

Electronic Tubes

INDUSTRIAL TYPES

PUBLISHED BY THE GENERAL ELECTRIC COMPANY



Electronic

Tubes

INDUSTRIAL

TYPES



**PUBLISHED BY THE
GENERAL ELECTRIC
COMPANY**

ELECTRONICS DEPARTMENT



BUSINESS REPLY CARD
 First Class Permit No. 1—Sec. 510, P. L. & R.—Schenectady, N. Y.

ELECTRONICS DEPARTMENT
 GENERAL ELECTRIC COMPANY
 1 RIVER ROAD
 SCHENECTADY, N. Y.

DEPT. 269-206



BUSINESS REPLY CARD
 First Class Permit No. 1—Sec. 510, P. L. & R.—Schenectady, N. Y.

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CHANGE OF ADDRESS

Manual Registration Number 6333 -I

My new address is , Transfer my manual to (check one)

Name..... Title.....

Company

Address.....

City and State.....

Transferred From (Name).....

Special Requests.....

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ELECTRONIC TUBE MANUAL INDEX

All Manuals

This Index indicates the particular manual which contains complete data on any tube. For convenience, the tubes are listed in alpha-numerical order. For listings by class refer to the Table of Contents sheet in each volume.

Tube Type	Class	Manual *	Tube Type	Class	Manual *
OA2	Glow Tube	F	GL-1P40	Phototube	
OA3	Glow Tube	F	GL-1Q26-A	Reference Cavity	T
OA4-G	Gas Triode	F	1R5	Heptode	R
OB2	Glow Tube	F	1S2-A	Rectifier	
OB3	Glow Tube	F	1S4	Pentode	R
OC3	Glow Tube	F	1S5	Diode-Pentode	R
OD3	Glow Tube	F	1T4	Pentode	R
OZ4	Diode	R	1U4	Pentode	R
OZ4-A	Twin Diode	F	1U5	Diode-Pentode	R
OZ4-G	Diode	R	1V2	Diode	R
KC-1	Rectifier		1V6	Triode-Pentode	R
1A5-GT	Pentode	R	1X2-A	Diode	R
1A7-GT	Pentagrid Converter	R	1X2-B	Diode	R
1AD4	Pentode		2A3	Triode	R
1AG4	Beam Pentode	R	2AF4	Triode	R
1AH4	Pentode	R	2AF4-A	Triode	R
1AJ5	Diode-Pentode		GL-2B22	Diode	T
1AX2	Diode	R	GL-2B23	Rectifier	
1B3-GT	Diode	R	2BN4	Triode	R
1DN5	Diode-Pentode	R	GL-2C39-B	Triode	T
1G3-GT	Rectifier		GL-2C40	Triode	T
1H5-GT	Diode-Triode	R	GL-2C40-A	Triode	T
1J3	Diode	R	GL-2C42	Triode	
1K3	Diode	R	GL-2C43	Triode	T
1L4	Pentode	R	GL-2C46	Triode	
1L6	Pentagrid Converter	R	2CY5	Tetrode	R
GL-1L21	Vacuum Capacitor		2D21	Thyratron	F
GL-1L24	Vacuum Capacitor		2E24	Beam Pentode	F
GL-1L25	Vacuum Capacitor		2E26	Beam Pentode	F
GL-1L31	Vacuum Capacitor		2E30	Beam Pentode	F
GL-1L32	Vacuum Capacitor		GL-2H21	Phasitron	
GL-1L33	Vacuum Capacitor		2X2-A	Diode	F
GL-1L36	Vacuum Capacitor		KC-3	Rectifier	
GL-1L38	Vacuum Capacitor		3A2	Diode	R
1LA6	Pentagrid Converter	R	3A3	Diode	R
1LH4	Diode-Triode	R	3AF4-A	Triode	R
1LN5	Pentode	R	3AL5	Twin Diode	R
1N5-GT	Pentode	R	3AU6	Pentode	R
GL-1P21	Phototube		3AV6	Duplex-Diode Triode	R
GL-1P39	Phototube		3B2	Diode	R

* R = Receiving Manual
F = Five-Star and Special-Purpose Manual
T = Transmitting Manual

ELECTRONIC COMPONENTS DIVISION

GENERAL  ELECTRIC

Schenectady 5, N. Y.

Supersedes ET-T1216A dated 11-56

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Tube Type	Class	Manual*	Tube Type	Class	Manual*
GL-3B24W	Rectifier		5CG8	Triode-Pentode	R
3BA6	Pentode	R	5CL8-A	Triode-Tetrode	R
3BC5	Pentode	R	5CQ8	Triode-Pentode	
3BE6	Heptode	R	5CZ5	Beam Power	
3BN4	Triode	R	5DH8	Triode-Pentode	R
3BN6	Gated-Beam	R	5EA8	Triode-Pentode	R
3BU8	Twin Pentode	R	5J6	Twin Triode	R
3BY6	Heptode	R	5R4-GYA	Twin Diode	F
3BZ6	Pentode	R	5T8	Triple-Diode Triode	R
GL-3C22	Triode		5U4-GA	Twin Diode	R
GL-3C23	Thyratron		5U4-GB	Twin Diode	R
3CB6	Pentode	R	5U8	Triode-Pentode	R
3CE5	Pentode	R	5V3	Rectifier	
3CF6	Pentode	R	5V4-GA	Twin Diode	R
3CS6	Heptode	R	5V6-GT	Pentode	R
3DK6	Pentode		5X8	Triode-Pentode	R
3DT6	Pentode	R	5Y3-GT	Diode	R
3Q4	Pentode	R	5Y3-WGTB	Service Designation†	
3Q5-GT	Pentode	R	5Y4-GT	Twin Diode	R
3S4	Pentode	R	5Z3	Diode	R
3V4	Pentode	R	6A7	Pentagrid Converter	R
GL-3X2500A3	Triode		6A8	Pentagrid Converter	R
PJ-4	Triode		6AB4	Triode	R
4AU6	Pentode		6AC5-GT	Triode	R
4RC8	Twin Triode	R	6AC7	Pentode	R
4BN6	Gated-Beam	R	6AC7-WA	Service Designation†	
4BQ7-A	Twin Triode	R	6AC7-Y	Pentode	
4BS8	Twin Triode	R	6AD7-G	Triode-Pentode	R
4BU8	Twin Pentode	R	6AF3	Diode	
4BZ6	Pentode	R	6AF4	Triode	R
4BZ7	Twin Triode	R	6AF4-A	Triode	R
4CB6	Pentode	R	6AG5	Pentode	R
4CS6	Heptode	R	6AG7	Pentode	R
4CY5	Tetrode	R	6AG7-Y	Pentode	
GL-4D21/4-125A	Tetrode		6AH4-GT	Triode	R
4DT6	Pentode	R	6AH6	Pentode	R
GL-4X150A	Tetrode		6AK5	Pentode	R
GL-4-1000A	Tetrode-Pentode		6AK6	Pentode	R
5AM8	Diode-Pentode	R	6AL5	Twin Diode	R
5AN8	Triode-Pentode	R	6AL7-GT	Electron-Ray Indicator	R
5AQ5	Beam Pentode	R	6AM4	Triode	R
5AS4	Twin Diode		6AM8	Diode-Pentode	R
5AS8	Diode-Pentode	R	6AN5	Beam Power	R
5AT8	Triode-Pentode	R	6AN8	Triode-Pentode	R
5AU4	Twin Diode	R	6AQ5	Beam Pentode	R
5AV8	Triode-Pentode	R	6AQ5-A	Beam Pentode	R
5AW4	Twin Diode		6AQ6	Duplex-Diode Triode	R
5BR	Triode-Pentode	R	6AQ7-GT	Duplex-Diode Triode	R
5BE8	Triode-Pentode	R	6AR5	Pentode	R
5BK7-A	Twin Triode	R	6AR8	Sheet Beam	R
5BQ7-A	Twin Triode	R	6AS5	Beam Power	R
5BR8	Triode-Pentode	R	6AS6	Pentode	R
5BT8	Double-Diode Pentode		6AS7-GA	Twin Triode	R
GL-5C21/C6J	Thyratron		6AS9	Diode-Pentode	R
GL-5C24	Triode		6AT6	Duplex-Diode Triode	R

* I=Industrial Manual

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† Because of the special nature of this type, data sheets are not maintained. Refer to the applicable Armed Service specifications for ratings.

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Tube Type	Class	Manual*	Tube Type	Class	Manual*
6AT8	Triode-Pentode	R	6C5	Triode	R
6AU4-GTA	Diode	R	6C6	Pentode	R
6AU5-GT	Beam Pentode	R	6CA5	Beam Pentode	R
6AU6-A	Pentode	R	6CB5-A	Beam Pentode	R
6AU6-WA	Service Designation †		6CB6-A	Pentode	R
6AU8-A	Triode-Pentode	R	6CD6-GA	Beam Pentode	R
6AV5-GA	Beam Pentode	R	6CE5	Pentode	R
6AV6	Duplex-Diode Triode	R	6CF6	Pentode	R
6AW8-A	Triode-Pentode	R	6CG7	Twin Triode	R
6AX4-GT	Diode	R	6CG8-A	Triode-Pentode	R
6AX5-GT	Diode	R	6CH8	Triode-Pentode	
6AZ8	Triode-Pentode	R	6CK4	Triode	
6B8	Duplex-Diode Pentode	R	6CL6	Pentode	R
6BA6	Pentode	R	6CL8-A	Triode-Tetrode	R
6BA7	Pentagrid Converter	R	6CM6	Beam Pentode	R
6BA8-A	Triode-Pentode	R	6CM7	Double Triode	R
6BC5	Pentode	R	6CN7	Duplex-Diode Triode	R
6BC7	Triple Diode	R	6CQ8	Triode-Tetrode	
6BC8	Twin Diode	R	6CR6	Diode-Pentode	R
6BD6	Pentode	R	6CS6	Heptode	R
6BE6	Heptode	R	6CS7	Double Triode	
6BF5	Beam Power	R	6CU5	Beam Power	R
6BF6	Duplex-Diode Triode	R	6CU6	Beam Pentode	R
6BG6-GA	Beam Pentode	R	6CU8	Triode-Pentode	
6BH6	Pentode	R	6CX8	Triode-Pentode	R
6BH8	Triode-Pentode	R	6CY5	Tetrode	R
6BJ6	Pentode	R	6CY7	Double Triode	R
6BJ7	Triple Diode	R	6CZ5	Beam Power	
6BJ8	Double-Diode Triode		6D4	Thyratron	F
6BK4	Beam Triode	R	6D6	Pentode	R
6BK5	Beam Pentode	R	6DA4	Diode	R
6BK7-B	Twin Triode	R	6DB5	Beam Pentode	
6BL7-GTA	Twin Triode	R	6DE6	Pentode	R
6BN4	Triode	R	6DG6-GT	Beam Pentode	R
6BN6	Gated-Beam	R	6DK6	Pentode	R
6BN8	Double-Diode Triode		6DN7	Double Triode	R
6BQ5	Power Pentode		6DQ5	Beam Power	
6BQ6-GA	Pentode	R	6DQ6-A	Beam Pentode	R
6BQ6-GTB	Beam Pentode	R	6DS5	Beam Power	
6BQ7-A	Twin Triode	R	6DT6	Pentode	R
6BR8	Triode-Pentode	R	6E5	Electron-Ray Indicator	R
6BS8	Twin Triode	R	6EAB	Triode-Pentode	R
6BU8	Twin Pentode	R	6EB8	Triode-Pentode	
6BV8	Duplex-Diode Triode	R	6EH8	Triode-Pentode	
6BW4	Rectifier		6EW6	Pentode	R
6BW8	Duplex-Diode Pentode	R	6F5	Triode	R
6BX7-GT	Twin Triode	R	6F6	Pentode	R
6BY4	Triode	R	6F6-GT	Pentode	R
6BY5-GA	Twin Diode		6H6	Twin Diode	R
6BY6	Heptode	R	6J4	Triode	R
6BY8	Pentode		6J5	Triode	R
6BZ6	Pentode	R	6J6	Twin Triode	R
6BZ7	Twin Triode	R	6J7	Pentode	R
6BZ8	Twin Triode	R	6K6-GT	Pentode	R
6C4	Triode	R	6K7	Pentode	R

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Tube Type	Class	Manual*	Tube Type	Class	Manual*
6K8	Triode-Hexode	R	7B5	Pentode	R
6L6	Beam Power	R	7B6	Duplex-Diode Triode	R
6L6-CB	Beam Power	R	7B7	Pentode	R
GL-C6M	Thyratron		7B8	Pentagrid Converter	R
6N7	Twin Triode	R	7C5	Beam Power	R
6Q7	Duplex-Diode Triode	R	7C6	Duplex-Diode Triode	R
6S4-A	Triode	R	7C7	Pentode	R
6S8-GT	Triple-Diode Triode	R	GL-7C29	Triode	
6SA7	Pentagrid Converter	R	GL-7D21	Tetrode	T
6SA7-Y	Pentagrid Converter		7EY6	Pentode	R
6SB7-Y	Pentagrid Converter	R	7F7	Twin Triode	R
6SC7	Twin Triode	R	7F8	Twin Triode	R
6SF5	Triode	R	7F8-TV	Twin Triode	
6SF7	Diode-Pentode	R	7H7	Pentode	R
6SG7	Pentode	R	7J7	Triode-Heptode	R
6SG7-Y	Pentode		7K7	Duplex-Diode Triode	R
6SH7	Pentode	R	7N7	Twin Triode	R
6SJ7	Pentode	R	7Q7	Pentagrid Converter	R
6SJ7-Y	Pentode		7S7	Triode-Heptode	R
6SK7	Pentode	R	7Y4	Diode	R
6SK7-WA	Service Designation†		7Z4	Diode	R
6SK7-Y	Pentode		8A8-A	Triode-Pentode	R
6SL7-GT	Twin Triode	R	8AW8-A	Triode-Pentode	R
6SN7-GTB	Twin Triode	R	8BQ5	Pentode	
6SQ7	Duplex-Diode Triode	R	8CG7	Twin Triode	R
6SR7	Duplex-Diode Triode	R	8CM7	Double Triode	R
6SS7	Pentode	R	8CN7	Duplex-Diode Triode	R
6SV7	Diode-Pentode	R	8CS7	Double Triode	
6T4	Triode	R	8CX8	Triode-Pentode	R
6T8	Triple-Diode Triode	R	8EB8	Triode-Pentode	
6T8-A	Triple-Diode Triode	R	9C18	Triode-Tetrode	R
6U5	Electron-Ray Indicator	R	9U8-A	Triode-Pentode	R
6U8	Triode-Pentode	R	10C8	Triode-Pentode	R
6U8-A	Triode-Pentode	R	10DE7	Double Triode	
6V3-A	Diode	R	11CY7	Double Triode	R
6V6	Beam Power	R	12A6	Beam Power	R
6V6-GT	Pentode	R	12A8-GT	Pentagrid Converter	R
6V6-GTY	Beam Power		12AB5	Beam Pentode	R
6V6-Y	Receiving		12AC6	Pentode	R
6W4-GT	Diode	R	12AD6	Heptode	R
6W6-GT	Beam Pentode	R	12AE6	Duplex-Diode Triode	R
6X4	Twin Diode	R	12AF3	Diode	
6X4-WA	Service Designation†		12AF6	Pentode	R
6X5-GT	Diode	R	12AJ6	Duplex-Diode Triode	
6X8	Triode-Pentode	R	12AL5	Twin Diode	R
6Y6-G	Beam Power	R	12AL8	Triode-Tetrode	
6Y6-GT	Beam Pentode	R	12AQ5	Beam Power	R
7A4	Triode	R	12AT6	Duplex-Diode Triode	R
7A6	Twin Diode	R	12AT7	Twin Triode	R
7A7	Pentode	R	12AT7-WA	Service Designation†	
7A8	Octode	R	12AU6	Pentode	R
7AF7	Twin Triode	R	12AU7	Twin Triode	R
7AG7	Pentode	R	12AU7-A	Twin Triode	R
7AU7	Twin Triode	R	12AV5-GA	Beam Pentode	R
7B4	Triode	R	12AV6	Duplex-Diode Triode	R

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Tube Type	Class	Manual*	Tube Type	Class	Manual*
12AV7	Twin Triode	R	12SG7	Pentode	R
12AW6	Pentode	R	12SG7-Y	Pentode	
12AX4-GTA	Diode	R	12SH7	Pentode	R
12AX7	Twin Triode	R	12SJ7	Pentode	R
12AY7	Twin Triode	F	12SK7	Pentode	R
12AZ7	Twin Triode	R	12SK7-Y	Pentode	
12B4-A	Triode	R	12SL7-GT	Twin Triode	R
12BA6	Pentode	R	12SN7-GTA	Twin Triode	R
12BA7	Pentagrid Converter	R	12SQ7	Duplex-Diode Triode	R
12BD6	Pentode	R	12SR7	Duplex-Diode Triode	R
12BE6	Heptode	R	12V6-GT	Pentode	R
12BF6	Duplex-Diode Triode	R	12W6-GT	Beam Pentode	R
12BH7-A	Twin Triode	R	12X4	Twin Diode	R
12BK5	Beam Pentode	R	14A7	Pentode	R
12BL6	Pentode	R	14AF7	Twin Triode	R
12BN6	Gated Beam	R	14B6	Duplex-Diode Triode	R
12BQ6-GA	Pentode	R	14Q7	Pentagrid Converter	R
12BQ6-GTB	Beam Pentode	R	14R7	Duplex-Diode Pentode	R
12BR7	Diode-Triode	R	14S7	Triode-Heptode	R
12BV7	Pentode	R	17AX4-GT	Diode	R
12BY7-A	Pentode	R	17D4	Diode	R
12BZ7	Twin Triode	R	17DQ6-A	Beam Pentode	R
12C5	Beam Pentode	R	17H3	Diode	R
12CA5	Beam Pentode	R	18A5	Beam Pentode	R
12CN5	Pentode		19AU4-GTA	Diode	R
12CR6	Diode-Pentode	R	19BG6-GA	Beam Pentode	R
12CT8	Triode-Pentode	R	19J6	Twin Triode	R
12CU5	Beam Power	R	19T8	Triple-Diode Triode	R
12CU6	Beam Pentode	R	21EX6	Receiving	
12CX6	Pentode		24A	Tetrad	R
12D4	Diode	R	25AV5-GA	Beam Pentode	R
12DB5	Beam Pentode		25AX4-GT	Diode	R
12DE8	Receiving		25BQ6-GA	Pentode	R
12DK7	Double-Diode Tetrad		25BQ6-GTB	Beam Pentode	R
12DL8	Receiving		25C5	Beam Pentode	R
12DQ6-A	Beam Pentode	R	25C6-G	Beam Power	
12DQ7	Pentode		25CA5	Beam Pentode	R
12DV8	Duplex-Diode Tetrad	R	25CD6-GB	Beam Pentode	R
12DZ6	Pentode	R	25CU6	Beam Pentode	R
12EA6	Pentode	R	25DN6	Beam Pentode	R
12EG6	Receiving		25EC6	Beam Pentode	R
12F8	Duplex-Diode Pentode	R	25L6-GT	Beam Pentode	R
12H6	Twin Diode	R	25W4-GT	Diode	R
12J5	Triode	R	25W6-GT	Beam Pentode	R
12J8	Double-Diode Tetrad		25Z5	Diode	R
12K5	Tetrad	R	25Z6-GT	Diode	R
12K7-GT	Pentode	R	26	Triode	R
12K8	Triode-Hexode	R	27	Triode	R
12L6-GT	Beam Pentode	R	FG-27-A	Thyratron	
12R5	Beam Pentode	R	28D7	Twin Beam Power	R
12SA7	Pentagrid Converter	R	32L7-GT	Diode Beam Power	R
12SA7-Y	Pentagrid Converter		35A5	Beam Power	R
12SC7	Twin Triode	R	35B5	Beam Power	R
12SF5	Triode	R	35C5	Beam Power	R
12SF7	Diode-Pentode	R	35L6-GT	Beam Power	R

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Tube Type	Class	Manual*		Tube Type	Class	Manual*	
35W4	Diode	R		807	Beam Pentode	F	
35Y4	Diode	R		GL-809	Triode		
35Z3	Diode	R		GL-810	Triode		
35Z5-GT	Diode	R		GL-811-A	Triode		
41	Pentode	R		GL-812-A	Triode		
42	Pentode	R		GL-813	Pentode		
47	Pentode	R		GL-814	Beam Power		
50A5	Beam Power	R		GL-815	Beam Power		
50B5	Beam Power	R		GL-816	Rectifier		
50C5	Beam Pentode	R		GL-828	Pentode		
50DC4	Diode	R		GL-829-B	Pentode		
50L6-GT	Beam Pentode	R		GL-832-A	Beam Power		
50X6	Diode	R		GL-833-A	Triode		
50Y6-GT	Diode	R		GL-836	Rectifier		
50Y7-GT	Diode	R		GL-837	Pentode		
58	Pentode	R		GL-838	Triode		
70L7-GT	Diode Beam Power	R		GL-845	Triode		
75	Duplex-Diode Triode	R		GL-851	Triode		T
78	Triode	R		GL-857-B	Rectifier		T
80	Twin Diode	R		GL-862-A	Triode		T
FG-81-A	Thyratron			GL-866-A	Rectifier		
83	Diode	R		GL-868	Phototube		
84/6Z4	Diode	R		GL-869-B	Rectifier		T
FG-97	Thyratron			GL-870-A	Rectifier		T
FG-98-A	Thyratron			GL-872-A	Rectifier		T
GL-100TH	Triode			GL-880	Triode		T
FG-105	Thyratron			884	Thyratron	F	
117N7-GT	Diode Beam Power	R		885	Thyratron		
117Z3	Diode Beam Power	R		GL-889-A	Triode		T
117Z6-GT	Diode	R		GL-889R-A	Triode		T
FG-154	Thyratron			GL-893A-R	Triode		
FG-172	Thyratron			GL-898-A	Triode		T
GL-207	Triode			GL-918	Phototube		
GL-242-C	Triode			GL-919	Phototube		
GL-266-B	Rectifier			GL-920	Phototube		
FG-280	Rectifier			GL-921	Phototube		
SA-302	Triode			GL-922	Phototube		
SA-350	Triode			GL-923	Phototube		
GL-393-A	Thyratron			GL-927	Phototube		
FP-400	Rectifier			GL-929	Phototube		
GL-411	Rectifier			GL-930	Phototube		
GL-414	Thyratron			GL-931-A	Phototube		
GL-441	Phototube			GL-1000T	Triode		
502-A	Thyratron		F	GL-1454	Phototube		
GL-575-A	Rectifier		T	1612	Heptode	F	
GL-592	Triode			1614	Beam Pentode	F	
Z-599	Magnetron			GL-1616	Rectifier		
GL-627	Thyratron			GL-1619	Pentode		
GL-672-A	Thyratron			1620	Pentode	F	
GL-673	Rectifier		T	2050	Thyratron	F	
GL-678	Thyratron			GL-5513	Triode		T
GL-801-A	Triode			GL-5516	Beam Pentode		
GL-802	Pentode			GL-5518	Triode		T
GL-803	Pentode			GL-5528/C6L	Thyratron		
GL-805	Triode			GL-5544	Thyratron		

* I = Industrial Manual
R = Receiving Manual
F = Five-Star and Special-Purpose Manual
T = Transmitting Manual

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Tube Type	Class	Manual*	Tube Type	Class	Manual*
GL-5549	Triode		5727/2D21 W	Service Designation†	
GL-5550	Ignitron	I	GL-5728	Thyratron	I
GL-5551-A	Ignitron	I	GL-5736	Triode	
GL-5552-A	Ignitron	I	GL-5740	Triode	
GL-5553-B	Ignitron	I	5749	Five-Star	
GL-5554	Ignitron	I	5749/65A6W	Service Designation†	
GL-5555	Ignitron	I	5750	Five-Star	
GL-5556	Triode		5750/68E6W	Service Designation†	
GL-5557	Thyratron	I	5751	Five-Star	
GL-5558	Rectifier	I	5751 WA	Service Designation†	
GL-5559	Thyratron	I	GL-5762	Triode	
GL-5560	Thyratron	I	5763	Beam Pentode	F
GL-5561	Rectifier	I	GL-5779	Ignitron	I
GL-5564	Ignitron	I	GL-5788	Ignitron	I
GL-5581	Phototube		5814-A	Five-Star	F
GL-5593	Phasitron		5814 WA	Service Designation†	
5610	Triode	F	GL-5820	Image Orthicon	T
GL-5620	Ballast Tube		GL-5822-A	Ignitron	I
GL-5621	Ballast Tube		5824	Pentode	F
GL-5623	Ballast Tube		GL-5830	Thyratron	I
GL-5624	Ballast Tube		5840	Five-Star	F
GL-5625	Rectifier		5844	Twin Triode	F
GL-5626	Vacuum Switch		GL-5855	Thyratron	F
GL-5627	Vacuum Switch		5879	Pentode	F
GL-5628	Vacuum Gage		5881	Beam Pentode	F
GL-5629	Vacuum Gage		GL-5894	Tetode	
GL-5630	Ignitron	I	5896	Five-Star	F
GL-5632/C3J	Thyratron		5899	Five-Star	F
5636	Five-Star	F	5902	Five-Star	F
5642	Diode	F	GL-5948	Thyratron	I
5651	Glow Tube	F	5963	Twin Triode	F
5654	Five-Star	F	5964	Twin Triode	F
5654/6AK5W	Service Designation†		5965	Twin Triode	F
5654/6AK5W/6096	Service Designation†		GL-5973	Rectifier	I
5662	Thyratron	F	6005	Five-Star	F
5663	Thyratron	F	6005/6AQ5W	Service Designation†	
GL-5665/C16J	Thyratron		6005/6AQ5W/6095	Service Designation†	
5670	Five-Star	F	GL-6011/710	Thyratron	I
5670 WA	Service Designation†		GL-6014/C1K	Thyratron	
GL-5674	Pentode		GL-6019	Tetode	T
5686	Five-Star	F	6021	Five-Star	F
5687	Twin Triode	F	GL-6039	Triode	T
5691	Twin Triode	F	GL-6044	Thyratron	
5692	Twin Triode	F	6046	Beam Pentode	F
5693	Pentode	F	6072	Five-Star	F
5696	Thyratron	F	6080	Twin Triode	
5718	Five-Star	F	6087	Five-Star	F
5719	Five-Star	F	6100/6C4WA	Service Designation†	
GL-5720	Thyratron	I	6111	Five-Star	F
5725	Five-Star	F	6112	Five-Star	F
5725/6AS6W	Service Designation†		6134	Five-Star	
5726	Five-Star	F	6135	Five-Star	
5726/6AL5W	Service Designation†		6136	Five-Star	F
5726/6AL5W/6097	Service Designation†		6137	Five-Star	
5727	Five-Star	F	6146	Beam Power	

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† Because of the special nature of this type, data sheets are not maintained. Refer to the applicable Armed Service specifications for ratings

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GL-6181	Tetrode		6661	Pentode	F
GL-6182	Tetrode	T	6662	Pentode	F
GL-6198-A	Camera Tube	T	6663	Twin Diode	F
6201	Five-Star	F	6669	Beam Pentode	F
6202	Five-Star	F	6677	Pentode	F
6203	Five-Star	F	6678	Triode-Pentode	F
6205	Five-Star	F	6679	Twin Triode	F
6206	Pentode		6680	Twin Triode	F
6211	Twin Triode	F	6681	Twin Triode	P
GL-6228	Ignitron		GL-6787	Magnetron	
GL-6237	Klystron	T	GL-6807	Thyratron	I
GL-6238	Klystron	T	GL-6808	Thyratron	I
GL-6239	Klystron	T	GL-6809	Thyratron	I
GL-6240	Klystron	T	6829	Five-Star	F
GL-6241	Klystron	T	GL-6849	Image Orthicon	T
GL-6242	Klystron	T	GL-6855/716	Thyratron	
GL-6251	Tetrode	T	GL-6856/740	Thyratron	
6265	Five-Star	F	GL-6857/740-P	Thyratron	
GL-6283	Tetrode	T	GL-6858/760	Thyratron	
GL-6299	Triode	T	GL-6859/760-P	Thyratron	
GL-6301	Reference Cavity	T	GL-6860/C6J/F	Thyratron	
GL-6346	Ignitron		GL-6878	Ignitron	I
GL-6347	Ignitron		GL-6897	Triode	T
GL-6348	Ignitron		GL-6917	Magnetron	T
6350	Triode		6919	Twin Diode	F
6386	Five-Star	F	GL-6930/635-P	Rectifier	
6397	Power Pentode		GL-6942	Tetrode	T
GL-6410	Magnetron	T	GL-6958	Ignitron	I
6414	Five-Star	F	7036	Heptode	F
GL-6442	Triode	T	GL-7042	Ignitron	
GL-6452	Reference Cavity	T	7077	Triode	
6463	Twin Triode	F	GL-7085/356	Triode	T
6485	Pentode	F	GL-7151	Ignitron	
GL-6504	Ignitron	I	GL-7171	Ignitron	
GL-6509	Ignitron	I	GL-7179	Ignitron	
GL-6511	Ignitron	I	GL-7180	Ignitron	
GL-6512	Ignitron	I	GL-8000	Triode	
GL-6513	Ignitron	I	GL-8002	Triode	
GL-6514	Ignitron	I	GL-8002-R	Triode	
GL-6515	Ignitron	I	GL-8005	Triode	
6525	Thyratron	F	GL-8008	Rectifier	T
GL-6619	Gas-Discharge Device	T	GL-8013-A	Rectifier	
GL-6620	Gas-Discharge Device	T	GL-8020	Rectifier	
GL-6621	Gas-Discharge Device	T	9001	Pentode	F
GL-6625	Klystron	T	9002	Triode	F
6660	Pentode	F	9003	Pentode	F

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ELECTRONIC COMPONENTS DIVISION
GENERAL ELECTRIC
Schenectady 5, N. Y.

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Supersedes ETI-101Z, dated 12-57

ELECTRONIC COMPONENTS DIVISION

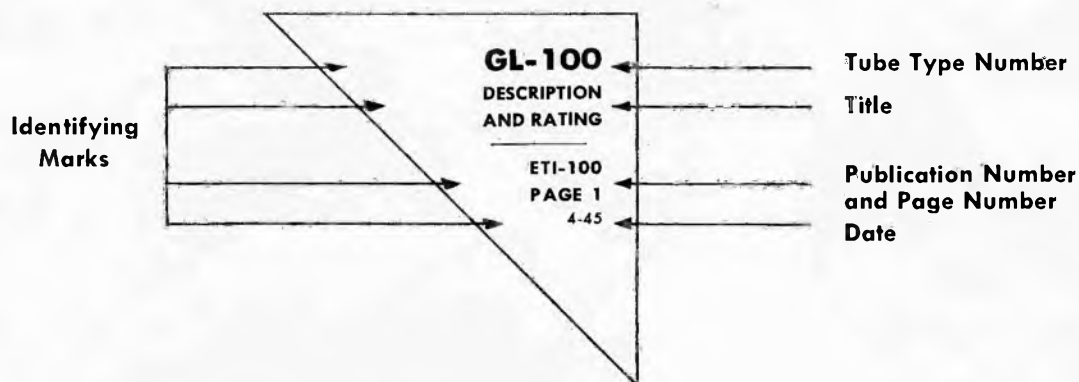
GENERAL  ELECTRIC

Schenectady 5, N. Y.

This manual on G-E electronic tubes for industry may offer the maximum of service, please advise is recorded in your name below. In order that we us promptly if this information requires correction.

Mr. F. S. Parker	
General Electric Company	
P. O. Box 909	
Portland 7, Ore.	
E-56	
#8333-I	6-28-47

The index-corner feature of the Description and Rating sheets enables you to locate data by tube type or by ETI number. The first page of each Description and Rating bears the following identification:



In addition, the **ETI** number and date are shown on each page of the manual to provide complete indexing.

You will receive new and revised data at various times during the subscription period. Prompt insertion of these data is vital in providing you with maximum value in the use of the technical information. This service comes to you at an annual fee of \$1.00.

Your requests for lost or missing data sheets should state the tube type number and title or the publication [**ETI**] number. If you require only cer-

tain sheets of a publication [**ETI**] mention the page numbers desired.

Be sure to notify us of any change in your address or of the transfer of your manual to another person. The "change of address" cards included in the back of this manual are for your convenience.

When corresponding with us please *state the manual registration number* as this will aid us in servicing your requests promptly.

Notifications of changes or requests for supplementary data should be forwarded promptly to:

**TUBE SALES SECTION
TUBE DIVISION
ELECTRONICS DEPARTMENT
GENERAL ELECTRIC COMPANY
SCHENECTADY 5, N. Y.**

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



**PRICES AND ORDERING
INSTRUCTIONS**

INDUSTRIAL TYPES

You will find the concise technical information and prices on these pages handy in quickly selecting the proper tube for your application.

The various types of tubes are shown in tabular form by class of tube and conveniently arranged

in order by key ratings and characteristics.

Description and rating publication numbers for each type of tube are listed to provide you a ready reference to these data sheets included in other sections of the manual.

Prices effective Oct. 1, 1950

IGNITRONS—high-peak-current, pool-cathode tubes

Welding Control Types*	Suggested User's Price§	MAXIMUM RATINGS				Type of Cooling	Shipping Weight in Lb	Description and Rating
		Kva Demand	Corresponding Average Anode Current, Amps.	Maximum Average Anode Current, Amps.	Corresponding Kva Demand			
GL-5550/GL-415	\$50.00	300	12.1	22.4	100	Water	5	ETI-114B
GL-5822**	143.00	424	20	70	188	Water	17	ETI-309
GL-5551/FG-271	80.50	600	30.2	56.0	200	Water	12	ETI-113
GL-5552/FG-235-A	121.00	1200	75.6	140	400	Water	17	ETI-109A
GL-5553/FG-258-A	265.00	2400	192.0	355	800	Water	41	ETI-111B

* Ratings are for voltages of 600 volts rms and below. Ignitor requirements for all welding-control types are 200 volts and 30 amperes.

** For Frequency Changer welding control.

Power Rectifier Types†	Suggested User's Price§	D-c Volts	MAXIMUM CURRENT			Type of Cooling	Shipping Weight in Lb	Description and Rating
			Peak Amp	Average Amp	Average Amp 1 Minute			
GL-5779	\$72.00	125	30	10	200	Air	6	ETI-301
GL-5554/FG-259-B	190.00	300	900	150	200	Water	22	ETI-112
			600	112.5	150			
GL-5555/FG-238-B	370.00	300	1800	300	400	Water	35	ETI-110A
			1200	225	300			
GL-5630	930.00	6000	200	50	50	Water	44	ETI-294
GL-506	3000.00	6000	900	150	300	Water	170	ETI-293A

† Typical ignitor requirements for power-rectifier ignitrons are 75–125 volts, 15–20 amperes. Maximum requirements are 150 volts, 40 amperes.

THYRATRONS—grid-controlled gaseous-discharge rectifier tubes

Type No.	Suggested User's Price§	No. of Electrodes	CATHODE		ANODE			Starting Grid Voltage	Temp Range Condensed Mercury C	Shipping Weight in Lb	Description and Rating
			Volts	Amp	Peak Inv. Volts	Peak Amp	Avg Amp				
GL-5662	\$2.40	3	6.3	0.15	200	Fuse tube	.....	.....	-55—+90*	3	ETI-300
GL-5663	1.90	4	6.3	0.15	500	0.060	0.020	Neg	-55—+90	3	ETI-284
GL-884	1.85	3	6.3	0.6	350	0.300	0.075	Neg		3	ETI-136
GL-885	2.00	3	2.5	1.4	350	0.300	0.075	Neg		3	ETI-137
GL-2D21	2.00	4	6.3	0.6	1300	0.500	0.100	Neg	-55—+90*	3	ETI-279
GL-2050	1.85	4	6.3	0.6	1300	0.500	0.100	Neg		3	ETI-138B
FG-178-A	24.00	3	2.5	2.25	500	0.500	0.125	Neg	-20—+50*	2	ETI-131
GL-502-A	1.85	4	6.3	0.6	1300	1.0	0.100	Neg	-50—+90	3	ETI-134C
FG-81-A	16.00	3	2.5	5.0	500	2.0	0.5	Neg	-20—+50*	2	ETI-124B
FG-98-A	24.00	4	2.5	5.0	500	2.0	0.5	Neg	-20—+50*	4	ETI-127B
FG-97	22.00	4	2.5	5.0	1000	2.0	0.5	Var	40—80	4	ETI-126C
GL-5557/FG-17	7.75	3	2.5	5.0	5000	2.0	0.5	Neg	40—80	3	ETI-118C
GL-627	17.25	3	2.5	6.0	2500	2.5	0.64	Neg	25—70	1	ETI-253
GL-3C23	12.50	3	2.5	7.0	1250	6.0	1.5	Neg	-40—+80	3	ETI-117A
GL-393-A	13.25	3	2.5	7.0	1250	6.0	1.5	Neg	-40—+80	3	ETI-132
GL-678	40.00	3	5.0	7.5	15000	6.0	1.6	Neg	25—50	3	ETI-255A
FG-154	42.00	4	5.0	7.0	500	10.0	2.5	Neg	-20—+50*	7	ETI-129
FG-27-A	23.00	3	5.0	4.5	1000	10.0	2.5	Neg	40—80	3	ETI-119C
GL-5720/FG-33	21.00	3	5.0	4.5	1000	15.0	2.5	Pos	35—80	7	ETI-120A
GL-5559/FG-57	19.50	3	5.0	4.5	1000	15.0	2.5	Neg	40—80	7	ETI-122C
GL-5728/FG-67	23.00	3	5.0	4.5	1000	15.0	2.5	Var	40—80	3	ETI-123B
GL-5560/FG-95	25.00	4	5.0	4.5	1000	15.0	2.5	Var	40—80	7	ETI-125C
			15.5	5.0	1000	40.0	0.5	Var	40—80		
GL-672-A	26.50	4	5.0	5.0	2500	40.0	3.2	Neg	40—80	1½	ETI-254A
GL-5632	12.15	3	2.5	9.0	1250	30.0	2.5	Neg	-55—+70	2	ETI-292
GL-5544	27.00	3	2.5	12.0	1500	40.0	3.2	Neg	-55—+70*	2	ETI-282
GL-5545	35.00	3	2.5	21.0	1500	80.0	6.4	Neg	-55—+70*	3	ETI-275B
FG-105	48.00	4	5.0	10.0	2500	40.0	6.4	Var	40—80	7	ETI-128B
			15.5	11.0	750	77.0	2.5	Var	30—95		
			15.0	10.0	10000	16.0	4.0	Var	25—50		
			5.0	10.0	2000	40.0	6.4	Var	40—80		
FG-172	65.00	4	15.5	11.0	750	77.0	2.5	Var	30—95	7	ETI-130A
GL-5830/FG-41	182.00	3	5.0	20.0	10000	75.0	12.5	Neg	40—65	8	ETI-121B
GL-414	120.00	4	5.0	20.0	2000	100.0	12.5	Neg	40—80	9	ETI-133C

* These tubes are inert-gas-filled, and the temperature ratings are expressed in terms of the ambient temperature range over which the tubes will operate.

† These ratings apply only when the tube is used for ignitor firing.

‡ These ratings apply only when the tube is used in thyatron welding-control service.

◆ Ambient temperature

KENOTRONS—high-vacuum rectifier tubes

Type No.	Suggested User's Price§	No. of Electrodes	CATHODE		PLATE		Shipping Weight in Lb	Description and Rating
			Volts	Amp	Peak Volts	Peak Amp		
FP-400	\$24.00	2	4.0	2.25	100	0.025	3	ETI-143
GL-2B23	21.00	2	6.3	0.3	150	0.030	3	ETI-286
GL-5741/FP-85-A	75.00	2	10.0	5.0	20000	0.100	3	ETI-142
GL-3B24	11.75	2	2.5	3	20000	0.150	3	ETI-280
			5.0	3	20000	0.300		
GL-8020	22.00	2	5.0	6.0	40000	0.750	8	ETI-145
			5.8Δ	6.0	12500Δ	2.00Δ		
GL-411	225.00	2	10	14.5	100000	0.3	9	ETI-144A
GL-5625/KC-4	225.00	2	20	24.5	150000	1.00	9	ETI-141B

Δ Surge-limiting diode operation.

PHANOTRONS—gaseous-discharge rectifier tubes

Type No.	Suggested User's Price§	No. of Electrodes	CATHODE		ANODE			Temp Range Condensed Mercury C	Shipping Weight in Lb	Description and Rating
			Volts	Amp	Peak Volts	Peak Amp	Avg Amp			
GL-866-A	\$ 1.95	2	2.5	5	10000	1	0.25	25-60	3	ETI-153A
FG-190	29.00	3	2.5	12	175	5	1.25	-20-+50*	3	ETI-150
GL-872-A	8.20	2	5.0	7.5	10000	5	1.25	20-60	8	ETI-155B
GL-8008	8.20	2	5.0	7.5	10000	5	1.25	20-60	8	ETI-256A
GL-575-A	21.00	2	5.0	10	15000	6	1.5	20-50	3	ETI-244C
GL-673	21.00	2	5.0	10	15000	6	1.5	20-60	3	ETI-243B
GL-5558/FG-32	14.00	2	5.0	4.5	5000	15	2.5	30-60	3	ETI-147B
GL-869-B	132.00	2	5.0	19	20000	10	2.5	30-40	7	ETI-154B
					15000†	15†	5.0†			
FG-280	56.00	2	5.0	10	2000	40	6.4	40-80	3	ETI-151B
GL-5561/FG-104	38.00	2	5.0	10	3000	40	6.4	40-80	3	ETI-148B
GL-857-B	209.00	2	5.0	30	22000	20	5.0	30-40	10	ETI-152
FG-166	150.00	2	2.5	100	1500	75	20	20-60	6	ETI-149A

† Quadrature operation.

PLIOTRONS—grid-controlled high-vacuum tubes

Control Types	Suggested User's Price§	No. of Electrodes	CATHODE		PLATE		Max Dis Watts	Mu			Shipping Weight in Lb	Description and Rating
			Volts	Amp	Max Volts	Max Amp						
GL-5691	\$ 7.75	6	6.3	0.6	275	0.010	1.0	80			3	ETI-297
GL-5692	7.75	6	6.3	0.6	275	0.015	1.75	22			3	ETI-298
GL-5693	6.40	5	6.3	0.3	300	0.010	2.0				3	ETI-299
GL-5743/PJ-21	12.50	3	4.5	1.1	350	0.019	7.5	3			3	ETI-159A
GL-5742/PJ-7	13.00	3	4.5	1.1	350	0.040	10	30			3	ETI-157A
GL-5556/PJ-8	12.00	3	4.5	1.1	350	0.040	10	8.5			3	ETI-158
Spec. Purpose												
GL-5740/FP-54	66.00	4	2.5	0.09	6	0.00015		Low grid-current measurement tube			7	ETI-160A
GL-5674	77.00	6	3.8	0.09	10	0.0001		Low grid-current measurement tube			7	ETI-284
GL-5739/FP-62	44.00	3	4.5	1.48	112.5	0.010		For gas-pressure measurements			9	ETI-161A
Therapy Types							Max Input Watts	Max Dis Watts	Mu		Shipping Weight in Lb	Description and Rating
FP-285	20.00	3	10	3.25	1350	0.200	270	100	12	6	6	ETI-164
FP-265	36.00	3	10	5.20	1500	0.200	350	160	75	6	6	ETI-163
Power Triodes	for high-frequency heating						Max Dis Watts	Mu	Type of Cooling		Shipping Weight in Lb	Description and Rating
GL-5610	1.98	3	6.3	0.15	300	0.017	3	14			2	ETI-291
GL-807	2.50	5	6.3	0.9	600	0.10	25	8			3	ETI-165
GL-810	14.50	3	10	4.5	2000	0.25	125	36			8	ETI-166A
GL-592	33.00	3	10	5.0	3500	0.25	200	24	Air		8	ETI-245B
GL-833-A	49.50	3	10	10.0	4000	0.50	400	35			9	ETI-167A
GL-1000-T	125.00	3	7.5	17.0	7500	0.75	1000	35	Air		8	ETI-314
GL-851	300.00	3	11	15.5	2500	1.00	750	20.5			8	ETI-168
GL-8002	132.00	3	16	38.0	3500	1.00	1200	2.15	Water		5	ETI-175B
GL-8002-R	160.00	3	16	38.0	3500	1.00	1200	21.5	Air		5	ETI-250A
GL-5549	275.00	3	12.6	57.0	8500	1.25	4000	23	Air		26	ETI-283
GL-473	144.00	3	6.0	60.0	5000	1.40	2500	22	Air		7	ETI-281
GL-889-A	210.50	3	11	120.0	8500	2.00	5000	21	Water		8	ETI-171
GL-889R-A	285.00	3	11	120.0	8500	2.00	5000	21	Air		52	ETI-249
GL-891	223.00	3	22	60.0	12000	2.00	6000	8	Water		10	ETI-172A
GL-891-R	362.00	3	22	60.0	10000	2.00	4000	8	Air		10	ETI-246A
GL-207	242.00	3	22	51.0	15000	2.00	10000	20	Water		10	ETI-162A
GL-892	223.00	3	22	60.0	15000	2.00	10000	50	Water		10	ETI-173A
GL-892-R	362.00	3	22	60.0	12500	2.00	4000	50	Air		10	ETI-247A
GL-893-A	630.00	3	20	183.0	20000	4.00	20000	34.5	Water		25	ETI-174A
GL-893A-R	1150.00	3	20	183.0	20000	4.00	20000	34.5	Air		290	ETI-248
GL-880	483.00	3	12.6	320.0	15000	4.50	20000	20	Water		21	ETI-170B
GL-895	866.00	3	19	138.0	17000	9.00	40000	37	Water		85	ETI-251B
GL-895-R	1180.00	3	19	138.0	17000	9.00	20000	37			455	ETI-252B
GL-862-A	1150.00	3	33	207.0	20000	10.00	100000	45	Water		90	ETI-169

GLOW TUBES—cold-cathode tubes for use as voltage regulators

Type No.	Suggested User's Price [§]	Starting Supply Voltage, D-c Min	Operating Voltage Maintained, D-c Approx	OPERATING CURRENT, MILLIAMPERES		Shipping Weight in Lb	Description and Rating
				Min	Max		
GL-OA3	\$1.35	105	75	5	40	3	ETI-176A
GL-OB3	1.20	125	90	10	30	3	ETI-176A
GL-B74	3.10	125	90	10	50	3	ETI-176A
GL-OC3	1.35	133	105	5	40	3	ETI-176A
GL-OB2	3.55	133	108	5	30	3	ETI-306
GL-OD3	1.30	185	150	5	40	3	ETI-176A
GL-OA2	3.20	185	150	5	30	3	ETI-305

PHOTOTUBES—light-sensitive tubes

Type No.	Sug-gested User's Price [§]	Gas or Vacuum	Spectral Response RMA Standard	Anode Volts	Sensitivity in Microamperes per Lumen	Window Dimensions in Inches	Max Amb Temp. C	Shipping Weight in Lb	Description and Rating
GL-1P21	\$50.00	Vacuum	S4	1250		1 1/2 x 1 5/8	75	3	ETI-315
GL-1P29/FJ-401	2.95	Gas	S3	100		1 1/2 x 1 3/8	100	3	ETI-178A
GL-1P37	2.85	Gas	S4	100	120	3/8 x 1 1/4	75	3	ETI-289
GL-1P39	1.75	Vacuum	S4	250	45	3/8 x 1 1/8	75	3	ETI-295
GL-1P40	1.85	Gas	S1	90	135	3/8 x 1 1/8	100	3	ETI-290
PJ-22	2.50	Vacuum	S1	500	20	1 1/2 x 1 3/8	100	3	ETI-179
FJ-405(Use GL-935)									
GL-441	4.50	Vacuum	S4	250	45	1 1/2 x 1 3/8	50	3	ETI-181
GL-868/PJ-23	2.50	Gas	S1	100	50	1 1/2 x 1 3/8	100	3	ETI-182A
GL-917	3.50	Vacuum	S1	500	20	1 1/2 x 1 3/8	100	3	ETI-183
GL-918	3.10	Gas	S1	100	110	1 1/2 x 1 3/8	100	3	ETI-184
GL-919	3.50	Vacuum	S1	500	20	1 1/2 x 1 3/8	100	3	ETI-185
GL-920	4.15	Gas	S1	100	75	1 1/2 x 1 3/8	100	3	ETI-186
GL-921	2.05	Gas	S1	90	135	3/8 x 3/4	100	3	ETI-187
GL-922	1.95	Vacuum	S1	500	20	3/8 x 3/4	100	3	ETI-188
GL-923	2.05	Gas	S1	90	135	1 1/2 x 3/8	100	3	ETI-189
GL-927	2.50	Gas	S1	90	125	7/16 x 3/8	100	3	ETI-190
GL-929	1.50	Vacuum	S4	250	45	1 1/2 x 3/8	50	3	ETI-191
GL-930	1.65	Gas	S1	90	135	1 1/2 x 3/8	100	3	ETI-192
GL-931-A	9.75	Vacuum	S4	1250	2.0 amperes	1 1/2 x 1	50	3	ETI-193A
GL-935	7.80	Vacuum	S5	250	30	1 1/2 x 1 3/8	75	3	ETI-270
GL-5581	2.25	Gas	S4	100	135	3/8 x 1 1/8	75	3	ETI-295

BALLAST TUBES—resistor-type tubes used to maintain a constant average current

Type No.	Suggested User's Price [§]	VOLTS		AMPERES		Shipping Weight in Lb	Description and Rating
		Min	Max	Min	Max		
GL-5620/FB-50	\$13.00	5	8	0.225	0.275	3	ETI-194A
GL-5622/B25	11.00	7	16	1.07	1.16	3	ETI-194A
GL-5623/B47	12.00	8	18	2.05	2.35	3	ETI-194A
GL-5624/B-46	12.00	8	18	2.70	3.25	3	ETI-194A
GL-5621/B-6	12.00	15	21	0.95	1.01	3	ETI-194A

VACUUM GAGES—to measure gas pressure

Type No.	Suggested User's Price [§]	Volts	Range in Microns	Shipping Weight in Lb	Description and Rating
GL-5628/FA-13	\$23.50	6	0-600	3	ETI-195A
GL-5629/FA-14	19.00	6	⊙	3	ETI-195A

⊙Used with GL-5628/FA-13 to compensate for temperature and voltage changes.

VACUUM SWITCHES—single-pole, double-throw

Type No.	Suggested User's Price [§]	Max Hold-off Voltage, Peak	Max Interrupting Rating, Amperes	Shipping Weight in Lb	Description and Rating
GL-5627/FA-6	\$24.00	700	10	3	ETI-197A
GL-5626/FA-15	20.00	3000	10	3	ETI-198A
GL-1S21	15.50	7500	15	3	ETI-287

VACUUM CAPACITORS

Type No.	Suggested User's Price [§]	Peak Voltage, Volts, A-c D-c or R-f	Capacitance, ±5% Micromicrofarads	Ambient Temperature		Net Weight in Oz Approx	Shipping Weight in Lb Approx	Description and Rating
				Min	Max			
GL-1L21	\$12.50	7500	12	-40	+65	4	1	ETI-262
GL-1L22	26.00	16000	25	-40	+65	6	1	ETI-263
GL-1L23	26.00	16000	50	-40	+65	6	1	ETI-264
GL-1L24	49.50	16000	100	-40	+65	8	1	ETI-265
GL-1L25	14.00	16000	12	-40	+65	6	1	ETI-266
GL-1L31	14.00	16000	6	-40	+65	6	1	ETI-307
GL-1L32	12.50	7500	6	-40	+65	4	1	ETI-308
GL-1L33	30.00	7500	100	-40	+65	6	1	ETI-267
GL-1L36	12.50	7500	25	-40	+65	4	1	ETI-268
GL-1L38	22.00	7500	50	-40	+65	4	1	ETI-269

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Prices and other data subject to change without notice



FOR RADIO APPLICATIONS*

SUGGESTED USER'S PRICES AND CONCISE TECHNICAL DATA

HIGH-VACUUM TYPES

Type No.	Sug- gested User's Price†	No. of Elec- trodes	CATHODE		PLATE				MAX. FREQ. MC.		Mu	Gm	Bulletin No.
			Volts	Amp	Max Volts	Max Amp	Max Input, Watts	Max Dissi- pation, Watts	@ Max Plate Input	@50% Max Plate Input			
GL-2C40	\$29.00	3	6.3	0.75	500	0.025	4.0	6.5	3370	.....	36	4850	ETX-123
GL-2C43	29.00	3	6.3	0.90	500	0.040	16.7	6.7	3370	.....	48	8000	ETX-124
GL-2E24	5.10	5	6.3	0.65	600	0.085	40	13.5	125	175 @ 68%	7.5	3200	ETX-223
GL-2E26	3.85	5	6.3	0.80	500	0.075	30	10	125	.....	6.5	3500	ETX-224
					600	0.075	40	13.5					
GL-2E30	2.45	5	6.0	0.65	250	0.060	15	10	165	.....			ETX-229A
GL-4D21/ 4-125A	27.50	4	5.0	6.5	3000	0.225	500	125	120	250 @ 56%	6.2	2450	ETX-225
GL-5C24	40.00	3	10.0	5.2	1750	0.107	250	160	.....	.....	8	5500	ETX-217
GL-35T	9.50	3	5.0	4.0	2000	0.150	300	50	100	.....	39	2800	ETX-216
GL-100TH	16.50	3	5.0	6.3	3000	0.225	675	100	.....	.....	40	5500	ETX-222
GL-146	24.00	3	10	3.25	1500	0.200	300	125	15	60	75	.....	ETX-127
GL-152	27.00	3	10	3.25	1500	0.200	300	125	15	60	25	.....	ETX-128
GL-159	145.00	3	10	9.60	2000	0.400	800	250	15	35	20	.....	ETX-129
GL-169	120.00	3	10	9.60	2000	0.400	800	250	15	35	85	.....	ETX-130
GL-203-A	13.75	3	10	3.25	1250	0.175	220	100	15	80	25	.....	ETX-131
GL-204-A	115.00	3	11	3.85	2500	0.275	690	250	3	30	23	.....	ETX-132
GL-211	13.75	3	10	3.25	1250	0.175	220	100	15	80	12	.....	ETX-134A
GL-242-C	13.75	3	10	3.25	1250	0.150	188	100	6	30	12.5	.....	ETX-136A
GL-800	11.50	3	7.5	3.25	1250	0.080	100	35	60	180 @ 55%	15	.....	ETX-142
GL-801-A	4.30	3	7.5	1.25	600	0.070	42	20	60	120	8	.....	ETX-143
GL-802	4.75	5	6.3*	0.90	500	0.060	25	10	30	100 @ 55%	.....	2250	ETX-144
					600	0.060	33	13					
GL-803	24.25	5	10	5.00	2000	0.175	350	125	20	70	.....	4000	ETX-145
GL-805	13.50	3	10	3.25	1500	0.210	315	125	30	80	.....	.....	ETX-146
GL-806	34.25	3	5	10.0	3000	0.200	600	150	30	100	12.6	.....	ETX-147
					3300	0.300	1000	225					
GL-809	4.00	3	6.3	2.50	750	0.100	75	25	60	120	50	.....	ETX-149
					1000	0.100	100	30					
GL-811-A	4.05	3	6.3	4.00	1250	0.175	175	45	30	100	160	.....	ETX-151A
					1500	0.175	260	65					
GL-812-A	4.05	3	6.3	4.00	1250	0.175	175	45	30	100 @ 55%	29	.....	ETX-152A
					1500	0.175	260	65					
GL-813	16.00	5	10.0	5.00	2000	0.180	360	100	30	120 @ 50%	8.5	3750	ETX-153C
					2250	0.225	500	125					
GL-814	14.25	5	10.0	3.25	1250	0.150	180	50	30	75 @ 64%	.....	3300	ETX-154
					1500	0.150	225	65					
GL-815	6.90	5	*6.3†	1.6†	400	0.150	60	20	125	200 @ 70%	6.5	4000	ETX-155
					500	0.150	75	25					
GL-826	12.50	3	7.5	4.0	1000	0.125	125	60	250	300 @ 80%	31	.....	ETX-157A
GL-828	13.75	5	10.0	3.25	1250	0.160	200	70	30	75 @ 65%	.....	2700	ETX-158
					1500	0.180	270	80					
GL-829-B	16.25	*5 †	6.3†	2.25†	750	0.240	120	40	200	250 @ 89%	9	8500	ETX-159
GL-830-B	11.50	3	10.0	2.0	1000	0.150	150	60	15	60 @ 54%	25	.....	ETX-160
GL-832-A	12.90	5	*6.3†	1.6†	750	0.090	36	15	200	250 @ 89%	7	3500	ETX-161
GL-835	19.50	3	10.0	3.25	1250	0.175	220	100	20	100	12	3600	ETX-163
GL-837	5.80	5	12.6*	0.70	500	0.080	32	12	20	60 @ 62%	.....	3400	ETX-165
GL-838	13.75	3	10.0	3.25	1250	0.175	220	100	30	120	.....	.....	ETX-166
GL-842	4.05	3	7.5	1.25	425	0.028	.....	12	.....	.....	3	1250	ETX-167
GL-843	2.60	3	2.5*	2.50	450	0.040	.....	15	6	30 @ 80%	7.7	.....	ETX-168
GL-845	13.75	3	10.0	3.25	1250	0.175	.....	75	.....	.....	5	.....	ETX-169
GL-849	138.00	3	11.0	5.00	2500	0.350	875	400	3	30	19	.....	ETX-170
GL-1613	2.65	5	6.3*	0.70	350	0.050	17.5	10	45	90 @ 85%	.....	2500	ETX-191
GL-1614	2.05	5	6.3*	0.90	375	0.110	35	2†	80	120 @ 75%	.....	6050	ETX-192A
GL-1619	2.50	4	2.5	2.0	400	0.075	30	15	45	90 @ 77%	.....	4500	ETX-194A
GL-1623	4.05	3	6.3	2.5	750	0.100	75	25	60	115	20	.....	ETX-195A
GL-1624	4.00	5	2.5	2.0	600	0.090	54	25	60	125 @ 55%	4000	ETX-196

* Types shown are not included elsewhere in the Industrial Tube Manual.

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Prices and other data subject to change without notice

Prices effective Oct. 1, 1950

Supersedes ETI-105F dated 2-48

HIGH-VACUUM TYPES (Cont'd)

Type No.	Sug- gested User's Price	No. of Elec- trodes	CATHODE		PLATE				MAX. FREQ. MC.		Mu	Gm	Bulletin No.	
			Volts	Amp	Max Volts	Max Amp	Max Input Watts	Max Dissi- pation, Watts	@ Max Plate Input	@50% Max Plate Input				
GL-1625	\$2.65	5	12.6*	0.450	600 750	0.100 0.100	60 75	25 30	—	60	125 @ 55%	8	6000	ETX-197
GL-5654	6.00	5	6.3*	0.175	180	0.007	—	1.7	—	—	—	—	5000	ETX-241
GL-5670	7.50	6	6.3*	0.350	300	0.018	—	1.5	—	—	—	35	5500	ETX-233
GL-5686	7.00	5	6.3*	0.350	250	0.040	—	2.7	—	—	—	—	—	ETX-244
GL-5725	6.00	5	6.3*	0.175	180	0.0052	—	1.7	—	—	—	—	—	ETX-258
GL-5726	4.50	4	6.3*	0.300	330	0.054	—	—	—	—	—	—	—	ETX-257
GL-5749	4.50	5	6.3*	0.300	300	0.011	—	3.0	—	—	—	—	—	ETX-261
GL-5750	4.50	6	6.3*	0.300	300	0.0026	—	1.0	—	—	—	—	—	ETX-262
GL-5751	5.65	6	6.3*	0.350	330	0.001†	—	1.1	—	—	—	70	1200	ETX-245
GL-5814	6.00	6	12.6* 6.3* 12.6* 12.6*	0.175 0.350 0.175	330	0.010	—	3.03†	—	—	—	17	2200	ETX-246
GL-5824	3.35	5	25.0*	0.300	200	0.069	—	12.5	—	—	—	—	5000	ETX-240
GL-8000	14.50	3	10.0	4.500	2500	0.300	750	175	30	100	—	16.5	—	ETX-215
GL-8005	7.40	3	10.0	3.250	1250 1500	0.200 0.200	240 300	75 85	60	100 @ 60%	—	20	—	ETX-210
GL-8012-A	15.50	3	6.3	2.000	1000	0.080	50	40	500	600 @ 63% ϕ	—	18	—	ETX-204
GL-8025-A	10.00	3	6.3	1.920	1000	0.080	50	30	500	600 @ 70%	—	18	—	ETX-214
					1000	0.080	75	40						

HIGH-VACUUM, FORCED-AIR-COOLED TYPES

Type No.	Suggested User's Price	No. of Elec- trodes	CATHODE		PLATE				MAX. FREQ. MC.		Mu	Bulletin No.
			Volts	Amp	Max Volts	Max Amp	Max Plate Input, Watts	Max Dissi- pation, Watts	@ Max Plate Input	@50% Max Plate Input		
GL-2C39	\$41.50	3	6.3*	1.1	350	0.045	15.8	4.8	500	.....	100	ETX-122
GL-3C22	80.00	3	6.3*	2.0	1000	0.150	150	125	1000	.....	40	ETX-126
GL-4X150A	48.00	4	6.0*	2.6	1250	0.250	.....	150	500	.....	5	ETX-237
GL-4-250A/5D22	37.50	4	5	14.5	4000	0.350	.....	250	75	120@62%	5.1	ETX-236
GL-5D24	37.50	4	5.0	14.1	3500 4000	0.350 0.350	600 1000	200 250	85	.....	6.4	ETX-226
GL-7C29	115.00	3	10.5	28.0	3000	0.400	1200	500	110	.....	29	ETX-218
GL-7D21	235.00	4	6.3	30.0	4000	1.0	3000	1200	110	.....	—	ETX-219A
GL-9C22	1225.00	3	19.5	415	17000	8.0	100000	20000	5	25@70%	41	ETX-212
GL-1000T	125.00	3	7.5	17.0	7500	0.750	4000	1000	50	.....	—	ETX-243
GL-5513	275.00	3	6.3	32.0	4000	1.0	3600	1200	220	.....	87	ETX-220A
GL-5518	495.00	3	6.3	250.0	7500	2.0	12000	4000	110	.....	22	ETX-221A
GL-5588	110.00	3	6.3	2.5	1000	0.300	250	200	1200	.....	—	ETX-239
GL-5648	41.50	3	6.3	1.1	1000	1.00	50	15	2500	.....	100	ETX-231

HIGH-VACUUM, WATER-COOLED TYPES

GL-8D21	\$1300.00	6	3.2	125	6000	2.0	10000	6000	300	.....	5	ETX-242
GL-9C21	866.00	3	19.5	415	17000	9.0	150000	40000	15	25@70%	40	ETX-211A
GL-9C24	550.00	3	6.3	240	6500	2.0	12000	5000	220	.....	21	ETX-213
GL-858	500.00	3	22	52.0	20000	2.00	40000	20000	1.5	40	42	ETX-173A
GL-898-A**	1150.00	3	16.5††	70.0††	20000	10.00	200000	100000	1.6	.....	45	ETX-190
GL-8009	816.00	3	12.6	320	10500	6.00	60000	20000	25	100	20	ETX-203

GASKETS FOR WATER-COOLED TYPES

Cat. No.	Suggested User's Price	Used on Tube Type	Cat. No.	Suggested User's Price	Used on Tube Type
5182028P1	\$1.18	GL-862-A, GL-880, GL-898-A	5182028P8	\$.42	GL-889-A
5182028P2	.96	GL-858, GL-893-A	5182028P10	.20	GL-8002
5182028P3	.20	GL-207, GL-891, GL-892	5182028P11	1.18	GL-8009

Figures in bold type are ICAS ratings.

* Heater-type cathode.

** Credit for return, prepaid, to Schenectady—carton \$5.00, tube \$10.00.

† Parallel operation.

†† Single- or three-phase filament. Voltage is per strand, current is per strand.

ϕ Maximum permissible percentage of only maximum plate voltage, the minimum plate input may be 100 per cent of its rated value.

MERCURY-VAPOR RECTIFIERS

Type No.	Suggested User's Price	No. of Electrodes	CATHODE		Max Peak Inverse Volts	Avg. Plate Amp	Bulletin No.
			Volts	Amp			
GL-266-B	\$209.00	2	5	30	22000	5.0 10.0¶	ETX-137
GL-816	1.65	2	2.5	2.0	7500	0.125	ETX-156
GL-870-A	1300.00	2	5	65.0	16000	75.0	ETX-177

HIGH-VACUUM RECTIFIERS

Type No.	Sug-gested User's Price	No. of Elec-trodes	CATHODE		PLATE			Voltage Drop Volts	Average Dissipa-tion Watts	Bulletin No.
			Volts	Amp	Max Inv. Volts	Max Amp	Aver-age Amp			
GL-2B22	\$21.00	2	6.3	0.75	100	0.7	.....	0.020	.....	ETX-232
GL-217-C	21.50	2	10	2.35	7500	0.600	.....	210	.....	ETX-135
GL-836	9.00	2	2.5*	5.0	5000	1.0	0.25	45	.....	ETX-164
GL-1616	8.65	2	2.5	5.0	5500	0.800	0.13	75	.....	ETX-193
GL-1641	2.75	3	5.0	3.0	2120	0.250	.....	61	.....	ETX-199
GL-8013-A	10.30	2	2.5	5.0	40000	0.150	0.020	.....	.....	ETX-205

* Heater-type cathode.
¶ Quadrature operation.

