds
Frequency Range	25–60	Cycles per Second

Ignitor

Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
Root Mean Square	10	Amperes
Average	1	Amperes
Maximum Averaging Time	5	Seconds

* RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. For voltages below the minimum, the minimum-voltage current rating applies. With the use of log-log paper straight-line interpolation between tabulated points may be used for other detailed ratings of: Demand kva vs average anode current, and maximum averaging time vs anode voltage.

Control thermostats, with mounting brackets, are available through regular tube supply channels under the following catalog numbers:

AC Control Service
- Flying-Lead Type
  - Water-Control Thermostat—N15272AA
  - Over-Temperature Thermostat—N15273AA
- Terminal-Block Type
  - Water-Control Thermostat—N15286AA
  - Over-Temperature Thermostat—N15287AA

See Ignitron Accessories publication in front of Ignitron section for details.

APPLICATION DATA

Since two thermostats are required to achieve both temperature and water control, these features can be obtained in combination only when the tubes are used in pairs, which is normal usage. The application information that follows is based on use of a pair of 5552-A's.

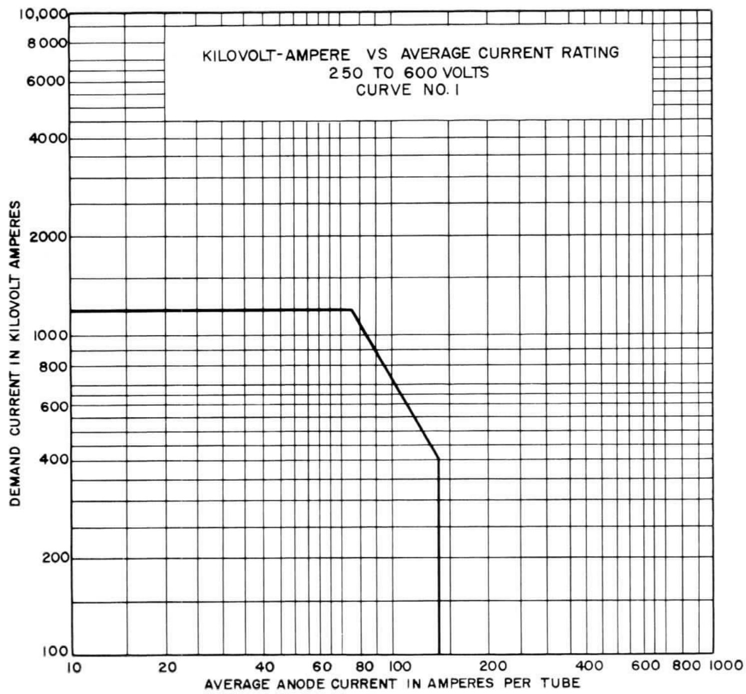
The water-flow thermostat should be mounted on the tube receiving water from the water-supply line; the over-temperature thermostat should be mounted on the other tube.

The water-control thermostat, whose contacts are set to close at 35 C, should be mounted on the tube and connected in series with the electric water valve that provides the cooling water. As long as the tube temperature remains below this value the valve remains closed, preventing water from flowing through the tube. When current is passed through the ignitron its temperature rises and at 35 C the thermostat contacts close, opening the water valve and allowing water to flow. Should the current be reduced, the water will cause the temperature to fall below the 35 C value and the valve will close and stop the water flow.

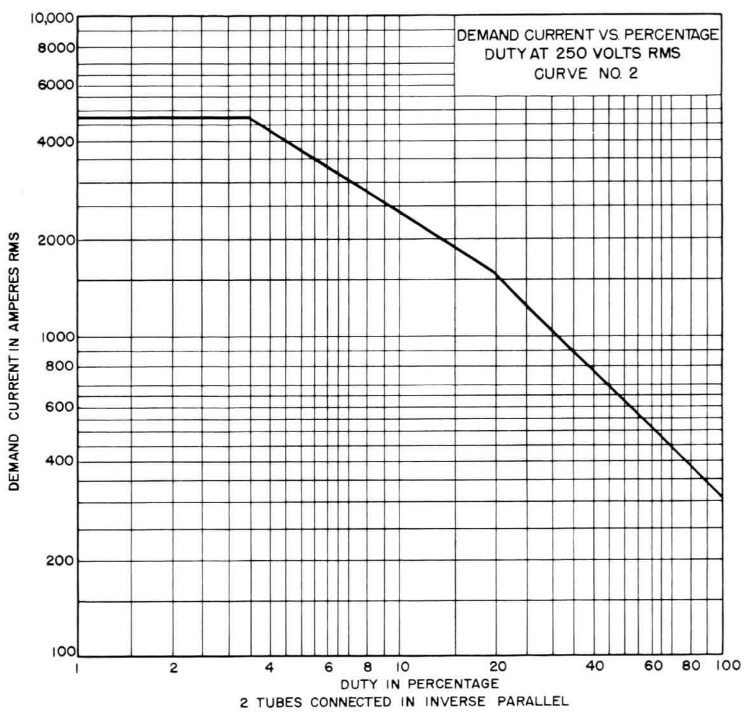
The over-temperature thermostat provides an additional protection should the water flow be interrupted or the water-supply valve fail to open. It operates under emergency conditions to remove power from the ignitrons before they reach an excessive temperature. This thermostat is set to open its contacts at 52 C.

Appreciable time is required for the mechanism of the thermostats to reach the temperature of the copper plate on the tube. Heavy currents at high percentage duty passing through the tubes will cause their temperatures to rise more rapidly than the action of the thermostat. Where heavy loads are likely to exist, an auxiliary contact should be provided to start water flow as soon as current flows. The curves on page four show the region of operation when this precaution must be provided for.

When the control thermostats are used with this tube, care must be taken that the cooling water has completely filled the tube before it is operated. This will prevent damage to the tube by arc-backs caused by rapid tube heating before the thermostats can function.

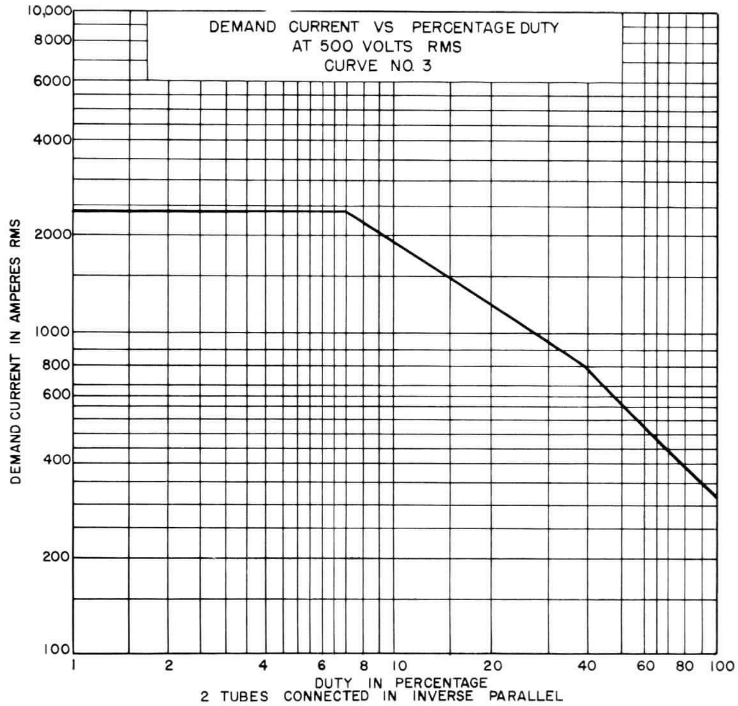


K-69087-72A862 7-11-58



AVERAGING TIME = 14 SECONDS

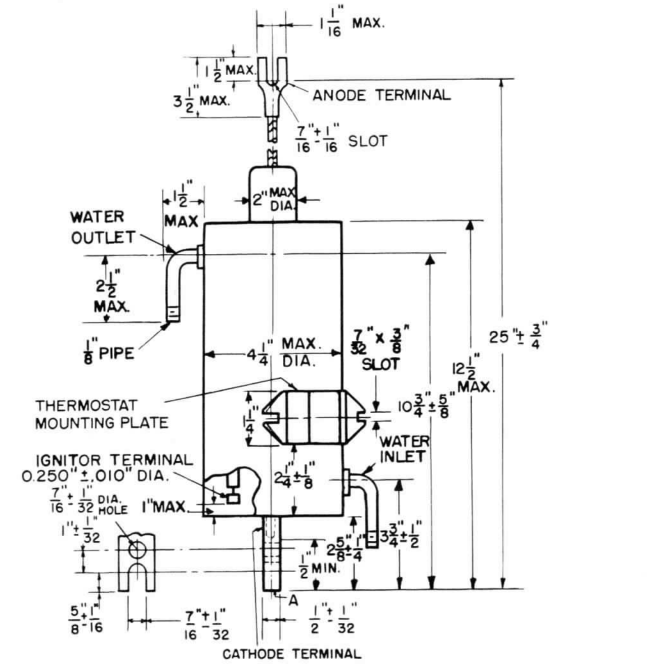
K-69087-72A865 7-11-58



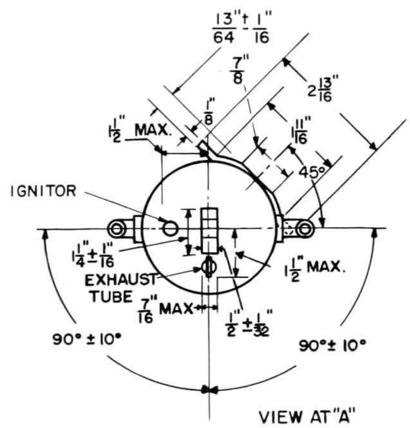
AVERAGING TIME = 7.1 SECONDS

K-69087-72A868

7-11-58



NOTE: ENVELOPE IS AT CATHODE POTENTIAL



VIEW AT "A"

N-22028-AZ

8-11-60

GENERAL ELECTRIC
POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

IGNITRON

ADAPTED TO WATER-FLOW CONTROL RECTIFIER SERVICE—190 AMPERES

ADAPTED TO TEMPERATURE CONTROL AC CONTROL SERVICE—355 AMPERES

The GL-5553-B is a sealed, stainless-steel jacketed, water-cooled ignitron for a-c control service. In such application two tubes in inverse-parallel connection will control 2400 kilovolt-amperes at voltages of 250 to 600 over a frequency range of 25 to 60 cycles.

This tube is identical in rating and size to the GL-5553-A for which it is a direct replacement. The new tube, however, has the advantage of providing for simple, economical, and effective control of tube temperature and cooling-water flow.

A copper plate on the tube envelope in thermal contact with the inner cylinder of the tube is maintained at substantially the same temperature as the inner cylinder. This plate is slotted to permit convenient mounting of a thermostat which on a single tube will either provide over-temperature protection or temperature control through regulation of the water flow.

Thermostats mounted on two tubes will provide both protection against excessive temperature and regulation of water flow. Advantages of the control feature include reduction of condensation on the tube walls during hot weather, protection against overload, elimination of water supply as a limiting factor in equipment location, and appreciable saving in water consumption.

GENERAL ELECTRIC

Supersedes ET-T1221A dated 12-56

GENERAL

Electrical

Cathode Excitation—Cyclic		
Cathode Spot Starting—Ignitor		
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Ignitors	1	
Arc Drop at 13,600 Peak Amperes	36	Volts
Arc Drop at 1115 Peak Amperes	17	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	200	Volts
Ignitor Current Required to Fire	30	Amperes
Starting Time at Required Voltage or Current	100	Microseconds

Mechanical

Envelope Material—Stainless Steel		
Over-all Length	19½	Inches
Over-all Width	5⅝	Inches
Net Weight	21	Pounds

Thermal

Type of Cooling—Water		
Inlet Water Temperature, minimum	0	C
Outlet Water Temperature, maximum	40	C
Water Flow, minimum, solenoid water valve open	3.0	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise, maximum	9	C
Pressure Drop at 3 Gallons per Minute, maximum	5.1	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

AC Control Service*

Two Tubes in Inverse Parallel, Ratings per Tube

(See Curves K-69087-72A723 and K-69087-72A724 for details)

Voltage	250 to 600	Volts RMS
Maximum Demand	2400	Kilovolt-Amperes
Average Current at Maximum Demand	192	Amperes
Maximum Average Current	355	Amperes
Demand at Maximum Average Current	800	Kilovolt-Amperes
Maximum Averaging Time at 220 Volts RMS	12.5	Seconds
Maximum Averaging Time at 600 Volts RMS	4.6	Seconds
Maximum Peak Fault Current at 250 Volts	27,000	Amperes
Maximum Peak Fault Current at 600 Volts	11,200	Amperes
Frequency Range	25–60	Cycles per Second

Power-Rectifier Service, Intermittent Duty

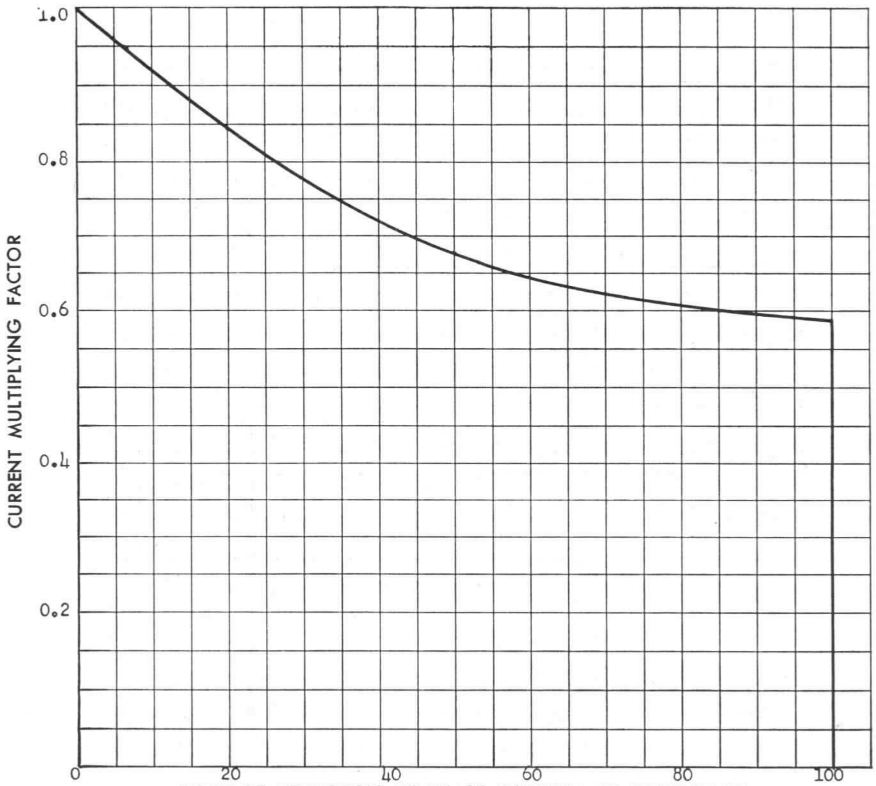
Ratings are for Zero-Phase-Control Angle

(See Curves K-69087-72A513 and K-69087-72A630 for details)

Ratings Apply Only at Inlet Water Temperatures Up to 40 C

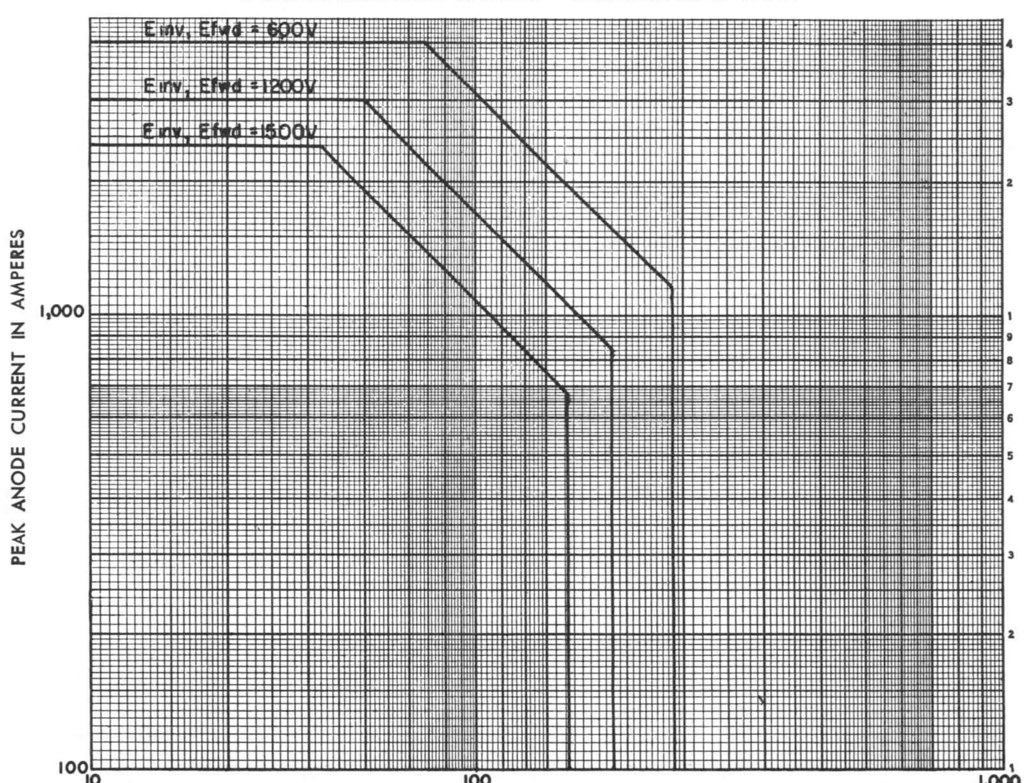
Maximum Peak Anode Voltage				
Inverse	600	1200	1500	Volts
Forward	600	1200	1500	Volts
Maximum Anode Current				
Peak	4000	3000	2400	Amperes
Corresponding Average	54	40	32	Amperes
Average	190	140	112	Amperes
Corresponding Peak	1140	840	672	Amperes
Maximum Averaging Time	6.23	6.25	6.25	Seconds
Ratio of Average to Peak Current, maximum				
Averaging Time 0.2 Second	0.166	0.166	0.166	
Ratio of Fault to Maximum Peak Current	12.5	12.5	12.5	
Maximum Duration of Fault Current	0.15	0.15	0.15	Seconds
Frequency Range	50–60	50–60	50–60	Cycles per Second

PHASE CONTROL
THREE-PHASE SINGLE-WAY
DOUBLE-WAY CIRCUITS



K-69087-72A513 8-21-53

POWER-RECTIFIER RATING—INTERMITTENT DUTY

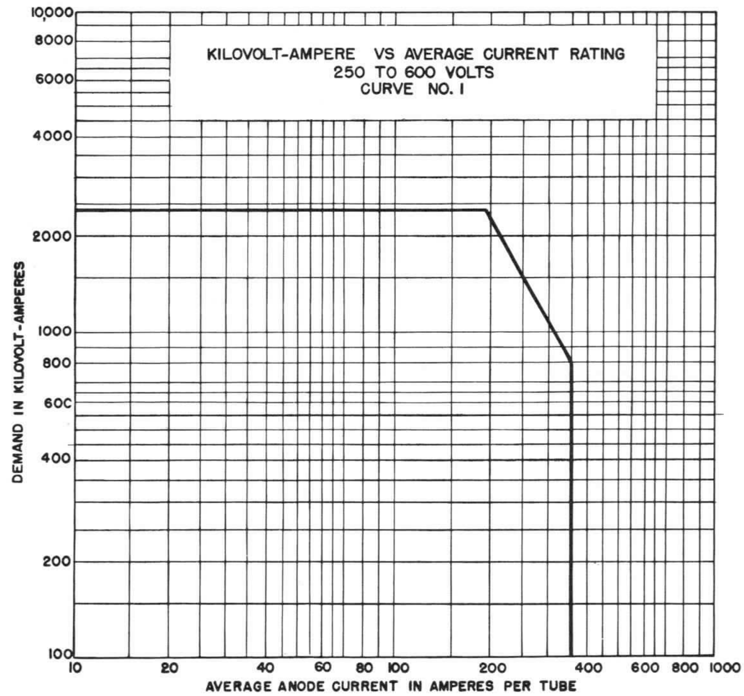


K-69087-72A630 9-21-55

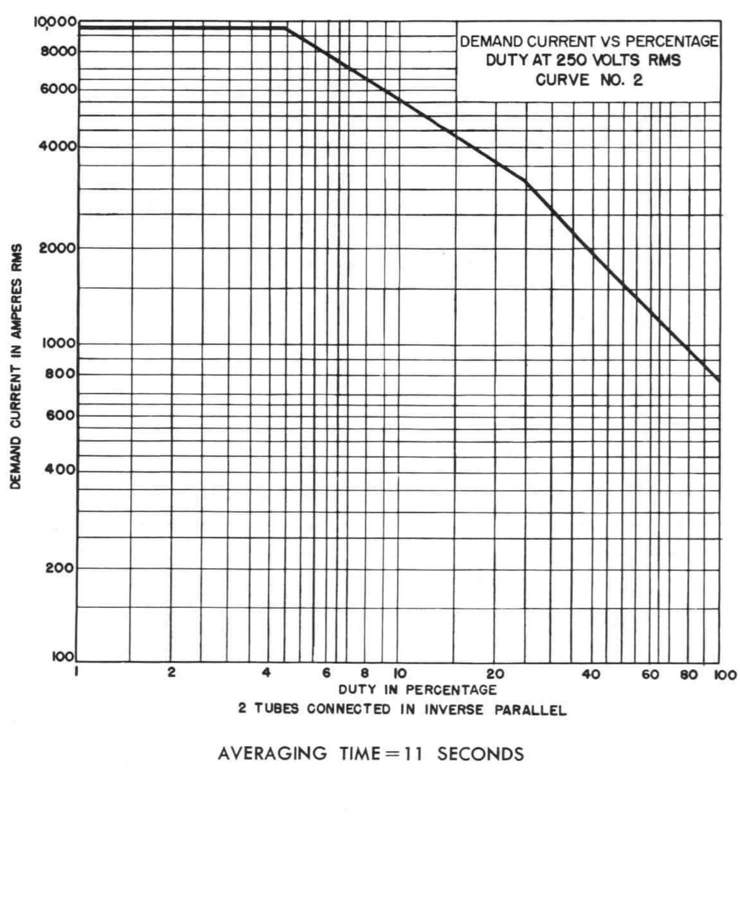
MAXIMUM AVERAGING TIME = 6.25 SECONDS

$\frac{\text{I AVERAGE}}{\text{I PEAK}}$ MAXIMUM AVERAGING TIME 0.2 SECONDS = 0.166 MAXIMUM

$\frac{\text{I FAULT}}{\text{I PEAK MAX.}}$ MAXIMUM DURATION OF FAULT CURRENT 0.15 SECONDS = 12.5 MAXIMUM

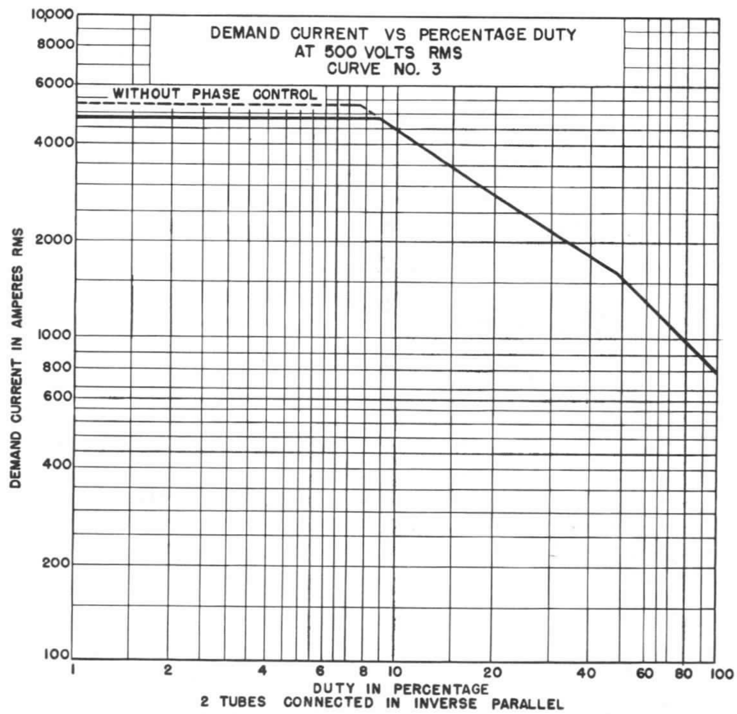


K-69087-72A217 7-11-58



AVERAGING TIME = 11 SECONDS

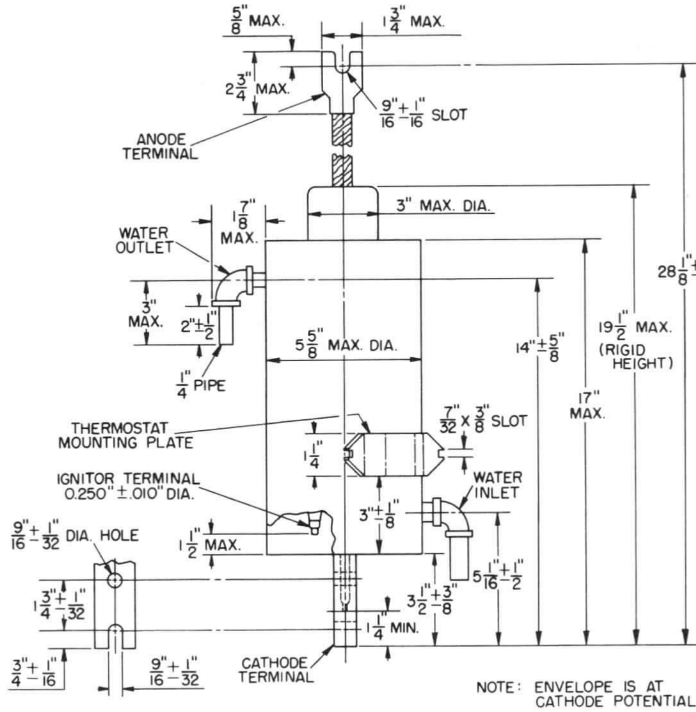
K-69087-72A218 7-11-58

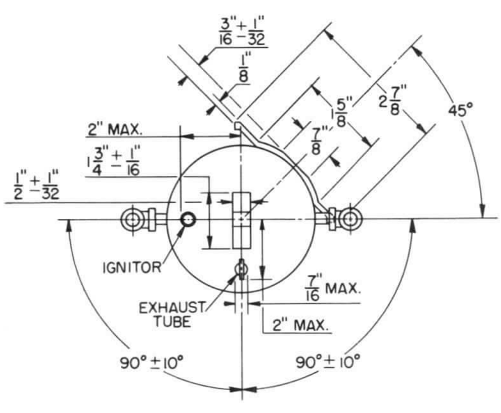


AVERAGING TIME = 5.6 SECONDS

K-69087-72A219

7-11-58





TUBE DEPARTMENT

GENERAL ELECTRIC

SCHENECTADY, N.Y. 12305

PRINTED IN U.S.A.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-5554

Technical data on tube type GL-5554 is filed in the "Rectifier Ignitrons" section of this manual.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-5555

Technical data on tube type GL-5555 is filed in the "Rectifier Ignitrons" section of this manual.

INDUSTRIAL EQUIPMENT TYPES MANUAL

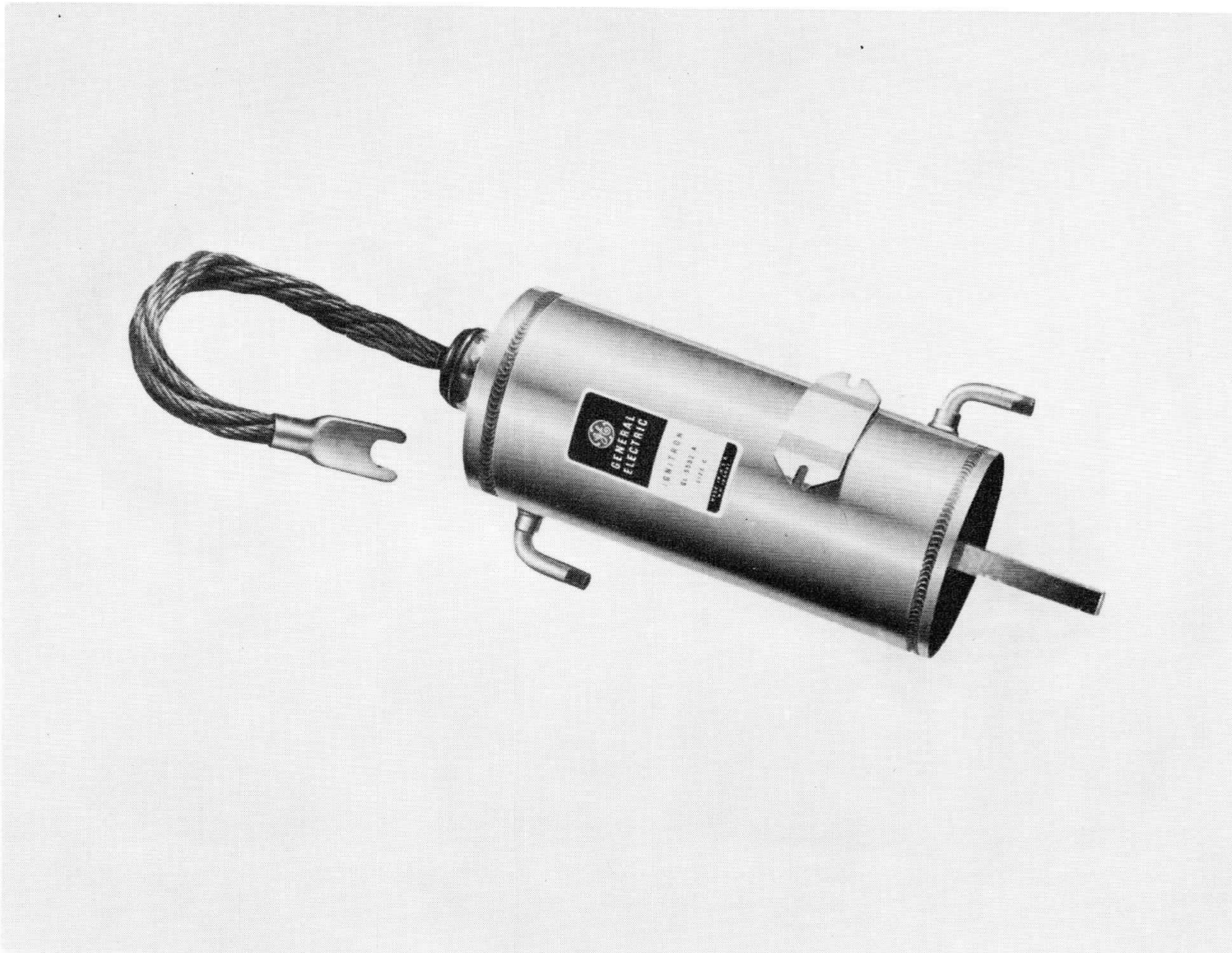
GL-5564

Technical data on tube type GL-5564 is filed in the "Rectifier Ignitrons" section of this manual.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-5788

Technical data on tube type GL-5788 is filed in the "Rectifier Ignitrons" section of this manual.



IGNITRON

ADAPTED TO WATER-FLOW CONTROL FREQUENCY-CHANGER WELDING SERVICE

ADAPTED TO TEMPERATURE CONTROL POWER-RECTIFIER SERVICE

The GL-5822-A ignitron is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube designed particularly for use in frequency-changer resistance welders. It is also suitable for use in power-rectifier service. The frequency-changer method converts three-phase 60-cycle power to single-phase power at four to twelve cycles per second. A particular advantage of this method is the appreciable reduction of kilovolt-ampere demand from that required in single-phase welding, with consequent saving in the amount of power required. In addition, the three-phase circuit balances the power load and makes possible improved results in welding aluminum, magnesium, and their alloys.

The tube is identical in rating and size to the GL-5822 for which it is a direct replacement. The new tube, however, has the advantage of providing for simple, economical, and effective control of tube temperature and cooling-water flow. A copper plate on the tube envelope in thermal contact with the inner cylinder of the tube is maintained at substantially the same temperature as the inner cylinder. This plate is slotted to permit convenient mounting of a thermostat which on a single tube will either provide over-temperature protection or temperature control through regulation of the water flow.

A feature of the GL-5822-A is the use of baffles which reduce deionization time and assure satisfactory operation under the severe conditions of commutation imposed by the service for which the tube is designed. Other design features are an ignitor adapted to intermittent service, and a helical water guide to assure uniform cooling.

GENERAL ELECTRIC

Supersedes ET-T1351 dated 12-56

GENERAL

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Ignitors	1	
Arc Drop at 1500 Amperes Peak	25	Volts
Cathode Excitation Requirements		
Ignitor Voltage Required to Fire	200	Volts
Ignitor Current Required to Fire	30	Amperes
Starting Time at Required Voltage or Current	100	Microseconds

Mechanical

Envelope Material—Stainless Steel

Over-all Length	14	Inches
Over-all Width	$4\frac{1}{4}$	Inches
Net Weight, approximate	$8\frac{1}{4}$	Pounds

Thermal

Type of Cooling—Water

Inlet Water Temperature, minimum	10	C
Outlet Water Temperature, maximum	35	C
Water Flow, Minimum		
At Continuous Rated Average Current	1.5	Gallons per Minute
At No Load	0.5	Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow		
Water Temperature Rise	6	C
Pressure Drop at 1.5 Gallon per Minute, maximum	5	Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Frequency-Changer Resistance Welding Service or Power-Rectifier Service—Intermittent Duty

Ratings are for zero-phase-control angle (see Curve K-69087-72A316 for details).

Maximum Peak Anode Voltage			
Inverse	1200	1500	Volts
Forward	1200	1500	Volts
Maximum Anode Current*			
Peak	1500	1200	Amperes
Corresponding Average	20	16	Amperes
Average	70	56	Amperes
Corresponding Peak	420	336	Amperes
Maximum Averaging Time	6.25	6.25	Seconds
Ratio of Average to Peak Current	0.166	0.166	
Maximum Averaging Time	0.2	0.2	Seconds
Ratio of Fault to Maximum Peak Current	12.5	12.5	
Maximum Duration of Fault Current	0.15	0.15	Seconds
Frequency Range	50–60	50–60	Cycles per Second

Ignitor

Maximum Voltage
Positive—Anode Voltage

Negative	5	Volts
Maximum Current		
Peak	100	Amperes
Root Mean Square	10	Amperes
Average	1	Amperes
Maximum Averaging Time	5	Seconds

* Straight line interpolation on log-log paper is allowed between corresponding points.

Control thermostats, with mounting brackets, are available through regular tube supply channels under the following catalog numbers:

AC Control Service
- Flying-Lead Type
  - Water-Control Thermostat—N15272AA
  - Over-Temperature Thermostat—N15273AA
- Terminal-Block Type
  - Water-Control Thermostat—N15286AA
  - Over-Temperature Thermostat—N15287AA

See Ignitron Accessories publication in front of Ignitron section for details.

APPLICATION DATA

Since two thermostats are required to achieve both temperature and water control, these features can be obtained in combination only when the tubes are used in pairs, which is normal usage. The application information that follows is based on use of a pair of 5822-A's.

The water-flow thermostat should be mounted on the tube receiving water from the water-supply line; the over-temperature thermostat should be mounted on the other tube.

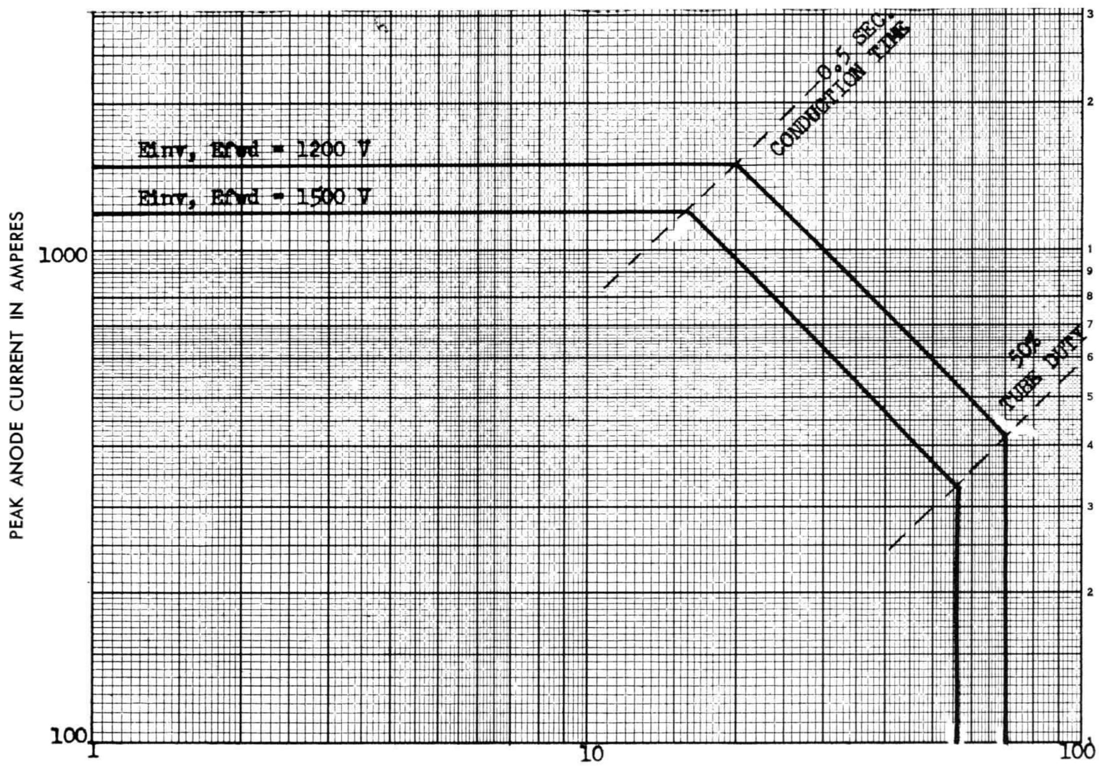
The water-control thermostat, whose contacts are set to close at 35 C, should be mounted on the tube and connected in series with the electric water valve that provides the cooling water. As long as the tube temperature remains below this value the valve remains closed, preventing water from flowing through the tube. When current is passed through the ignitron its temperature rises and at 35 C the thermostat contacts close, opening the water valve and allowing water to flow. Should the current be reduced, the water will cause the temperature to fall below the 35 C value and the valve will close and stop the water flow.