PHASITRON

Type No.	Suggested User's Price	No. of Electrodes	CATHODE		Anode Volts	Deflector Volts	RF Output, Volts	Frequency for Max Rating, Kc	Bulletin No.
			Volts	Amp					
GL-2H21	\$90.00	10	6.3	0.30	300	100	4	500	ETX-125
GL-5593	77.00	10	6.3	0.30	300	100	4	250	ETX-230

TELEVISION CAMERA TUBES

IMAGE ORTHICONS Type	Suggested User's Price	CATHODE		Anode Voltage	Photocathode Voltage	Image Size Inches	Bulletin No.
		Voltage	Current Amp				
GL-5820	\$1200.00	6.3	0.6	1500	- 550	1.6 Diagonal	ETX-259
GL-5826	1300.00	6.3	0.6	1500	- 550	1.6 Diagonal	ETX-260

TR, A-TR, AND PRE-TR TUBES—GAS SWITCHING TUBES FOR AUTOMATIC SWITCHING SERVICE IN PULSED MICROWAVE CIRCUITS

TR Type No.	Suggested User's Price	Frequency Range Megacycles	Max. Transmitter Power—Average Watts	Spike Leakage Energy per Pulse—Ergs	Flat Leakage Power Milliwatts	Bulletin No.
GL-1B63-A	\$87.00	8940-9575	250	0.1	30	ETX-256
A-TR Type No.		Frequency Range Megacycles	Equivalent Conductance	Minimum Firing Power	Loaded Q	
GL-1B35	\$18.00	9000-9600	0.04	5	4	ETX-251
GL-1B37	21.00	8500-9000	0.04	5	4	ETX-252
GL-1B44	71.00	2680-2830	0.03	20	4	ETX-254
GL-1B56	71.00	2783-2922	0.03	20	4	ETX-255
PRE-TR Type No.						
GL-1B38	\$50.00	2700-2910	1000	Max. Leakage Energy = 1.3 x 10 ⁻⁴ Joules		ETX-253

CATHODE-RAY TUBES—FOR MEASUREMENT USE

Type No.	Suggested User's Price	Screen Diam, Minimum, Inches	HEATER		Screen Fluorescence	Focusing and Deflection	High-voltage Electrode, Max Volts	Bulletin No.
			Volts	Amp				
2BP1	\$9.60	1 3/4	6.3	0.6	Green	Electrostatic	2500	ETI-310
3KP1	14.50	2 3/4	6.3	0.6	Green	Electrostatic	2500	ETI-311
3MP1	14.75	2 3/4	6.3	0.6	Green	Electrostatic	2500	ETI-313
5UP1	17.75	4 1/2	6.3	0.6	Green	Electrostatic	2500	ETI-312

Tube Divisions, Electronics Department

GENERAL  ELECTRIC
Schenectady, N. Y.



RECEIVING TYPES

LIST PRICE

The G-E electronic receiving tubes listed below include only those types most commonly used in industrial applications. Information on other receiving type tubes will be furnished upon request.

Type of Tube	List Price*	Type of Tube	List Price*	Type of Tube	List Price*
1D8GT	\$3.20	6E5	\$1.80	7K7	\$2.65
1F4	2.20	6F6GT	1.50	10	3.90
1LA4	2.65	6F8G	2.65	12A7	2.65
1LN5	2.65	6G6G	2.20	12J5GT	1.35
1N5GT/G	1.80	6H6GT	1.50	12SJ7GT	1.50
1R5	1.80	6J5GT	1.35	12SL7GT	2.20
1S4	2.20	6J7GT	1.80	12SN7GT	2.00
1S5	1.65	6K6GT	1.35	25B6G	3.90
1T4	1.80	6K7GT	1.50	25L6GT	1.50
1V	1.80	6K8GT	1.80	25Z5	1.35
2A3	2.65	6L6G	2.65	25Z6GT	1.35
3Q4	1.80	6L7G	2.65	30	1.80
3S4	1.80	6N7GT	2.20	35/51	1.80
5T4	3.20	6R7GT	1.80	37	1.50
5U4G	1.35	6SA7GT	1.50	42	1.50
5V4G	2.20	6SC7	1.80	43	1.50
5W4GT	1.25	6SF5GT	1.80	45	1.50
5Y3GT	.95	6SG7	1.80	46	2.20
5Z3	1.50	6SH7	1.80	56	1.50
5Z4	2.20	6SJ7GT	1.50	57	1.80
6A6	2.20	6SK7GT	1.50	80	1.05
6AC7/1852	2.65	6SL7GT	2.20	83	2.20
6AF6G	2.20	6SN7GT	2.00	85	1.80
6AG7	2.65	6SQ7GT	1.35	117N7GT	3.55
6B7	2.65	6V6GT	1.80	117P7GT	3.55
6C5GT	1.50	6X5GT	1.35		
6C8G	2.65	6Y6G	2.20		
6D6	1.50	7C7	1.80		

All prices include excise tax. All prices subject to change without notice. F.O.B. delivered destination in minimum quantities of 50 in one shipment.

Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



WHERE TO BUY G - E ELECTRONIC TUBES

- Send your electronic tube orders, requests for quotations or for delivery estimates to your nearest G-E office, distributor or dealer. These G-E electronic tube outlets are located strategically throughout the United States and are ready to serve you.
- Prompt attention will be given to your orders and requests by:

Name.....*

BUSINESS ADDRESS

FIRM.....

STREET.....

CITY.....

STATE.....

TELEPHONE.....

HOME ADDRESS

STREET.....

CITY.....

STATE.....

TELEPHONE.....

*If not available on emergency calls ask for:

.....

Electronics Department
GENERAL  ELECTRIC
 Schenectady, N. Y.

INTERCHANGEABILITY LIST

Industrial Tubes

This listing includes those types for which the General Electric Company has either a direct replacement or a similar type comparable in capabilities and application.

TGRA—WL-17

Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type	Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type
TGRA	R	IH	GL-575-A		AX-3B28	R	A	GL-866-A	
TGRB	R	IH	GL-872-A		3B28/6277	R	T	GL-866-A	
CE-1 (A-D)	P	CE	GL-868		3C23	T	GE, RCA, UE	GL-3C23	
EL-C1B	T	EL		GL-3C23	NL-3C23	T	NL	GL-3C23	
EL-C1B/A	T	EL		GL-3C23	WL-3C23	T	WL	GL-3C23	
EL-C1J/A	T	EL		GL-3C23	CE-4	P	CE		GL-923
EL-C1K	T	EL	GL-6014/C1K		4B32	R	GE, CH	GL-4B32	
GL-1L21	VC	GE	GL-1L21		CE-5 (A-D)	P	CE		GL-927
GL-1L24	VC	GE	GL-1L24		GL-5C21/C6J	T	GE	GL-5C21/C6J	
GL-1L25	VC	GE	GL-1L25		EL-C6J	T	EL	GL-6807*	
GL-1L31	VC	GE	GL-1L31		C6J/5C21	T	RCA	GL-5C21/C6J	
GL-1L32	VC	GE	GL-1L32		EL-C6J/A	T	EL	GL-6807*	
GL-1L33	VC	GE	GL-1L33		C6J-A/5685	T	RCA	GL-6807	
GL-1L36	VC	GE	GL-1L36		EL-C6J/F	T	EL	GL-6860/ C6J/F	
GL-1L38	VC	GE	GL-1L38		EL-C6J/K	T	EL	GL-6807†	
1P21	P	GE, RCA	GL-1P21		EL-C6J/KF	T	EL	GL-6808†	
1P32	P	CE	GL-927		EL-C6J/KL	T	EL	GL-6809†	
1P39	P	GE, RCA, S	GL-1P39	GL-8020	EL-C6J/L	T	EL	GL-6809	
1P40	P	GE, RCA	GL-1P40		EL-C6L	T	EL	GL-5528/C6L	GL-5561
2-1500	R	EM		GL-930, GL-1P40	EL-6B	R	EL		
CE-2 (A-D)	P	CE			6Q5-G	T	D	884	
2B4	T	D	885		CE-13	P	CE		GL-868
GL-2B23	R	GE	GL-2B23		NL-14	T	NL		GL-5557
2D21	T	GE, A, CH, NU, RCA	2D21		EL-C16J	T	EL	GL-5665/C16J	
WL-2D21	T	WL	2D21		C16J/5665	T	RCA	GL-5665/C16J	
EL-C3J	T	EL	GL-5632/C3J		17	T	CH	GL-5557	
C3J/5632	T	RCA	GL-5632/C3J	GL-5632/ C3J	DR-17	T	GES		GL-5557
EL-C3J/A	T	EL			FG-17	T	A, NU	GL-5557	GL-5557
3B24	R	GE, RK	GL-3B24		TT-17	T	T		GL-5557
3B28	R	CH, RCA, UE		GL-866-A	WL-17	T	WL	GL-5557	

* Minor dimensional and grid voltage differences exist which will not affect interchangeability in the majority of circuits.

† Minor dimensional differences which will not affect interchangeability in the majority of circuits.

MANUFACTURER'S IDENTIFICATION

A—AMPEREX ELECTRONIC CORPORATION
 CE—CONTINENTAL ELECTRIC COMPANY (CETRON)
 CH—CHATHAM ELECTRONICS
 D—ALLEN B. DuMONT LABORATORIES, INCORPORATED
 EE—ELECTRONIC ENTERPRISES, INCORPORATED
 EL—ELECTRONS, INCORPORATED
 EM—EITEL-McCULLOUGH, INCORPORATED (EIMAC)
 F—FEDERAL TELEPHONE AND RADIO COMPANY
 GE—GENERAL ELECTRIC COMPANY
 GES—GENERAL ELECTRONICS, INCORPORATED
 IH—INDUCTION HEATING CORPORATION
 KU—KUTHE LABORATORIES

ML—MACHLETT LABORATORIES, INCORPORATED
 NL—NATIONAL ELECTRONICS, INCORPORATED
 NU—NATIONAL UNION ELECTRIC CORPORATION
 R—THE RAULAND CORPORATION
 RCA—RADIO CORPORATION OF AMERICA
 RK—RAYTHEON MANUFACTURING COMPANY
 S—SYLVANIA ELECTRIC PRODUCTS, INCORPORATED
 T—TAYLOR TUBES, INCORPORATED
 UE—UNITED ELECTRONICS COMPANY
 WE—WESTERN ELECTRIC
 WL—WESTINGHOUSE ELECTRIC CORPORATION
 WT—WELTRONIC COMPANY

TUBE CLASSIFICATION

B—BALLAST
 I—IGNITRON
 P—PHOTOTUBE
 R—RECTIFIER
 RVG—RESISTANCE VACUUM GAGE
 T—THYRATRON
 VC—VACUUM CAPACITOR
 VS—VACUUM SWITCH

GENERAL  ELECTRIC

Supersedes ET-T1218 dated 10-55

CE-20—ML-315A

INTERCHANGEABILITY LIST

Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type	Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type
CE-20	P	CE	GL-927		WT210-0008 ¶	R	WT	GL-866-A	
CE-21 (A-D)	P	CE	GL-920		WT210-0015 ¶	T	WT	GL-5557	
RX-21A	R	EM		GL-872-A	WT210-0017 ¶	T	WT	GL-6856/740	
CE-23 (A-D)	P	CE	GL-923		WT210-0027 ¶	R	WT	GL-872-A	
CE-25 (A-D)	P	CE	GL-927		WT210-0038 ¶	T	WT	FG-172	
CE-29 (A-D)	P	CE	GL-929		WT210-0043 ¶	T	WT	GL-5632/C3J	
CE-30 (A-D)	P	CE	GL-930		WT210-0044 ¶	R	WT	GL-575-A	
CE-31V	P	CE		GL-919	WT210-0054 ¶	T	WT	GL-5830	
FG-32	R	CE	GL-5558		WT210-0056 ¶	T	WT	GL-5559	
WL-32	R	WL	GL-5558		WT210-0057 ¶	T	WT	GL-5560	
WL-33	T	WL	GL-5720						
CE-36 (A-D)	P	CE		GL-927	WT210-0062 ¶	T	WT	GL-5557	
CE-41	P	CE	GL-921		WT210-0063 ¶	T	WT	GL-6807	
WL-41	T	WL	GL-5830		WT210-0067 ¶	T	WT	GL-393-A	
CE-42	P	CE	GL-922		WT210-0069 ¶	T	WT	GL-5557	
					WT210-0070 ¶	I	WT	GL-5550	
R-51A	P	R	GL-927						
53AWB	P	RK		GL-927	WT210-0071 ¶	I	WT	GL-5551-A	
WL-57	T	WL	GL-5559		WT210-0072 ¶	I	WT	GL-5552-A	
R-58A	P	R		GL-927	WT210-0073 ¶	I	WT	GL-5553-B	
CE-59	P	CE	GL-5581		WT210-0074 ¶	T	WT	FG-105	
					WT210-0077 ¶	T	WT	5727	
R-59A	P	R	GL-868						
SK-60	P	WL		GL-868	WT210-0078 ¶	T	WT	FG-172	
R-60A	P	RK	GL-920		WT210-0079 ¶	T	WT	FG-105	
R-61-A	P	R	GL-930		WT210-0106 ¶	T	WT	GL-5632/C3J	
SK-63	P	WL		GL-918	WT210-0116 ¶	T	WT	GL-5560	
				GL-930, GL-1P40	WT210-0149 ¶	I	WT	GL-5551-A	
FG-81-A	T	GE	FG-81-A		CE-220	R	CE		GL-8020
WL-81A	T	WL	FG-81-A		Z-225/866A	R	NU, UE		GL-866-A
FG-97	T	GE	FG-97		CE-232	R	CE	GL-5558	
FG-98-A	T	GE, T	FG-98-A		WT-245§ ¶	T	WT	See WT210-0003	
					WT-246§ ¶	T	WT	See WT210-0004	
ML-100/5575	R	ML	GL-5625 ‡						
100R	R	EM	GL-8020		249A	R	WE		GL-866-A
WL-104	R	WL	GL-5561		249B	R	T, WE		GL-866-A
WT-T104§ ¶	T	WT	See WT210-0044		WE-249C	R	WE		GL-866-A
105	T	GE, RCA	FG-105		255-A	R	WE		GL-869-B
					255B	R	WE		GL-869-B
WL-105	T	WL	FG-105						
AX-105/FG-105	T	A	FG-105						
WT-T106§ ¶	T	WT	See WT210-0043 or WT210-0106		HF-255B	R	A		GL-869-B
					258B	R	A, T, UE		GL-866-A
WT-T110§ ¶	T	WT	See WT210-0054		WT262§ ¶	R	WT	See WT210-0008	
WT-T111§ ¶	T	WT	See WT210-0056		266B	R	WE		GL-857-B
WT-T112§ ¶	T	WT	See WT210-0057		F-266B	R	F		GL-857-B
WT-T117§ ¶	T	WT	See WT210-0062 or WT210-0069		266C	R	WE		GL-857-B
					267B	R	WE		GL-872-A
WT-T118§ ¶	T	WT	See WT210-0074		F-267B	R	F		GL-872-A
WT-T119§ ¶	T	WT	See WT210-0078		HF-267B	R	A		GL-872-A
WT-T133§ ¶	T	WT	See WT210-0067						
WT-T139§ ¶	T	WT	See WT210-0063		WT-272§ ¶	T	WT	See WT210-0015	
WT-T149 ¶	T	WT	FG-172		FG-280	R	GE	FG-280	
FG-154	T	GE	FG-154		287A	T	WE		GL-5557
172	T	RCA	FG-172		CE-302	T	CE		GL-3C23
FG-172	T	GE	FG-172		CE-305	T	CE		GL-3C23
WL-172	T	WL	FG-172						
ML-199	R	ML		GL-5973	CE-309	T	CE	GL-5557	
WT210-0001 ¶	T	WT	2D21		CE-311	T	CE	GL-3C23	
WT210-0003 ¶	T	WT	884		315A	R	A, WE		GL-673
WT210-0004 ¶	T	WT	2050		F-315A	R	F		GL-673
					ML-315A	R	ML		GL-673

‡ At rated current of 1.0 ampere, the GL-5625 has a voltage drop of 4000 volts; whereas the ML-100/5575 has a voltage drop of 800 volts at 1.0 ampere.

§ Old part number. Refer to Weltronic's new part number for G-E equivalent.

¶ These are tube socket markings on equipment bearing the Weltronic trade mark.

INTERCHANGEABILITY LIST

319A—872-A

Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type	Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type
319A	R	WE		GL-872-A	673	R	GE, A, F, RCA	GL-673	
F-319A	R	F		GL-872-A	ML-673	R	ML	GL-673	
ML-319A	R	ML		GL-872-A	676	T	RCA		GL-5632/ C3J
321A	R	WE		GL-673					GL-5632/ C3J
HF-321A	R	A		GL-673	KU-676	T	WL		
ML-321A	R	ML		GL-673	678	T	GE, A, RCA	GL-678	
323B	T	CH		GL-3C23					
NL-323B	T	NL		GL-3C23	WL-678	T	WL	GL-678	
UE-323B	T	UE		GL-3C23	WL-679	I	WL	GL-5554	
F-353A	R	F	GL-872-A		WL-681/686	I	WL	GL-5550	
					WL-688	I	WL	GL-5564	
					WL-689	I	WL	GL-6228	
F-357-B	R	F	GL-857-B		NL-710	T	NL	GL-6011/710	
366A	R	WE	GL-866-A		NL-710/6011	T	NL	GL-6011/710	
F-367-A	R	F		GL-673	NL-714	T	NL		GL-5557
371-B	R	EE, UE		GL-8020	NL-715/5557	T	NL	GL-5557	
F-375A	R		GL-575-A		NL-716	T	NL	GL-6855/716	
393A	T	WE		GL-3C23					
CE-393A	T	CE		GL-3C23	ML-728	T	ML	GL-5557	
NL-393A	T	NL	GL-393-A		WL-735	P	WL	GL-868	
UE-393A	T	UE		GL-3C23	WL-739	P	WL		GL-927
394A	T	CH		GL-627	NL-740	T	NL	GL-6856/740	
FP-400	R	GE	FP-400		NL-740-P	T	NL	GL-6857/740-P	
GL-411	R	GE	GL-411		WL-741	P	WL		GL-923
GL-414	T	GE	GL-414		NL-760	T	NL	GL-6807	
WL-414	T	WL	GL-414		NL-760-L	T	NL	GL-6809	
WT-T439§ ¶	T	WT	See WT210-0038		NL-760-P	T	NL	GL-6808	
GL-441	P	GE	GL-441		857	R	RCA	GL-857-B	
502-A	T	GE, RCA	502-A		857-B	R	GE, A, RCA	GL-857-B	
WL-502A	R	WL	502-A		DR-857-B	R	GES	GL-857-B	
575-A	R	GE, A, EE, NU, RCA	GL-575-A		F-857-B	R	F	GL-857-B	
DR-575-A	R	GES	GL-575-A		ML-857-B	R	ML	GL-857-B	
F-575-A	R	F	GL-575-A		WL-857-B	R	WL	GL-857-B	
ML-575-A	R	ML	GL-575-A		866	R	A, RCA	GL-866-A	
WL-575-A	R	WL	GL-575-A		866-A	R	GE, CE, CH, EM, NU, RCA, S	GL-866-A	
UE-578	R	UE		GL-8020	DR-866-A	R	GES	GL-866-A	
WL-578	R	WL		GL-8020	EE-866-A	R	EE	GL-866-A	
WT-606§ ¶	T	WT	See WT210-0001		HF-866-A	R	A	GL-866-A	
NL-615	R	NL		GL-5558	ML-866-A	R	ML	GL-866-A	
NL-618	R	NL		GL-5561	RK-866-A	R	RK	GL-866-A	
627	T	GE, RCA	GL-627		T-866-A	R	T	GL-866-A	
KU-627	T	WL	GL-627		UE-866-A	R	UE	GL-866-A	
KU-628	T	WL		GL-5559	WL-866-A	R	WL	GL-866-A	
WL-630	T	WL	2050		866-A/866	R	RCA	GL-866-A	
WL-630A	T	WL	2050		866-AX	R	A		GL-866-A
WL-631	T	WL	GL-5559		866-JR	R	NU, T		GL-866-A
WL-632B	T	WL	GL-5560		868	P	GE, RCA	GL-868	
KU-634	T	WL		GL-5561	WL-868	P	WL	GL-868	
635P	R	NL	GL-6930/635-P		GL-868/PJ-23	P	GE	GL-868	
WL-651/656	I	WL	GL-5552-A		869-A	R	RCA	GL-869-B	
WL-652/657	I	WL	GL-5551-A		869-B	R	GE, A, RCA	GL-869-B	
WL-653B	I	WL	GL-5555		DR-869-B	R	GES	GL-869-B	
WL-655/658	I	WL	GL-5553-B		F-869-B	R	F	GL-869-B	
672	T	RCA	GL-672-A		ML-869-B	R	ML	GL-869-B	
WL-672	T	WL	GL-672-A		WL-869-B	R	WL	GL-869-B	
672-A	T	WL	GL-672-A		872	R	RCA	GL-872-A	
WL-672-A	T	GE, RCA	GL-672-A		872-A	R	GE, CE, EM, NU, RCA, S, T	GL-872-A	

§ Old part number. Refer to Weltronic's new part number for G-E equivalent.

¶ These are tube socket markings on equipment bearing the Weltronic trade mark.

|| 3/8 inch shorter, 1/8 inch greater in diameter; control-grid cap extends from side of bulb instead of from base.

DR-872-A—NL-5559/FG-57

INTERCHANGEABILITY LIST

Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type	Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type
DR-872-A	R	GES	GL-872-A		1904	T	RCA	GL-5728	
EE-872-A	R	EE	GL-872-A		2050	T	GE, A, CH, HY, NU, RCA, S	2050	
F-872-A	R	F	GL-872-A		WL-2050	T	WL	2050	
RK-872-A	R	RK	GL-872-A		RK-2050	T	RK	2050	
UE-872-A	R	UE	GL-872-A		2051	T	A, CH, NU, RCA	2050	
872-A/872	R	RCA	GL-872-A		RK-2051	T	RK	2050	
ML-872-A/872	R	ML	GL-872-A		5544	T	GE, A	GL-5544	
WL-872-A/872	R	WL	GL-872-A		GL-5545	T	GE	GL-6807	
872-AX	R	A	GL-872-A		5550	I	GE, NL, RCA	GL-5550	
EE-873	T	EE		GL-678	AX-5550	I	A	GL-5550	
T-875-A	R	T	GL-575-A		GL-5550/GL-	I	GE	GL-5550	
884	T	GE, A, CH, NU, RCA, S	884		415	I			
DR-884	T	GES	884		WL-5550/681/	I	WL	GL-5550	
RX-884	T	RK	884		686	I			
WL-884	T	WL	884		5551	I	NL, RCA	GL-5551-A	
885	T	GE, A, CH, NU, RCA, S	885		AX-5551/652	I	A	GL-5551-A	
RX-885	T	RK	885		WL-5551/652	I	WL	GL-5551-A	
WL-885	T	WL	885		5552	I	GE, A	GL-5552-A	
918	P	GE, RCA	GL-918		NL-5552	I	NL, RCA	GL-5552-A	
WL-918	P	WL	GL-918		AX-5552/651	I	A	GL-5552-A	
919	P	GE, RCA	GL-919		5551-A	I	GE, A	GL-5551-A	
WL-919	P	WL	GL-919		WL-5551-A	I	WL	GL-5551-A	
920	P	GE, RCA	GL-920		5552	I	NL, RCA	GL-5552-A	
WL-920	P	WL	GL-920		NL-5552	I	NL	GL-5552-A	
921	P	GE, RCA	GL-921		AX-5552/651	I	A	GL-5552-A	
WL-921	P	WL	GL-921		WL-5552/651	I	WL	GL-5552-A	
922	P	GE, RCA, S	GL-922		5552-A	I	GE, A, NL, RCA	GL-5552-A	
WL-922	P	WL	GL-922		WL-5552-A	I	WL	GL-5552-A	
923	P	GE, RCA	GL-923		5553	J	RCA	GL-5553-B	
WL-923	P	WL	GL-923		AX-5553/655	I	A	GL-5553-B	
927	P	GE, RCA	GL-927		5553-A	I	RCA	GL-5553-B	
WL-927	P	WL	GL-927		5553-B	I	GE, A, NL, RCA	GL-5553-B	
929	P	GE, RCA, S	GL-929		WL-5553-B	I	WL	GL-5553-B	
WL-929	P	WL	GL-929		5554	I	GE, RCA	GL-5554	
930	P	GE, RCA, S	GL-930		AX-5554/679	I	A	GL-5554	
WL-930	P	WL	GL-930		WL-5554/679	I	WL	GL-5554	
931-A	P	GE, RCA, S	GL-931-A		GL-5554/FG-	I	GE	GL-5554	
WL-931-A	P	WL	GL-931-A		259-B	I			
UE-966	R	UE	GL-866-A		5555	I	GE, RCA	GL-5555	
UE-966-A	R	UE	GL-866-A		AX-5555/653-B	I	A	GL-5555	
967	T	NU	GL-5557		5556	R	GE, RCA	GL-5556	
NU-967	T	NU	GL-5557		GL-5556/PJ-8	R	GE	GL-5556	
UE-967	T	UE	GL-5557		5557	T	GE, RCA	GL-5557	
UE-972	R	UE	GL-872-A		WL-5557/17	T	WL	GL-5557	
UE-972-A	R	UE	GL-872-A		AX-5557/FG-	T			
UE-973	T	UE		GL-5559	17/1701	T	A	GL-5557	
975-A	R	NU	GL-575-A		GL-5557/FG-	T	GE	GL-5557	
UE-975-A	R	UE		GL-575-A	17	T			
NL-1001	I	NL		GL-5550	5558	R	GE, RCA	GL-5558	
NL-1005	I	NL		GL-5551-A	WL-5558/32	R	WL	GL-5558	
NL-1051	I	NL	GL-5551-A		GL-5558/FG-32	R	GE	GL-5558	
NL-1052	I	NL	GL-5552-A		5559	T	GE, RCA	GL-5559	
NL-1053	I	NL	GL-5553-B		AX-5559	T	A	GL-5559	
1701	T	A	GL-5557		GL-5559/FG-57	T	GE	GL-5559	
1754	T	KU	GL-5948		NL-5559/FG-	T	NL	GL-5559	
					57				

INTERCHANGEABILITY LIST

WL-5559/57—8020/100R

Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type	Type No.	Class	Manufacturer	Direct G-E Replacement Type	G-E Similar Type
WL-5559/57	T	WL	GL-5559		5728	T	GE, RCA	GL-5728	
5560	T	GE, RCA	GL-5560		GL-5728/FG-67	T	GE	GL-5728	
GL-5560/FG-95	T	GE	GL-5560		GL-5740/FP-54	R	GE	GL-5740	
NL-5560/FG-95	T	NL	GL-5560		GL-5779	I	GE	GL-5779	
5561	R	RCA	GL-5561		GL-5788	I	GE	GL-5788	
GL-5561	R	GE	GL-5561		5822	I	A, RCA	GL-5822-A	
GL-5561/FG-104	R	GE	GL-5561		NL-5822	I	NL	GL-5822-A	
WL-5561/104	R	WL	GL-5561		5822-A	I	GE, A, RCA	GL-5822-A	
F-5563	T	F		GL-678	NL-5822-A	I	NL	GL-5822-A	
5563-A	T	RCA		GL-678	GL-5830	T	GE	GL-5830	
GL-5564	I	GE	GL-5564		GL-5830/FG-41	T	GE	GL-5830	
GL-5564/GL507	I	GE	GL-5564		GL-5855	T	GE	GL-5855	
ML-5575/100	R	ML	GL-5625 ϕ		5948	T	GE, CH, KU	GL-5948	
5581	P	GE, RCA	GL-5581		5948/1754	T	CH, KU	GL-5948	
WL-5581	P	WL	GL-5581		GL-5973	R	GE	GL-5973	
GL-5620	B	GE	GL-5620		GL-6011/710	T	GE	GL-6011/710	
GL-5620/FB-50	B	GE	GL-5620		WL-6011/710	T	WL	GL-6011/710	
GL-5621	B	GE	GL-5621		6014	T	EL	GL-6014/C1K	
GL-5621/B-6	B	GE	GL-5621		GL-6014/C1K	T	GE	GL-6014/C1K	
GL-5623	B	GE	GL-5623		GL-6228	I	GE	GL-6228	
GL-5623/B-47	B	GE	GL-5623		GL-6228/506	I	GE	GL-6228	
GL-5624	B	GE	GL-5624		6228/689	I	WL	GL-6228	
GL-5624/B-46	B	GE	GL-5624		6277/3B28A	R	T	GL-866-A	
GL-5625	R	GE	GL-5625		GL-6346	I	GE	GL-6346	
GL-5625/KC-4	R	GE	GL-5625		GL-6347	I	GE	GL-6347	
GL-5626	VS	GE	GL-5626		GL-6348	T	GE	GL-6348	
GL-5626/FA-15	VS	GE	GL-5626		GL-6504	I	GE	GL-6504	
GL-5627	VS	GE	GL-5627		GL-6509	I	GE	GL-6509	
GL-5627/FA-6	VS	GE	GL-5627		GL-6511	I	GE	GL-6511	
GL-5628	RVG	GE	GL-5628		GL-6512	J	GE	GL-6512	
GL-5628/FA-13	RVG	GE	GL-5628		GL-6513	I	GE	GL-6513	
GL-5629	RVG	GE	GL-5629		GL-6514	I	GE	GL-6514	
GL-5629/FA-14	RVG	GE	GL-5629		GL-6515	I	GE	GL-6515	
GL-5630	I	GE	GL-5630		GL-6807	T	GE	GL-6807	
5632	T	EL	GL-5632/C3J		GL-6808	T	GE	GL-6808	
GL-5632/C3J	T	GE	GL-6011/710		GL-6809	T	GE	GL-6809	
5662	T	GE	5662		GL-6855/716	T	GE	GL-6855/716	
5663	T	GE	5663		GL-6856/740	T	GE	GL-6856/740	
5664	T	EL		GL-3C23	GL-6857/740-P	T	GE	GL-6857/740-P	
WL-5664	T	WL		GL-3C23	GL-6858/760	T	GE	GL-6858/760	
5665	T	EL	GL-5665/C16J		GL-6859/760-P	T	GE	GL-6859/760-P	
GL-5665/C16J	T	GE	GL-5665/C16J		GL-6860/C6J/F	T	GE	GL-6860/C6J/F	
GL-5674	R	GE	GL-5674		F				
5683	T	EL		GL-3C23	GL-6878	I	GE	GL-6878	
5685/C6J	T	EL		GL-6860/C6J/F	GL-6930/635-P	R	GE	GL-6930/635-P	
AX-5685/C6J	T	A		GL-6860/C6J/F	8008	R	GE, A, CH, RCA, T	GL-8008	
WL-5685/C6J/A	T	WL		GL-6807	DR-8008	R	GES	GL-8008	
5696	T	GE, RCA	5696		EE-8008	R	EE	GL-8008	
GL-5720	T	GE	GL-5720		ML-8008	R	ML	GL-8008	
GL-5720/FG-33	T	GE	GL-5720		UE-8008	R	UE	GL-8008	
NL-5720/FG-33	T	NL	GL-5720		WL-8008	R	WL	GL-8008	
5727	T	GE	5727		8020	R	GE, A, NU, RCA	GL-8020	
5727/2D21-W	T	GE	5727		DR-8020	R	GES	GL-8020	
					EE-8020	R	EE	GL-8020	
					WL-8020	R	WL	GL-8020	
					8020/100R	R	EM	GL-8020	

ϕ At rated current of 1.0 ampere, the GL-5625 has a voltage drop of 4000 volts; whereas the ML-5575/100 has a voltage drop of 800 volts at 1.0 ampere.

This information has been carefully compiled from tube data available at the date of publication and is believed to be accurate. No responsibility, however, is assumed for errors caused by inaccuracies in tube data.

IGNITRONS



DESCRIPTION

Ignitrons are gas-discharge, pool-type cathode tubes in which the arc is started for each conducting cycle by means of a starting or ignition electrode. The tubes are of the half-wave type in which current is carried through the tube during only the positive part of the cycle. During the remainder or non-conducting part the residual ionization reaches very low values in comparison with the ionization present in the multi-anode type of pool tube where it is proportional to the load current carried. As a result of the so-called dark, negative half-cycle, the shielding required in half-wave tubes is greatly reduced from that in the multi-anode tube. Reduction of shielding in turn lowers the arc voltages so that tubes of this type may be efficiently applied in the lower voltage (125 to 250 volt) fields. Mercury-pool

cathodes are capable of supplying emission currents of many thousands of amperes. By phase control of the point in the cycle at which the ignitor is fired, the output voltage or current may be reduced from the maximum to provide voltage or current control. The ignitron, therefore, possesses many of the control characteristics of the thyatron, and in addition has emission capacity for carrying very high currents. In general, the tubes are water-cooled, but in the smaller sizes may be air-cooled. Exceptions are the GL-415 ignitron for welder control use in which temperature control is provided by clamping the cathode portion of the tube in an air or water-cooled metal clamp, and the GL-427 ignitron which is a small glass tube designed specifically for ignitor demonstration purposes.

GENERAL CLASS OF OPERATION AND APPLICATION

There are three main fields of applications for which ignitrons are particularly suited—resistance welding, power rectification, and power conversion or transmission.

1. In welding control applications ignitron tubes are used to control the primary current supplied to resistance welding transformers. They are used in voltage supply circuits of 220, 440, 550, 1100, and 2300 volts rms. The control is the most exact that has been developed. The tubes operate as contactors and through suitable thyatrons and other electronic control, may be arranged to provide one, two, or a dozen cycles of current. Off periods may likewise be controlled with the same exactness in line welding operations. Given weld settings may be repeated indefinitely without change in the number of cycles. As a result, very great uniformity in the welds is obtained, and losses from poor welds are reduced almost to the vanishing point.

2. In the power rectification field ignitrons are available in sizes which permit d-c outputs of 40 to 1000 kilowatts to be obtained in single units depend-

ing on the operating voltage. Usual d-c voltage levels are 125, 250, 600, and 900 volts. Such rectifiers are used to provide d-c power for machine shops, elevators, mines, electrolytic reduction plants, arc welding, and similar types of service. Suitable voltage regulating equipment may be provided to give practically constant output voltage from zero to full load. Variable voltage output and control (similar to the Thy-mo-trol) will provide speed control for d-c motors.

3. The third class of application is high-voltage d-c power transmission, or conversion of power at one frequency to power at another. In such applications the tubes are primarily for power conversion and are grouped to form units of 2000 to 20,000 kilowatt capacity. Higher capacity may, of course, be obtained by additional units. These electronic power converters provide a non-synchronous tie between two power systems and are able to transmit a constant amount of power independent of the usual variations in either the supply or receiving system frequencies and voltages.

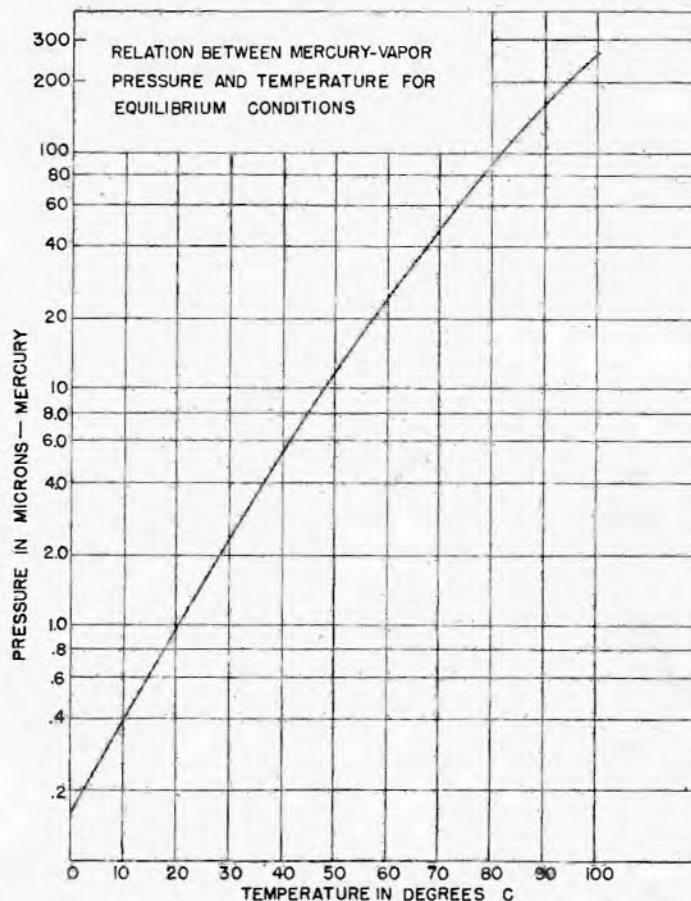
PRINCIPLES AND FUNDAMENTALS OF OPERATION

The ignitor is a small rod of highly refractory material about the shape and size of the pointed end of an ordinary lead pencil. This point dips into a mercury pool and by passing a current of 10 to 30 amperes through the ignitor, a cathode spot is established at the junction between the ignitor and mercury pool. The mechanism is one in which the passage of current establishes sufficient voltage gradient at the mercury pool to draw electrons from the pool and start the cathode spot. Ionization from this initial spot spreads throughout the volume of the tube and if the main anode is positive, electrons begin to flow to it. Passage of the electrons in turn ionizes the gas and establishes the conditions for the low arc drop that is characteristic of gas-filled

tubes. As the current increases above 20 amperes, the cathode spot divides and sub-divides until a sufficient number of spots exist to supply the anode current. These spots move rapidly and indiscriminately over the surface of the pool, tending in general to occupy a circle of given diameter for a given current, centered around the ignitor. The cathode spots in effect remain anchored around the ignitor, and the usual insulated pools used in the multi-anode tubes to prevent the arc from wandering onto the walls of the tube, are not required. At the end of conduction when the current begins to decrease, the number of spots decrease and finally at zero current die out altogether. Ionization rapidly decays at this point to values which permit

the application of the inverse voltage for which the tubes are designed without the occurrence of arc backs (that is, current conduction in the reverse direction with the anode acting as cathode). Mercury which is evaporated by the action of the cathode spot is condensed on the water-cooled walls of the tube. From this point it rolls back into the mercury pool to maintain the required ignitor im-

mersion. Approximately $\frac{3}{4}$ grams of mercury are evaporated for each 100 ampere-seconds a tube conducts current. The pressure (see Fig. 1) due to this mercury must be controlled and the water cooling serves in this function as well as to remove the arc losses. The arc drop is relatively low, approximately 12 to 18 volts, and the over-all efficiency even at low output voltages is, therefore, very high.



K-9033553

Fig. 1

12-6-44

DESIGN AND CONSTRUCTION

General Electric ignitrons have a number of design and construction features (see Fig. 19, page 11) which provide reliable operation and long trouble-free service. The tube jackets and water-cooling sections are constructed of stainless steel which minimizes corrosive effects as well as provides a vacuum-tight enclosing envelope. The insulating bushings which separate the anode from the main body of the tube, as well as the ignitor seals and leads, are constructed of fernico and a high-resistance borosilicate glass. Fernico is an iron-nickel-cobalt alloy which was developed in the General Electric Research Laboratories. It has the unique characteristic of having an inflection point in its temperature elongation characteristic at the same

temperature as that of certain hard glasses. The expansion of the fernico and the proper glass match very closely over the entire temperature range encountered in manufacture and use. Such seals are strain-free under usual operating conditions and form one of the strongest glass-to-metal combinations developed. The ignitor is one of the most essential parts in the tube and its manufacture requires very close control to insure uniformity of characteristics and life. Every operation in the manufacture of these ignitrons is carefully controlled through inspection and testing. All of the welds in the General Electric ignitrons are made by means of ignitron controlled resistance welding machines. These welds are unusually strong and vacuum tight.

RATINGS

The ratings of ignitron tubes, in common with other electronic tubes, are defined in terms of the maximum instantaneous voltage and current conditions under which the tube may operate. Other factors are the water temperature which controls vapor pressure; and the capacity of the tube to dissipate losses, which is described in terms of the average anode current. One of the larger rectifier ignitrons, the FG-238-B for example, has an average anode current rating of 200 amperes and an arc drop of approximately 17 volts, so that the water cooling is required to dissipate approximately 3.5 kilowatts. The electrodes of ignitron tubes in common with other electronic tubes have much smaller mass than rotating machinery or other heavy electrical apparatus. The time required for welder tubes to reach equilibrium temperature is only a few seconds and is shorter than the time constant of most other electrical apparatus. The limiting factor encountered in this service is the high-current short-time peaks which rapidly increase the vapor pressure to values which may cause loss of control or arc back. The same factors govern rectifier tubes, but since the usual load is of a continuous nature with relatively low ratios between maximum and average currents, the time constant is of the order of minutes. The instantaneous capacity in either case is very high and meets the usual welder requirements, or those of rectifiers to clear fuses or breakers in case of short circuit. Minimum and maximum outlet water temperatures are other ratings. The graph in Fig. 1 shows the relation between mercury-vapor pressure and temperature for equilibrium conditions.

Roughly, mercury-vapor pressure doubles for each 10-degree increase in temperature, so that at higher temperatures the limiting pressures may be approached rapidly. The ignitor will fire even in a pool of frozen mercury. The lower limit is usually dictated by the point of freezing water and by a vapor pressure so low that there are insufficient ions to carry the required current. Arc constriction or starvation under these conditions is very unlikely to occur in the welder tubes which are of relatively open construction. Neither does it occur in the rectifier ignitrons, which are more completely shielded, within the temperature limits given as part of the technical data. In tubes with grids, such as the pentode ignitron, the effect becomes more pronounced and minimum temperatures are correspondingly higher.

Ignitor

The ignitor rating is described in terms of *maximum instantaneous potential and current required for ignition* as well as *maximum allowable forward and inverse voltages*. The ignitor, when not operating and cold, may have a resistance of 20 to 100 ohms. Under operating conditions, this resistance decreases to about 2 to 10 ohms. The ignitor behaves as though it were a constant resistance over any one cycle, but due to wave motion in the mercury pool,

resistance on successive cycles may vary widely. Ignition currents likewise vary widely from cycle to cycle, and normally require much less current than the values stated. Ignitors will not stand reverse current as this may cause a cathode spot on the ignitor itself and the resulting heat and burning tends to destroy the point. Some rectifying device such as a thyatron, or a dry-plate rectifier, must be connected in series with the ignitor.

Welder Ignitrons

The capacity of these tubes is described in terms of *maximum kva demand* for each type, for voltages from 220 to 600 rms and frequencies of 25 to 60 cycles. For higher voltages, tubes of the rectifier type are used and corresponding ratings applied. Each tube has a *maximum average anode current* rating which represents its heat dissipating ability and which may be read on an ordinary d-c ammeter. These two ratings, in conjunction with the supply voltage and the *maximum time of averaging the anode current* completely describe the necessary conditions for welder service. For example, assume a power demand of 500 kva and a supply voltage of 250 volts (rms).

The line current demand is:

$$I_{\text{line}} = \frac{500,000}{250} = 2000 \text{ amperes (rms)} \quad (1)$$

$$\text{or } = \sqrt{2} \times 2000 = 2800 \text{ amperes (max)} \quad (2)$$

Then, the demand average current per tube over any conducting cycle is:

$$I_{\text{D.avg./tube}} = \frac{I_{\text{max}}}{\pi} = \frac{2800}{3.14} = 891 \text{ amperes} \quad (3)$$

The demand kva is within the rating of the FG-271 and at this value of kva, the tube has an average anode current rating of 33 amperes, and at 250 volts a maximum time of averaging the anode current of 18 seconds as shown in the Technical Information. The maximum tube capacity, therefore, in ampere-seconds is:

$$\text{Tube } I_{\text{avg.}} \times t_{\text{max. avg.}} = 33 \times 18 = 594 \text{ ampere-seconds}$$

The length of time the tube can conduct the demand current in any 18-second period must be within the tube ampere-second capacity. The permissible length of conduction, or weld, may, therefore, be represented by t in the expression:

$$I_{\text{Demand avg./tube}} \times t = 594 \text{ ampere-seconds}$$

$$t_{\text{max}} = \frac{594}{891} = .67 \text{ seconds} \quad (4)$$

or since we are usually interested in cycles, the corresponding number for a 60-cycle supply is,

$$n = t \times 60 = 40 \text{ cycles} \quad (4a)$$

A single weld using the 40 cycles is permissible or any number of welds using fewer cycles (2, 3, 4, etc.) may be made providing the total conduction does not exceed the maximum during any 18-second averaging time.

The duty in percent is the ratio of the on to total cycles in the averaging period.

$$\text{Duty} = \frac{\text{No. of conducting cycles}}{\text{No. of cycles in averaging time}} \times 100 \quad (5)$$

which for the above case is:

$$= \frac{n}{t_{\text{max. avg.}} \times 60} \times 100 = \frac{40}{18 \times 60} \times 100 \quad (5a)$$

$$= 3.7\%$$

The *maximum surge current* represents a measure of the circuit stiffness in case of fault conditions. It is the maximum current that the tube may be expected to carry under fault conditions without immediate damage. Repeated operations under such conditions may, of course, shorten the tube life.

Phased-back operation ratings are determined by the conditions at full advance (no phase retard). That is, phase-back operation produces a greater stress on the tubes. Therefore, the permissible current is reduced from full-on in proportion to the angle of retard.

Rectifier Ignitrons

Rectifier ignitron tube ratings also are given in terms of the usual circuit requirements. Most in-

dustrial rectifiers have current ratings of 100 per cent continuous, 125 per cent for two hours, and 200 per cent for one minute. The *maximum average anode current* is described in these terms. The *maximum instantaneous current* represents the maximum cycle-by-cycle duty for which the tube is designed to operate. Two levels of inverse voltage are given with different current ratings corresponding to output voltages of 300 and 600 volts d-c. The *surge current* represents the maximum forward current which the tube should carry under fault conditions. Its duration should not exceed the time given. These last two factors define the transformer and supply system impedance and the minimum operating speed of the circuit breakers. The value of the surge current is such that rectifiers having overall regulation of 6 to 7 per cent can be obtained with practicable designs of transformers. Higher regulation tends to reduce the duty on the tube by reducing the possible short-circuit current. In terms of d-c output, the current is simply the average current per tube times the number of tubes employed, provided the tubes are used in the usual circuits and that the peak anode current is not exceeded.

CLASSES OF TUBES

There are three classes of ignitron tubes especially designed for each type of service:

1. Welder Ignitrons

These tubes are of relatively open construction with little shielding and are designed specifically to carry the high currents encountered in resistance welding. They also may be used as rectifiers in certain welding equipment where the output voltage is usually less than 150 volts d-c. These tubes have the lowest arc drop voltage of any of the ignitrons.

2. Rectifier Ignitrons

These tubes are more highly shielded to withstand the voltage and current conditions encountered each cycle during the commutation period at the end of conduction. The arc drop is approximately 2 volts higher than that of corresponding

sizes of welder ignitrons. While used primarily for rectifier service, they are also applied in 2400-volt welding control applications where the higher voltage requires a more shielded tube.

3. Grid-Pool Tubes

This type of tube, such as the pentode ignitron, is primarily for high-voltage rectification or inversion in power or frequency-conversion work. Grids are added to the usual ignitron structure to provide additional control and deionization when the tube is used in inverter service. Its application requires considerable detailed coordination between the circuit and tubes, and it is recommended that applications for this type of tube be referred to the Electronics Department, Tube Division, Schenectady 5, N. Y.

APPLICATION CIRCUITS#

Ignitrons for resistance welding control are used in spot, pulsation, seam, and flash welding ma-

chines. Fig. 2 shows a typical circuit with two tubes in a back-to-back connection.

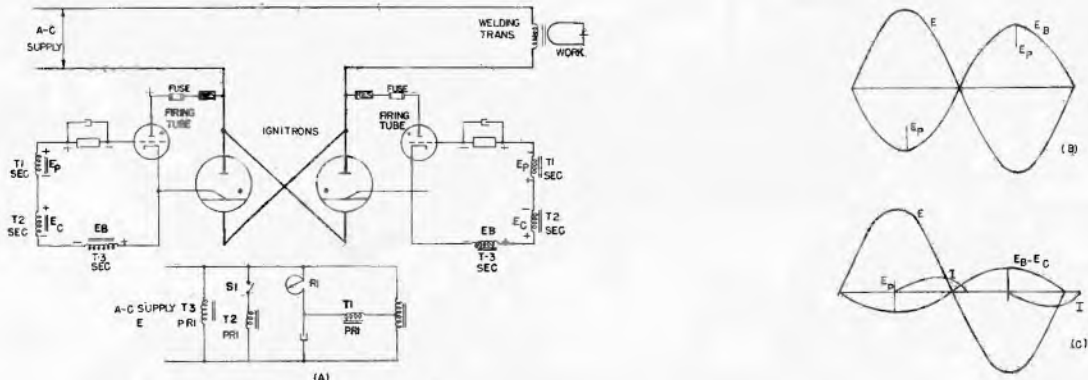


Fig. 2—Power Circuit for Synchronous Control of Welding Currents

APPLICATION CIRCUITS (CONT'D)#

One older method (for illustration) of controlling the number of on and off cycles in line welding consisted of a moving tape or chain with insulated sections which supplied off-on bias to the grids of the thyatron. The length of the conducting sections was such that at synchronous speed, the on-time corresponded to the number of cycles desired; say, 3, 5, etc. The non-conducting sections were of length to give off periods of say 4, 6, etc. It is present practice to use electronic control with thyatron tubes and capacitor-resistance combinations to give the proper time constant for controlling the on-off period. These electronic controls are comparatively complex and requests should be sent to the General Electric Company for a detailed description. Speed of control, cycle-by-cycle response, small space requirements, lack of noise, and flexibility of application all contribute to the success of welding ignitron control.

Ignitron contactors which operate in the same manner but which do not have the precise control of the number of cycles are also in wide use. In effect, the ignitron units simply replace ordinary contactors with the advantage of noise reduction and decreased maintenance. Fig. 3 shows the typical connections for this type of service.

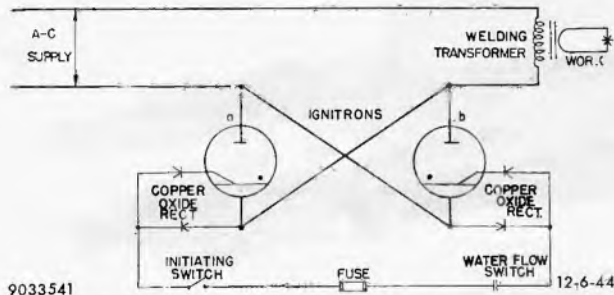


Fig. 3—Electronic Welding Contactor Circuit with Manual Non-Synchronous Control

Such contactors are found in welding service where precise control is not required, and in applications where frequent opening and closing of the circuit is required such as in temperature-regulated furnaces. Phase control which permits a gradual change of the output voltage may be obtained by a modification of the control circuit and the addition of phase shifting networks and thyatron. Another application for this type of equipment is the interruption of the power supply for radio transmitters. In case of arc over in the transmission line or coils, or flashing in the vacuum tubes, it is desirable to remove the plate power supply as rapidly as possible to prevent possible gassing or burning of the transmitting tube. These contactors, when placed in each line of the primary of the rectifier, may be controlled completely to interrupt the flow of power in one to two cycles, in case of a fault.

This compares with 6 to 8 cycles for most mechanical breakers. Regular circuit breakers are still required for overall fault protection.

Typical rectifier applications include the d-c supply for lighting and power loads in buildings, elevators, d-c motor supply in machine shops, printing presses, power for the electrolytic separation of hydrogen, oxygen, chlorates, aluminum and magnesium, plating and mining. Mining rectifiers, may be designed with very low head room (42 inches) so that the unit may be placed in the actual mine itself near the working source. As the mine is worked, the ignitron rectifier may be conveniently moved to provide full voltage at the location where the mining is centered. One particular advantage of rectifier equipment in mine service is that the rectifier does not have the problem of pull-out torque encountered in synchronous machines. Most mine

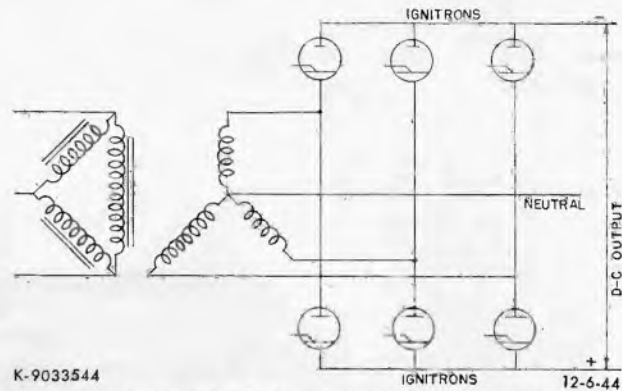


Fig. 4—Three-Phase, Double-Way Rectifier Circuit for Three-Wire Service

load stations are at a considerable distance from the power source and as a result, reactance in the supply lines is usually high. This decreases the overload that can be carried without exceeding the torque limit. Three-wire rectifiers are possible (see Fig. 4) where 125/250 volt supplies are needed. Such units have also been used for d-c arc welding power supplies.

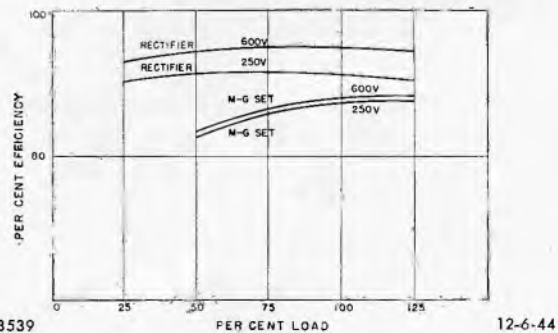


Fig. 5—Overall Efficiency of 300KW, 250- and 600-Volt Ignitron Rectifier in Comparison with Motor-Generator Sets of Same Ratings

Circuits shown in ETI-108 are examples of possible tube applications and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company.

Ignitron rectifiers have all the advantages of quiet operation, small space requirements, no special foundation requirements, ease of control, and low maintenance that are common to electronic tubes. The principal advantage from the user standpoint, however, is efficiency. Fig. 5 (see bottom of page 6) shows efficiency of the 300 kilowatt, 250 volt ignitron rectifier in comparison with other forms of conversion equipment.

In terms of losses for this size rectifier, there is a constant kilowatt difference of approximately 10 kilowatts in favor of the ignitron rectifier over the usual load range. Therefore, if the rectifier is operated continuously during the year, there is a net power saving of approximately $10 \text{ kw} \times 8760 \text{ hours} \times .01 = \876 at a power rate of one cent per kilowatt hour. Such savings are more than adequate to pay for the probable tube replacement cost.

SELECTION OF TUBES

Selection of ignitron tubes for welder service depends primarily on the kilovolt-ampere demand and the duty. The maximum kilovolt-ampere demand in terms of volts and amperes in the welding transformer primary can be obtained from the manufacturer. Where such data are not available, a clamp-on ammeter with a pointer stop or maximum swing indicator may be placed around one of the primary leads and the secondary of the welder shorted through well clamped copper bars or strips. The welder is then energized for periods long enough to allow equilibrium readings to be obtained on the meter. With synchronous ignitron control, 3 or more cycles will give accurate readings. With non-synchronous control, longer periods may be necessary to eliminate the probable starting transient. This constitutes the maximum current demand pro-

viding the maximum tap settings have been used. The tube selected should have sufficient capacity to conduct the maximum current demand within the tube rating. The permissible duty is then determined by the average current capacity of the tube and if this capacity is below that required, a larger size of tube must be selected. For example, suppose that a welder having a 1000-ampere rms current demand and a 20 per cent duty is required, and that the supply voltage is 500. Demand rms current for this voltage in terms of percentage duty has been plotted for convenience on curves included with the Technical Information. Reference will show that the FG-235-A tube has sufficient capacity and is the tube required. If the duty were less than 7 per cent two FG-271 tubes could be used.

Selection of the size and number of tubes for

KILOWATT RATINGS AT				IGNITRONS		TRANSFORMER SECTION CONNECTIONS	PHASE OPERATION		PRINCIPLE RIPPLE COMPONENT IN OUTPUT VOLTAGE FREQUENCY MAGNITUDE	
125V D-C	300V D-C	600V D-C	900V D-C	NO.	TYPE		INPUT	OUTPUT		
40	75	100	100	3	FG-259-B	Y, ZIG-ZAG	3	3	3X INPUT	0.25E D-C
50	100	150	150	6	FG-259-B	DOUBLE Y	3	6	6X INPUT	0.057E D-C
75	150	200	200	6	FG-259-B	DOUBLE Y	3	6	6X INPUT	0.057E D-C
100	200	300	300	6	FG-238-B	DOUBLE Y	3	6	6X INPUT	0.057E D-C
150	300	400	400	6	FG-238-B	DOUBLE Y	3	6	6X INPUT	0.057E D-C
---	---	500	500	6	FG-238-B	DOUBLE Y	3	6	6X INPUT	0.057E D-C
200	400	750	750	12	FG-238-B	QUADRUPLE Y	3	6 or 12	6 or 12X INPUT	0.057E D-C or 0.014E D-C
300	500	1000	1000	12	FG-238-B	QUADRUPLE Y	3	6 or 12	6 or 12X INPUT	0.057E D-C or 0.014E D-C

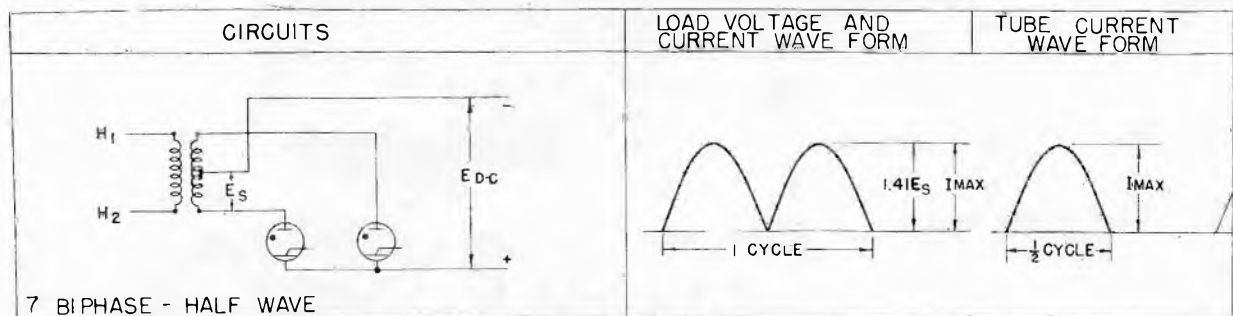
Fig. 6—Ratings of Standard Sizes of General Electric Sealed Ignitron Rectifiers for Industrial Service

rectifier service to supply a given d-c output is relatively simple. Assuming that the usual overload ratings apply, the average current per tube is the d-c load current divided by the number of phases

(see Useful Factors pages 9 and 10). Fig. 6 shows combinations for rectifiers of 40 to 1000 kilowatts at d-c outputs of 125 to 900 volts.

These values correspond to standard units which

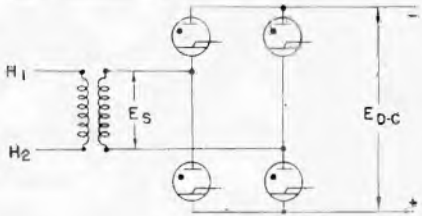
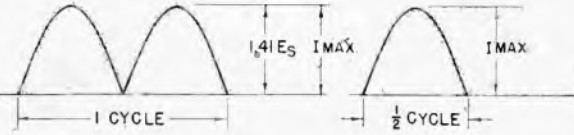
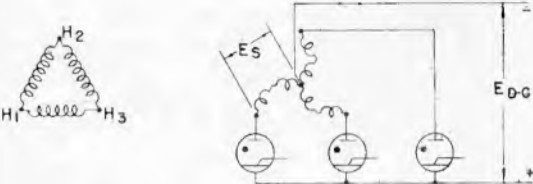
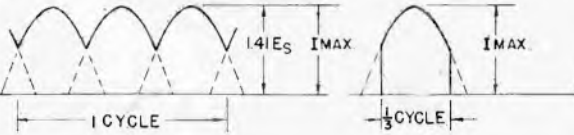
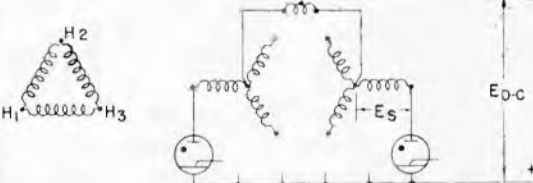
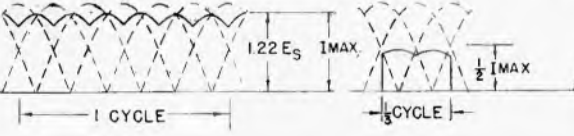
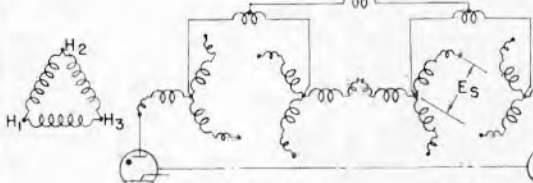
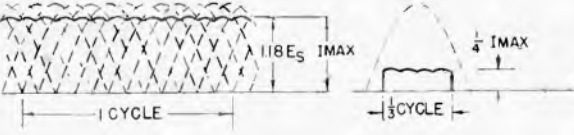
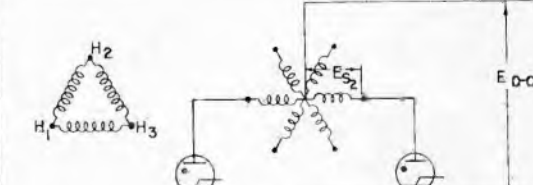
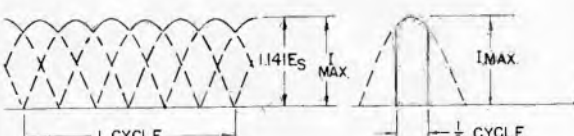
CIRCUITS FOR RECTIFIER TUBES (Figs. 7 through 16)



the General Electric Company supplies as unit substations. They require only electrical and water connections to function as a direct-current power substation. Various combinations of tubes may be used such as shown in Figs. 7 through 16, but in

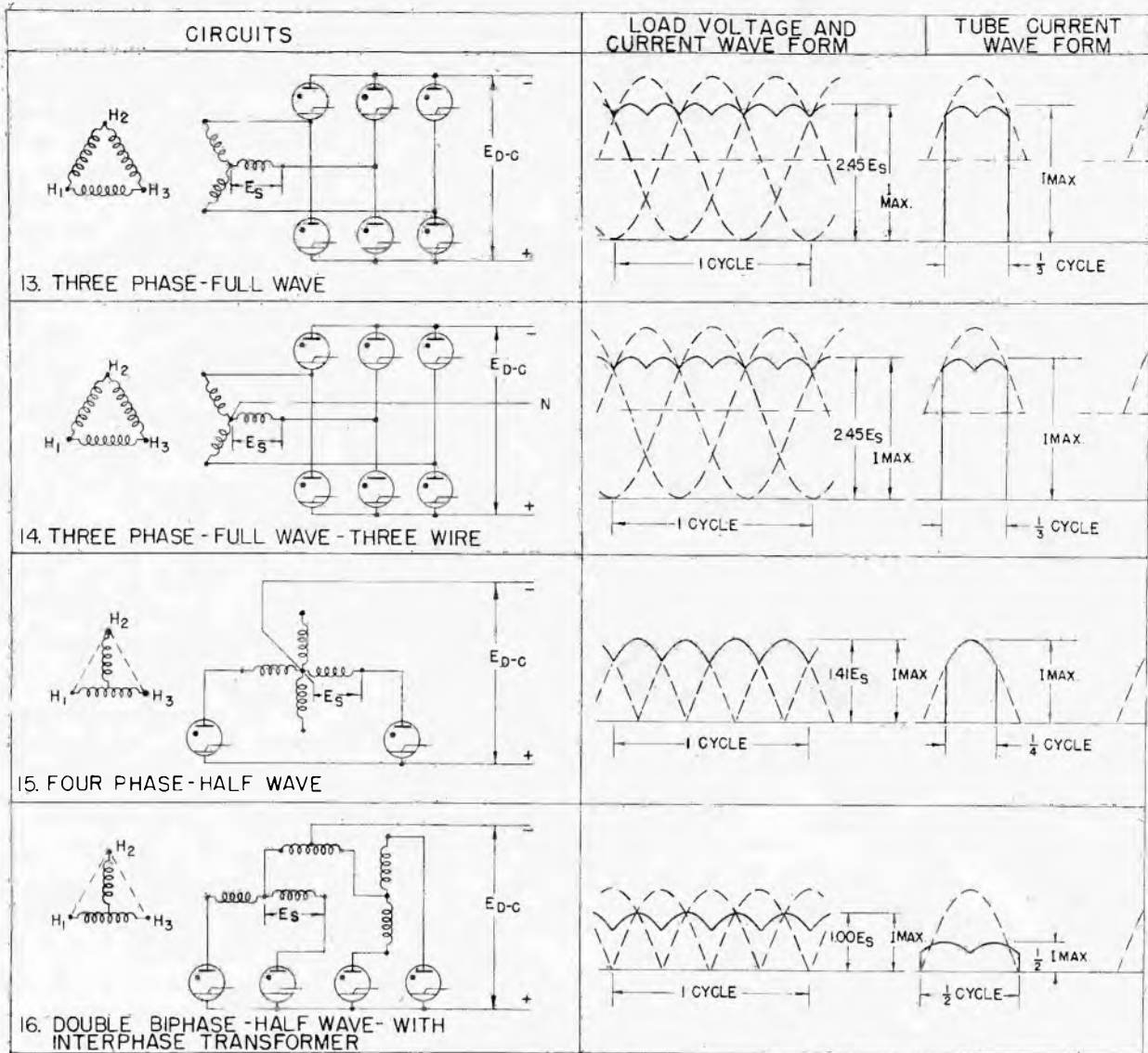
general the 3-phase double-Y half-wave, and the 3 phase, half-wave circuits are widely used. These circuits give a 6-phase and 3-phase output ripple which is so low that it causes little effect on units using direct-current power.

CIRCUITS FOR RECTIFIER TUBES (CONT'D)

CIRCUITS	LOAD VOLTAGE AND CURRENT WAVE FORM	TUBE CURRENT WAVE FORM
 <p>8 BI PHASE - FULL WAVE</p>		
 <p>9. THREE PHASE - HALF WAVE</p>		
 <p>10 THREE PHASE - DOUBLE Y - HALF WAVE</p>		
 <p>11. THREE PHASE - QUADRUPLE Y - HALF WAVE</p>		
 <p>12. SIX PHASE - HALF WAVE</p>		

Notes for Figs. 7 through 16:

The theoretical wave forms are for a resistance load neglecting voltage reduction due to tube arc drop and current overlap at commutation.
Es = Secondary voltage, RMS value.



USEFUL FACTORS

FIG. NO.	AVERAGE TUBE CURRENT LOAD CURRENT	E _{D-C} (AVERAGE OUTPUT VOLTAGE)	PEAK INVERSE VOLTAGE
7	.500	0.900 E _S 0.636 E _{M D-C}	2.282 E _S 3.141 E _{D-C}
8	.500	0.900 E _S 0.636 E _{M D-C}	1.414 E _S 1.570 E _{D-C}
9	.333	1.170 E _S 0.827 E _{M D-C}	2.450 E _S 2.090 E _{D-C}
10	.167	1.170 E _S 0.955 E _{M D-C}	2.450 E _S 2.090 E _{D-C}
11	.0833	1.170 E _S 0.955 E _{M D-C}	2.450 E _S 2.090 E _{D-C}
12	.167	1.350 E _S 0.955 E _{M D-C}	2.280 E _S 1.690 E _{D-C}

Note: E_{M D-C} = Maximum of D-C voltage.

USEFUL FACTORS (CONT'D)

FIG. NO.	AVERAGE TUBE CURRENT LOAD CURRENT	E.D.-C (AVERAGE OUTPUT VOLTAGE)	PEAK INVERSE VOLTAGE
13	333	2.340 ES 0.955 E M D-C	2.450 ES 1.045 E D-C
14	333	2.340 ES 0.955 E M D-C	2.450 ES 1.045 E D-C
15	250	1.273 ES 0.900 E M D-C	2.280 ES 1.790 E D-C
16	250	0.900 ES 0.900 E M D-C	2.280 ES 2.530 E D-C

DESIGN OF CIRCUITS

Mechanical

Tube supports should be of sufficient size to carry the tube weight and should be designed to provide sufficient electrical contact. Ignitrons are mechanically very strong and will withstand moderate shock. In general, however, excess vibration should be avoided. An adequate water supply of reasonably clean water should be available. Waters that are suitable for drinking are in general suitable for cooling tubes. In fact, such water is not contaminated in the passage through the ignitron water jacket and may be used for plant purposes. Water containing considerable acid or foreign matter which might clog the water jackets should be avoided. Stainless steel is immune to the effects of most corrosive waters, but is subject to attack by waters containing chlorides. If the chloride ion concentration exceeds 20 parts per million the water should be considered as suspicious and an analysis made to determine its corrosiveness. An excellent reference on the subject of water supplies is the United States Department of Interior, Geological Water Supply Paper 658. In general, local experience is one of the best guides as to the corrosiveness of water. Where highly corrosive waters are encountered, such as in mines, a heat exchanger may be employed of either the water-to-water or the water-to-air type. In such installations, corrosion may be minimized by the addition of 0.1 to 0.2 percent by weight of sodium or potassium dichromate to the circulating water-cooling system. In general, tubes are connected in series when connected directly to water supplies, and in parallel when connected to heat exchanger units. The minimum water supply temperature must be such that the outlet temperature of the hottest rectifier does not exceed the values given under Technical Information for the

voltage at which the unit is operated. The relation between water flow, temperature rise, and watts dissipated is as follows:

$$\text{Kilowatts} = 263.5 \times \text{gpm} \times \Delta C$$

Electrical

Electronic tubes of the ignitron type are power devices in exactly the same sense that transformers and rotating equipment are power devices and as a result adequate circuit breaker protection must be provided. In the case of the welder, the welding transformer acts in effect as a current limiting inductance. However, back-up or line protection in the form of fuses, contactors or breakers should be provided to remove the unit from the line in case there is a fault in the primary of the transformer.

In the case of rectifiers, similar switch gear must be provided for the primary and, in addition d-c breakers are usually required in the output. The d-c breaker is required when several units are connected in parallel to form a common bus bar. In this case, arc back in one tube will permit direct current to be fed through the tube and transformer from the remaining units. These breakers may also be adjusted to limit the permissible overloads as is the case with any conversion apparatus. The primary breaker must be capable of interrupting the maximum kilovolt-ampere of the supply system in case there is a short circuit directly across the primary terminals of the power transformer. Fig. 17 shows the schematic layout of a unit substation including circuit breaker equipment.

Special switch gear for these requirements have been developed by the General Electric Company and reference should be made through the nearest General Electric office or the General Electric Company, Schenectady, New York.

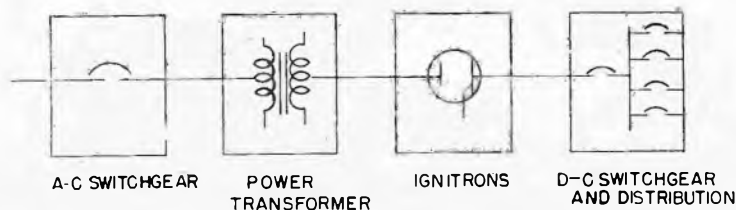


Fig. 17—Line Diagram Showing Component Parts of Ignitron Rectifiers

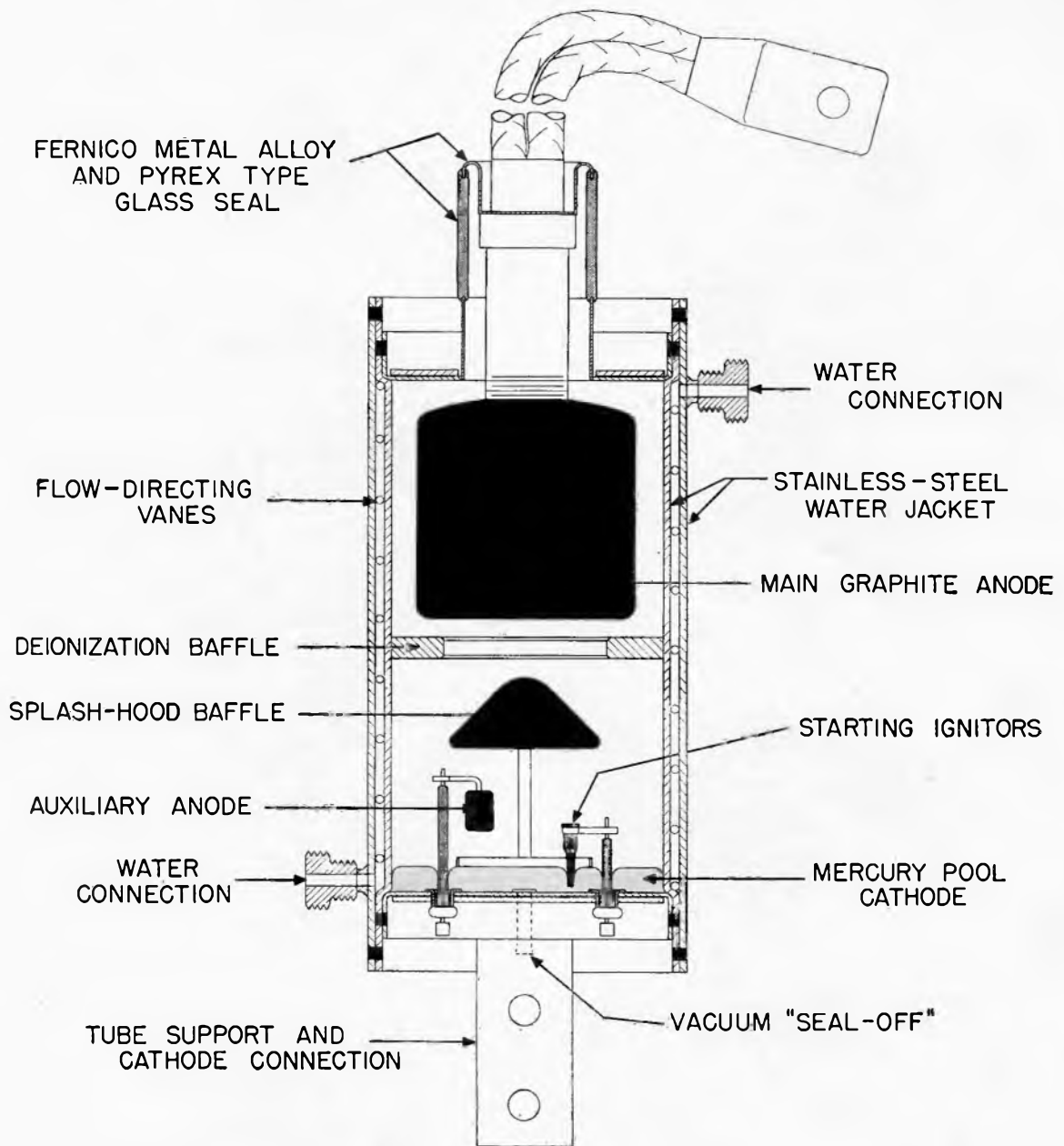
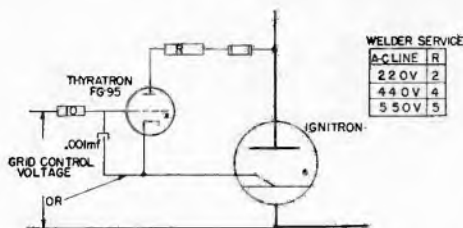


Fig. 19—Cross-Sectional View of the Sealed Ignitron for Power-Rectifier Service

IGNITOR EXCITATION CIRCUITS

Ignition power is usually provided by (1) diverting a part of the load current through the ignitor or (2) by a separate-excitation system which is independent of load current.

The self or anode firing system (see Fig. 18) uses a thyatron to determine the instant of firing and to prevent reverse current from flowing through the ignitor.



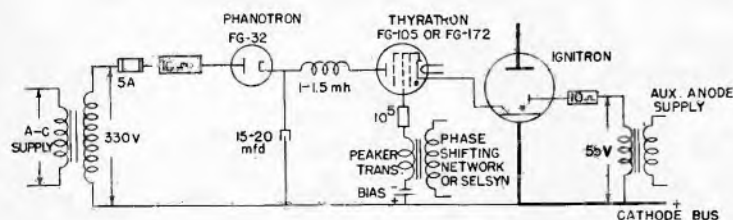
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Fig. 18—Self or Anode Excitation in which a Part of the Load Current is Diverted through the Ignitor

A series resistor is used to reduce the duty on the thyatron by limiting the current which passes through the thyatron during the time between ignition and pickup of the main anode, or when misfiring occurs. The recommended value of this resistance depends upon the anode voltage for which the set is designed to operate. It is usually 4 ohms for 600 volts and less, and approximately 50 ohms for 2300 volts. It is the simpler and more direct system and is used in the majority of welder applications. In rectifier work the loads, even on large capacity sets, frequently reach such low values that the available current is below the required ignition current. As a result, there tends to be some flickering of the output voltage which may be objectionable if lamps are a part of the connected load. Consequently, most rectifiers are equipped with a separate excitation system which fires the ignitor each cycle and is independent of the load. There is a small auxiliary anode near the cathode pool of each rectifier ignitron (see the cross sectional view, Fig. 19, page 11) which provides for cathode spot excitation current in case the main anode current falls below the stable value which is about 3 amperes.

Fig. 20A shows one form of separate-excitation system in which a capacitor is discharged through a phanotron during one part of the cycle and discharged through a thyatron into the ignitor at the instant it is desired to carry current. The circuit is relatively simple and direct. Complete details show-

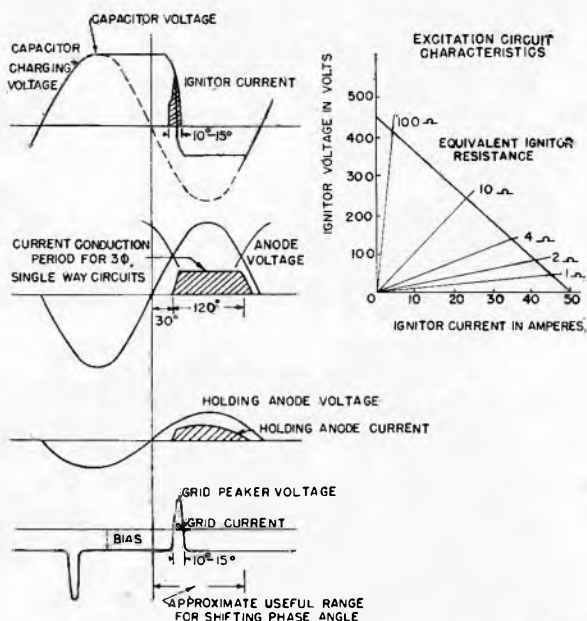


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Fig. 20A—Capacitor-Inductance Separate Excitation Circuit

ing the charging period, ignitor current wave shape, and output characteristics are shown in Fig. 20B.

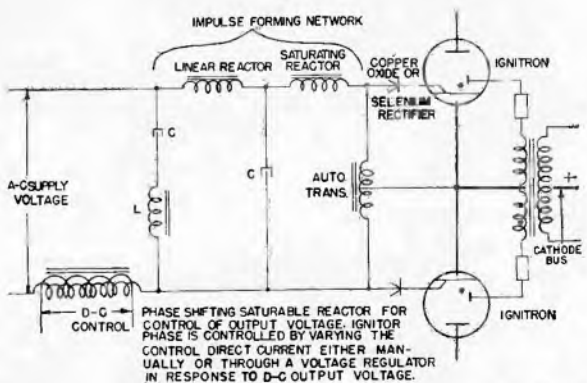


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Fig. 20B—Voltage, Current and Phase Relationships for Three-Phase Single Rectifier Circuit

In another form of separate-excitation equipment magnetic circuits in conjunction with saturating reactors have been arranged to produce the required ignitor peak current. Fig. 21 shows the connections in this system. Special reactors are required both for the saturating reactor which determines the wave shape and for the saturable reactor which determines the phase position.



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Fig. 21—Magnetic Separate Excitation Circuit for Firing Diametrically Opposite Tubes

Circuit constants for welder applications have been described previously and are essential to the ignitron tube in so far as the demands do not exceed the tube ratings. The ignitrons in the back-to-back connection operate simply as a switch.

RECTIFIER CONSIDERATIONS

In the case of the rectifier, various circuit relations in terms of d-c output, voltage and current wave shapes are given in Figs. 7 through 16. The constants give the theoretical output voltage at no-load conditions. Actually all rectifiers have a certain amount of regulation usually of the order of 6 to 7 per cent depending on the reactance in the power transformer and a-c supply system. Voltage regulation in the rectifier is due to the increase in tube drop with increasing current, the IR drop in the transformer and the voltage loss due to commutation. During the commutation period, current is transferred from one winding to another and for a short time both windings conduct giving an output voltage which is the average of the two phase voltages rather than the higher. This effect is shown in Fig. 22.

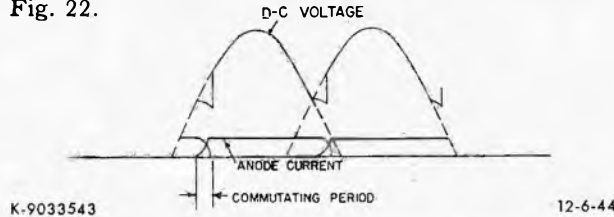


Fig. 22—Wave Diagram Showing Voltage Loss Due to Commutation

The average voltage loss due to commutation is:

$$E_x = pfLI \text{ volts (d-c)} \quad (1)$$

where p — Number of phases in each simple rectifier. Circuits shown in Figs. 7, 8, 9, 14 and 16 are simple single-way (current conducted in only one direction in transformer winding connected to tube) rectifiers having 2, 2, 3, 4, and 6 phases respectively.

Rectifiers formed of simple units such as Figs. 10 and 15 have "p" factors corresponding to the simple rectifier, i.e. $p = 3$ and $p = 2$.
 f = Frequency in cycles per second.

L = Commutating inductance in henrys. It is determined from the transformer secondary reactance ($X_L = 2\pi fL$) of any two successively conducting phases in a simple rectifier, and is most easily determined by short circuiting the primary and determining the voltage to force rated secondary current through any two successively conducting phases. Then, the impedance,

$$Z = \frac{E}{I} \text{ ohms}$$

and if the resistance is known, X_L may be determined from

$$Z = \sqrt{R^2 + X_L^2}$$

I = Current at the start of commutation. This is equal (essentially) to the direct current in the case of simple rectifiers, or to the proportion carried if there are several simple rectifiers in the unit.

The theoretical average or d-c output voltage of a rectifier is:

$$E_{do} = P/\pi\sqrt{2} E_s (\sin \pi/P)$$

where E_s = the rms value of the transformer secondary line to neutral voltage

For the normal delta double - Y circuit where $P = 3$;

$$E_{do} = 3/\pi\sqrt{2} E_s (\sin \pi/3)$$

$$= \frac{3\sqrt{3}}{\sqrt{2}\pi} E_s = 1.17E_s$$

If it is desired to find the secondary voltage required to supply a given output, the theoretical d-c voltage is first determined by adding the resistance, commutation and tube losses to the full load output voltage.

For example, assume a 300-kilowatt, 3-phase double-Y, 275-volt rectifier. Then,

D-c voltage at full load = 275 v

IR voltage loss in transformer Y at 545A_{mp} = 4.5 v

Commutation voltage loss at 545A_{mp} = 10.5 v

Tube arc drop = 15.8 v

Summation: E_{do} = 305.8 v

and $305.8 = 1.17 E_s$
or $E_s = \frac{305.8}{1.17} = 261 \text{ v (rms)}$

The regulation is due to the IR loss in transformer = 4.5 v

Commutation loss = 10.5 v

Change in tube drop (0 to 545A_{mp}) = 2.4 v

Total loss in voltage = 17.4 v

and the percentage regulation:

$$\text{Reg} = \frac{(\text{no load voltage} - \text{full load voltage})}{\text{full load voltage}} \times 100$$

$$= \frac{\text{loss in voltage}}{\text{full load voltage}} \times 100 = \frac{17.4}{275} = 6.25\%$$

Circuits other than those shown for rectifier or welder service may be desirable for a particular use. In general, the tube requirements for such circuits and service may be determined by writing to the Electronics Department, Tube Division, Schenectady 5, New York.

MAINTENANCE AND OPERATION

There is very little maintenance in the usual sense of the word that is required for ignitron tubes. The tube should be clean and accumulations of waste should not be allowed to collect around the anode insulation bushing. (Caution: All power should, of course, be removed prior to any cleaning operation.) In case water jackets become clogged with silt, they can, of course, be cleaned out with the usual cleaning solutions. Operational failures of ignitron tubes which are due to the tubes themselves are usually the result of air leakage, gas, or ignitor failure. Gas and air leakage most frequently result in arc back and thus is usually accompanied by severe flashing or showers of red-hot sparks in the anode seal. Such failures can be indicated in general from a visual inspection of the equipment while it is operating. Spare tubes may be checked for vacuum by means of a spark coil of the make and break type. Ignitor failure where the tip has been burned off results in misfire. This fault can be detected by connecting an ohmmeter between the ignitor lead and cathode terminal and slightly tipping the tube to lower the mercury level on the ignitor. The normal tube may be tipped approximately 20 degrees from vertical before the ignitor-mercury contact breaks. Ignitor wetting sometimes occurs in tubes which have carried excessive current. In this case, the cathode spots form on the side walls of the tube and vaporize metal into the mercury pool to cause wetting. This metal in turn is re-evaporated by the arc around the ignitor and since the arc starts each cycle at the ignitor, it tends to become coated with a layer of vaporized metal. This in turn is usually without an oxide for protection, and amalgamation with the mercury takes place. A simple check for this type of

failure is again to connect the ignitor and cathode terminals to a resistance analyzer. As the tube is tipped slightly to withdraw the ignitor from the mercury, there should be a gradual increase in the ignitor resistance. If the ignitor is wet, the resistance will remain constant and then suddenly jump to a new and higher value. Operation at too-high water temperatures usually results in arc back in the case of the rectifier tubes, and extra conduction cycles in the case of the welder tube.

Ignitron tubes, in common with most other electronic devices, operate under the instantaneous conditions which occur cycle by cycle. In general, the ignitron tube forms the closing switch in the circuit whether it is a welder or rectifier. Most faults, therefore, appear when this switch is closed, and trouble in other parts of the equipment may frequently be considered as tube trouble. The simplest initial check is to replace the tube which seems in trouble with a spare tube. If additional work is required, a cathode-ray oscilloscope will be found almost invaluable. These units permit a visual observation of the voltage wave shapes across the tube and across component parts of the circuit. A knowledge of these wave shapes under normal conditions and a comparison under fault conditions usually gives a direct solution to the trouble. The General Electric Company is preparing a cathode-ray oscilloscope particularly suited for industrial electronic use. Information on this may be obtained by writing to the Electronics Department, Specialty Division, Syracuse, New York. In addition to a cathode-ray oscilloscope one of the small volt-ohm analyzers is useful in checking circuit constants.

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.

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. In the case of temperature-controlled tubes, where the water flow is maintained by the temperature-control switch, proper water flow will be assured provided the control-switch power supply is not removed simultaneously with the anode supply.

The following table indicates the minimum time during which water flow should continue after removal of anode power:

Ignitron Type	After Removal of Anode Voltage Continue Water Flow for	Temperature-Controlled Ignitron Type	After Removal of Anode Voltage Maintain Power on Control Switch for
GL-5552-A	15 Minutes	GL-6346	15 Minutes
GL-5553-B	30 Minutes	GL-6347	15 Minutes
GL-5554	15 Minutes	GL-6348	30 Minutes
GL-5555	30 Minutes	GL-6512	15 Minutes
GL-5564	1 Hour	GL-6513	30 Minutes
GL-5630	30 Minutes	GL-6514	30 Minutes
GL-5822-A	15 Minutes	GL-6515	1 Hour
GL-6228	1 Hour		
GL-6509	30 Minutes		
GL-6878	1 Hour		

ELECTRONIC COMPONENTS DIVISION

GENERAL  ELECTRIC

Schenectady 5, N. Y.

IGNITRONS

Recommended Types and Selection Chart

Values listed are maximum and do not necessarily apply concurrently.
Refer to data sheet for detailed technical information for a particular application.

Current		Demand Kilovolt- Amperes	Voltage		Class of Service*	Water Temperature, Centigrade			Tube Type	
Average, Amperes	Peak, Amperes		Peak Inverse, Volts	RMS Supply, Volts		Inlet		Outlet		
						Min	Max	Max		
0.25	35,000	.....	10,000	.....	Capacitor Discharge DC Short Circuiting	Natural Convection			GL-7171
22.4	.....	300	.....	600	AC Control Capacitor Discharge	10 (Clamp tempera- ture)	75 (Clamp tempera- ture)	—	GL-5550
50	200	.....	20,000	.....	Power Rectifier— Continuous Duty	35	40	45	GL-5630
56	700	600	1500	600	AC Control Frequency-Changer Resistance Welding	0	30	40	GL-5551-A (Tempera- ture-control bracket)	
					Power Rectifier— Intermittent Duty	10	40	—	GL-6346 (Integral- temperature control)	
70	1500	.....	1500	.....	Frequency-Changer Resistance Welding	10	30	35	GL-5822-A (Tempera- ture-control bracket)
					Power Rectifier— Intermittent Duty	10	30	—	GL-6511 (Integral- temperature control)	
113	900	1200	2100	2400	AC Control Power Rectifier— Continuous Duty	6	50	60	GL-5554	
					—	—15	50	—	GL-6512 (Integral- temperature control)	
140	1600	1200	500	600	AC Control Power Rectifier— Intermittent Duty	0	30	40	GL-5552-A (Tempera- ture-control bracket)	
					Frequency-Changer Resistance Welding	10	40	—	GL-6347 (Integral- temperature control)	
200	1800	.....	2100	.....	Power Rectifier— Continuous Duty (Railroad Service)	30	50	60	GL-6509
	6000	2000	20,000	500	AC Control Capacitor Discharge DC Short Circuiting Power Rectifier— Intermittent or Continuous Duty	35	40	45	GL-6228	
207	1800	2400	2100	2400	AC Control Power Rectifier— Continuous Duty	6	50	60	GL-5555 GL-5788 †	
						—15	50	—	GL-6513 (Integral- temperature control)	
						—10	55	—	GL-6514 (Integral- temperature control) ‡	
275	2000	.....	4000	.....	Inverter— Continuous Duty	30	45	55	GL-6958
					Power Rectifier— Continuous Duty	10	45	55	GL-7042 (Integral- temperature control)	
350	2000	.....	4000	.....	Power Rectifier— Continuous Duty (Railroad Service)	30	45	55	GL-6504
355	4000	2400	1500	600	AC Control Frequency-Changer Resistance Welding	0	30	40	GL-5553-B (Tempera- ture-control bracket)	
					Power Rectifier— Intermittent Duty	10	40	—	GL-6348 (Integral- temperature control)	

(over)

IGNITRONS (Cont'd)

Current		Demand	Voltage		Class of Service*	Water Temperature, Centigrade			Tube Type
Average, Amperes	Peak, Amperes	Kilovolt-Amperes	Peak Inverse, Volts	RMS Supply, Volts		Inlet		Outlet	
						Min	Max	Max	
670	2500	.....	700 (Max Peak Anode Voltage)	.....	Power Rectifier— Continuous Duty	30	40	50	GL-7179
						10	40	50	GL-7180 (Integral-temperature control)
675	2500	.....	4000	.....	Power Rectifier— Continuous Duty (Railroad Service)	30	40	55	GL-6878
850	3600	4800	2100	2400	AC Control Power Rectifier— Continuous Duty	0	40	60	GL-5564
						0	50	—	GL-6515 (Integral-temperature control)
900	.....	4800	.....	600	AC Control	0	30	40	GL-7151

* The tubes listed are rated for the classes of service shown. However, each tube is capable of operating at other classes of service not shown here. For a specific application, please consult your Power Tube Department sales representative.

† Lower water pressure drop and more baffling than the GL-5555.

‡ Lower water pressure drop and more baffling than the GL-6513.

ELECTRONIC COMPONENTS DIVISION
GENERAL  **ELECTRIC**
 Schenectady 5, N. Y.



IGNITRON

SPECIAL DESIGN FEATURES

1. Stainless-steel, seam-welded construction
2. Uniform water cooling
3. Strong, compact design
4. Easy to install
5. Copper terminals
6. Flexible anode lead
7. Mercury-pool cathode allows extremely high instantaneous currents to be passed through the tube without damage.

DESCRIPTION

The ability of this tube to carry very high peak currents for short periods makes it especially suited to welder-control service. In this service, two tubes in the inverse-parallel connection will control 1200 kilovolt-amperes at voltages of 250 to 600 volts and over the frequency range of 25 to 60 cycles.

Ease of installation, economical use of space, and reliability of operation are assured by design features inherent in the steel-jacketed construction.

The GL-5552/FG-235-A is similar to the GL-5553/FG-258-A and the GL-5551/FG-271. All of

these tubes can be used for a wide range of applications where welds are made infrequently or in rapid succession.

The current range required for the welding operation determines which tube to use. Another factor, of course, is the nature of the material to be welded. Low-resistance materials, such as the aluminum alloys, require more current than such high-resistance metals as stainless steel.

The GL-5552/FG-235-A ignitron is equivalent to a 600-ampere magnetic contactor.

GENERAL  ELECTRIC


Electronic
TUBE

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Type cathode excitation	cyclic
Type 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 Data

Envelope material	metal
Over-all length, maximum	27 $\frac{1}{4}$ inches
Over-all width exclusive of water connections, maximum	4 $\frac{1}{4}$ inches
Net Weight	8 pounds
(See outline drawing for details).	
Type of cooling	water
Characteristic for water cooling at rated minimum flow	
Water temperature rise, maximum	.6 C
Pressure drop, maximum	4.5 pounds per square inch

Thermal

Water cooling	
Maximum outlet water temperature	40 C
Minimum inlet water temperature	10 C
Minimum water flow	1.5 gallons per minute

MAXIMUM RATINGS

As Power Rectifier Tube (Intermittent Service)

Maximum peak anode voltage	
Inverse	500 volts
Forward	500 volts
Maximum anode current	
Peak	1600 amperes
Average	100 amperes
Maximum averaging time	6 seconds
Surge	6000 amperes
Maximum duration of surge current	0.15 second
Frequency range	25-60 cycles per second

As A-c Control Tube (Two Tubes in Inverse Parallel)

Voltage range	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 600 volts rms	5.8 seconds
Maximum averaging time at 250 volts rms	14.0 seconds
Maximum peak surge current at 250 volts	13450 amperes
Maximum peak surge current at 600 volts	5600 amperes

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

Note 1—RMS demand voltage, current, and kilovolt-ampere are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used.

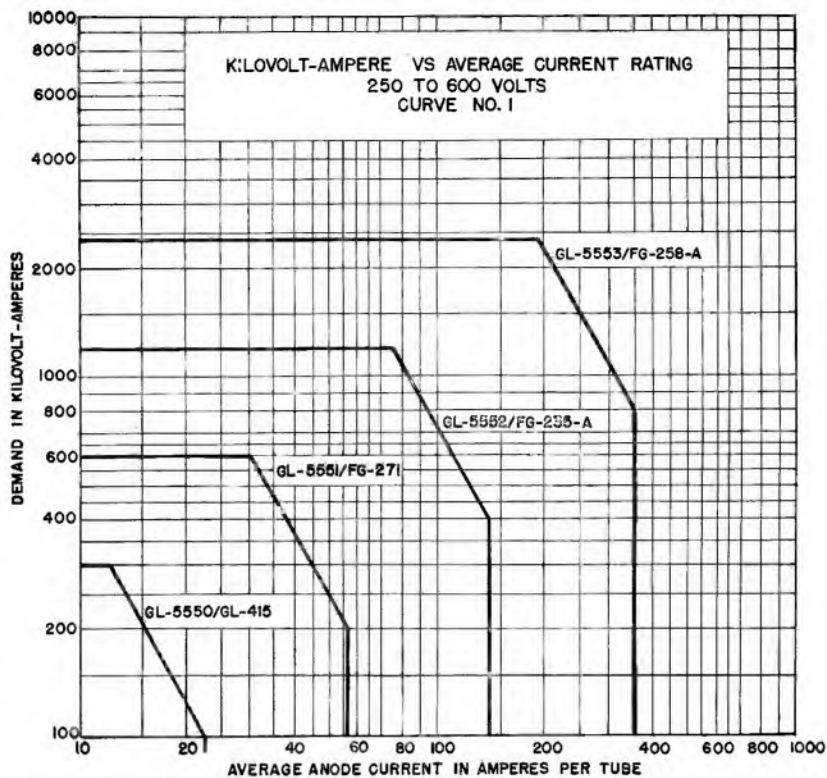
Note 2—For voltages below the minimum, the minimum-voltage current rating applies.

◆ Completely revised.

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 kilovolt-ampere vs average anode current.
2. Maximum averaging time vs anode voltage.

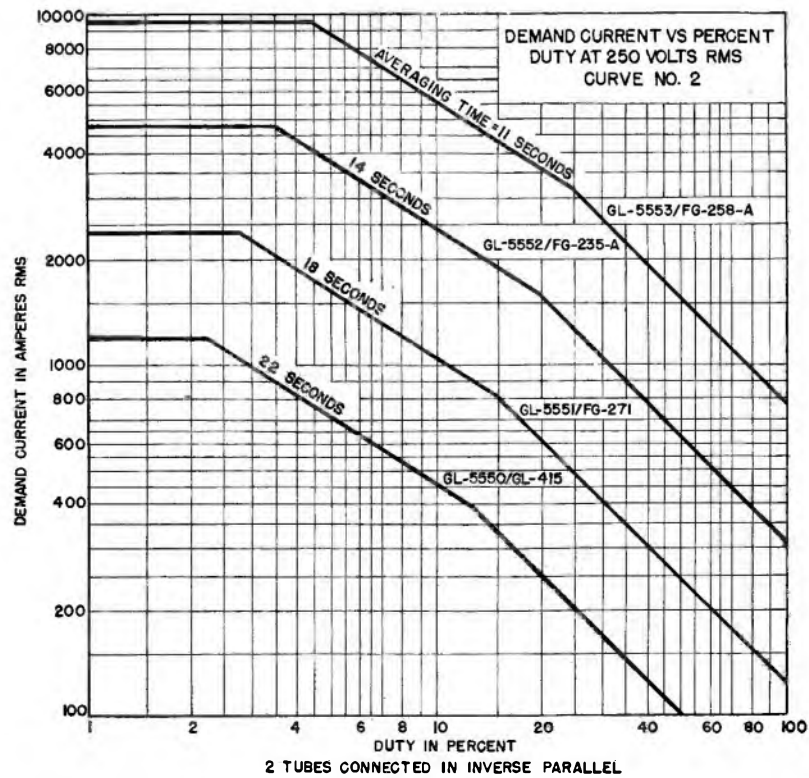
CURVES K-69087-72A217, K-69087-72A218 AND K-69087-72A219 MUST NOT BE USED FOR INTERMITTENT RECTIFIER SERVICE



K-69087-72A217 (New drawing)

FIG. 1

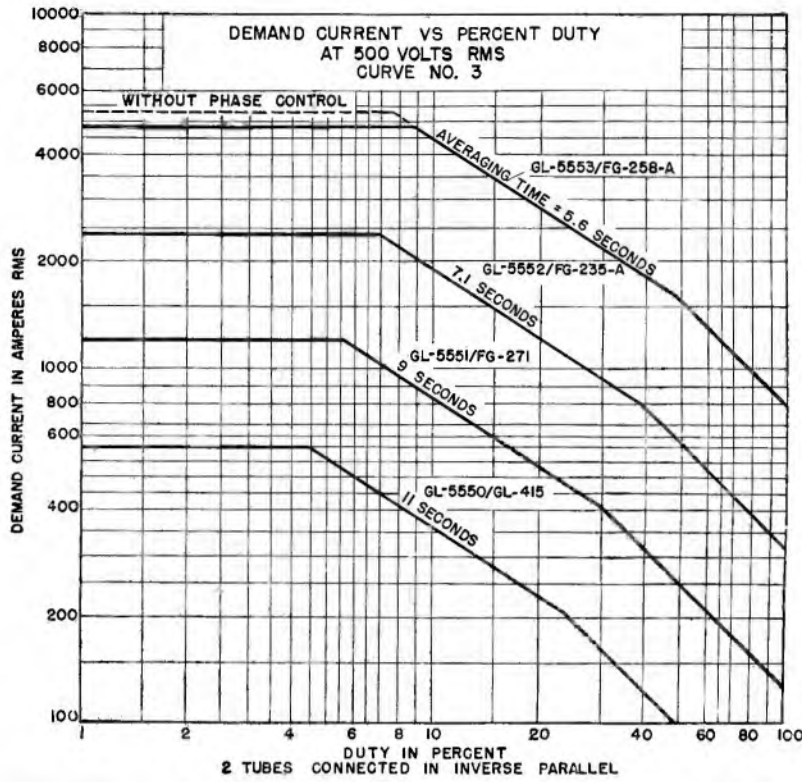
3-31-48



K-69087-72A218 (New drawing)

FIG. 2

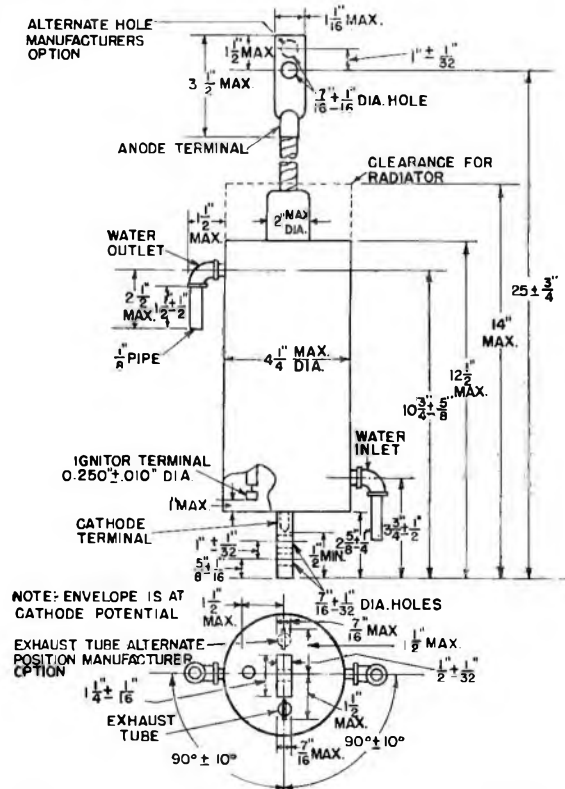
3-31-48



K-69087-72A219 (New drawing)

FIG. 3

3-31-48



K-5309175

OUTLINE GL-5552/FG-235-A

10-21-49

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



IGNITRON

SPECIAL DESIGN FEATURES

1. Stainless-steel, seam-welded construction
2. Uniform water cooling
3. Strong, compact design
4. Easy to install
5. Copper terminals
6. Flexible anode lead
7. Mercury-pool cathode allows extremely high instantaneous currents to be passed through the tube without damage.

DESCRIPTION

This steel-jacketed ignitron is designed for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. The GL-5555/FG-238-B 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 aver-

age 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 auxiliary anode stabilizes the cathode spot for very small anode currents. Two ignitrons, only one of which is used at a time, assure long life.

GENERAL  ELECTRIC

Supersedes ETI-110 dated 4-45


Electronic
TUBE

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

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	150 volts
Ignitor current required to fire	40 amperes
(See curve 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 a-c

Mechanical Data

Envelope material	metal
Net weight	25 pounds
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

Thermal

Water cooling

Maximum outlet water temperature	
Peak inverse anode voltage = 900	60 centigrade
Peak inverse anode voltage = 2100	45 centigrade
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

MAXIMUM RATINGS

As Power Rectifier Tube*

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	
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

*Ratings are for zero phase-control angle.

As A-c 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

TECHNICAL INFORMATION (CONT'D)

Ignitor

Maximum voltage	
Positive	anode volts
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

Auxiliary 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

◆ GL-5555/FG-238-B

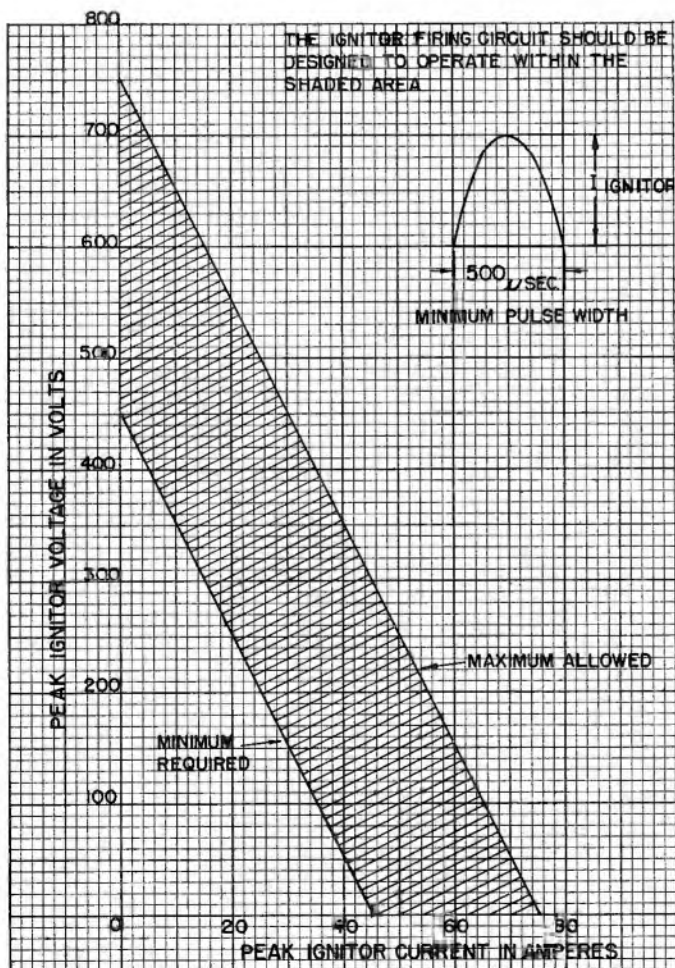


FIG. 2

K-9033883
◆New drawing.

6-14-45

◆ GL-5555/FG-238-B

ELEMENTARY CIRCUIT FOR CAPACITOR FIRING

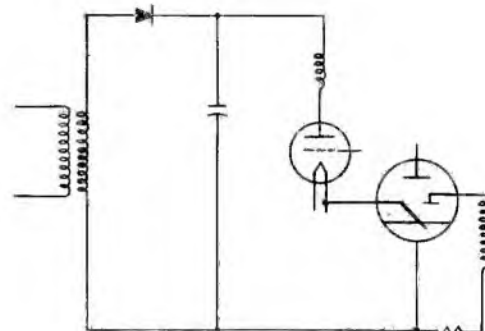


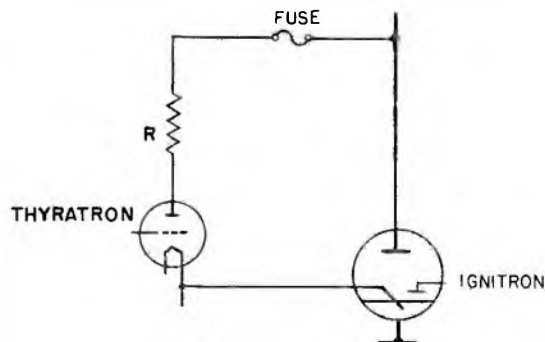
FIG. 1

K-9033525

10-25-50

◆ GL-5555/FG-238-B

ELEMENTARY CIRCUIT FOR ANODE FIRING



TYPICAL VALUES OF R

- ANODE VOLTAGE = 600 VOLTS OR LESS - 4 OHMS
- ANODE VOLTAGE = 601 TO 1000 VOLTS - 10 OHMS
- ANODE VOLTAGE = 1001 TO 1500 VOLTS - 20 OHMS
- ANODE VOLTAGE = 1501 TO 2000 VOLTS - 35 OHMS
- ANODE VOLTAGE = 2001 TO 2400 VOLTS - 50 OHMS

FIG. 3

K-9033528
◆Revised drawing.

10-25-50

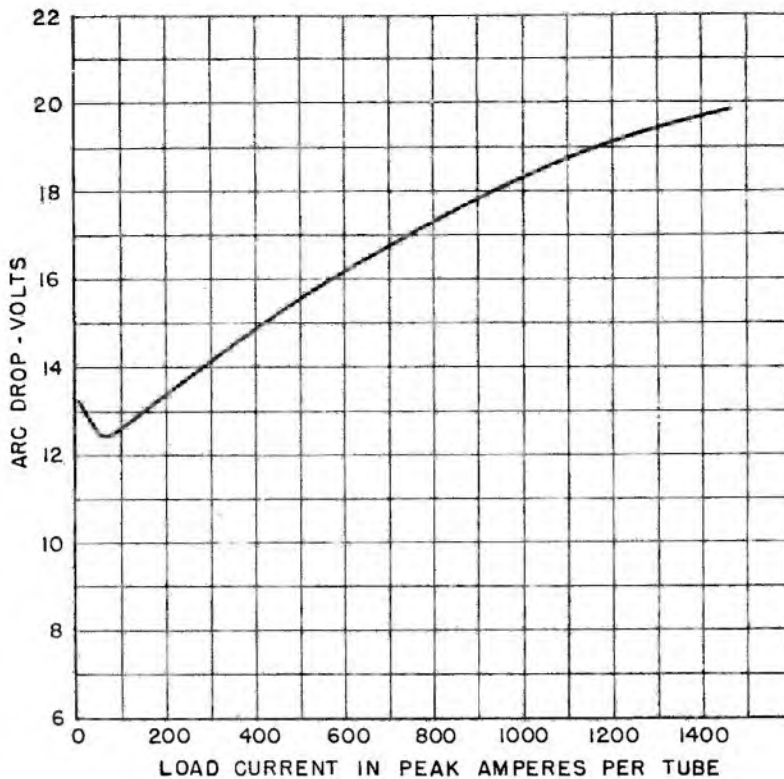


FIG-238-B ARC DROP, OUTLET WATER TEMPERATURE—40 C TO 60 C, WATER FLOW—3 GPM
 K-6917495 FIG. 4 8-25-44

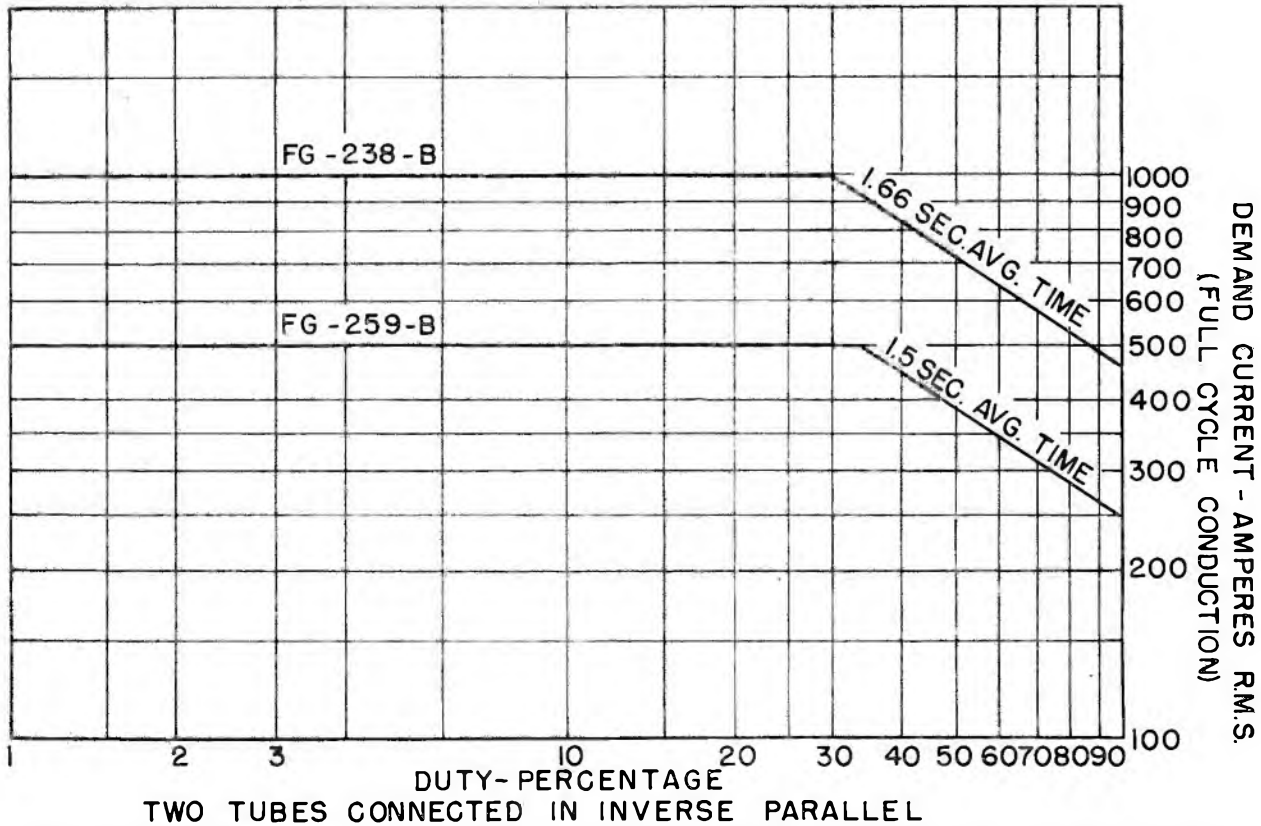
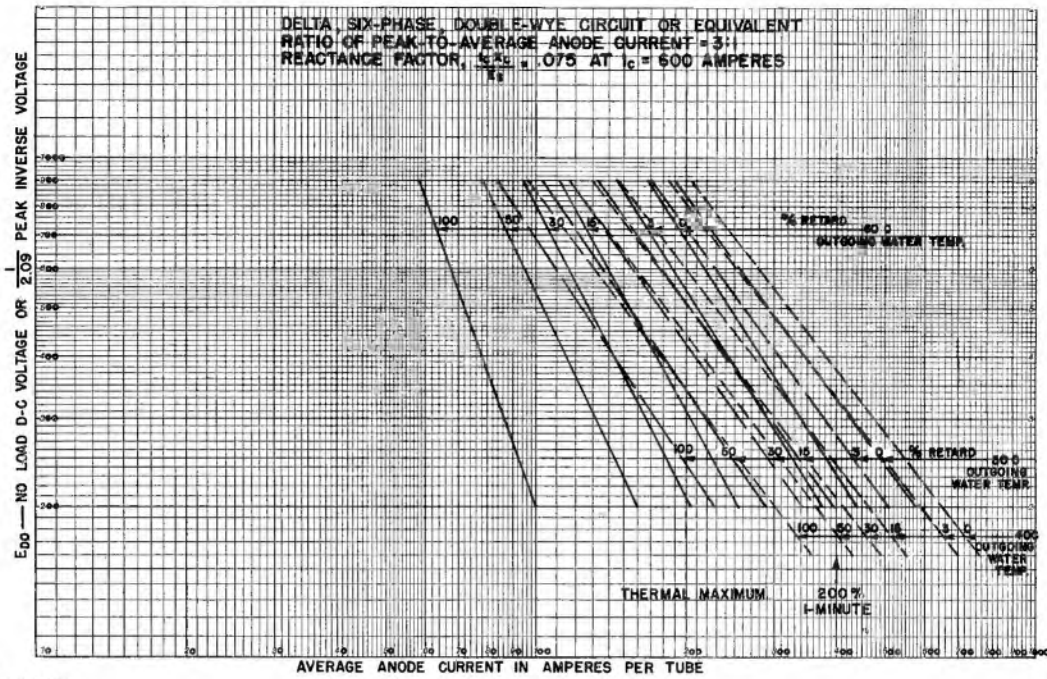


FIG-238-B IGNITRON; DEMAND CURRENT VS PERCENTAGE DUTY AT 2400 VOLTS RMS, MAX OUTLET WATER TEMP 30 C, MIN WATER RATE 3 GAL/MIN, WELDER CONTROL SERVICE

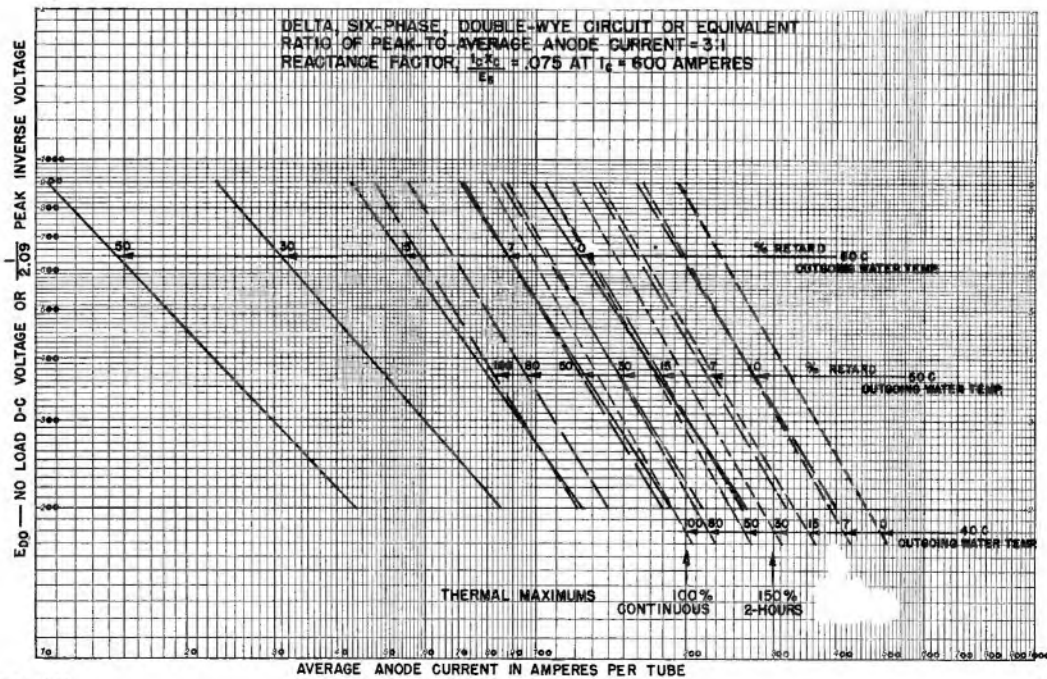
◆ GL-5555/FG-238-B
 COMMUTATION LIMITS—1-MINUTE LOADS



K-69087-72A180
 ◆ New drawing.

11-29-48

◆ GL-5555/FG-238-B
 COMMUTATION LIMITS—2-HOUR LOADS

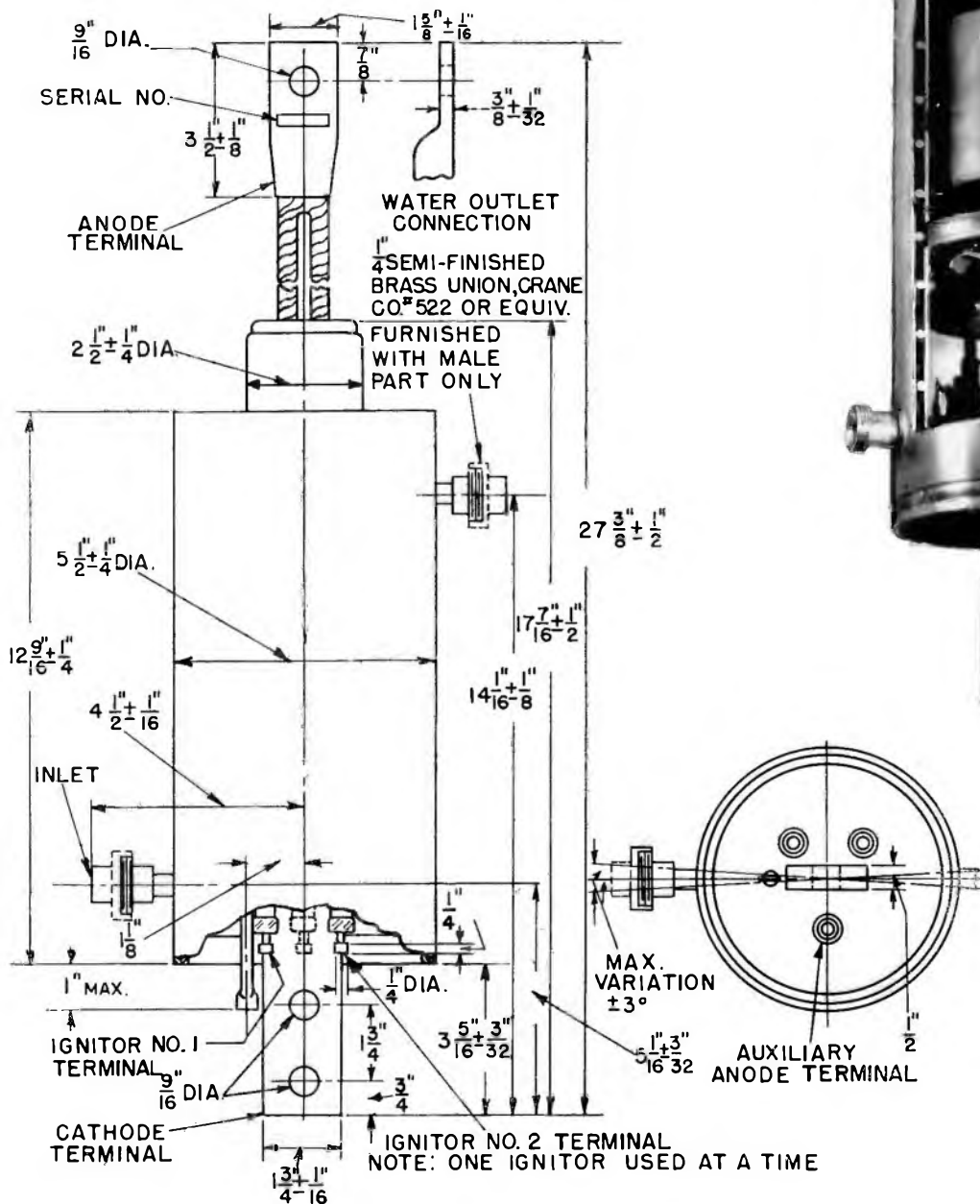


K-69087-72A181
 ◆ New drawing.

11-29-48

CUT-AWAY VIEW OF
GL-5555/FG-238-B IGNITRON

◆ OUTLINE
GL-5555/FG-238-B IGNITRON



K-5344658
◆ Revised drawing.

9-22-48

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



IGNITRON

SPECIAL DESIGN FEATURES

1. Stainless-steel, seam-welded construction
2. Uniform water cooling
3. Strong, compact design
4. Easy to install
5. Copper terminals
6. Flexible anode lead
7. Mercury-pool cathode allows extremely high instantaneous currents to be passed through the tube without damage.

▲DESCRIPTION

The ability of this tube to carry very high peak currents for short periods makes it especially suited to welder-control service. In such service, two tubes in the inverse-parallel connection will control 2400 kilovolt-amperes at voltages of 250 to 600 volts over the frequency range of 25 to 60 cycles. It may also be used for conversion in low-power circuits.

Ease of installation, economical use of space, and reliability of operation are assured by design and construction features inherent in the steel-jacketed construction.

▲Revised.

The GL-5553/FG-258-A is similar to the GL-5552/FG-235-A and the GL-5551/FG-271. All of these tubes can be used for a wide range of applications where welds are made infrequently or in rapid succession.

The current range required for the welding operation determines which tube to use. Another factor, of course, is the nature of the material to be welded. Low-resistance materials, such as aluminum alloys, require more current than such high-resistance metals as stainless steel.

The GL-5553/FG-258-A ignitron is equivalent to a 1200-ampere magnetic contactor.

GENERAL  ELECTRIC

Supersedes ETI-111A dated 10-47


Electronic
TUBE

▲ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL**Electrical Data**

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
(See Curve for details)	
Starting time at required voltage or current	100 microseconds

Mechanical Data

Envelope material—Metal	
Net weight	21 pounds
Type of cooling—Water	
Characteristics for water cooling at rated minimum flow	
Water temperature rise, maximum	9 degrees
Pressure drop, maximum	5.1 pounds per square inch

MAXIMUM RATINGS**AS A-C CONTROL TUBE**

Two tubes in inverse parallel	
Voltage range	250 to 600 rms volts
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
Two tubes in inverse parallel	
Maximum averaging time at 250 volts rms	11 seconds
Maximum averaging time at 600 volts rms	4.6 seconds
Maximum surge current at 250 volts rms	27,000 peak amperes
Maximum surge current at 600 volts rms	11,200 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.

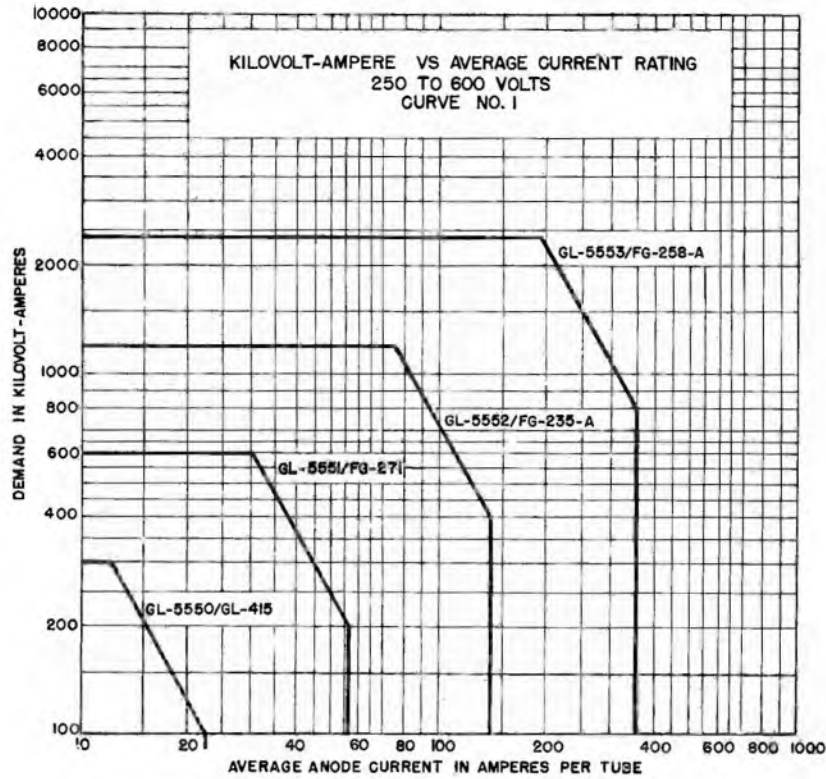
Note 3—With the use of log-log paper straight line interpolation between tabulated points may be used for other detailed ratings of:

1. Demand kva vs. average anode current.
2. Maximum averaging time vs anode voltage.

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
Thermal water cooling	
Maximum outlet water temperature	40 C
Minimum inlet water temperature	10 C
Minimum water flow	3 gallons per minute

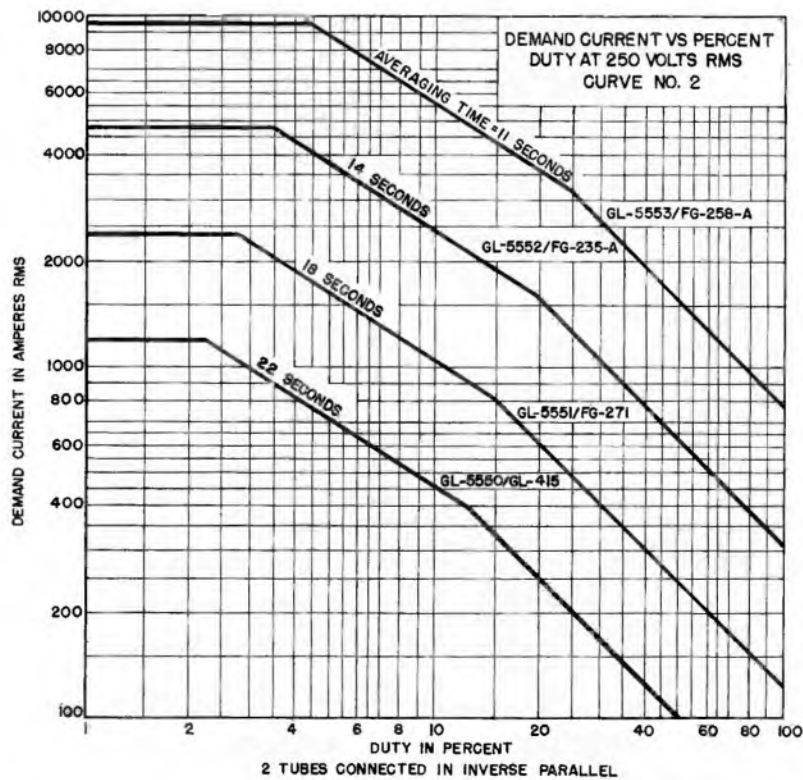
▲ Data completely revised.



K-69087-72A217 (Revised)

FIG 1

3-31-48



K-69087-72A218 (New drawing)

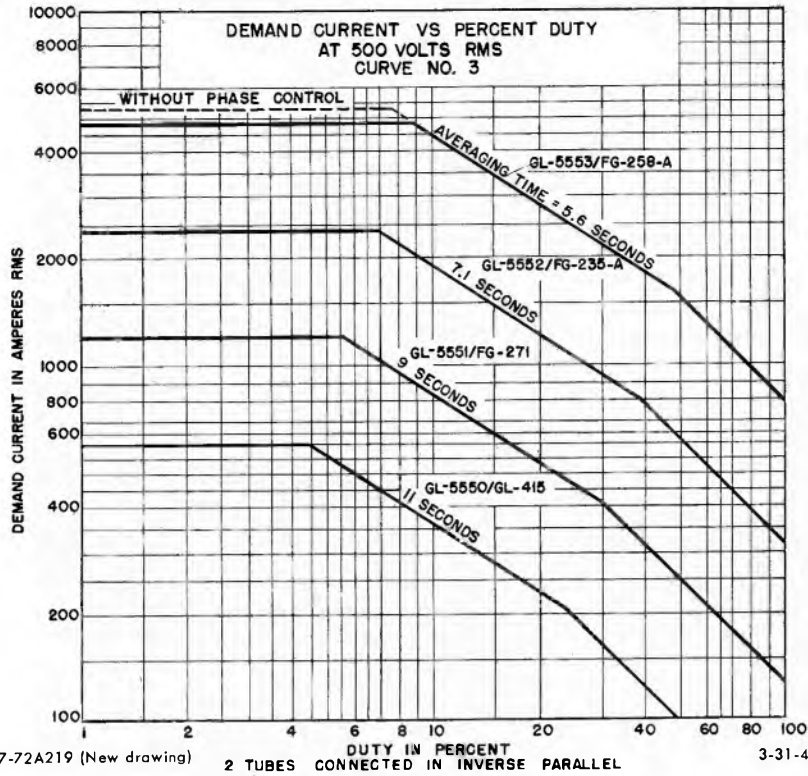
3-31-48

GL-5553/FG-258-A

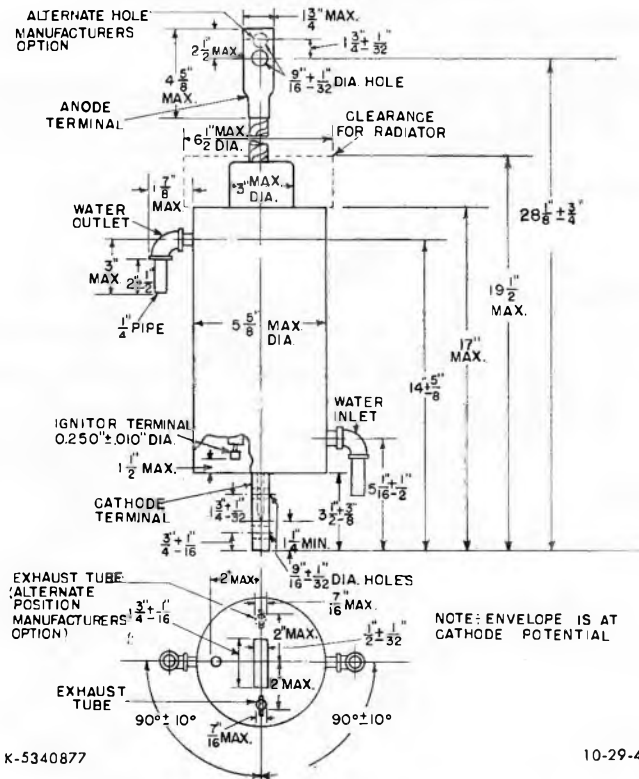
ETI-111B

PAGE 4

3-50



OUTLINE GL-5553-FG-258A IGNITRON



Tube Divisions, Electronics Department

GENERAL ELECTRIC
Schenectady, N. Y.