The over-temperature thermostat provides an additional protection should the water flow be interrupted or the water-supply valve fail to open. It operates under emergency conditions to remove power from the ignitrons before they reach an excessive temperature. This thermostat is set to open its contacts at 52 C.

Appreciable time is required for the mechanism of the thermostats to reach the temperature of the copper plate on the tube. Heavy currents at high percentage duty passing through the tubes will cause their temperatures to rise more rapidly than the action of the thermostat. Where heavy loads are likely to exist, an auxiliary contact should be provided to start water flow as soon as current flows. The curves on page four show the region of operation when this precaution must be provided for.

When the control thermostats are used with this tube, care must be taken that the cooling water has completely filled the tube before it is operated. This will prevent damage to the tube by arc-backs caused by rapid tube heating before the thermostats can function.

FREQUENCY-CHANGER RESISTANCE WELDING SERVICE
OR
POWER RECTIFIER SERVICE—INTERMITTENT DUTY



AVERAGE ANODE CURRENT IN AMPERES PER TUBE

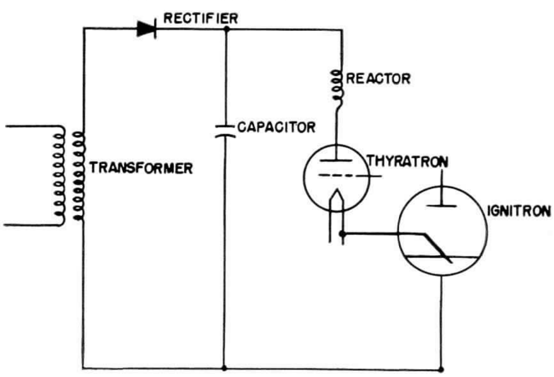
K-69087-72A316 3-20-63

MAXIMUM AVERAGING TIME = 6.25 SECONDS

$\frac{\text{AVERAGE CURRENT}}{\text{PEAK CURRENT}}$ MAXIMUM AVERAGING TIME 0.2 SECOND = 0.166 MAXIMUM

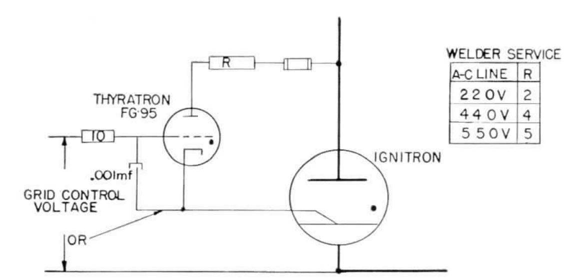
$\frac{\text{SURGE CURRENT}}{\text{PEAK CURRENT}}$ MAXIMUM DURATION OF FAULT CURRENT 0.15 SECOND = 12.5 MAXIMUM

ELEMENTARY CIRCUIT FOR CAPACITOR FIRING

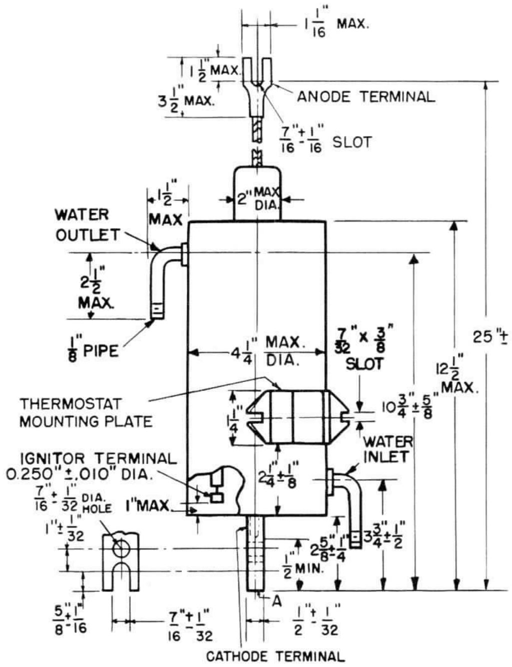


K-9033525 5-25-54

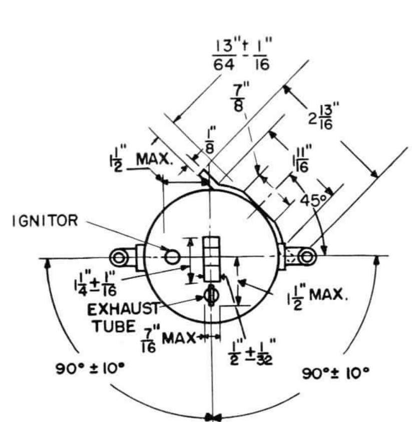
SELF OR ANODE EXCITATION IN WHICH A PART OF THE LOAD CURRENT IS DIVERTED THROUGH THE IGNITOR



K-9033542 12-6-44



NOTE: ENVELOPE IS AT CATHODE POTENTIAL



VIEW AT "A"

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.

PRINTED IN U.S.A.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-6512

Technical data on tube type GL-6512 is filed in the "Rectifier Ignitrons" section of this manual.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-6513

Technical data on tube type GL-6513 is filed in the"Rectifier Ignitrons" section of this manual.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-6514

Technical data on tube type GL-6514 is filed in the "Rectifier Ignitrons" section of this manual.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-6515

Technical data on tube type GL-6515 is filed in the "Rectifier Ignitrons" section of this manual.

GL-7151
IGNITRON

THERMOSTAT BRACKET HIGH-EFFICIENCY COOLING
AC CONTROL SERVICE—900 AMPERES

The GL-7151 is a sealed water-cooled ignitron with a stainless-steel jacket for a-c control service. In such application two tubes in an inverse-parallel connection will control 4800 kilovolt-amperes at voltages of 250 to 500 volts over a frequency range of 25 to 60 cycles. The water-cooling chamber is especially designed to provide high-efficiency cooling at the bottom of the tube without increasing the water pressure drop of the cooling jacket.

ELECTRICAL

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1	
Main Cathodes	1	
Ignitors	1	

MECHANICAL

Envelope Material—Stainless Steel

Net Weight	70	Pounds

Mounting Position—Vertical, Anode Terminal Up

THERMAL

Type of Cooling—Water

Inlet Water Temperature, minimum	0	C
Outlet Water Temperature, maximum	40	C
Water Flow, minimum	10	Gallons per Minute

Water flow should be continued for at least one hour after removal of anode power.

Maximum Working Water Pressure, Non-Shock	100	Pounds per Square Inch

Characteristics at 10 Gallons per Minute

Water Temperature Rise, maximum	8	C
Pressure Drop, maximum	1.5	Pounds per Square Inch

MAXIMUM RATINGS—AC CONTROL SERVICE

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage Range	250 to 600	Volts RMS
Maximum Demand	4800	Kilovolt-Amperes
Corresponding Average Current*	486	Amperes
Maximum Average Current*	900	Amperes
Corresponding Demand	1600	Kilovolt-Amperes
Maximum Demand Current Below 500 Volts*	9600	Amperes RMS
Maximum Peak Fault Current		
At 250 Volts	54,000	Amperes
At 600 Volts	22,400	Amperes
Frequency Range	25–60	Cycles per Second

Cathode Excitation Requirements

Anode Firing

Ignitor Voltage Required to Fire	200	Volts
Ignitor Current Required to Fire	30	Amperes
Starting Time at Required Voltage or Current	100	Microseconds

Separate Excitation

Pulse Width

Recommended	500	Microseconds
Maximum	4000	Microseconds

When the average anode current is greater than 20 amperes the pulse width must not fall below 150 microseconds.

Maximum Rate of Rise of Ignitor Current	2.5	Amperes per Microsecond

Ignitor

Maximum Voltage

Positive—Anode Voltage

Negative	5	Volts

Maximum Current

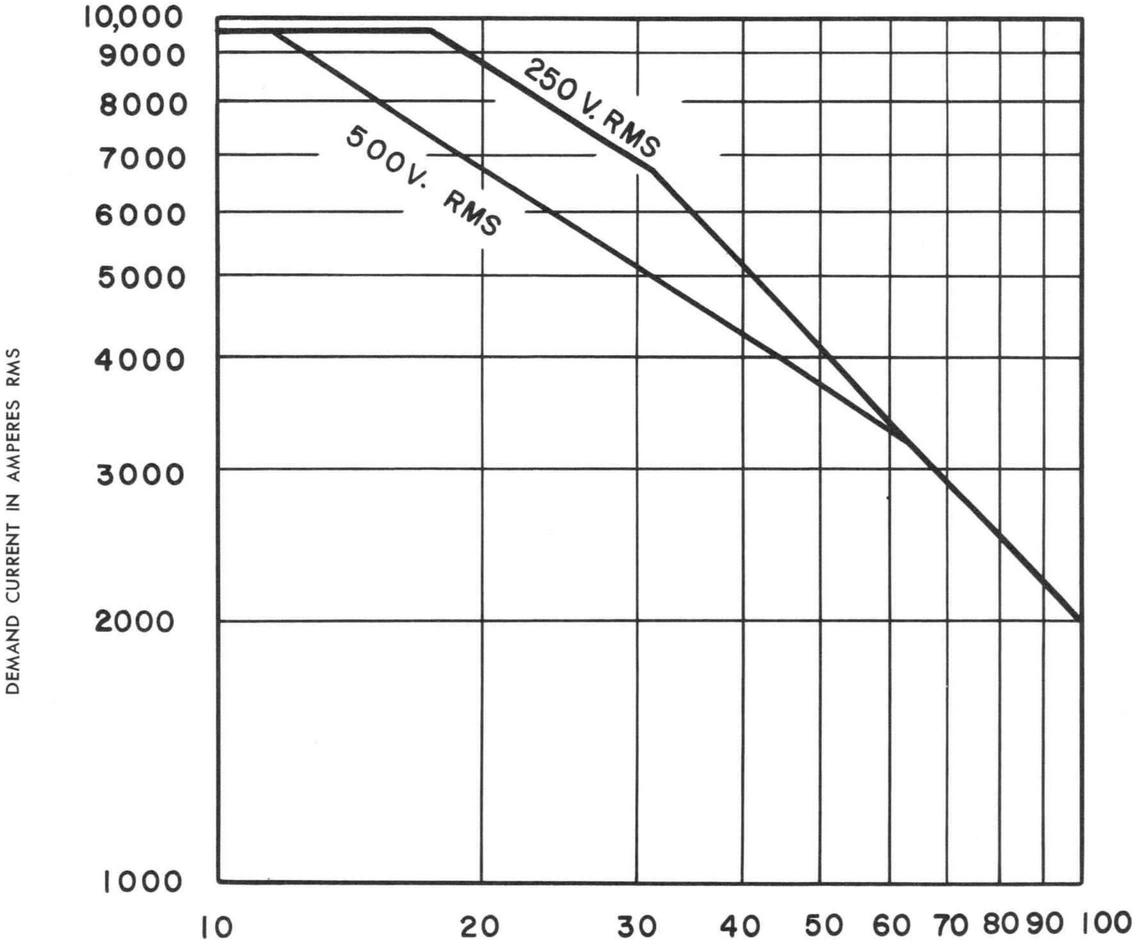
Peak	100	Amperes
Root Mean Square	10	Amperes
Average	1	Ampere
Maximum Averaging Time	5	Seconds

* A concentric current-return path from the cathode terminal to the top of this tube should be provided in installations where high-current conductors, including other ignitrons, are operating within 20 inches of it. This is necessary to prevent the magnetic field established by the high current from disturbing the arc within the GL-7151. This return path can be made by clamping the cathode connection to the top of the tube jacket; or by extending, from the cathode terminal to a bus-bar connection at the top of the tube, four or more equally spaced copper bars placed around the circumference and running the length of the tube. Clean tight connections are necessary for proper conduction of the high currents.

DEMAND CURRENT VS PERCENTAGE DUTY

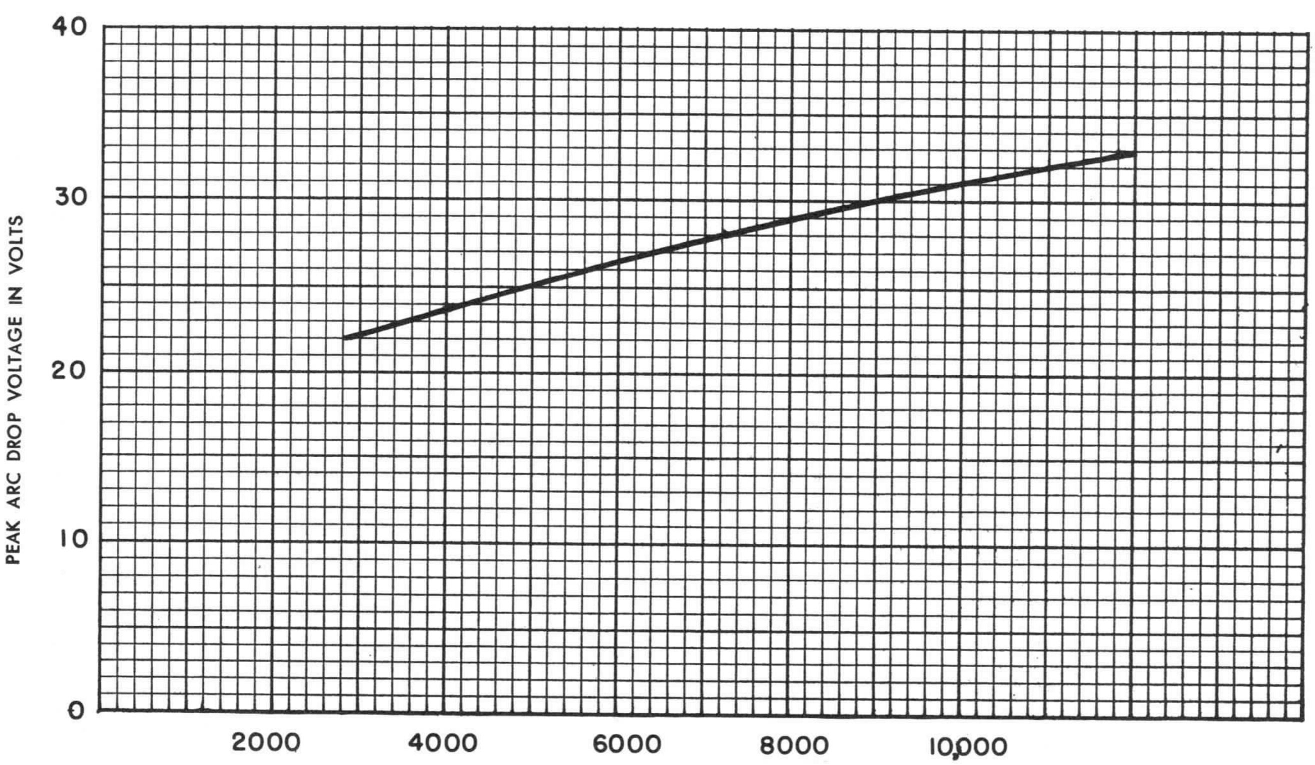
TWO TUBES CONNECTED IN INVERSE PARALLEL

Averaging Time
250 Volts—8.9 Seconds
500 Volts—4.5 Seconds

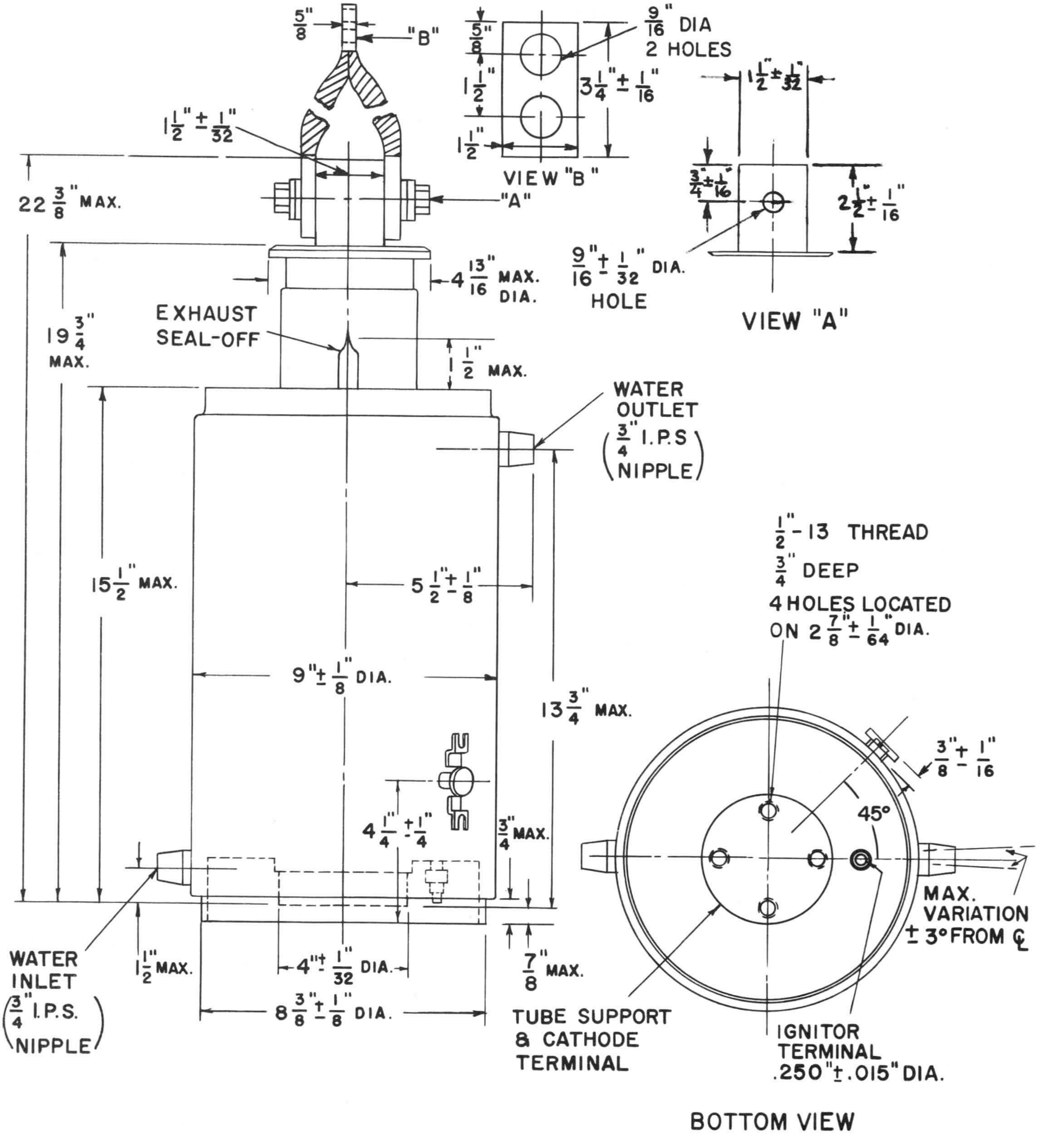


K-69087-72A854 11-6-58

ARC DROP



K-69087-72A847 5-15-58


5"/8
"B"
9"/16 DIA
2 HOLES
5"/8
1 1/2"
3 1/4" ± 1"/16
1 1/2"
VIEW "B"
1 1/2" ± 1"/32
1 1/2" ± 1"/32
22 3/8" MAX.
"A"
3/4 ± 1/16
2 1/2 ± 1"/16
9"/16 ± 1"/32 DIA.
HOLE
VIEW "A"
4 13"/16 MAX. DIA.
19 3/4" MAX.
EXHAUST
SEAL-OFF
1 1"/2 MAX.
WATER
OUTLET
(3"/4 I.P.S
NIPPLE)
15 1"/2 MAX.
5 1"/2 ± 1"/8
9" ± 1"/8 DIA.
13 3"/4 MAX.
4 1"/4 ± 1"/4
3"/4 MAX.
1/2"-13 THREAD
3"/4 DEEP
4 HOLES LOCATED
ON 2 7"/8 ± 1"/64 DIA.
3"/8 ± 1"/16
45°
MAX.
VARIATION
± 3° FROM ℄
WATER
INLET
(3"/4 I.P.S.
NIPPLE)
1 1"/2 MAX.
4" ± 1"/32 DIA.
8 3"/8 ± 1"/8 DIA.
7"/8 MAX.
TUBE SUPPORT
& CATHODE
TERMINAL
IGNITOR
TERMINAL
.250" ± .015" DIA.
BOTTOM VIEW

GENERAL ELECTRIC

POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

PRINTED IN U.S.A.

PRODUCT INFORMATION

IGNITRON

GL-7669

IGNITRON—Coaxial

RECTIFIER SERVICE—40 AMPERES
AC CONTROL SERVICE—56 AMPERES

ADAPTED TO WATER-FLOW CONTROL

The GL-7669 is a sealed, stainless-steel-jacketed, water-cooled ignitron for a-c control service. In such application two tubes in inverse-parallel connection will control 1200 kilovolt-amperes at voltages of 250 to 600 over a frequency range of 25 to 60 cycles.

The 7669 features a new coaxial construction in which current flows through the tube from anode to cathode, then up the tube wall to a coaxial cathode terminal at the top. This coaxial current flow provides a magnetic shield to eliminate the arc deflection which the high peak currents of this tube might cause in standard design ignitrons.

ADAPTED TO TEMPERATURE CONTROL

A slotted mounting plate permits convenient mounting of a thermostat to provide control of the water flow or over-temperature protection.

Advantages of the control feature include reduction of condensation on the tube walls during hot weather, protection against overloads, elimination of water supply as a limiting factor in equipment location, and appreciable savings in water consumption.

Electrical

Cathode Excitation—Cyclic	
Cathode Spot Starting—Ignitor	
Number of Electrodes	
Main Anodes	1
Main Cathodes	1
Ignitors	1
Arc Drop at 3400 Peak Amperes	26 Volts
Arc Drop at 176 Peak Amperes	13 Volts

Mechanical

Envelope Material—Stainless Steel	
Over-all Length	10¼ Inches
Over-all Width	3¼ Inches
Net Weight	3.6 Pounds

Thermal

Type of Cooling—Water	
Inlet Water Temperature, minimum	0 C
Inlet Water Temperature, maximum	30 C
Outlet Water Temperature, maximum	40 C
Water Flow, minimum, solenoid water valve open	1.0 Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow	
Water Temperature Rise, maximum	4 C
Pressure Drop at 1 Gallon per Minute	1.8 Pounds per Square Inch

MAXIMUM RATINGS

Power-Rectifier Service, Intermittent Duty

Ratings are for Zero Phase-Control Angle
(See Curve K-69087-72A310 for Details)
Ratings Apply only at Inlet Water Temperatures up to 40 C

Maximum Peak Anode Voltage				
Inverse	500	1200	1500	Volts
Forward	500	1200	1500	Volts
Maximum Anode Current				
Peak	700	600	480	Amperes
Corresponding Average	—	5	4	Amperes
Average	40	22.5	18	Amperes
Corresponding Peak	—	135	108	Amperes
Maximum Averaging Time	6	10	10	Seconds
Fault	8000	8000	8000	Amperes
Maximum Duration of Fault Current	0.15	0.15	0.15	Second
Ratio of Average to Peak Current, maximum Averaging Time 0.2 Second	—	0.166	0.166	
Ratio of Fault to Maximum Peak Current	12.5	12.5	12.5	
Frequency Range	50–60	50–60	50–60	Cycles per Second

AC Control Service*

Two Tubes in Inverse Parallel, Ratings per Tube

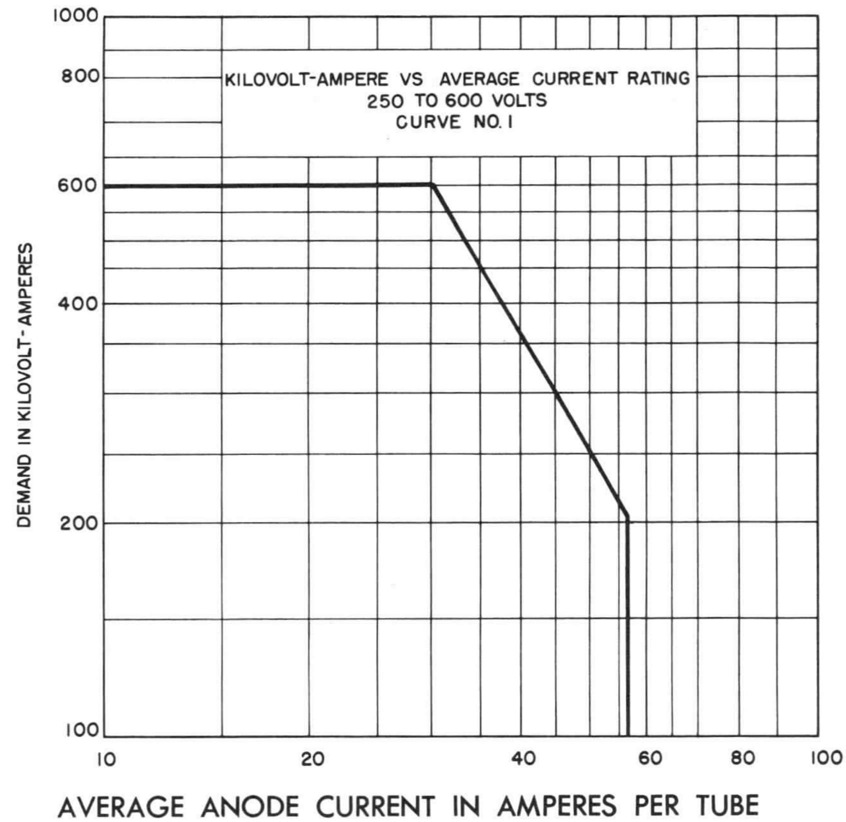
Voltage	250 to 600 Volts RMS
Maximum Demand	600 Kilovolt-Amperes
Average Current at Maximum Demand	30.2 Amperes
Maximum Average Current	56.0 Amperes
Demand at Maximum Average Current	200 Kilovolt-Amperes
Maximum Averaging Time at 250 Volts RMS	18 Seconds
Maximum Averaging Time at 600 Volts RMS	7.5 Seconds
Maximum Peak Fault Current at 250 Volts	6720 Amperes
Maximum Peak Fault Current at 600 Volts	2800 Amperes
Frequency Range	25–60 Cycles per Second

Cathode Excitation Requirements

Ignitor Voltage Required to Fire	200 Volts
Ignitor Current Required to Fire	30 Amperes
Starting Time at Required Voltage or Current	100 Microseconds

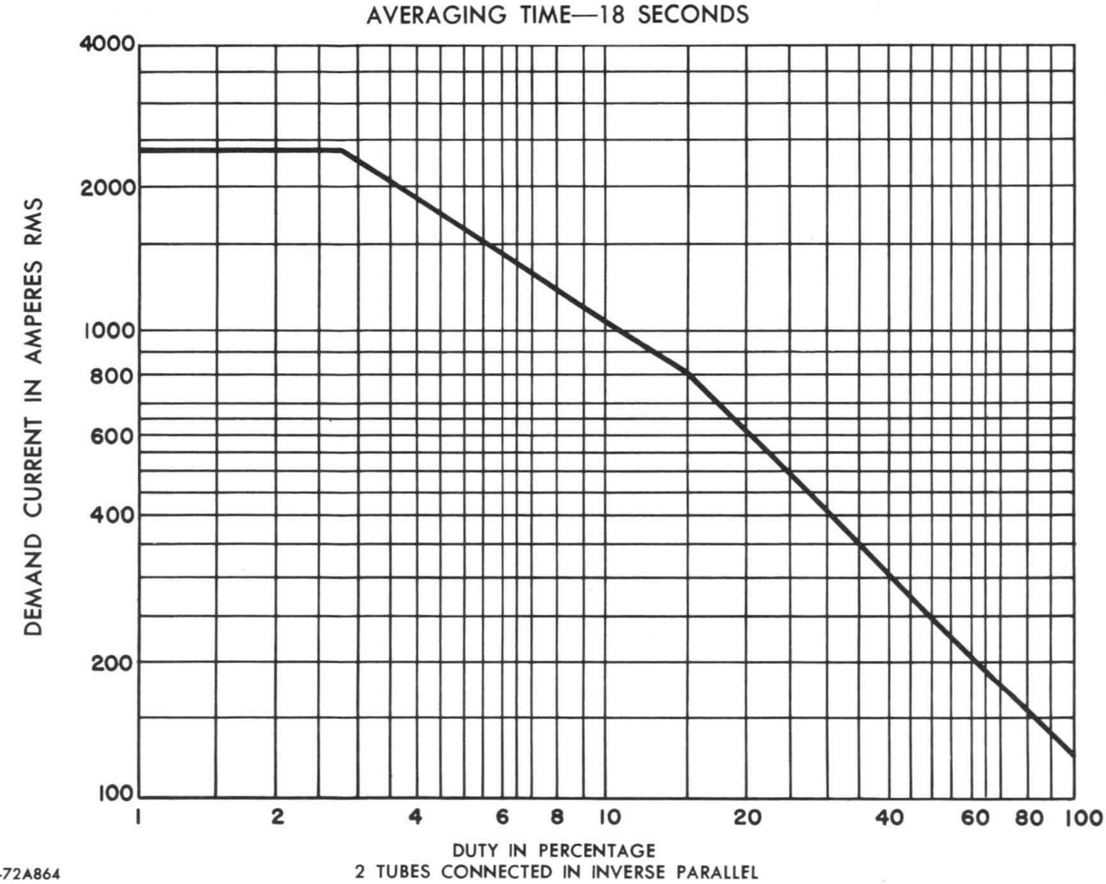
Ignitor	
Maximum Voltage	
Positive—Anode Voltage Negative	5 Volts
Maximum Current	
Peak	100 Amperes
Root Mean Square	10 Amperes
Average	1 Ampere
Maximum Averaging Time	5 Seconds

* RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. For voltages below the minimum, the minimum-voltage current rating applies. With the use of log-log paper straight-line interpolation between tabulated points may be used for other detailed ratings of: Demand kva vs average anode current, and maximum averaging time vs anode voltage.

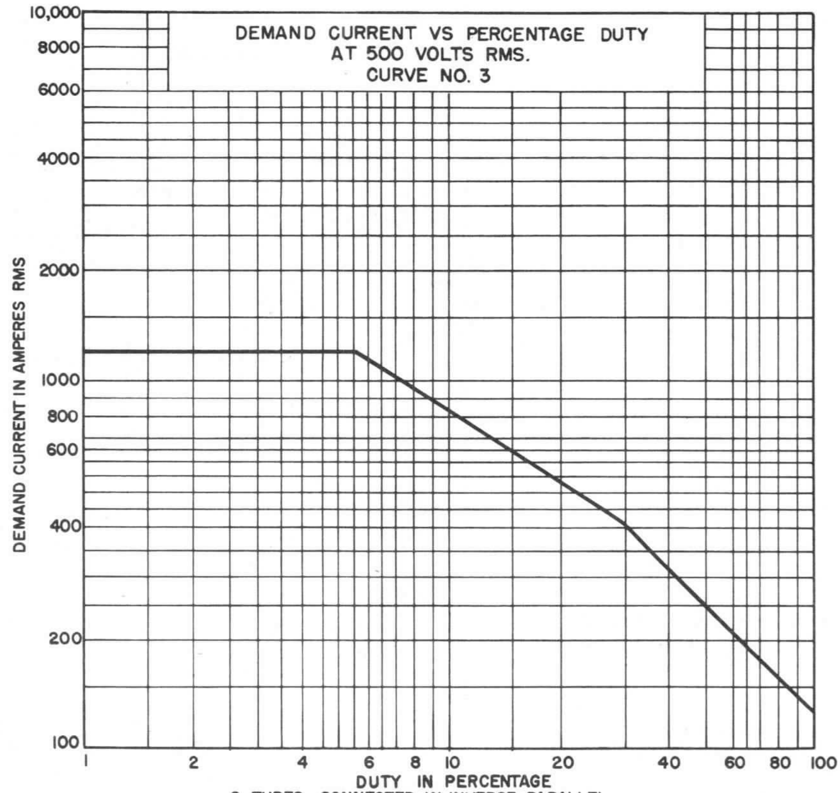


K-69087-72A861 7-11-58

DEMAND CURRENT VS PERCENTAGE DUTY AT 250 VOLTS RMS
AVERAGING TIME—18 SECONDS



K-69087-72A864 7-11-58

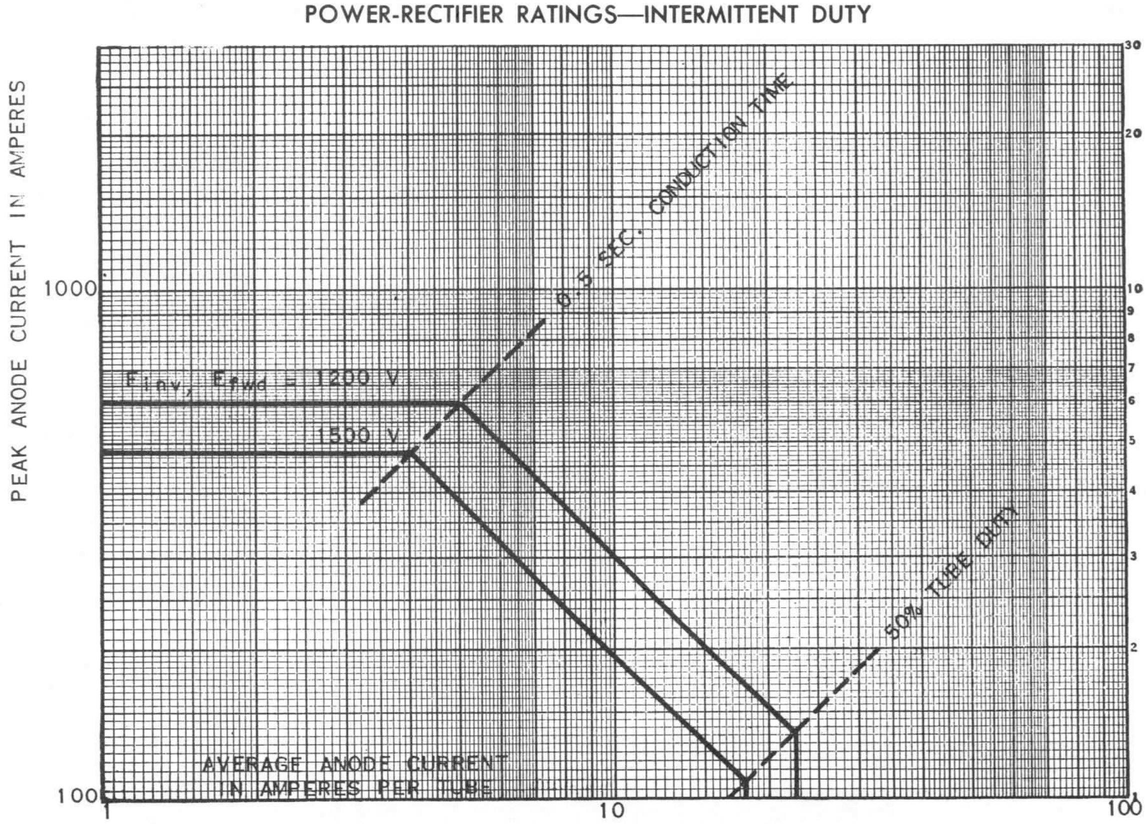


2 TUBES CONNECTED IN INVERSE PARALLEL

Averaging Time=9 Seconds
K-69087-72A867

7-11-58

POWER-RECTIFIER RATINGS—INTERMITTENT DUTY



K-69087-72A310

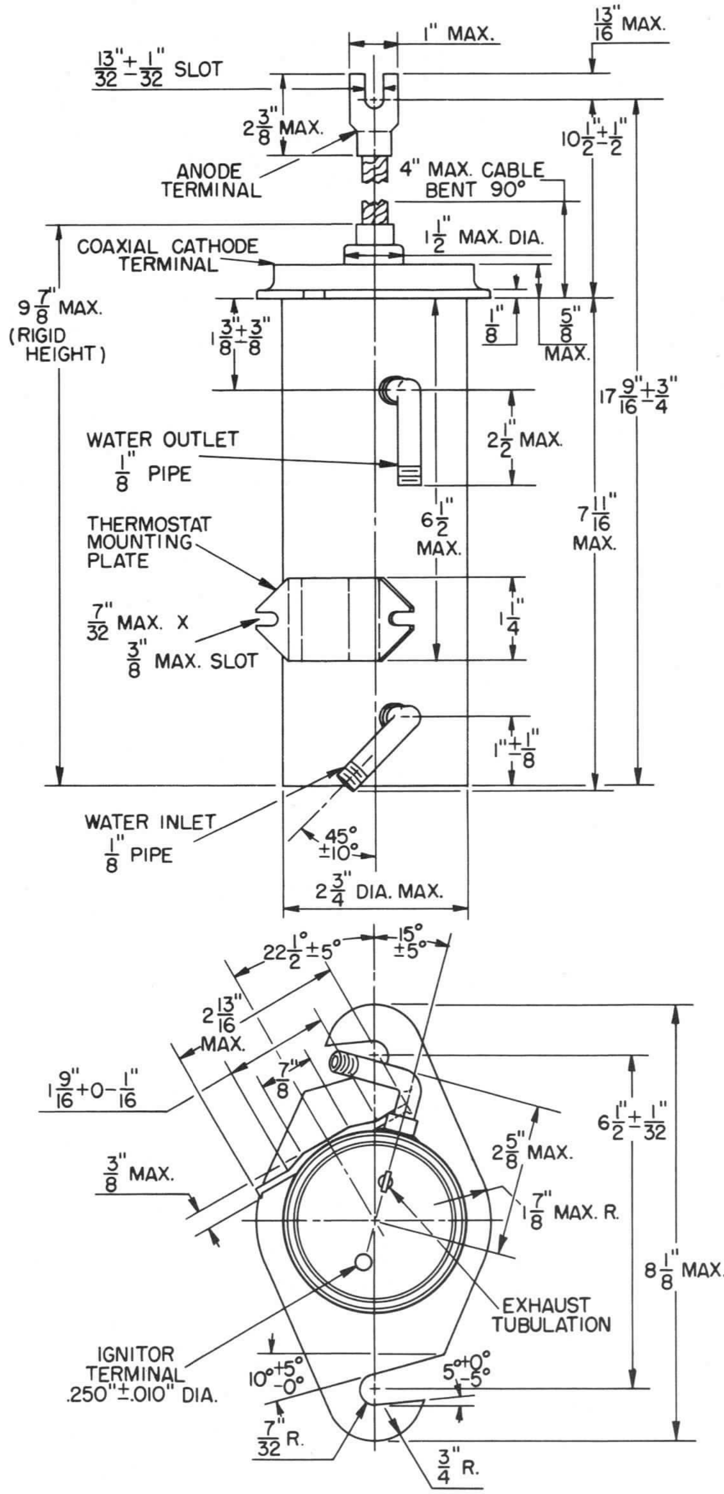
AVERAGE ANODE CURRENT IN AMPERES PER TUBE

9-21-55

MAXIMUM AVERAGING TIME=10 SECONDS

$\frac{\text{I AVERAGE}}{\text{I PEAK}}$ MAXIMUM AVERAGING TIME 0.2 SECOND=0.166 MAXIMUM

$\frac{\text{I FAULT}}{\text{I PEAK MAX}}$ MAXIMUM DURATION OF FAULT CURRENT 0.15 SECOND=12.5 MAXIMUM



Control thermostats, with mounting brackets, are available through regular tube supply channels under the following catalog numbers:

- AC Control Service
  - Flying-Lead Type
    - Water-Control Thermostat—N15272AA
    - Over-Temperature Thermostat—N15273AA
  - Terminal-Block Type
    - Water-Control Thermostat—N15286AA
    - Over-Temperature Thermostat—N15287AA

See Ignitron Accessories publication in front of Ignitron section for details.