IGNITRON

SPECIAL DESIGN FEATURES

1. Stainless-steel, seam-welded construction
2. Uniform water cooling
3. Strong, compact design
4. Easy to install
5. Copper terminals
6. Flexible anode lead
7. Mercury-pool cathode allows extremely high instantaneous currents to be passed through the tube without damage.

DESCRIPTION

This steel-jacketed ignitron is designed, as is the FG-238-B, for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. The FG-259-B is used for rectifiers rated up to 200 kilowatts depending on the number of ignitrons used, the output voltage, and the circuit.

The FG-259-B is also rated for 2400-volt resistance-welder-control service and has a capacity of 1200 kilovolt-amperes in this service. The FG-

259-B has a continuous average current rating of 100 amperes per tube for use in rectifiers rated up to 200 kilowatts.

Arc losses are low. Phase control of the ignitron impulses permits voltage control of the rectified output. Excitation of the small auxiliary anode stabilizes the cathode spot for very small anode currents. Two ignitrons, only one of which is used at a time, assure long life.

GENERAL  **ELECTRIC**


Electronic
TUBE

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Voltage drop

At 100 amperes instantaneous anode current.....	12.6	volts
At 300 amperes instantaneous anode current.....	14.4	volts
At 600 amperes instantaneous anode current.....	17.3	volts

Mechanical

Cathode.....	pool type
Number of ignitors.....	2
Number of main anodes.....	1
Number of auxiliary anodes.....	1
Type of cooling.....	water
Typical flow.....	1.5 to 3 gallons per minute
Pressure drop at above flow.....	2 to 5 pounds per square inch
Temperature rise with lower rate of flow	
150 amperes per anode.....	6 centigrade
Net weight, approx.....	13.5 pounds
Shipping weight, approx.....	22 pounds

MAXIMUM RATINGS

Rectifier Service—For Power Supply-Frequency 25 to 60 Cycles, Phase Retard = 0

Maximum inverse and forward anode voltage.....	900 volts	2100 volts
Maximum anode current		
Instantaneous.....	900 amperes	600 amperes
Average continuous current.....	100 amperes	75 amperes
2-hour-average current over any 2-minute period.....	150 amperes	112.5 amperes
1-minute-average current over any 1-minute period.....	200 amperes	150 amperes
Surge current, maximum duration 0.15 second.....	6000 amperes	4500 amperes
Maximum outlet water temperature.....	60 centigrade	45 centigrade
Minimum inlet water temperature.....	6 centigrade	6 centigrade
Minimum water flow		
At continuous average anode current.....	1.5 gallons per minute	1.5 gallons per minute
At no load*.....	0.5 gallon per minute	0.5 gallon per minute

**For systems in which the flow of water is controlled by the load.*

Welder-Control Service—Ratings are for 2400 Volts Rms, Frequency 25 to 60 Cycles

Maximum demand.....	1200 kva
Corresponding average anode current.....	75 amperes
Maximum average anode current.....	113 amperes
Corresponding demand.....	600 kva
Maximum time of averaging anode current at 2400 volts, rms.....	1.50 seconds
Minimum water flow.....	1.5 gallons per minute
Maximum outlet water temperature.....	30 centigrade
Maximum surge current.....	3000 amperes
Maximum duration of surge current.....	0.15 second

Ignition Requirements (Ratings are the same for both Welder and Rectifier Service)

Ignitor voltage

Maximum instantaneous allowed, ignitor positive—same as anode voltage.....	
Maximum instantaneous allowed, ignitor negative.....	5 volts

Ignitor current

Maximum instantaneous allowed.....	100 amperes
Maximum average allowed.....	2.0 amperes
Time of averaging current.....	10 seconds
Maximum ignition time.....	100 microseconds

TECHNICAL INFORMATION (CONT'D)

Anode firing (See elementary circuit K-9033528)

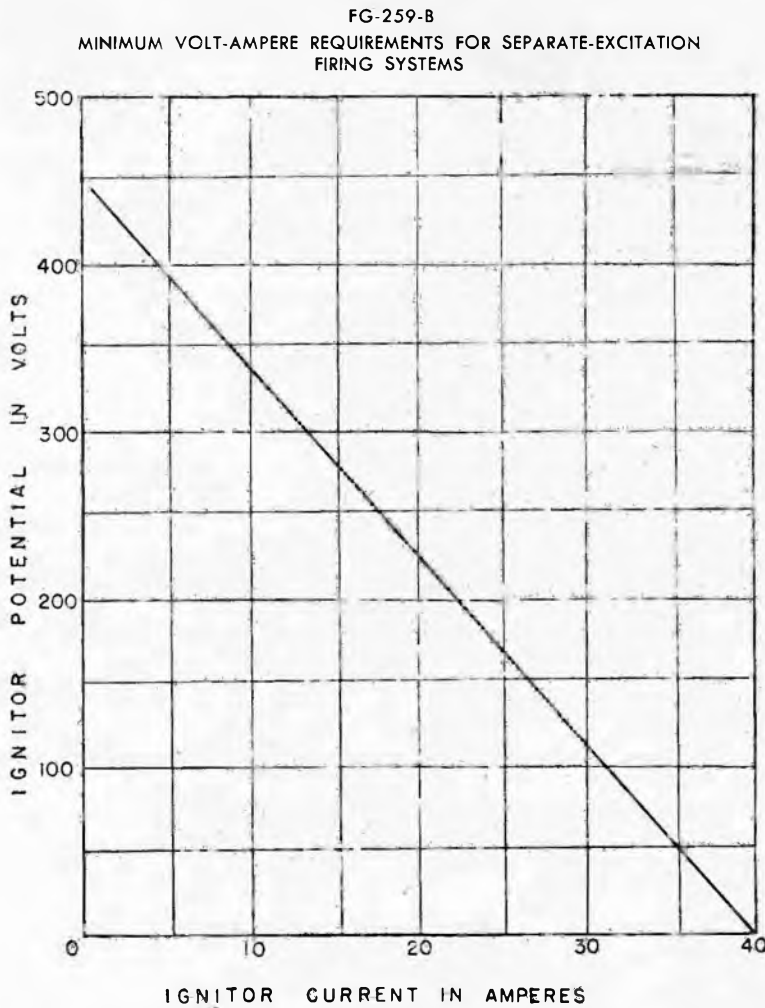
Maximum instantaneous ignitor potential required.....	150 volts
Maximum instantaneous ignitor current required.....	40 amperes
Typical resistance added to ignitor circuit for anode firing	
At anode voltage of 600 volts or less.....	4 ohms
At anode voltage of 601 volts to 1000 volts.....	10 ohms
At anode 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

Separate excitation (See elementary circuit K-9033525)

Minimum volt-ampere requirements for separate excitation
 Firing systems are shown on K-9033529

Auxiliary Anode Requirements (Ratings are the same for both Welder and Rectifier Service)

Maximum average current.....	5 amperes
Maximum inverse voltage	
With main anode conducting.....	25 volts
With main anode not conducting.....	150 volts



K-9033529

FIG. 2

11-15-44

FG-259-B
 ELEMENTARY CIRCUIT FOR CAPACITOR FIRING

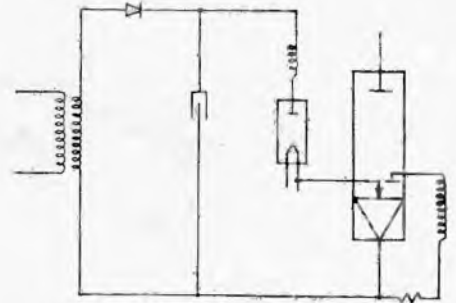


FIG. 1

K-9033525

11-15-44

FG-259-B
 ELEMENTARY CIRCUIT FOR ANODE FIRING

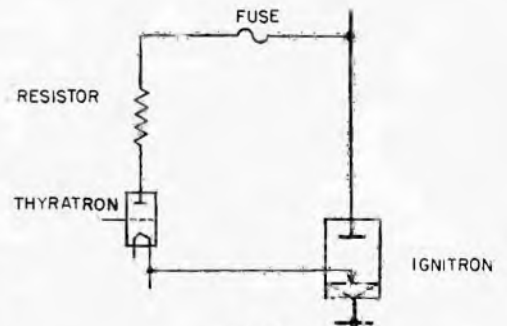
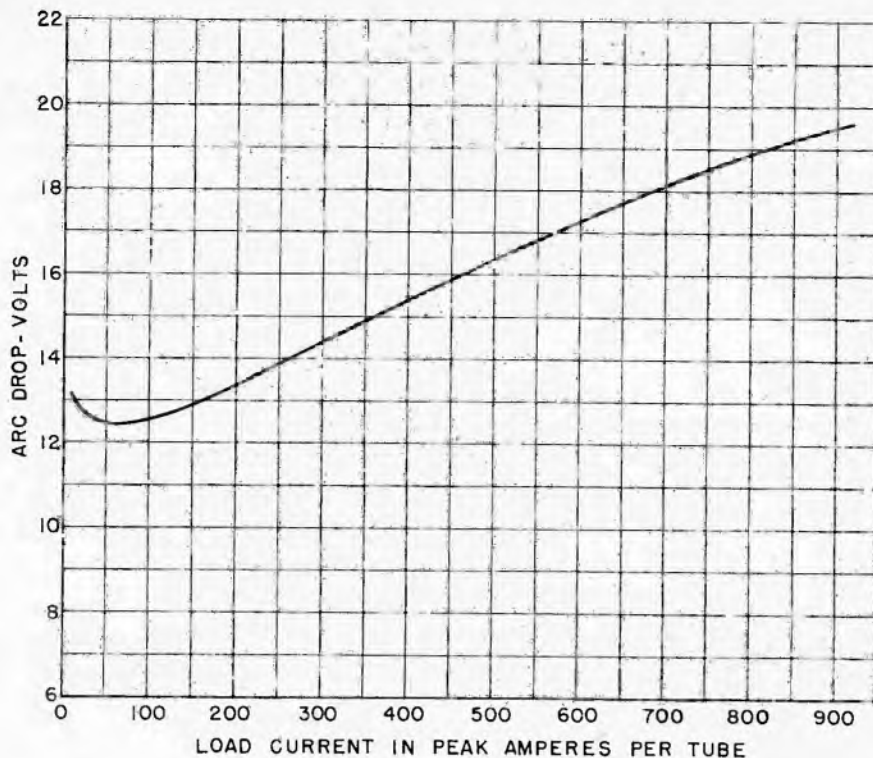


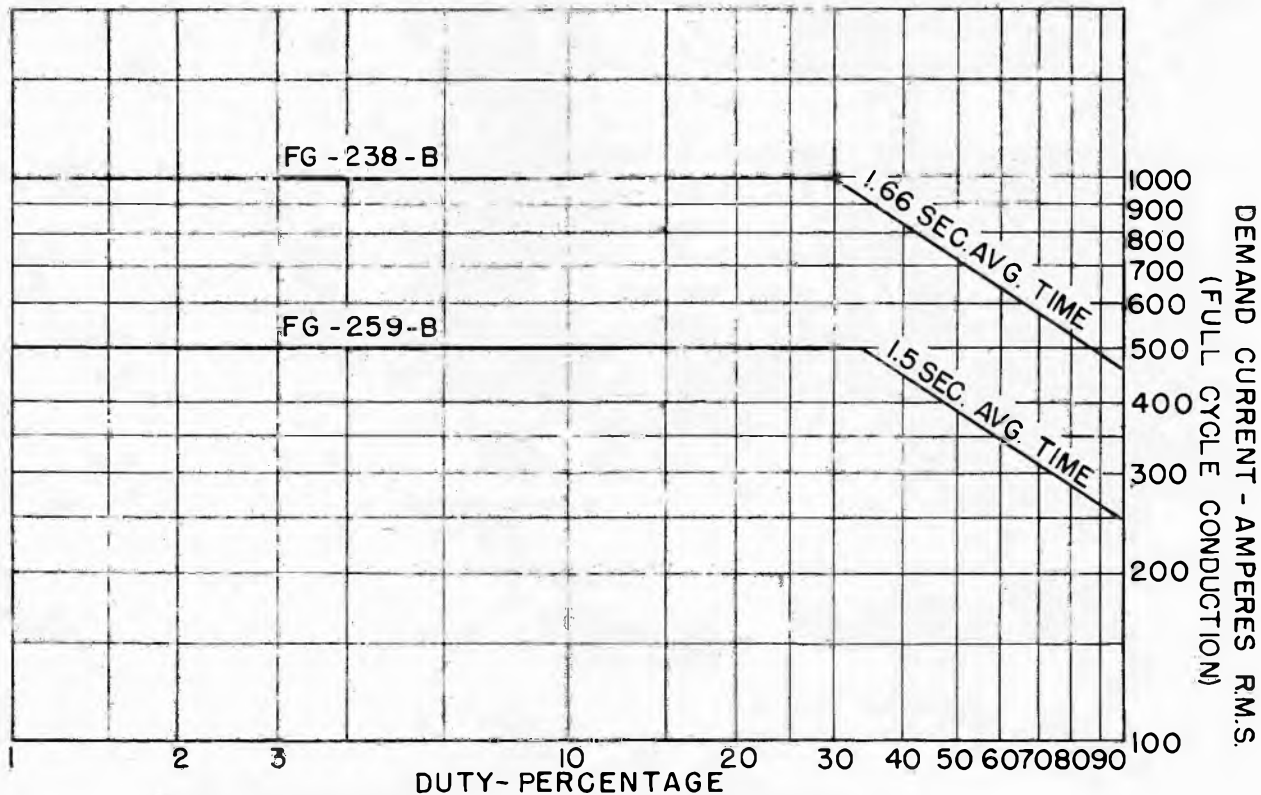
FIG. 3

K-9033528

12-16-44

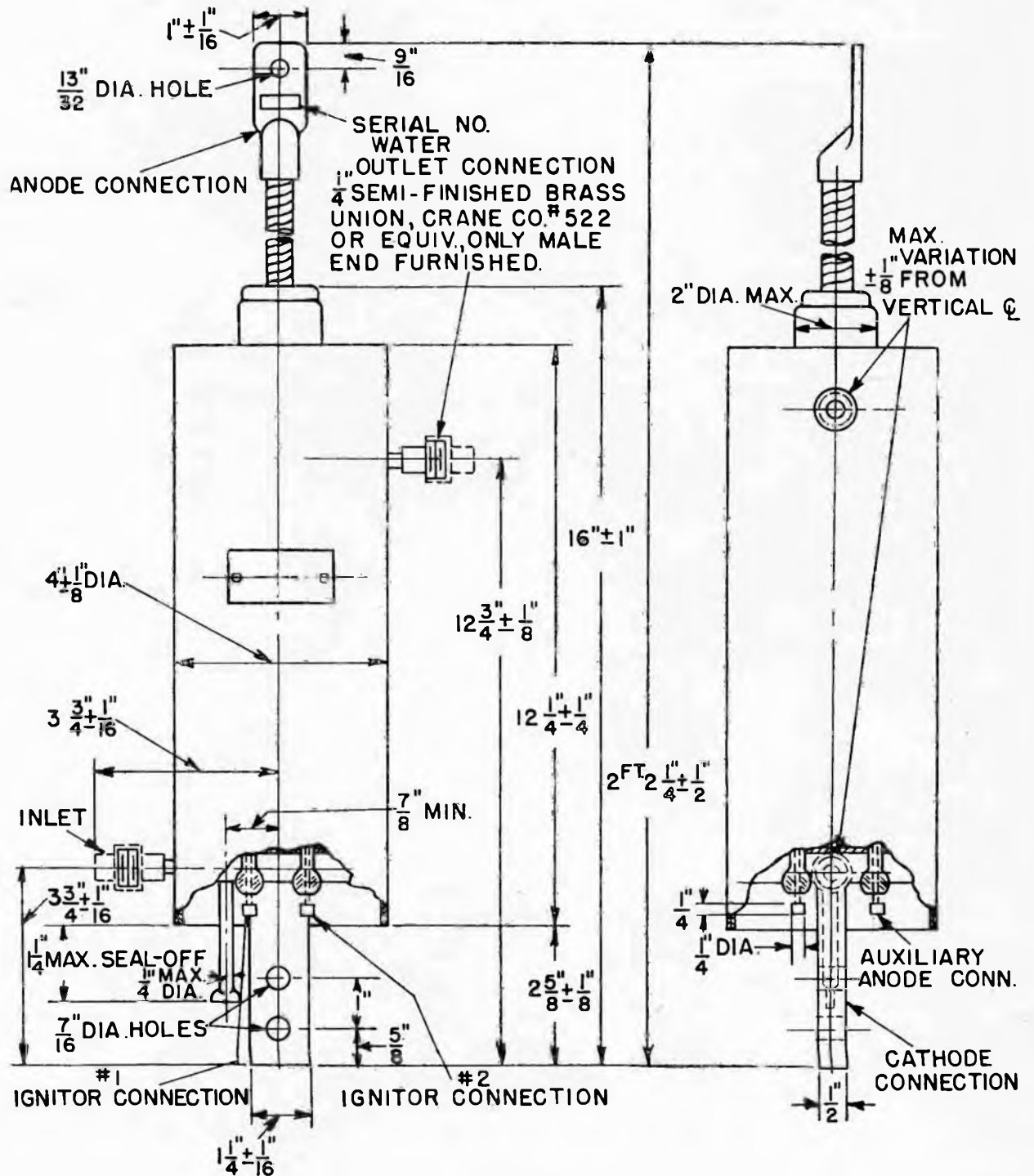


K-6917493 FG-259-B ARC DROP, OUTLET WATER TEMPERATURE—40 TO 60 C, WATER FLOW—1.5 GPM 7-1-44
FIG. 4



TWO TUBES CONNECTED IN INVERSE PARALLEL

FG-259-B IGNITRON; DEMAND CURRENT VS PERCENTAGE DUTY AT 2400 VOLTS RMS, MAX OUTLET WATER TEMP 30 C, MIN WATER RATE 1.5 GAL/MIN, WELDER CONTROL SERVICE



OUTLINE
 FG-259-B IGNITRON

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



IGNITRON

SPECIAL DESIGN FEATURES

1. Stainless-steel, seam-welded construction
2. Uniform water cooling
3. Strong, compact design
4. Easy to install
5. Copper terminals
6. Flexible anode lead
7. Mercury-pool cathode allows extremely high instantaneous currents to be passed through the tube without damage.

DESCRIPTION

The ability of this tube to carry very high peak currents for short periods makes it especially suited to welder-control service. It may also be used for conversion in low-power circuits and for intermittent rectifier service.

Ease of installation, economical use of space, and reliability of operation are assured by design features inherent in the steel-jacketed construction.

The GL-5551/FG-271 is similar to the GL-5552/FG-235-A and the GL-5553/FG-258-A. All of these tubes can be used for a wide range of ap-

plications where welds are made infrequently or in rapid succession.

The current range required for the welding operation determines which tube to use. Another factor, of course, is the nature of the material to be welded. Low-resistance materials, such as aluminum alloys, require more current than such high-resistance metals as stainless steel.

The GL-5551/FG-271 ignitron is equivalent to a 300-ampere magnetic contactor.

GENERAL  ELECTRIC

Supersedes ETI-113 dated 4-45


Electronic
TUBE

◆ TECHNICAL INFORMATION

These data are for reference only. For design information, refer to specifications.

GENERAL

Electrical Data

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 Data

Envelope material	metal
Over-all length, maximum	23 $\frac{3}{4}$ inches
Over-all width exclusive of water connections	2 $\frac{3}{4}$ inches
Net weight	3.6 pounds
Type of cooling	water
Characteristics for water cooling at rated minimum flow	
Water temperature rise, maximum	4 C
Pressure drop	1.8 pounds per square inch

Thermal

Water Cooling	
Maximum outlet water temperature	40 C
Minimum inlet water temperature	10 C
Minimum water flow	1.0 gallons per minute

MAXIMUM RATINGS

As Power Rectifier Tube

Maximum peak anode voltage	
Inverse	500 volts
Forward	500 volts
Maximum anode current	
Peak	700 amperes
Average	40 amperes
Maximum averaging time	6 seconds
Maximum anode current	
Surge	8000 amperes
Maximum duration of surge current	0.15 second
Frequency range*	25-60 cycles per second

*Ratings are for zero phase-control angle—see curve for details.

As A-c Control Tube

Two Tubes in Inverse Parallel	
Voltage range	250 to 600 rms volts
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 surge current at 250 volts	6720 amperes
Maximum peak surge current at 600 volts	2800 amperes

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS

Ignitor

Maximum Voltage

Positive.....	900 volts
Negative.....	5 volts

Maximum Current

Peak.....	100 amperes
RMS.....	10 amperes
Average.....	1 ampere
Maximum averaging time.....	5 seconds

Note 1—RMS demand voltage, current, and kilovolt-ampere are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used.

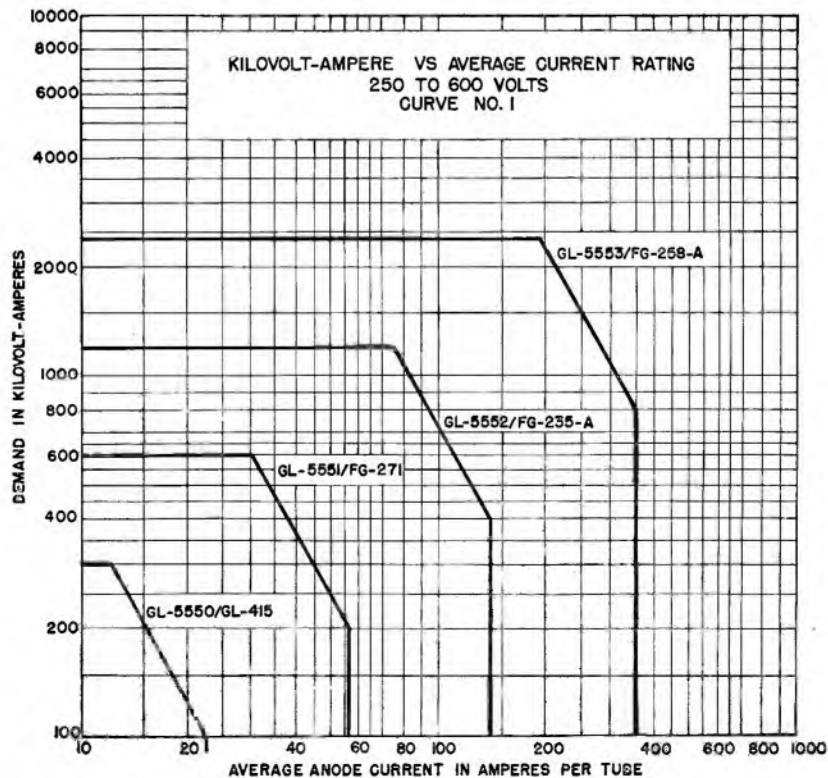
Note 2—For voltages below the minimum, the minimum-voltage current rating applies.

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 kilovolt-ampere vs average anode current.
2. Maximum averaging time vs anode voltage.

◆ Completely revised.

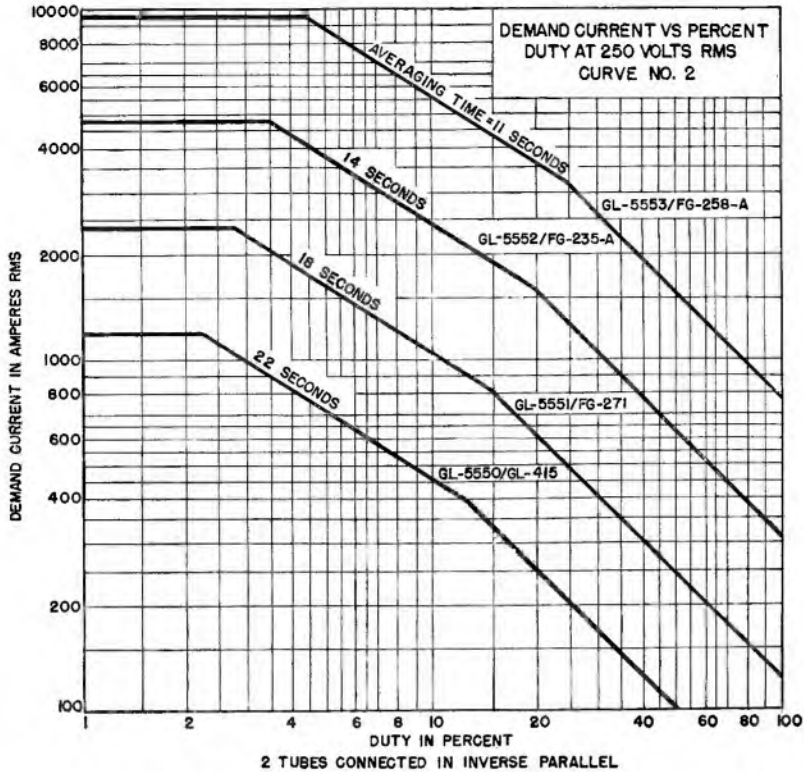
CURVES K-69087-72A217, K-69087-72A218 AND K-69087-72A219
MUST NOT BE USED FOR INTERMITTENT RECTIFIER SERVICE



K-69087-72A217 (New drawing)

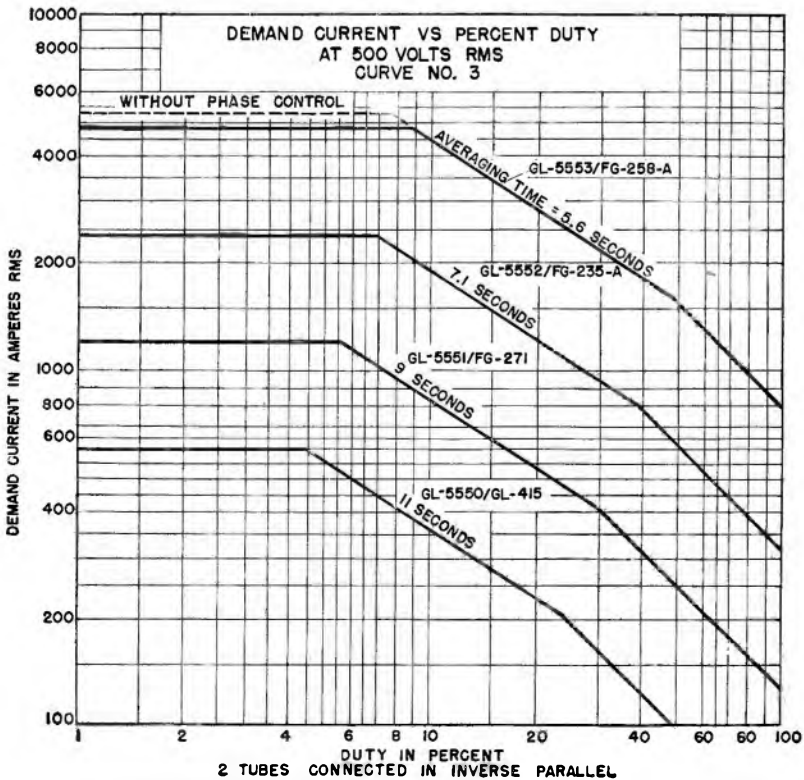
3-31-43

Note: For capacitor-corrected welder service, this curve may be used to 2000 volts rms to allow for the additional voltage caused by the presence of the capacitor.



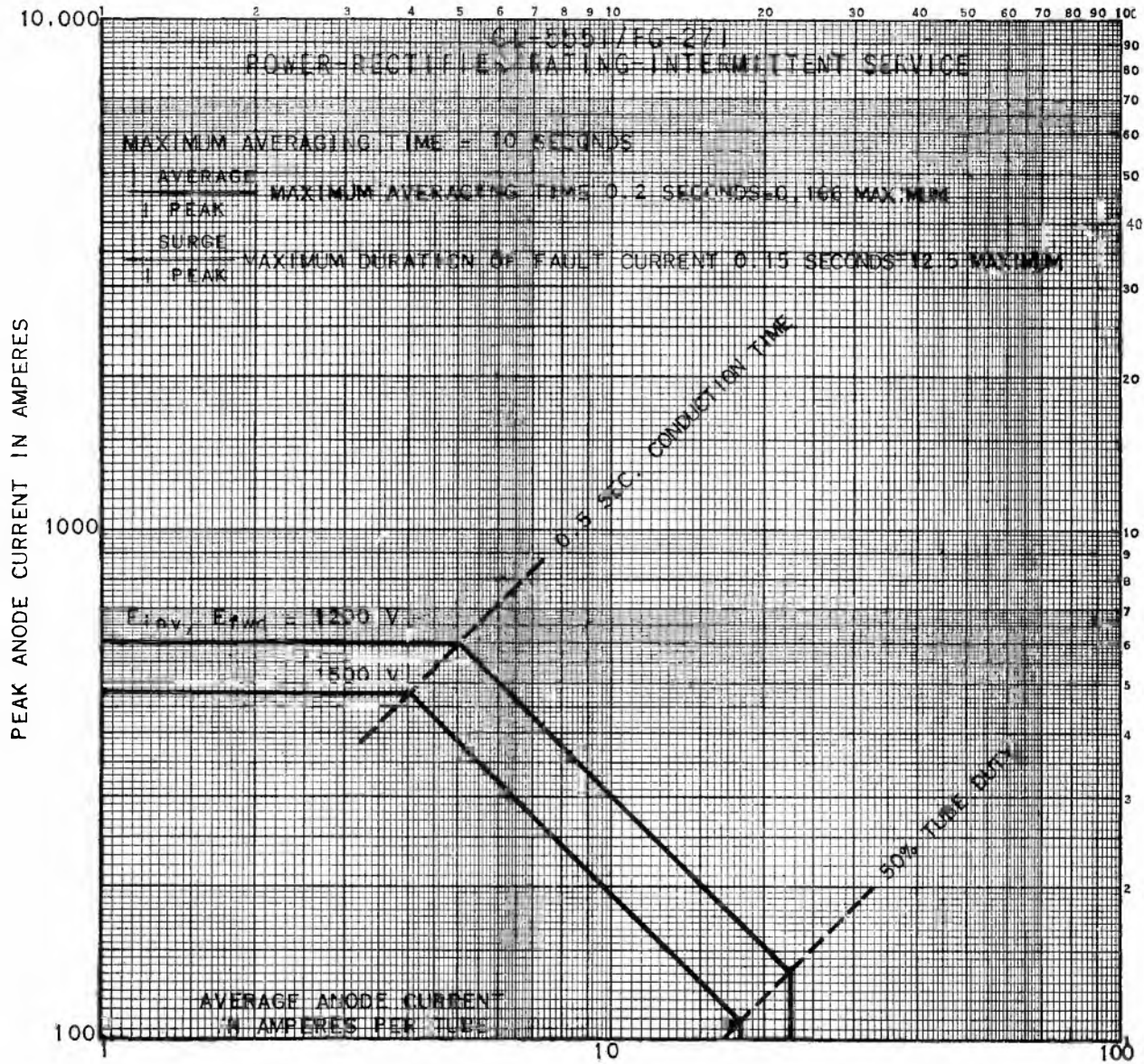
K-69087-72A218 (New drawing)

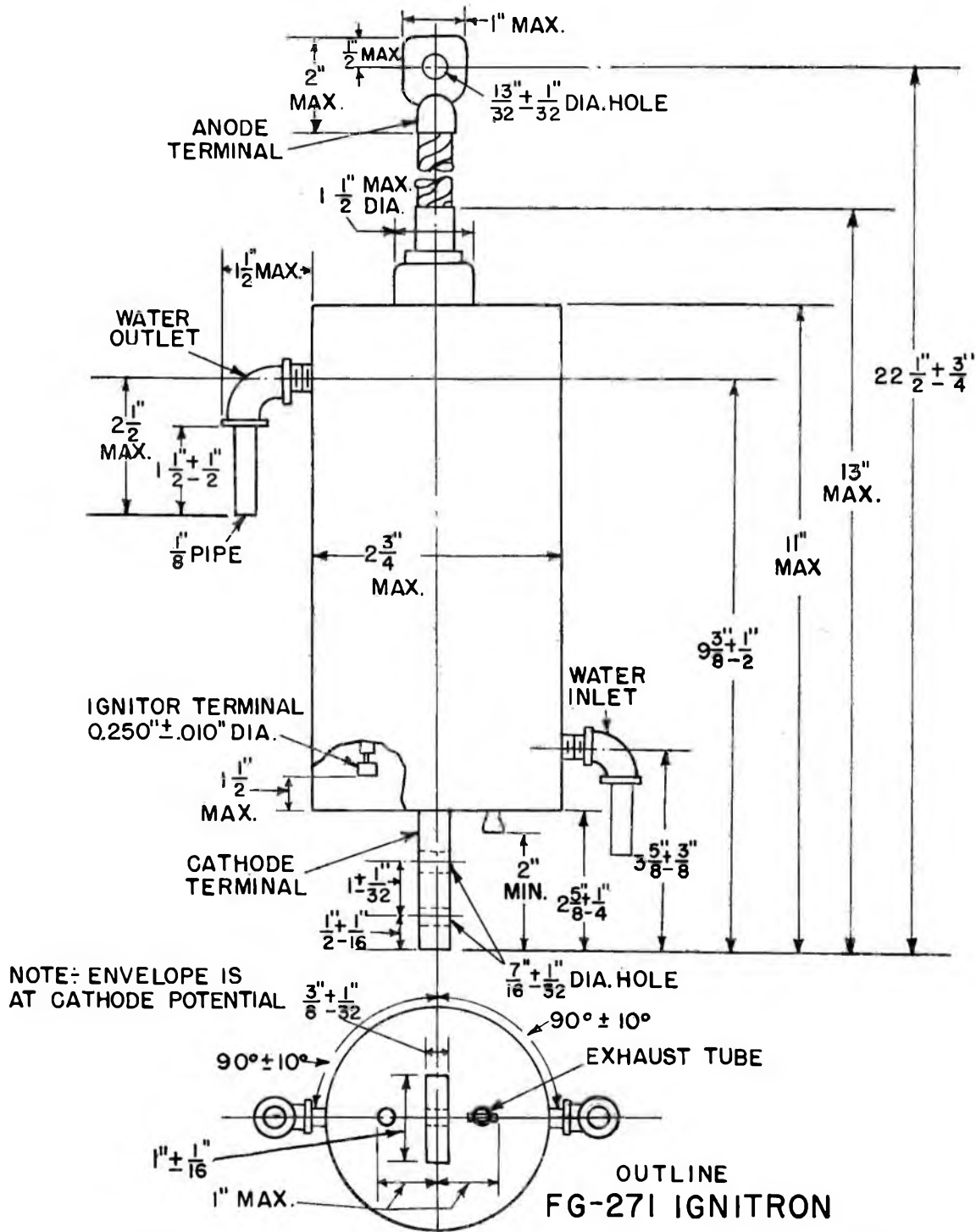
3-31-48



K-69087-72A219 (New drawing)

3-31-48





K-5344676

10-5-44

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



IGNITRON

SPECIAL DESIGN FEATURES

1. Steel, seam-welded construction
2. Uniform water cooling
3. Compact and strong design
4. Easy to install
5. Copper terminals
6. Flexible anode lead
7. Mercury-pool cathode allows extremely high instantaneous currents to be passed through the tube without damage.

DESCRIPTION

The GL-5550/GL-415 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.

GENERAL  ELECTRIC


Electronic
TUBE

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications

GENERAL

Electrical Data

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
(See curve for details)	
Starting time at required voltage or current	100 microseconds

Mechanical Data

Envelope material—Metal	
Over-all length	17 ⁵ / ₈ inches
Over-all width	2 ³ / ₄ inches
Net weight	1.5 pounds
Type of cooling—Removable clamp	
Clamp contact width	1 ⁷ / ₈ ± ¹ / ₈ inches
Clamp contact area	9.4 square inches

MAXIMUM RATINGS

As A-c Control Tube

Two tubes in inverse parallel	
Voltage range	250 to 600 RMS volts
Maximum clamp temperature	75 50 C
Minimum clamp temperature	10 10 C
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

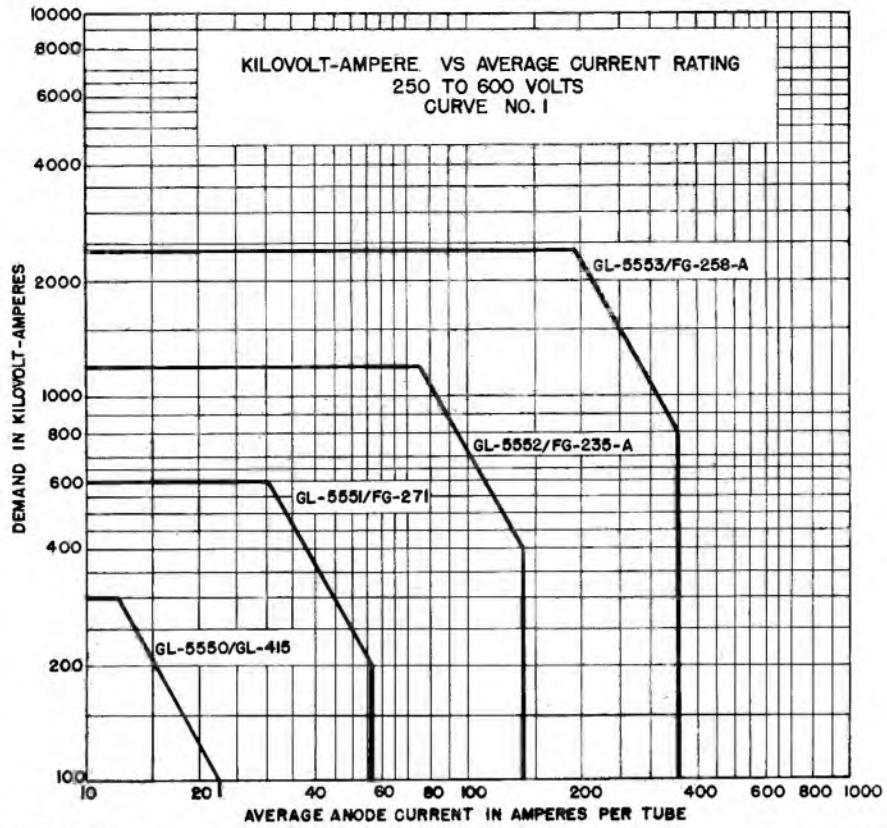
Maximum number of discharges per second	60	60
Maximum peak forward anode voltage	3000	6000 volts
Maximum peak inverse anode voltage	3000	3000 volts
Maximum peak anode current	500	500 amperes
Maximum temperature of cooling clamp	70 40 60	40 C
Corresponding maximum average anode current	3 15 2.5	8 amperes
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

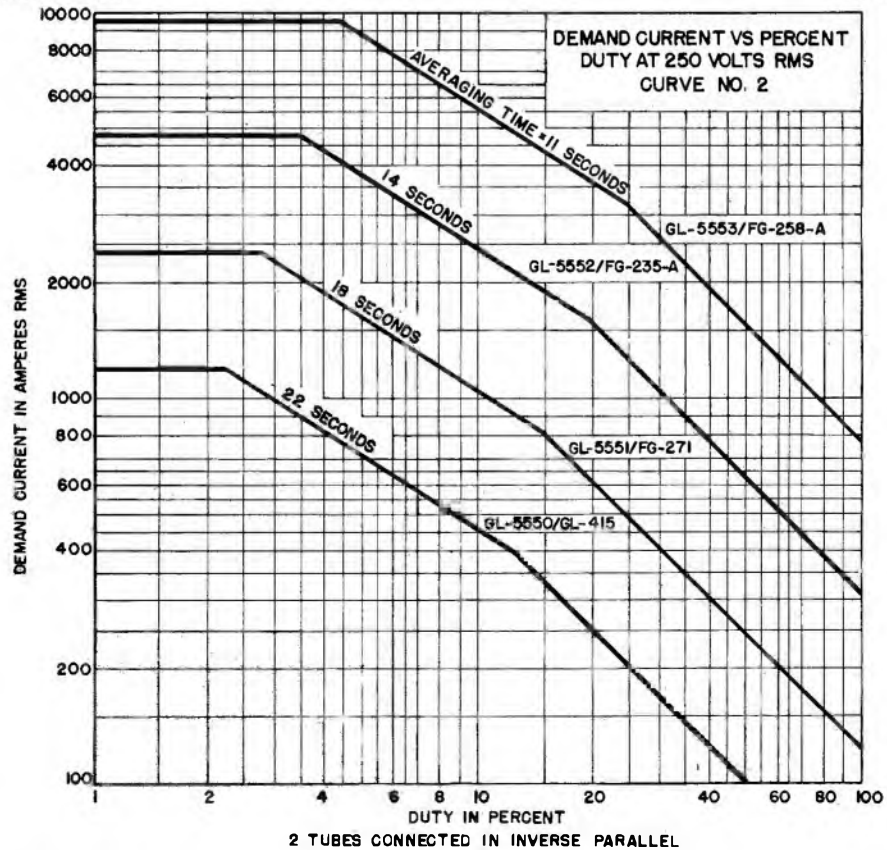
Maximum voltage	
Positive	900 volts
Negative	5 volts
Maximum current	
Peak	100 amperes
Root mean square	10 amperes
Average	1 ampere
Maximum averaging time	5 seconds

◆ Technical Information completely revised.



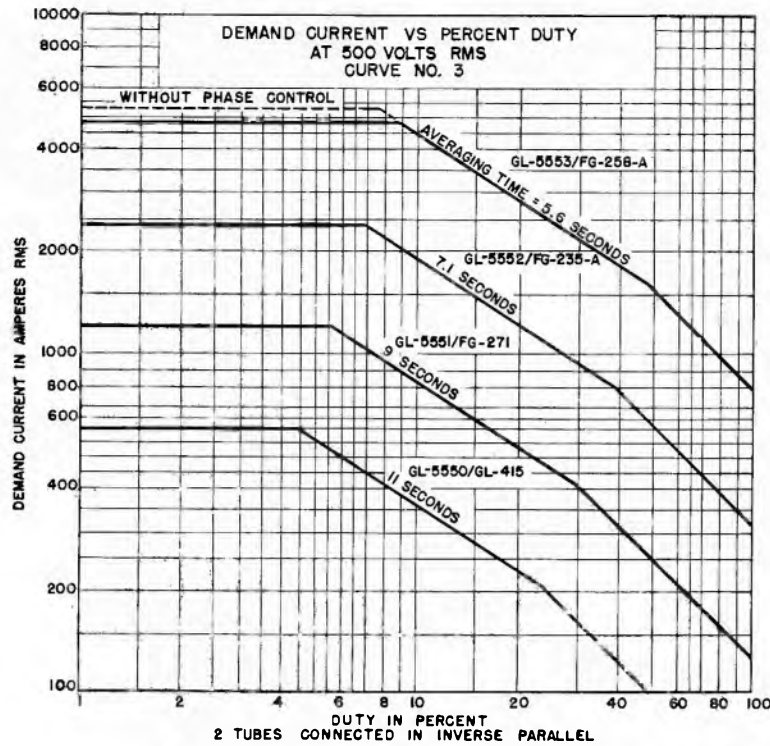
K-69087-72A217

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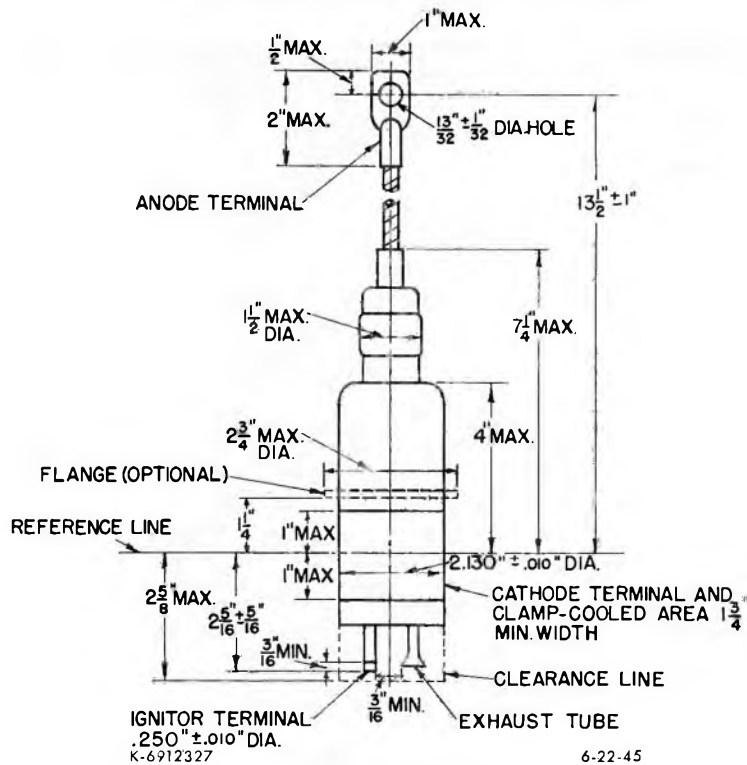
3-31-48



K-69087-72A219

8-25-44

■ OUTLINE GL-5550/GL-415 IGNITRON



6-22-45

■ Outline drawing revised

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



PENTODE-IGNITRON

SPECIAL DESIGN FEATURES

1. Stainless-steel, seam-welded construction
2. Uniform water cooling
3. Strong, compact design
4. Easy to install
5. Copper terminals
6. Flexible anode lead
7. Mercury-pool cathode allows extremely high instantaneous currents to be passed through the tube without damage.

DESCRIPTION

The GL-506 is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube designed primarily for use in electronic frequency changers. In this

service 6 tubes will rectify or invert up to 7500 kilowatts at 17,500 volts.

GENERAL  ELECTRIC

Supersedes ETI-293 dated 12-48


Electronic
TUBE

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Cathode excitation—cyclic	
Cathode spot starting—ignitor	
Number of electrodes	
Main anodes	1
Main cathodes	1
Auxiliary anodes	2
Ignitors	3
Control grids	2
Auxiliary grids	1
Arc drop at 450 peak amperes	23 ± 2 volts
(See arc-drop curve for details)	
Cathode excitation requirements	
Ignitor voltage required to fire	450 volts
Ignitor current required to fire	45 amperes
(See curve for details)	
Grid requirements	
Positive current to establish conduction	1.00 ampere
Minimum voltage to establish conduction	+100 volts
Minimum voltage to prevent conduction	-50 volts
(See curves for grid characteristics)	

Mechanical

Envelope material—metal	
Over-all length	57 ± 2 inches
Over-all width	12½ ± 1 inch
Net weight	100 ± 5 pounds
Type of cooling—water	
Characteristics for water cooling	
Water temperature rise, maximum	4 C
Pressure drop at 5 gallons per minute, maximum	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	5 gallons per minute
Minimum water flow at no load	5 gallons per minute

MAXIMUM RATINGS

AS POWER RECTIFIER TUBE

Maximum peak anode voltage	
Inverse	20,000 volts
Forward	20,000 volts
Maximum anode current	
Peak	900 amperes
Average	
Continuous	150 amperes
2 hours	200 amperes
1 minute	300 amperes
Surge	5000 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 seconds
Starting time at required voltage or current	100 microseconds

TECHNICAL INFORMATION (CONT'D)

AUXILIARY-ANODE

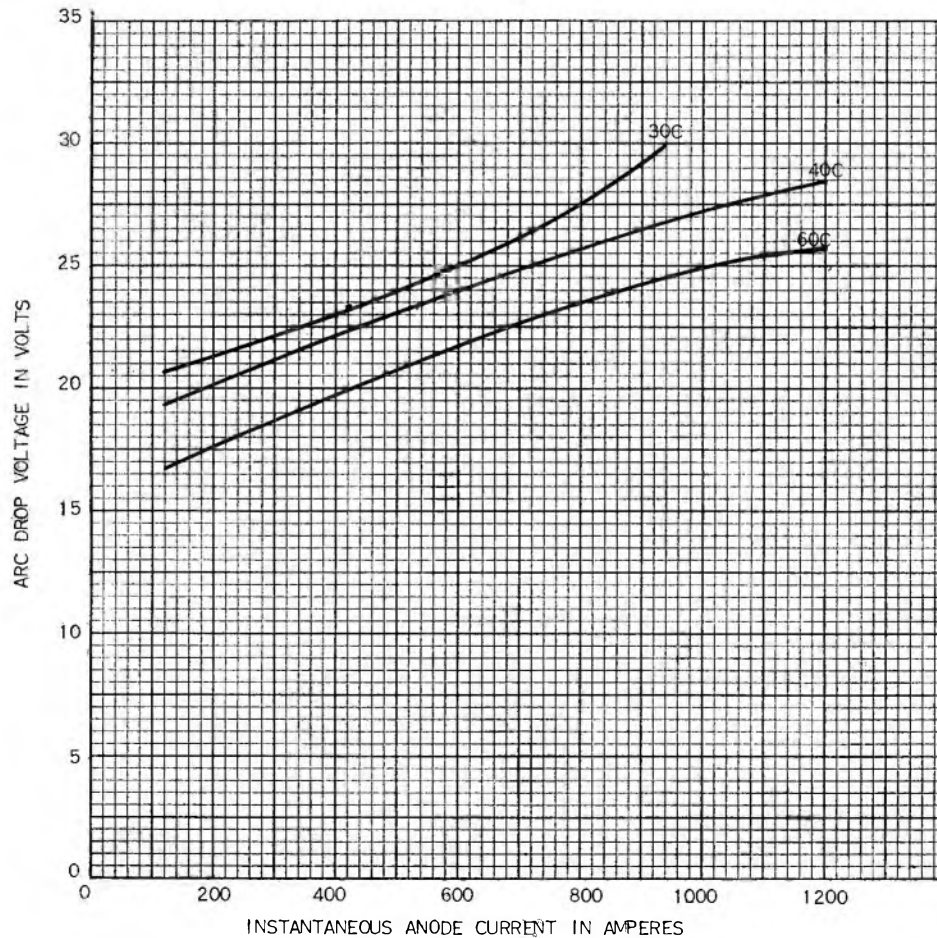
Maximum current	
Peak	20 amperes
Average	5 amperes
Maximum averaging time	1 second
RMS	10 amperes
Maximum peak forward voltage	200 volts
Maximum peak inverse voltage	
Main anode conducting	25 volts
Main anode not conducting	150 volts

GRID

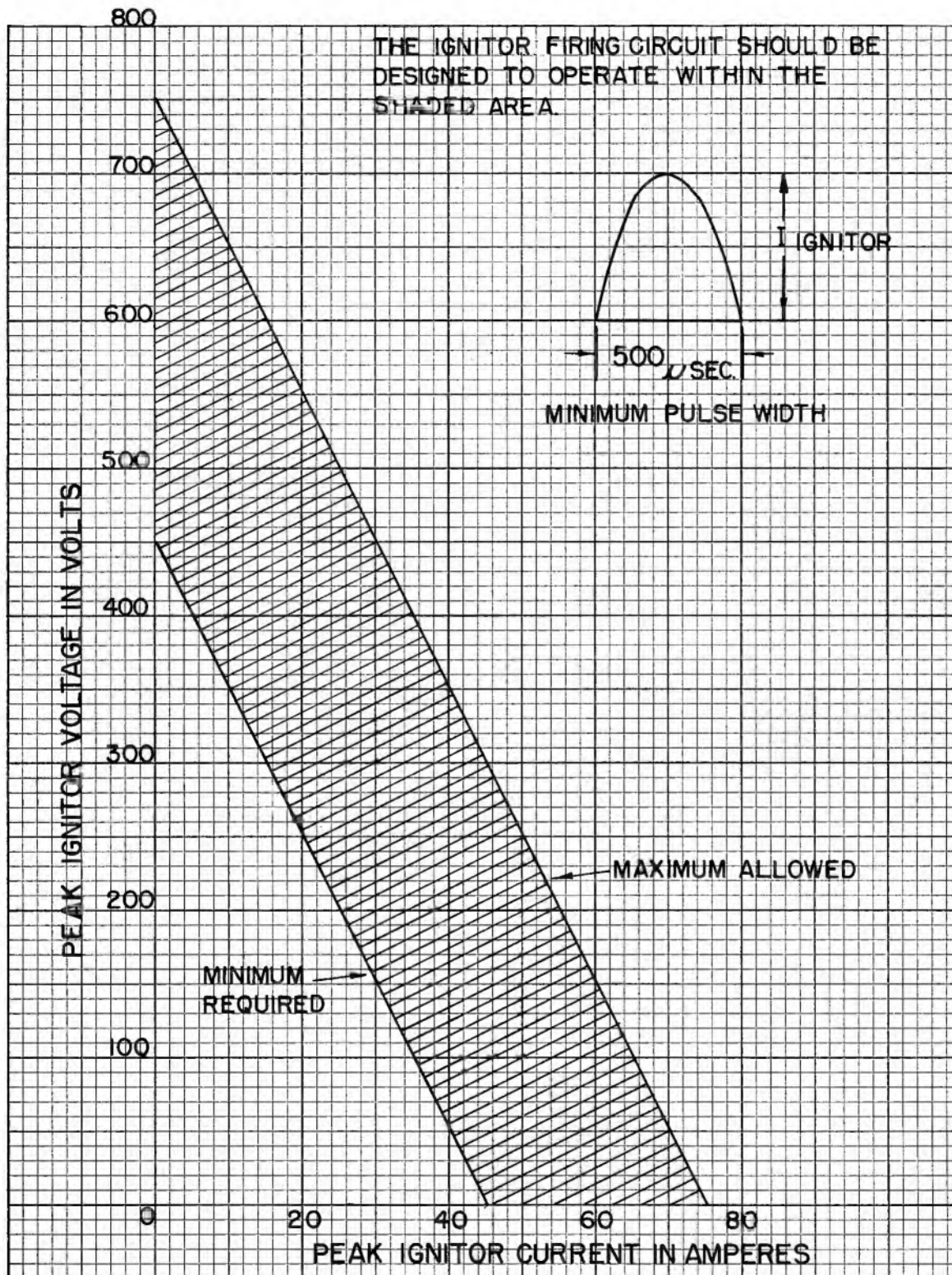
Maximum peak forward voltage	500 volts
Maximum peak inverse voltage	200 volts
Maximum grid-current	
Peak positive	5 amperes
Peak negative	0.1 ampere
Average	1.0 ampere
RMS	2.0 amperes

* Ratings are for zero phase-control angle

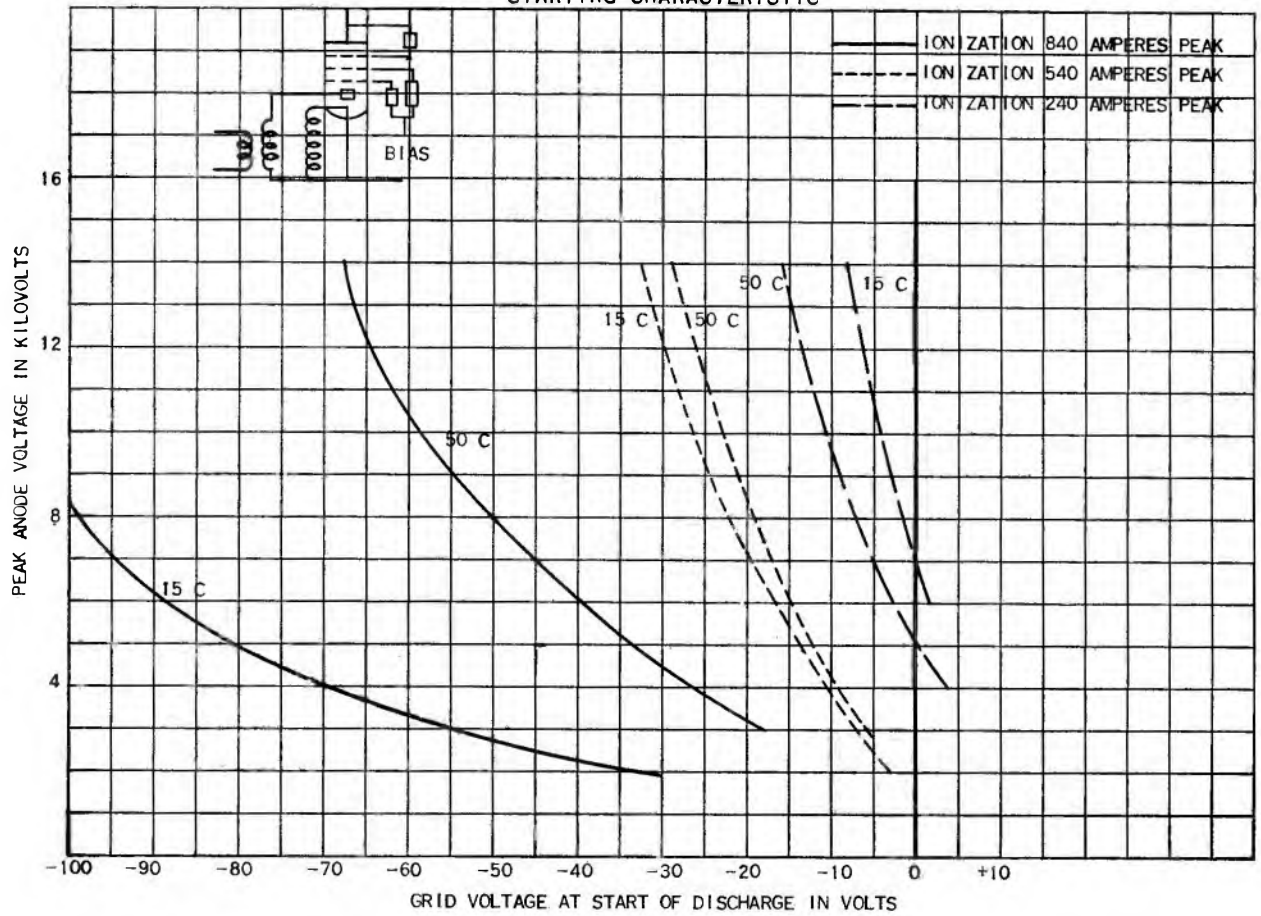
◆ GL-506
 ARC DROP CHARACTERISTIC
 FOR COOLING WATER TEMPERATURES
 OF
 30-60 C



IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS



GL-506
STARTING CHARACTERISTIC

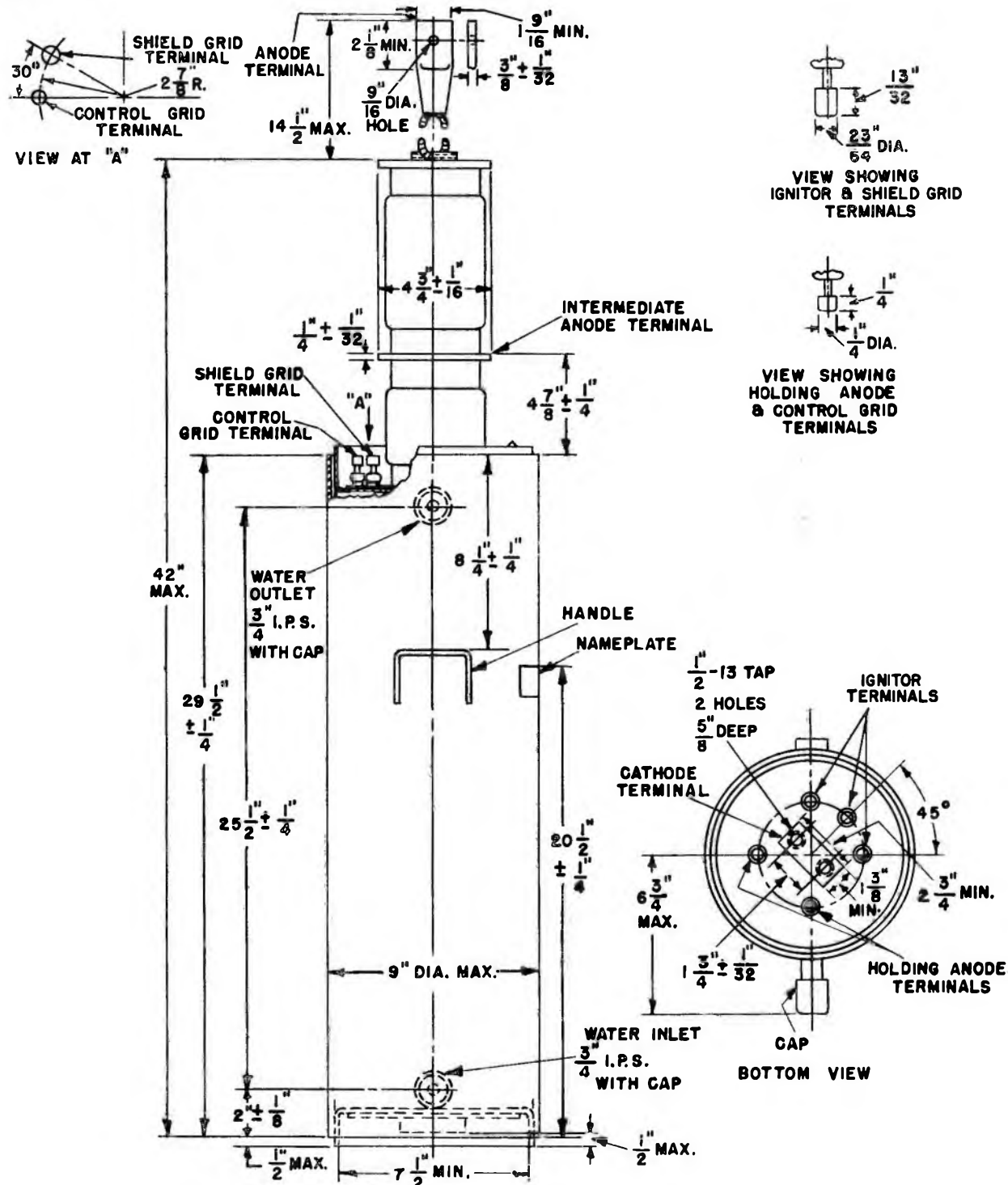


GL-506

ETI-293A

PAGE 6

10-50



OUTLINE
GL-506 IGNITRON

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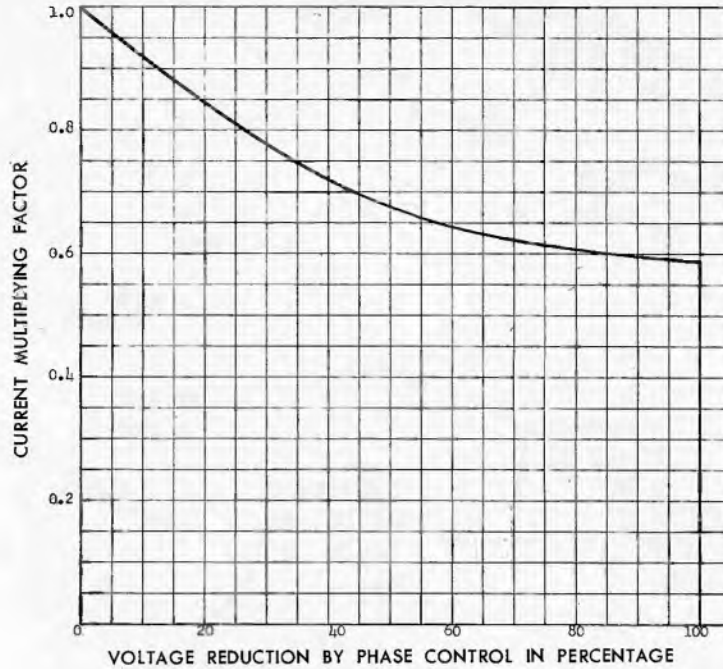
9-29-47

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.