GL-7670

IGNITRON
Coaxial

PULSE-WELDER SERVICE—2000 AMPERES PEAK

ADAPTED TO WATER-FLOW CONTROL

ADAPTED TO TEMPERATURE CONTROL

The GL-7670 is a sealed, stainless-steel-jacketed, water-cooled ignitron designed to control the high-current, short-duration power pulses required in pulse-welding service. In such use two tubes in inverse-parallel connection will control 2000 amperes peak at voltages up to 2500 volts peak at a frequency of 60 cycles. The tube is also useful in other high-peak-current applications such as capacitor-discharge circuits.

The 7670 features a new coaxial construction in which current flows through the tube from anode to cathode, then up the tube wall to a coaxial cathode terminal at the top. This coaxial current flow provides a magnetic shield to eliminate the arc deflection which the high peak currents of this tube might cause in standard design ignitrons.

A slotted mounting plate permits convenient mounting of a thermostat to provide control of the water flow or over-temperature protection.

Electrical

Cathode Excitation—Cyclic	
Cathode Spot Starting—Ignitor	
Number of Electrodes	
Main Anodes	1
Main Cathodes	1
Ignitors	1
Arc Drop at 2500 Peak Amperes	25 Volts
Arc Drop at 150 Amperes	13 Volts

Mechanical

Envelope Material—Stainless Steel	
Over-all Length	$8^{11}/_{16}$ Inches
Over-all Width	$2^{3}/_{4}$ Inches
Net Weight	3.6 Pounds

Thermal

Type of Cooling—Water	
Inlet Water Temperature, minimum	10 C
Inlet Water Temperature, maximum	30 C
Outlet Water Temperature, Maximum	35 C
Water Flow, minimum, solenoid water-valve open	1.0 Gallons per Minute
Characteristics for Water Cooling at Rated Minimum Flow	
Water Temperature Rise, Maximum	4 C
Pressure Drop at 1 Gallon per Minute	1.8 Pounds per Square Inch

MAXIMUM RATINGS—PULSE WELDER SERVICE

Peak Forward Anode Voltage	2500 Volts
Peak Inverse Anode Voltage	2500 Volts
Initial Inverse Voltage*	1250 Volts
Peak Anode Current	2000 Amperes
Average Anode Current	10 Amperes
Averaging Time	2 Seconds
Anode Current Repetition Rate	60 Pulses per Second
Anode Current Pulse Width	1000 Microseconds

Cathode Excitation Requirements

Ignitor Voltage Required to Fire	200 Volts
Ignitor Current Required to Fire	30 Amperes
Starting time at Required Voltage or Current	100 Microseconds
Ignitor	
Maximum Voltage	
Positive—Anode Voltage	
Negative	5 Volts
Maximum Current	
Peak	100 Amperes
Root Mean Square	10 Amperes
Average	1 Ampere
Maximum Averaging Time	5 Seconds

* Initial inverse voltage is the negative voltage applied to the anode immediately after anode current conduction.

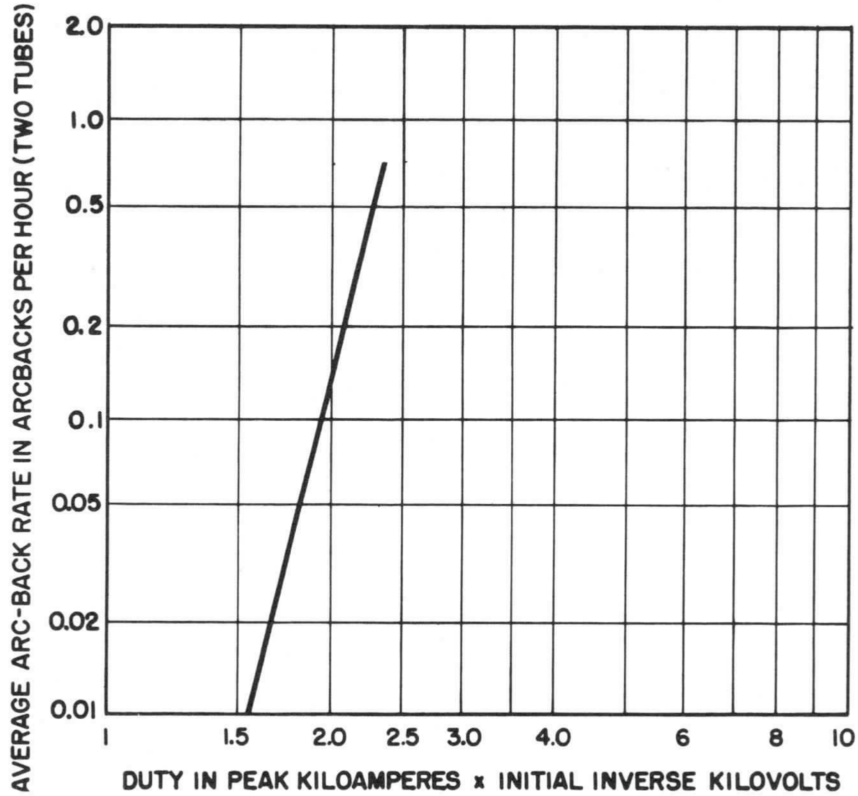
GENERAL ELECTRIC

Supersedes ET-T1628 dated 8-60

PERFORMANCE CHARACTERISTIC CURVE FOR PULSE-WELDING SERVICE
Average Arc-back Rate vs. Circuit Duty

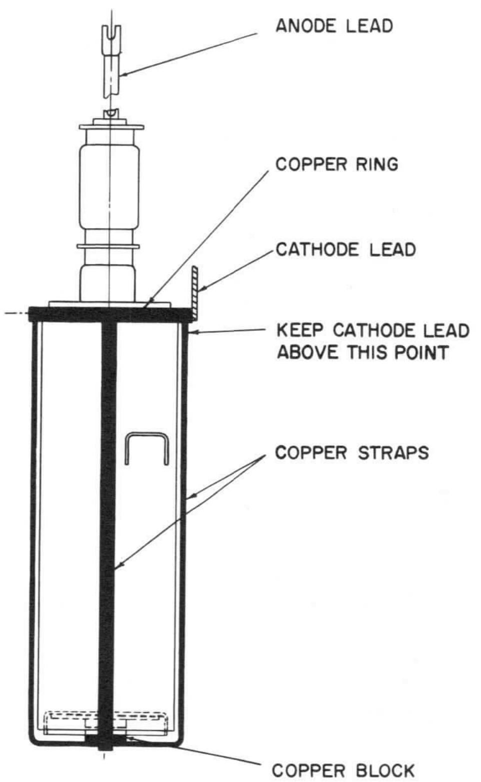
CONDITIONS:

Half-sine-wave current pulses 1000 microseconds long. 60-cycle repetition rate (maximum).
10 per cent duty cycle—10 half-sine-wave current pulses followed by 90 cycles of non-conduction.

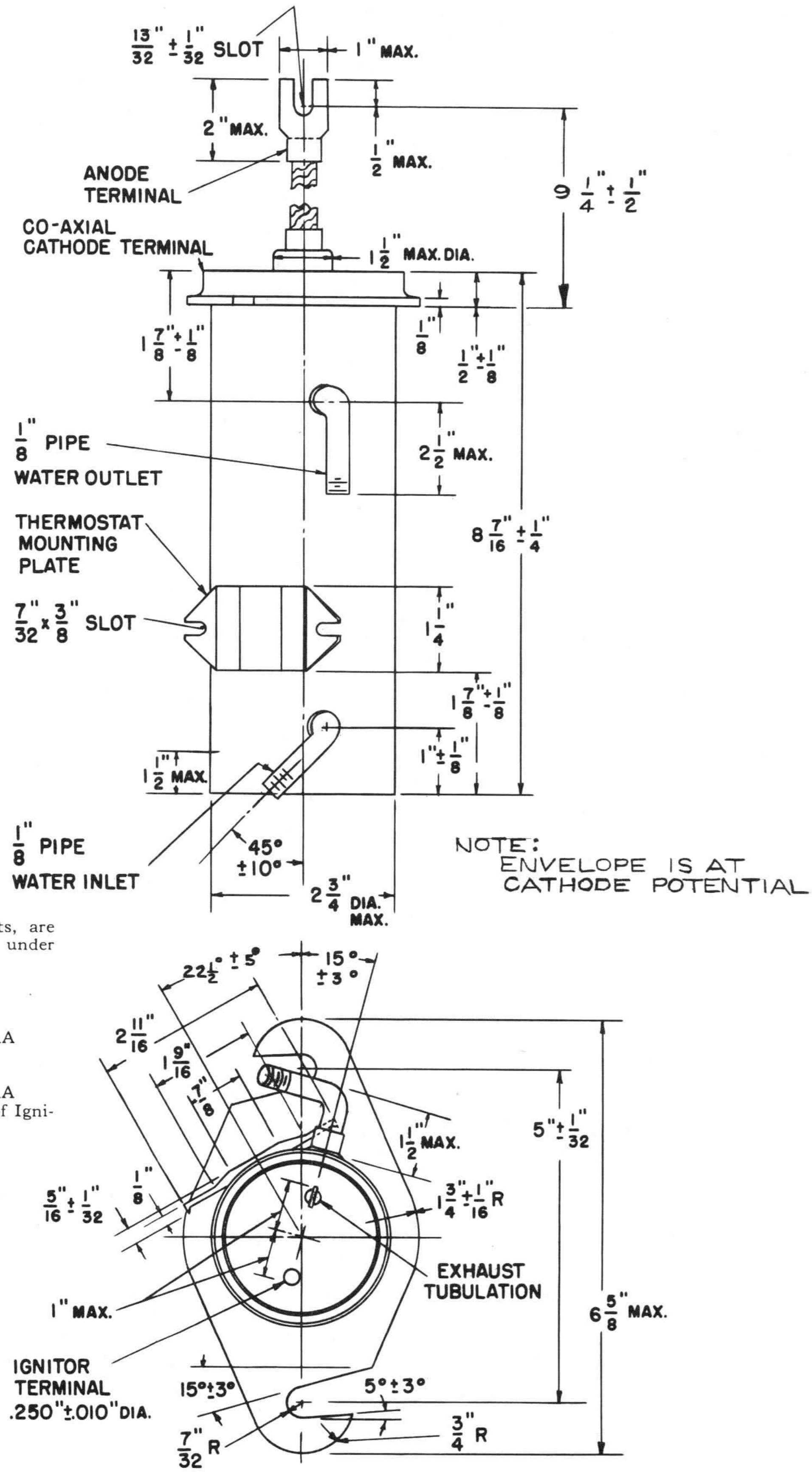


K-69087-72A978 8-60

COAXIAL CATHODE RETURN



K-69087-72A949 4-60



Control thermostats, with mounting brackets, are available through regular tube supply channels under the following catalog numbers:

- AC Control Service
  - Flying-Lead Type
    - Water-Control Thermostat—N15272AA
    - Over-Temperature Thermostat—N15273AA
  - Terminal-Block Type
    - Water-Control Thermostat—N15286AA
    - Over-Temperature Thermostat—N15287AA

See Ignitron Accessories publication in front of Ignitron section for details.

GENERAL ELECTRIC

TUBE DEPARTMENT

Schenectady, N. Y. 12025

PRINTED IN U.S.A.

GL-7671

IGNITRON
Coaxial

RECTIFIER SERVICE—100 AMPERES
AC CONTROL SERVICE—140 AMPERES

ADAPTED TO WATER-FLOW CONTROL

The GL-7671 is a sealed, stainless-steel-jacketed, water-cooled ignitron for a-c control service. In such application two tubes in inverse-parallel connection will control 1200 kilovolt-amperes at voltages of 250 to 600 over a frequency range of 25 to 60 cycles.

The 7671 features a new coaxial construction in which current flows through the tube from anode to cathode, then up the tube wall to a coaxial cathode terminal at the top. This coaxial current flow provides a magnetic shield to eliminate the arc deflection which the high peak currents of this tube might cause in standard design ignitrons.

ADAPTED TO TEMPERATURE CONTROL

A slotted mounting plate permits convenient mounting of a thermostat to provide control of the water flow or over-temperature protection.

Advantages of the control feature include reduction of condensation on the tube walls during hot weather, protection against overloads, elimination of water supply as a limiting factor in equipment location, and appreciable savings in water consumption.

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1
Main Cathodes	1
Ignitors	1
Arc Drop at 6800 Peak Amperes	28 Volts
Arc Drop at 440 Peak Amperes	14 Volts

Mechanical

Envelope Material—Stainless Steel

Over-all Length	14¼ Inches
Over-all Width	4⅝ Inches
Net Weight	8 Pounds

Thermal

Type of Cooling—Water

Inlet Water Temperature, minimum	0 C
Inlet Water Temperature, maximum	30 C
Outlet Water Temperature, maximum	40 C
Water Flow, minimum, solenoid water valve open	1.5 Gallons per Minute

Characteristics for Water Cooling at Rated Minimum Flow

Water Temperature Rise, maximum	6 C
Pressure Drop at 1.5 Gallons per Minute, maximum	4.5 Pounds per Square Inch

MAXIMUM RATINGS

Power-Rectifier Service, Intermittent Duty

Ratings are for Zero Phase-Control Angle
Ratings Apply Only at Inlet Water Temperatures Up to 40 C

Maximum Peak Anode Voltage	
Inverse	500 Volts
Forward	500 Volts
Maximum Anode Current	
Peak	1600 Amperes
Average	100 Amperes
Maximum Averaging Time	6 Seconds
Fault	6000 Amperes
Maximum Duration of Fault Current	0.15 Second
Frequency Range	25–60 Cycles per Second

AC Control Service*

Two Tubes in Inverse Parallel, Ratings per Tube
(See Curves K-69087-72A721 and K-69087-72A722 for Details)

Voltage	250 to 600 Volts RMS
Maximum Demand	1200 Kilovolt-Amperes
Average Current at Maximum Demand	75.6 Amperes
Maximum Average Current	140 Amperes
Demand at Maximum Average Current	400 Kilovolt-Amperes
Maximum Averaging Time at 250 Volts RMS	14 Seconds
Maximum Averaging Time at 600 Volts RMS	5.8 Seconds
Maximum Peak Fault Current at 250 Volts	13,450 Amperes
Maximum Peak Fault Current at 600 Volts	5600 Amperes
Frequency Range	25–60 Cycles per Second

Cathode Excitation Requirements

Ignitor Voltage Required to Fire	200 Volts
Ignitor Current Required to Fire	30 Amperes
Starting Time at Required Voltage or Current	100 Microseconds

Ignitor

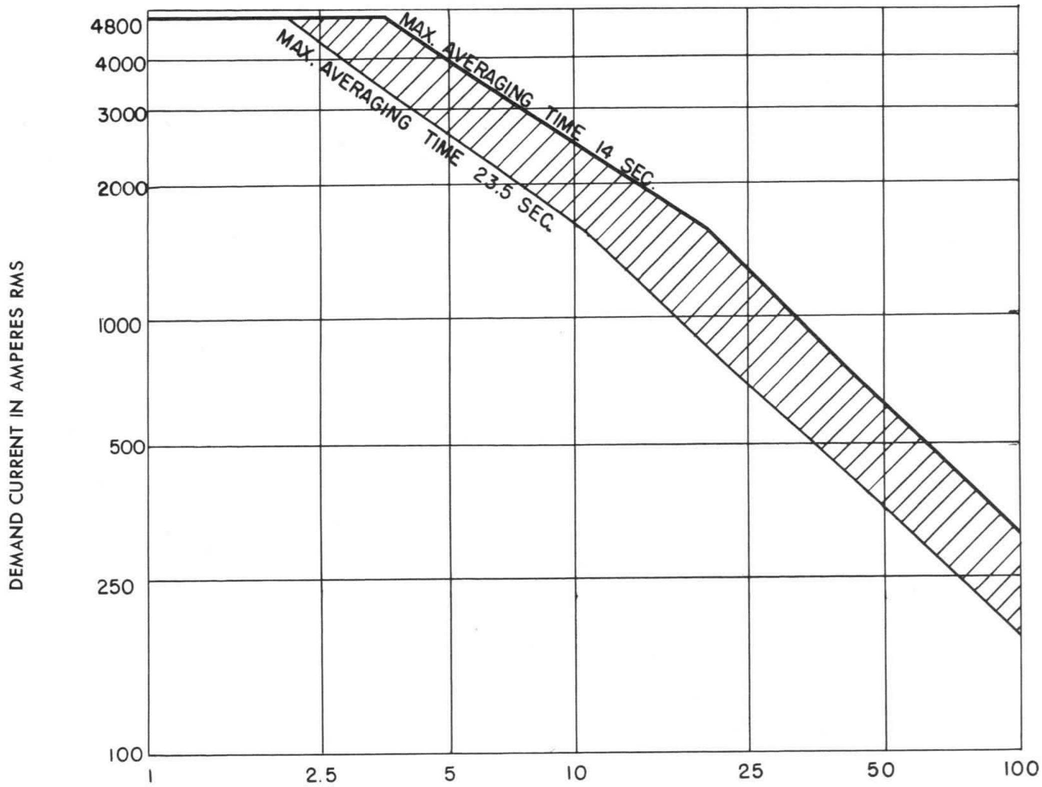
Maximum Voltage	
Positive—Anode Voltage	
Negative	5 Volts
Maximum Current	
Peak	100 Amperes
Root Mean Square	10 Amperes
Average	1 Ampere
Maximum Averaging Time	5 Seconds

* RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. For voltages below the minimum, the minimum-voltage current rating applies. With the use of log-log paper straight-line interpolation between tabulated points may be used for other detailed ratings of: Demand kva vs average anode current, and maximum averaging time vs anode voltage.

GENERAL ELECTRIC

Supersedes ET-T1640 dated 3-61

DEMAND CURRENT VS PERCENTAGE DUTY AT 250 VOLTS RMS

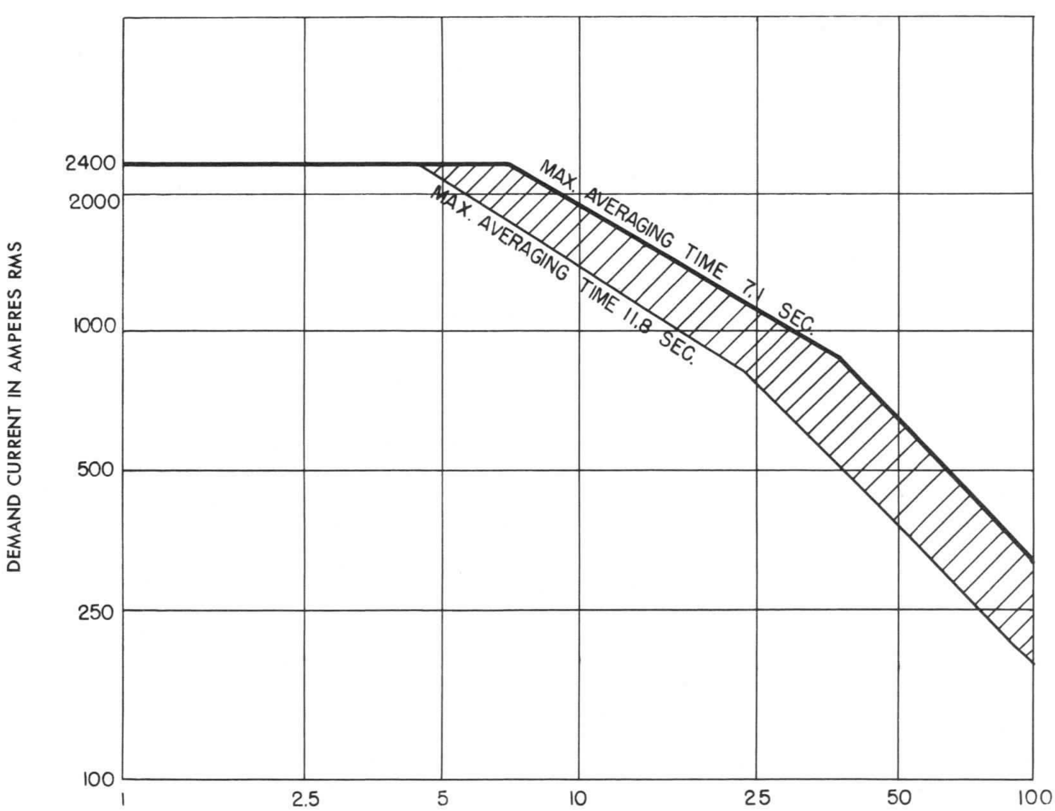


K-69087-72A721

DUTY IN PERCENTAGE
2 TUBES CONNECTED IN INVERSE PARALLEL

3-56

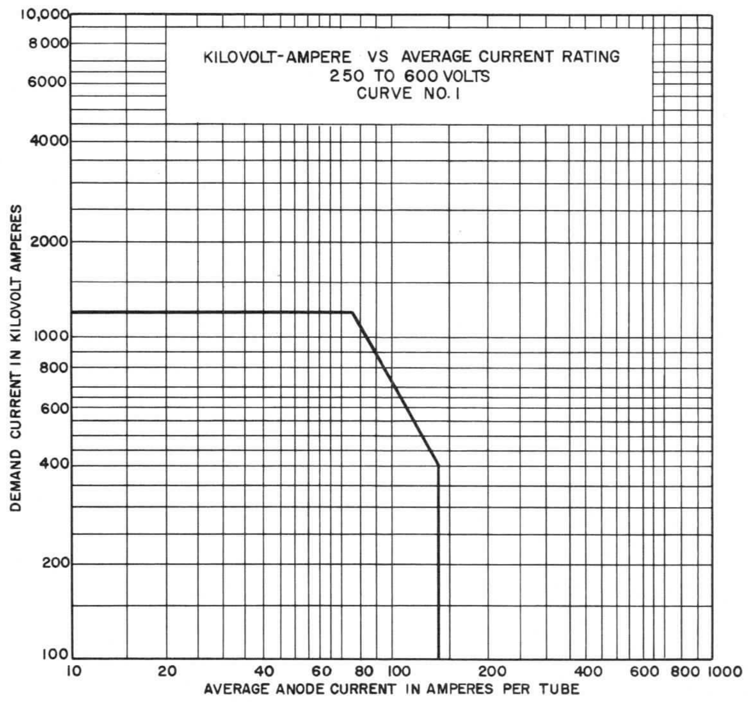
DEMAND CURRENT VS PERCENTAGE DUTY AT 440 VOLTS RMS



K-69087-72A722

DUTY IN PERCENTAGE
2 TUBES CONNECTED IN INVERSE PARALLEL

3-56



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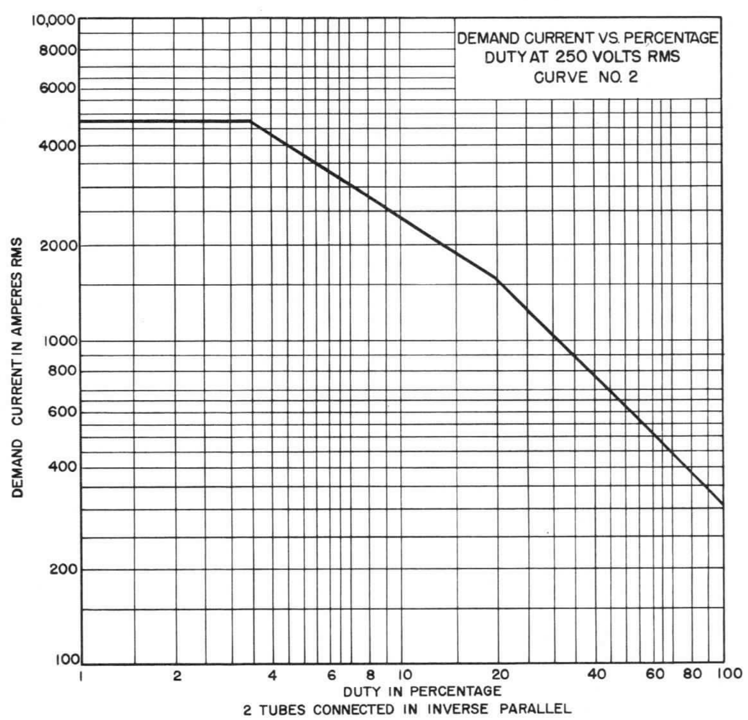

Averaging Time = 14 Seconds

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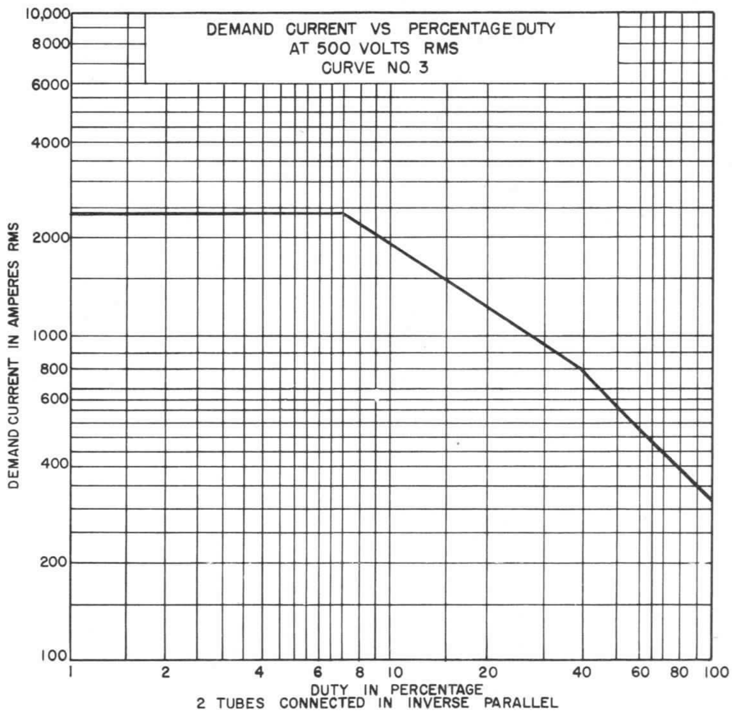
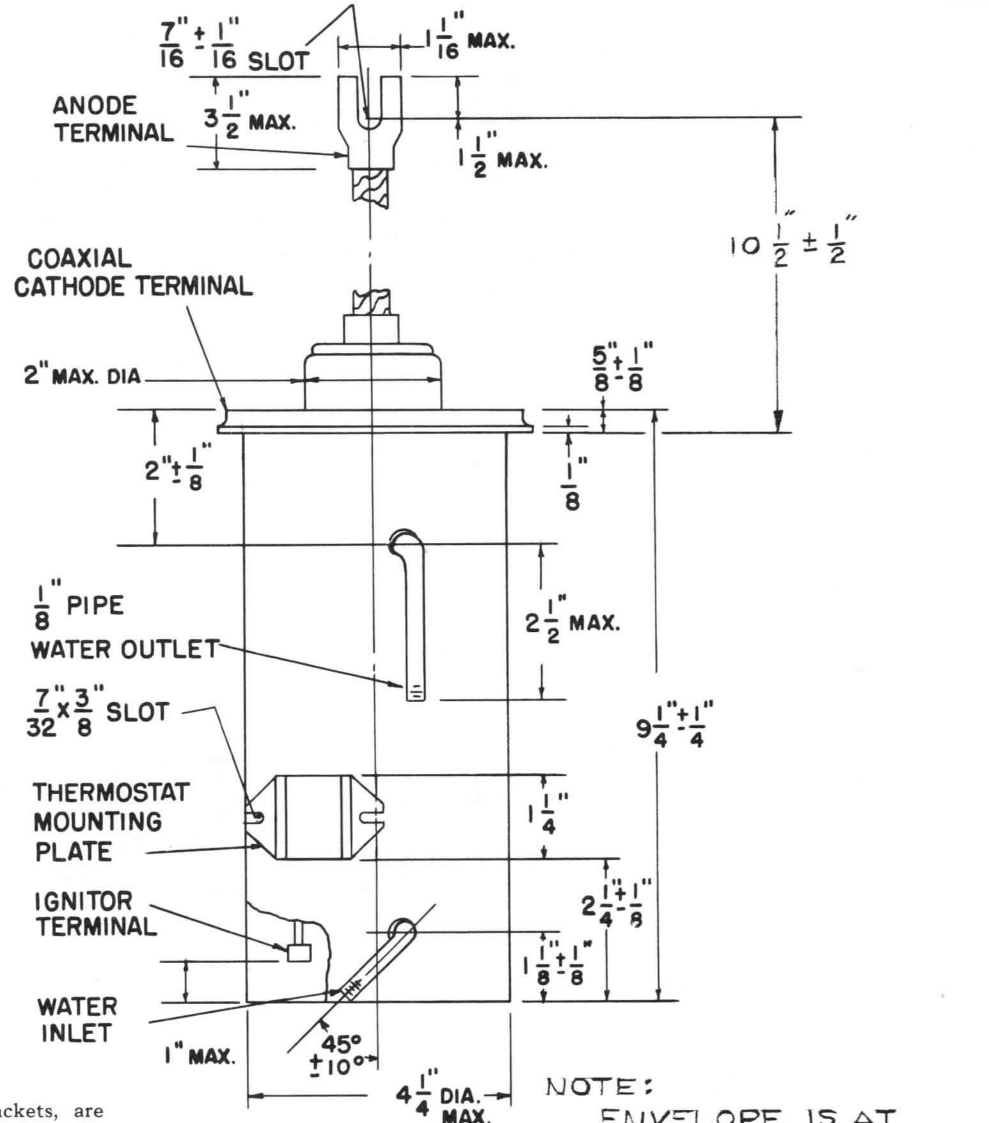


K-69087-72A868

Averaging Time=7.1 Seconds

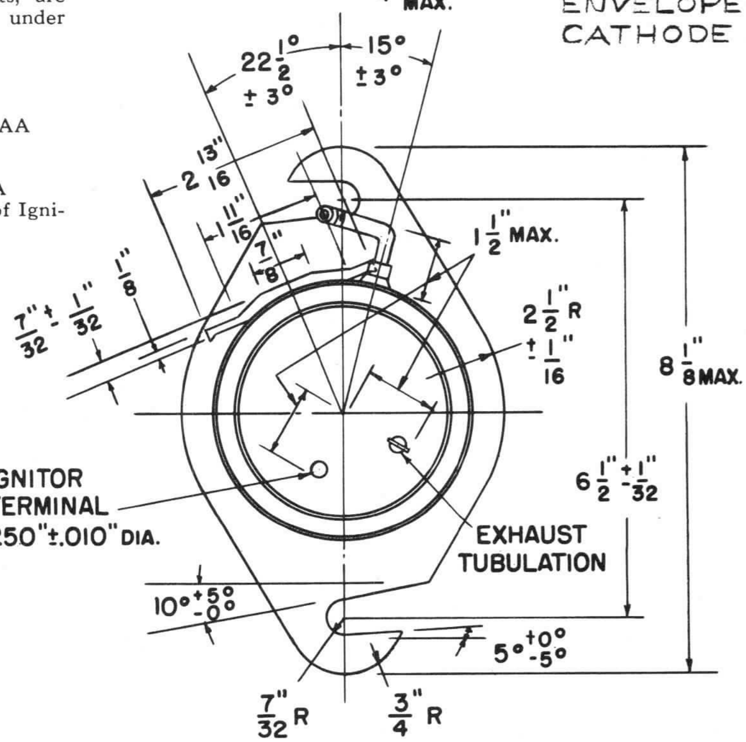
7-58



Control thermostats, with mounting brackets, are available through regular tube supply channels under the following catalog numbers:

AC Control Service
- Flying-Lead Type
  - Water-Control Thermostat—N15272AA
  - Over-Temperature Thermostat—N15273AA
- Terminal-Block Type
  - Water-Control Thermostat—N15286AA
  - Over-Temperature Thermostat—N15287AA

See Ignitron Accessories publication in front of Ignitron section for details.



GENERAL ELECTRIC

TUBE DEPARTMENT

Schenectady, N. Y. 12025

PRINTED IN U.S.A.

GL-7681
IGNITRON

FREQUENCY-CHANGER WELDER SERVICE — AC-CONTROL SERVICE

The GL-7681 is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube for use in electronic-contactor and resistance-welding-control service, both single-phase and three-phase.

In AC-control service two tubes in an inverse-parallel connection will control 1800 kilovolt amperes at 440 to 600 volts RMS, 25 to 60 cycles. Six tubes will control 2250 amperes peak at 1200 volts inverse in frequency-changer welder service.

A thermostat mounting plate, thermally coupled to the mercury-condensing surface of the tube, provides protection against excessive temperature or temperature control through regulation of the water flow.

Electrical

Electrodes		
Anodes	1	
Cathodes	1	
Ignitors	1	
Deionization Baffles	1	
Arc Drop		
At 5000 Amperes Peak	30	Volts
At 500 Amperes Peak	16	Volts

Mechanical

Envelope—Stainless Steel		
Mounting—Vertical, Cathode Terminal Down		
Net Weight, approximate	15	Pounds

Thermal

Cooling—Liquid. If other than water is used, correct for conductivity, specific heat and viscosity.

Inlet Water Temperature, minimum	6	C
Outlet Water Temperature, maximum	45	C
Water Flow, minimum		
At Continuous Rated Average Current	2.0	Gallons per Minute
At No Load	0	

Note: Flow at intermediate loads may be decreased to an amount proportional to load. Water flow should be continued for 30 minutes after load is removed.

Characteristics for Water Cooling at Rated Minimum Flow

Water Temperature Rise at Maximum Current	9	C
Water Pressure Drop at 2.0 Gallons per Minute, Maximum	5	pounds per square inch

AC-Control Service*

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	500–600	Volts RMS
Maximum Demand	1800†	Kilovolt Amperes
Average Current at Maximum Demand	113.5	Amperes
Maximum Average Current	210	Amperes
Demand at Maximum Average Current	600	Kilovolt Amperes
Maximum Averaging Time		
At 250 Volts RMS	9.5	Seconds
At 500 Volts RMS	7.1	Seconds
Maximum Peak Fault Current		
At 250 Volts	20,040	Amperes
At 600 Volts	8400	Amperes
Frequency Range	25–60	Cycles per second

Frequency-Changer-Welder Service

Ratings are for zero phase-control angle

Maximum Peak Anode Voltage			
Inverse and Forward	1200	1500	Volts
Maximum Anode Current			
Peak	2250	1800	Amperes
Corresponding Average	30	24	Amperes
Average	105	84	Amperes
Corresponding Peak	630	502	Amperes
Maximum Averaging Time	6.25	6.25	Seconds
Ratio of Average to Peak Current	0.166	0.166	
Maximum Averaging Time	0.2	0.2	Seconds
Ratio of Fault to Maximum Peak Current	12.5	12.5	
Maximum Duration of Fault Current	0.15	0.15	Seconds
Frequency Range	50–60	50–60	Cycles per second

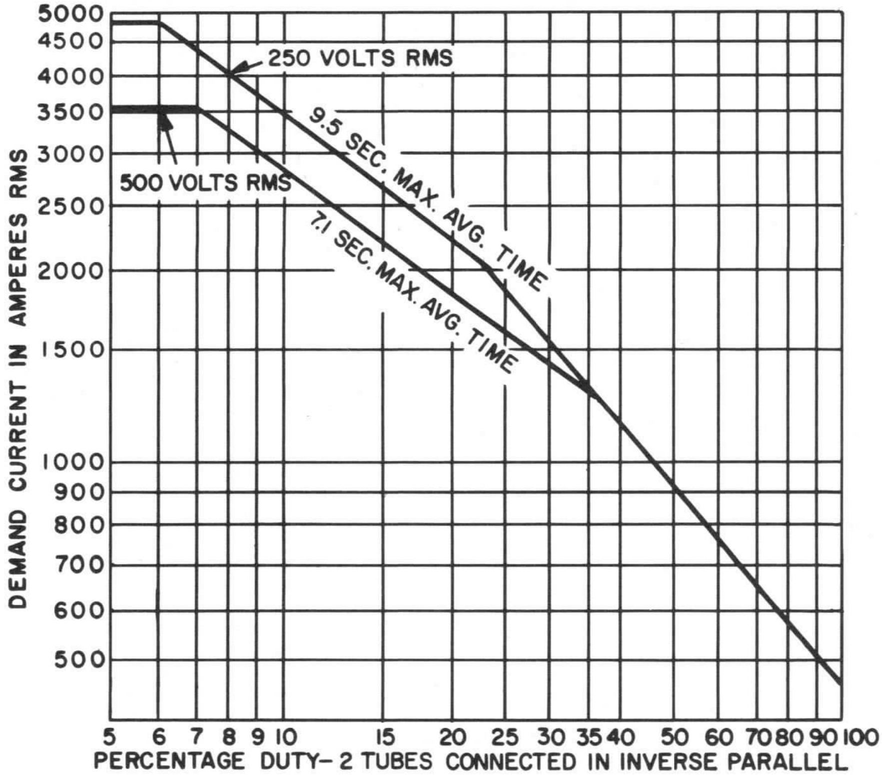
Cathode Excitation Requirements

Ignitor Voltage Required to Fire	200	Volts
Ignitor Current Required to Fire	30	Amperes
Starting Time at Required Voltage or Current	100	Microseconds
Ignitor		
Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
RMS	10	Amperes
Average	1	Ampere
Maximum Averaging Time	5	Seconds

* RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. Straight-line interpolation on log-log paper is allowed between corresponding points.

† Maximum demand current for 250 volts RMS is 4800 amperes. For voltages between 250 and 500 use proportional values between 4800 and 3600 amperes.

AC CONTROL SERVICE
DEMAND CURRENT VS PERCENTAGE DUTY



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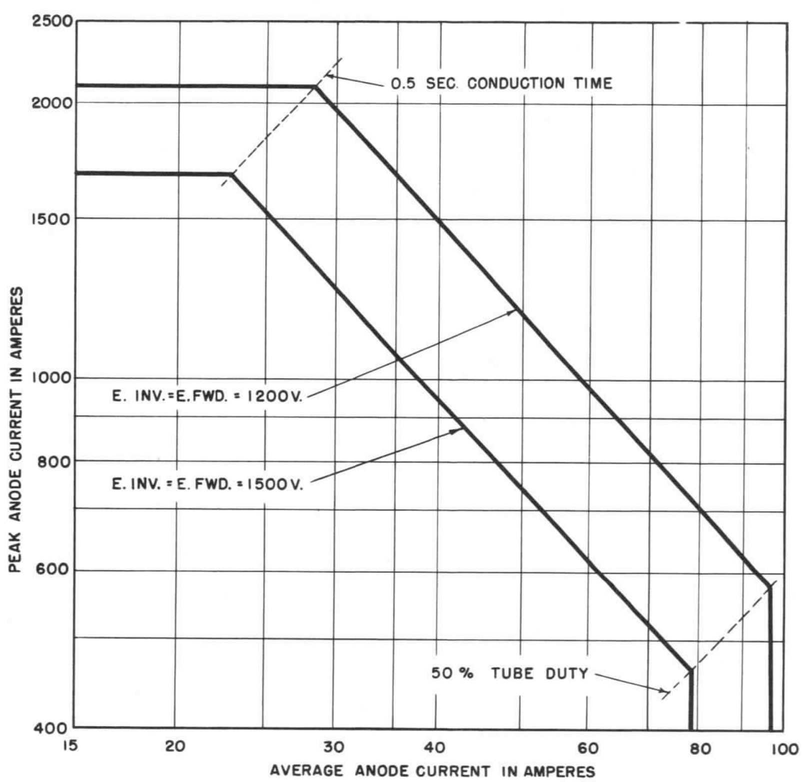
FREQUENCY-CHANGER WELDER SERVICE



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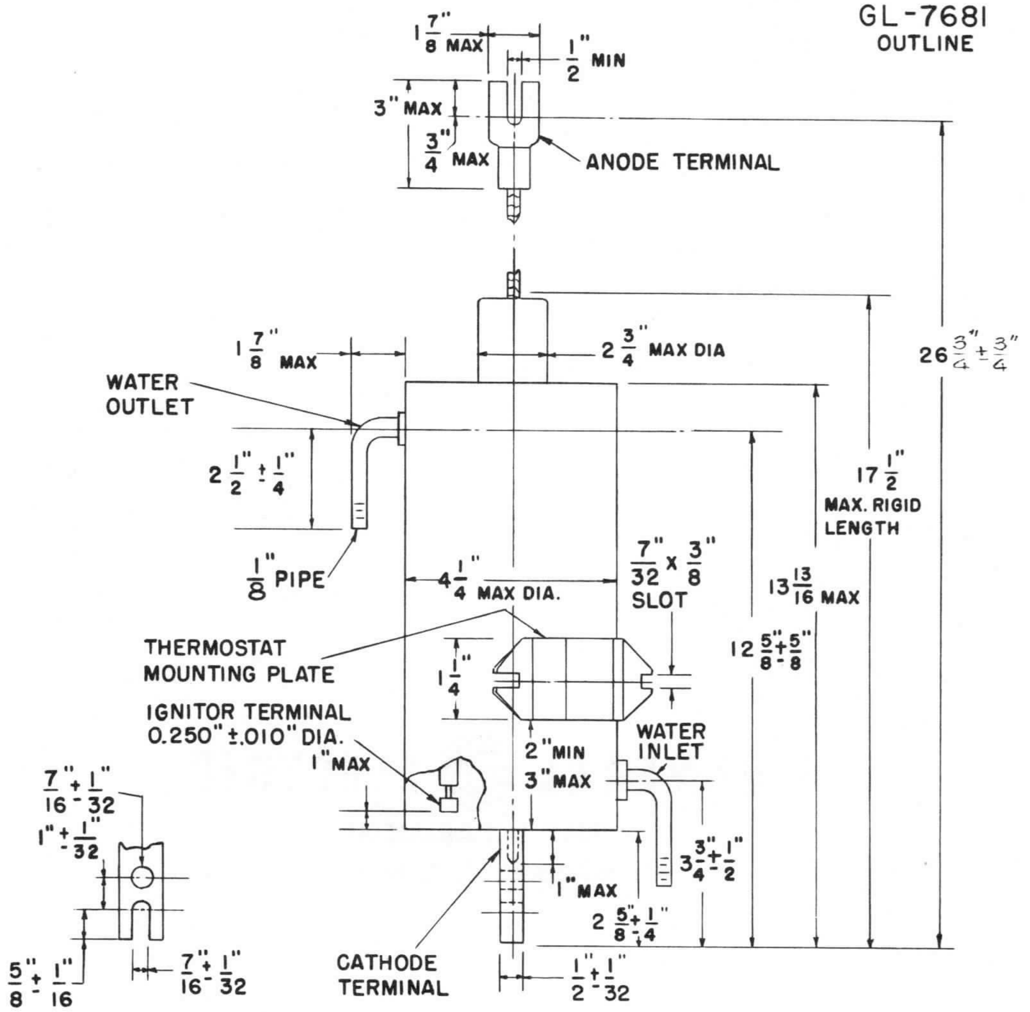
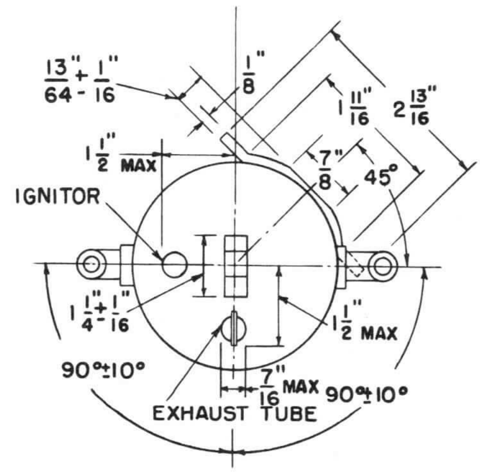
3-61

GL-7681
OUTLINE





NOTE: ENVELOPE IS AT CATHODE POTENTIAL

GENERAL ELECTRIC

TUBE DEPARTMENT

Schenectady 5, N. Y.

PRINTED IN U.S.A.

GL-7998
COAXIAL IGNITRON

FREQUENCY-CHANGER WELDER SERVICE
2250 AMPERES PEAK

AC-CONTROL SERVICE
1800 KILOVOLT-AMPERES

The GL-7998 is a sealed, stainless-steel-jacketed, water-cooled ignitron for use in electronic-contactor and resistance-welding-control service, both single-phase and three-phase. It is a coaxial-design version of the GL-7681.

In AC-control service two tubes in an inverse-parallel connection will control 1800 kilovolt-amperes at 440 to 600 volts RMS, 25 to 60 cycles. In frequency-changer welder service six tubes will control 2250 amperes peak at 1200 volts inverse.

In the coaxial construction current flows through the tube from anode to cathode, then up the tube wall to a coaxial cathode terminal at the top. This current flow provides a magnetic shield which eliminates the arc deflection that the high peak currents possible with this tube might cause in standard design ignitrons.

A thermostat mounting plate thermally coupled to the mercury-condensing surface of the tube facilitates attachment of a thermostat to provide either protection against excessive temperature or temperature control through regulation of the water flow.

Electrical

Electrodes		
Anodes	1	
Cathodes	1	
Ignitors	1	
Deionization Baffles	1	
Arc Drop		
At 5000 Amperes Peak	30	Volts
At 500 Amperes Peak	16	Volts

Mechanical

Envelope—Stainless Steel
Mounting—Vertical, Anode Terminal Up

Net Weight, approximate	15	Pounds

Thermal

Cooling—Liquid. If other than water is used, correct for conductivity, specific heat and viscosity.

Inlet Water Temperature, minimum	6	C
Outlet Water Temperature, maximum	45	C
Water Flow, minimum		
At Continuous Rated Average Current	2.0	Gallons per Minute
At no Load	0	

Note: Flow at intermediate loads may be decreased to an amount proportional to load. Water flow should be continued for 30 minutes after load is removed.

Water Cooling Characteristics at Rated Maximum Flow		
Water Temperature Rise at Maximum Current	9	C
Water Pressure Drop, maximum	5	Pounds per Square Inch

MAXIMUM RATINGS

AC-Control Service*

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	440–600	Volts RMS
Maximum Demand	1800†	Kilovolt-Amperes
Corresponding Average Current	113.5	Amperes
Maximum Average Current	210	Amperes
Corresponding Demand	600	Kilovolt-Amperes
Maximum Averaging Time		
At 250 Volts RMS	9.5	Seconds
At 500 Volts RMS	7.1	Seconds
Maximum Peak Fault Current		
At 250 Volts	20,040	Amperes
At 600 Volts	8400	Amperes
Frequency Range	25–60	Cycles per second

Frequency-Changer-Welder Service

Ratings are for zero phase-control angle

Maximum Peak Anode Voltage			
Inverse and Forward	1200	1500	Volts
Maximum Anode Current			
Peak	2250	1800	Amperes
Corresponding Average	30	24	Amperes
Average	105	84	Amperes
Corresponding Peak	630	502	Amperes
Maximum Averaging Time	6.25	6.25	Seconds
Ratio of Average to Peak			
Current	0.166	0.166	
Maximum Averaging Time	0.2	0.2	Seconds
Ratio of Fault to Maximum Peak			
Current	12.5	12.5	
Maximum Duration of Fault			
Current	0.15	0.15	Seconds
Frequency Range	50–50	50–60	Cycles per second

Supersedes ET-T1674 dated 5-62

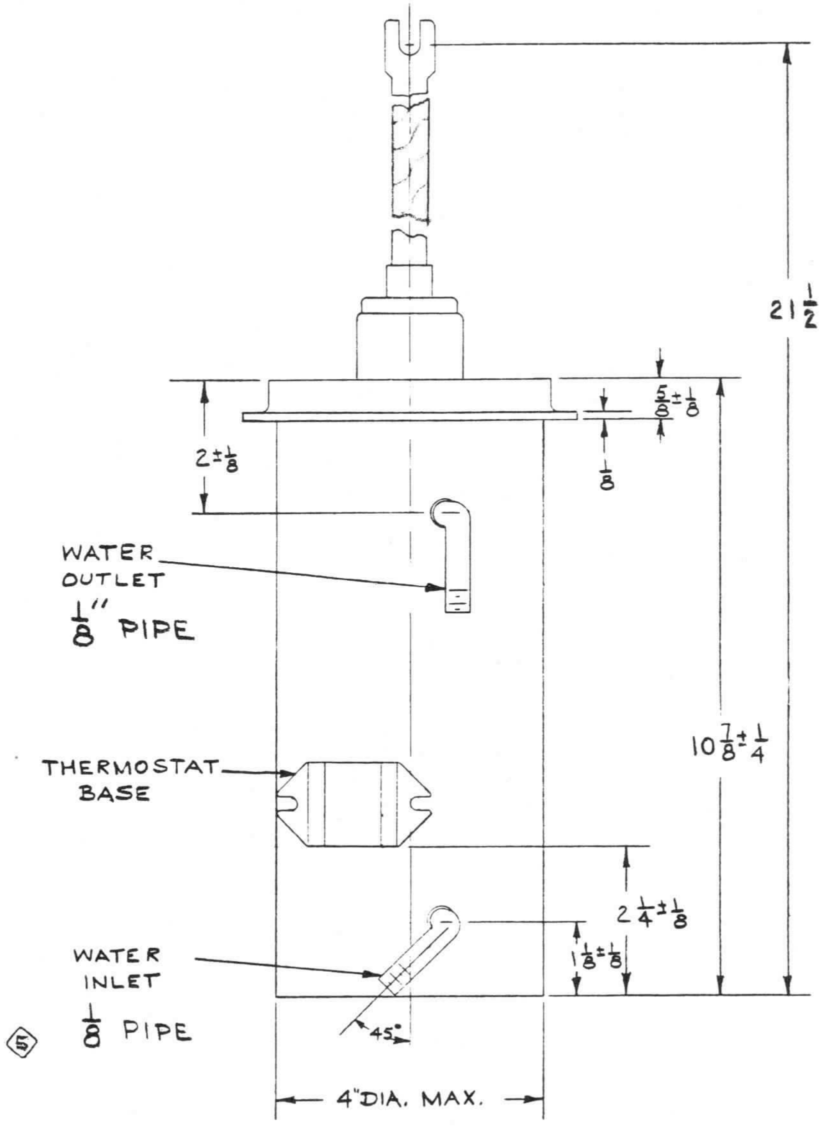
MAXIMUM RATINGS (Cont'd)

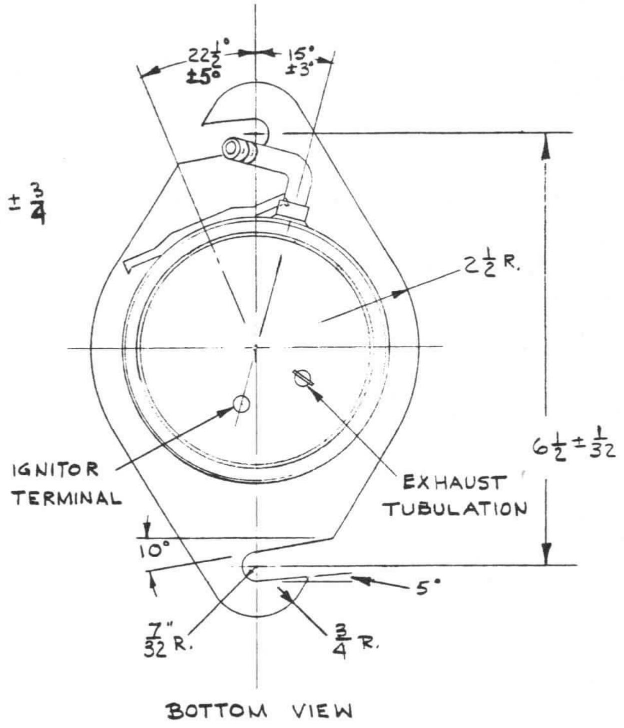
Cathode Excitation Requirements

Ignitor Voltage Required to Fire	200	Volts
Ignitor Current Required to Fire	30	Amperes
Starting Time at Required Voltage or Current	100	Microseconds

Ignitor		
Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
RMS	10	Amperes
Average	1	Ampere
Maximum Averaging Time	5	Seconds

* RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. Straight-line interpolation on log-log paper is allowed between corresponding points.
† Maximum demand current for 250 volts RMS is 4800 amperes. For voltages between 250 and 500 use proportional values between 4800 and 3600 amperes.





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GL-8205
COAXIAL IGNITRON

AC-CONTROL SERVICE

4800 KILOVOLT-AMPERES — **HIGH EFFICIENCY COOLING**

The GL-8205 is a sealed, stainless-steel-jacketed ignitron for a-c control welder service. It is a coaxial-design version of the GL-7151.

Two tubes in an inverse-parallel connection will control 4800 kilovolt-amperes at 250 to 600 volts RMS, 25 to 60 cycles.

In the coaxial construction, current flows through the tube from anode to cathode, then up the tube wall to a coaxial cathode terminal at the top. This current flow provides a magnetic shield which eliminates the arc deflection that the high peak currents possible with this tube might cause in standard-design ignitrons.

Other features of the 8205 include a specially designed water-cooling chamber that provides high-efficiency cooling at the bottom of the tube without increasing the water-pressure drop of the cooling jacket. A thermostat mounting plate, thermally coupled to the mercury-condensing surface of the tube, facilitates attachment of a thermostat to provide either protection against excessive temperature or temperature control through regulation of the water flow.

ELECTRICAL

Electrodes		
Main Anodes	1	
Main Cathodes	1	
Ignitors	1	
Arc Drop		
At 9600 Amperes Peak	31	Volts
At 1000 Amperes Peak	20	Volts

MECHANICAL

Envelope Material—Stainless Steel
Mounting Position—Vertical, Anode Terminal Up

Over-all Length	20½	Inches
Over-all Width	9⅛	Inches
Net Weight	70	Pounds

THERMAL

Cooling—Water		
Inlet Water Temperature, minimum	0	C
Outlet Water Temperature, maximum	40	C
Water Flow, minimum	10	Gallons per Minute

Water flow should be continued for at least one hour after removal of anode power.

Maximum Working Water Pressure, Non-Shock	100	Pounds per Square Inch
Water-Cooling Characteristics at Rated Minimum Flow		
Water Temperature Rise at Maximum Current	8	C
Water Pressure Drop, maximum	1.5	Pounds per Square Inch

AC-Control Service*

Two Tubes in Inverse Parallel, Ratings per Tube

Voltage	250 to 600	Volts RMS
Maximum Demand	4800	Kilovolt-Amperes
Corresponding Average Current*	486	Amperes
Maximum Average Current*	900	Amperes
Corresponding Demand	1600	Kilovolt-Amperes
Maximum Demand Current		
Below 500 Volts	9600	Amperes RMS
Maximum Averaging Time		
At 250 Volts RMS	8.9	Seconds
At 500 Volts RMS	4.5	Seconds
Maximum Peak Fault Current		
At 250 Volts	54,000	Amperes
At 600 Volts	22,400	Amperes
Frequency Range	25–60	Cycles per second

Cathode Excitation Requirements

Anode Firing

Ignitor Voltage Required to Fire	200	Volts
Ignitor Current Required to Fire	30	Amperes
Starting Time at Required Voltage or Current	100	Microseconds

Separate Excitation

Pulse Width		
Recommended	500	Microseconds
Maximum	4000	Microseconds

When the average anode current is greater than 20 amperes the pulse width must not fall below 150 microseconds.

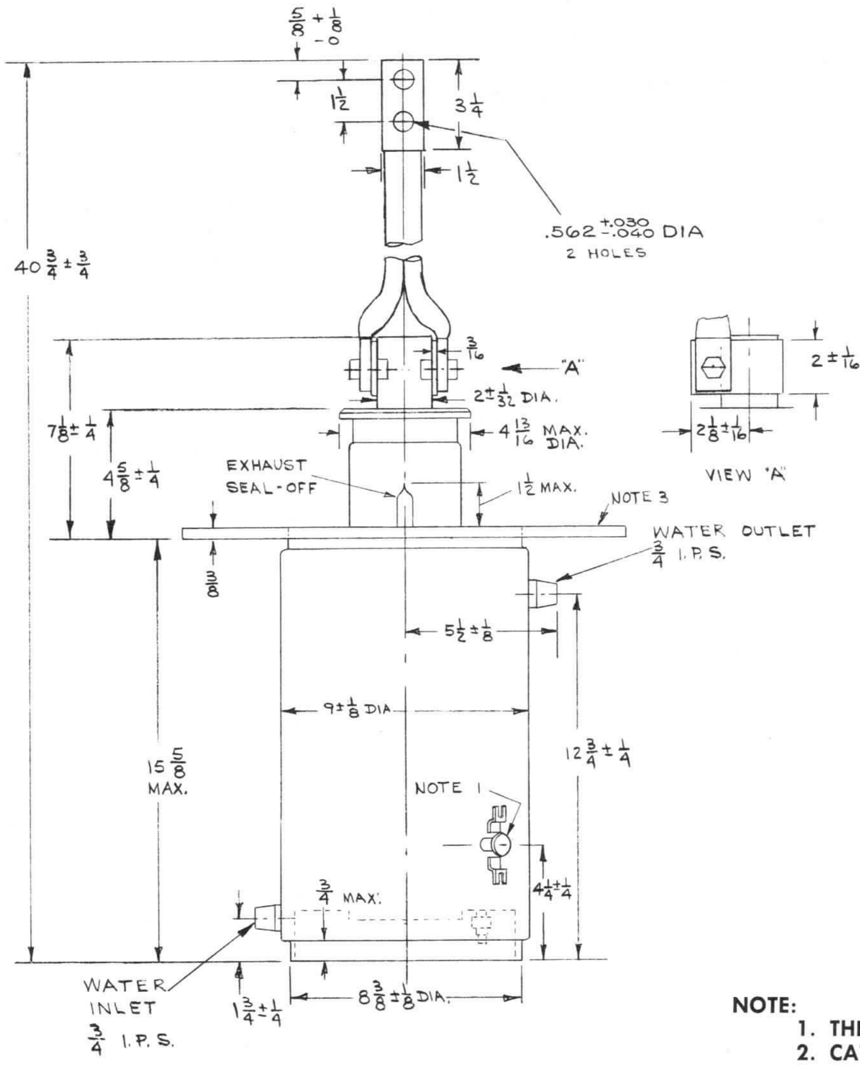
Maximum Rate of Rise of Ignitor Current	2.5	Amperes per Microsecond

Ignitor†

Maximum Voltage		
Positive—Anode Voltage		
Negative	5	Volts
Maximum Current		
Peak	100	Amperes
RMS	10	Amperes
Average	1	Ampere
Maximum Averaging Time	5	Seconds

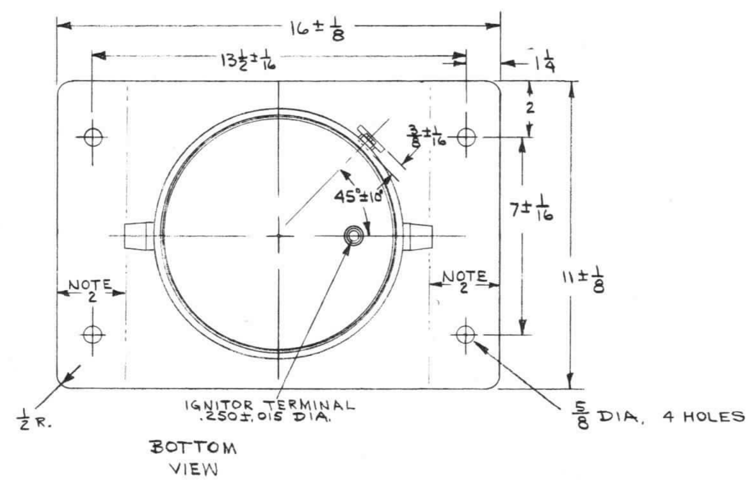
* RMS demand voltage, current, and kilovolt-ampere demand are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used. Straight-line interpolation on log-log paper is allowed between corresponding points.

† These ratings apply only when anode firing of the ignitor is employed.



NOTE:

1. THERMOSTAT CONTACT AREA
2. CATHODE CONTACT AREA, 2½ WIDE
3. TUBE SUPPORT & CATHODE TERMINAL



GENERAL ELECTRIC

POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

PRINTED IN U.S.A.

GL-8360

IGNITRON
Coaxial

PULSE-WELDER SERVICE—2000 AMPERES PEAK

ADAPTED TO WATER-FLOW CONTROL

ADAPTED TO TEMPERATURE CONTROL

The GL-8360 is a sealed, stainless-steel-jacketed, water-cooled ignitron designed to control the high-current, short-duration power pulses required in pulse-welding service. In such use two tubes in inverse-parallel connection will control 2000 amperes peak at voltages up to 2500 volts peak at a frequency of 60 cycles. The tube is also useful in other high-peak-current applications such as capacitor-discharge circuits.

The 8360 features a new coaxial construction in which current flows through the tube from anode to cathode, then up the tube wall to a coaxial cathode terminal at the top. This coaxial current flow provides a magnetic shield to eliminate the arc deflection which the high peak currents of this tube might cause in standard design ignitrons. Except for an increase in the size of the coaxial mounting plate, this tube is identical to the GL-7670.

A slotted mounting plate permits convenient mounting of a thermostat to provide control of the water flow or over-temperature protection.

Electrical

Cathode Excitation—Cyclic
Cathode Spot Starting—Ignitor
Number of Electrodes

Main Anodes	1
Main Cathodes	1
Ignitors	1
Arc Drop at 2500 Peak Amperes	25 Volts
Arc Drop at 10 Amperes	13 Volts

Mechanical

Envelope Material—Stainless Steel

Over-all Length	13 Inches
Over-all Width	2¾ Inches
Net Weight	3.6 Pounds

Thermal

Type of Cooling—Water

Inlet Water Temperature, minimum	10 C
Inlet Water Temperature, maximum	30 C
Outlet Water Temperature, maximum	35 C
Water Flow, minimum, solenoid water-valve open	1.0 Gallons per Minute

Characteristics for Water Cooling at Rated Minimum Flow

Water Temperature Rise, maximum	4 C
Pressure Drop at 1 Gallon per Minute	1.8 Pounds per Square Inch

MAXIMUM RATINGS—PULSE WELDER SERVICE

Peak Forward Anode Voltage	2500 Volts
Peak Inverse Anode Voltage	2500 Volts
Initial Inverse Voltage*	1250 Volts
Peak Anode Current	2000 Amperes
Average Anode Current	10 Amperes
Averaging Time	2 Seconds
Anode Current Repetition Rate	60 Pulses per Second
Anode Current Pulse Width	1000 Microseconds

Cathode Excitation Requirements

Ignitor Voltage Required to Fire	200 Volts
Ignitor Current Required to Fire	30 Amperes
Starting time at Required Voltage or Current	100 Microseconds

Ignitor
Maximum Voltage
Positive—Anode Voltage

Negative	5 Volts

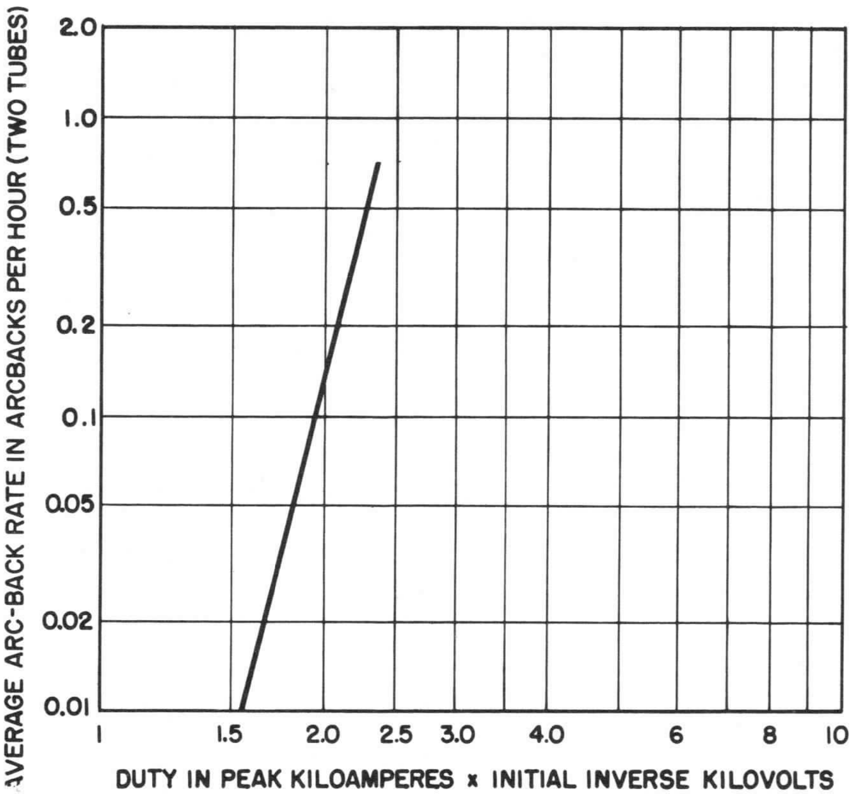
Maximum Current

Peak	100 Amperes
Root Mean Square	10 Amperes
Average	1 Ampere
Maximum Averaging Time	5 Seconds

* Initial inverse voltage is the negative voltage applied to the anode immediately after anode current conduction.

PERFORMANCE CHARACTERISTIC CURVE FOR PULSE-WELDING SERVICE
Average Arc-back Rate vs. Circuit Duty

CONDITIONS:
Half-sine-wave current pulses 1000 microseconds long. 60-cycle repetition rate (maximum).
10 per cent duty cycle—10 half-sine-wave current pulses followed by 90 cycles of non-conduction.



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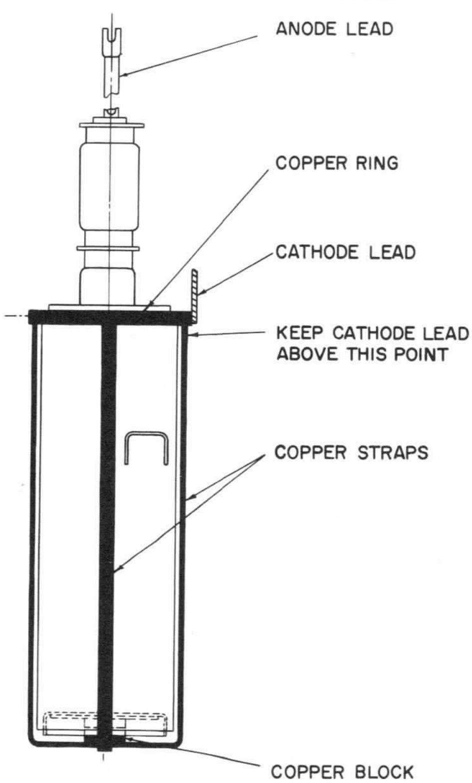
COAXIAL CATHODE RETURN



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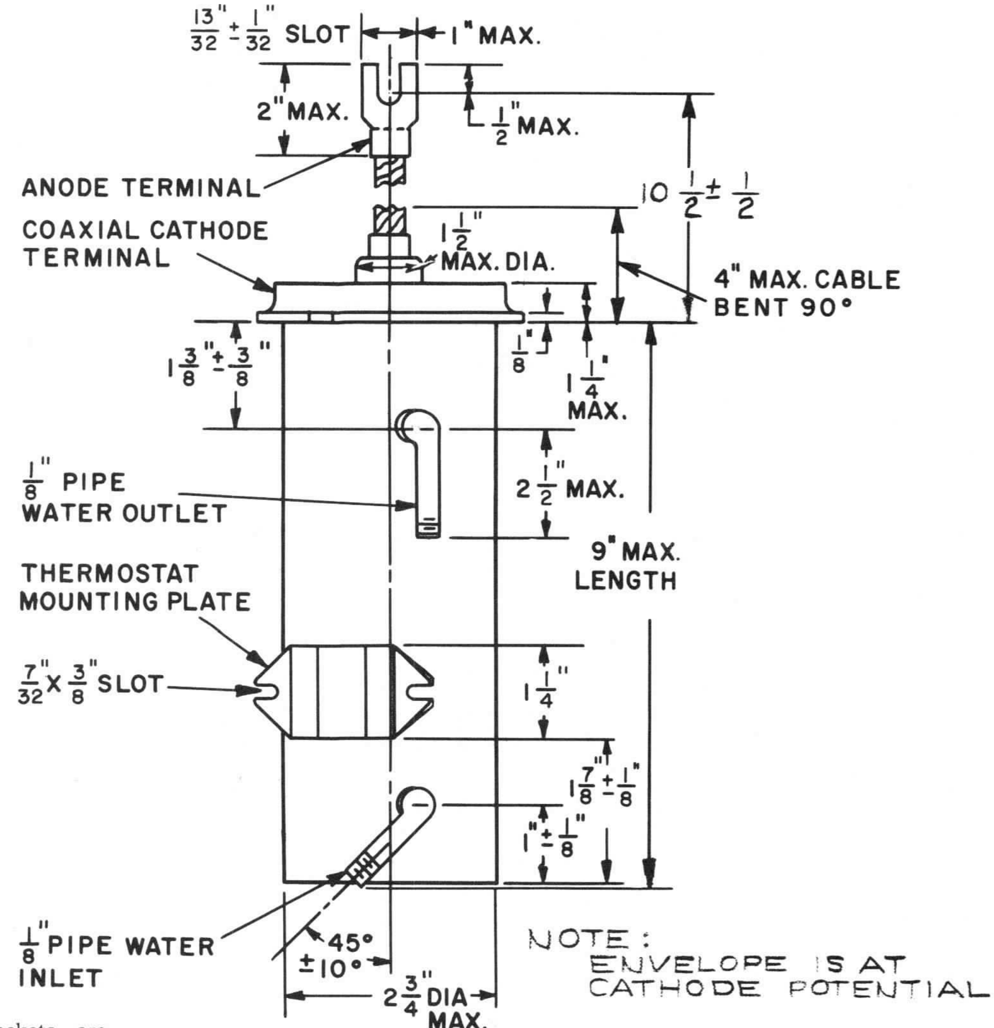
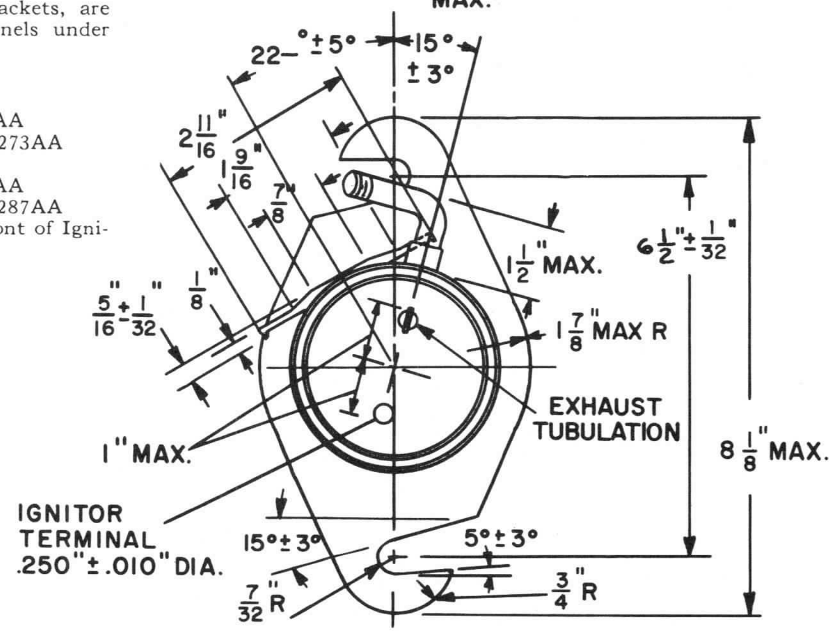


Control thermostats, with mounting brackets, are available through regular tube supply channels under the following catalog numbers:

- AC Control Service
  - Flying-Lead Type
    - Water-Control Thermostat—N15272AA
    - Over-Temperature Thermostat—N15273AA
  - Terminal-Block Type
    - Water-Control Thermostat—N15286AA
    - Over-Temperature Thermostat—N15287AA

See Ignitron Accessories publication in front of Ignitron section for details.



GENERAL ELECTRIC
TUBE DEPARTMENT
Schenectady, N. Y. 12025

PRINTED IN U.S.A.

INDUSTRIAL EQUIPMENT TYPES MANUAL

GL-8465, GL-8466

Technical data on these types is filed in the "Rectifier Ignitrons" section of this manual.

FG-280
RECTIFIER

HALF-WAVE

MERCURY VAPOR

6.4 AMPERES

The FG-280 is a half-wave, all metal, mercury-vapor rectifier.