10-50 (11M)

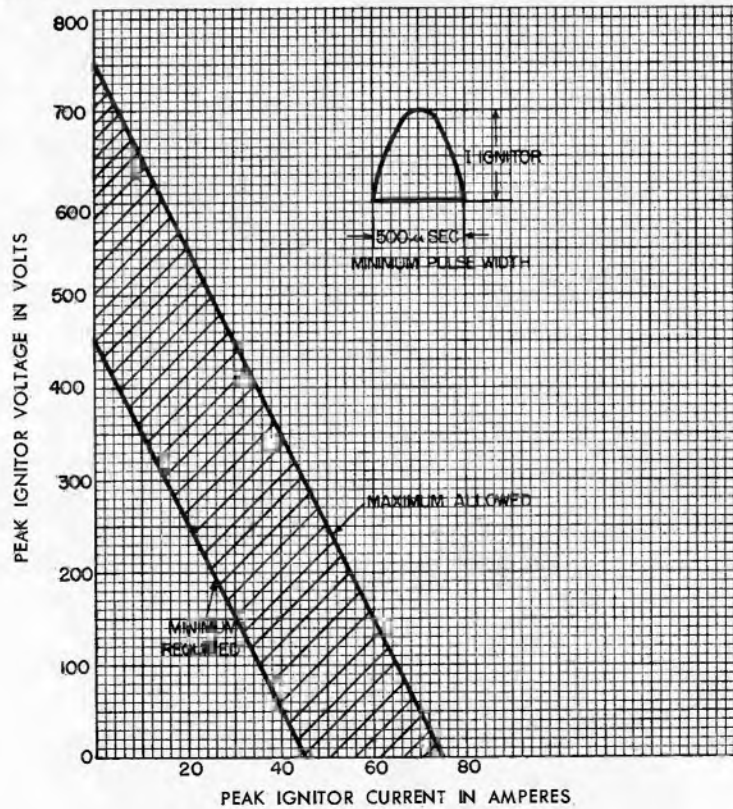


K-69087-72A513

9-10-52

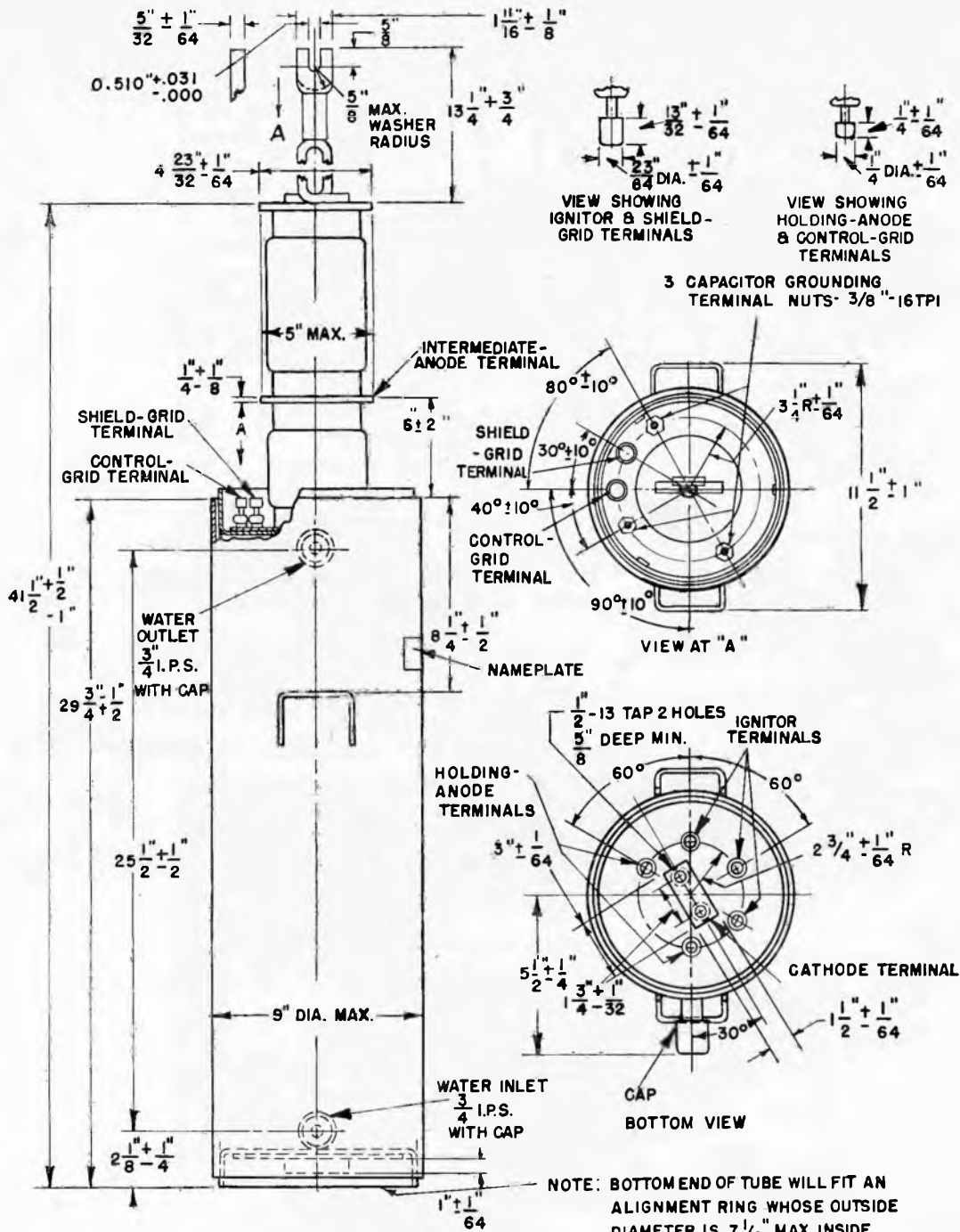
IGNITOR VOLT-AMPERE REQUIREMENTS FOR SEPARATE EXCITATION SEALED-IGNITRON RECTIFIERS

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



K-69087-72A741

12-9-55



N-22002AZ-Outline revised.

6-25-58

ELECTRONIC COMPONENTS DIVISION
GENERAL ELECTRIC
 Schenectady 5, N. Y.

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 IN
 U.S.A.



IGNITRON

SPECIAL DESIGN FEATURES

1. Stainless-steel, seam-welded construction
2. Uniform water cooling
3. Strong, compact design
4. Easy to install
5. Copper terminals
6. Flexible anode lead
7. Mercury-pool cathode allows extremely high instantaneous currents to be passed through the tube without damage.

DESCRIPTION

The GL-5630 ignitron is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube designed primarily for use in radio-transmitter power sup-

plies. 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.

GENERAL  ELECTRIC

Supersedes ETI-294 dated 12-48


Electronic
TUBE

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Type cathode excitation—cyclic

Type cathode spot starting—ignitor

Number of electrodes

Main anodes 1

Main cathodes 1

Auxiliary anodes 1

Ignitors 2

Control grids 1

Auxiliary 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 33 $\frac{1}{2}$ ± 1 $\frac{1}{2}$ inches

Over-all width, maximum 9 ± 1 $\frac{1}{2}$ inches

Net weight 23 ± 2 pounds

Type cooling—water

Characteristics for water cooling

Water temperature rise 2 C maximum

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*

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 second

Frequency range 25-60 cycles per second

* Ratings are for zero phase-control angle.

TECHNICAL INFORMATION (CONT'D)

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

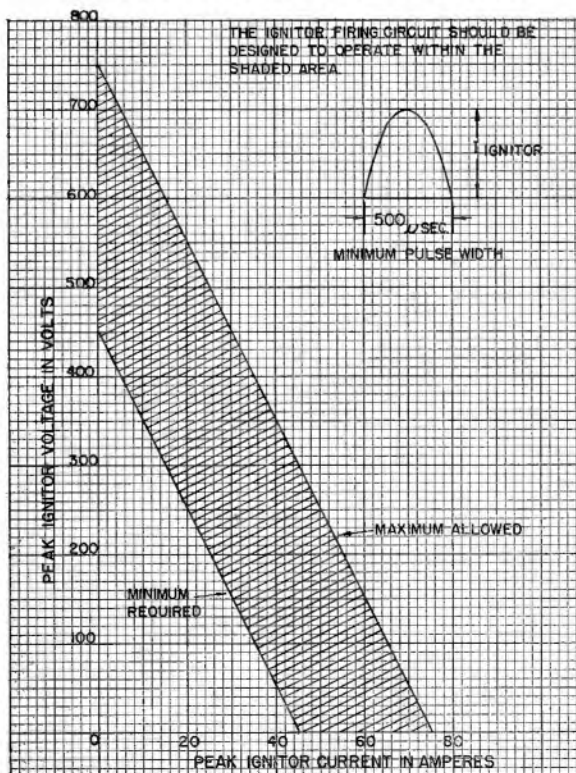
AUXILIARY ANODE

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

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 ampere
Average.....	1.0 ampere
RMS.....	2.0 amperes

IGNITOR VOLT-AMPERE REQUIREMENTS



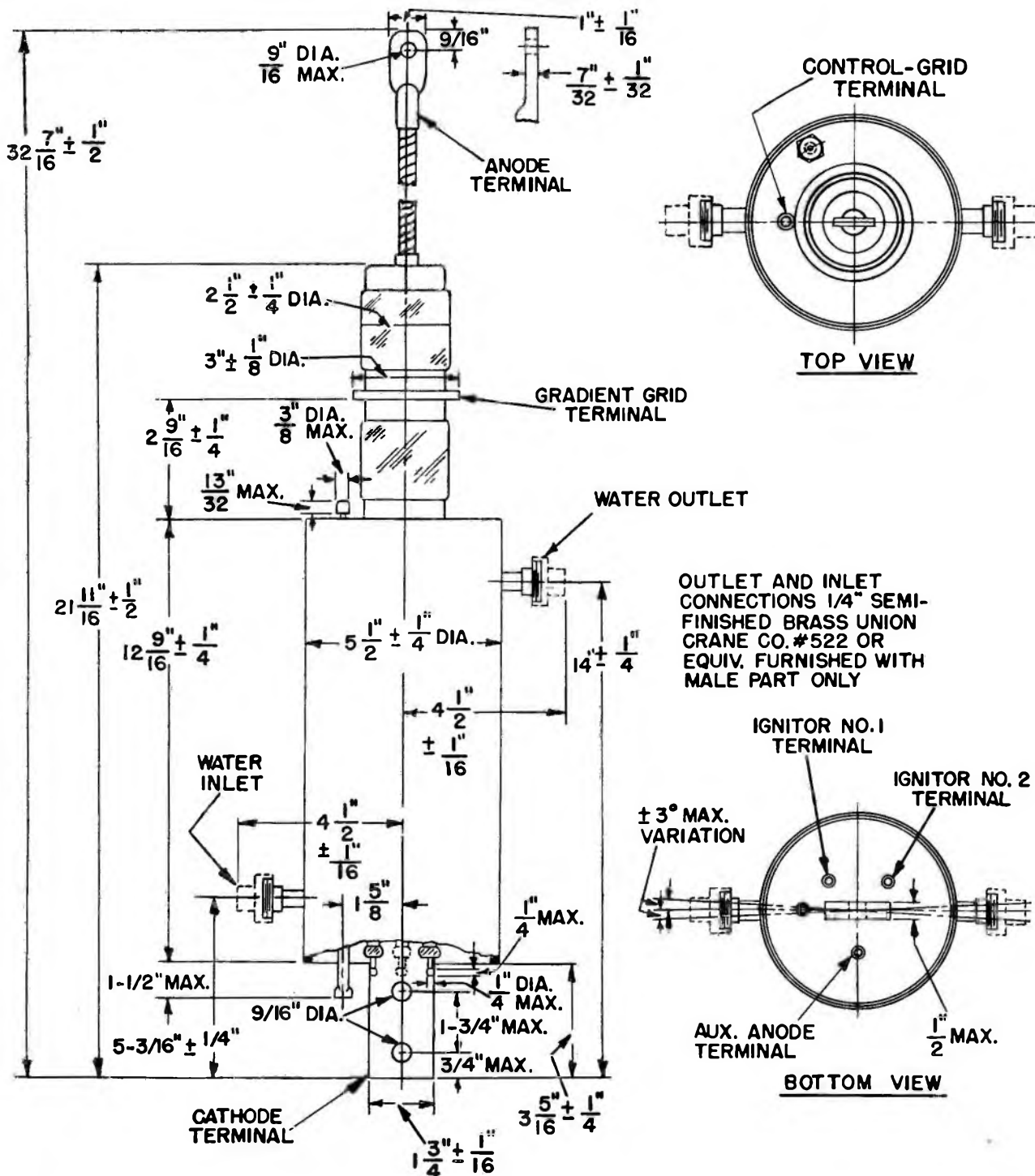
GL-5630

ETI-294A

PAGE 4

5-51

OUTLINE GL-5630 IGNITRON



N-22003AZ

3-26-51

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



IGNITRON

DESCRIPTION

The GL-5779 is a small glass, air-cooled ignitron tube designed primarily for demonstrating the operating principles of ignitors and ignitron tubes.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

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	450 volts
Ignitor current required to fire	45 amperes
(See curve for details)	



TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Envelope material—Glass	
Over-all length	8 $\frac{3}{16}$ inches
Over-all width	2 $\frac{1}{2}$ inches
Net weight	1 $\frac{1}{2}$ pounds
Type of cooling—Air*	

* An ordinary desk fan will provide sufficient cooling for most purposes.

Thermal

Air cooling	
Maximum average tube temperature	100 C
Minimum average tube temperature	10 C

MAXIMUM RATINGS**As Power Rectifier Tube**

Maximum peak anode voltage	
Inverse	350 volts
Forward	350 volts
Maximum anode current	
Peak	30 amperes
Average	
Continuous	10 amperes
Surge	300 amperes
Maximum duration of surge current	.03 second
Frequency range**	25-60 cycles per second

**Ratings are for zero phase-control angle.

Ignitor

Maximum voltage	
Positive	Anode volts
Negative	5 volts
Maximum current	
Peak	100 amperes
RMS	15 amperes
Average	2 amperes
Maximum averaging time	10 seconds
Starting time at required voltage or current	100 microseconds

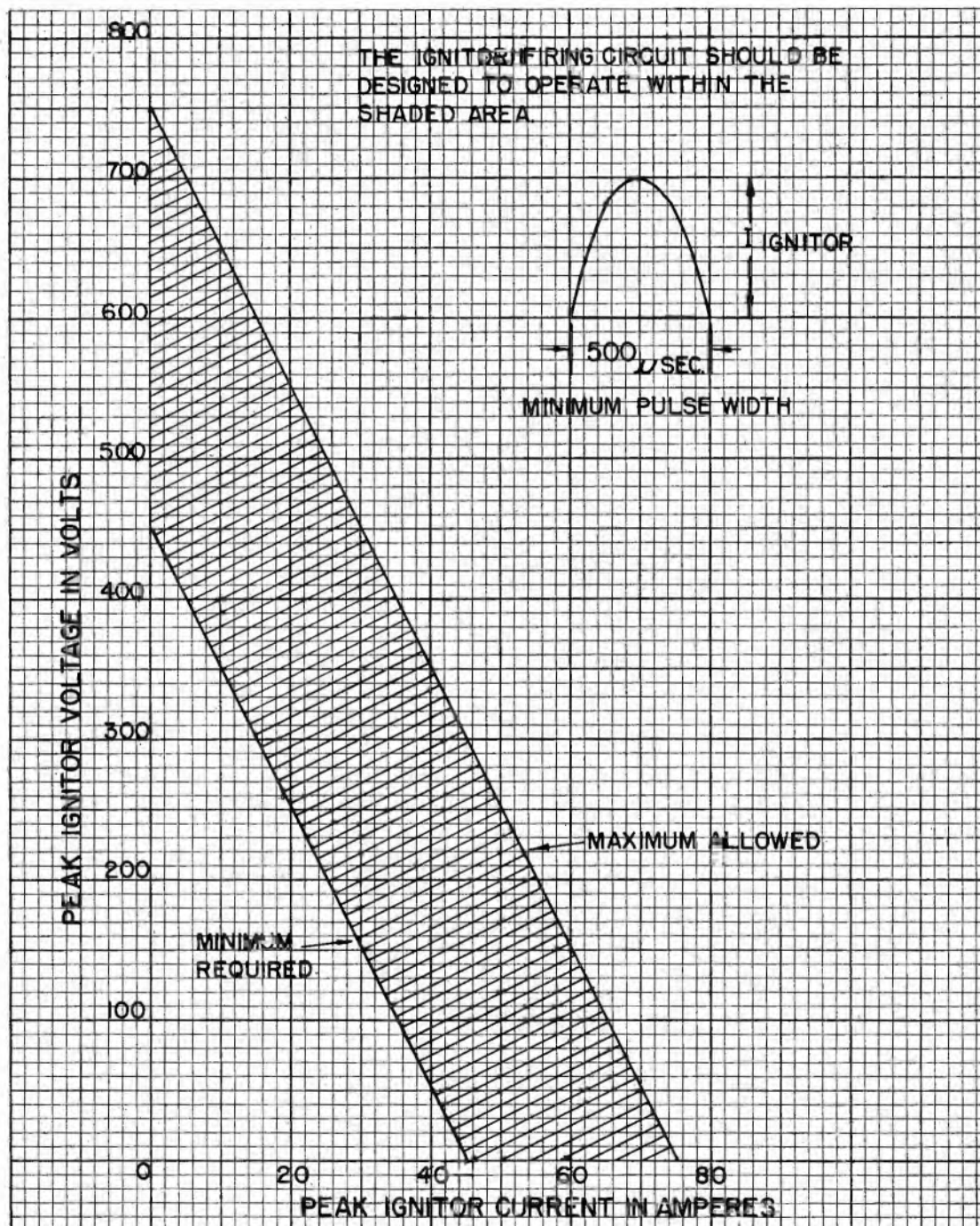
Auxiliary Anode

Maximum current	
Peak	20 amperes
Average	5 amperes
Maximum averaging time	1.0 second
RMS	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
-------------------------	------------

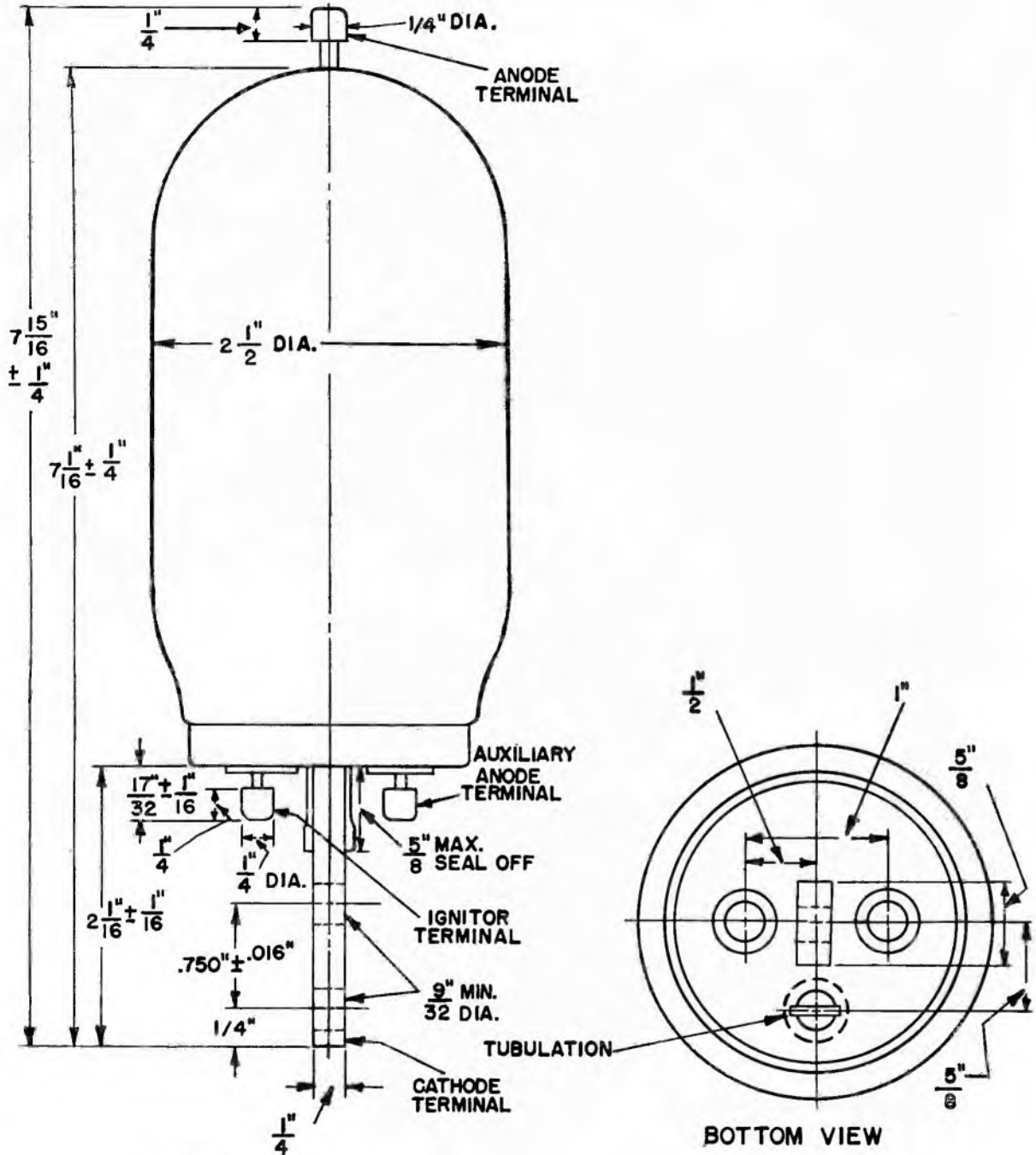
GL-5779 IGNITRON
IGNITOR VOLT-AMPERE REQUIREMENTS
SEALED-IGNITRON RECTIFIERS



GL-5779

ETI-301
PAGE 4
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OUTLINE
GL-5779 IGNITRON



N-22012AZ

9-22-48

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



IGNITRON

RECTIFIER SERVICE—200 AMPERES
AC CONTROL SERVICE—2400 KILOVOLT-AMPERES

AUXILIARY 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, the operation of six tube cooling jackets in series on normal water-supply line pressures, and assure the user against premature ignitor failures caused by connecting the auxiliary 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 200 amperes per tube in rectifiers rated up to 400 volts d-c.

GENERAL  ELECTRIC

Supersedes pages 1, thru 4, 7 and 8, dated 1-55

TECHNICAL INFORMATION

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
(See Curve K-6917495 on page four for details)	
Peak Excitation Arc Current Required, minimum	8 Amperes
(See curve K-69087-72A438 on page seven for details)	
Excitation Arc-Drop Voltage	9 ± 0.5 Volts
Excitation Arc-Open-Circuit Voltage, minimum	55 Volts AC

Mechanical

Envelope Material—Stainless Steel	
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	60 C
Peak Inverse Anode Voltage = 2100 Volts	55 C
AC Control Service	
Voltage = 2400 Volts RMS	45 C
Water Flow, minimum, solenoid water valve open	
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	3 Pounds per Square Inch

* Dependent upon load conditions. For substantially constant load 6C is satisfactory. For widely fluctuating loads 20C is required.

† Water flow should be continued for at least thirty minutes after removal of anode power.

MAXIMUM RATINGS AND TYPICAL OPERATION

Power-Rectifier Service, Continuous Duty

Ratings are for Zero-Phase-Control Angle—See curves K-69087-72A504 on page five and K-69087-72A503 on page six 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

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

TECHNICAL INFORMATION (CONT'D)

□ Ignitor Characteristics

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 K-69087-72A803 on page four for details.		

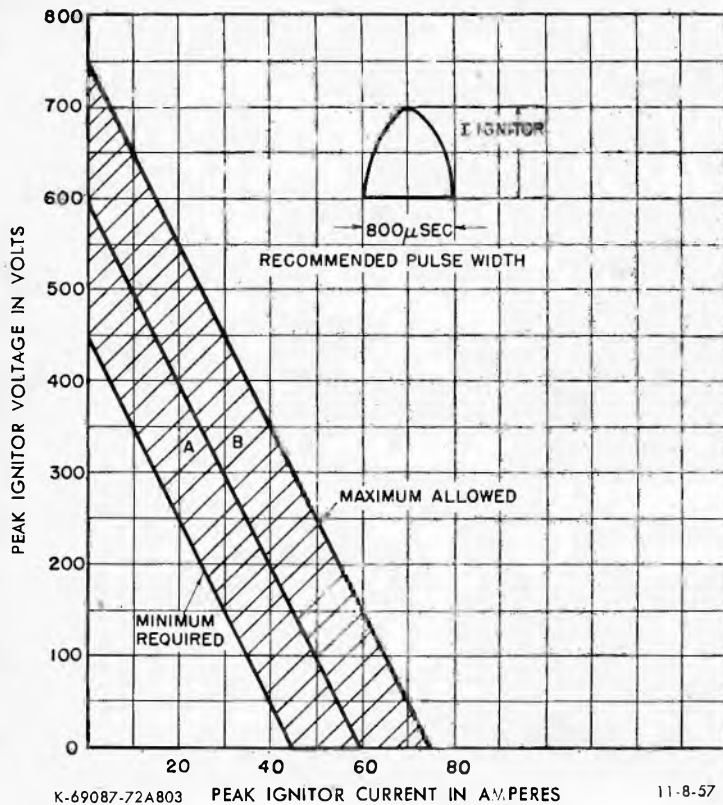
Auxiliary-Anode

(See Curve K-69087-72A438 on page seven for details)

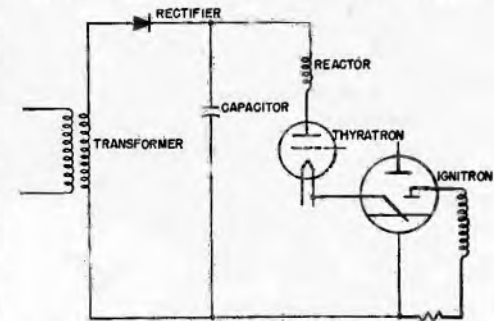
Maximum Peak Forward Voltage	160	Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting	25	Volts
Main Anode Not Conducting	160	Volts
Maximum Current		
Peak	30	Amperes
Average	9	Amperes
Maximum Averaging Time	10	Seconds
Root Mean Square	15	Amperes

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

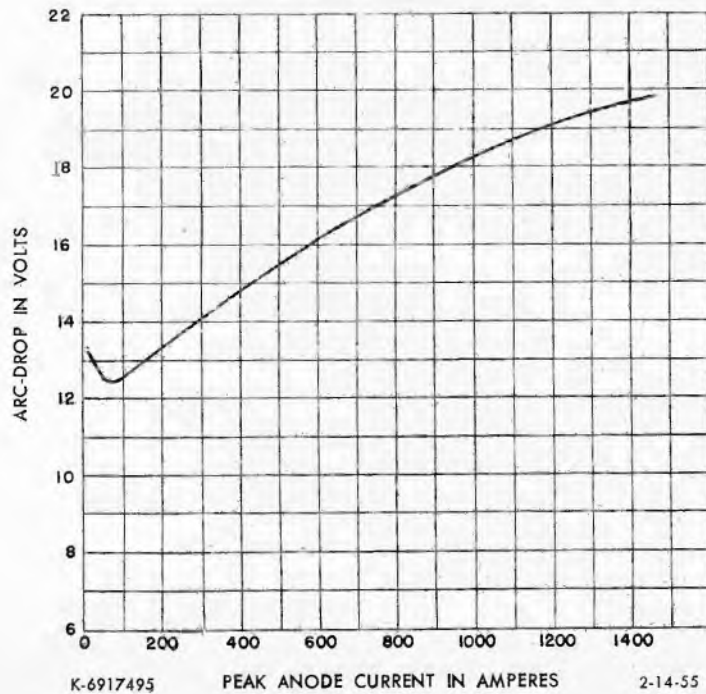
THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO
OPERATE WITHIN THE SHADED AREA



ELEMENTARY CIRCUIT FOR CAPACITOR FIRING



ARC DROP



AUXILIARY-ANODE REQUIREMENTS

GL-5788

ET-11184

PAGE 7

11-57

$$I_{max} = \frac{\sqrt{2} E_{rms} \sin \phi}{R} \sin (\alpha + \beta)$$

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 APPROX. 40 PERCENT TO MAINTAIN ARC EVERY CYCLE.

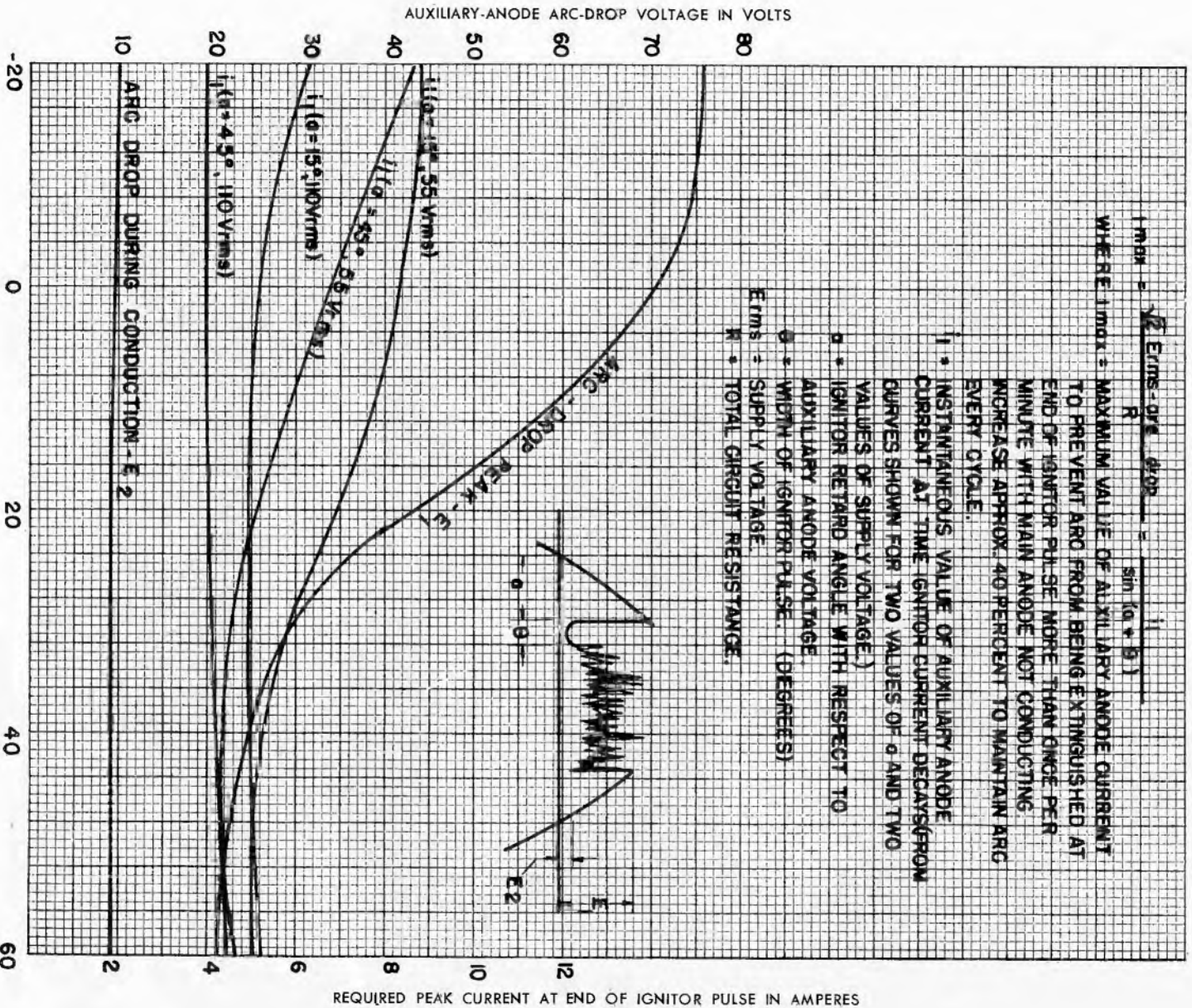
I = INSTANTANEOUS VALUE OF AUXILIARY ANODE CURRENT AT TIME IGNITOR CURRENT DECAYS FROM VALUES OF SUPPLY VOLTAGE.)

ϕ = IGNITOR RETARD ANGLE WITH RESPECT TO AUXILIARY ANODE VOLTAGE

α = WIDTH OF IGNITOR PULSE. (DEGREES)

E_{rms} = SUPPLY VOLTAGE.

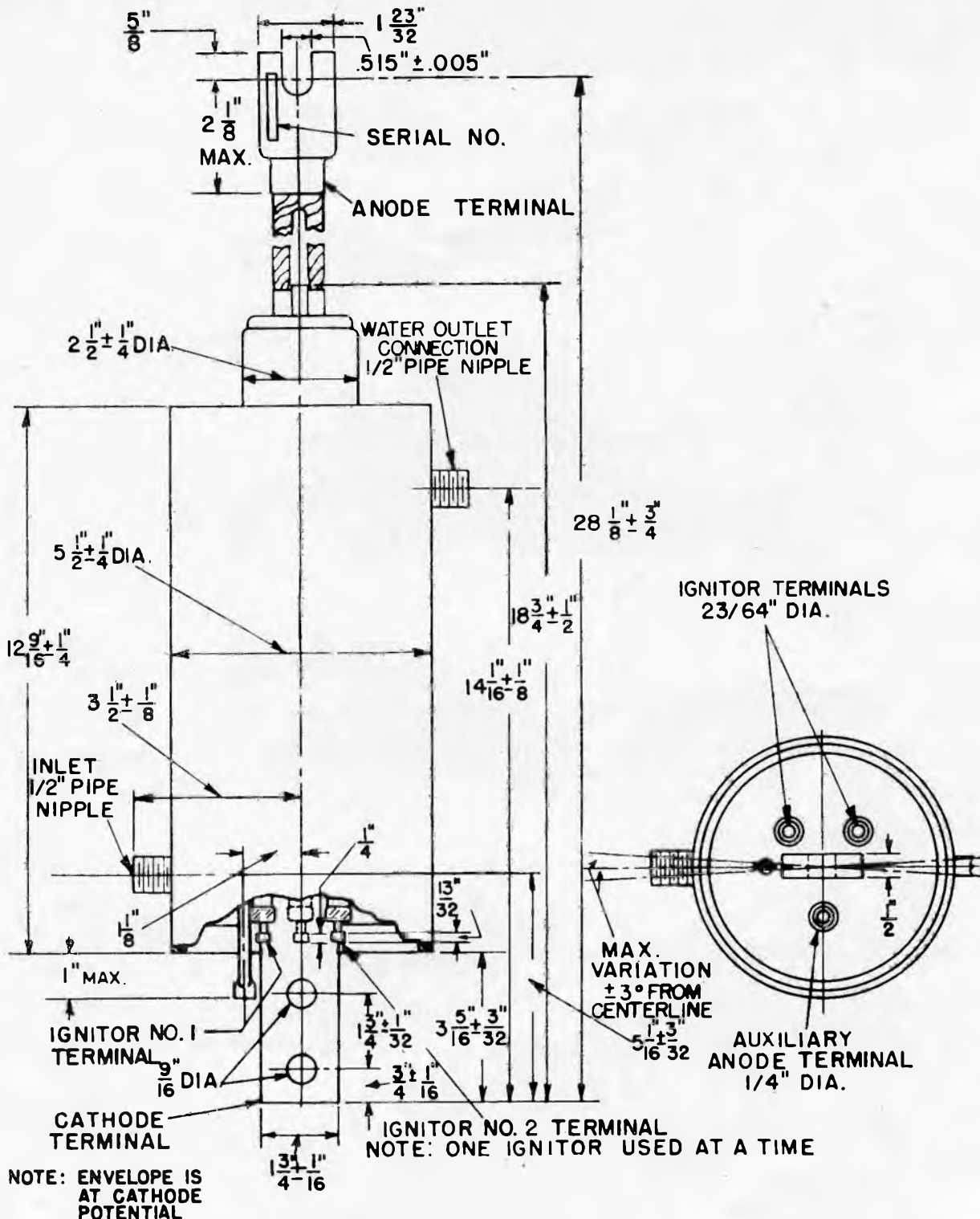
R = TOTAL CIRCUIT RESISTANCE.



K-49087-72A438

INLET WATER TEMPERATURE IN C

12.1-54



K-69087-72A685—Outline revised

11-14-57

ELECTRONIC COMPONENTS DIVISION

GENERAL  ELECTRIC

Schenectady 5, N. Y.

PRINTED IN U.S.A.

GL-5822

DESCRIPTION
AND RATING

ETI-309

PAGE 1

3-50



IGNITRON

DESCRIPTION

The GL-5822 ignitron is a sealed, stainless-steel-jacketed, water-cooled, mercury-pool tube for control of frequency-changer resistance welders. This method of resistance welding 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 kva 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 im-

proved results in welding aluminum, magnesium, and their alloys.

A feature of the GL-5822 is the use of baffles in the tube to reduce deionization time so that the tube will operate satisfactorily under the severe conditions of commutation imposed by this class of service. Other design features are an ignitor adapted to intermittent service, and a spiral metal tube within the ignitron through which the cooling water circulates to assure uniform cooling.


Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

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 Data

Envelope material—Metal	
Over-all length, maximum	27 $\frac{1}{4}$ inches
Over-all width exclusive of water connections, maximum	4 $\frac{1}{4}$ inches
Net weight	8 $\frac{1}{4}$ pounds
Type of cooling—Water	
Characteristics for water cooling	
Water temperature rise, maximum	6 C
Pressure drop at 1.5 gallons per minute, maximum	5 pounds per square inch

Thermal

Water cooling	
Maximum outlet water temperature	35 C
Minimum inlet water temperature	10 C
Minimum water flow at continuous rated average current	1.5 gallons per minute
Minimum water flow at no load	0.5 gallons per minute

MAXIMUM RATINGS

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, maximum averaging time 0.2 second	0.166	0.166
Ratio of surge to peak current	12.5	12.5
Maximum duration of surge current	0.15	0.15 second
Frequency range	50 to 60	50 to 60 cycles per second

IGNITOR

Maximum voltage

Positive	Anode	volts
Negative	5	volts

Maximum current

Peak	100	amperes
Rms	10	amperes
Average	1	ampere
Maximum averaging time	5	seconds

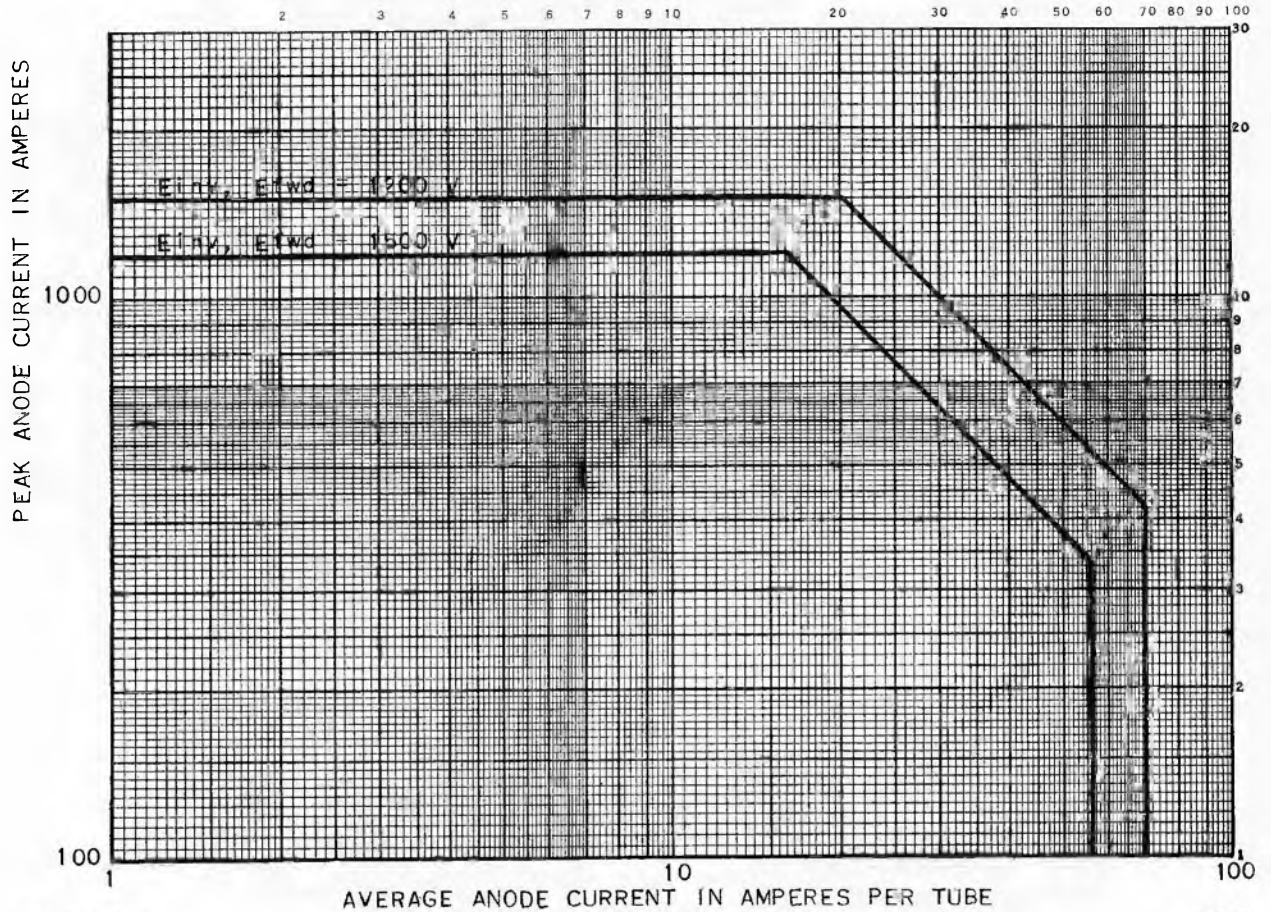
*Straight line interpolation on log-log paper is allowed between corresponding points. Ratings are for zero phase-control angle.

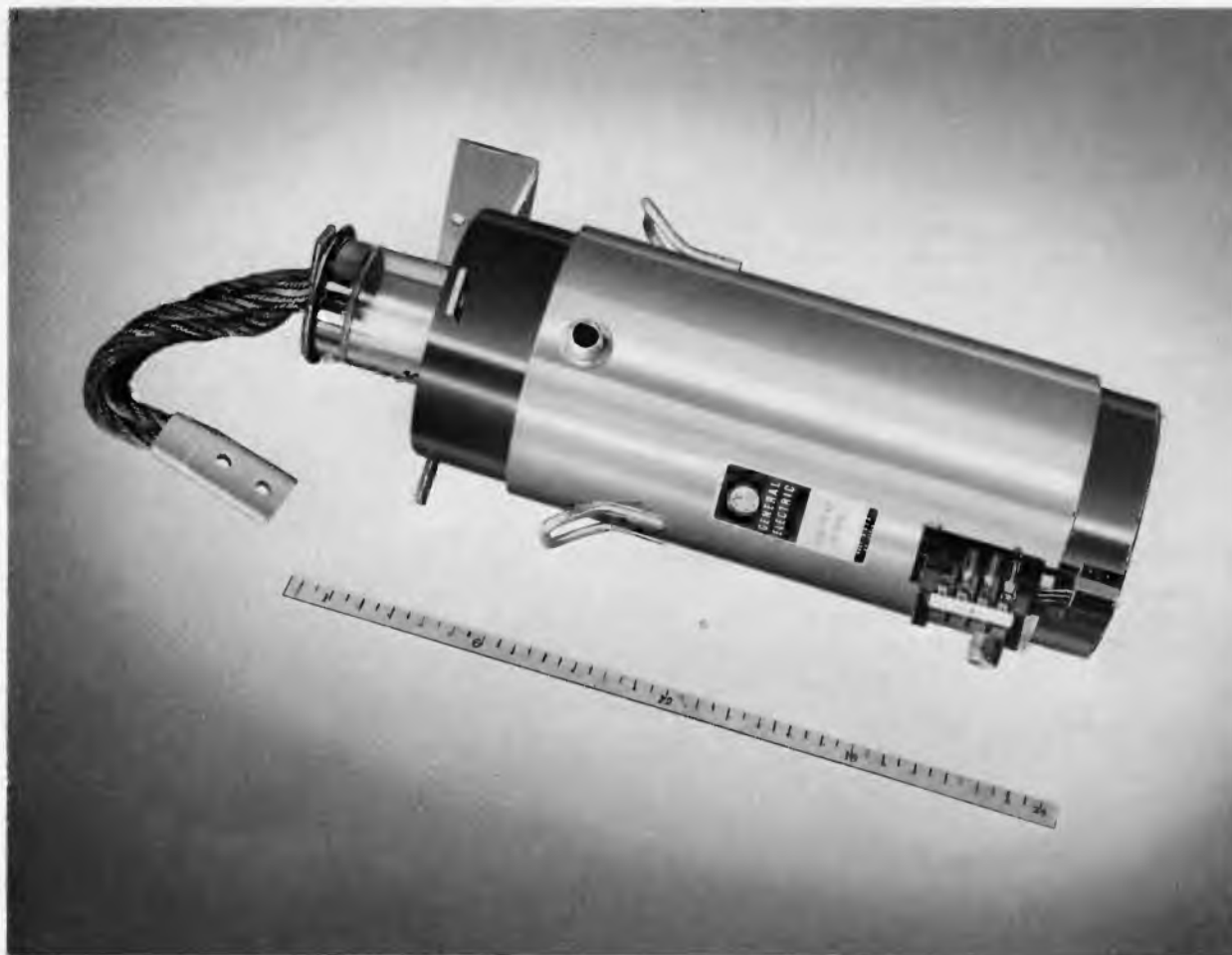
GL-5822

POWER RECTIFIER RATING—INTERMITTENT SERVICE
 MAXIMUM AVERAGING TIME=6.25 SECONDS

$$\frac{1 \text{ Average}}{1 \text{ Peak}} \text{ Maximum Averaging Time } 0.2 \text{ Seconds} = 0.166 \text{ Maximum}$$

$$\frac{1 \text{ Surge}}{1 \text{ Peak}} \text{ Maximum Duration of Fault Current } 0.15 \text{ Seconds} = 12.5 \text{ Maximum}$$





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 con-

tact 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.

TECHNICAL INFORMATION

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 Peak Amperes	20.5 ± 2	Volts
⊕ Arc Drop at 2000 Peak Amperes	24 ± 2	Volts

(See Curve K-69087-72A709 on page three for details)

GENERAL  ELECTRIC

Supersedes ET-T1131 dated 4-55

TECHNICAL INFORMATION (CONT'D)

Mechanical

Envelope Material—Stainless Steel

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 on page three for details.

Shield-Grid Voltage

Minimum

Maximum

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.

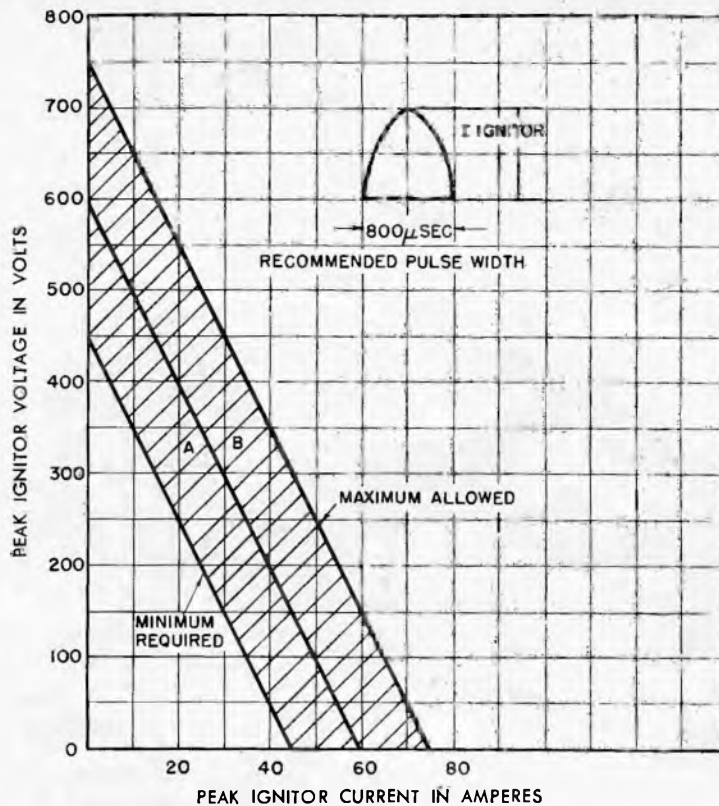
§ Water flow should be continued for at least one hour after removal of anode power.

 Denotes an addition.

⊕ Denotes a change.

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

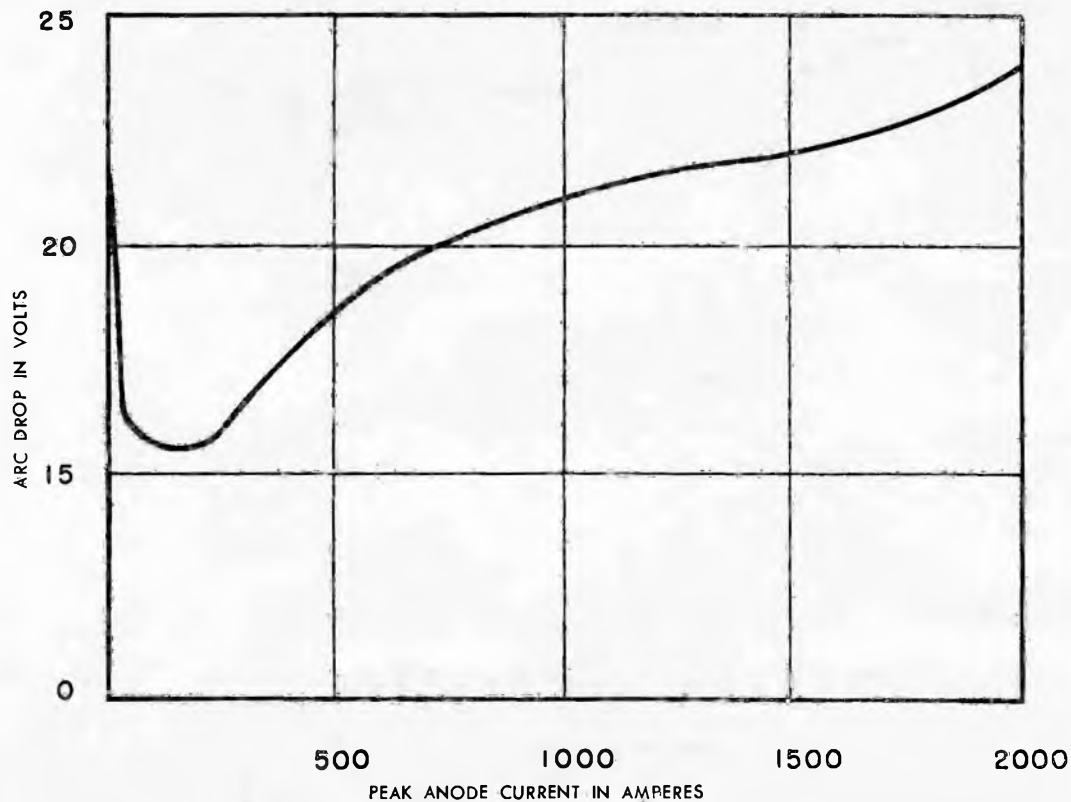
THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



K-69087-72A803—New curve

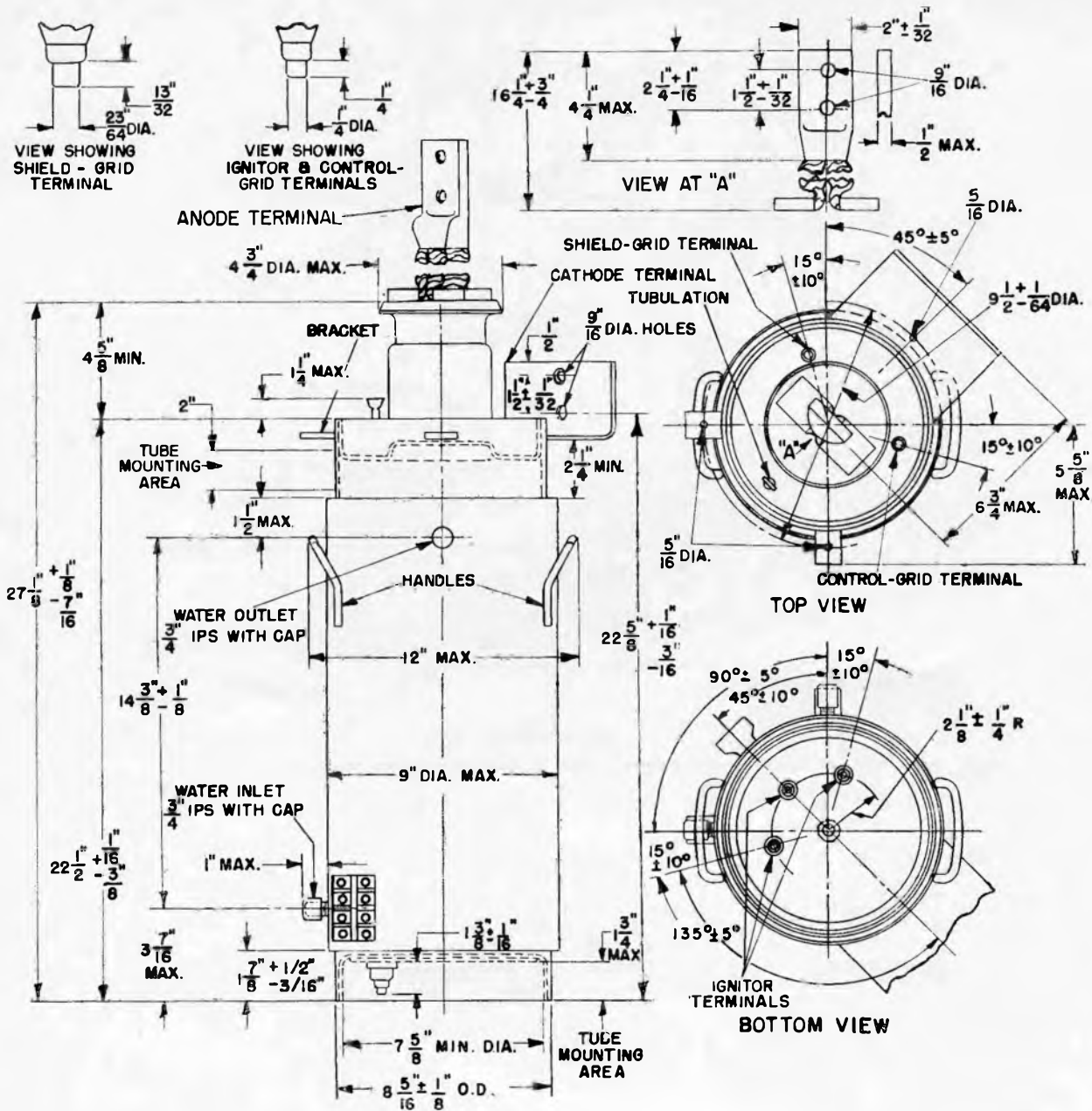
11-8-57

ARC DROP



K-69087-72A709—Curve revised

11-8-57



N-22020AZ—Outline Revised

11-15-57

ELECTRONIC COMPONENTS DIVISION
GENERAL ELECTRIC
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IGNITRON

TEMPERATURE CONTROLLED
POWER-RECTIFIER SERVICE

FREQUENCY-CHANGER WELDING SERVICE

The GL-6511 ignitron is a sealed, stainless-steel jacketed, water-cooled mercury-pool tube for control of frequency-changer resistance welders. This method of resistance welding 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.

This tube is identical in ratings and characteristics to the GL-5822-A. 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 tem-

perature, 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 construction prevents excessive condensation over the external parts of the tube under conditions of high humidity. Another advantage is the appreciable saving in maintenance costs over tubes of the old design since this control feature, in addition to greatly reducing the amount of water required, eliminates the necessity for such safety devices as water-flow relays, water over-temperature relays, and water-pressure interlocks required with the older design tubes. In applications where the cooling water flows through three tubes in series, this tube can be used with two GL-5822-A's since the GL-6511, in the position nearer the water drain where it receives the warmer water, can control the flow to all tubes under normal conditions.

GENERAL  ELECTRIC

Supersedes ET-T1142 dated 1-55

TECHNICAL INFORMATION

GENERAL

Electrical

Cathode Excitation—Cyclic	
Cathode Spot Starting—Ignitor	
Number of Electrodes	
Main Anodes	1
Main Cathodes	1
Ignitors	1
Arc Drop at 1500 Peak Amperes	25 Volts

Mechanical

Envelope Material—Stainless Steel	
Net Weight, approximate	8.4 Pounds

Thermal

Type of Cooling—Water	
Inlet Water Temperature, minimum	10 C
Inlet Water Temperature, maximum	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 1.5 Gallons per Minute, maximum	5 Pounds per Square Inch
<input type="checkbox"/> Working Water Pressure—Non-shock	100 Pounds per Square Inch

MAXIMUM RATINGS AND TYPICAL OPERATION

Frequency-Converter Resistance Welding Service or Power-Rectifier Service—Intermittent Duty

Ratings are for Zero-phase Control Angle—See curve K-69087-72A316 on page four 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 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 Characteristics

Anode Firing	
Maximum Inverse Voltage	5 Volts
Maximum Positive Voltage—Anode Voltage	
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	
Maximum Inverse Voltage	5 Volts
Recommended Pulse Length	500 Microseconds
Minimum Pulse Length, for average anode currents greater than 20 amperes	150 Microseconds
Maximum Pulse Length	4000 Microseconds
Volt-Ampere Characteristics—See Curve K-69087-72A741 on page three for details.	

Temperature-Control-Switch Ratings†

Maximum Voltage	575 Volts
Maximum Current	
Over-Temperature Switch	6 Amperes
Water-Control Switch	1.5 Amperes

TECHNICAL INFORMATION (CONT'D)

Temperature-Control-Switch Ratings† (Cont'd)

Maximum Peak Potential of Tube Water Cylinder
 Above 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)

* Straight line interpolation on log-log paper is allowed between corresponding points.

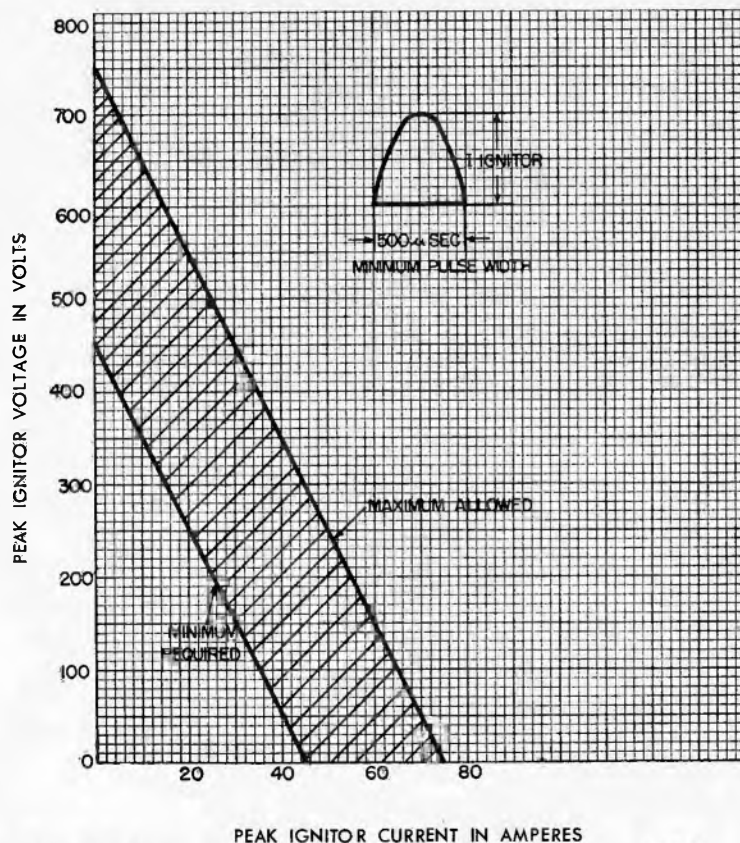
† Suitable fuses should be provided in the switch circuits to prevent a power arc, should a ground occur in the switch or wiring.

‡ Water flow should be continued for fifteen minutes after removal of anode power.

□ Denotes an addition.

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

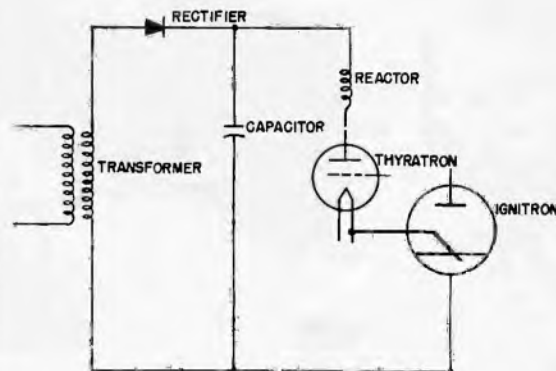
THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED
 TO OPERATE WITHIN THE SHADED AREA



K-69087-72A741

12-9-55

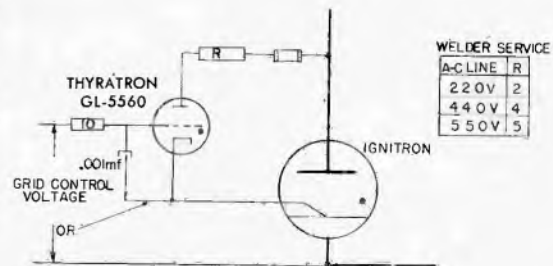
ELEMENTARY CIRCUIT FOR CAPACITOR FIRING



K-9033525

5-25-54

SELF OR ANODE EXCITATION IN WHICH A PART OF THE
 LOAD CURRENT IS DIVERTED THROUGH THE IGNITOR

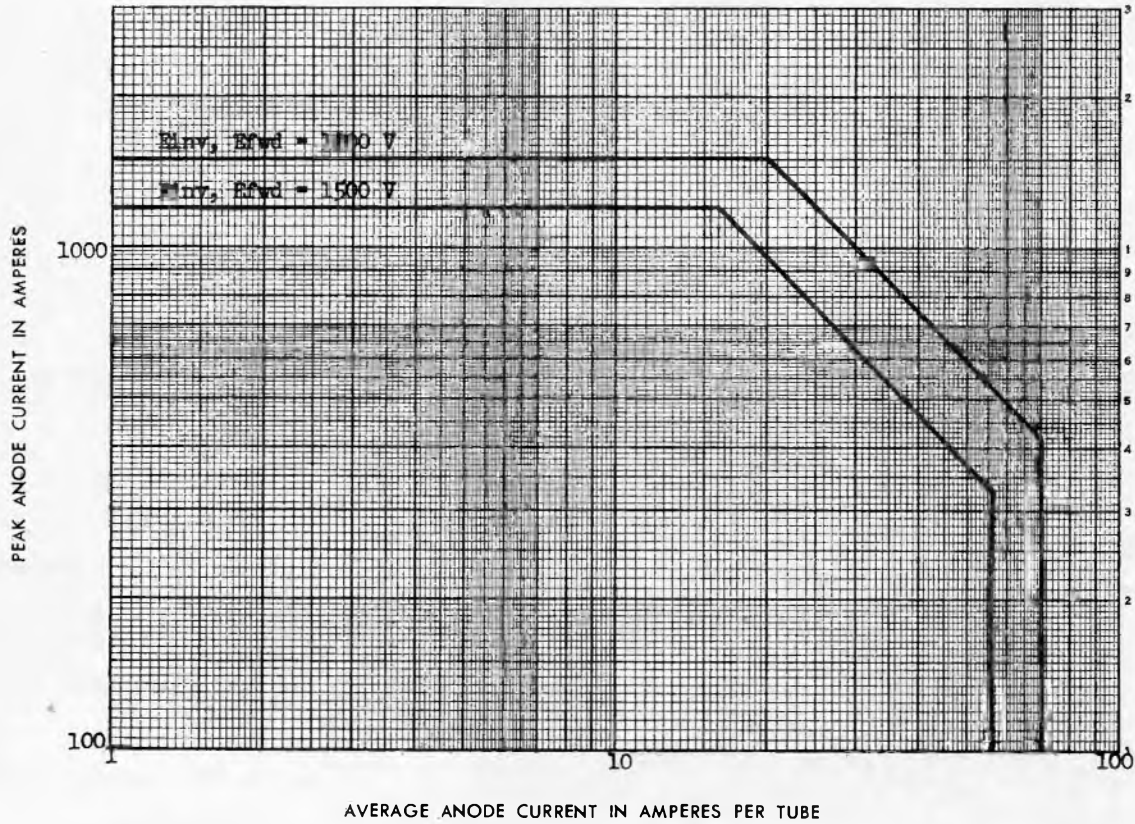


WELDER SERVICE		
A-C LINE	R	
220V	2	
440V	4	
550V	5	

K-9033542

12-6-44

FREQUENCY-CHANGER RESISTANCE WELDING SERVICE
OR
POWER RECTIFIER RATING—INTERMITTENT SERVICE



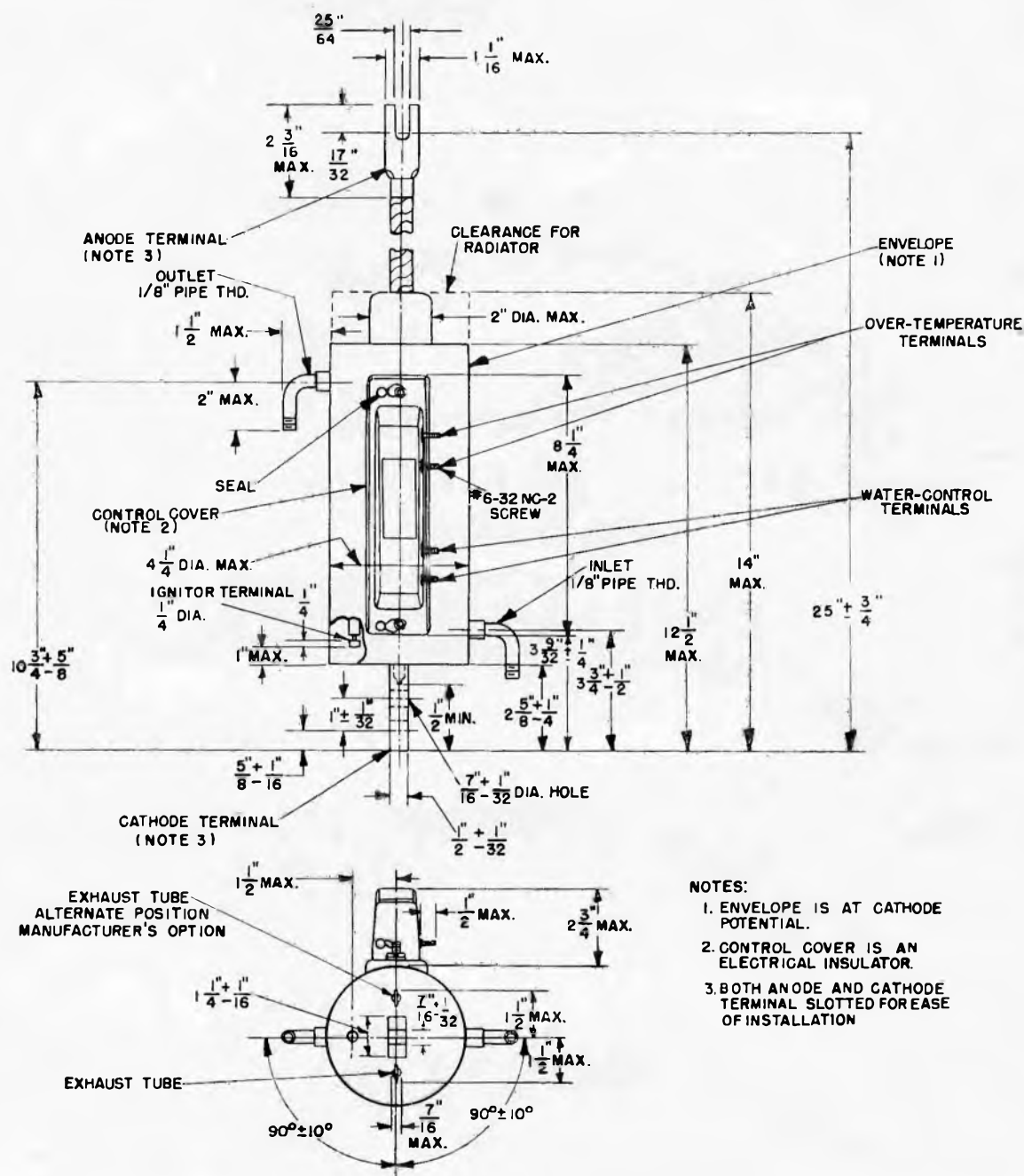
K-69087-72A316

11-3-54

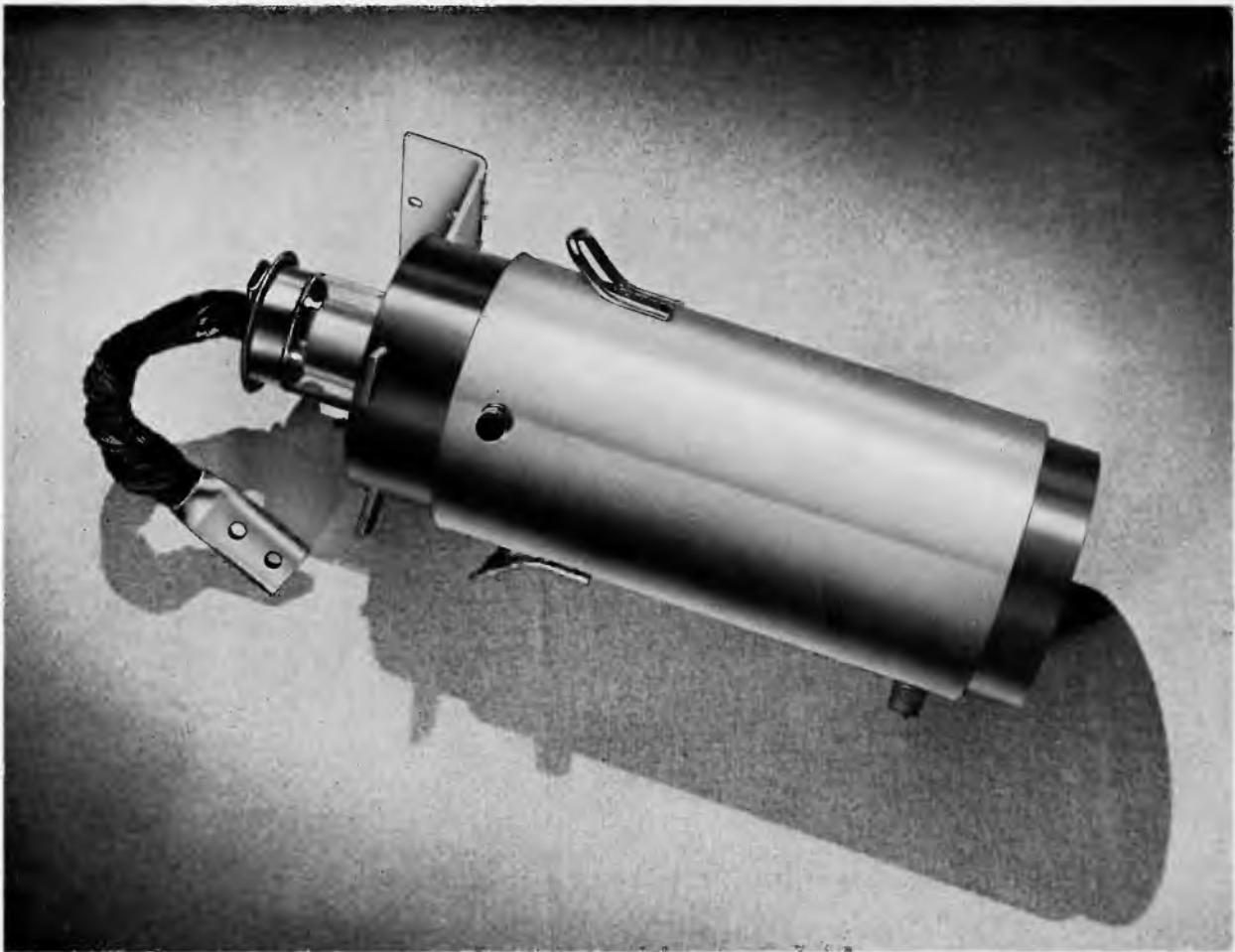
MAXIMUM AVERAGING TIME = 6.25 SECONDS

$$\frac{I_{\text{AVERAGE}}}{I_{\text{PEAK}}} \text{ MAXIMUM AVERAGING TIME } 0.2 \text{ SECOND} = 0.166 \text{ MAXIMUM}$$

$$\frac{I_{\text{FAULT}}}{I_{\text{PEAK MAX.}}} \text{ MAXIMUM DURATION OF FAULT CURRENT } 0.15 \text{ SECOND} = 12.5 \text{ MAXIMUM}$$



ELECTRONIC COMPONENTS DIVISION
GENERAL  ELECTRIC
Schenectady 5, N. Y.