Electrical

Cathode—indirectly heated		
Heater Voltage	5.0	Volts
Heater Current, approximate	10.0	Amperes
Heating Time, typical	5	Minutes
Peak Voltage Drop, typical	15	Volts

Mechanical

Net Weight, approximate	22	Ounces
Mounting Position		Vertical, with Radiator End Down

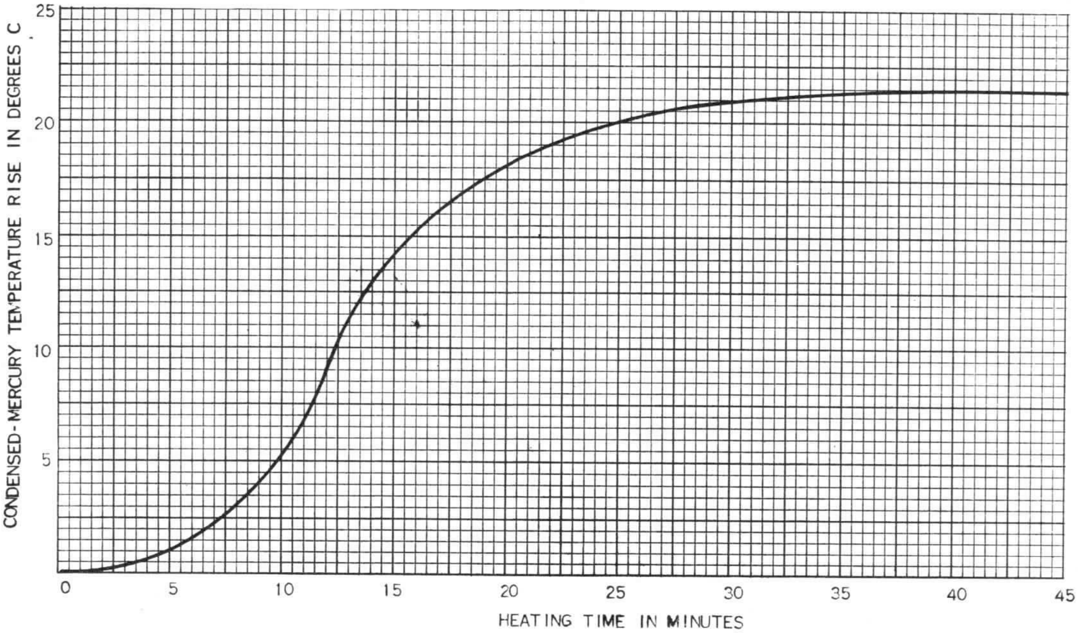
MAXIMUM RATINGS

Maximum Peak Inverse Anode Voltage	2000	Volts
Anode Current		
Maximum Instantaneous		
25 Cycles and Above	40	Amperes
Below 25 cycles	12.8	Amperes
Average	6.4	Amperes
Maximum Averaging Time	15	Seconds
Fault	400	Amperes
Duration	0.1	Second
Temperature Limits, condensed mercury	+40 +80	C
Recommended Temperature, condensed mercury	40	C

GENERAL ELECTRIC

Supersedes ETI-151B dated 10-50

RATE OF RISE OF CONDENSED-
MERCURY TEMPERATURE ABOVE AMBIENT
$E_f = 4.75$ VOLTS



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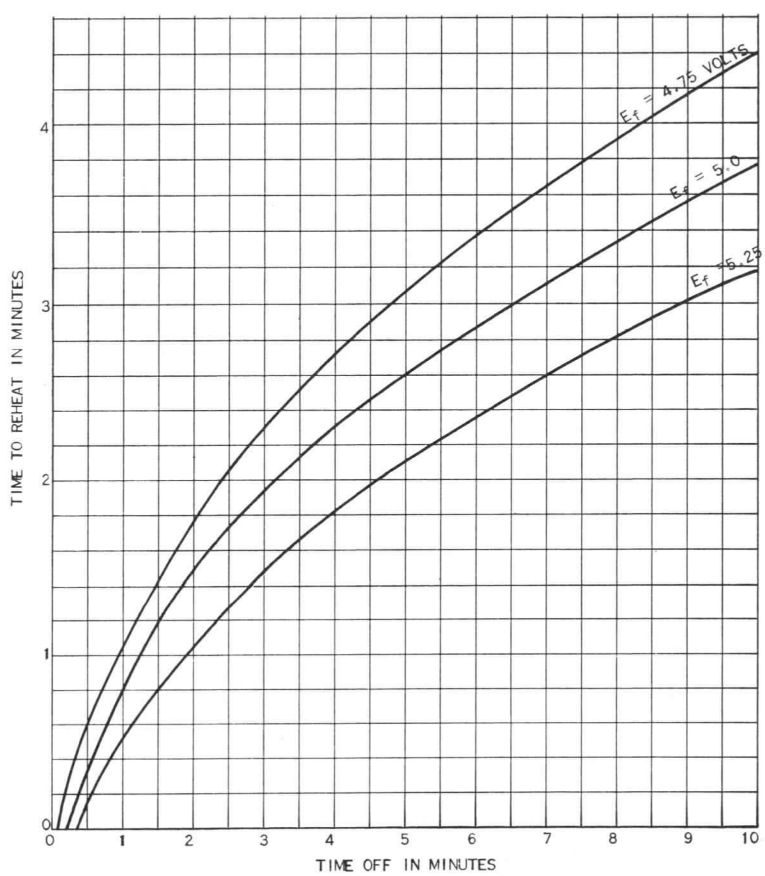
CATHODE REHEATING CURVE
ANODE VOLTAGE=0



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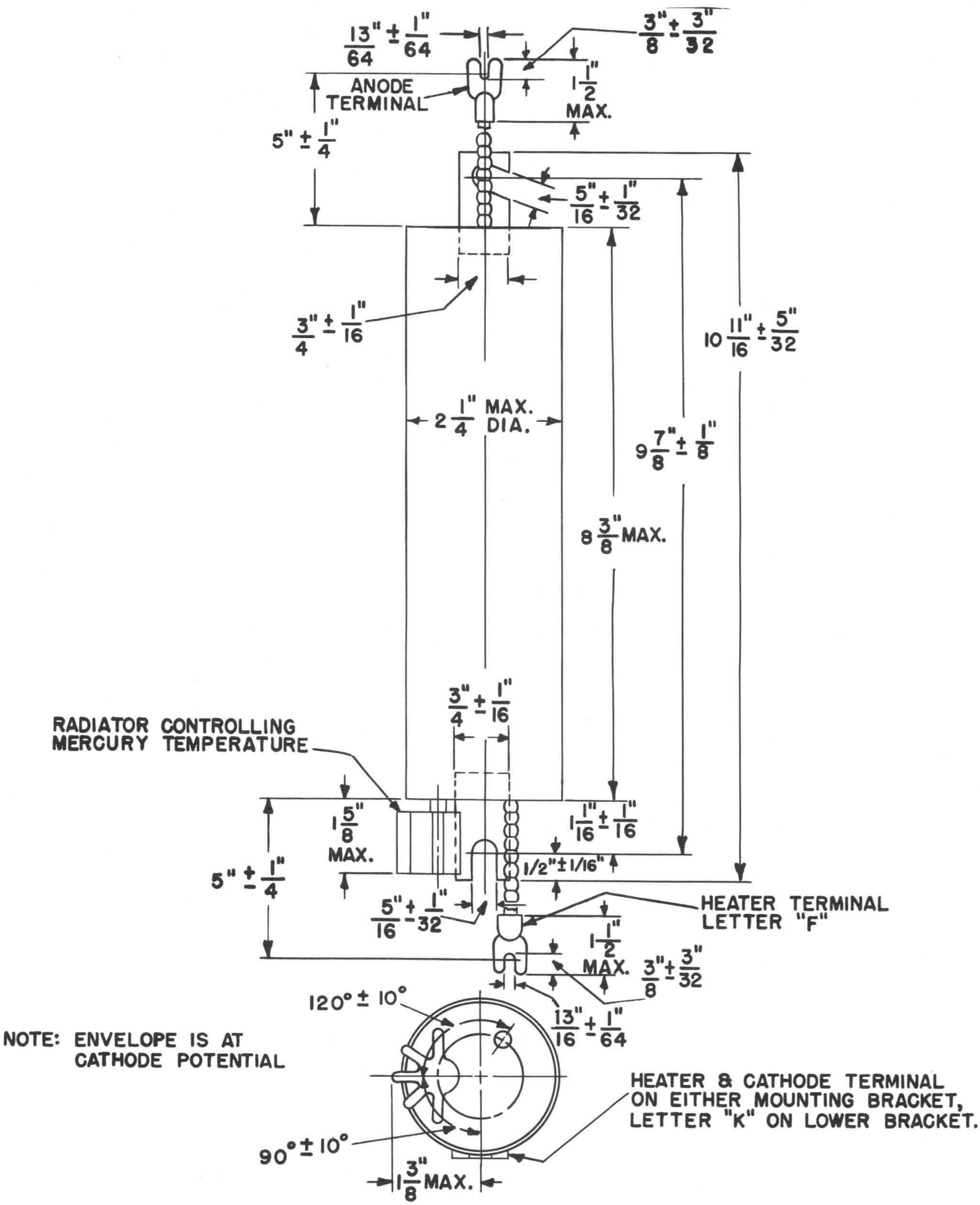
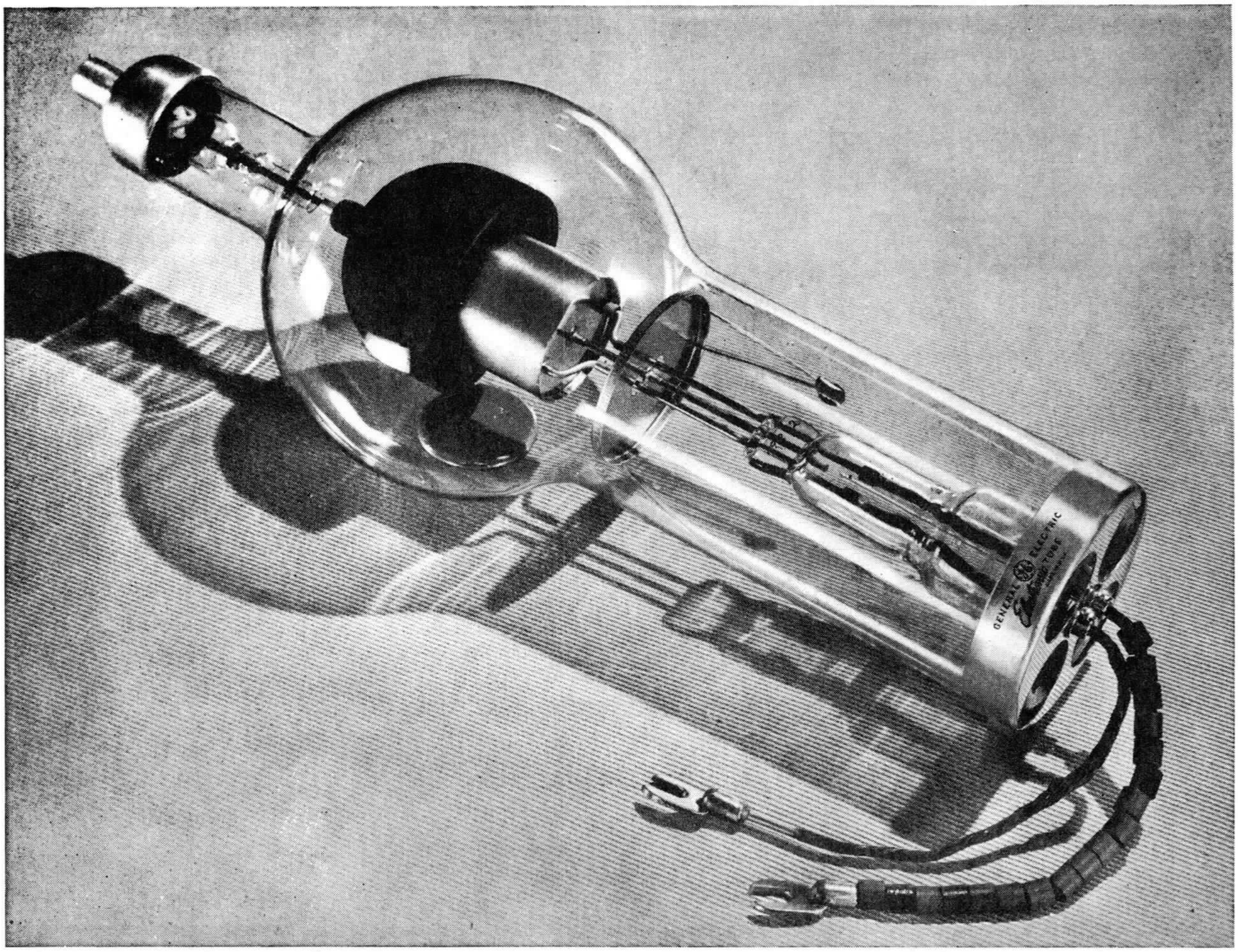

13/64" ± 1/64"
3/8" ± 3/32"
ANODE TERMINAL
1 1/2" MAX.
5" ± 1/4"
5/16" ± 1/32"
3/4" ± 1/16"
10 11/16" ± 5/32"
2 1/4" MAX. DIA.
9 7/8" ± 1/8"
8 3/8" MAX.
3/4" ± 1/16"
RADIATOR CONTROLLING MERCURY TEMPERATURE
1 5/8" MAX.
1 1/16" ± 1/16"
1/2" ± 1/16"
5" ± 1/4"
5/16" ± 1/32"
HEATER TERMINAL LETTER "F"
1 1/2" MAX.
3/8" ± 3/32"
13/16" ± 1/64"
120° ± 10°
NOTE: ENVELOPE IS AT CATHODE POTENTIAL
HEATER & CATHODE TERMINAL ON EITHER MOUNTING BRACKET, LETTER "K" ON LOWER BRACKET.
90° ± 10°
1 3/8" MAX.

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.

PRINTED IN U.S.A.



PHANOTRON

The GL-857-B is a half-wave, mercury-vapor rectifier tube for use in the high voltage field. The low voltage drop characteristic inherent in mercury-vapor tubes, together with other features of design and construction assure maximum efficiency of operation in many different rectifier applications.

GENERAL

Electrical

	Minimum	Bogey	Maximum	
Filament Voltage	4.75	5	5.25	Volts
Filament Current at 5 Volts	—	30	33	Amperes
Cathode Heating Time	60	—	—	Seconds
Anode Voltage Drop	—	15	—	Volts
Critical Anode Voltage	—	—	100	Volts

Mechanical

Type of Cooling—Convection or Forced Air

Equilibrium Condensed-Mercury Temperature Rise above Ambient

At Full Load, approximate .... 15 C

At No Load, approximate .... 11.5 C

Mounting Position—Vertical, Base Down

Net Weight, maximum .... 3.5 Pounds

MAXIMUM RATINGS, Absolute Values

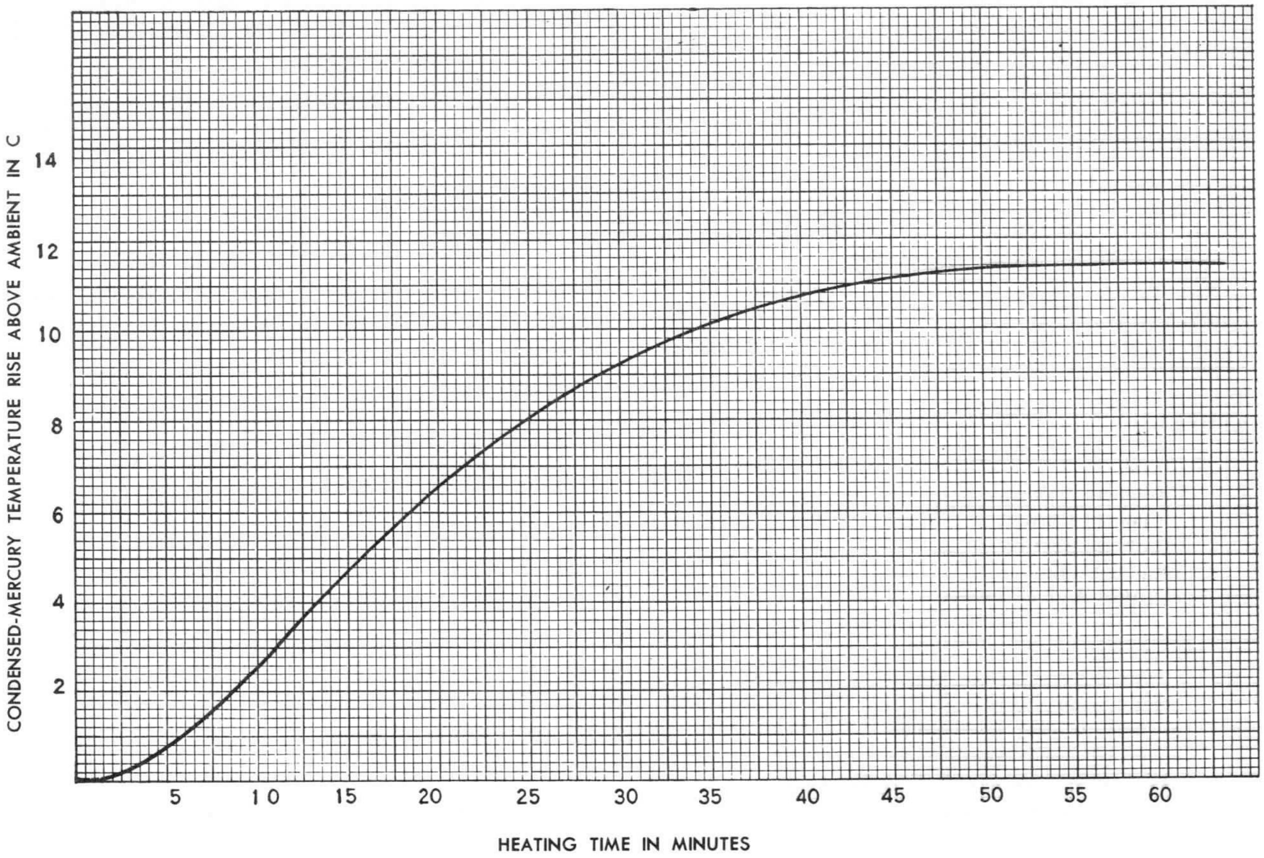
	Convection	Forced Air	
Maximum Peak Inverse Anode Voltage	10,000	22,000	Volts
Condensed-Mercury Temperature Limits	+25 to +60	+30 to +40	C
Maximum Cathode Current			
Peak	40	40	Amperes
Average	10	10	Amperes
Maximum Averaging Time	30	30	Seconds
Fault	400	400	Amperes
Maximum Duration	0.2	0.2	Seconds
Maximum Frequency	150	150	Cycles per Second

X-RAY WARNING NOTICE

This device may produce X-rays when energized. X-ray warning signs or labels should be permanently attached to the equipment.

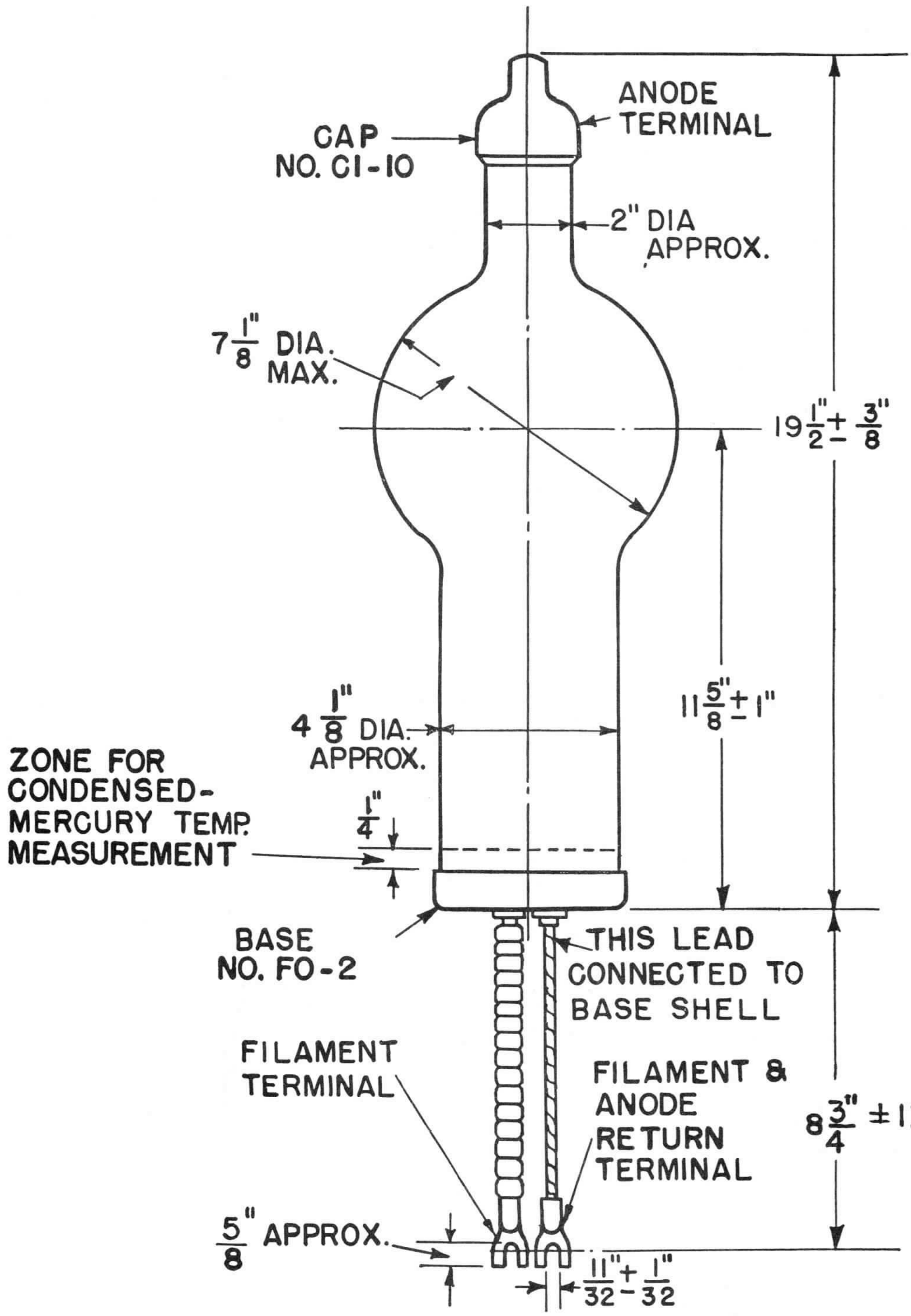
Precautions must be exercised during the service and operation of equipment to assure that any shielding components are replaced to their intended position before the equipment is operated.

RATE OF RISE OF
CONDENSED-MERCURY TEMPERATURE
$E_f = 4.75$ VOLTS



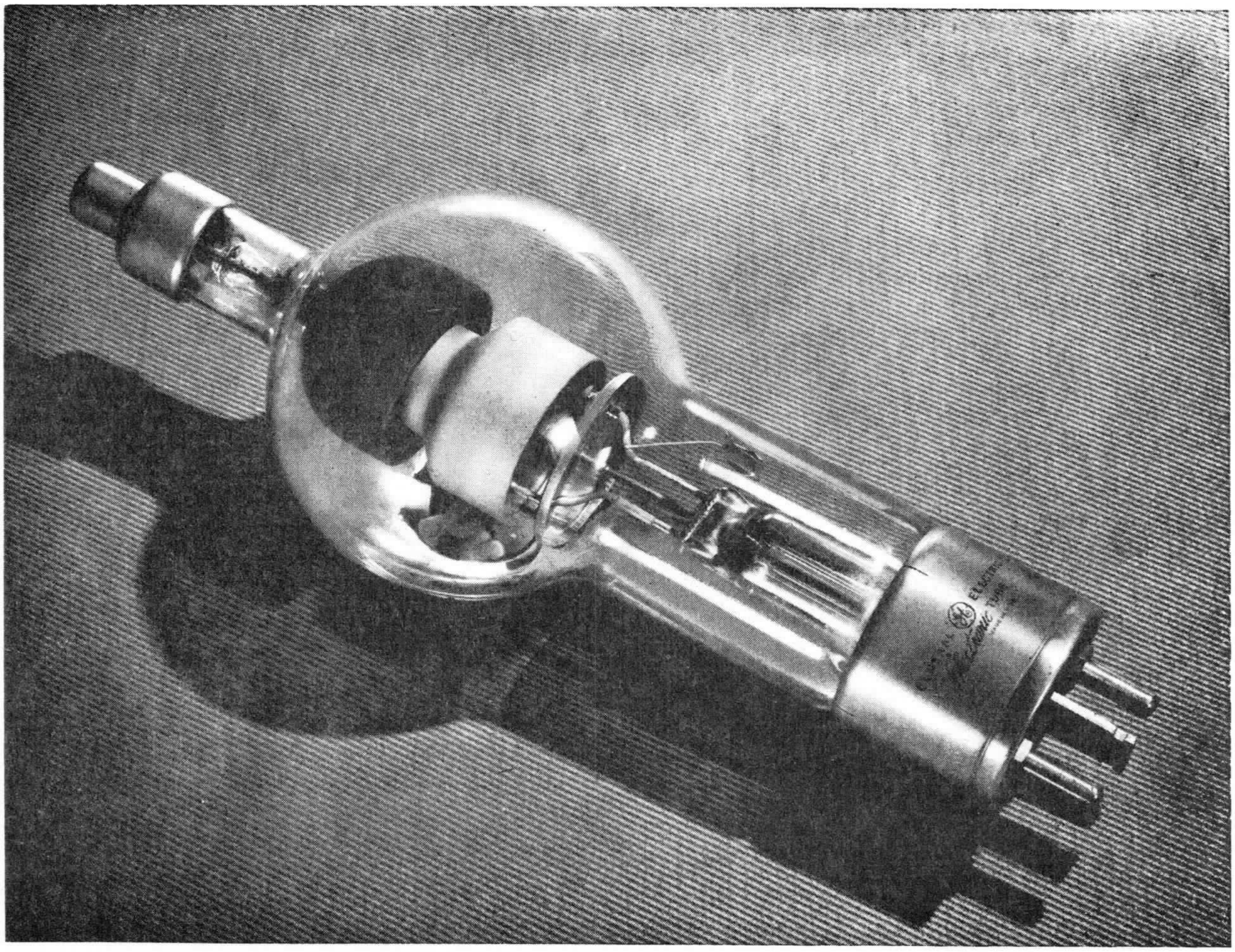
K-69087-72A134

4-10-47



K-4903593

1-23-51



PHANOTRON

The GL-869-B is a half-wave, mercury-vapor rectifier tube for use in broadcast transmitters and other applications where high d-c voltages are required. The cathode is designed for economical, long-life operation.

GENERAL

Electrical

	Minimum	Bogey	Maximum	
Filament Voltage	4.75	5.0	5.25	Volts
Filament Current at 5.0 Volts	....	19	21	Amperes
Cathode Heating Time	60	....	....	Seconds
Anode Voltage Drop	....	15	....	Volts
Critical Anode Voltage	....	....	100	Volts

GENERAL (CONT'D)

Mechanical

Type of Cooling—Convection or Forced Air
Equilibrium Condensed-Mercury Temperature Rise above Ambient
At Full Load, approximate .... 20 C
At No Load, approximate .... 15 C
Mounting Position—Vertical, Base Down
Net Weight, maximum .... 1.6 Pounds

MAXIMUM RATINGS, Absolute Values

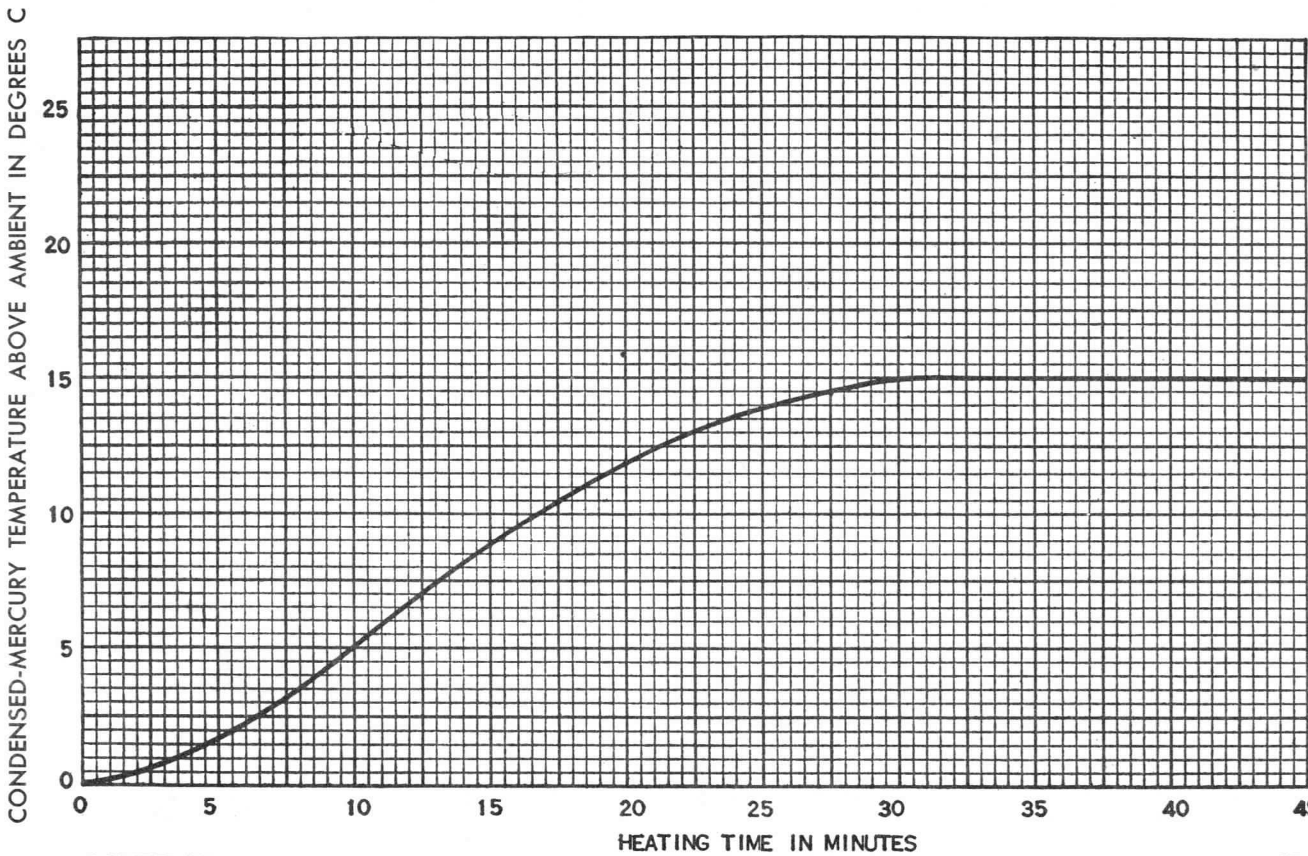
Maximum Peak Inverse Anode Voltage	10,000	15,000	20,000	Volts
Condensed-Mercury Temperature Limits	30 to 60	30 to 50	30 to 40	C
Maximum Cathode Current				
Peak				
In-Phase Operation	10	10	10	Amperes
Quadrature Operation	20	20	10	Amperes
Average				
In-Phase Operation	2.5	2.5	2.5	Amperes
Quadrature Operation	5	5	2.5	Amperes
Maximum Averaging Time	30	30	30	Seconds
Fault	100	100	100	Amperes
Maximum Duration	0.1	0.1	0.1	Seconds
Maximum Frequency	150	150	150	Cycles per Second

X-RAY WARNING NOTICE

This device may produce X-rays when energized. X-ray warning signs or labels should be permanently attached to the equipment.

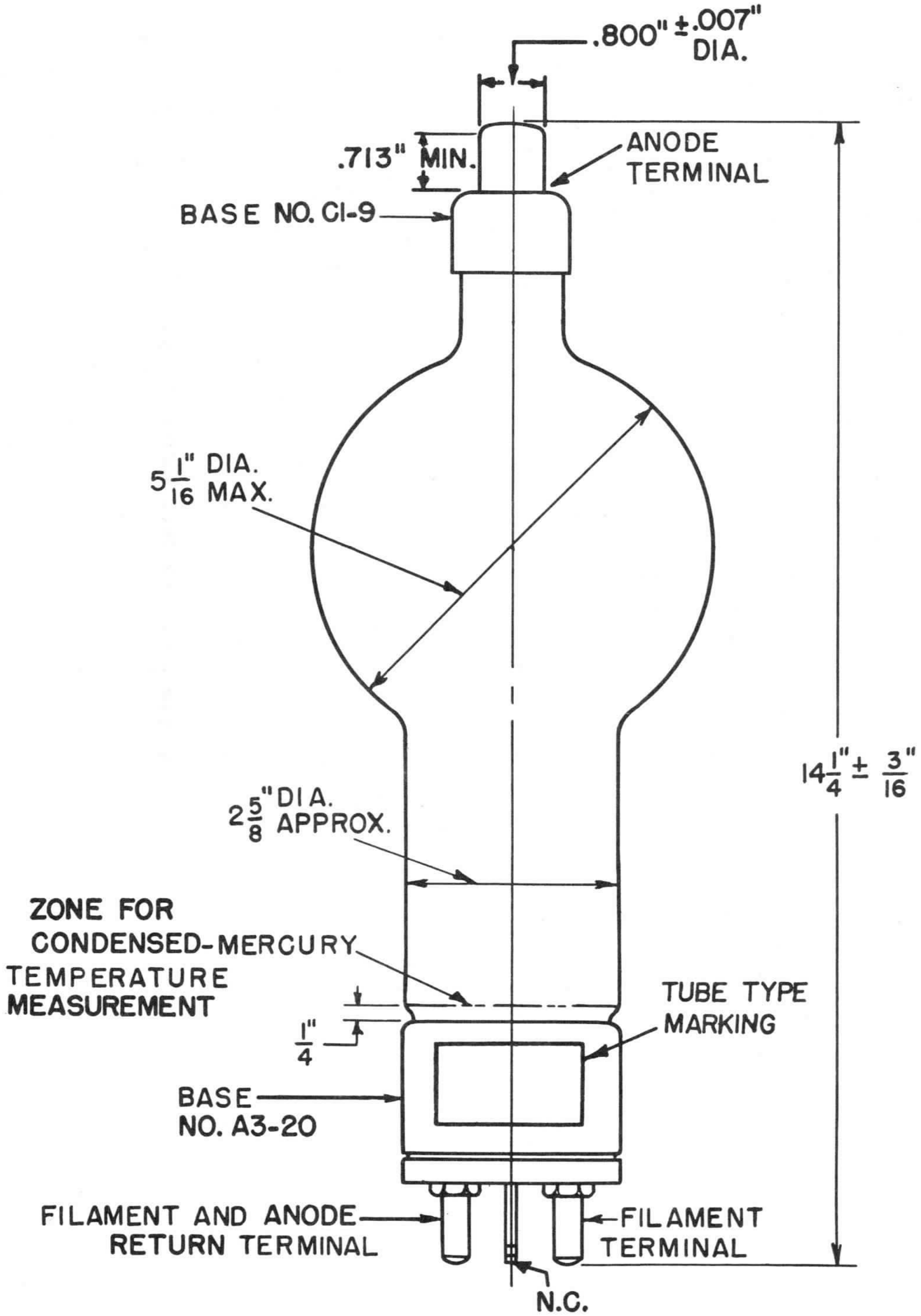
Precautions must be exercised during the service and operation of equipment to assure that any shielding components are replaced to their intended position before the equipment is operated.

RATE OF RISE OF
CONDENSED-MERCURY TEMPERATURE
$E_f = 4.75$ VOLTS



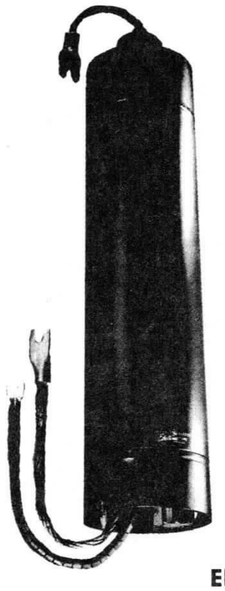
K-69087-72A133

2-17-49



K-4909011

2-14-58



GL-870-A

RECTIFIER

HALF-WAVE **MERCURY-VAPOR**

75 AMPERES

The GL-870-A is a heavy duty, half-wave mercury-vapor rectifier tube containing a heater-cathode of the equipotential type. The cathode consists of a coated cylinder heated by means of an enclosed tungsten filament (heater). The cathode is connected to one side of the heater within the tube.

Electrical

Number of Electrodes	2	
Cathode—Coated Unipotential		
Voltage	5.0	Volts
Current, approximate	65.0	Amperes
Transformer Power, for design purposes	400	Watts
Heating Time, typical	30	Minutes
Peak Voltage Drop, typical	16	Volts

Mechanical

Net Weight, approximate	25	Pounds
Shipping Weight, approximate	40	Pounds
Mounting Position—Vertical, Leads Down		

Thermal

Type of Cooling—Forced Air

MAXIMUM RATINGS

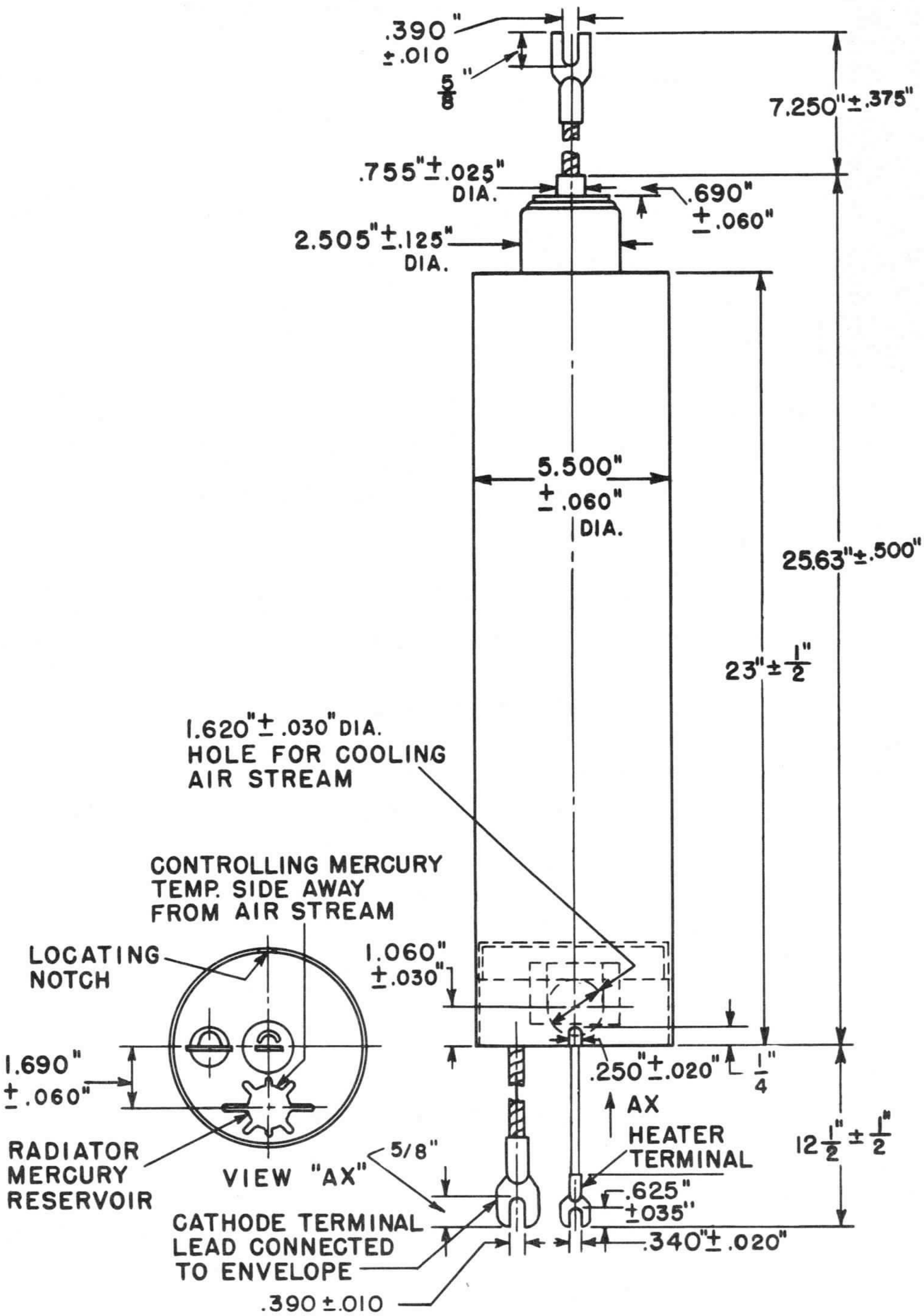
Condensed-Mercury Temperature	+35 to +40	+35 to +50	C
Maximum Peak Inverse Anode Voltage, 150 cycles or less	16,000	7500	Volts
Maximum Anode Current			
Instantaneous, 25 cycles and above	450	450	Amperes
Average	75	75	Amperes
Surge, for design only	4500	4500	Amperes
Maximum Time of Averaging Current	60	60	Seconds
Maximum Time of Surge Anode Current	0.2	0.2	Seconds

X-RAY WARNING NOTICE

This device may produce X-rays when energized. X-ray warning signs or labels should be permanently attached to the equipment.

Precautions must be exercised during the service and operation of equipment to assure that any shielding components are replaced to their intended position before the equipment is operated.

GENERAL ELECTRIC



K-6979159

TUBE PRODUCTS DEPARTMENT
GENERAL ELECTRIC
Schenectady, New York 12305

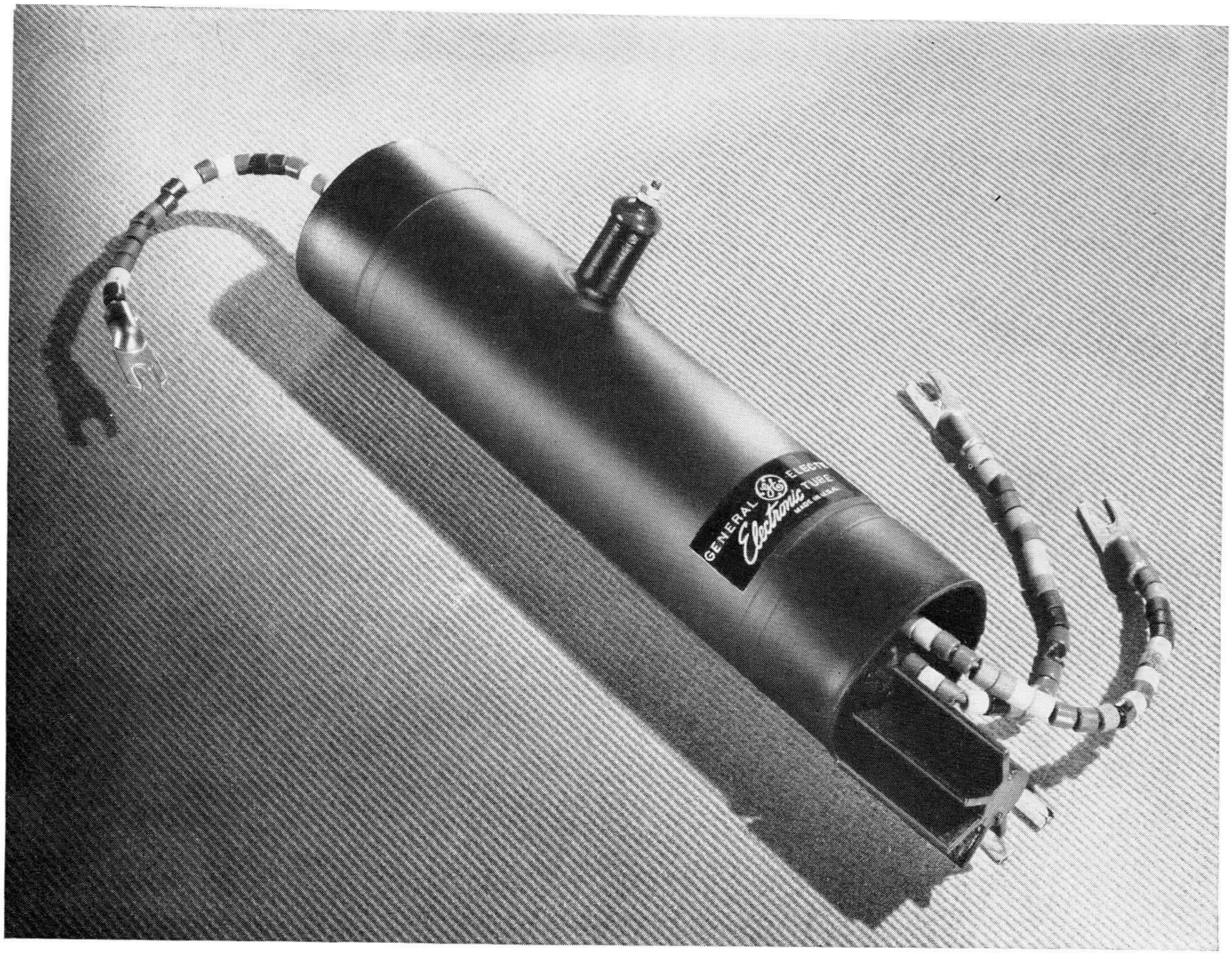
RECOMMENDED TYPES AND SELECTION CHART

Thyratrons

Maximum Cathode Current in Amperes			Max Peak Inverse Voltage	Control Characteristics			Cathode		Temperature Range C	Type
Average	Peak	Fault		At 100 Volts	Intermediate Voltage	At 1000 Volts	Heater Volts	Heater Amperes		
0.2 / 0.1	1.0	10	360 / 1300	−1.3	−3.3@650V	......	6.3	0.6	−75 to +90	2050-A
2.5	30	250	1500 / 3500	−1.0		−6.5@1500V / −9.0@3500V	2.5	9.0	−40 to +80	GL-6011/710, GL-7518 / GL-7725, GL-7726
6.4	77	400	2000	+2.0	....	−9.0	5.0	10.0	+30 to +95	FG-172
12.5	75	1500	10,000	....	−6.0@8000V	+1.0	5.0	20.0	+40 to +65	GL-5830
	100	1500	3000	....	0@200V	−10.0	5.0	19.0	+40 to +80	GL-414

Supersedes ET-T1469B dated 10-61

PRINTED IN U.S.A.



THYRATRON

The FG-172 is a double-grid, mercury-vapor thyratron. Double-grid tubes are designed for applications where the grid is actuated from a high-impedance source and where the available grid power is very small. The all-metal construction results in a sturdy tube for industrial applications.

GENERAL

Number of Electrodes 4

Electrical	Continuous Service		Welder-Control Service		
Cathode—Indirectly Heated					
Voltage	5.0			5.5	Volts
Current, approximate	10.0			11.0	Amperes
Heating Time, typical	5			5	Minutes
Peak Voltage Drop, typical	16			16	Volts
Control Characteristics, approximate					
Anode Voltage	100	2000	100	2000	Volts
Shield-Grid Voltage	0	0	0	0	Volt
Control-Grid Voltage	+1.0	−14	+1.0	−14	Volts
Anode to Grid Capacitance, approximate	0.07			0.07	$\mu\mu f$
Ionization Time, approximate	10			10	Microseconds
Deionization Time, approximate	1000			1000	Microseconds

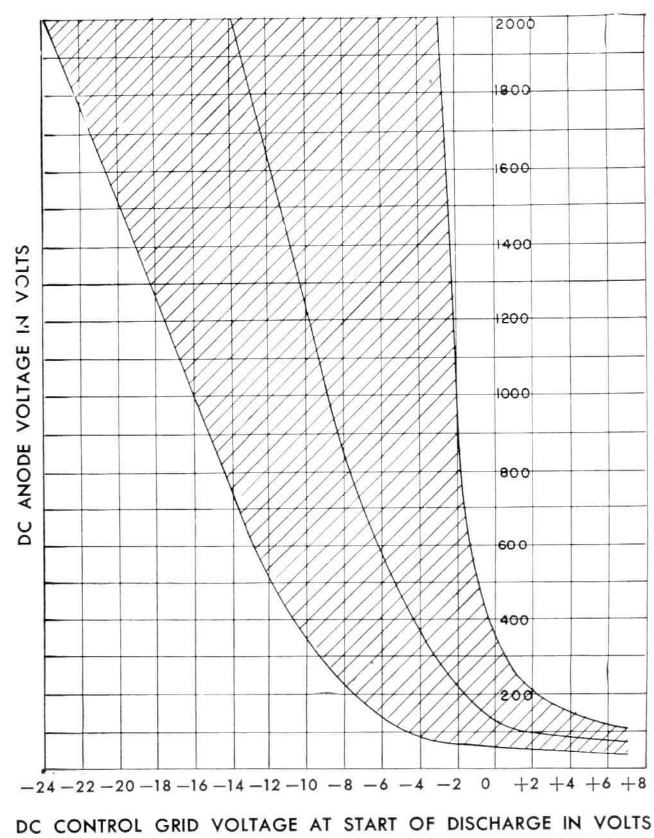
Mechanical

Net Weight, approximate .... 22 Ounces
Shipping Weight, approximate .... 7 Pounds
Mounting Position—Vertical, Radiator Down

MAXIMUM RATINGS

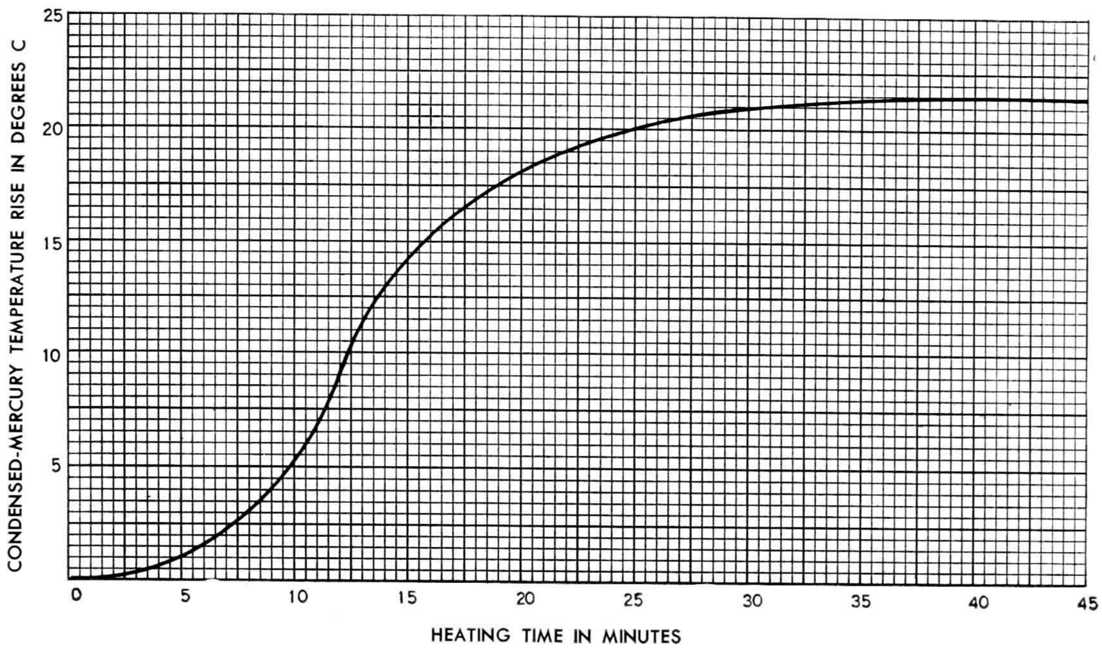
	Continuous Service	Welder-Control Service	
Maximum Peak Anode Voltage			
Inverse	2000	750	Volts
Forward	2000	750	Volts
Maximum Negative Control-Grid Voltage			
Before Conduction	1000	1000	Volts
During Conduction	10	10	Volts
Maximum Negative Shield-Grid Voltage			
Before Conduction	300	300	Volts
During Conduction	5.0	5.0	Volts
Maximum Anode Current			
Instantaneous, 25 cycles and above	40	77	Amperes
Instantaneous, below 25 cycles	13.0	13.0	Amperes
Average	6.4	2.5	Amperes
Surge, for design only	400	400	Amperes
Maximum Duration	0.1	0.1	Seconds
Maximum Control-Grid Current			
Instantaneous	1.0	1.0	Ampere
Average	0.25	0.25	Amperes
Maximum Shield-Grid Current			
Instantaneous	2.0	2.0	Amperes
Average	0.50	0.50	Amperes
Maximum Averaging Time	15	15	Seconds
Temperature Limits, condensed mercury	+40 to +80	+30 to +95	C
Recommended Temperature, condensed mercury	40	40	C

TYPICAL CONTROL CHARACTERISTIC
SHADED AREA SHOWS RANGE OF CHARACTERISTIC
CONDENSED-MERCURY TEMP 40 C, SHIELD GRID CONNECTED TO CATHODE



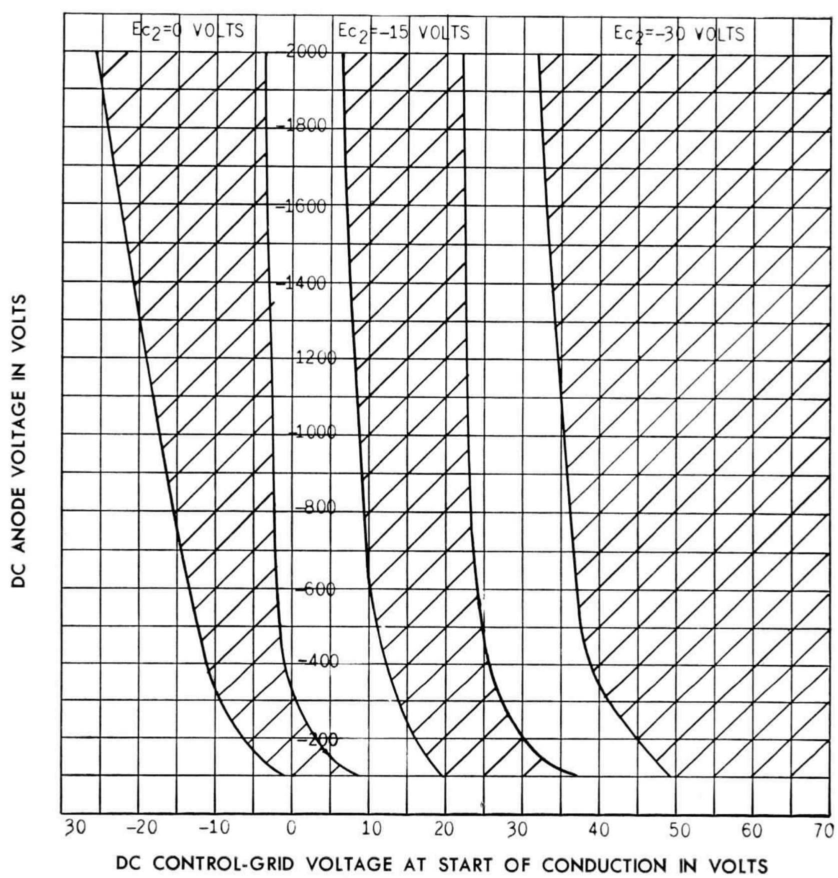
K-8639645 6-27-44

RATE OF RISE OF CONDENSED-
MERCURY TEMPERATURE ABOVE AMBIENT
$E_f = 4.75$ VOLTS



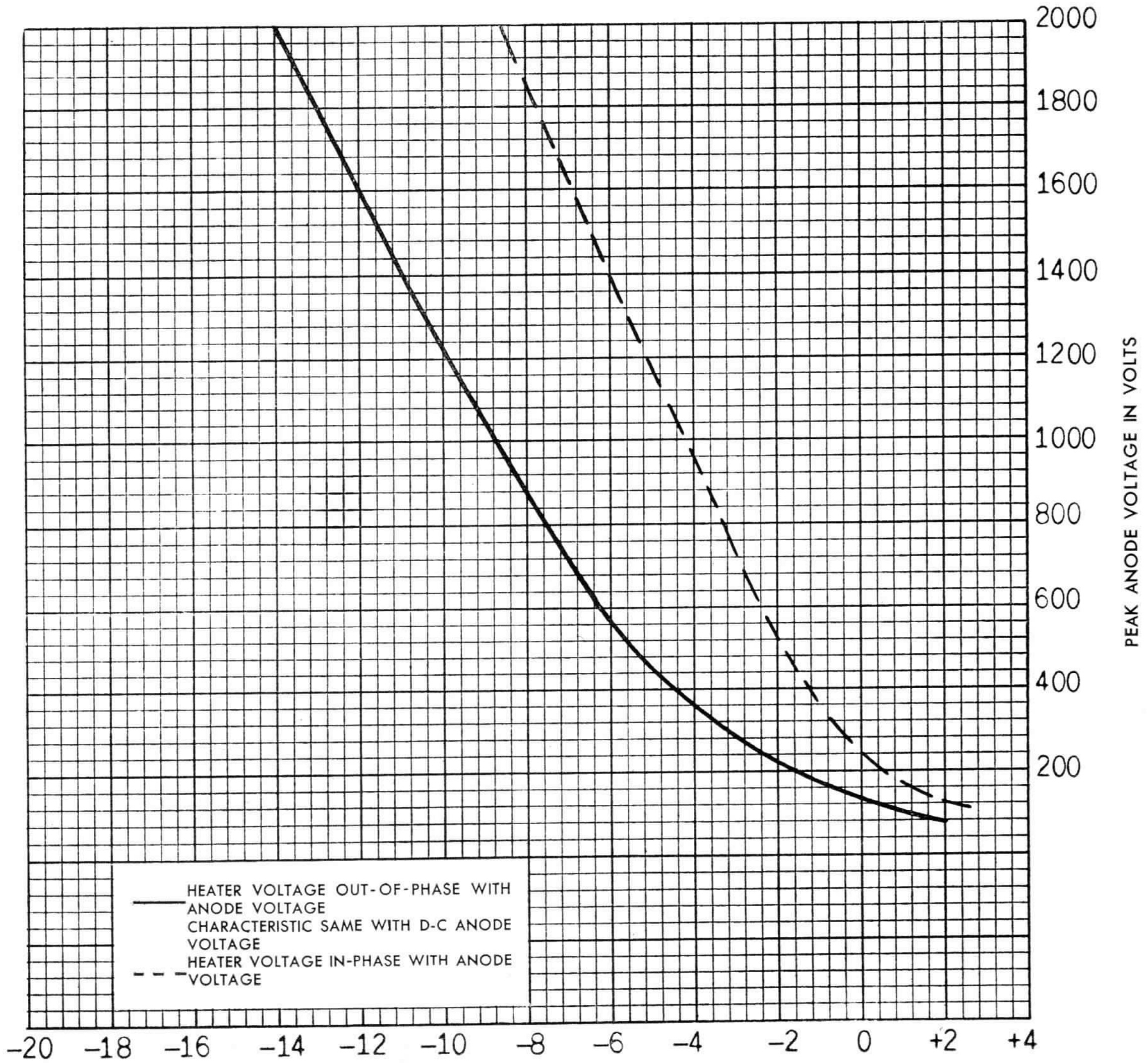
N-21526ZA 3-10-47

RANGE OF CHARACTERISTICS VS SHIELD-GRID VOLTAGES
CONDENSED MERCURY TEMPERATURE 40C



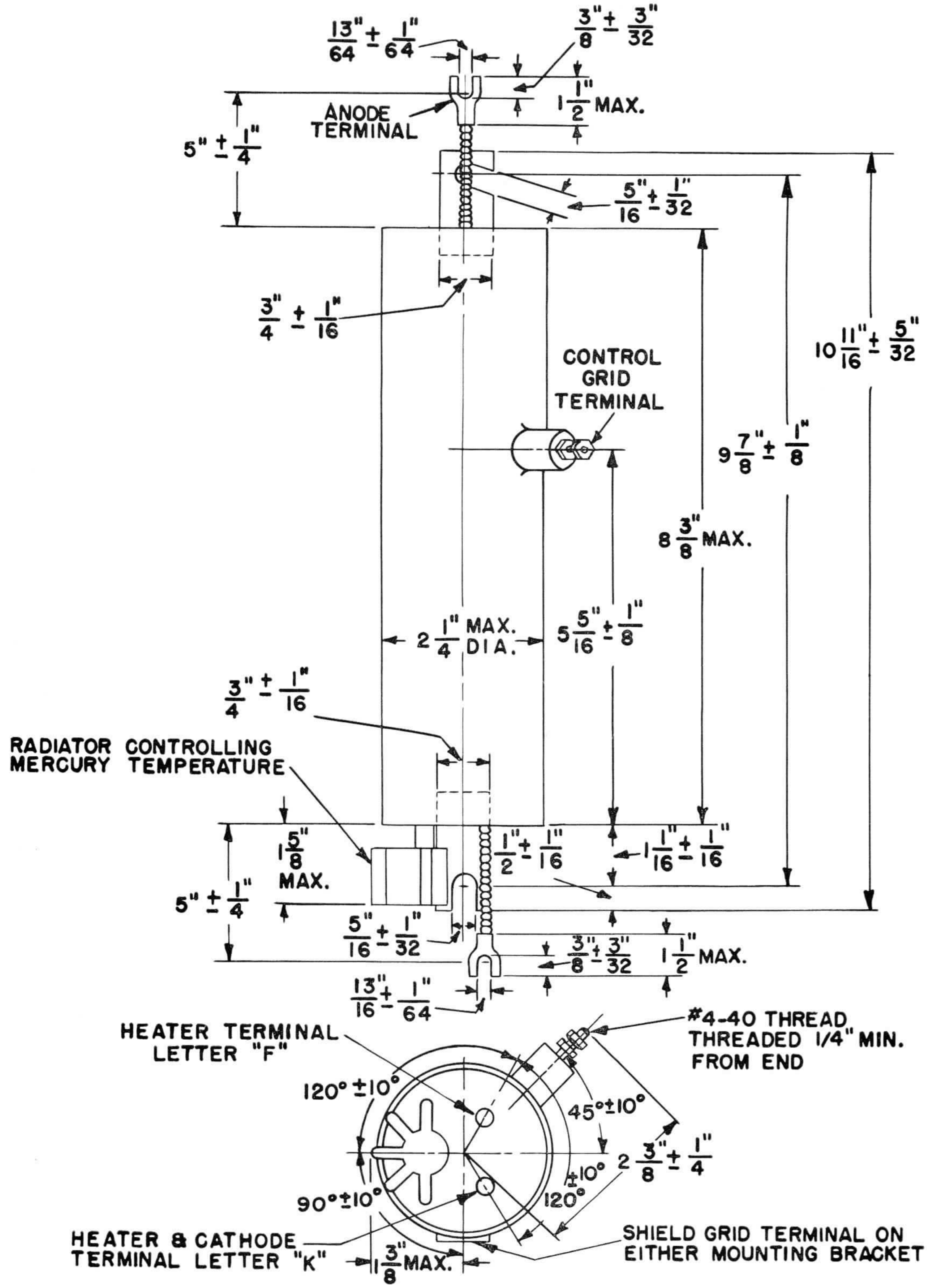
K-9186170 6-17-46

TYPICAL VARIATION OF CONTROL CHARACTERISTIC
WITH A HEATER PHASE VARIATION OF 180 DEGREES
CONDENSED-MERCURY TEMPERATURE 40 C, $E_f = 5.0$ VOLTS, $E_C2 = 0$



K-69087-72A22

5-13-46

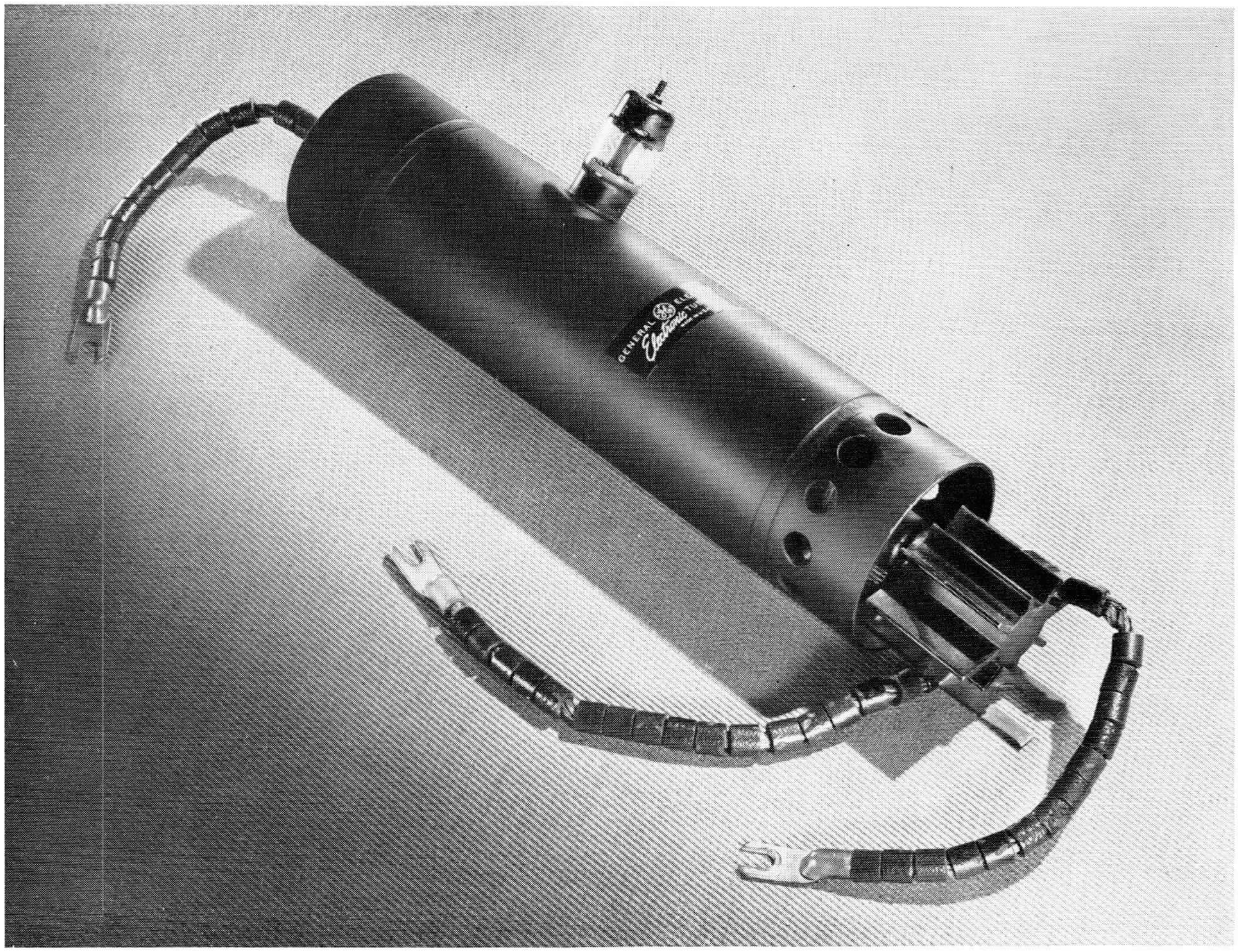

ANODE TERMINAL
CONTROL GRID TERMINAL
RADIATOR CONTROLLING MERCURY TEMPERATURE
HEATER TERMINAL LETTER "F"
#4-40 THREAD THREADED 1/4" MIN. FROM END
HEATER & CATHODE TERMINAL LETTER "K"
SHIELD GRID TERMINAL ON EITHER MOUNTING BRACKET
2 1/4" MAX. DIA.
8 3/8" MAX.
1 1/2" MAX.
1 5/8 MAX.
1 3/8" MAX.
120° ±10°
90° ±10°
45° ±10°

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Schenectady 5, N. Y.

PRINTED IN U.S.A.



THYRATRON

The GL-414 is a three-electrode, mercury-vapor, metal thyratron with negative control characteristic. This tube is designed for industrial use in welder-control and grid-control-rectifier applications.

GENERAL

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage	4.75	5.0	5.25	Volts
Heater Current at 5.0 Volts	...	19.0	22.5	Volts
Cathode Heating Time Required	10	...	...	Minutes
Anode-to-Control Grid Capacitance	...	0.1	...	$\mu\mu f$
Control Grid-to-Cathode Capacitance	...	6.5	...	$\mu\mu f$
Deionization Time, approximate				
$E_b = 120$ v d-c; $I_b = 12.5$ a d-c; $R_g = 1000$ ohms				
$E_{cc} = -20$ v d-c	...	2200	...	Microseconds
$E_{cc} = -1000$ v d-c	...	900	...	Microseconds
Ionization Time, approximate				
$E_b = 100$ v; $I_b = 100$ amperes				
$E_c = +30$ v	...	8	...	Microseconds
Anode Voltage Drop	...	20	...	Volts
Critical Grid Current at $E_p = 220$ v a-c	...	...	12	Microamperes

Supersedes ET-T1509 dated 12-58

Mechanical

Type of Cooling—Convection

Equilibrium Condensed-Mercury Temperature Rise above Ambient

At Full Load, approximate	26 C
At No Load, approximate	23 C

Mounting Position—Vertical, Radiator Down

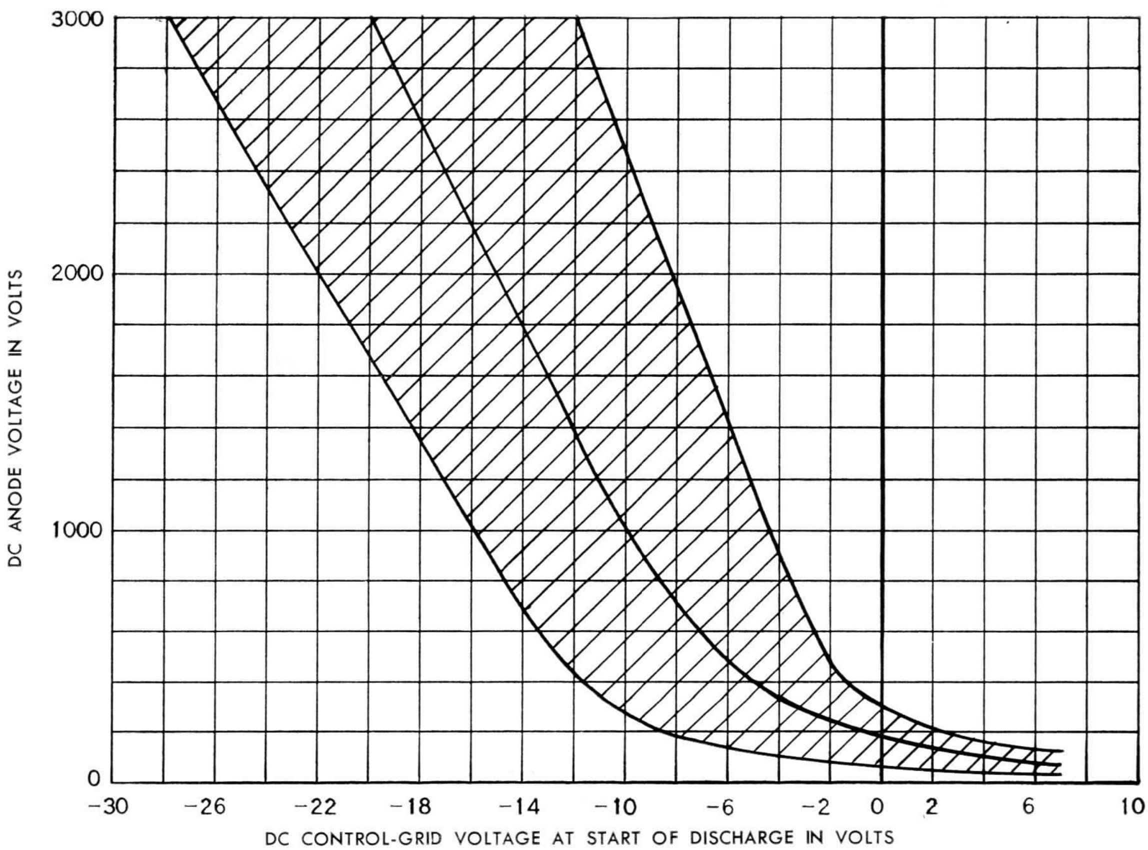
Net Weight, maximum	4 Pounds

MAXIMUM RATINGS, Absolute Values

Maximum Peak Anode Voltage			
Inverse	3000	2000	Volts
Forward	3000	2000	Volts
Maximum Cathode Current			
Peak	100	100	Amperes
Average	5	12.5	Amperes
Maximum Averaging Time	30	30	Seconds
Surge	1500	1500	Amperes
Maximum Duration	0.1	0.1	Second
Maximum Negative Control-Grid Voltage			
Before Conduction	1000	1000	Volts
During Conduction	10	10	Volts
Maximum Positive Control-Grid Current			
Average	1.0	1.0	Amperes
Averaging Time	1	1	Cycle
Condensed-Mercury Temperature Limits	+40 to +80	+40 to +80	C

CONTROL CHARACTERISTIC

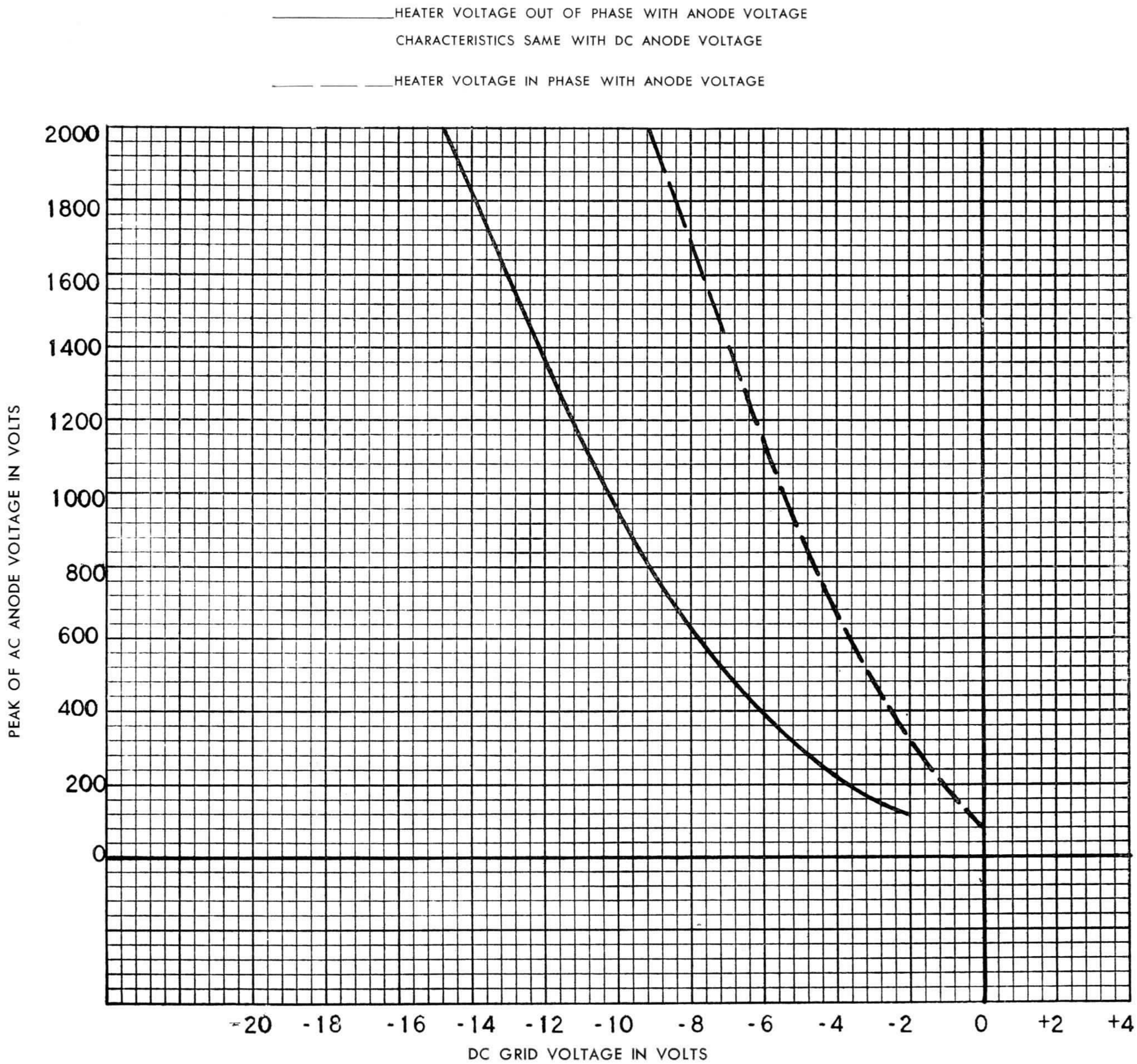
SHADED AREA SHOWS RANGE OF CHARACTERISTIC
CONDENSED-MERCURY TEMPERATURE +40 TO +80 C
E_f=4.75–5.25 VOLTS



K-69087-72A220

4-6-48

TYPICAL VARIATION OF CONTROL CHARACTERISTIC
WITH A HEATER PHASE VARIATION OF 180 DEGREES
CONDENSED-MERCURY TEMPERATURE +40 C, $E_f = 5.0$ VOLTS