IGNITRON

POWER-RECTIFIER SERVICE

TWO IGNITORS

INVERTER SERVICE

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.

A particular design feature of this tube makes it especially suitable for use where voltage control by phase retard is in excess of the amounts usually required. In addition, the tube features a coaxial cathode current return which reduces magnetic fields caused by the tube currents.

TECHNICAL INFORMATION

GENERAL

Electrical

Cathode Excitation—Cyclic

Cathode Spot Starting—Ignitor

Number of Electrodes

Main Anodes 1

Auxiliary Anodes 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 on page three for details)

TECHNICAL INFORMATION (CONT'D)

Mechanical

Envelope Material—Stainless Steel	
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 on page three for details.	

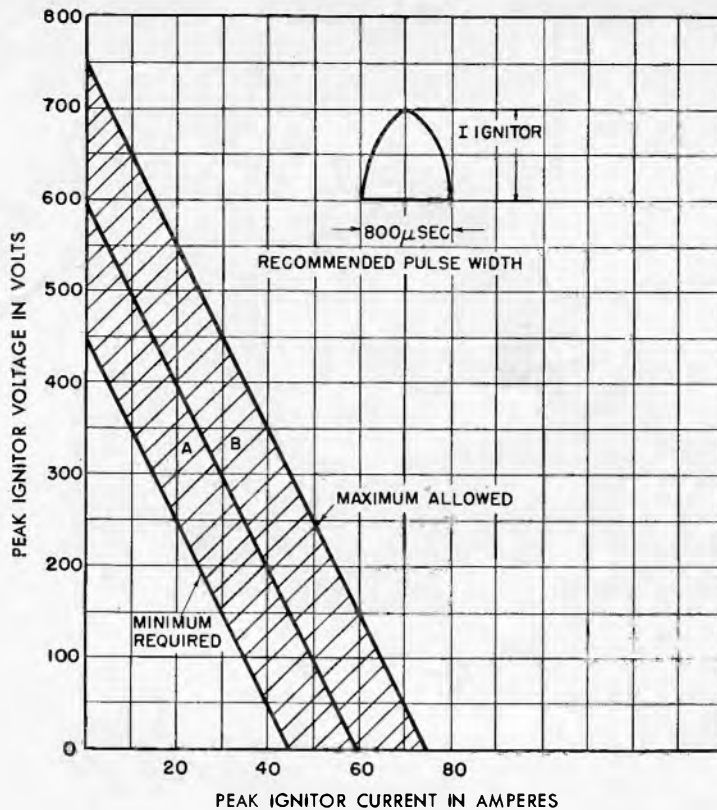
Minimum Maximum

Shield-Grid Voltage		
Peak Forward	200	500 Volts
Peak Inverse		200 Volts
Shield-Grid Voltage		
Peak Forward	0.2	5.0 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	5.0 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.

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

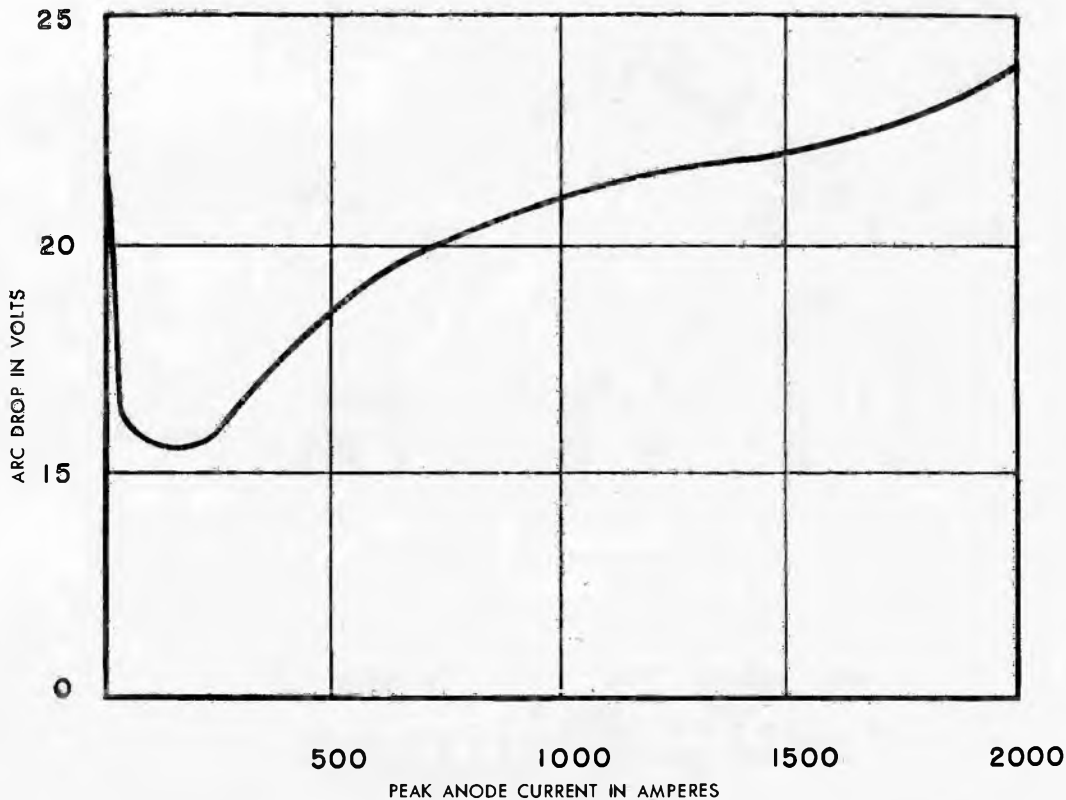
THE IGNITOR FIRING CIRCUIT SHOULD BE DESIGNED TO OPERATE WITHIN THE SHADED AREA



K-69087-72A803

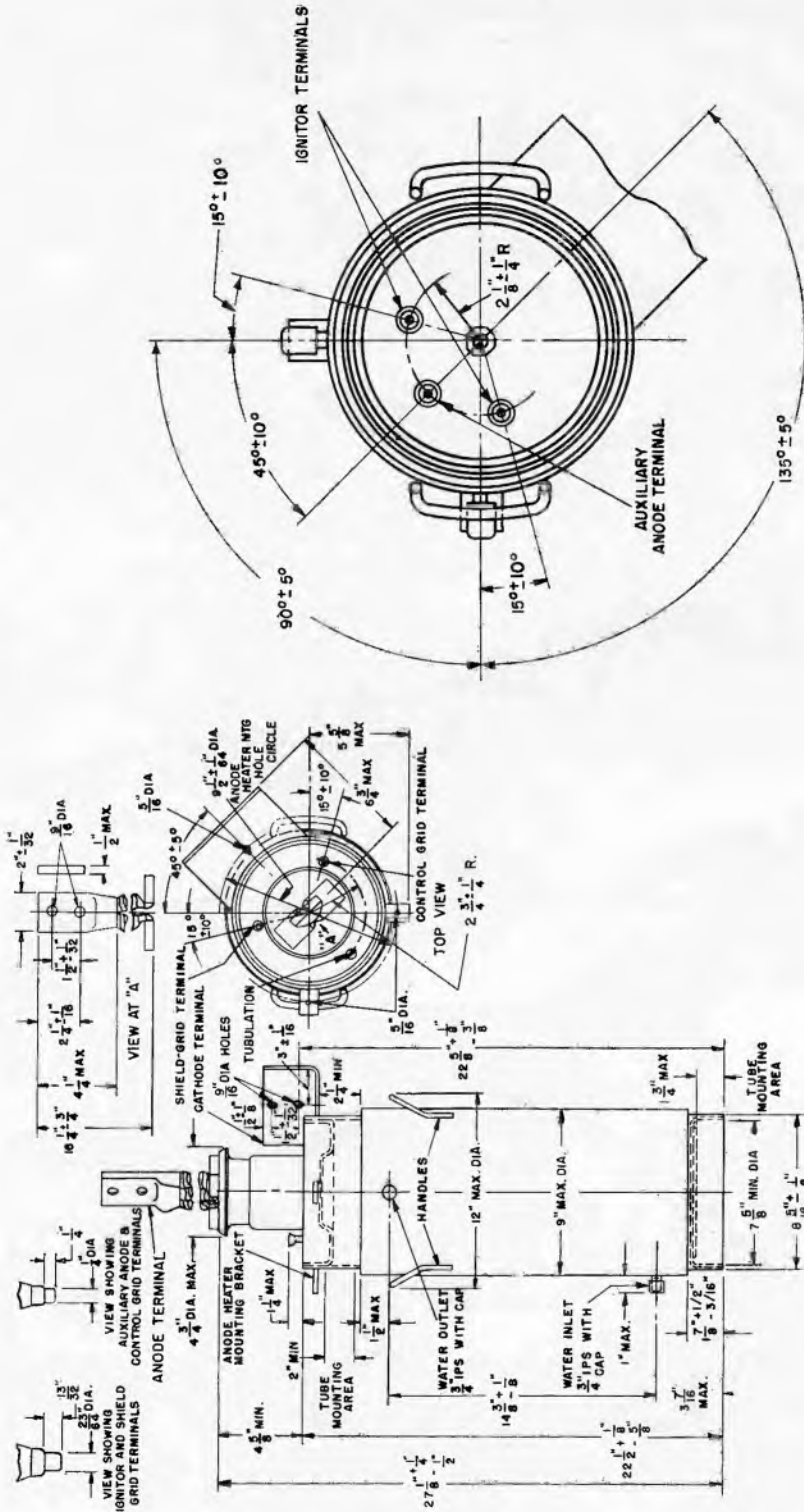
11-8-57

ARC DROP



K-69087-72A709

11-8-57



10-30-57

K69087-72A787

*Industrial
Tube Manual*

ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

Ignitron FG-235-A--Specifications

General

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given in the Technical Information.

Mechanical Requirements

The tubes shall have the dimensions and be within the tolerances shown on the outline drawing.

Electrical Requirements

TEST	See Note	I _p Amp Min	RMS Demand Current Amp-Min	I _b Amp Min	Conduction	Averaging	Duration Of Test	E _p Volts	LIMITS	
					Per Spot Seconds Minimum	Time Seconds Max			Min	Max
Ignitor Resistance	1								5	110 Ohms
Peak Voltage Drop	2	100								16 Volts
A-c Welder Control Operation-Intermittent	3		1265	100	1	6.19	15 min. Minimum			5 Arc Backs 200 Ignitor Voltage for Ignition 30 Ignitor Current for Ignition 100 Ignitor Ignition time
High Potential	4								10 sec	12000

Notes

1. With no other voltage applied, the ignitor-to-cathode resistance shall be measured with the tube mounted vertically and shall be within the limits specified.

For this test the tube temperature shall be between 15 and 35 C.

2. With the tube operating in a 60-cycle, half-wave rectifier adjusted to give the specified peak anode current and no greater than average anode current, the peak voltage drop exclusive of starting voltage measured from anode to cathode shall not exceed the limit specified. This voltage may be observed by use of a cathode-ray oscilloscope connected directly, or through an amplifier to the tube under test.

For this test the water temperature shall be less than 15 C. Rated water flow shall be used.

3. The tube shall be connected "back to back" with a previously tested good tube to control alternating current to an inductive load with a power factor lower than 30 per cent. The tube under test shall be in the trailing position. The ignitor of each tube shall be connected to a suitable firing control circuit in such a manner that current will flow through the ignitor in the forward direction only.

The supply voltage shall be 575 plus or minus 25 volts rms, 60 cycles. With no phase retard the minimum rms demand current, conduction time per spot, and minimum average anode current shall be as specified.

After the initial spot and for the next four spots, the ignitor voltage for ignition shall not exceed 200 volts. During this and subsequent operation, the ignitor shall maintain control and the time required to initiate the arc shall not exceed 100 microseconds.

During the last three minutes of tube operation, the ignitor firing shall be retarded in phase so that the rms demand current is 75 plus or minus 5 per cent of the previous value. During this period, the number of arc backs shall not exceed the specified maximum. At the end of this period, the ignitor current for ignition shall not exceed 30 amperes when flowing for a time not exceeding 100 microseconds.

For this test rated water cooling shall be used at rated flow.

4. With the tube mounted in a vertical position, the specified voltage shall be applied for the specified time. During the last half of this test, there shall be no indication of current flow through the tube. Momentary flashes shall not be considered as an indication of current flow.

This test shall be given at least 15 hours after operation for those tubes which have been operated.

For this test the tube temperature shall be between 15 and 35 C.

Electronics Department

GENERAL ELECTRIC

5564--Technical Information

Type of Pool Tube - Ignitron

Principle Use - Rectification

The 5564 is a mercury-pool tube of permanently sealed, steel construction, designed for rectifier service in the 125-, 250-, 600-, and 900-volt d-c power fields. The tube has two ignitors, only one of which is used at a time. Outputs up to 2000 kilowatts may be obtained depending on the number of ignitrons, the output voltage, and the circuit. Arc losses are low. Phase control of the ignition impulse permits voltage control of the rectified output. Excitation of the small auxiliary anode stabilizes the cathode spot for very small anode currents.

GENERAL

Electrical Data

Type Cathode Excitation - Cyclic	
Type Cathode Spot Starting - Ignitor	
Number of Electrodes	
Main Anodes	1
Main Cathodes	1
Auxiliary Anodes	1
Ignitors	2
Control Grids	1
Arc Drop at 1200 Peak Amperes	18.8 Volts
Cathode Excitation Requirements	
Ignitor Voltage Required to Fire	150 Volts
Ignitor Current Required to Fire	40 Amperes
Peak Excitation Arc Current Required, minimum	4 Amperes
Excitation Arc-Drop Voltage	12 Volts
Grid Requirements	
Positive Current to Establish Conduction	0.1 Ampere
Minimum Voltage to Establish Conduction	50 Volts
Minimum Voltage to Prevent Conduction	100 Volts

Mechanical Data

Envelope Material - Metal	
Maximum Overall Length	41 Inches
Maximum Overall Width, Exclusive of Handles and Water Connections	9 1/8 Inches
Net Weight	90 Pounds
Type of Cooling - Water	
Characteristics for Water Cooling at Rated Minimum Flow	
Water Temperature Rise, maximum	5 C
Pressure Drop at 6 Gallons per Minute, maximum	1 Pound per Square

MAXIMUM RATINGS

As Power Rectifier Tube*

Maximum Peak Anode Voltage			
Inverse	900	2100	Volts
Forward	900	2100	Volts
Maximum Anode Current			
Peak	3600	2400	Amperes
Average			
Continuous	400	300	Amperes
2 Hours	600	450	Amperes
1 Minute	800	600	Amperes
Surge	25,000	19,000	Amperes
Maximum Duration of Surge Current	0.15	0.15	Second
Frequency Range	25	60	Cycles per Second
Maximum Outlet Water Temperature	60	50	C
Minimum Outlet Water Temperature	10	10	C
Minimum Water Flow at Continuous Rated			
Average Current	6	6	Gallons per Minute
Minimum Water Flow at No Load	1	1	Gallon per Minute

* Electrical ratings are for zero phase-control angle.

Ignitor

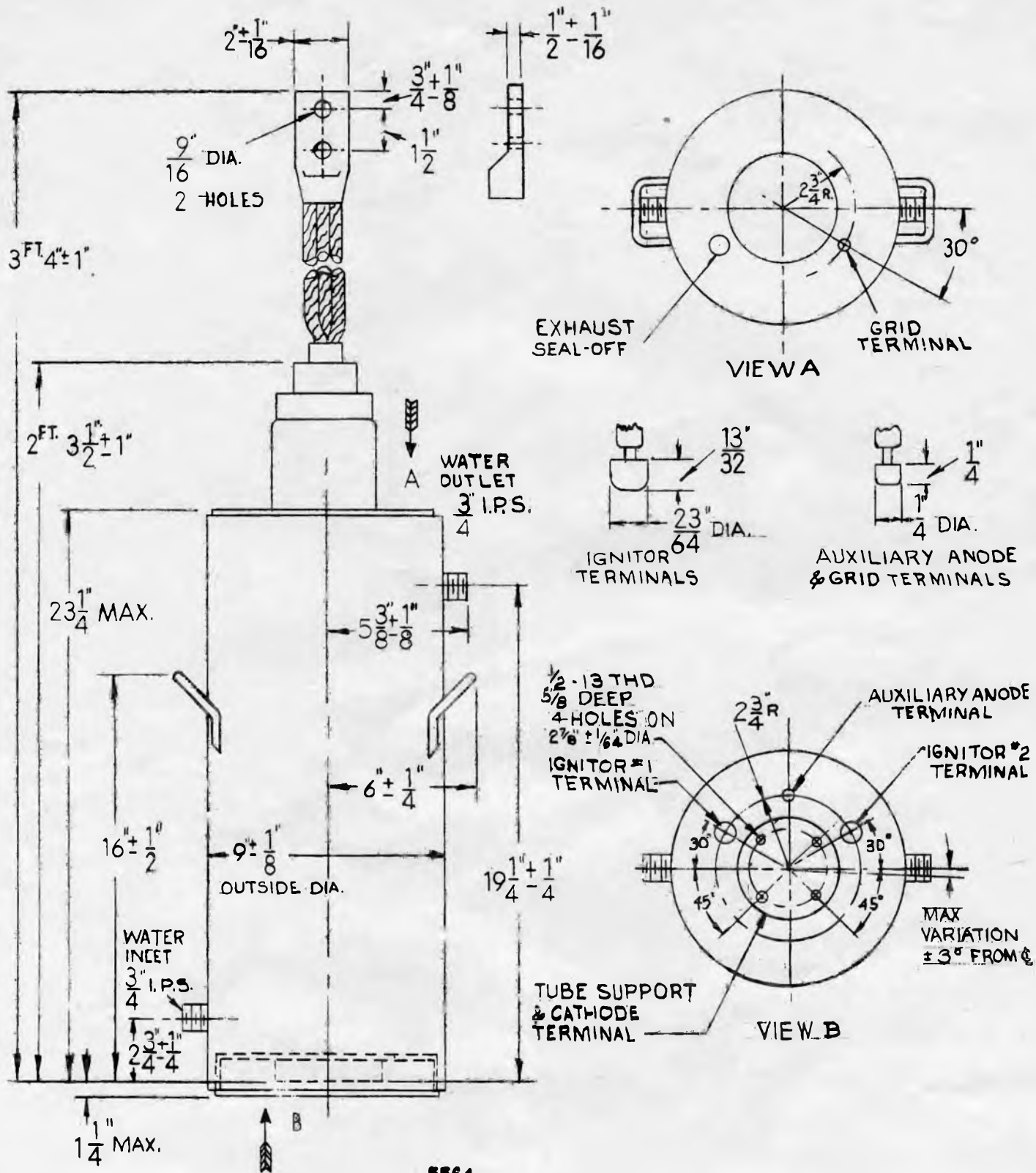
Maximum Voltage		
Positive		Anode Volts
Negative		5 Volts
Maximum Current		
Peak		100 Amperes
RMS		15 Amperes
Average		2 Amperes
Maximum Averaging Time		10 Seconds
Starting Time at Required Voltage or Current		100 Microseconds

Auxiliary-Anode

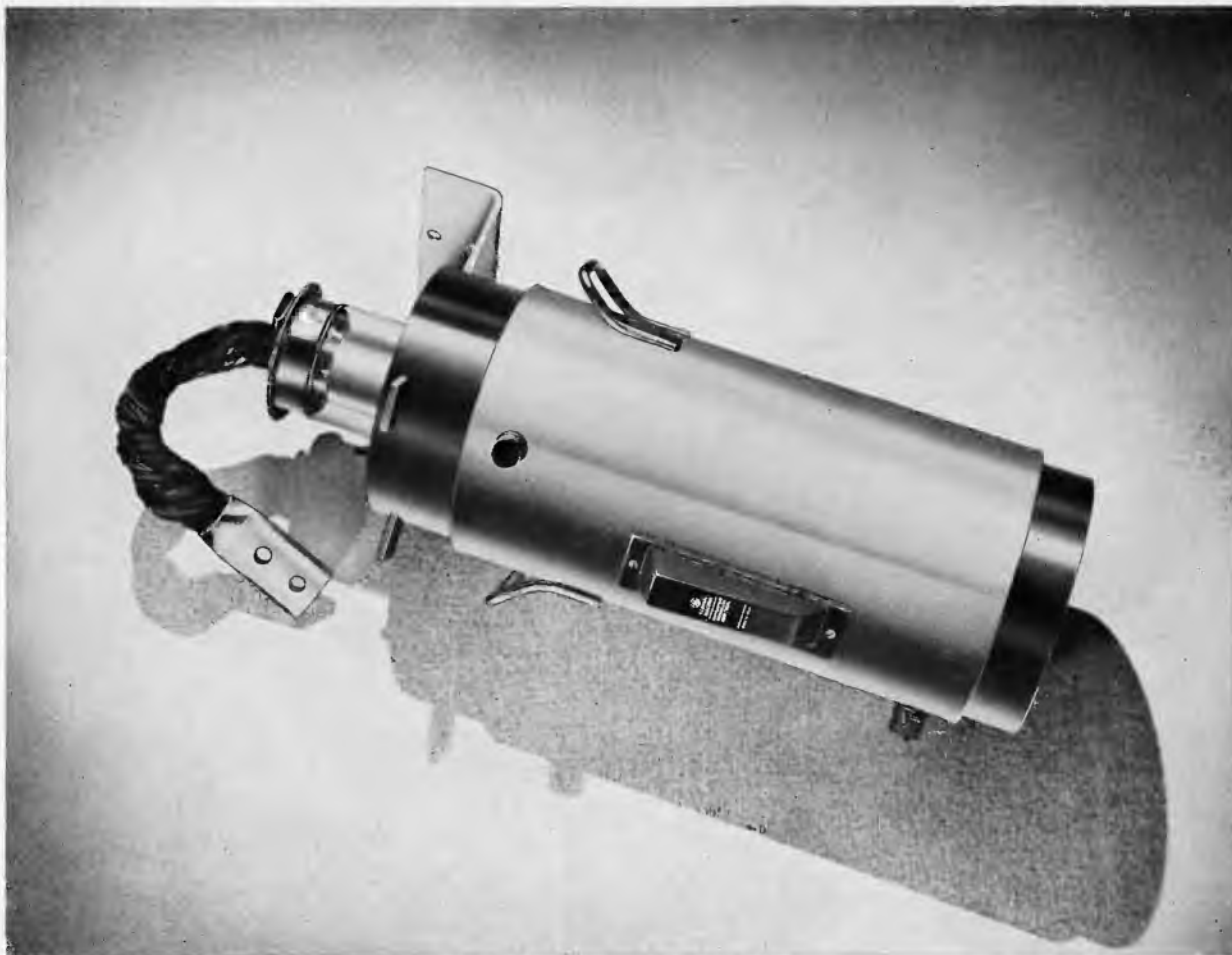
Maximum Current		
Peak		30 Amperes
Average		5 Amperes
Maximum Averaging Time		10 Seconds
RMS		12.5 Amperes
Maximum Peak Forward Voltage		150 Volts
Maximum Peak Inverse Voltage		
Main Anode Conducting		25 Volts
Main Anode Not Conducting		150 Volts

Grid

Maximum Peak Forward Voltage	250	Volts
Maximum Peak Inverse Voltage	250	Volts
Maximum Grid-Current		
Peak Positive	1.5	Amperes
Peak Negative	0.5	Ampere
Average	0.5	Ampere
RMS	1.0	Ampere



5564
OUTLINE



IGNITRON

**POWER RECTIFIER SERVICE
TWO IGNITORS**

**INVERTER SERVICE
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 where 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 arrange-

ment 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.

TECHNICAL INFORMATION

GENERAL

Electrical

Cathode Excitation—Cyclic	
Cathode Spot Starting—Ignitor	
Number of Electrodes	
Main Anodes.....	1
Auxiliary Anodes.....	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 on Page Three for Details)

TECHNICAL INFORMATION (CONT'D)

Mechanical

Envelope Material—Stainless Steel	
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 on Page Four for Details.)	

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

TECHNICAL INFORMATION (CONT'D)

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.

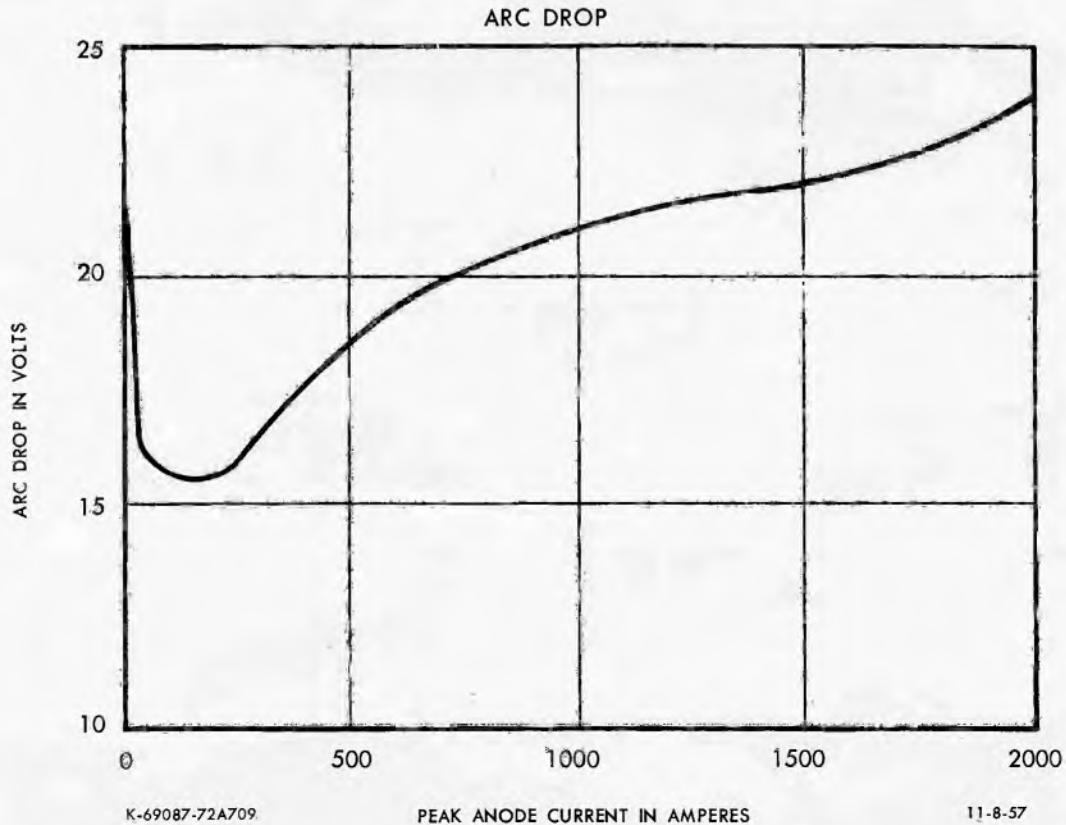
APPLICATION NOTES

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.

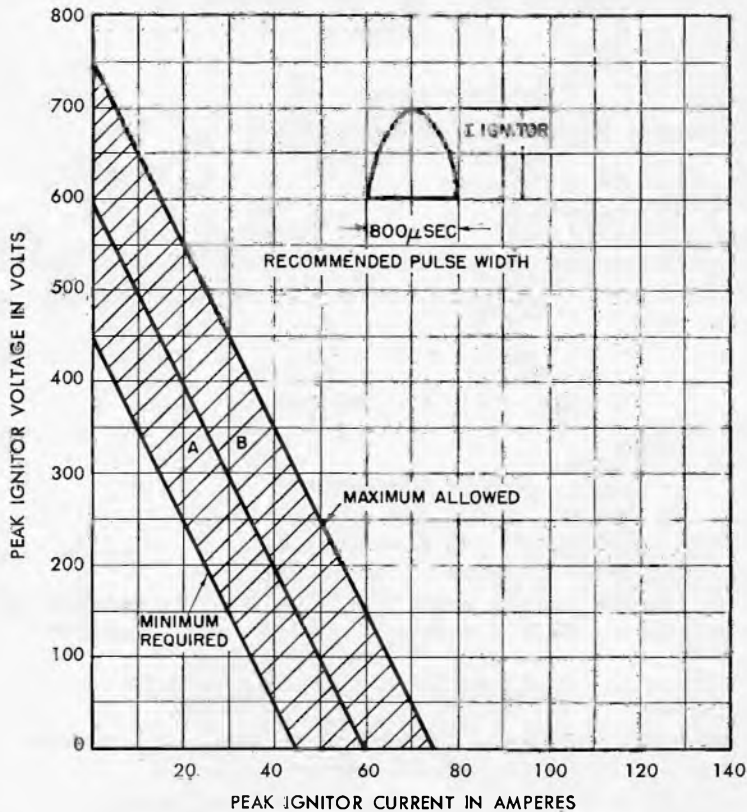
For inlet water temperatures below 20 C, each tube should be connected to the water supply through a rapid-closing solenoid valve controlled by the water-control switch on the tube thermostat.

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



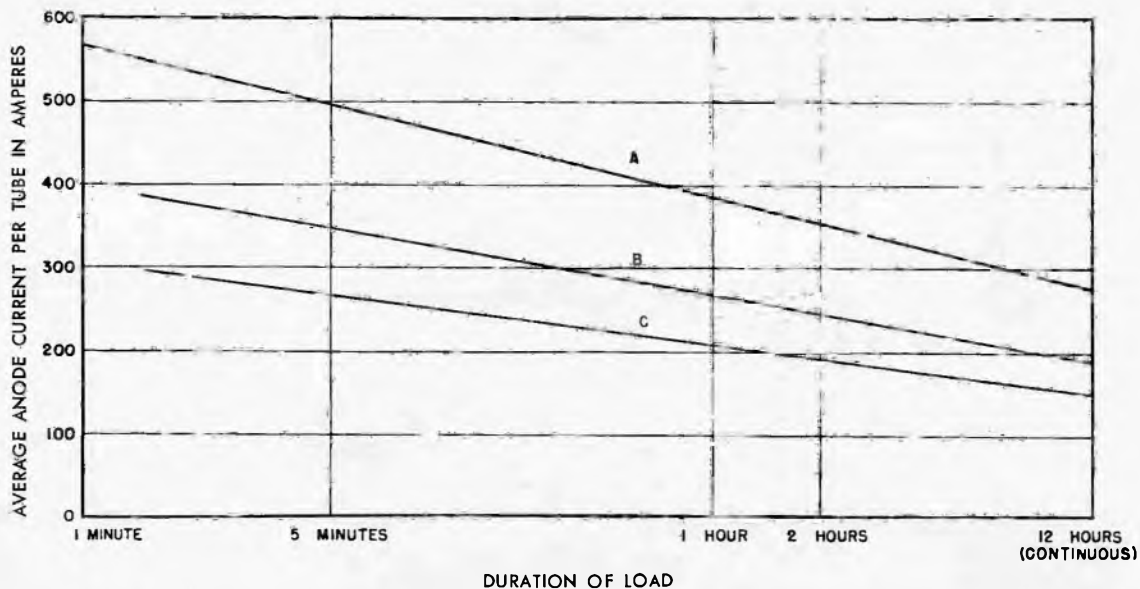
K-69087-72A803

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SHORT-PERIOD OPERATION RATINGS

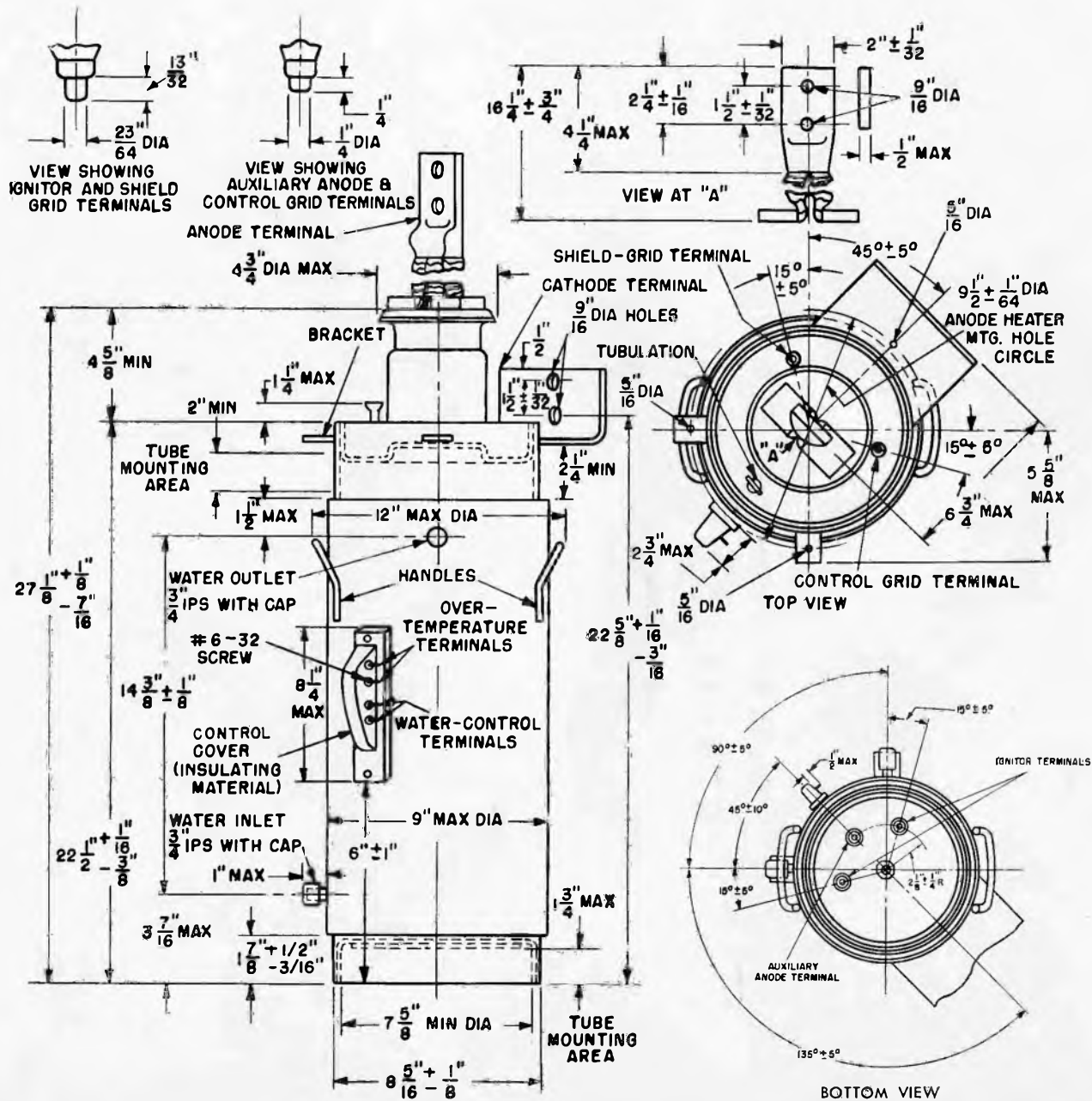
PEAK INVERSE VOLTAGE = 4000 VOLTS
INLET WATER TEMPERATURE = 45 C

PHASE RETARD
A = ZERO
B = 15%, ESTIMATED
C = 50%, ESTIMATED



K-69087-72A809

1-29-58



ELECTRONIC COMPONENTS DIVISION
GENERAL  ELECTRIC
Schenectady 5, N. Y.



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.

TECHNICAL INFORMATION

GENERAL

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	

TECHNICAL INFORMATION (CONT'D)

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
Maximum Peak Fault Current at 600 Volts	22,400	Amperes
Frequency Range	25-60	Cycles per Second

Ignitor Characteristics

Anode Firing		
Maximum Inverse Voltage	5	Volts
Maximum Positive Voltage—Anode Voltage		
Ignitor Voltage Required to Fire, minimum	200	Volts
Ignitor Current Required to Fire, minimum	30	Amperes
Starting Time at Required Voltage or Current	100	Microseconds
Separate Excitation		
Maximum Inverse Voltage	5	Volts
Recommended Pulse Length	500	Microseconds
Minimum Pulse Length, for average anode currents greater than 20 amperes	150	Microseconds
Maximum Pulse Length	4000	Microseconds
Maximum Rate of Rise of Ignitor Current	2.5	Amperes per Microsecond

Volt-Ampere Characteristics—See Curve K-69087-72A741 on Page Three for Details.

*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.

Control thermostats with mounting brackets are available through regular tube supply channels under the following catalog numbers:

Flying-Lead Type

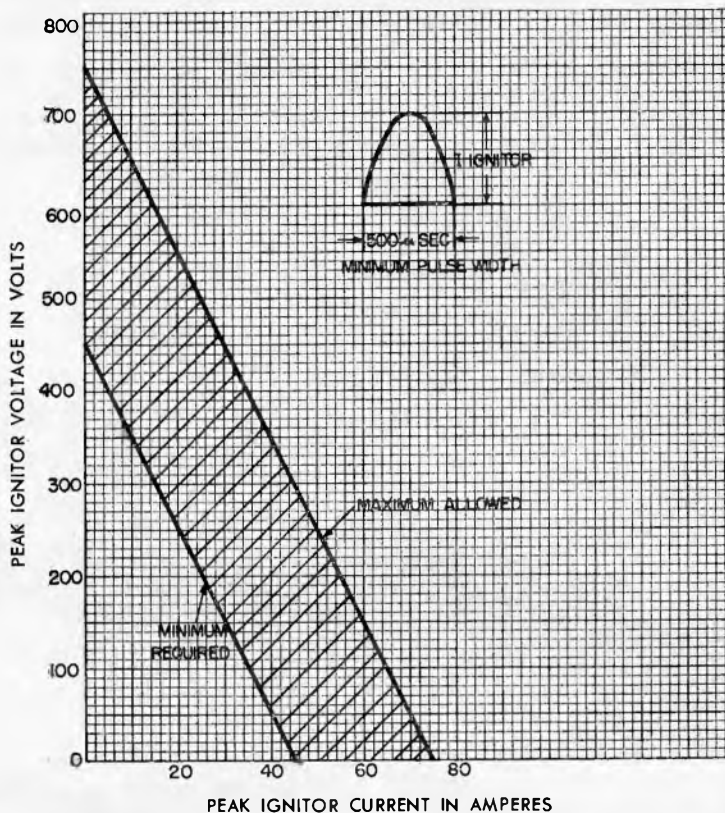
- Water-Control Thermostat—N15272AA
- Over-Temperature Thermostat—N15273AA

Terminal-Block Type

- Water-Control Thermostat—N15286AA
- Over-Temperature Thermostat—N15287AA

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

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



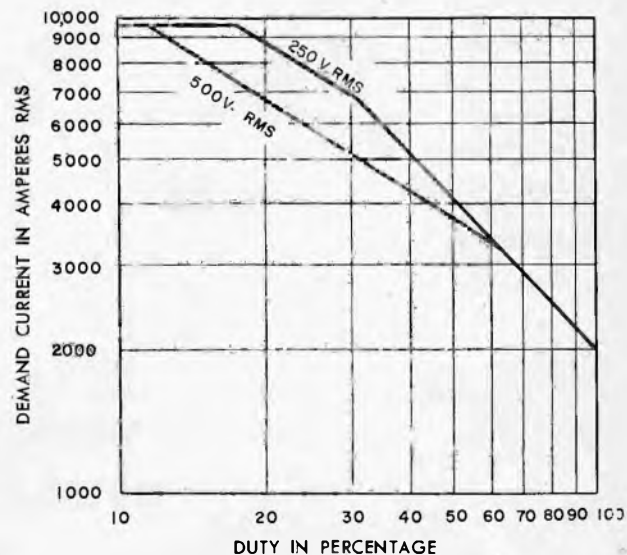
K-69087-72A741

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DEMAND CURRENT VS PERCENTAGE DUTY

TWO TUBES CONNECTED IN INVERSE PARALLEL

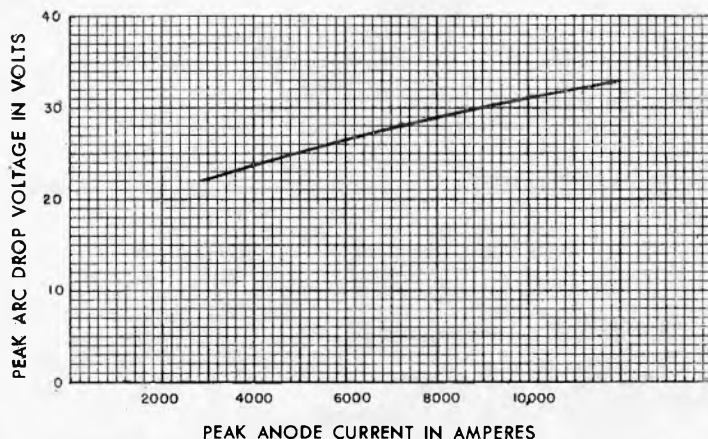
Averaging Time
250 Volts—8.9 Seconds
500 Volts—4.5 Seconds



K-69087-72A854

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ARC DROP



K-69087-72A847

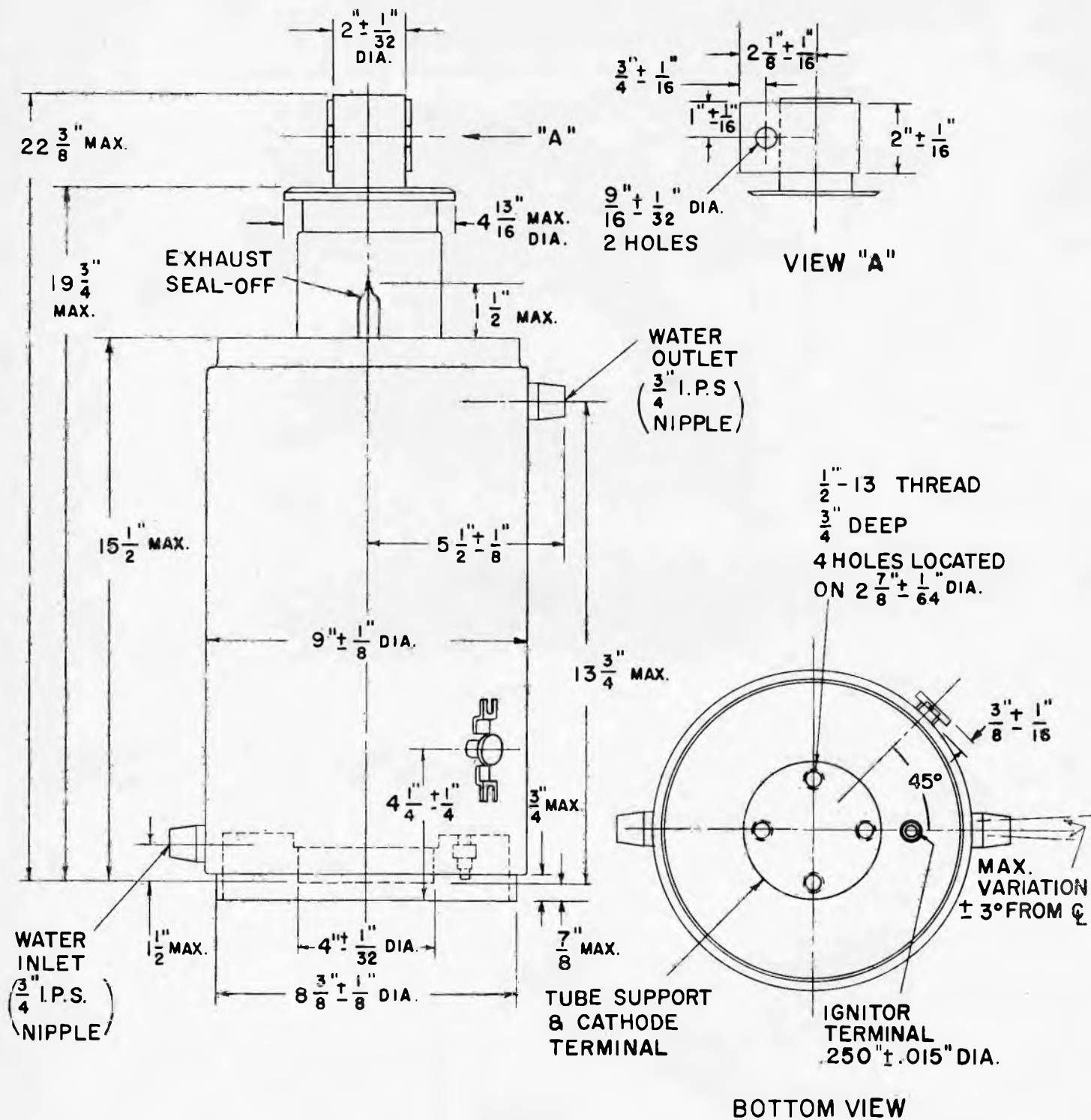
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GL-7151

ET-T1511

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K-69087-72A816

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ELECTRONIC COMPONENTS DIVISION

GENERAL

ELECTRIC

Schenectady 5, N. Y.

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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.

TECHNICAL INFORMATION

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

TECHNICAL INFORMATION (CONT'D)

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 on Page Three 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 Micro-second
Minimum.....	1400	Amperes per Micro-second
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 on Page Three 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 Micro-second
Minimum.....	1400	Amperes per Micro-second
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

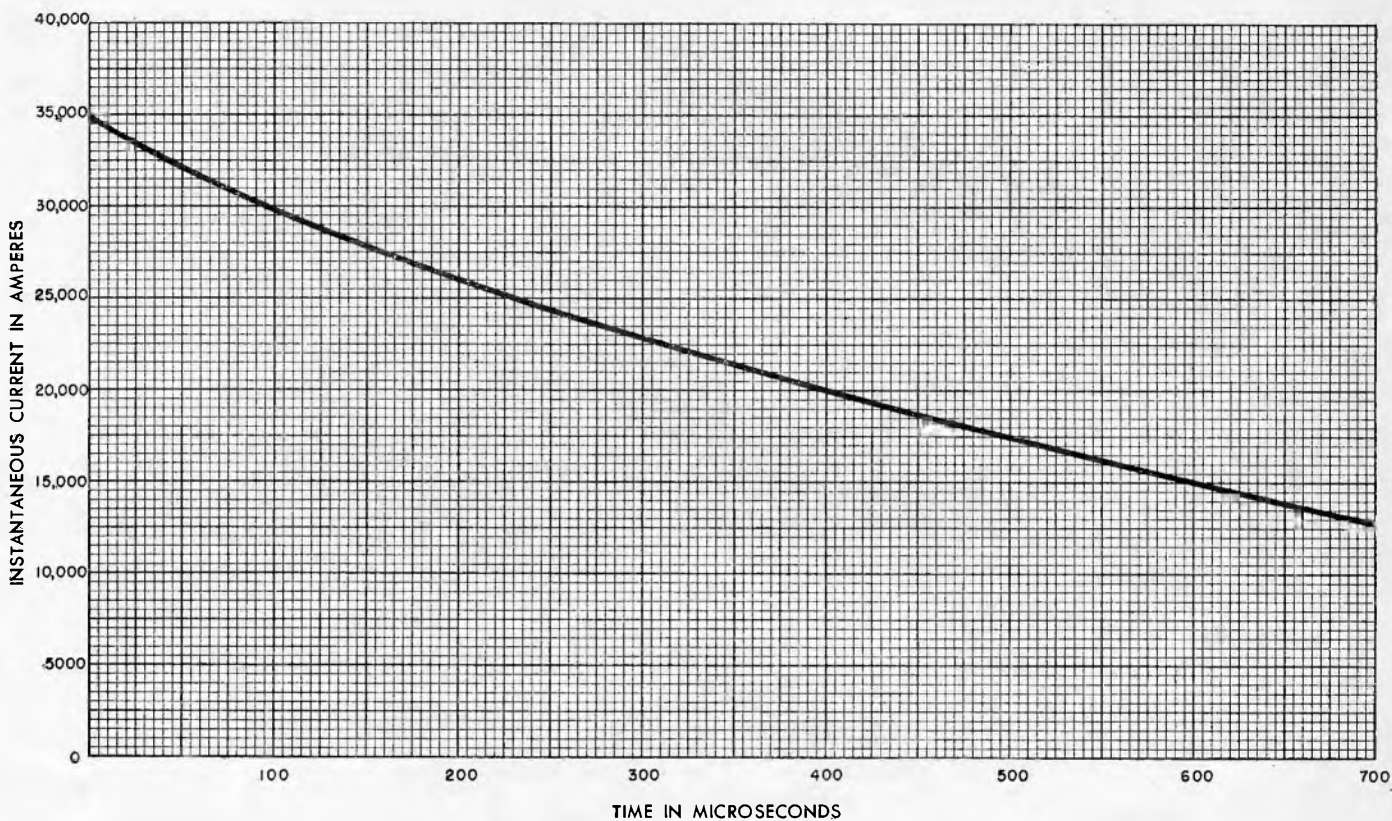
*To prevent mercury condensation, the anode-header temperature should be higher than the cathode temperature at all times. Mercury must be kept away from the anode and anode seals. Before tube operation, the anode seals must be warmed, with respect to the cathode, long enough to vaporize all mercury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

†Damped 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.

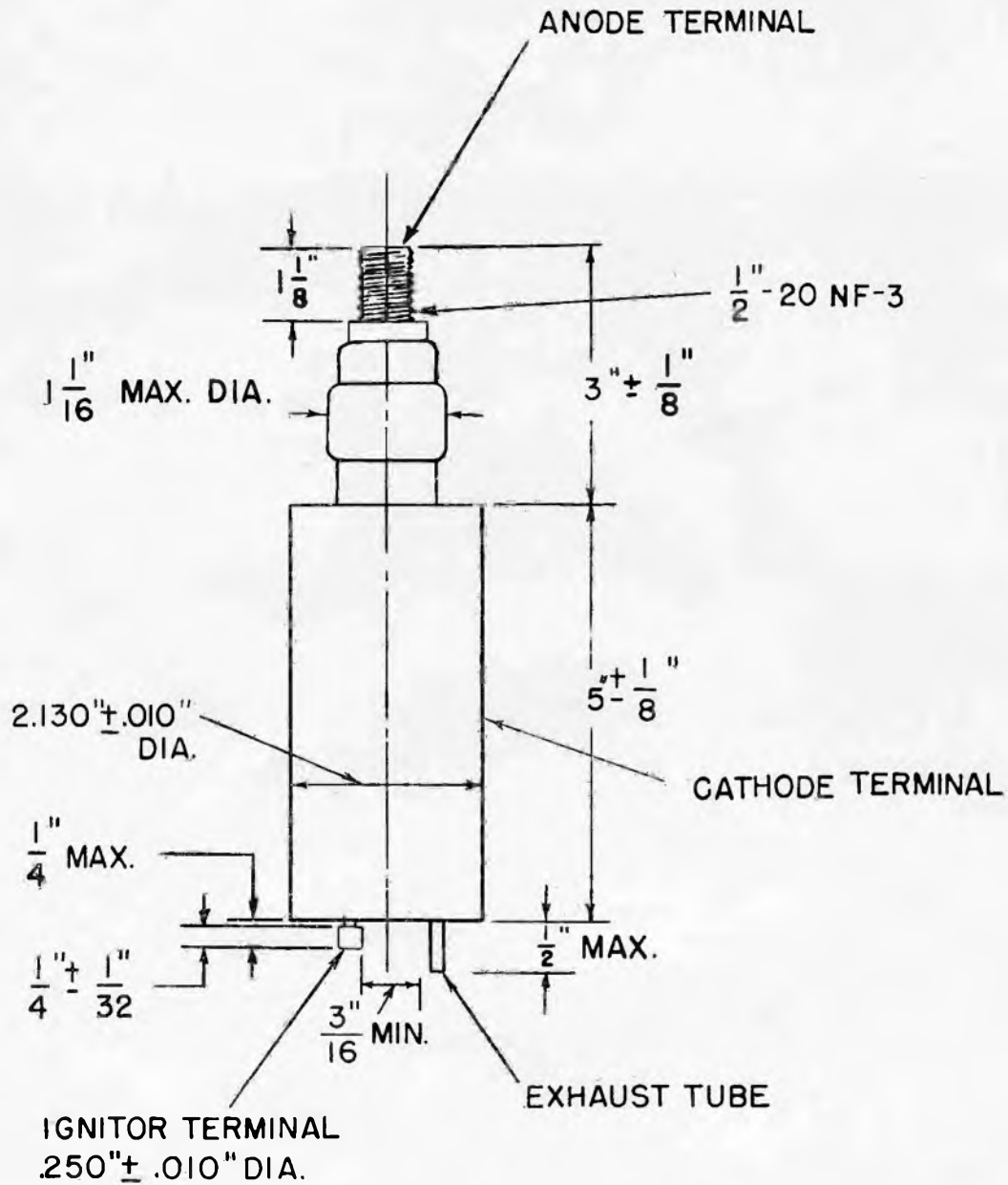
CURRENT-WAVEFORM CURVE

MAXIMUM PERMISSIBLE CURRENT



K-69087-72A858

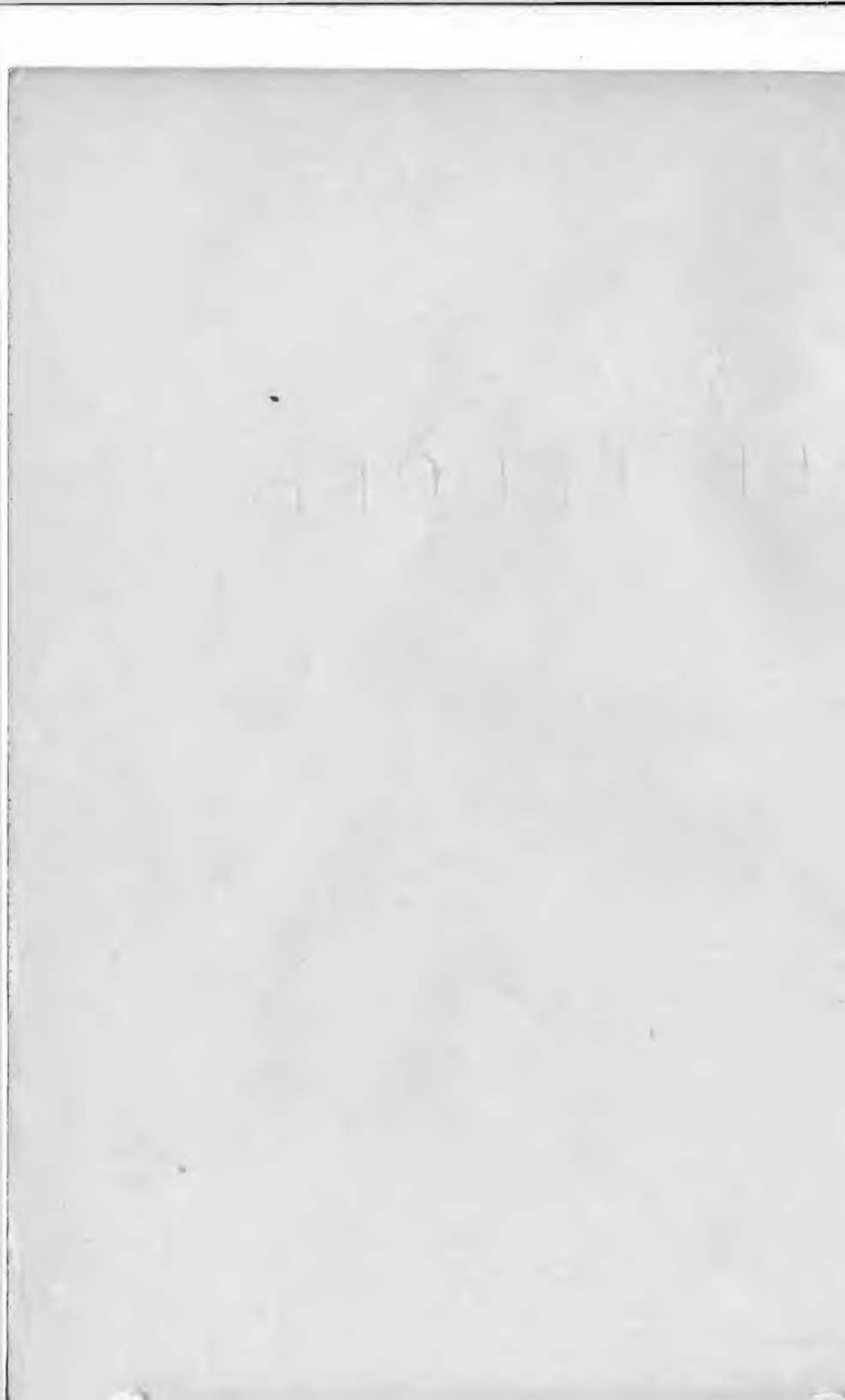
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K-69087-72A819

9-8-58

ELECTRONIC COMPONENTS DIVISION
GENERAL ELECTRIC
Schenectady 5, N. Y.



THYRATRONS

GENERAL  ELECTRIC

THYRATRONS



DESCRIPTION

A thyratron is a thermionic gas tube in which one or more electrodes initiate the current flow.

The gas used may be one of the inert gases such as argon, xenon, or helium, or the vapor pressure of a few drops of mercury. The presence of this gas neutralizes by ionization, the electron space-charge around the cathode created by the electrons emitted from it. This space-charge, which is negative in effect and tends to drive the electrons back into the cathode, is one of the limitations on the amount of current a high-vacuum electronic tube can carry. Another limitation of high-vacuum tubes is the ability of the cathode to emit the electrons which comprise the unidirectional current flow. This factor however, can be controlled by design of an electron-emitting source satisfactory for the size of the tube required.

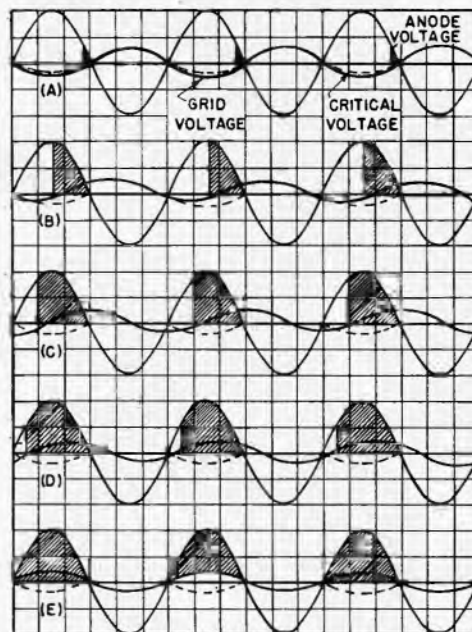
The absence of space charge and its accompanying losses in the thyratron allows larger electrode spacing and smaller-size electrodes for a given current-carrying capacity than is possible with high-vacuum tubes. The elimination of space-charge also permits the use of an electron-emitting cathode of higher efficiency and much larger current-carrying capabilities than otherwise could be used. A gas-filled tube, therefore, can carry much higher current than a high-vacuum tube of corresponding dimensions. The vapor pressure, however, is sufficiently low so that the anode can withstand, when negative, the voltage for which the tube is designed.

The construction of the thyratron is similar to that of the phanotron. In the thyratron, however, the addition of an electrode called a grid increases greatly the usefulness of the tube. Inasmuch as the action of the grid is quite different from that of the grid in the high-vacuum three-electrode tube, it is necessary to describe its action in detail.

The grid, as employed in the thyratron, controls only the starting of the discharge. After starting, under usual operating conditions, it neither modulates, limits, nor extinguishes the arc. Herein lies the fundamental difference between the thyratron as ordinarily used, and the high-vacuum tube. In a gas tube, the positive ions neutralize the space-charge with the result that a prohibitively high current would have to be supplied to the grid before it could gain control with anode current flowing. In order to enable the grid to act with practical amounts of current, the anode voltage must be reduced substantially to zero or made negative for a period long enough for the gas or vapor to become deionized. Once this deionization takes place the grid can resume control. In a high-vacuum tube, since this ionization is not present, the grid can control the flow of current. Any change in the grid voltage of a high-vacuum tube will cause a corresponding change in the current. If an alternating voltage is applied to the anode of the thyratron, the grid has an opportunity to regain control once each cycle and can delay the starting of the arc for as long a period during the subsequent positive half-cycle as the grid voltage is sufficiently negative. This

means that the grid can control the average current flowing through the tube and that this averaging can be made as fine-grained as desired by increasing the frequency of interruption.

If the grid as well as the anode is supplied with alternating current, the phase relation between the grid and anode determines the amount of average current passing through the tube. Fig. 1 shows the wave forms occurring with a shift in phase between the grid and anode. Example A shows the wave forms with the tube in an almost nonconductive condition, while E illustrates rectification throughout the entire half wave. The other diagrams show several intermediate stages of grid control.



K-9033592

1-10-45

Fig. 1—Control of Thyatron Anode Current by Variations in the Grid Voltage

The voltage conditions for starting the current depend largely upon the structural design of the tube. A tube may be designed so that within the normal anode voltage limits the current always starts at a negative grid voltage, always at a positive grid voltage, or at a negative voltage for high anode voltages and a positive voltage for low anode voltages.

Negative-control tubes require relatively little grid power and are therefore suitable for use with high-impedance circuits.

Positive-control tubes are useful in applications where it is desired that no current flow in the absence of grid excitation.

The intermediate type of tube is often used in inverter circuits and is usually designed to ensure as rapid deionization as possible, as the time allowed for deionization in certain circuits is sometimes very short.

DEFINITIONS OF RATINGS

The ratings of gas-discharge tubes are given in terms of fundamental conditions on the tube itself rather than in terms of any circuit constants. Values for a particular tube are given on the individual tube descriptive sheets, (i.e., in terms of actual anode voltage and current, grid voltage and current, etc.).