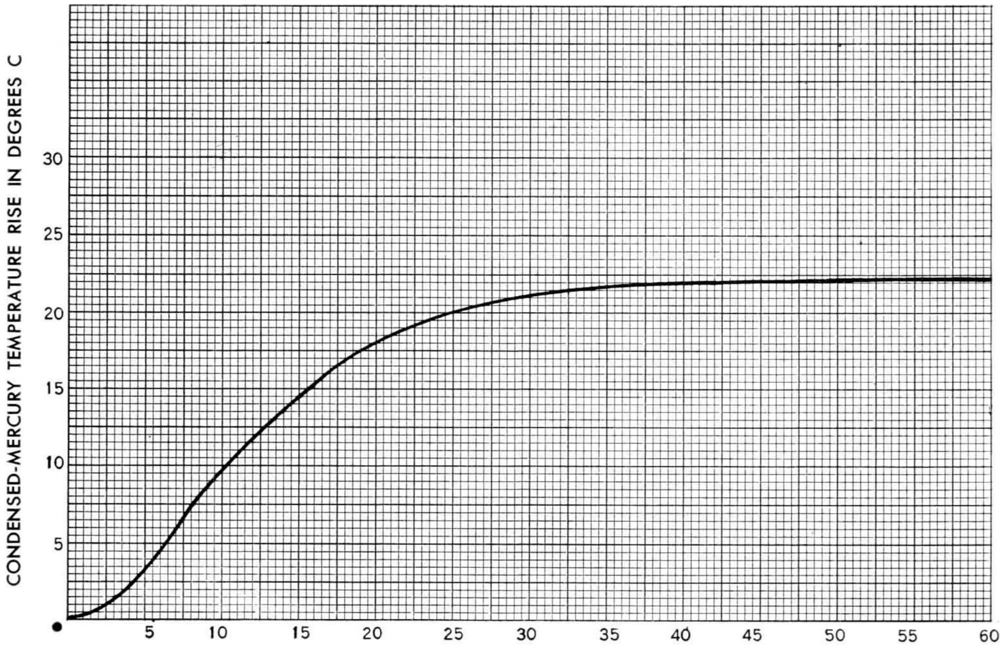


K-69087-72A19

4-2-48

RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE ABOVE AMBIENT

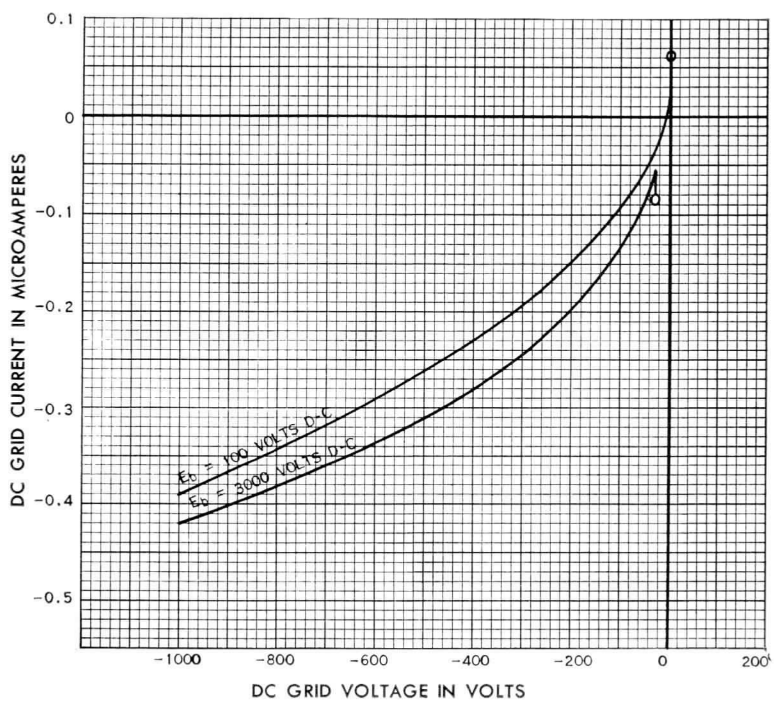
$E_f = 4.75$ VOLTS



K-69087-72A215 3-19-48

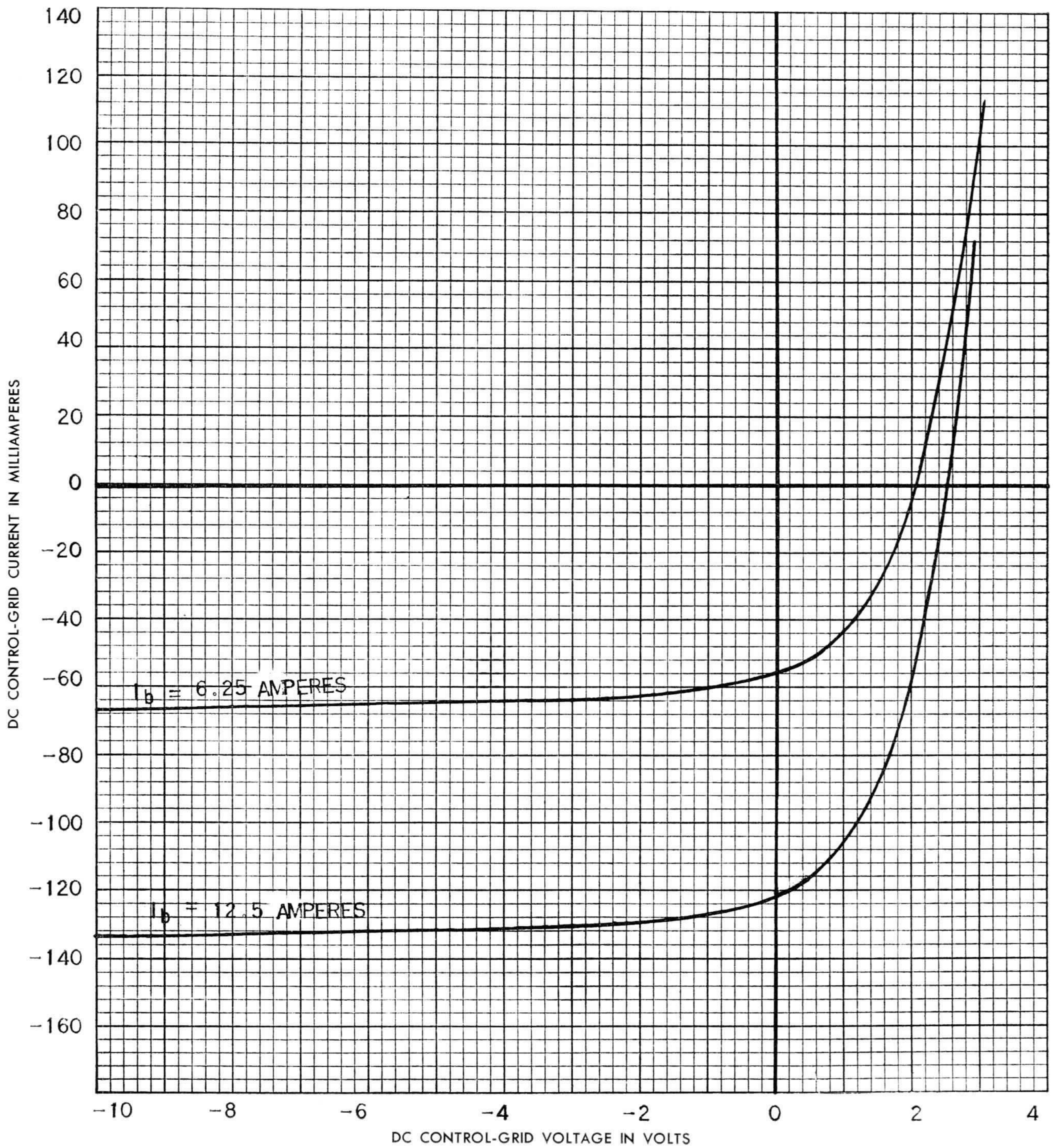
TYPICAL GRID CURRENT BEFORE ANODE CONDUCTION

$E_f = 5.0$ VOLTS 0—CONDUCTION STARTS



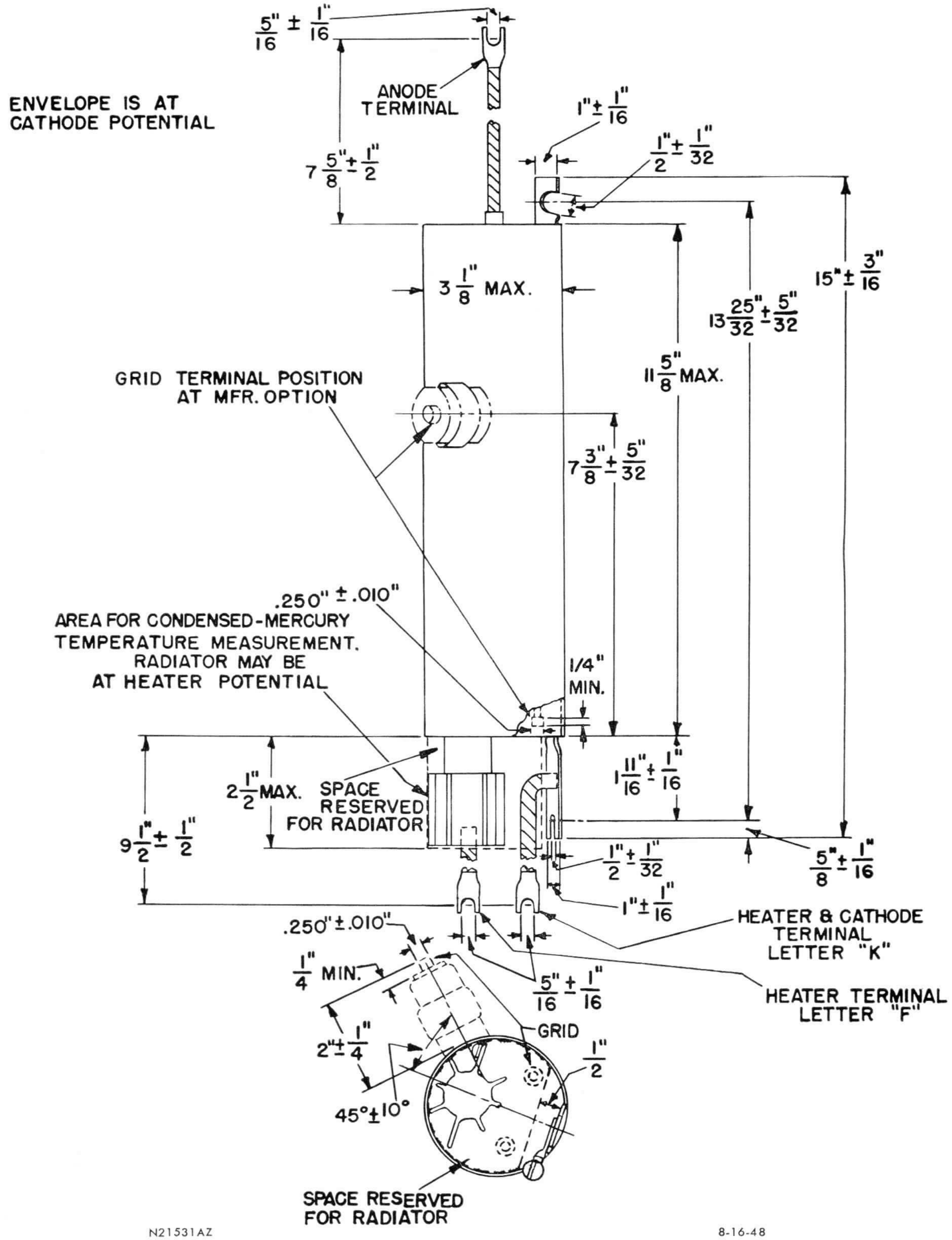
K-69087-72A221 4-13-48

TYPICAL CONTROL-GRID CHARACTERISTICS
DURING ANODE CONDUCTION
$E_f = 5.0$ VOLTS AC



K-59087-72A214

4-13-48


ENVELOPE IS AT CATHODE POTENTIAL
ANODE TERMINAL
GRID TERMINAL POSITION AT MFR. OPTION
3 1/8" MAX.
11 5/8" MAX.
13 25/32" ± 5/32
15" ± 3/16
7 5/8" ± 1/2
7 3/8" ± 5/32
.250" ± .010"
AREA FOR CONDENSED-MERCURY TEMPERATURE MEASUREMENT. RADIATOR MAY BE AT HEATER POTENTIAL
1/4" MIN.
2 1/2" MAX.
SPACE RESERVED FOR RADIATOR
9 1/2" ± 1/2
1 11/16" ± 1/16
5/8" ± 1/16
HEATER & CATHODE TERMINAL LETTER "K"
HEATER TERMINAL LETTER "F"
GRID
45° ± 10°
2" ± 1/4
SPACE RESERVED FOR RADIATOR
N21531AZ
8-16-48

2050-A

THYRATRON

The 2050-A is a four-electrode, inert-gas-filled thyratron for relay and grid-controlled-rectifier service. Features of the tube include a control characteristic independent of ambient temperature over a wide range, low grid-anode capacitance, low grid current, and high sensitivity. The 2050-A differs from the 2050 in having a T-9 envelope and a larger base.

ELECTRICAL

Cathode—Coated Unipotential

Heater Voltage, AC or DC	6.3 ±10%	Volts
Heater Current	0.6	Amperes
Cathode Heating Time, minimum	10	Seconds
Direct Interelectrode Capacitances, approximate*		
Grid-Number 1 to Anode	0.15	$\mu\mu f$
Grid-Number 1 to Cathode and Grid-Number 2	2.2	$\mu\mu f$

MECHANICAL

Mounting Position—Any
Envelope—T-9, Glass
Base—B6-229, Intermediate-Shell Octal 6-Pin or B8-142, Intermediate-Shell Octal 8-Pin

THERMAL

Type of Cooling—Air

MAXIMUM RATINGS, ABSOLUTE VALUES

Peak Anode Voltage			
Inverse	360	1300	Volts
Forward	180	650	Volts
Cathode Current			
Peak	1.0	1.0	Amperes
Average	0.2	0.1	Amperes
Maximum Averaging Time	30	30	Seconds
Fault	10	10	Amperes
Maximum Duration	0.1	0.1	Seconds
Negative Control-Grid Voltage			
Before Conduction	250	250	Volts
During Conduction	10	10	Volts
Positive Control-Grid Current			
Average, Averaging Time One Cycle	0.01	0.01	Amperes
Negative Shield-Grid Voltage			
Before Conduction	100	100	Volts
During Conduction	10	10	Volts
Positive Shield-Grid Current			
Average, Averaging Time One Cycle	0.01	0.01	Amperes
Heater-Cathode Voltage			
Heater Positive with Respect to Cathode	25	25	Volts
Heater Negative with Respect to Cathode	100	100	Volts
Ambient Temperature Limits	−75 to +90		C

Design-Maximum ratings are limiting values of operating and environmental conditions applicable to a bogey tube of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

These values are chosen by the tube manufacturer to provide acceptable serviceability of the tube, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration.

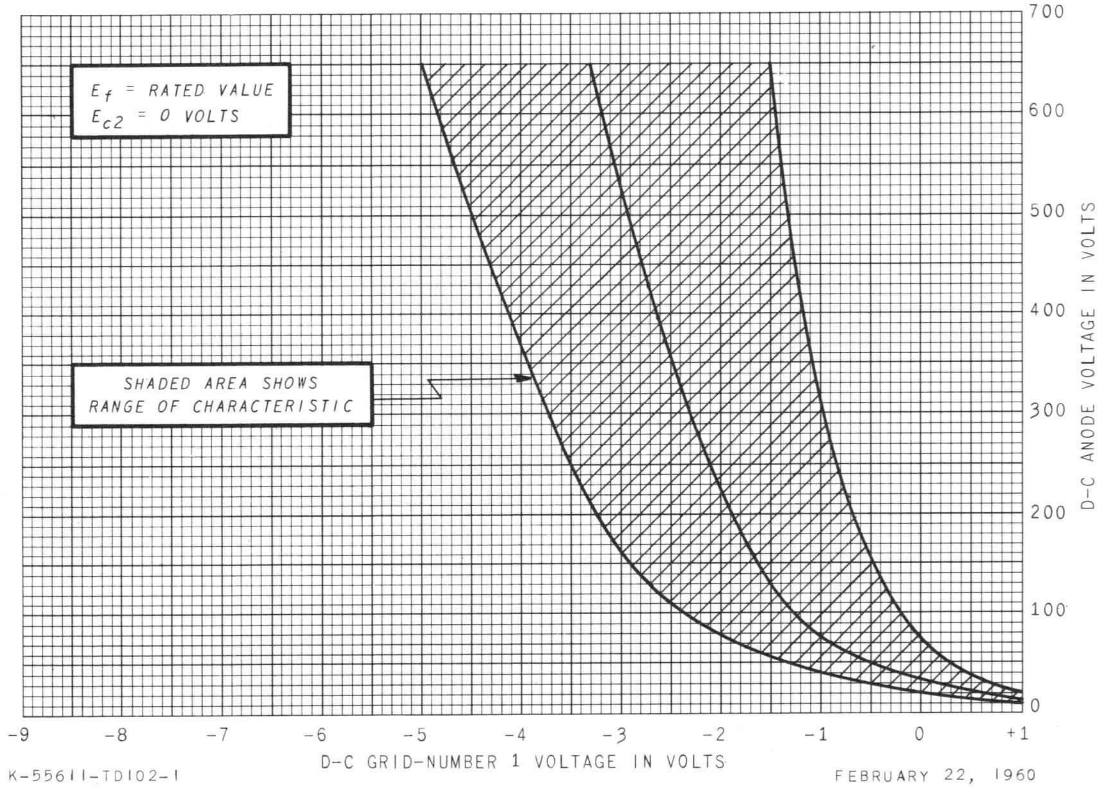
The equipment manufacturer should design so that initially and throughout life no design-maximum value for the intended service is exceeded with a bogey tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, variation in characteristics of all other tubes in the equipment, equipment control adjustment, load variation, signal variation, and environmental conditions.

TYPICAL OPERATION

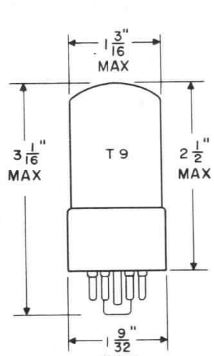
Ionization Time, approximate	0.5	Microseconds
Deionization Time, approximate		
Eb=125 volts, Ib=100 milliamperes, Rg=1000 ohms		
Ecc= −250 volts	50	Microseconds
Ecc= −10 volts	100	Microseconds
Anode Voltage Drop	8	Volts
Critical Grid Current, maximum		
Ebb=460 volts, RMS; Ib=100 milliamperes	0.5	Microamperes

* Without external shield.

AVERAGE CONTROL CHARACTERISTICS



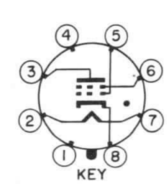
OUTLINE
(EIA 9-7)



TERMINAL CONNECTIONS

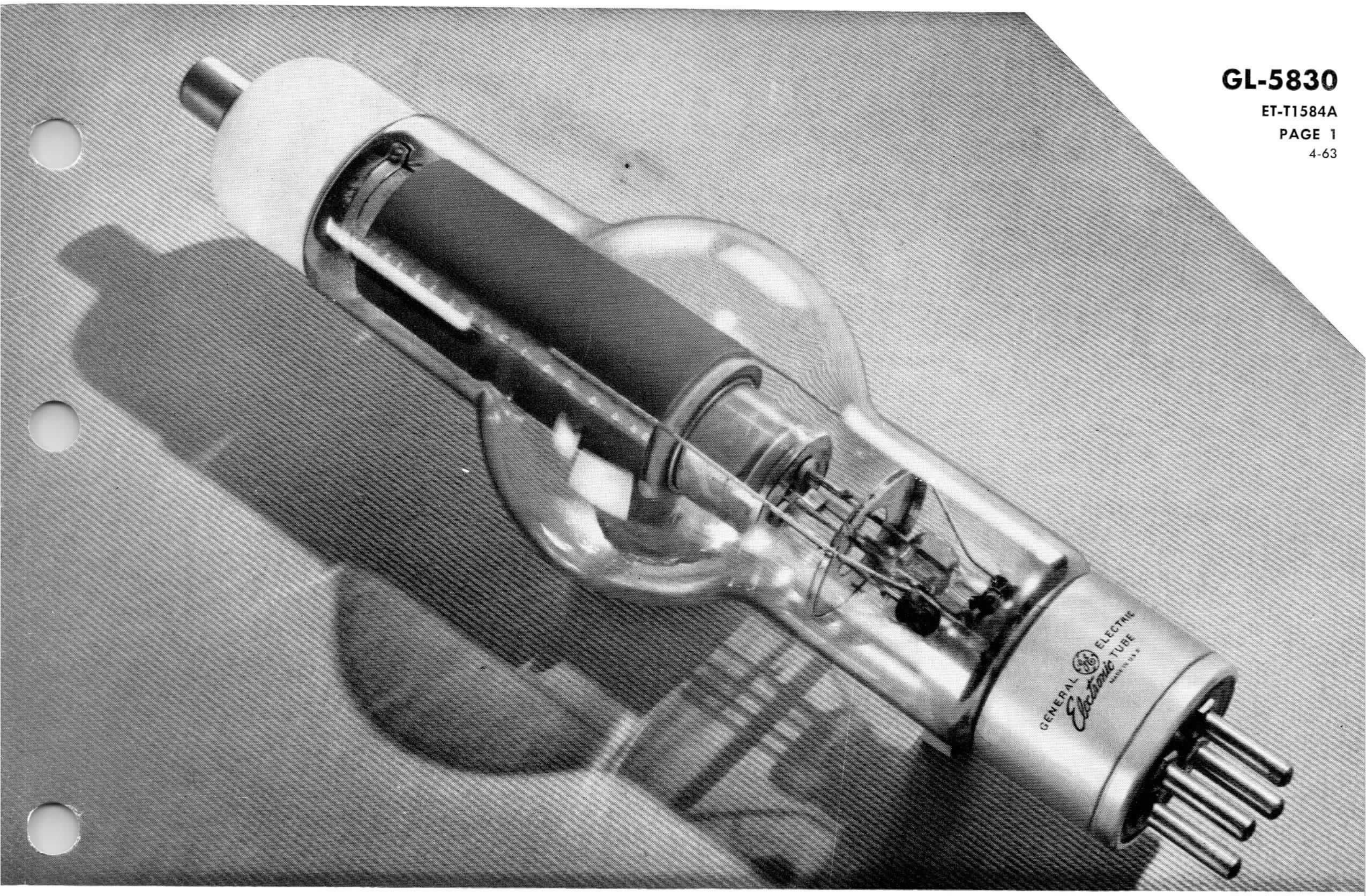
Pin 1—No Connection
Pin 2—Heater
Pin 3—Anode
Pin 4—No Connection
Pin 5—Grid Number 1 (Control Grid)
Pin 6—Grid Number 2 (Screen Grid)
Pin 7—Heater
Pin 8—Cathode

BASING DIAGRAM
(EIA 6BS)



GENERAL ELECTRIC

POWER TUBE DEPARTMENT
Schenectady 5, N. Y.



THYRATRON

The GL-5830 is a three-electrode mercury-vapor thyratron with negative control characteristic. This tube is designed for grid control rectifier application of relatively high voltage and current.

GENERAL

Electrical	Minimum	Bogey	Maximum	
Heater Voltage	4.75	5.0	5.25	Volts
Heater Current at 5.0 Volts	....	20	22.5	Amperes
Cathode Heating Time Required	300	....	....	Seconds
Anode-to-Control-Grid Capacitance	....	15	....	$\mu\mu$f
Control-Grid-to-Cathode Capacitance	....	18	....	$\mu\mu$f
Deionization Time, approximate				
$E_b = 120$ v d-c, $I_b = 12.5$ amp d-c, $R_g = 1000$ ohms				
$E_{cc} = -1000$ v	....	250	....	Microseconds
$E_{cc} = -22$ v	....	4000	....	Microseconds
Ionization Time, approximate				
$E_b = 100$ v, $E_c = +30$ v, $I_b = 75$ amp	....	10	....	Microseconds
Anode Voltage Drop	....	16	....	Volts

GENERAL ELECTRIC

Supersedes ET-T1584 dated 10-55

Mechanical

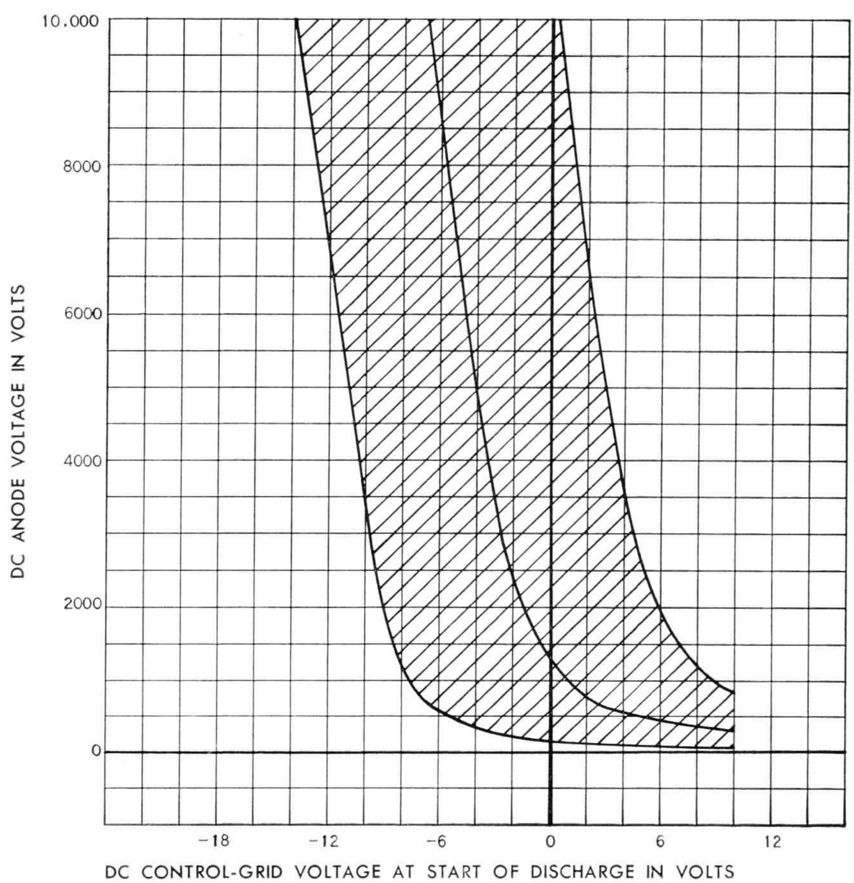
Type of Cooling—Convection	
Equilibrium Condensed Mercury Temperature Rise	
At Full Load, approximate	31 C
At No Load, approximate	25 C
Mounting Position—Vertical, Base Down	
Net Weight, maximum	2.3 Pounds

MAXIMUM RATINGS, Absolute Values

Maximum Peak Anode Voltage	
Inverse	10,000 Volts
Forward	10,000 Volts
Maximum Cathode Current	
Peak	75 Amperes
Average	12.5 Amperes
Fault	1500 Amperes
Maximum Duration	0.1 Seconds
Maximum Averaging Time	30 Seconds
Maximum Negative Control-Grid Voltage	
Before Conduction	1000 Volts
During Conduction	15 Volts
Maximum Positive Control-Grid Current	
Average (averaging time, one cycle)	1.0 Amperes
Condensed Mercury Temperature Limits	+40 to +65 C

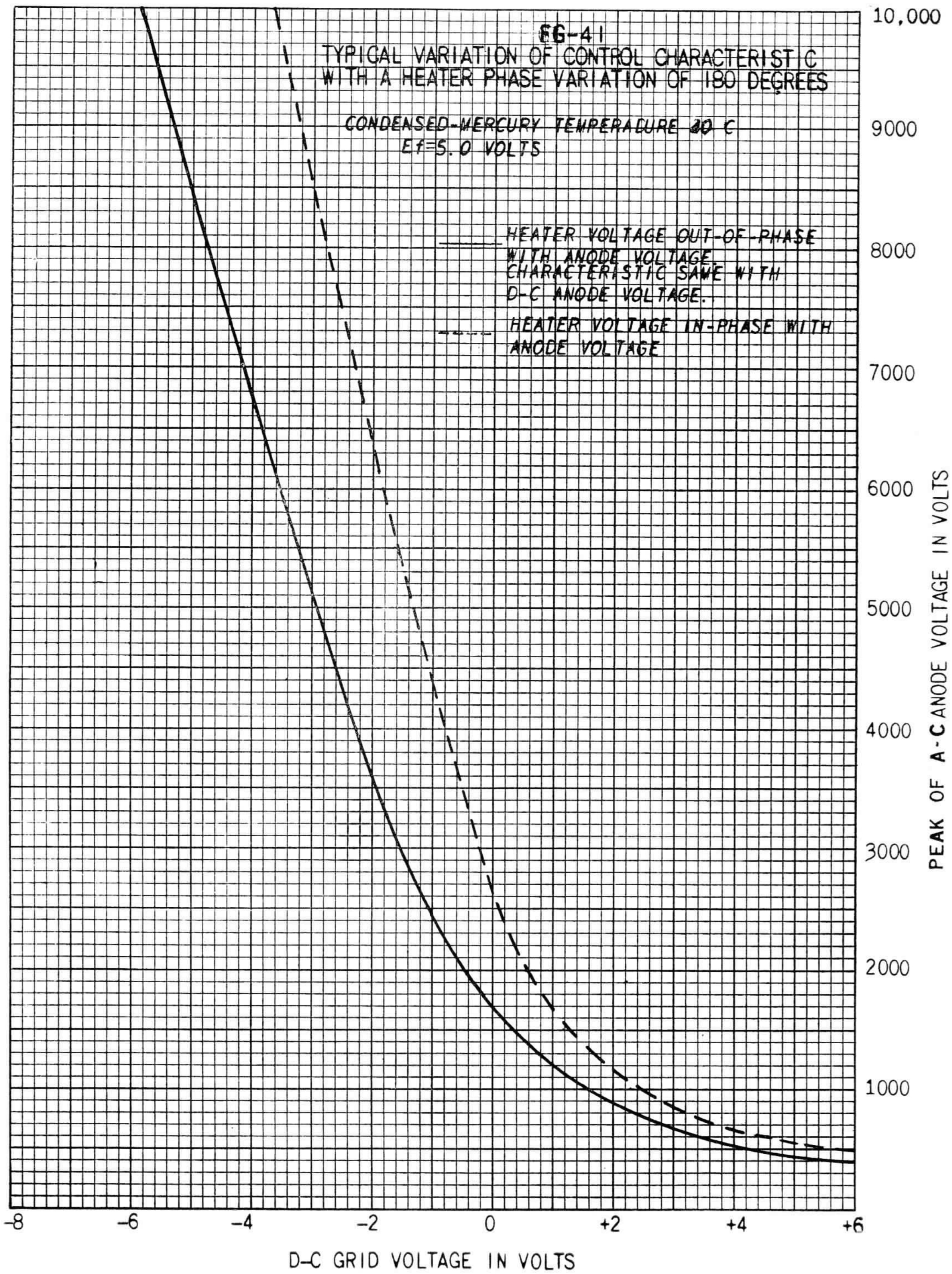
CONTROL CHARACTERISTICS

Shaded Area Shows Range of Characteristic
Condensed Mercury Temperature 40–65 C
$E_f = 4.75–5.25$ Volts



K-69087-72A246 5-4-49

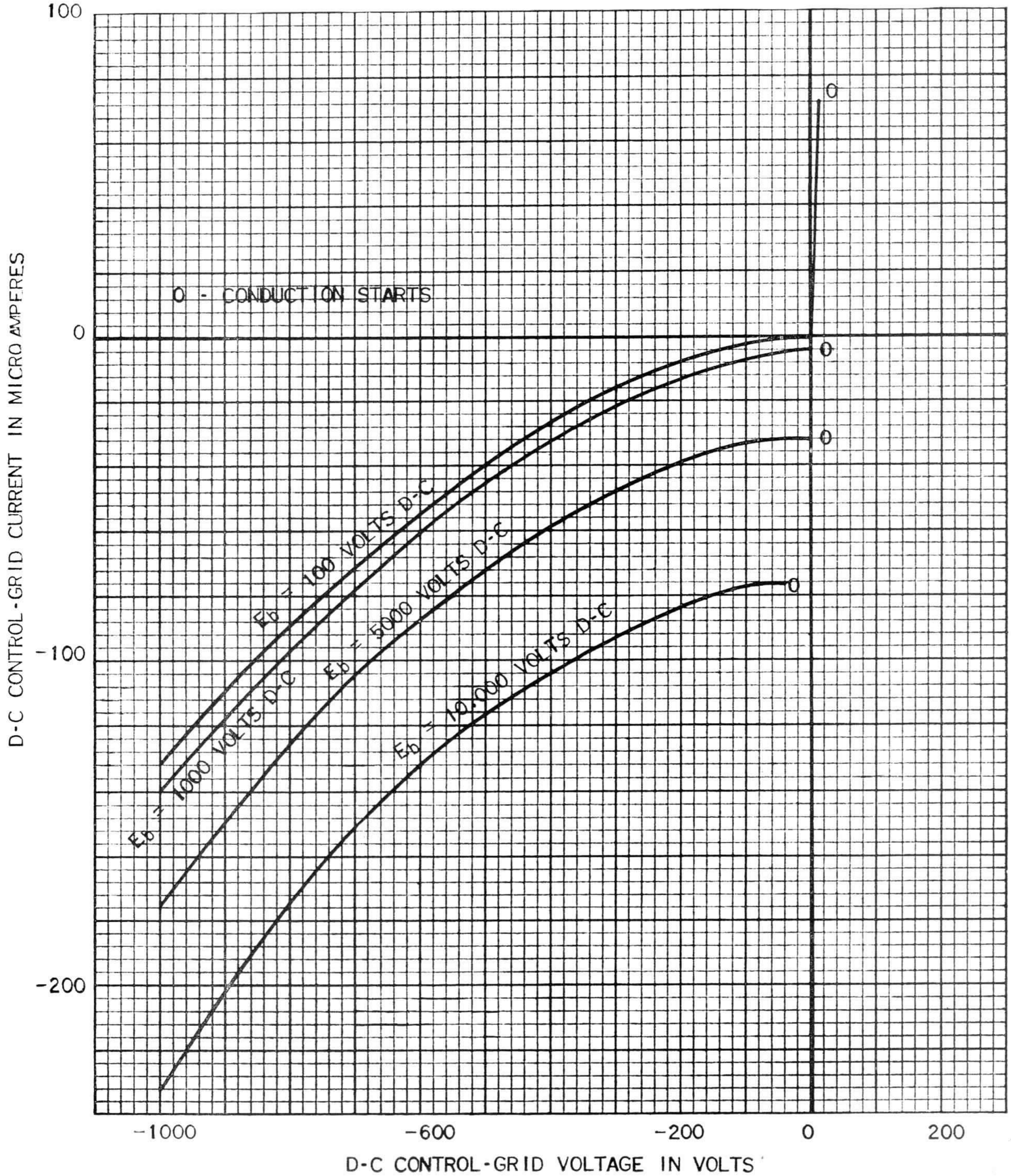
TYPICAL VARIATION OF CONTROL CHARACTERISTIC
WITH A HEATER PHASE VARIATION OF 180 DEGREES



K-69087-72A20

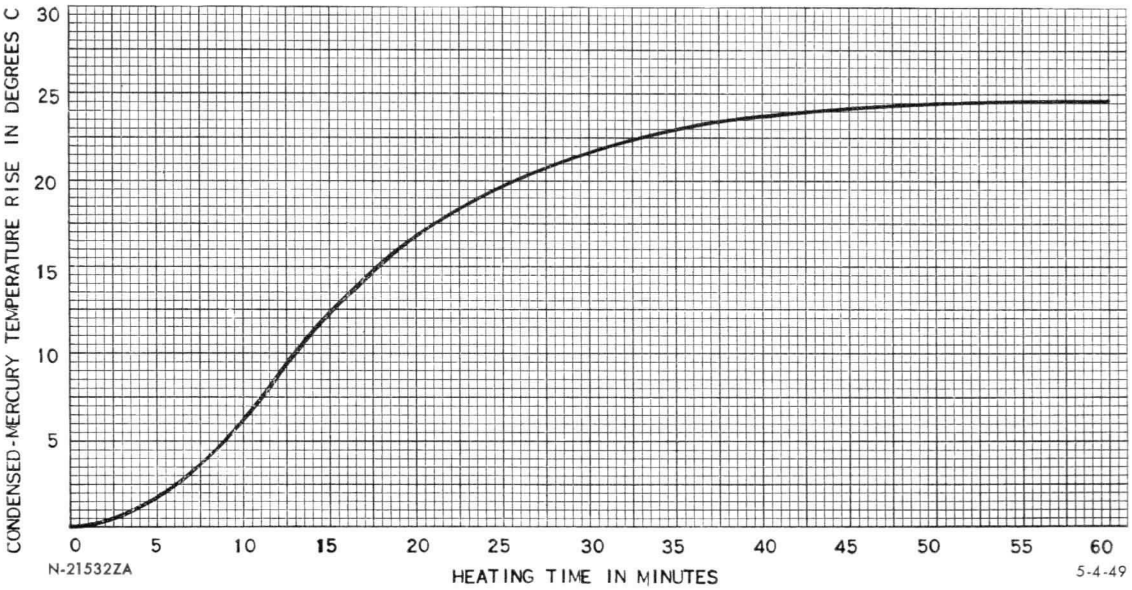
5-4-49

AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION
$E_f = 5.0$ Volts

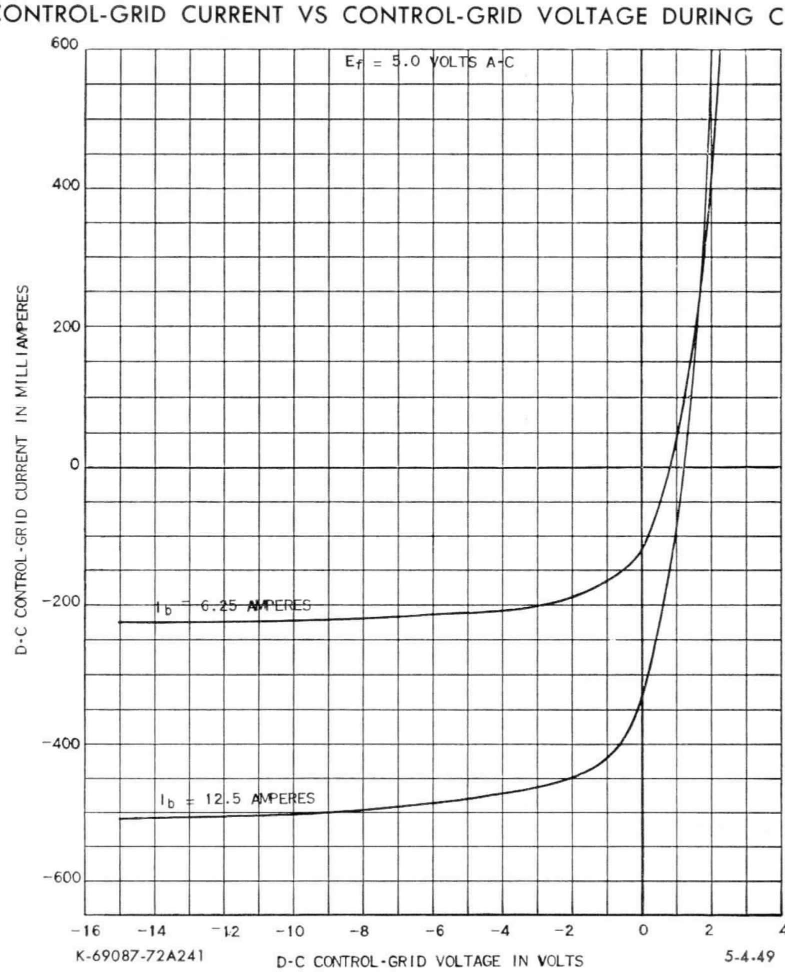


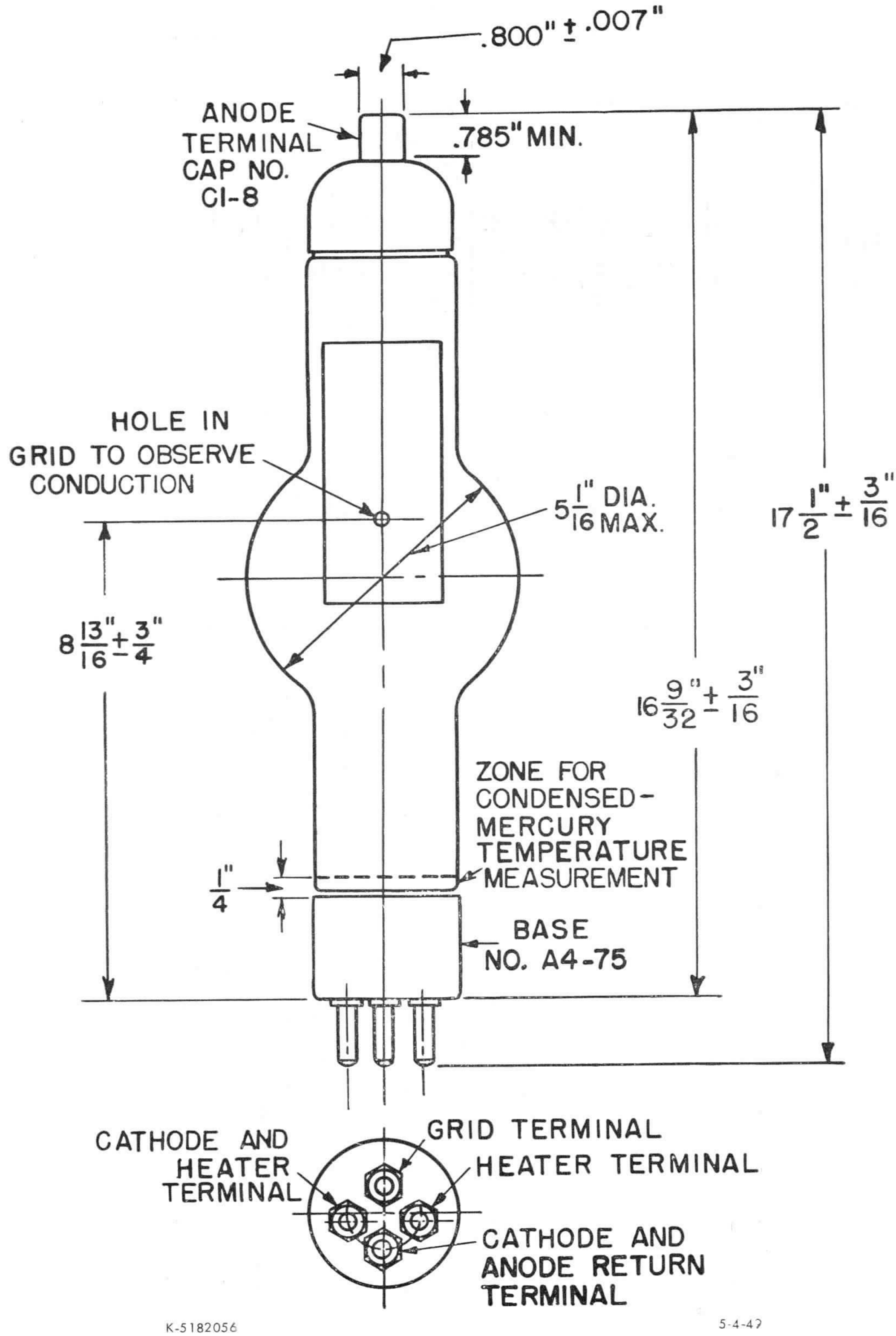
K-69087-72A240 5-4-49

RATE OF RISE OF CONDENSED MERCURY TEMPERATURE ABOVE AMBIENT
$E_f = 4.75$ Volts



TYPICAL CONTROL-GRID CURRENT VS CONTROL-GRID VOLTAGE DURING CONDUCTION




.800" ± .007"
ANODE TERMINAL CAP NO. CI-8
.785" MIN.
HOLE IN GRID TO OBSERVE CONDUCTION
5 1/16" DIA. MAX.
17 1/2" ± 3/16"
8 13/16" ± 3/4"
16 9/32" ± 3/16"
ZONE FOR CONDENSED-MERCURY TEMPERATURE MEASUREMENT
1/4"
BASE NO. A4-75
CATHODE AND HEATER TERMINAL
GRID TERMINAL
HEATER TERMINAL
CATHODE AND ANODE RETURN TERMINAL
K-5182056
5-4-42

—PRODUCT INFORMATION—

TRIODE THYRATRONS

ET-T1615B

6011/710, 7518/710L, 7725, 7726

TRIODE THYRATRON

QUICK-HEATING CATHODE

2.5 AMPERES

GAS AND MERCURY NEGATIVE CONTROL

These four thyratrons constitute a family of tubes particularly designed for industrial service under stringent operating conditions, ignitor firing, regulated rectifier, and similar applications.

They feature a negative control characteristic and a quick-heating cathode requiring only twenty seconds to attain operating temperature. Throughout life initial conduction is possible at temperatures as low as −40 C.

A specially designed electrode structure permits mounting in any vertical to horizontal position, base down.

With the exception of peak voltage ratings and bases used, the tubes are identical both electrically and mechanically.

Electrical

	Minimum	Bogey	Maximum	
Cathode—Filamentary				
Filament Voltage	2.37	2.50	2.63	Volts
Filament Current at 2.50 Volts	7	9	11	Amperes
Heating Time	20	—	—	Seconds
Anode to Control-Grid Capacitance	—	2	—	$\mu\mu f$
Control-Grid to Cathode Capacitance	—	12	—	$\mu\mu f$
Deionization Time, approximate	—	1000	—	Microseconds
Ionization Time, approximate	—	10	—	Microseconds
Anode Voltage Drop	—	15	—	Volts
Critical Grid Current, $E_p = 220$ v a-c or RMS	—	—	10	Microamperes

Approximate Control Characteristics

6011/710, 7518		7725, 7726	
Anode Voltage	Grid Voltage	Anode Voltage	Grid Voltage
100	−1	100	−1
1000	−5	1000	−5
1500	−6.5	3500	−9

Mechanical

Mounting Position—Any Position from Vertical to Horizontal, Base Down

Net Weight, maximum . . . . . 5 Ounces

Thermal

Condensed-Mercury Temperature Limits*	−40 to +80	C
Equilibrium Condensed-Mercury Temperature Rise Above Ambient		
At Full Load, approximate	30	C
At No Load, approximate	25	C

MAXIMUM RATINGS, ABSOLUTE VALUES

	6011/710 7518	7725 7726	
Maximum Peak Anode Voltage			
Inverse	1500	3500	Volts
Forward	1500	3500	Volts
Maximum Cathode Current†			
Peak		30	Amperes
Average		2.5	Amperes
Maximum Averaging Time		5	Seconds
Fault		250	Amperes
Maximum Duration		0.1	Seconds

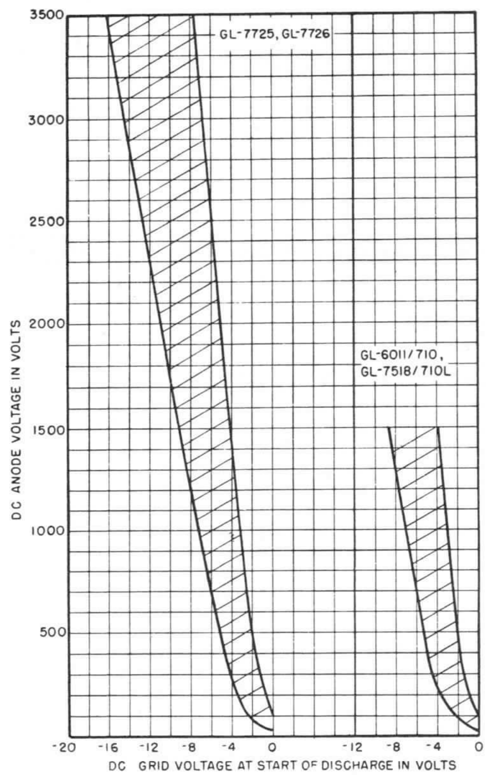
Maximum Negative Grid Voltage		
Before Conduction	500	Volts
During Conduction	10	Volts
Maximum Positive Grid Current*		
Average	0.25	Amperes
Averaging Time	1	Cycle

* The tube may be started throughout life at condensed-mercury temperatures as low as −40 C. Although it will operate satisfactorily between −40 C and +30 C condensed mercury life will be reduced at these low temperatures. For maximum life the condensed-mercury temperature after warm-up should be maintained between +40 and +80 C (+10 to +50 C ambient).

† Since the center of the filament is internally connected to pin No. 2, the anode and grid-circuit returns should be made to that pin. If this is not possible, the returns can be made to the center tap of the filament transformer, but in such a case the anode current and therefore any fault current will pass through the transformer.

TYPICAL CONTROL CHARACTERISTICS

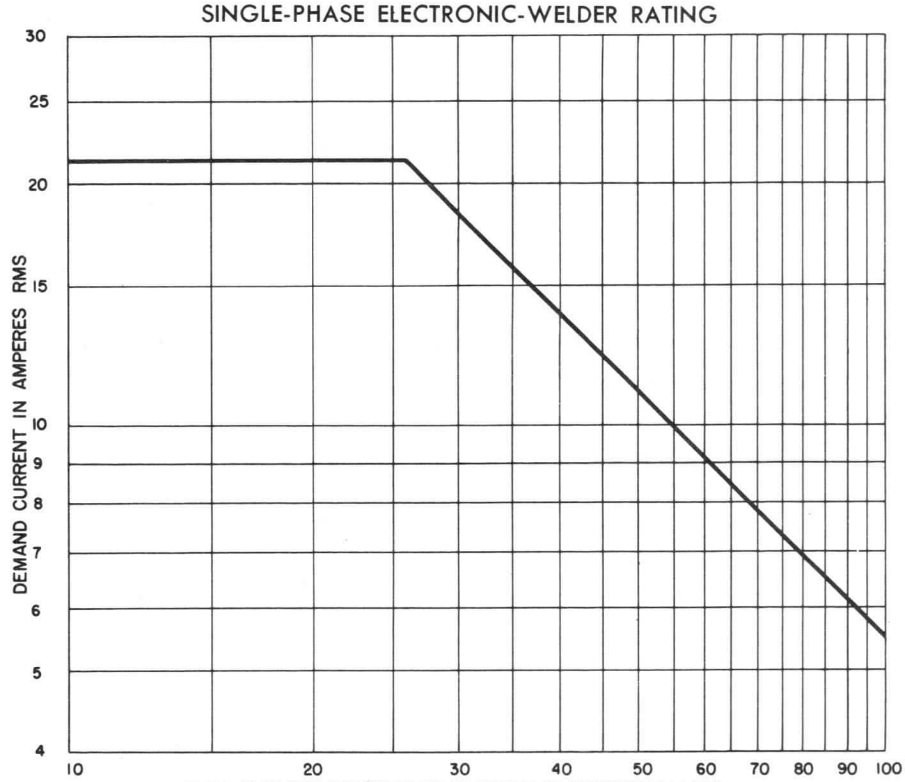
SHADED AREA SHOWS RANGE OF CHARACTERISTICS



K-69087-72A951

6-60

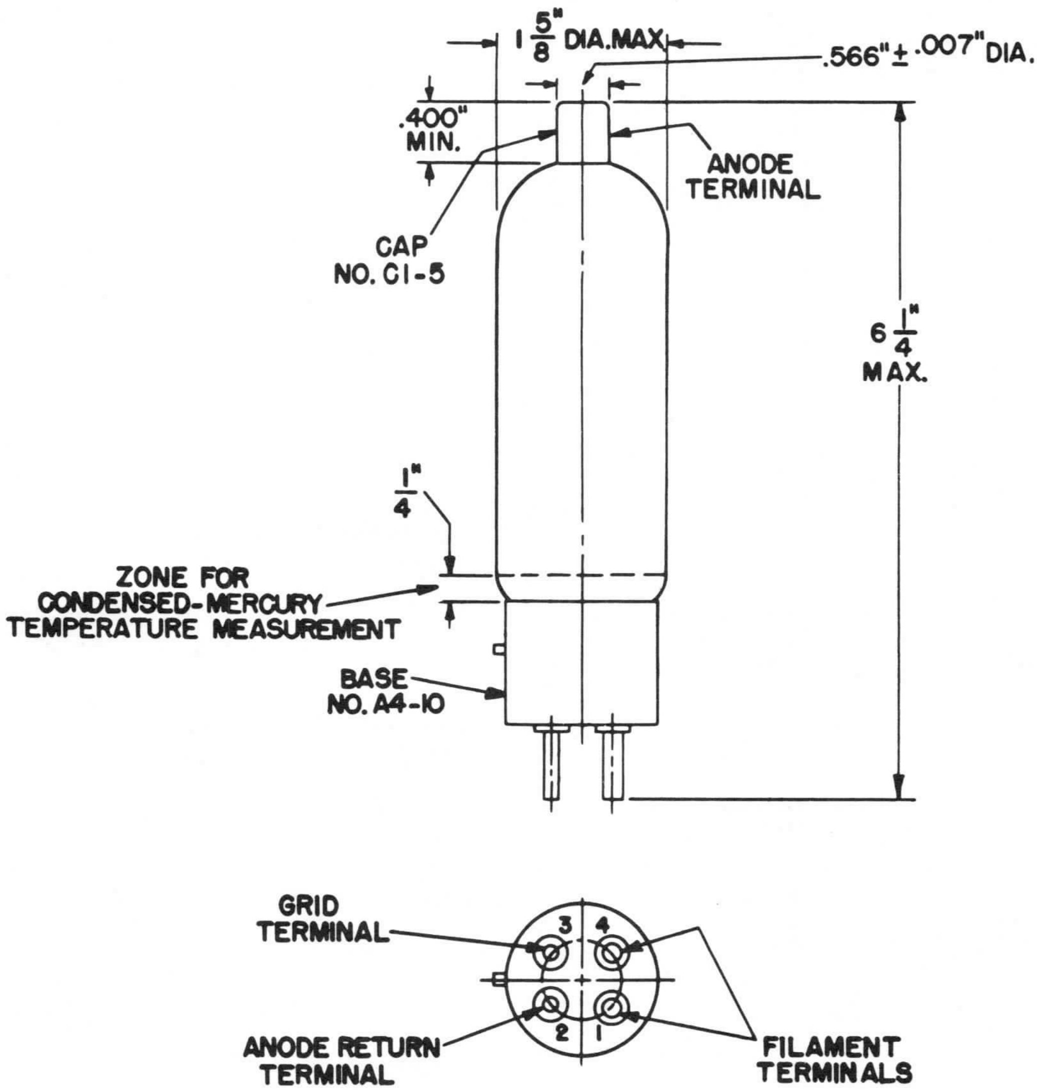
SINGLE-PHASE ELECTRONIC-WELDER RATING



K-69087-220A87

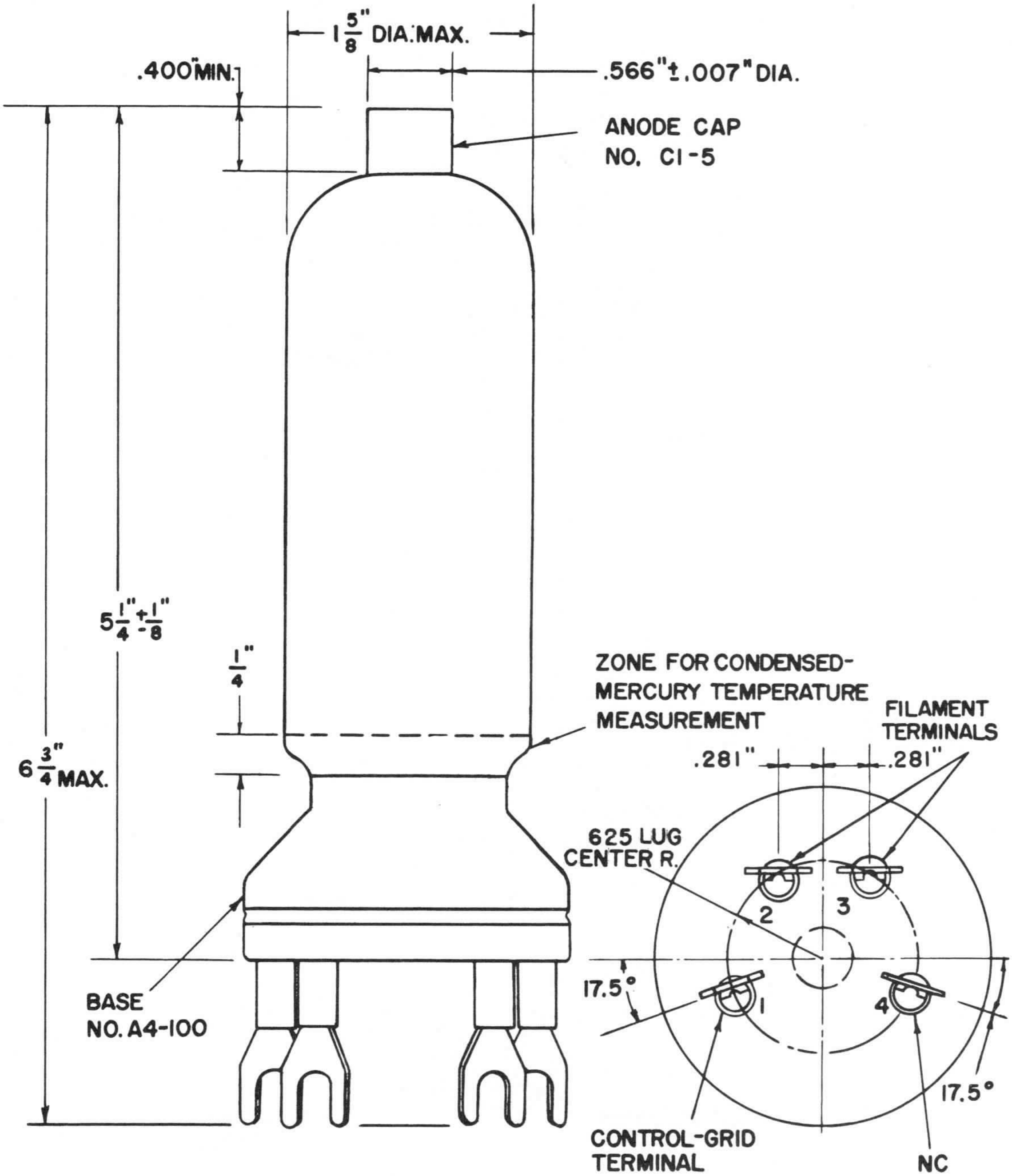
6-58

Maximum Peak Forward and Inverse Anode Voltage
6011/710 and 7518/710L=1500 Volts
7725 and 7726=3500 Volts
Demand Current Measured with Full Conduction During Each Half Cycle
Averaging Time=5 Seconds



OUTLINE

6011/710
7725



OUTLINE
7518/710L
7726

BOTTOM
VIEW

K-69087-72A902

8-60

Tube Department
GENERAL ELECTRIC
Schenectady, New York

PRINTED IN U.S.A.

OBJECTIVE
Technical Information

These ratings represent the design objective for this product. Refer to the preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Products Department Regional Sales Office.

ZM–6287

INDUSTRIAL HEATING MAGNETRON

918 Megahertz
Forced-Air Cooled

1000 Watts Output Power
Integral Series Field Coils

The ZM–6287 is a low-voltage CW magnetron assembly for use in the 915-MHz ISM Band for microwave heating applications. It is designed for operation from a low cost, voltage doubler circuit, connected to a 240-volt a-c line. Approximately 50 volts a-c boost from an autotransformer is needed to achieve the 1000-watt output(Fig. 1). It contains an integral electromagnet energized by the voltage doubler output(series connection). The r-f output line contains a d-c bypass arrangement which allows the body of the tube to run off ground.

GENERAL

Mechanical

Mounting Position – Tube axis vertical
Weight . . . . 17 Pounds

Thermal

Forced-Air Cooled . . . . 100 Cu. ft/min.
Thermostat Temperature . . . . 230° F

MAXIMUM RATINGS
(Absolute Values)

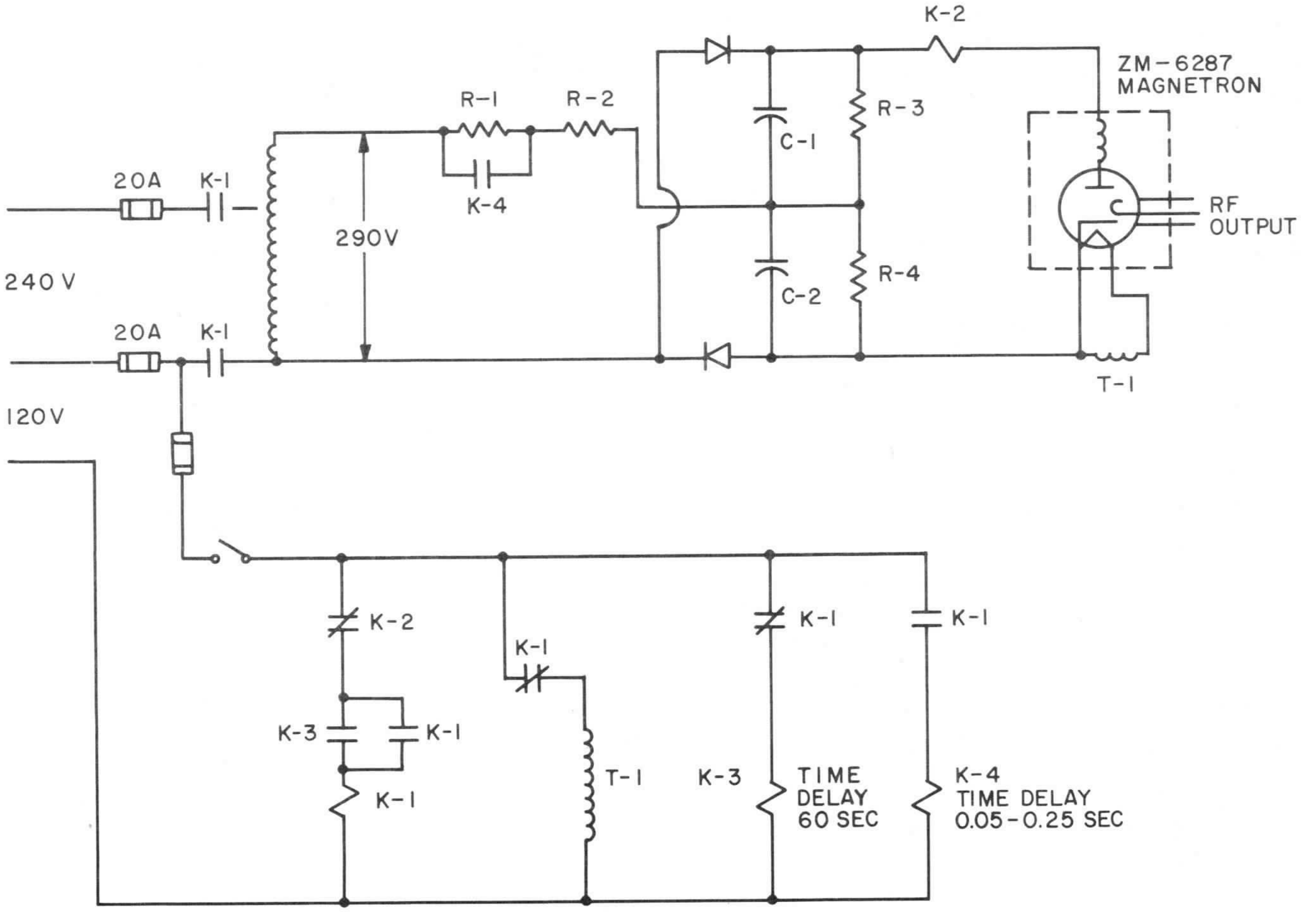
Electrical

	Min.	Max.
Filament		
Voltage		
Starting	-	6.3 Volts
Standby	-	5.5 Volts
Operating(650 watt level)	1.0	1.5 Volts
Operating(1000 watt level)	0	0 Volts
Current		
Starting		
Surge	-	75 Amperes
Stabilized (1 min.)	-	18 Amperes
Standby	-	15 Amperes
Operating (650 watt)	8	5 Amperes
Operating (1000 watt)	0	0 Amperes

	Min.	Max.
Preheat Time	50	Seconds
Plate Voltage		725 Volts DC
Plate Current		3.5 Amperes DC
Load VSWR		
Opposite Sink		3/1 VSWR
In Sink		2/1 VSWR
A-C Input Voltage to Doubler		300 V AC
Power Output (300 V AC Matched Load)	1000	Watts
Frequency, Matched Load	913	923 MHz

TYPICAL OPERATING CONDITIONS

Input to Doubler	290 V AC
Output Power (Matched)	Figure 2
Output Power (Mismatch)	Figure 3



K-1	Main Contactor	R-1	25Ω, 25W
K-2	DC Overload (4A)	R-2	.5Ω, 100W (Open coil of Nichrome or equiv.)
K-3	Time Delay Relay (Thermal Type)	R-3, 4	20,000Ω, 25W
K-4	Short Time Delay Relay	T-1	Filament Transformers (6.3V, 18A)
C-1, 2	500 μf, 500V		

FIGURE 1

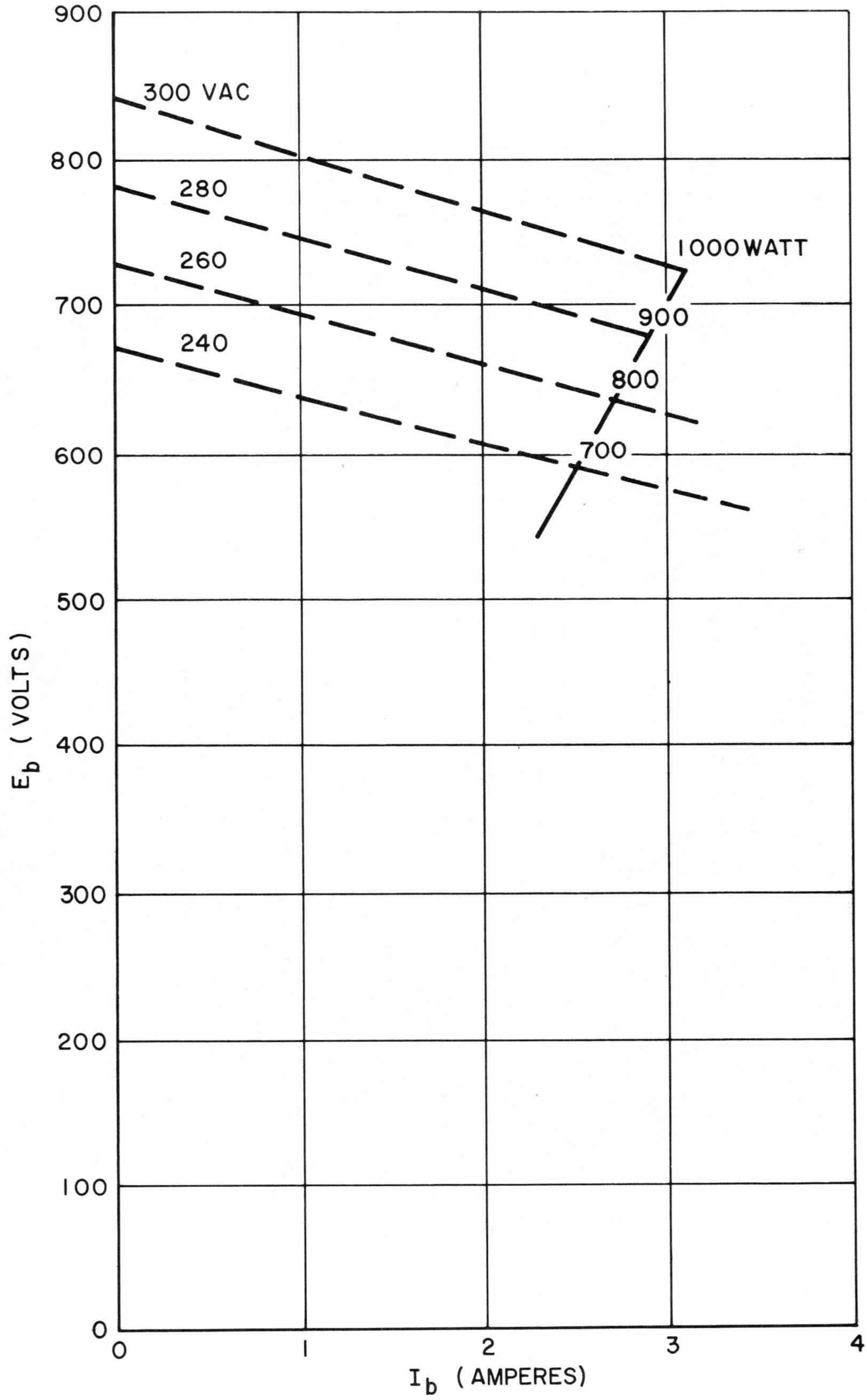

900
800
700
600
500
400
300
200
100
0
E_b (VOLTS)
300 VAC
280
260
240
1000 WATT
900
800
700
0
1
2
3
4
I_b (AMPERES)

FIGURE 2

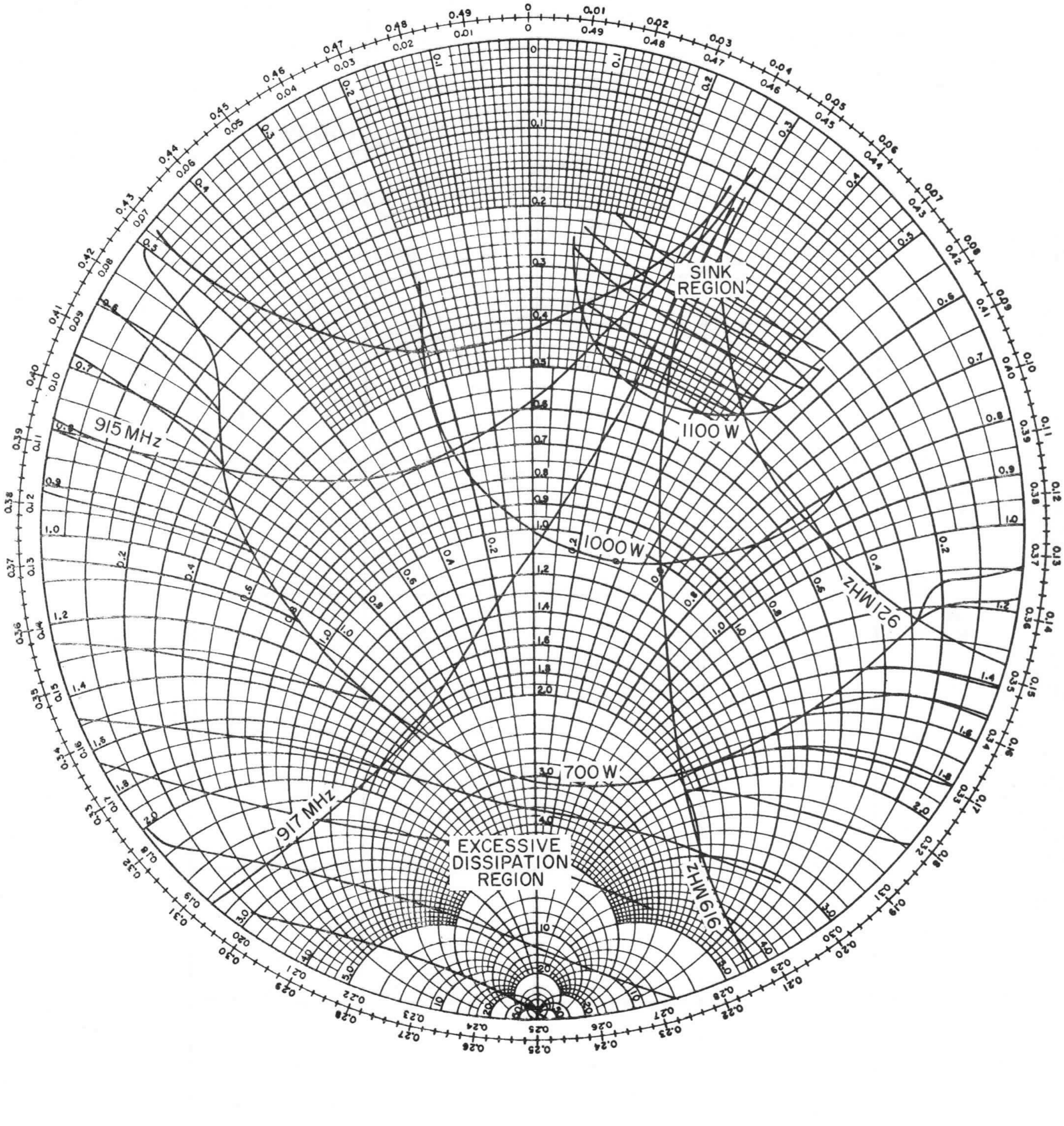

SINK REGION
1100 W
915 MHz
1000 W
921 MHz
700 W
917 MHz
EXCESSIVE DISSIPATION REGION
919 MHz

FIGURE 3

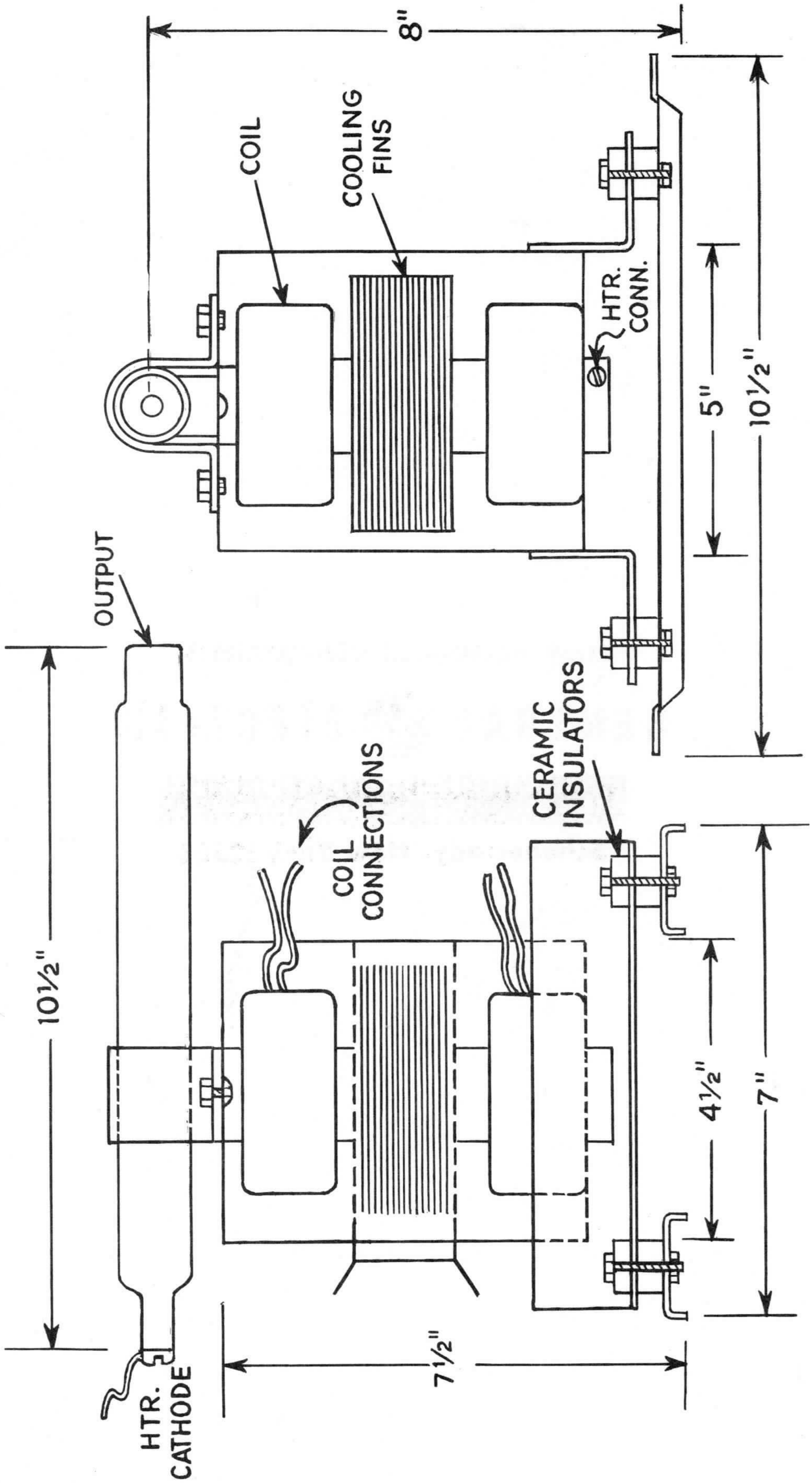

8"
COIL
COOLING FINS
HTR. CONN.
5"
10½"
OUTPUT
10½"
COIL CONNECTIONS
CERAMIC INSULATORS
4½"
7"
7½"
HTR. CATHODE

FIGURE 4

TUBE PRODUCTS DEPARTMENT

GENERAL ELECTRIC

[redacted]

Schenectady, New York 12305