The **Maximum Peak Inverse Voltage** is a rating which is common to both thyratrons and phanotrons. It is the highest instantaneous voltage that the tube will safely withstand in the direction opposite to that in which it is designed to pass current and depends upon operation within the specified temperature range and within the surge current rating. It should be emphasized that the maximum rating of the tube refers to the actual inverse voltage and not to the calculated values. A cathode-ray oscilloscope or a spark gap connected across the tube is useful in determining the actual peak inverse voltage.

The **Maximum Peak Forward Voltage** is a rating which applies only to thyratrons. It is the maximum instantaneous voltage that can be held back by the action of a suitable grid voltage and for mercury-vapor tubes depends particularly upon operation within the maximum temperature specified.

The **Maximum Instantaneous Anode Current** is the highest instantaneous current that a tube can safely conduct under normal operating conditions in the direction of normal current flow.

The **Maximum Surge Current** rating is a measure of the ability of a tube to withstand extremely high transient currents; it is also a measure of the stiffness of the anode circuit in which the tube will operate satisfactorily at rated temperature and with maximum peak inverse voltage applied.

The **Maximum Average Anode Current** is a rating based on tube heating. It is the highest average current which can be carried continuously through the tube.

The grid current ratings are given in terms of the **Maximum Instantaneous Grid Current** and the **Maximum Average Grid Current**; the integration period is the same as that for the anode current.

Thyratrons are built in both glass and metal envelopes. The higher voltage tubes utilize glass construction for ease of insulation. Tubes built for control of large amounts of power at lower voltages (as for motor control and welding applications) are of metal construction to withstand handling and shock, and are adapted for panel-mounting, whereas smaller tubes are generally socket-mounted and may even have all electrodes connected at one end

In addition to the above ratings, there are a number of other tube characteristics. The **Voltage Drop** from anode to cathode is a characteristic which becomes important when the anode supply voltage is low, as it then becomes a large part of the working voltage. The typical voltage drop which may be encountered is included in the tube ratings, and the maximum is given in the Specifications. This includes the effect of temperature change during tube life and variation between individual tubes.

The **Control Characteristic** shows the relation between grid and anode voltage for the starting of a discharge, and gives the range of variations between tubes held at a condensed-mercury temperature of 40 C. In the case of gas tubes, temperature is not an important factor, The control characteristic is affected somewhat by the temperature, and this information is also available in the form of characteristic curves.

The **Ionization Time** may be defined as the time required for conduction to occur when the tube is operated with ample anode voltage and with the grid or grids at a potential substantially more positive than required for discharge.

The **Deionization Time** is the time required under normal conditions to bring about the deionization necessary to regain control. The time given is based on a condition of full maximum average anode current and condensed-mercury temperature of 40 C.

Condensed-Mercury Temperature is the temperature which controls the mercury-vapor pressure and hence many of the tube characteristics. This is measured on the bulb just above the base, the point where the mercury vapor is condensing within the tube. Satisfactory tube operation depends upon operating within the specified temperature limits. When the tube is being heated it must be remembered that the heating time specified on the Description and Rating sheets refers only to the cathode. Additional heating must be allowed to bring the condensed-mercury temperature within limits.

CLASSES OF TUBES

for ease of installation and conservation of space.

Mercury tubes are available where temperature can easily be controlled. Tubes with insert-gas filling are available for those applications where a wide range of ambient temperatures will be encountered. Where inert gas is used the tube characteristics vary only with pressure of the gas and are essentially independent of normal temperature changes.

APPLICATION CIRCUITS#

The versatility of these gas-filled tubes gives them a wide field of application. One of their ap-

#Circuits shown in ETI-116 are examples of possible tube applications and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company.

plications is the control of the speed of d-c motors. One of the first motor speed-control applications was completed in 1929. Other trials followed and there is now a large demand for Thy-Mo-Trol (GE's trademark for motor control using electronic tubes) drives, by which d-c motors are operated from

APPLICATION CIRCUITS (CONT'D)

constant potential a-c systems. These can provide speed control over ranges even larger than one hundred to one, operating at constant torque below basic speed by means of armature control and at constant horsepower above basic speed by means of field control. A circuit for such an application is shown in Fig. 2 below.

Some of the uses to which such a circuit may be applied include the maintenance of the correct tension during the reeling of the wire output of wire-drawing machines, the correlation of the speeds of various sections of rubber process conveyors to maintain a given loop of rubber sheet between the conveyor sections. It may be used to vary over wide ranges the speed of d-c motors driving frequency changers which supply power to highspeed textile motors, and to maintain the speed of the motors within narrow limits at any given setting, in spite of wide load changes. Used in these and similar applications, the thyatron provides an efficient, dependable aid to modern industry.

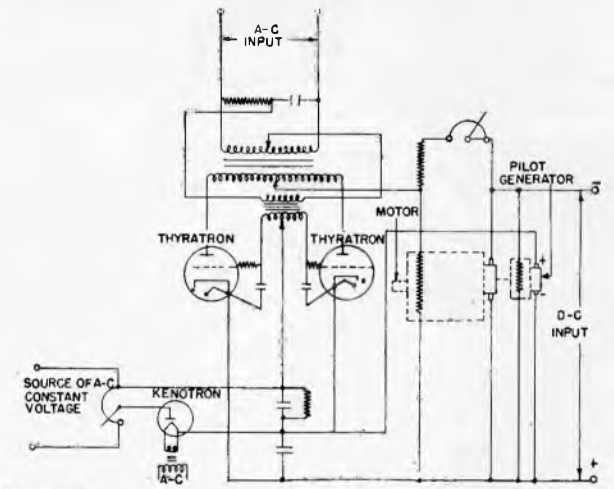


Fig. 2—Electron Tube Motor Control Circuit

Another application is the thyatron motor-control circuit illustrated in Fig. 3 below. This is another circuit arrangement which can be used to operate a motor at constant speed in spite of wide load changes. The error signal may be

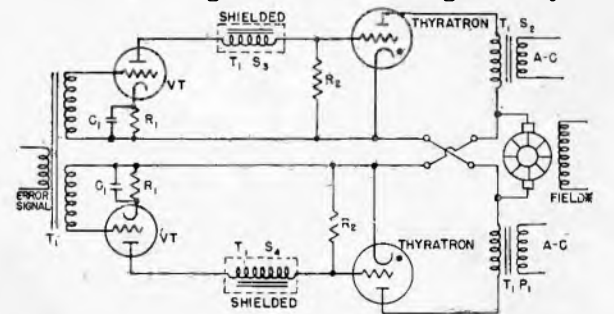


Fig. 3—Motor Control Circuit (*The Field of the D-c Motor is Supplied from a Separate D-c Source)

obtained from a tachometer and standard source of voltage.

The use of gas-filled tubes for the control of power flow to resistance welders has revolutionized the fabrication of high-production units by accurate timing and uniform heating; the welding of high-strength aluminum alloys has been made practical by the use of thyatron control. Welders so controlled vary in size from 3 to 5 kilovolt-amperes to as high as 2000 kilovolt-amperes. A typical welder-control circuit is shown in Fig. 4 below.

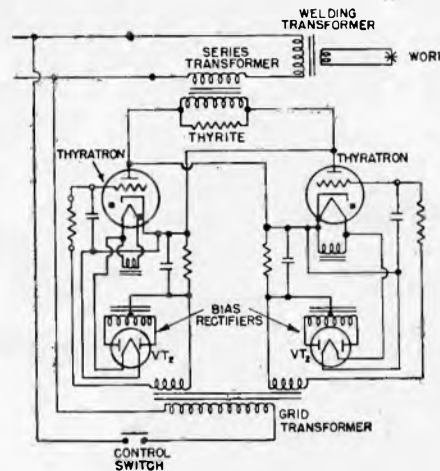


Fig. 4—Thyatron Welder-Control Circuit

One of the first large industrial applications of the thyatron tube was the light-drawing control board of the Chicago Civic Opera. This was followed by that of the Radio City Music Hall where 313 lighting circuits were controlled electronically. Many subsequent applications have proved the greater smoothness, efficiency, and flexibility of tube control, particularly with large numbers of circuits, than can be obtained with the conventional resistor board. A circuit for illumination control is illustrated in Fig. 5. The same basic scheme, using a saturable reactor may be applied to electric furnaces where thyatron rectifiers provide precision temperature control.

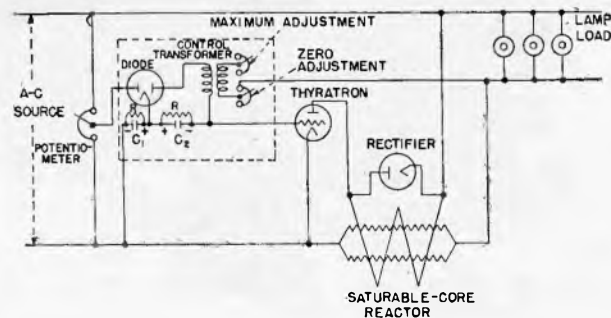


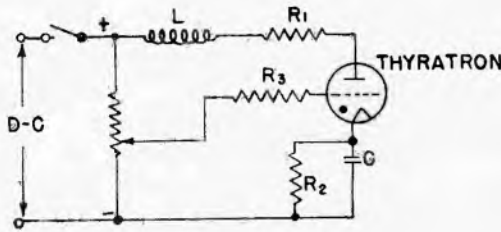
Fig. 5—Feed-back Circuit Used in Illumination Control

Fig. 5—Henney, *Electron Tubes in Industry*, P-250; McGraw-Hill Book Co., Inc., 1937

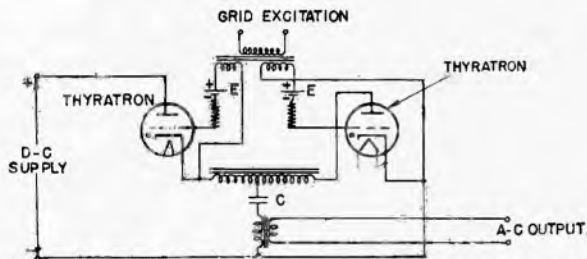
Potentiometers are provided to adjust circuits properly when the intensity control is set at maximum and at zero. These adjustments are made easily at the time of installation and are fixed thereafter.

The feed-back circuit compares the voltage on the lamps with the voltage from the intensity control and acts on the grid of the controlled rectifier to hold the lamp voltage constant for any one setting of the intensity control.

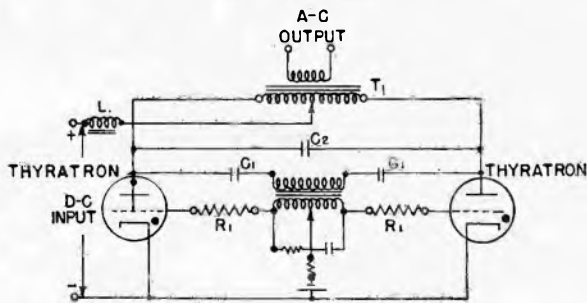
Gas-filled tubes may be used in inverter circuits for the conversion of d-c to a-c power, using the deionization time of the tube for commutation. Three typical inverter circuits are shown in Figs. 6, 7, and 8.



K-9033511 Fig. 6—Fundamental Single-Tube Inverter Circuit 10-14-44



K-9033586 Fig. 7—A Series Connection of Thyratrons for Inverter Operation J-9-45

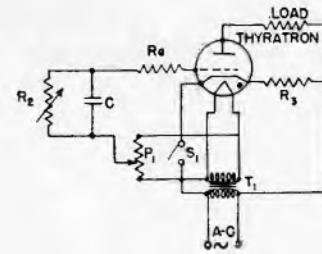


K-9033512 Fig. 8—Self-excited Parallel-type Inverter Circuit 10-14-44

The time-delay circuit shown in Fig. 9 may be used for timing purposes in switching sequences for delayed applications of power, for printing presses, and for welding.

Fig. 6—Henney, *Electron Tubes in Industry*, P-232; McGraw-Hill Book Co., Inc., 1937

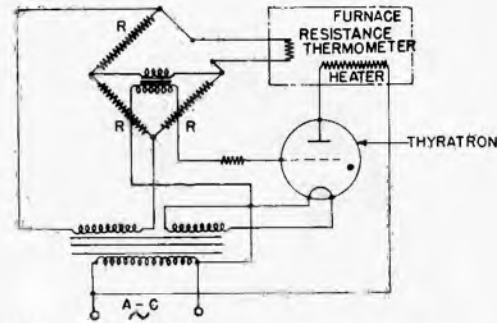
Figs. 7, 8, 10 and 12—Hull, A. W., *General Electric Review*, Vol. 32, No. 7; July 1929.



K-9033510 Fig. 9—Time-Delay Circuit 10-14-44

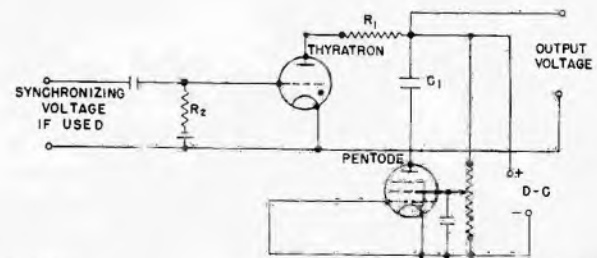
Another use of the thyatron is in temperature-control applications. A circuit for high-temperature control is shown in Fig. 10 below.

This circuit is generally applicable at temperatures for which a resistance thermometer may be used to form one arm of the a-c Wheatstone bridge. Variation of resistance of any arm of the bridge controls the normal temperature which is obtained. The thyatron is used to control the operation of current contactors when the heater current is extremely high.



K-9033563 Fig. 10—High-temperature Control Circuit 1-1-45

The thyatron may be utilized in relaxation-oscillator circuits to provide a linear time base for cathode-ray oscilloscopes. A relaxation-oscillator circuit is shown in Fig. 11 below in which R_1 and C_1 determine the frequency of operation.

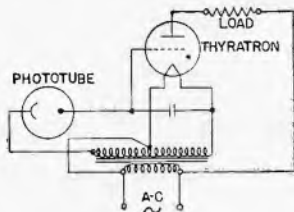


K-9033506 Fig. 11—Relaxation Oscillator Circuit, for Time Base 10-14-44

Figs. 9 and 11—Maddock, A. J., *Journal of Scientific Instruments*, March 1943.

APPLICATION CIRCUITS (CONT'D)

Thyratrons used with phototubes in circuits, such as that shown in Fig. 12 provide a fast, trouble-free, automatic means for counting articles or persons, or for operating doors. It is useful in many switching operations. The turning on of lights, when daylight falls below a certain level of intensity is an example.

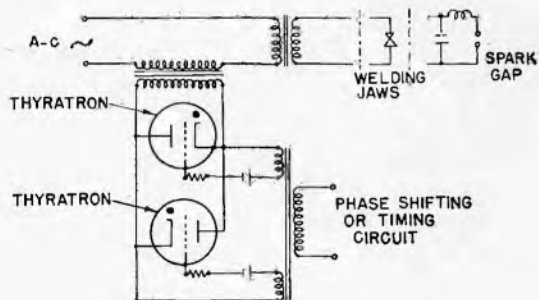


K-9033509

10-14-44

Fig. 12—Photoelectric Relay with a Thyratron (On-off Control Circuit)

Thyratrons are used to control the duration and amount of current passing for welding, X-ray work, or spectographic analysis using spark electrodes. A circuit for such applications is shown in Fig. 13.



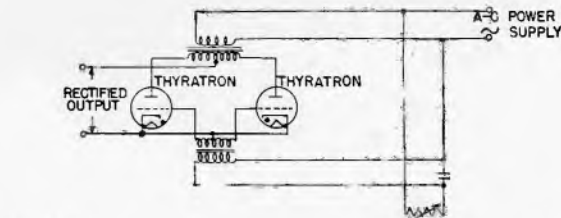
K-9033524

1-1-45

Fig. 13—Impedance Control of Alternating Current

Tubes are selected for these applications by consideration of the ratings, including peak and average currents to be conducted, and peak inverse and forward voltages to be applied.

If very high-impedance grid-supply voltage is to be used, a tube of shielded-grid construction

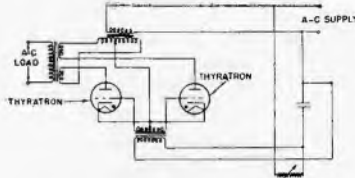


K-9033502

10-14-44

Fig. 14—Variable Resistance Method of Control Producing Variation in Phase Between Resistance and Capacity Voltages

Since thyratrons are essentially rectifiers, one of their main uses is in rectifier circuits providing controlled d-c from an a-c source. Two circuits that may be used for power supply applications are shown in Figs. 14 and 15. Fig. 14 shows an arrangement designed to supply d-c power from an a-c source while Fig. 15 shows a means of supplying a load with variable a-c power from an a-c source.



K-9033565

1-1-45

Fig. 15—Power Supply Circuit Using Thyratrons (Supplying Variable A-c Power from an A-c Source)

In general, applications of these tubes can be used to provide faster operation, reduced maintenance and more precise control than can be accomplished by other methods. The automatic operation, amplification of power, quiet operation, flexibility, and saving of space, are additional features valuable for many industrial applications.

CIRCUIT DESIGN

should be chosen so that the grid current will be small and cause negligible drop in the supply. Ambient temperatures should be considered and mercury tubes used only where the condensed mercury can be held at temperatures above + 40 C.

CIRCUITS

The circuits illustrated are examples of types that may be used in some of the applications discussed in this article. It is impossible to illustrate in any discussion reasonably brief even a fraction of the circuits in which these tubes may be used for specific applications. Those illustrated show a few of the basic circuits for some of the major applications. Many of the others are modifications or com-

binations of these for the particular requirements of the task the tubes may be called upon to perform.

When a tube has been chosen for the application, the Specifications should be consulted to determine the limits of operation. The remainder of the circuit constants, voltages, and currents may then be checked to assure satisfactory operation of all tubes within the specified limits.

Fig. 13—Griffith, R. C., *General Electric Review*, Vol. 33, No. 9, Sept. 1930.

Fig. 14—Henney, *Electron Tubes in Industry*, P-198; McGraw-Hill Book Co., Inc., 1937

INSTALLATION

Mechanical

Thyratrons should be mounted in sockets or supports of good quality with connections of sufficient current-carrying capacity. A shock-absorbing mounting must be used if the tube is to be subjected to excessive vibration or sudden shock.

Electrical

The cathode should be operated preferably from an a-c source. If alternating current is not available, a d-c source may be used.

The cathode must assume operating temperature before electron current is drawn. The delay may be accomplished either by manual or automatic control of the anode or grid circuit. The time required for the cathode to come up to normal operating temperature is included under Technical

Information. In the case of mercury-filled tubes, it is also necessary to bring the condensed-mercury temperature to the minimum operating value.

Thermal

When a mercury-vapor thyratron tube is first placed in operation, it is necessary to distribute the mercury properly before anode voltage is applied. This is usually accomplished by applying filament voltage to distill the mercury into the cooling chamber of the tube. The location of the cooling chamber is indicated on the outline drawing by the words "controlling mercury temperature."

The design of equipment should allow the tube to operate within the condensed-mercury temperature limits over the range of ambient temperatures to be encountered.

OPERATION

Four of the fundamental limits on the operation of thyratron tubes are the maximum peak inverse anode voltage, maximum peak forward anode voltage, maximum instantaneous anode current, and the maximum average anode current. These ratings were previously defined under "Definitions of Ratings."

Cathode Circuit

The cathode voltage should not deviate from the rated value by more than five per cent and the cathode should be allowed to attain operating temperature before any other potential is applied. Filament voltage should be set so that voltage fluctuations give an average value equal to the rated filament voltage. Too low filament voltage may result in very short life or perhaps immediate failure due to loss of emission. Too high voltage will shorten the life of the cathode somewhat.

Anode Circuit

Maximum Peak Inverse Voltage—The relations between the peak inverse voltage, the direct voltage, and the rms value of alternating voltage depend largely upon the individual characteristics of the rectifier circuit and the power supply. The presence of line surges, keying surges, or any other transient or wave-form distortion may raise the actual peak voltage to a value which is higher than that calculated from the sine-wave voltages in the transformer.

Maximum Instantaneous Anode Current—The ability of a given tube to conduct this instantaneous current without excessive voltage drop will depend upon cathode heating and the condition of the emitting surface.

Maximum Surge Current—The rating is intended to form a basis for set design in limiting the abnormal currents that occur during short-circuit

conditions. It does not mean that the tube can be subjected to repeated short circuits without the probability of a corresponding reduction in life and the possibility of a failure.

Maximum Average Anode Current—In the case of a rapidly repeating duty cycle, this current may be measured on a d-c meter. Otherwise, it is necessary to calculate the average current over a period not to exceed a definite interval of time which is specified for each design of tube. For example, in a two-tube, 60-cycle rectifier feeding into an inductive load (so that the tube conducts approximately half the time with a square wave) a tube with a maximum instantaneous anode current of 15 amperes, a maximum average current of 2.5 amperes, and an integration period of 15 seconds, can carry a series of 15-ampere, 180-degree blocks of current (half the time) for 5 seconds out of each 15 seconds, or a series of 7.5-ampere, 180-degree blocks of current (half the time) for 10 seconds out of each 15 seconds.

Ionization Time—This time varies with the wave form and amplitude of the impressed grid voltage. When the tube is operated under normal conditions, this time will not exceed the value given.

Deionization Time—This time is dependent on temperature, grid voltage, anode voltage, and instantaneous anode current. The value under normal conditions is included under Technical Information.

The ionization and deionization times place a limitation on the maximum frequency at which the tubes can operate for any set of conditions.

The Voltage Drop—Where uninterrupted service is desired, the tube voltage drop should be checked at regular intervals by means of a cathode-ray oscilloscope or other suitable means. This drop is one criterion of tube condition, and its rapid rise from one test to the next will anticipate failure.

Grid Circuit

Approximate Control Characteristic—Since the control characteristic varies with individual tubes, only average curves can be given. In the case of mercury-vapor tubes, variation is also experienced as a function of temperature. For these reasons, and because of variable grid currents, it is always advisable in practice to supply the grid with several times the voltage apparently necessary.

Whenever possible, a phase shift or some other method of control which does not give an objectionable error due to these changes in characteristic should be used. This method permits fixing the time of starting of anode current anywhere in the positive half cycle of anode voltage.

The average value of anode current is thereby completely controlled for variations from zero to maximum.

For a strictly on-and-off control, the magnitude method is satisfactory provided ample voltages are used on the grids. With the phase-shift method, more uniform control is obtainable since an excess of these voltages may be used at all times. This method eliminates the effects of grid currents, variation in grid supply voltages and variation in starting characteristic.

Note: The ratings and characteristics of a particular tube are given under Technical Information on the Description and Rating sheet for that tube.

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THYRATRONS

Recommended Types and Selection Chart

Peak Cathode Current in Amperes*			Max Peak Inverse Voltage	Control Characteristics†			Cathode		Max Temperature Range	Tube Type	
Average	Peak	Fault		At 100 Volts	Intermediate Voltage	At 1000 Volts	Volts	Amperes			
0.5	2.0	40	5000	-1.0	.....	-7.0	2.5	5.0	+40 to +80	GL-5557
1.0	1000	.....	25,000	.....	.....	.....	6.3	30.0	-50 to +75	GL-5948‡
1.5	6.0	120	1250	-2.5	.....	-5.0	2.5	7.0	-40 to +80	GL-3C23
		55	1250	-2.5	.....	-5.5	2.5	7.0	-40 to +80	GL-393-A
2.5	15	200	1000	-1.6	.....	-6.5	5.0	4.5	+40 to +80	GL-5559
	30	250	1500	+1.0	.....	-9.0	5.0	4.5	+40 to +80	GL-5560
3.2	40	560	1500	-1.0	.....	-5.0	2.5	9.0	-40 to +80	GL-6011/710
		.....	.....	0	.....	-8.0	2.5	12.0	-55 to +70	GL-5544§
6.4	77	400	2000	+2.0	.....	-9.0	5.0	10.0	+30 to +95	FG-172
		10,000	.....	+1.0	.....	-9.0	5.0	10.0	+25 to +95	FG-105
12.5	80	1120	1500	0	.....	-6.0	2.5	21.0	-55 to +70	GL-6807§|| GL-6808 GL-6809
		+1.0@1000V -6.0@8000V	5.0	20.0	+40 to +65	GL-5830
18.0	160	2000	1500	0@200V	5.0	19.0	+40 to +80	GL-414
		0@300V	2.5	34.0	-55 to +70	GL-5855§

* Values listed are maximum values and do not apply for all types of application. Refer to data sheet for detailed information.

† Grid characteristic ratings are bogey values. The screen-grid voltage is zero for four-element tubes.

‡ Designed for pulse switching applications.

§ Designed for a high commutation factor.

|| Tubes identical except for bases.

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THYRATRON

TRIODE TYPE NEGATIVE CONTROL CHARACTERISTIC
INERT-GAS AND MERCURY-VAPOR

The GL-3C23 is a 3-electrode mercury-vapor and inert-gas-filled thyratron with negative control characteristic. The mixture of inert-gas and mercury-vapor provides constancy of characteristic

within wide temperature limits. The construction however, enables the tube to withstand higher voltages than many gas-filled types.

TECHNICAL INFORMATION

GENERAL

Electrical

	Minimum	Bogey	Maximum	
Cathode—Filamentary				
① Filament Voltage	2.37	2.50	2.62	Volts
② Filament Current at 2.50 Volts	6.25	7.0	7.75	Amperes
Heating Time Required	15			Seconds
Anode-to-Control-Grid Capacitance		1.8		μf
Deionization Time, approximate		1000		Microseconds
Ionization Time, approximate		10		Microseconds
Anode Voltage Drop		15		Volts

Mechanical

Type of Cooling—Convection

Equilibrium Condensed-Mercury Temperature

Rise Above Ambient, typical

At Full Load 22 C

At No Load 18 C

Mounting Position—Vertical, Base Down

Net Weight, maximum 3 Ounces

GENERAL  ELECTRIC

Supersedes ETI-117B dated 4-51

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS, Absolute Values

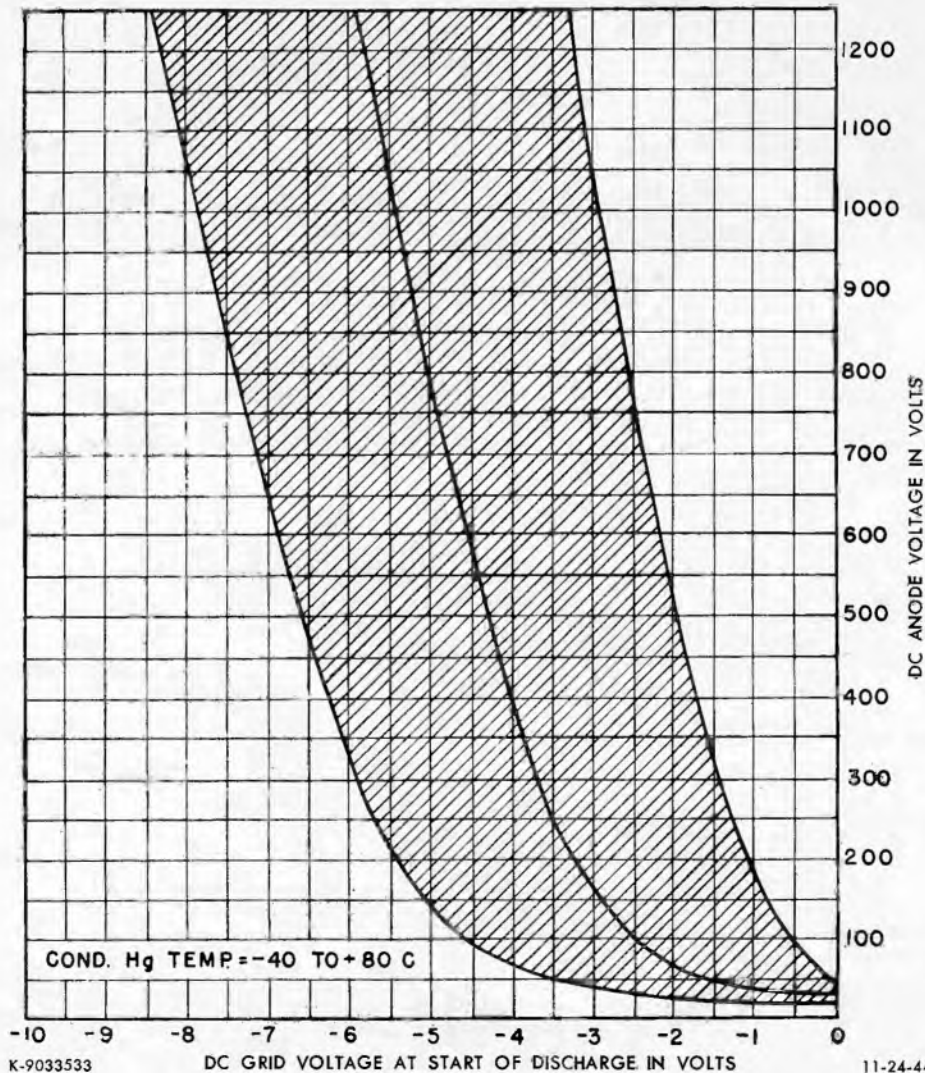
Maximum Peak Anode Voltage		
Inverse	200	1250 Volts
Forward	200	1250 Volts
Condensed-Mercury Temperature Limits*	-40 to +100	-40 to +80 C
Maximum Cathode Current		
Peak	6.0	6.0 Amperes
Average	1.5	1.5 Amperes
<input type="checkbox"/> Maximum Averaging Time	5	5 Seconds
Fault	120	120 Amperes
Maximum Duration	0.1	0.1 Seconds
Maximum Negative Control-Grid Voltage		
Before Conduction	500	500 Volts
During Conduction	10	10 Volts
Maximum Positive Control-Grid Current		
Average, averaging time—one cycle	0.010	0.010 Amperes
Maximum Frequency	400	400 Cycles per Second

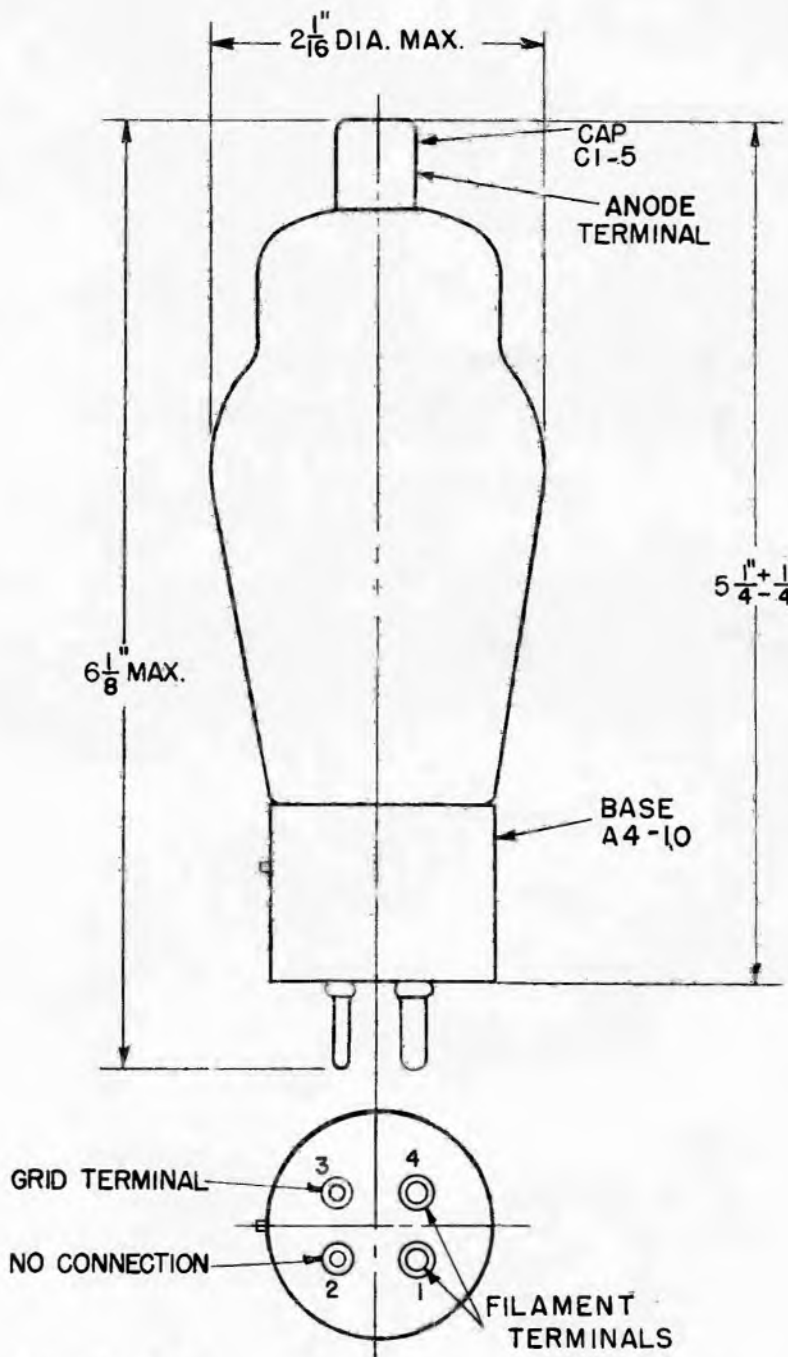
* The tube may be started and satisfactory operation will result between -40 C and +80 C. For maximum life the condensed-mercury temperature after warm-up should be as specified.

Denotes an addition.

⊕ Denotes a change.

TYPICAL CONTROL CHARACTERISTICS
SHADED AREA SHOWS RANGE OF CHARACTERISTIC





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THYRATRON

DESCRIPTION

The FG-27-A is a negative-control mercury-vapor tube for use where it is desired to actuate the tube with a change in negative grid voltage.

It requires relatively little grid power and is suitable for use in relay circuits where current flow is desired in the absence of grid excitation.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 3

Electrical

Cathode—Filamentary type

Filament voltage 5.0 volts

Filament current, approximate 4.5 amperes

Filament heating time, typical 60 seconds

Peak voltage drop, typical 16 volts

Approximate control characteristics

Anode voltage 60 100 1000 volts

Grid voltage 0 -2.25 -8.0 volts

Anode to grid capacitance, approximate 4.4 micromicrofarads

Ionization time, approximate 10 microseconds

Deionization time, approximate 1000 microseconds



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TECHNICAL INFORMATION (CONT'D)

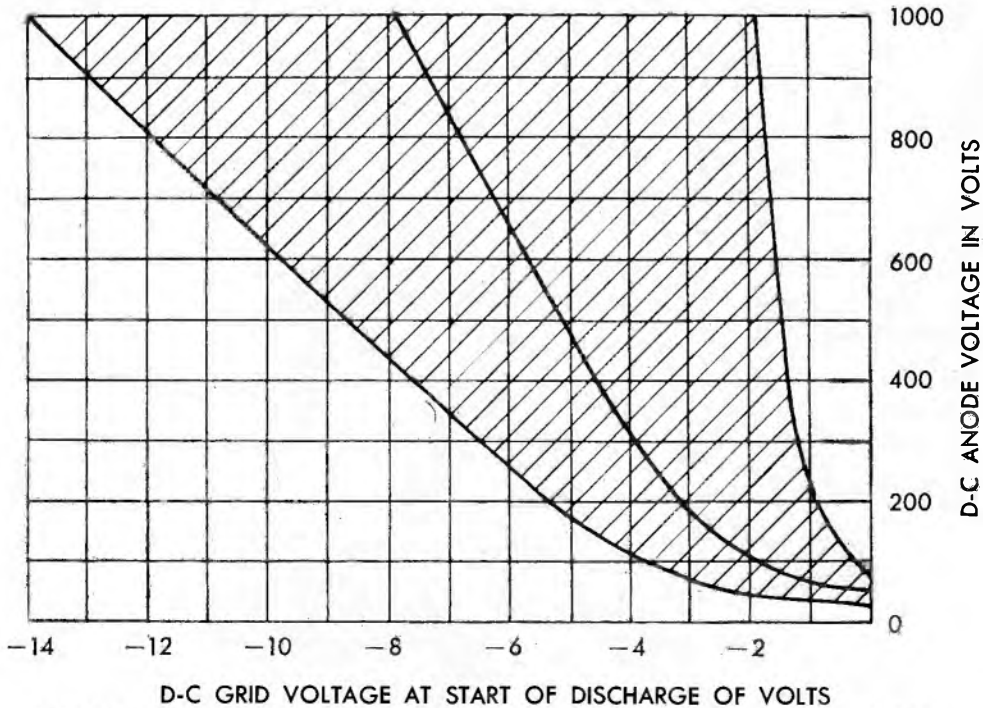
Mechanical

Net weight, approximate	4 ounces
Shipping weight, approximate	3 pounds
Mounting position	vertical, base down

MAXIMUM RATINGS

Maximum peak anode voltage	
Inverse	1000 volts
Forward	1000 volts
Maximum negative grid voltage	
Before conduction	500 volts
During conduction	10 volts
Maximum anode current	
Instantaneous, 25 cycles and above	10.0 amperes
Instantaneous, below 25 cycles	5.0 amperes
Average	2.5 amperes
Surge, for design only	200 amperes
Duration of surge current	0.1 second
Maximum grid current	
Instantaneous	1.0 ampere
Average	0.25 ampere
Maximum time of averaging current	15 seconds
Temperature limits, condensed mercury	+40 to +80 centigrade
Recommended temperature, condensed mercury	+40 centigrade

THYRATRON FG-27-A
TYPICAL CONTROL CHARACTERISTICS
SHADED AREA SHOWS RANGE OF CHARACTERISTICS
CONDENSED MERCURY TEMPERATURE 40 C



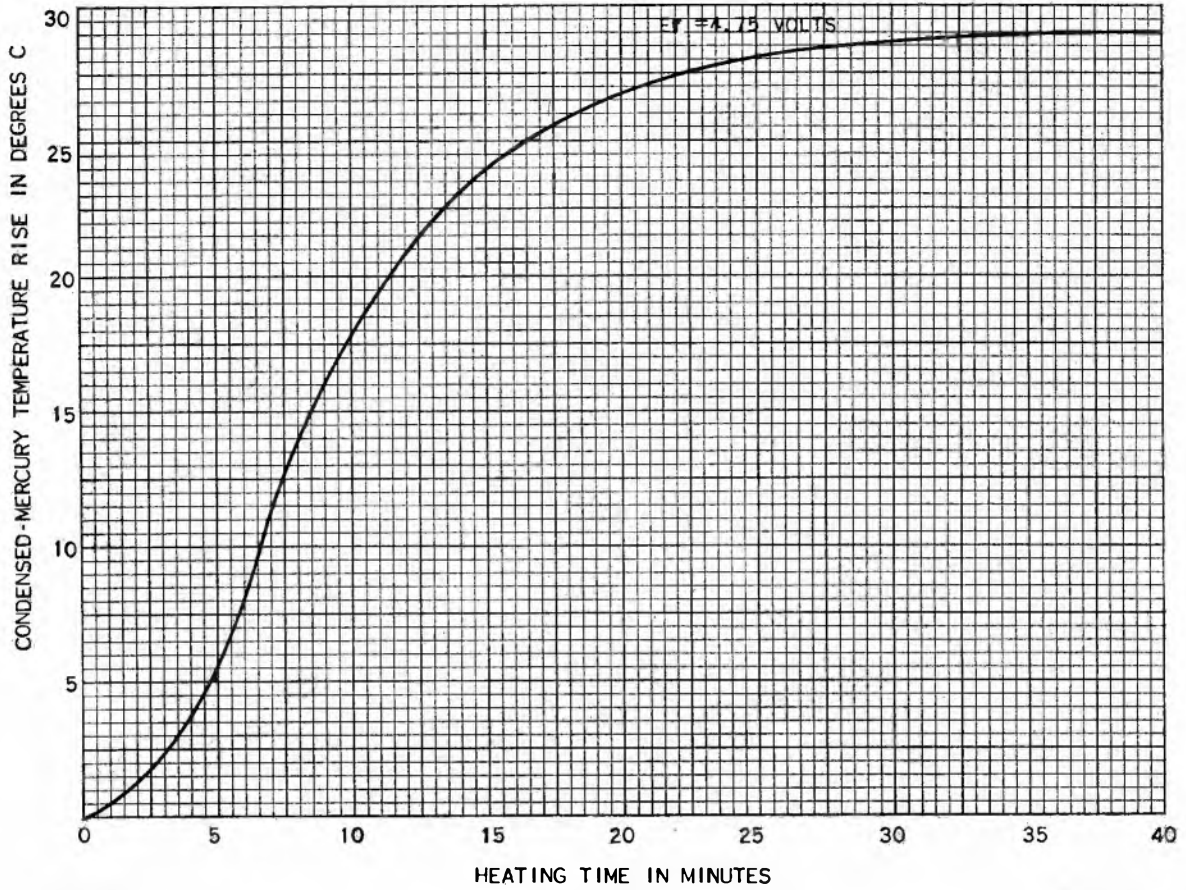
▲FG-27A
 RATE OF RISE OF CONDENSED-
 MERCURY TEMPERATURE ABOVE AMBIENT

FG-27-A

ETI-119C

PAGE 3

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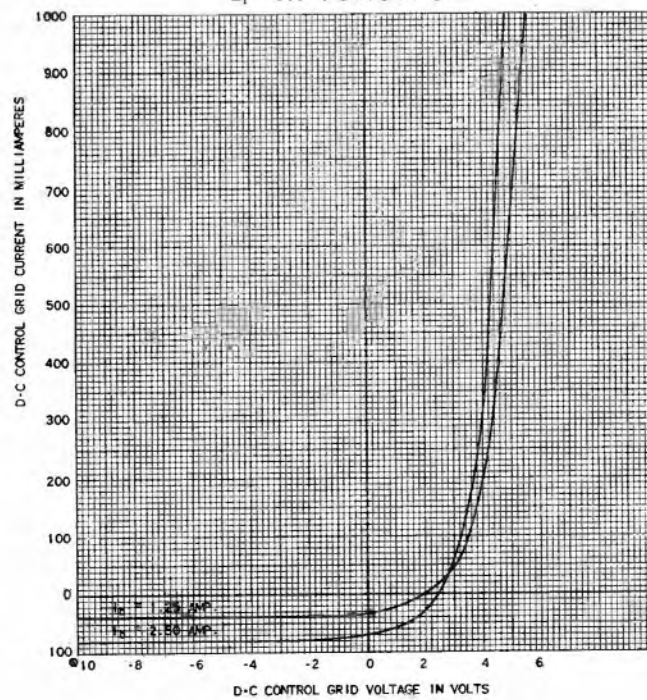


N-215392A

▲New curve.

3-10-47

▲FG-27-A
 TYPICAL CONTROL GRID CURRENT
 VS
 CONTROL GRID VOLTAGE DURING CONDUCTION
 $E_t = 5.0$ VOLTS A-C



K-69087-72A136

▲New curve.

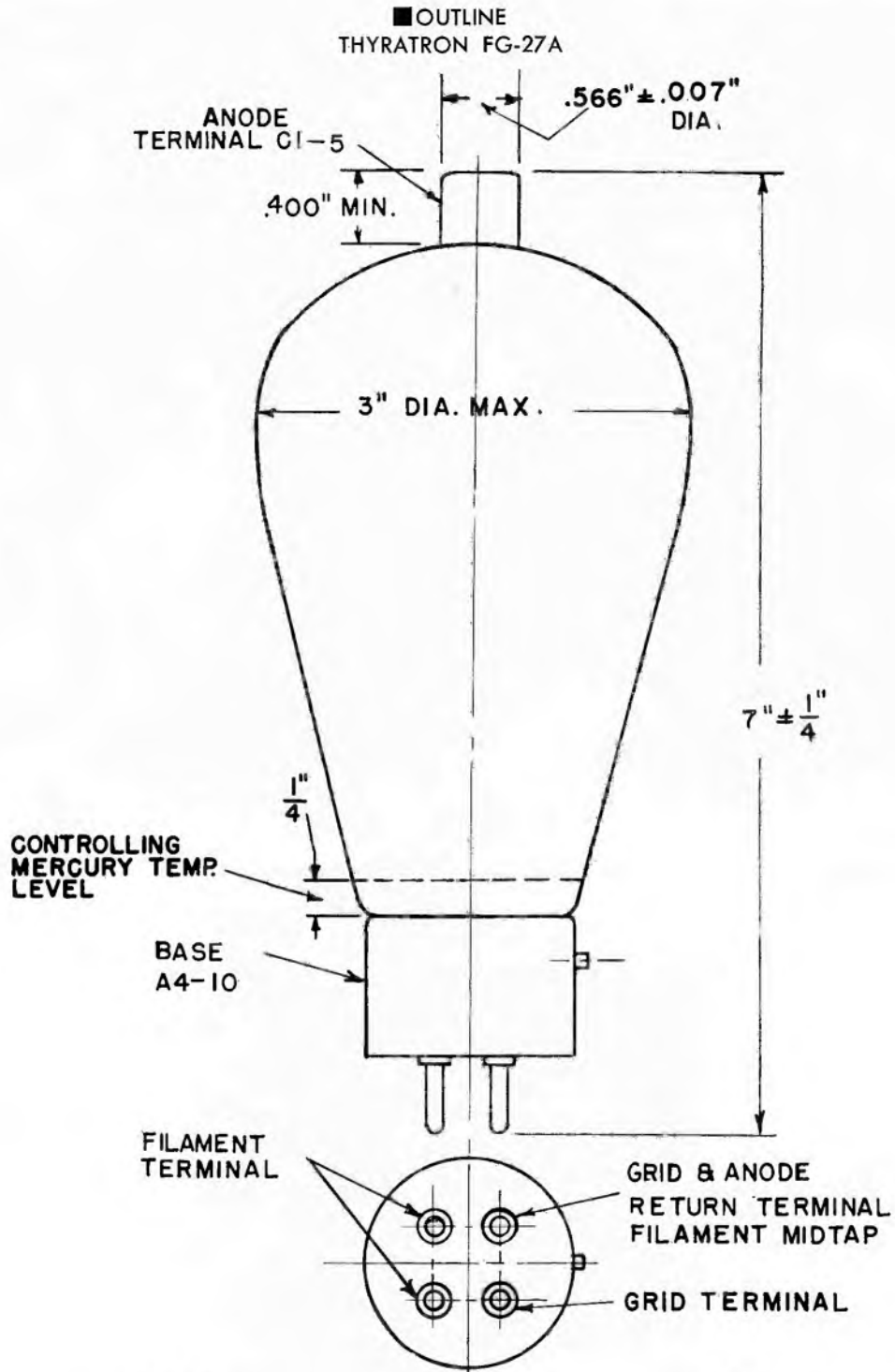
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FG-27-A

ETI-119C

PAGE 4

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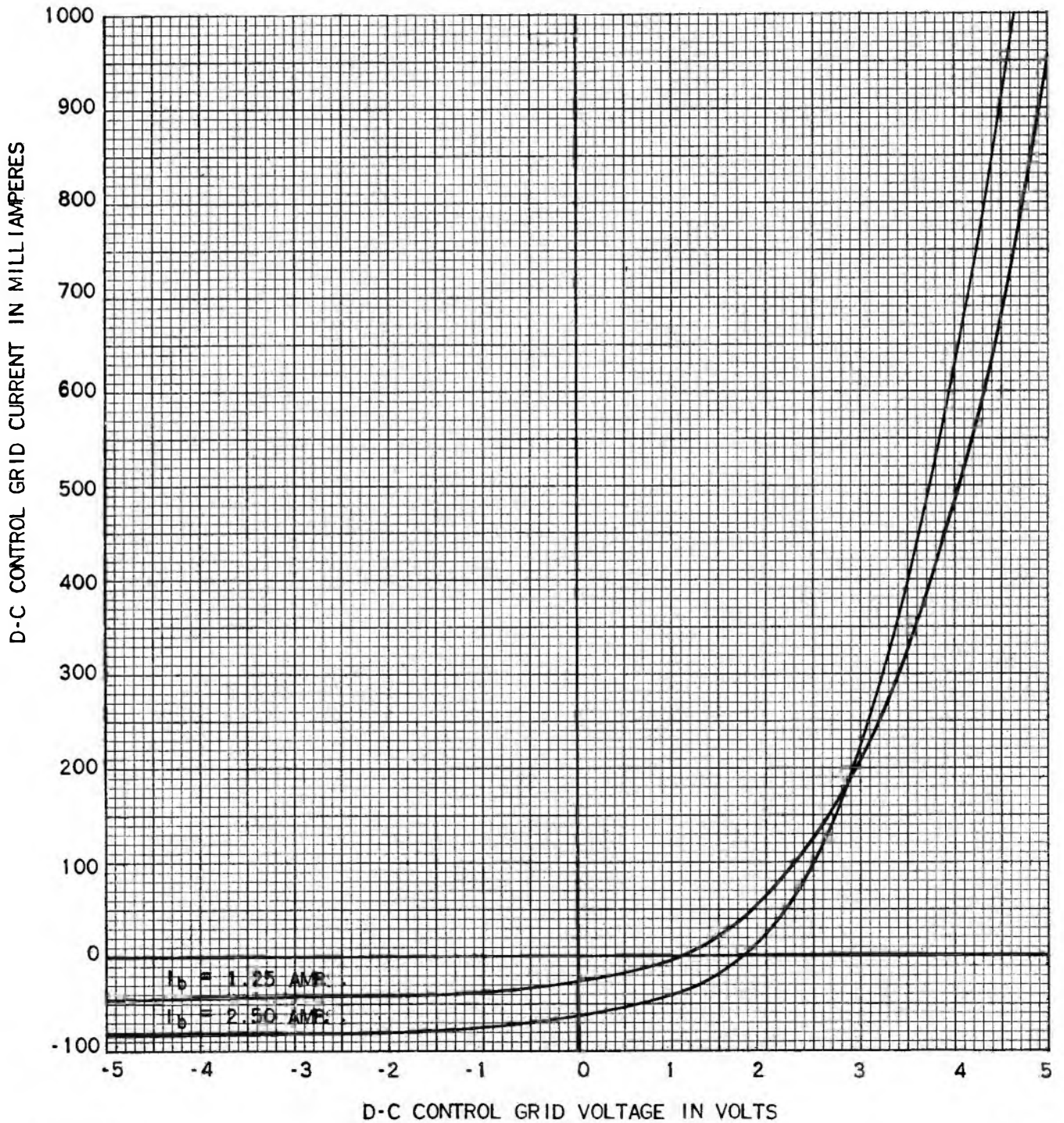
■ Revised outline

Electronics Department

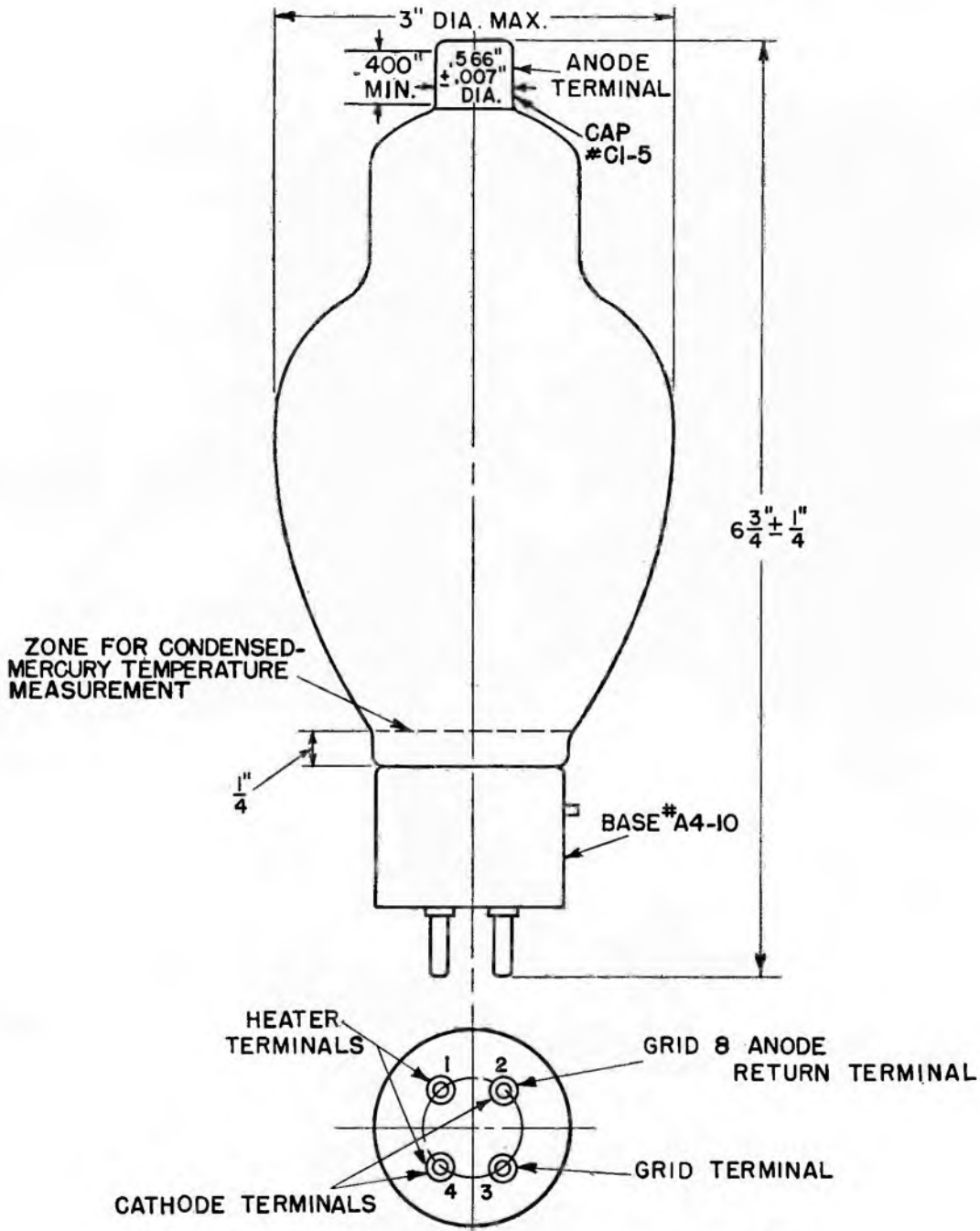
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GL-5728/FG-67
TYPICAL CONTROL GRID CURRENT
VS.
CONTROL GRID VOLTAGE DURING CONDUCTION
 $E_i = 5.0$ VOLTS A-C



■ OUTLINE
GL-5728 / FG-67 THYRATRON



K-3846065

■ Revised outline.

4-18-48

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THYRATRON

DESCRIPTION

The FG-81-A is an inert-gas-filled thyatron with a negative control characteristic.

Although inert-gas-filled tubes can be operated in much lower ambient temperatures than mercury-vapor types, they are not rated at as high voltages as mercury tubes of comparable size.

This tube is particularly adapted to applications where it is desired to have current flow in the absence of grid excitation, where constancy of characteristic is required with large variations in ambient temperature and where the tube is subjected to intermittent operation.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes3

Electrical

Cathode—Filamentary type

Filament voltage 2.5 volts

Filament current, approx. 5.0 amperes

Filament heating time, typical 5 seconds

Peak voltage drop, typical 16 volts

Approximate control characteristics

Anode voltage 25 100 500 volts

Grid voltage 0 -3.0 -5.25 volts

Anode to grid capacitance, approx. 4.4 micromicrofarads

Ionization time, approx. 10 microseconds

Deionization time, approx. 1000 microseconds



GENERAL  ELECTRIC

Supersedes ETI-124A dated 12-45

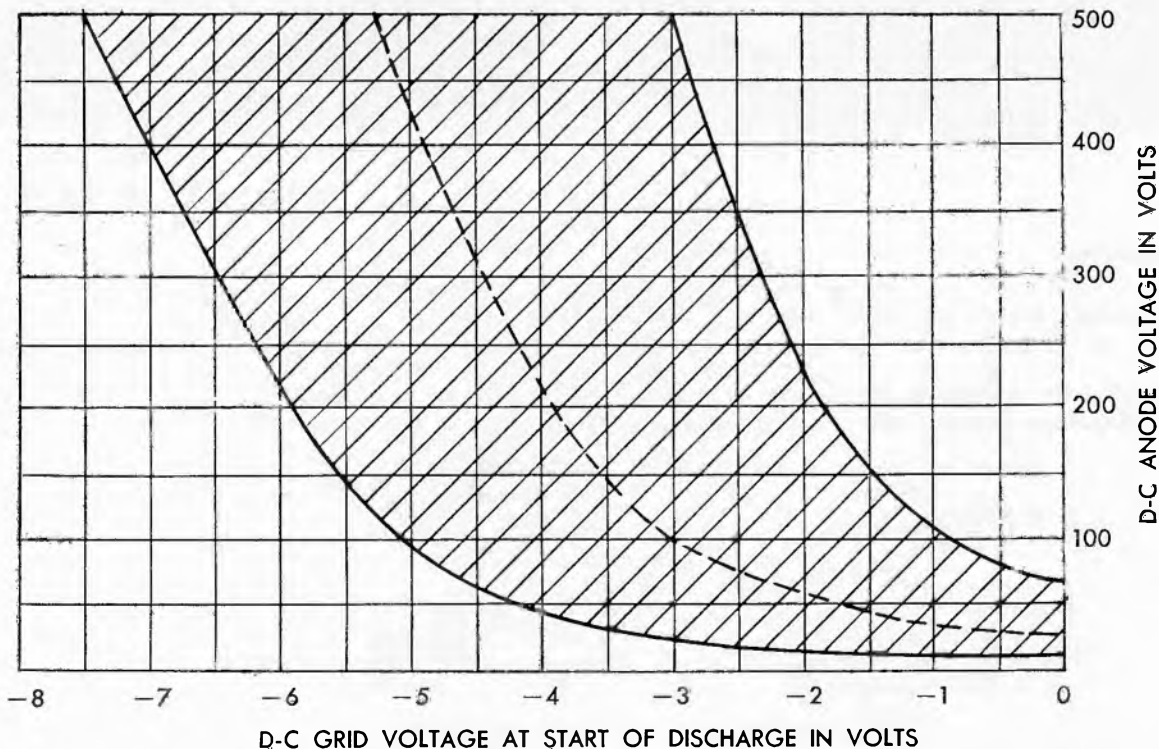
TECHNICAL INFORMATION (CONT'D)

Mechanical

Net weight, approx.....	4 ounces
Shipping weight, approx.....	3 pounds
Mounting position.....	vertical, base down

MAXIMUM RATINGS

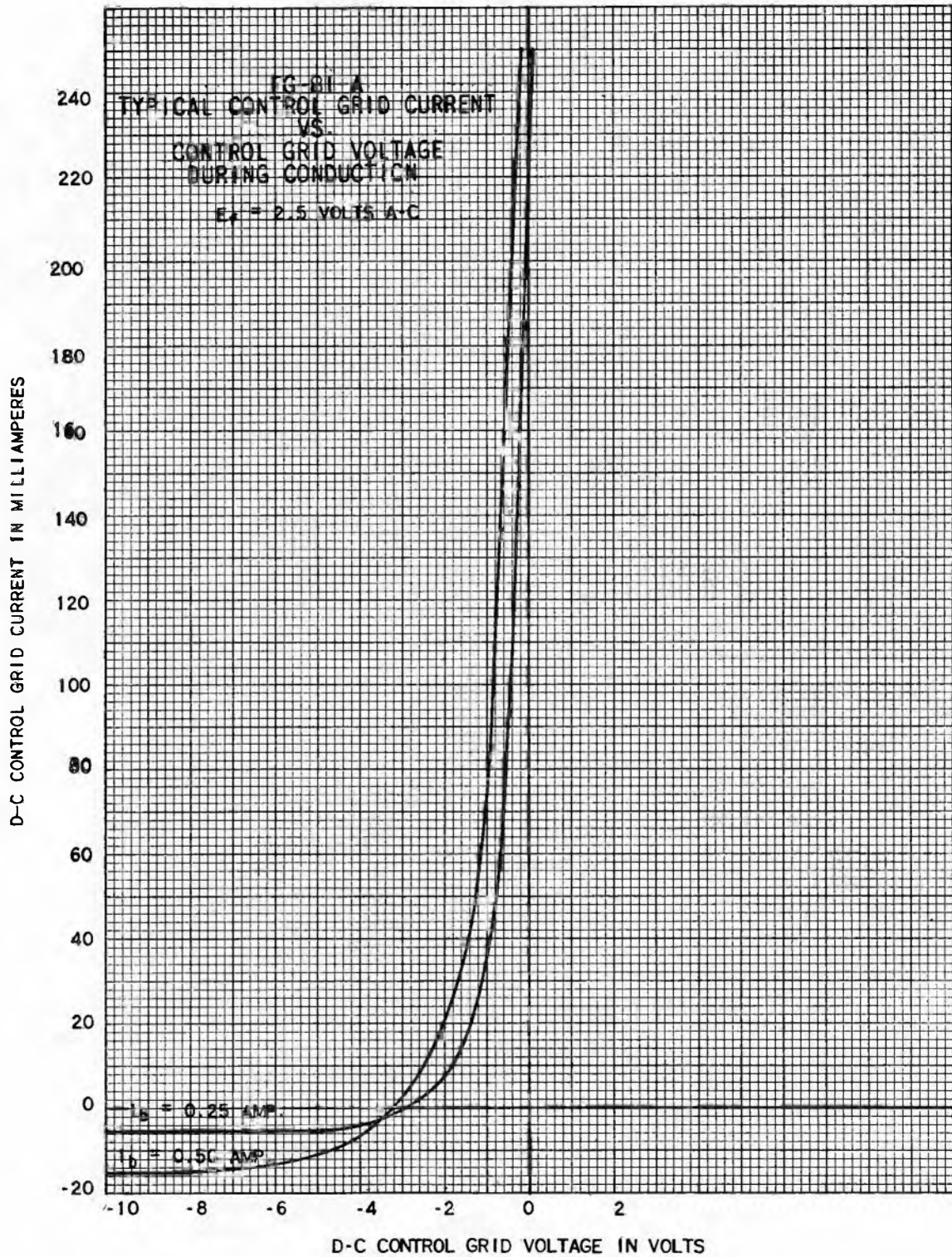
Maximum peak anode voltage	
Inverse.....	500 volts
Forward.....	500 volts
Maximum negative grid voltage	
Before conduction.....	70 volts
During conduction.....	10 volts
Maximum anode current	
Instantaneous, 25 cycles and above.....	2.0 amperes
Instantaneous, below 25 cycles.....	1.0 ampere
Average.....	0.5 ampere
Surge, for design only.....	40 amperes
Duration of surge current.....	0.1 second
Maximum grid current	
Instantaneous.....	0.25 ampere
Average.....	0.05 ampere
Maximum time of averaging current.....	15 seconds
Ambient temperature limits.....	-55 to +85 centigrade



K-6917474

8-20-43

THYRATRON FG-81-A
 TYPICAL CONTROL CHARACTERISTICS
 SHADED AREA SHOWS RANGE OF CHARACTERISTICS

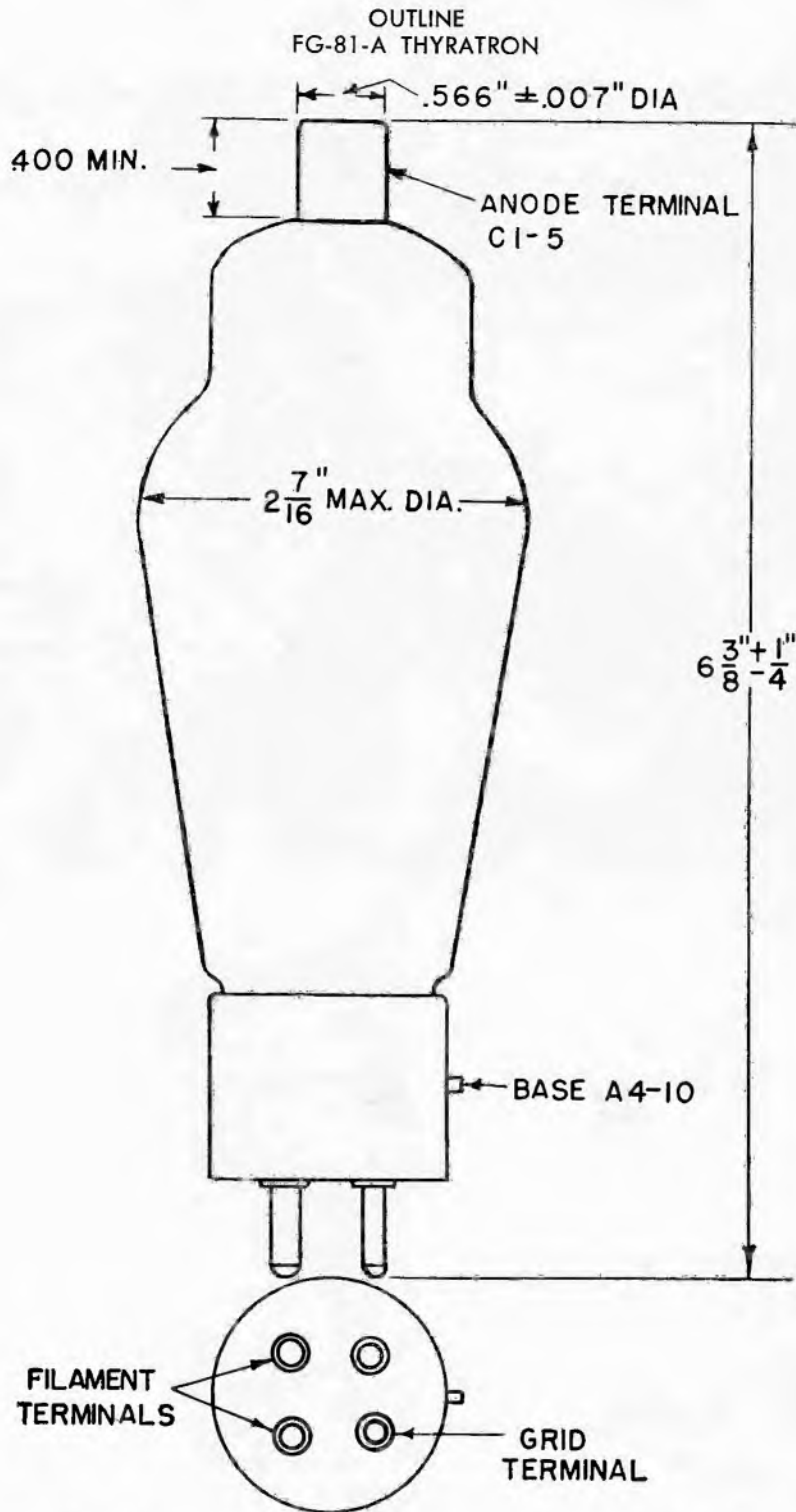


FG-81-A

ETI-124B

PAGE 4

10-49



K-4373365

8-20-45

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



THYRATRON

DESCRIPTION

The FG-97 is a mercury-vapor double-grid thyatron designed for applications where the available grid power is very small and where it is desired

to actuate the grid from a high-impedance source. It may be used in applications where the tube temperature can be maintained relatively constant.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 4

Electrical

Cathode—Filamentary type

Filament voltage 2.5 volts
 Filament current, approximate 5.0 amperes
 Filament heating time, typical 5 seconds

Peak voltage drop, typical 16 volts

Approximate control characteristics

Anode voltage	100	1000	volts
Shield-grid voltage	0	0	volt
Control-grid voltage	+0.5	-13.0	volts

Anode to control-grid capacitance, approximate 0.3 micromicrofarad

Ionization time, approximate 10 microseconds

Deionization time, approximate 1000 microseconds



GENERAL  ELECTRIC

Supersedes ETI-126B dated 10-47

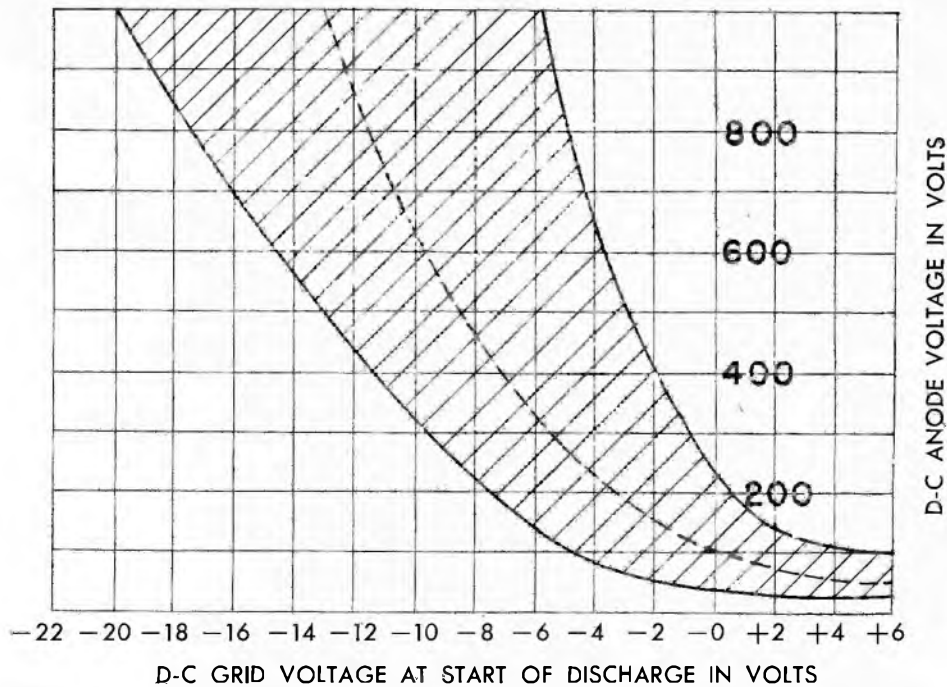
TECHNICAL INFORMATION (CONT'D)

Mechanical

Net weight, approximate.....	5	ounces
Shipping weight, approximate.....	4	pounds
Operating position.....		vertical, base down

MAXIMUM RATINGS

Maximum peak anode voltage		
Inverse.....	1000	volts
Forward.....	1000	volts
Maximum negative control-grid voltage		
Before conduction.....	1000	volts
During conduction.....	10	volts
Maximum negative shield-grid voltage		
Before conduction.....	300	volts
During conduction.....	5	volts
Maximum anode current		
Instantaneous, 25 cycles and above.....	2.0	amperes
Instantaneous, below 25 cycles.....	1.0	ampere
Average.....	0.5	ampere
Surge, for design only.....	40	amperes
Duration of surge current.....	0.1	second
Maximum control-grid current		
Instantaneous.....	0.25	ampere
Average.....	0.05	ampere
Maximum shield-grid current		
Instantaneous.....	0.25	ampere
Average.....	0.05	ampere
Maximum time of averaging current.....	15	seconds
Temperature limits, condensed mercury.....	+40 to +80	centigrade
Recommended temperature, condensed mercury.....	40	centigrade

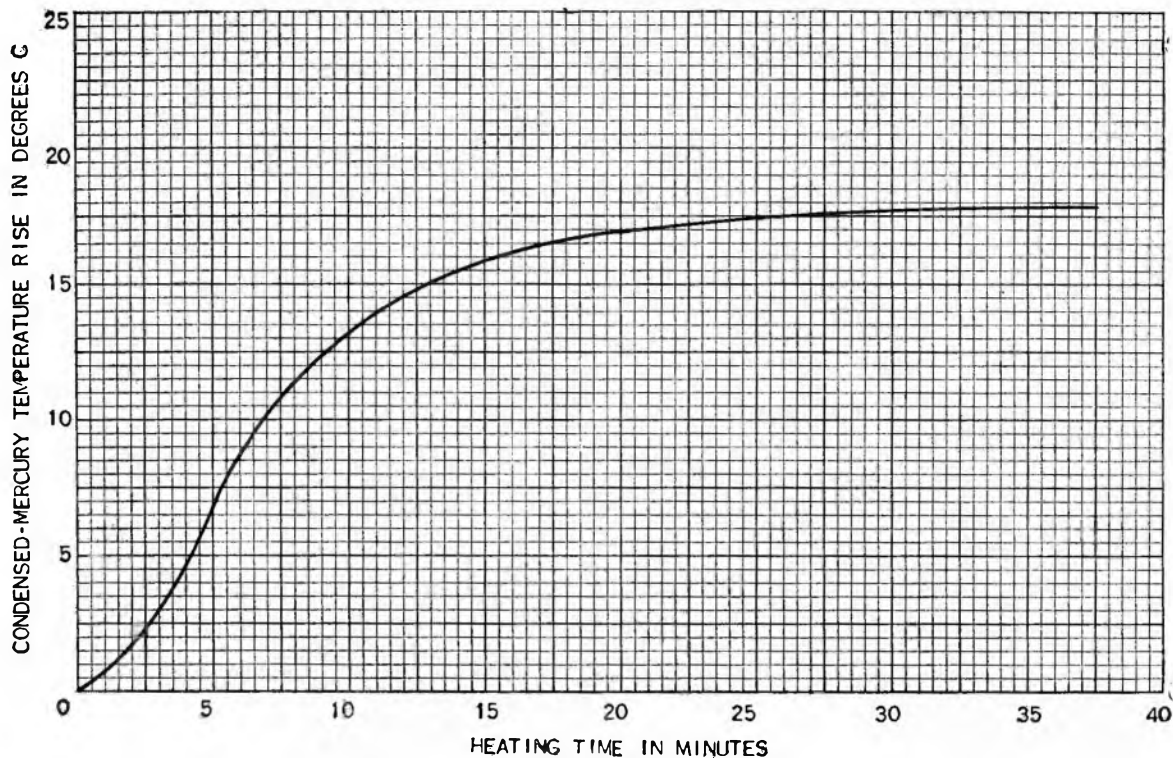


K-8639317

11-13-44

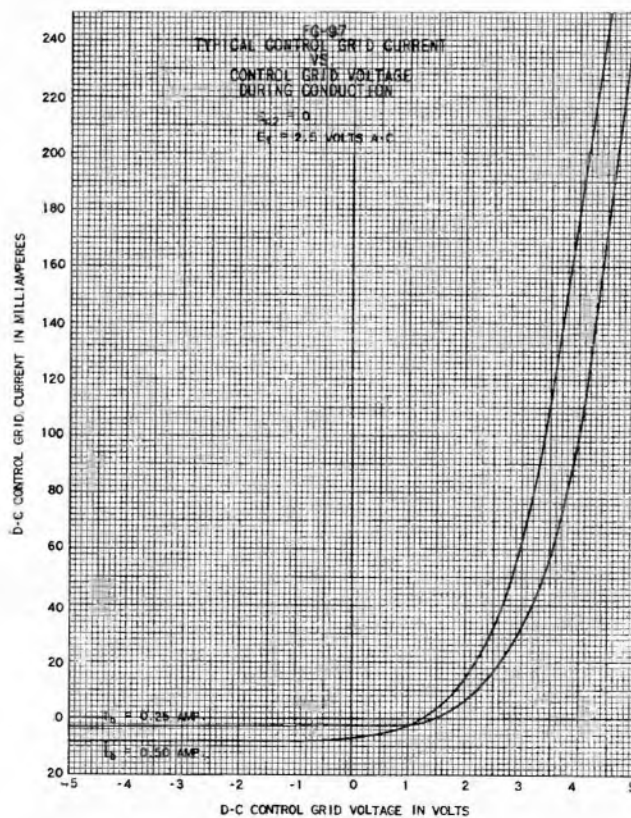
THYRATRON FG-97
 TYPICAL CONTROL CHARACTERISTICS
 SHADED AREA SHOWS RANGE OF CHARACTERISTICS
 CONDENSED MERCURY TEMPERATURE 40 C
 SHIELD GRID VOLTAGE ZERO

RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE ABOVE AMBIENT
 $E_f = 2.37$ VOLTS



N-21528ZA

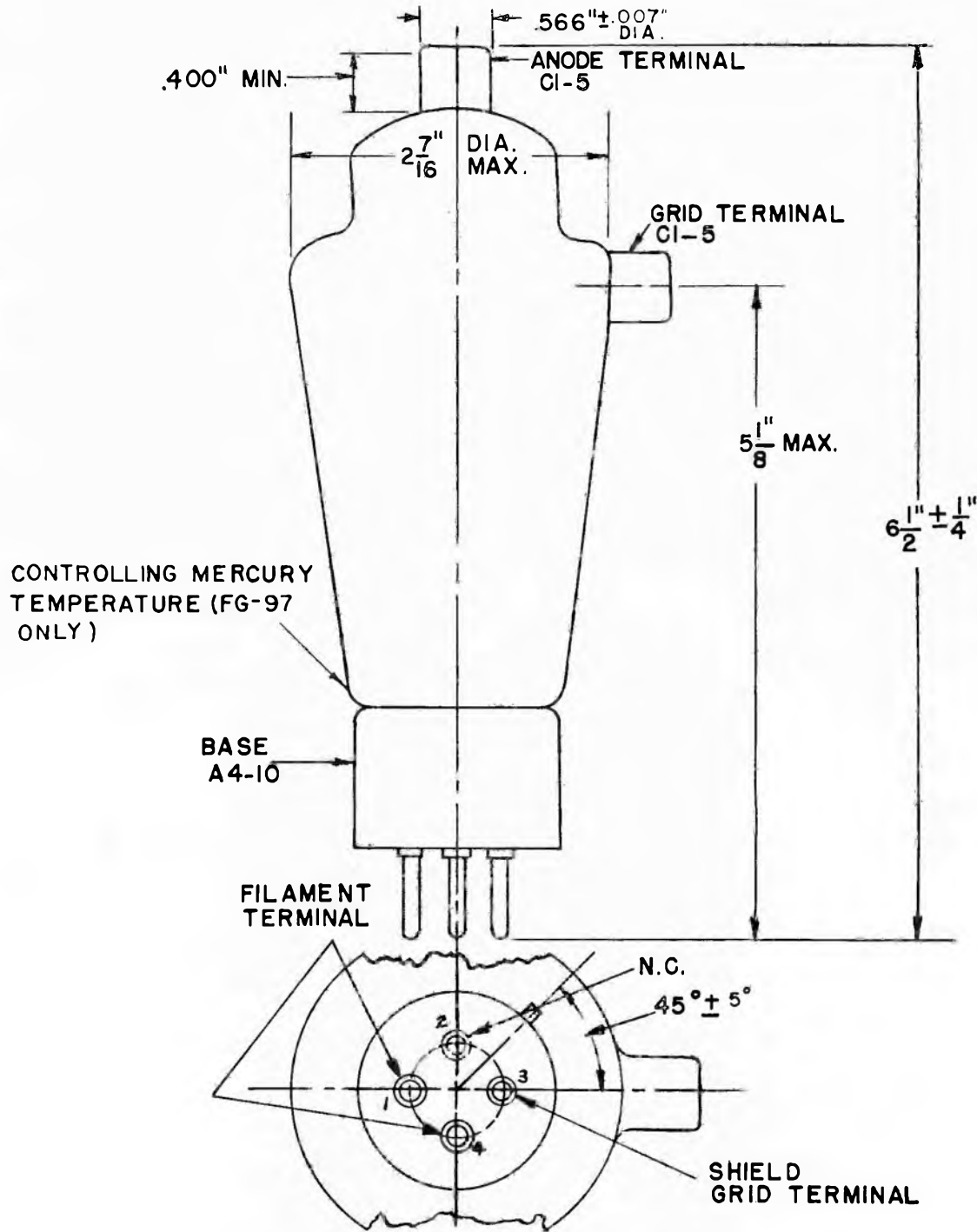
3-11-47



K-69087-72A142 (New drawing)

4-29-47

■ OUTLINE
FG-97 THYRATRON



K-4955906

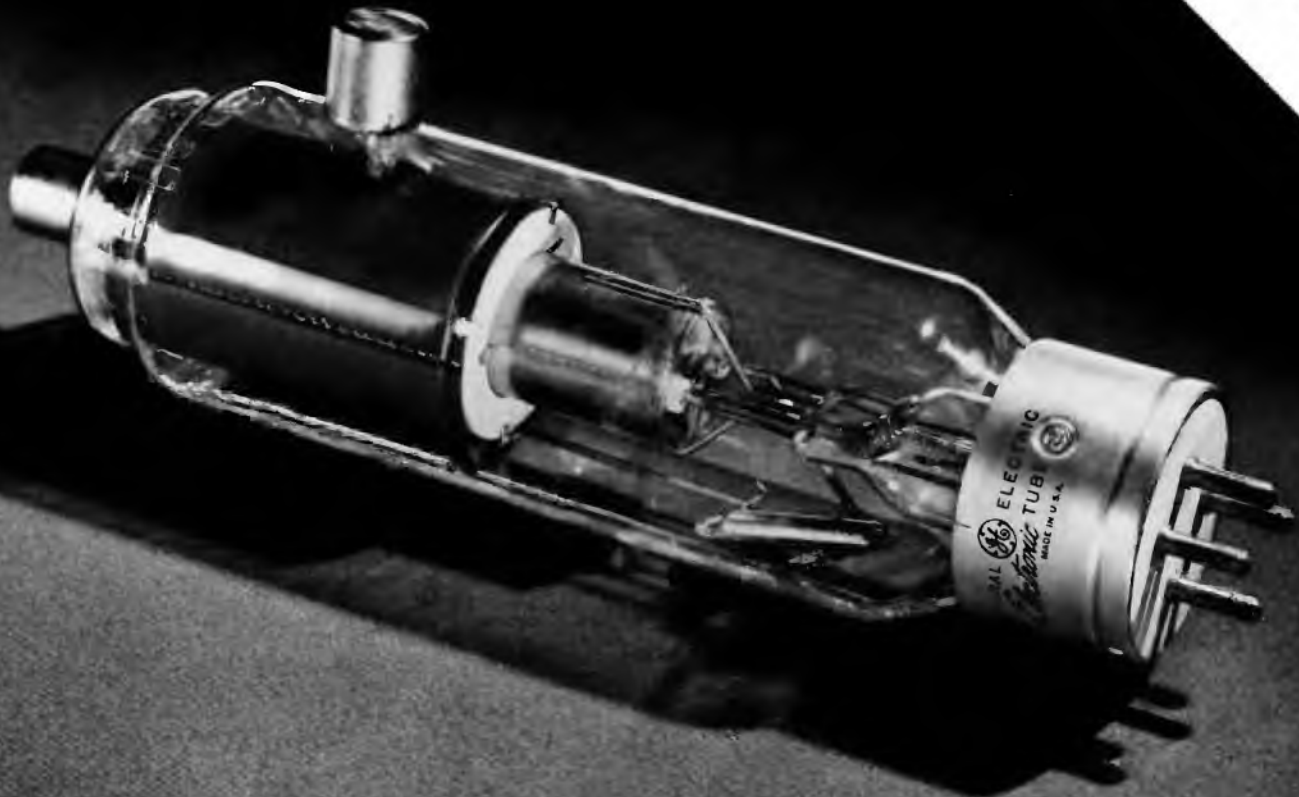
■ Revised drawing

11-12-47

Tube Divisions, Electronics Department

GENERAL  **ELECTRIC**

Schenectady, N. Y.



THYRATRON

DESCRIPTION

The FG-105 is a double-grid, mercury-vapor thyratron. Double-grid tubes are designed for applica-

tions where the grid is actuated from a high-impedance source and where available grid power is small.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes.....	4		
	Continuous Service		Intermittent Service
Electrical			
Cathode—Indirectly heated type			
Voltage.....	5.0	5.5	5.0 volts
Current, approximate.....	10.0	11.0	10.0 amperes
Heating time, typical.....	5	5	5 minutes
Peak voltage drop, typical.....	16	16	16 volts
Approximate control characteristics			
Anode voltage.....	100	1000	100 1000 volts
Shield-grid voltage.....	0	0	0 0 volt
Control-grid voltage.....	+1.0	-9.0	+1.0 -9.0 volts
Anode-to-control grid capacitance, approximate.....	0.3	0.3	0.3 micromicrofarad
Ionization time, approximate.....	10	10	10 microseconds
Deionization time, approximate.....	1000	1000	1000 microseconds



GENERAL  ELECTRIC

Supersedes ETI-128A dated 10-47

TECHNICAL INFORMATION (CONT'D)

Mechanical

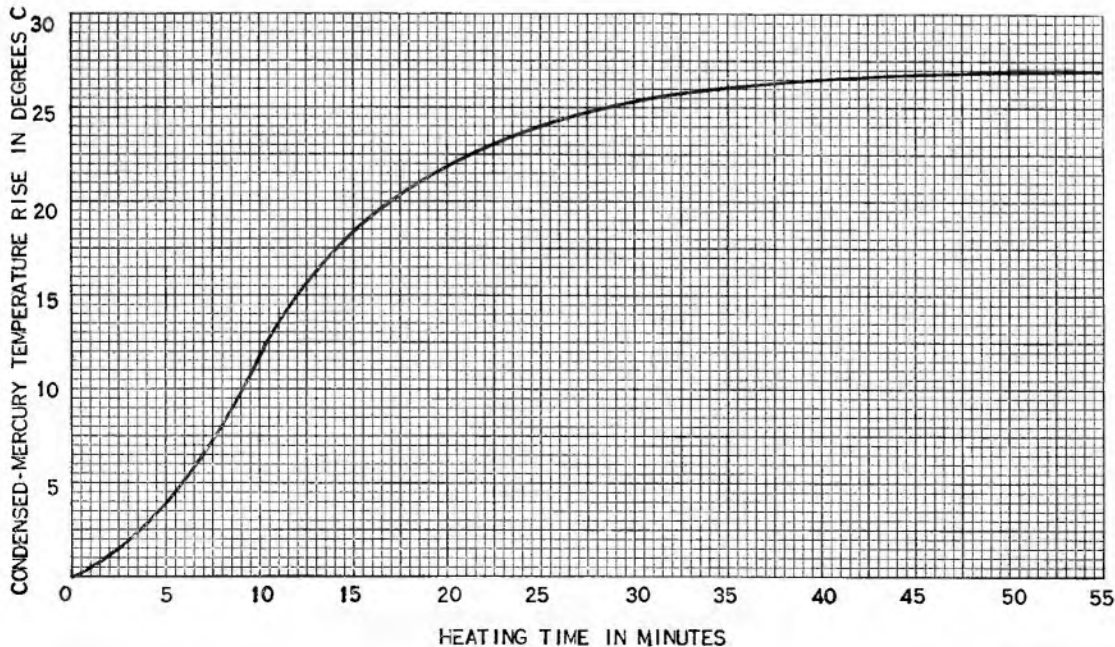
Net weight, approximate 22 ounces
 Shipping weight, approximate 7 pounds
 Mounting position vertical, base down

MAXIMUM RATINGS

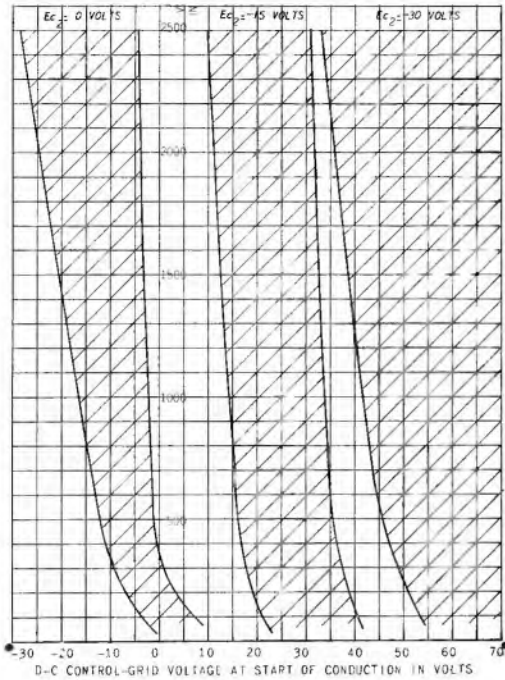
	Continuous Service	Intermittent* Service	
Maximum peak anode voltage			
Inverse	2500	750	10,000 volts
Forward	2500	750	10,000 volts
Maximum negative control-grid voltage			
Before conduction	1000	1000	1000 volts
During conduction	10	10	10 volts
Maximum negative shield-grid voltage			
Before conduction	500	500	500 volts
During conduction	10	10	10 volts
Maximum anode current			
Instantaneous, 25 cycles and above	40	77	16 amperes
Instantaneous, below 25 cycles	12.8	5.0	8.0 amperes
Average	6.4	2.5	4.0 amperes
Surge, for design only	400	400	160 amperes
Duration of surge current	0.1	0.1	0.1 second
Maximum control-grid current			
Instantaneous	1.0	1.0	1.0 ampere
Average	0.25	0.25	0.25 ampere
Maximum shield-grid current			
Instantaneous	2.0	2.0	2.0 amperes
Average	0.50	0.50	0.50 ampere
Maximum time of averaging current	15	5	15 seconds
Temperature limits, condensed mercury	+40 to +80	+30 to +95	+25 to +50 centigrade
Recommended temperature, condensed mercury	40	40	40 centigrade

*Interpolate linearly for values of anode current and temperature for operation at voltages between 2500 and 10,000 volts.

FG-105
 RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE ABOVE AMBIENT



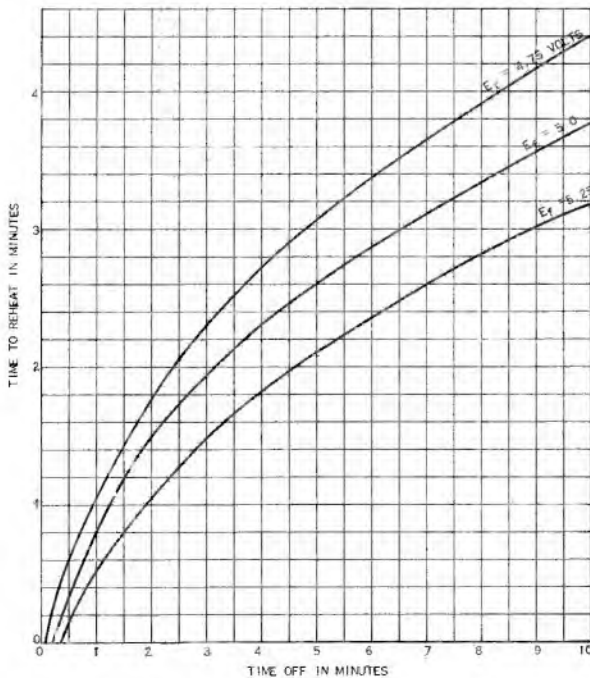
FG-105
RANGE OF CHARACTERISTICS VS SHIELD-GRID VOLTAGE
CONDENSED MERCURY TEMPERATURE 40 C



K-9033537

6-17-46

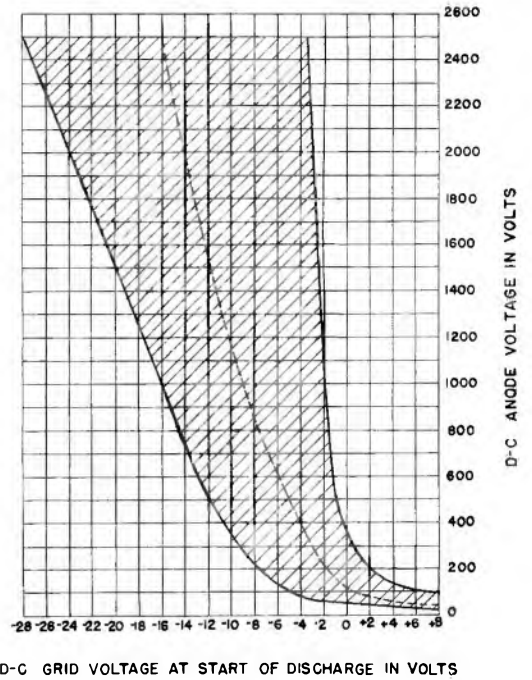
◆ FG-105
CATHODE REHEATING CURVE
ANODE VOLTAGE = 0



K-69087-72A268
◆ New drawing

2-21-49

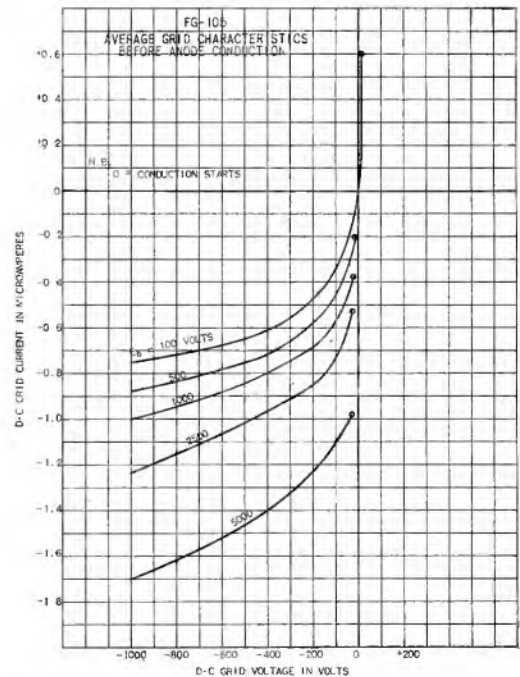
THYRATRON FG-105
TYPICAL CONTROL CHARACTERISTICS
SHADED AREA SHOWS RANGE OF CHARACTERISTICS
CONDENSED H_G TEMPERATURE 40C
SHIELD-GRID VOLTAGE ZERO



K-8639321

7-27-45

◆ FG-105
AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION

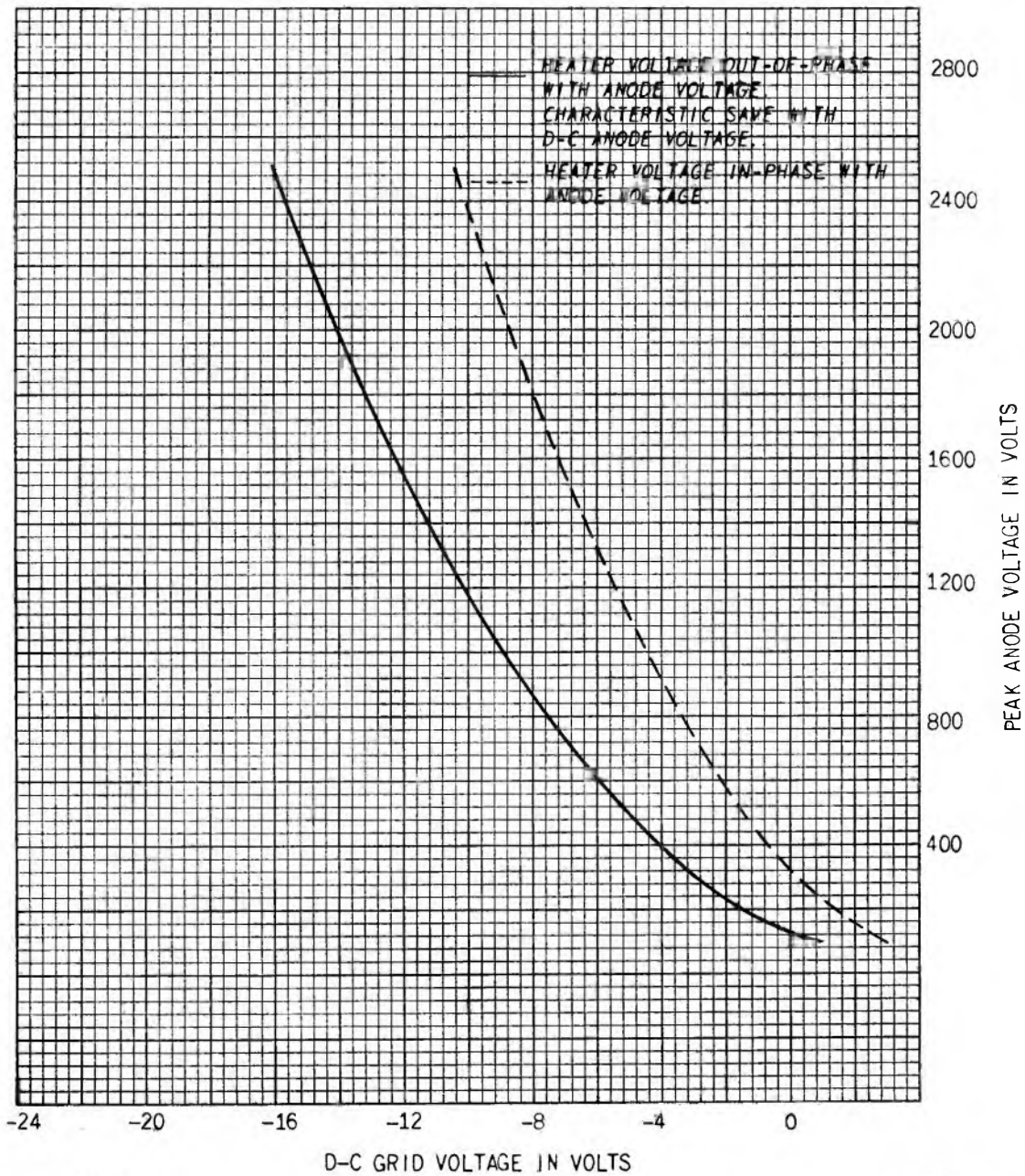


K-69087-72A274
◆ New drawing

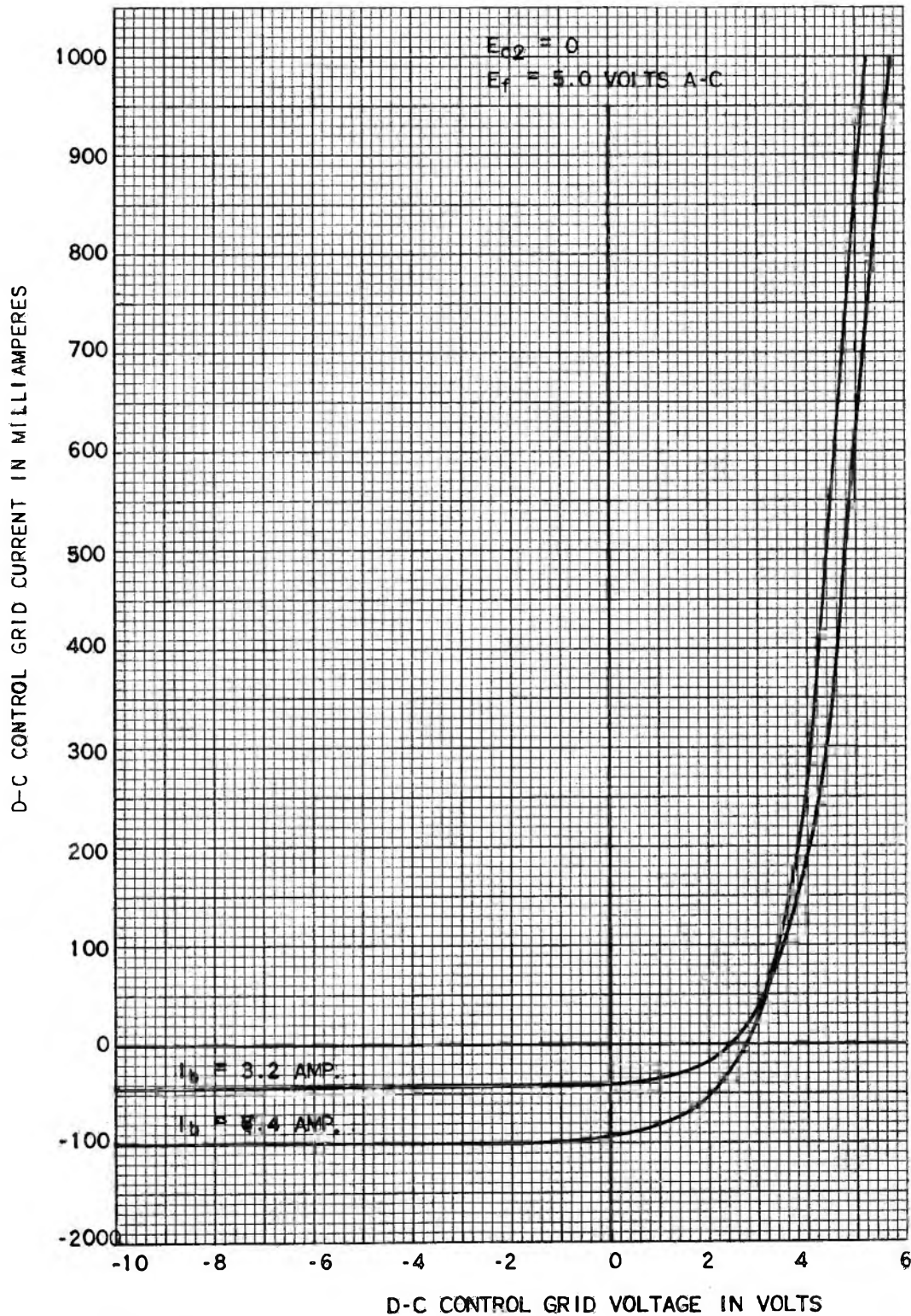
3-21-49

FG-105

TYPICAL VARIATION OF CONTROL CHARACTERISTIC
WITH A HEATER PHASE VARIATION OF 180 DEGREES



◆ FG-105
 TYPICAL CONTROL GRID CURRENT
 VS.
 CONTROL GRID VOLTAGE
 DURING CONDUCTION
 $E_{c2} = 0, E_f = 5.0$ VOLTS A-C



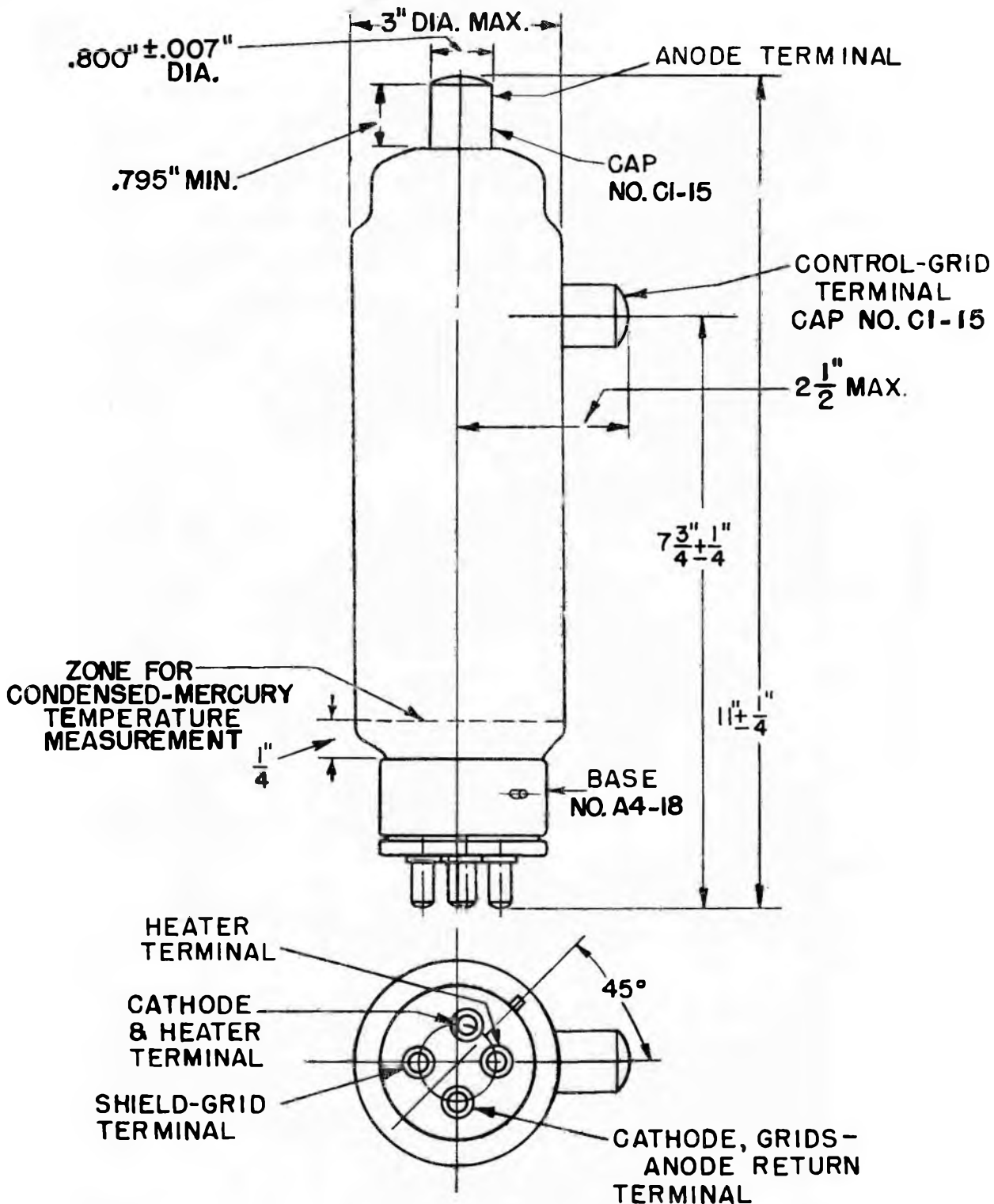
FG-105

ETI-128B

PAGE 6

f0-50

◆ OUTLINE
FG-105 THYRATRON



K-4955972

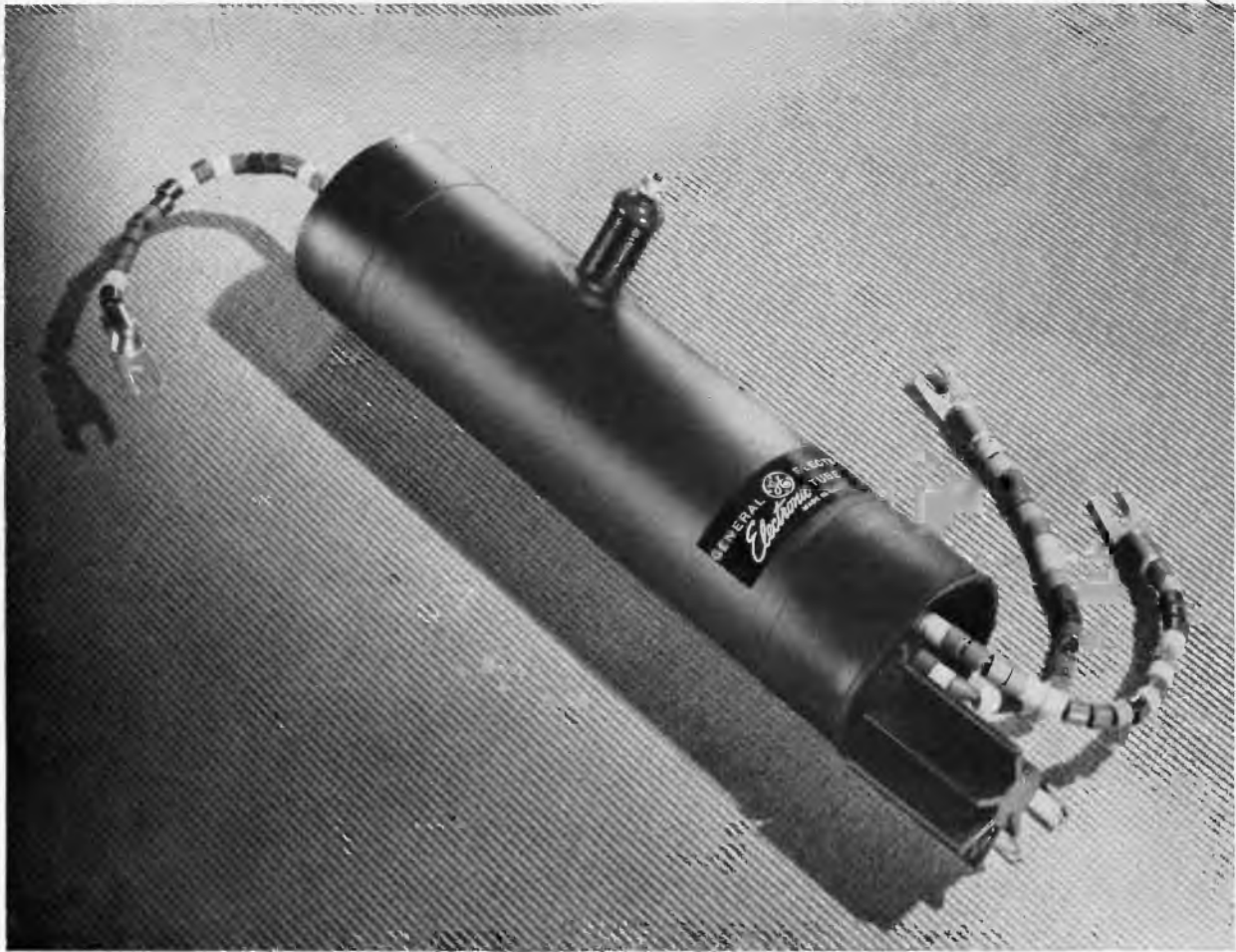
◆ Revised drawing

9-15-50

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



THYRATRON

The FG-172 is a double-grid, mercury-vapor thyatron. 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.

TECHNICAL INFORMATION

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 $\mu\mu\text{f}$
Ionization Time, approximate.....	10	10 Microseconds
Deionization Time, approximate.....	1000	1000 Microseconds

GENERAL  ELECTRIC

Supersedes ETI-130A dated 10-47

TECHNICAL INFORMATION (CONT'D)

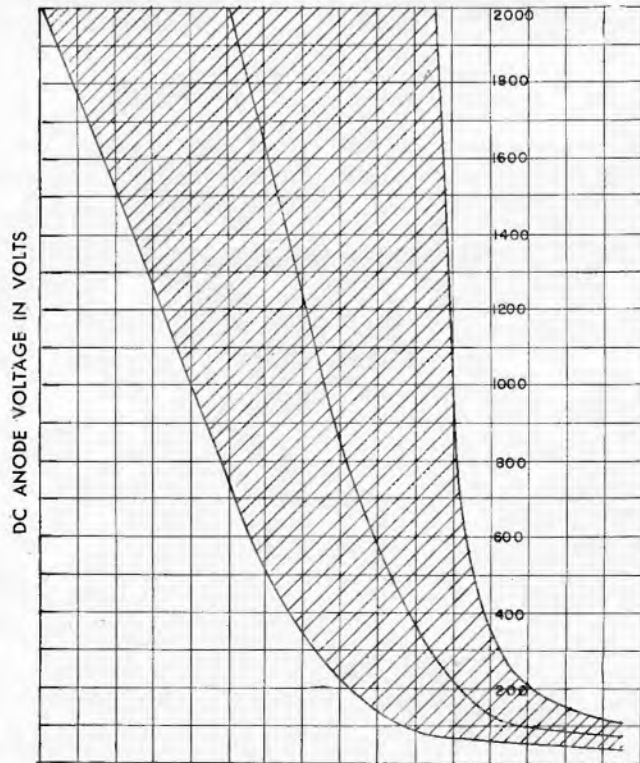
Mechanical

Net Weight, approximate.....	22	Ounces
Shipping Weight, approximate.....	7	Pounds
Mounting Position—Vertical, Radiator Down		

MAXIMUM RATINGS

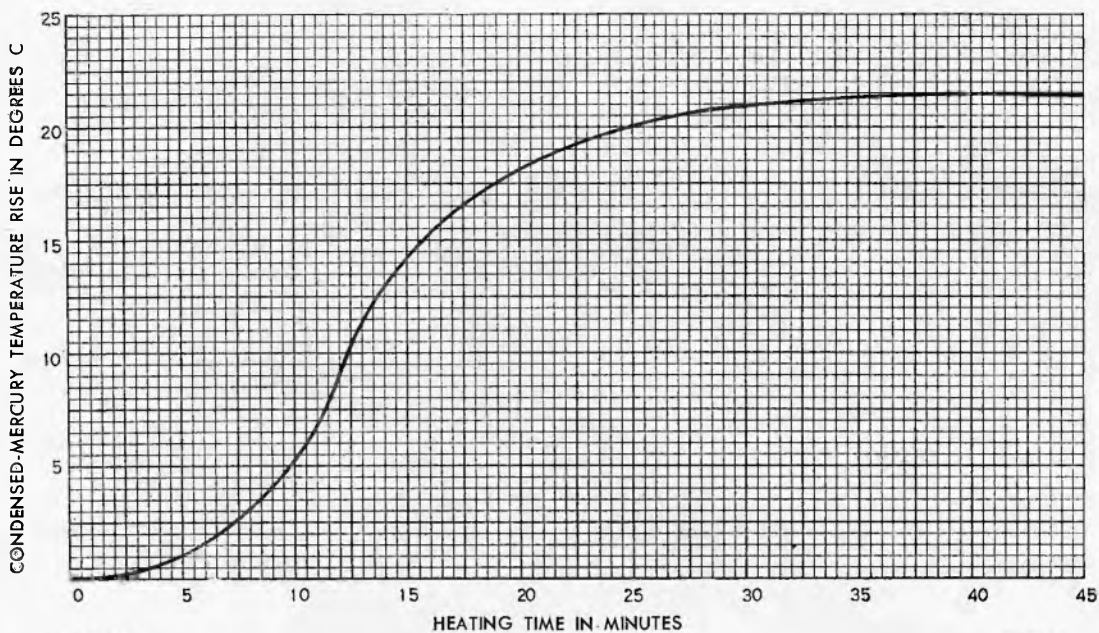
	Continuous Service	Welder-Control Service
Maximum Peak Anode Voltage		
Inverse.....	2000	750 Volts
Forward.....	2000	750 Volts
Maximum Negative Control-Grid Voltage		
Before Conduction.....	1000	1000 Volts
During Conduction.....	10	10 Volts
Maximum Negative Shield-Grid Voltage		
Before Conduction.....	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



RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE ABOVE AMBIENT

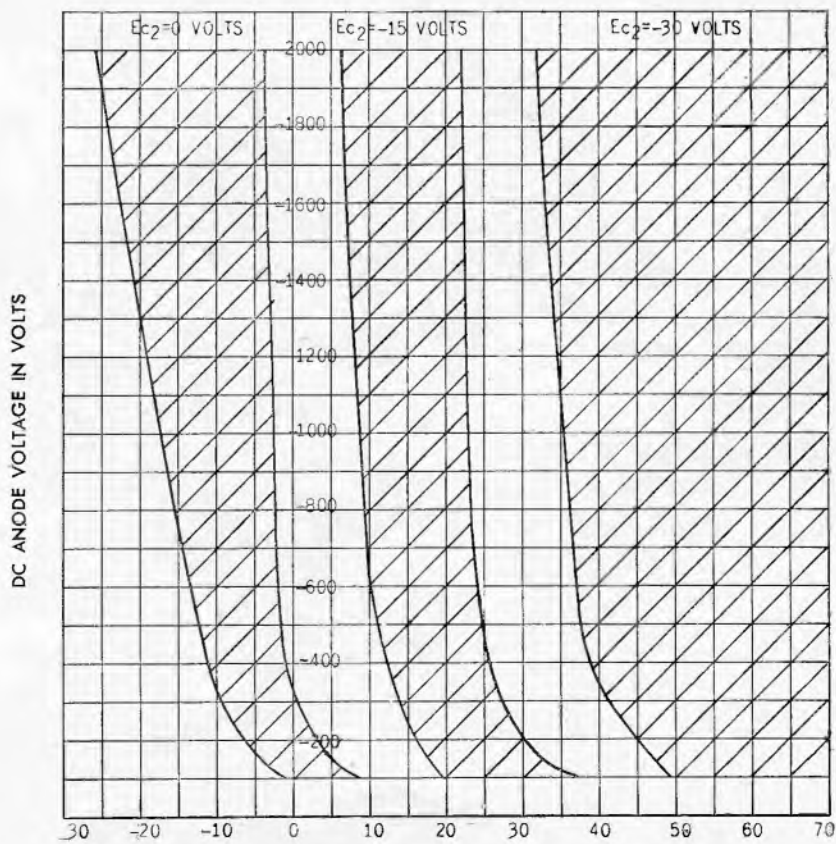
$E_f = 4.75$ VOLTS



N-21526ZA

3-10-47

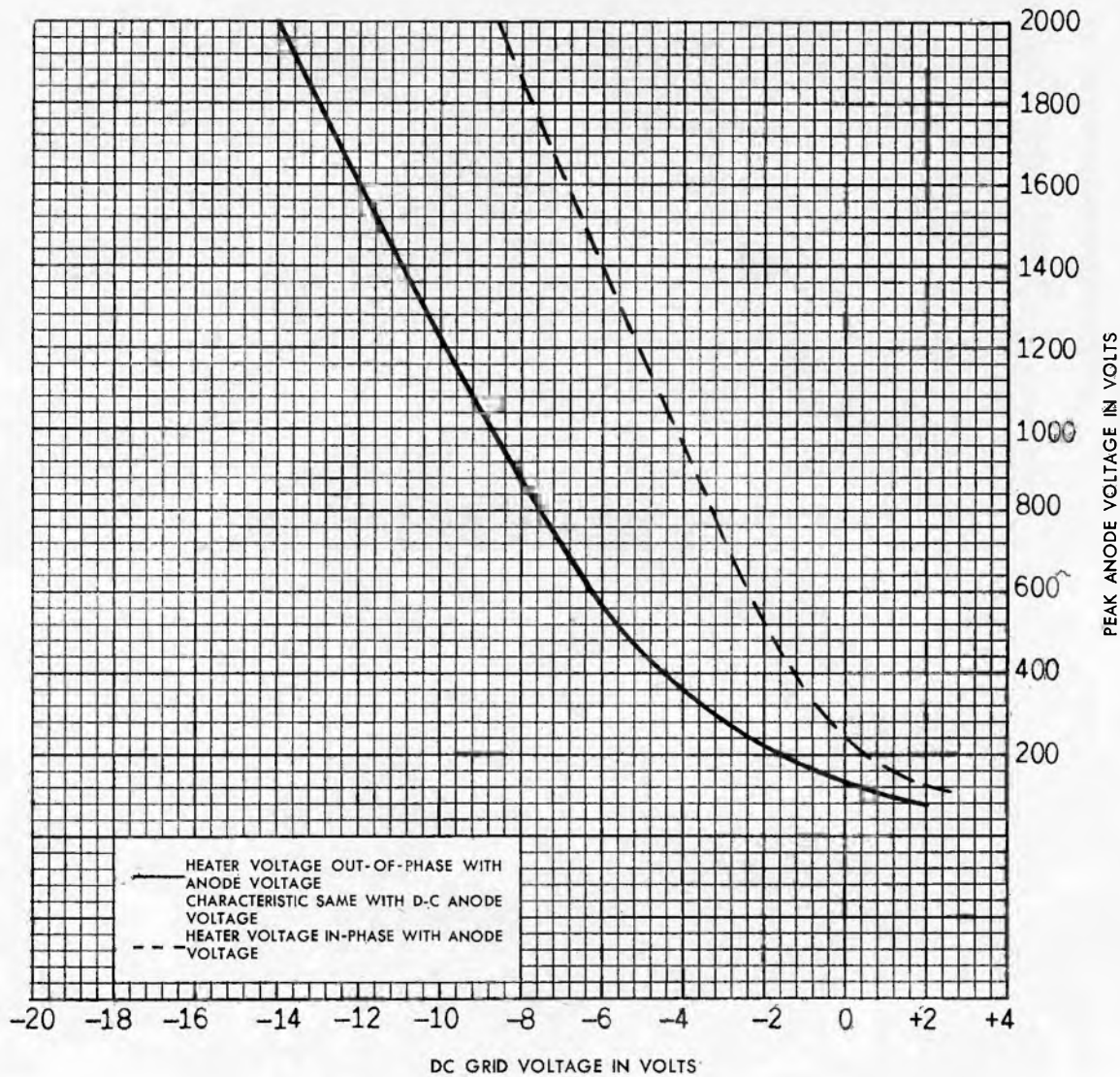
RANGE OF CHARACTERISTICS VS SHIELD-GRID VOLTAGES
CONDENSED MERCURY TEMPERATURE 40C

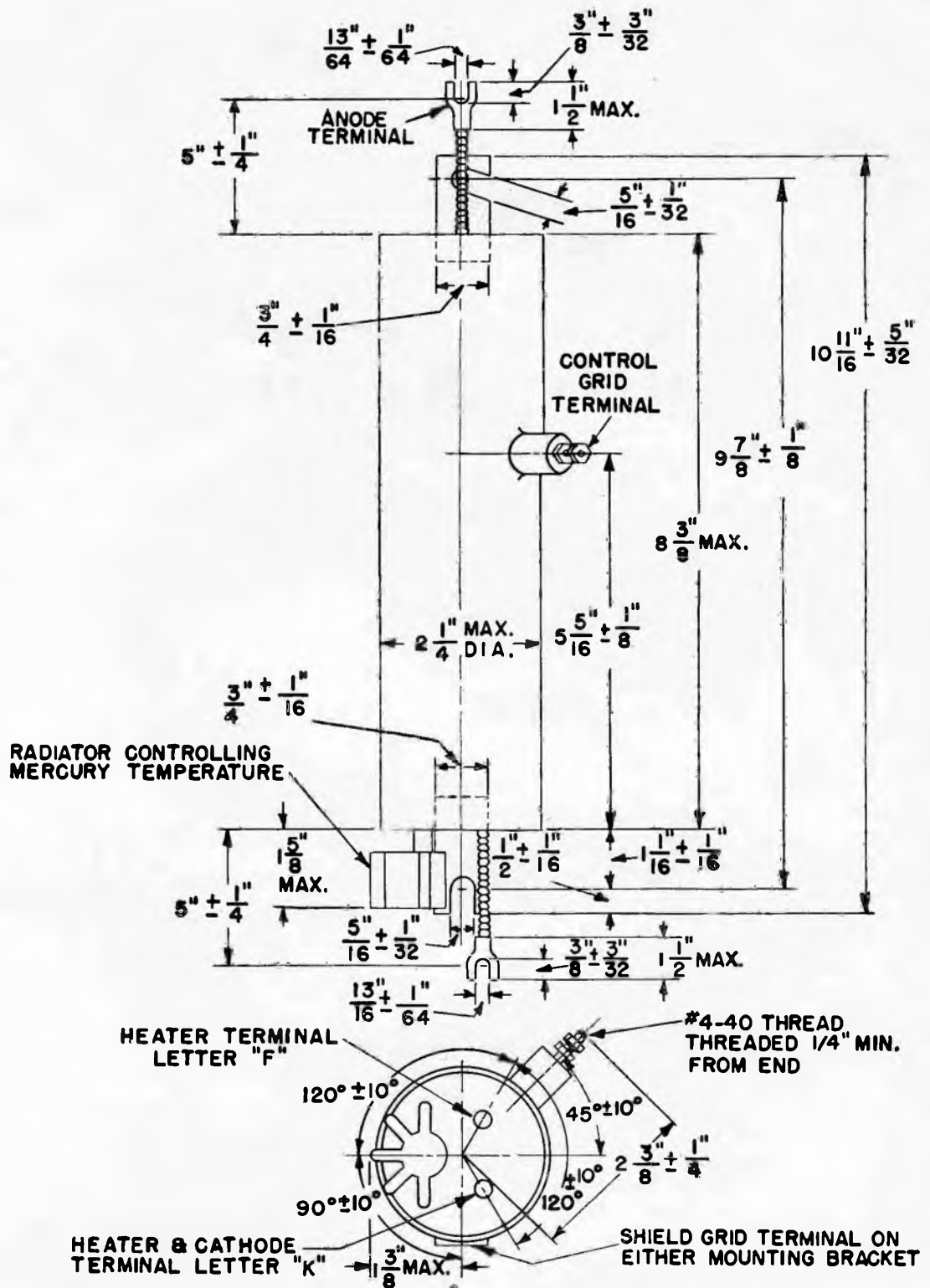


K-9186170

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, $E_{c2} = 0$





ELECTRONIC COMPONENTS DIVISION

GENERAL  **ELECTRIC**

Schenectady 5, N. Y.



THYRATRON

TRIODE TYPE NEGATIVE CONTROL CHARACTERISTIC
INERT-GAS AND MERCURY-VAPOR

The GL-393-A is a 3-electrode mercury-vapor and inert-gas-filled thyratron with negative control characteristic. The mixture of inert-gas and mercury-vapor provides constancy of characteristic

within wide temperature limits. The construction however, enables the tube to withstand higher voltages than many gas-filled types.

TECHNICAL INFORMATION

GENERAL

Electrical	Minimum	Bogey	Maximum	
Cathode—Filamentary				
Filament Voltage	2.37	2.50	2.62	Volts
Filament Current at 2.50 Volts	6.25	7.0	7.75	Amperes
Heating Time Required	15			Seconds
Anode-to-Control-Grid Capacitance		1.8		$\mu\mu\text{f}$
Deionization Time, approximate		1000		Microseconds
Ionization Time, approximate		10		Microseconds
Anode Voltage Drop		15		Volts
Mechanical				
Type of Cooling—Convection				
Equilibrium Condensed-Mercury Temperature				
Rise Above Ambient, typical				
At Full Load			22	C
At No Load			18	C
Mounting Position—Vertical, Base Down				
Net Weight, maximum			3	Ounces

GENERAL  ELECTRIC

Supersedes ETI-132 dated 4-45

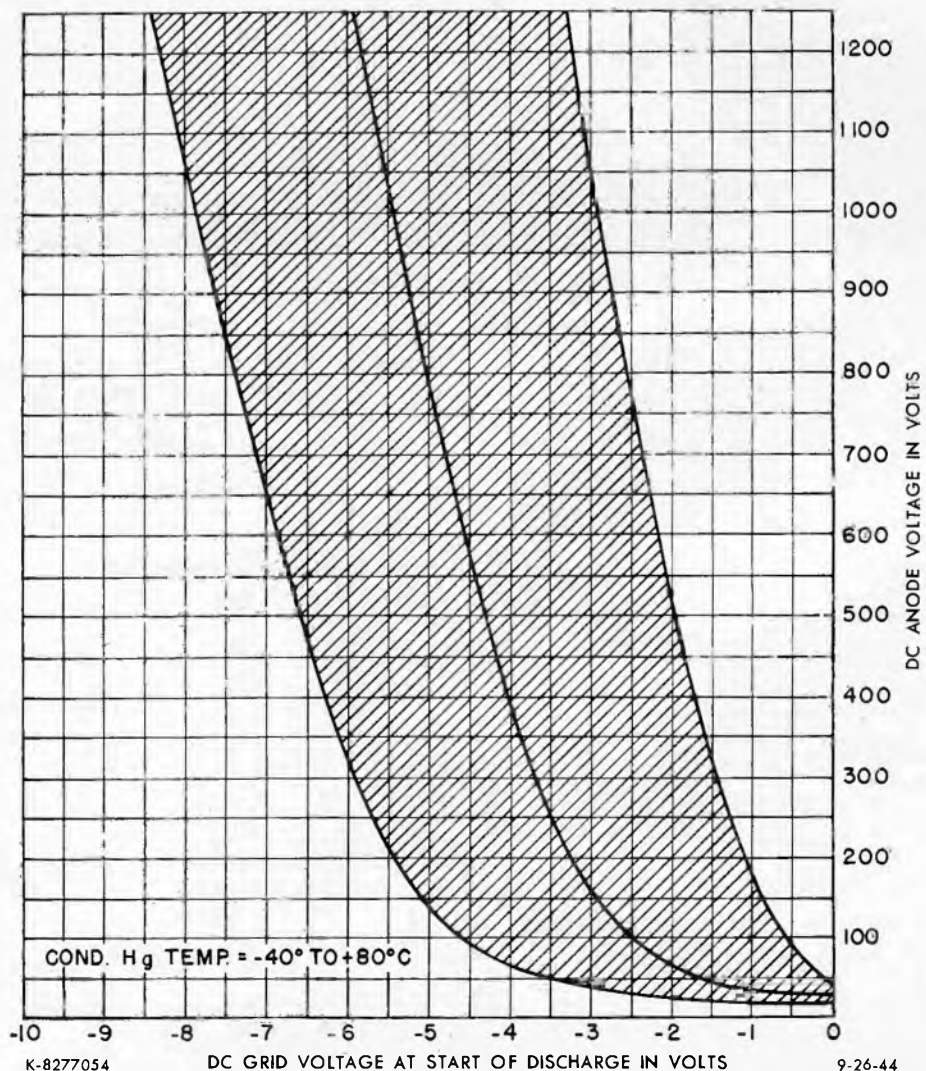
TECHNICAL INFORMATION (CONT'D)

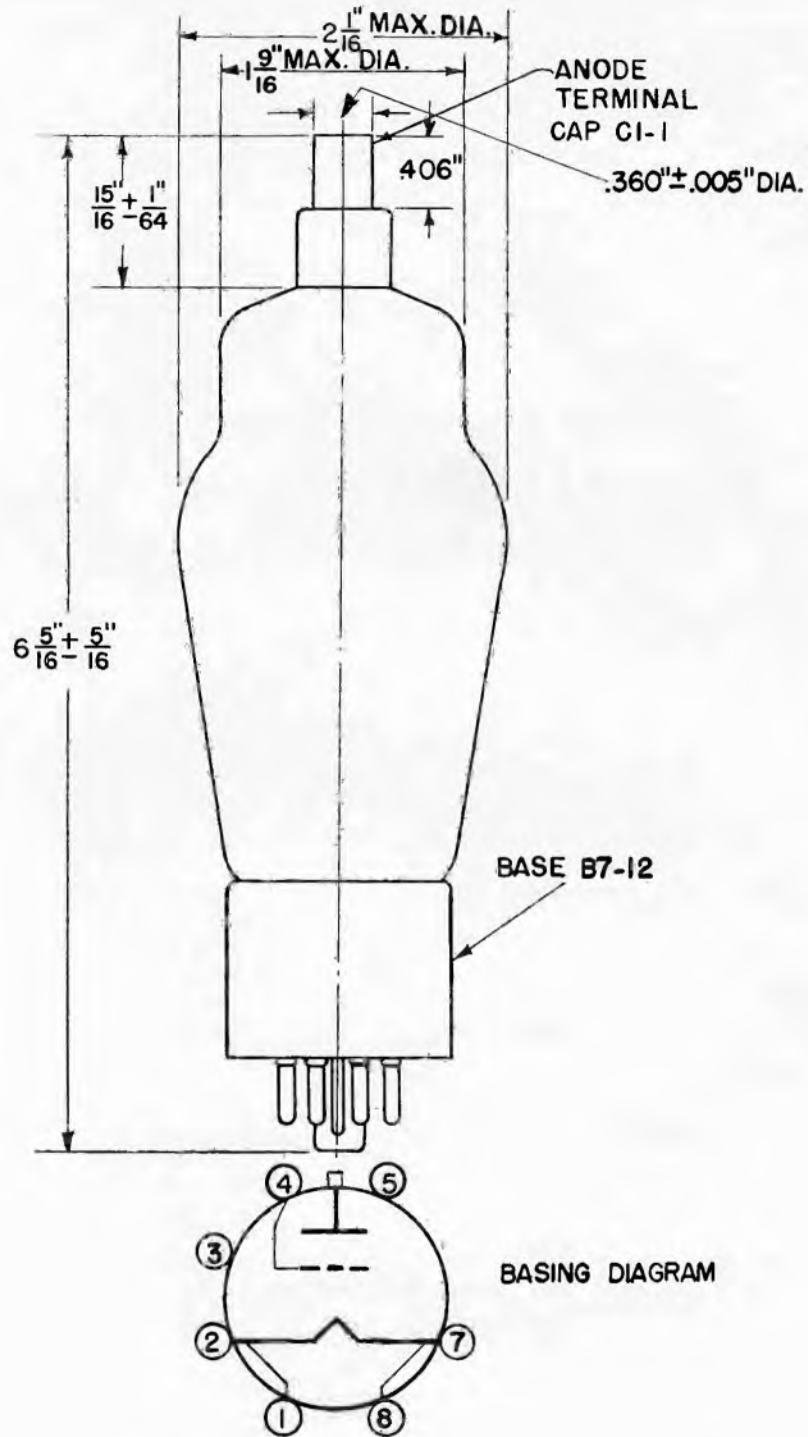
MAXIMUM RATINGS, Absolute Values

Maximum Peak Anode Voltage		
Inverse	200	1250 Volts
Forward	200	1250 Volts
Condensed-Mercury Temperature Limits*		
	-40 to +100	-40 to +80 C
Maximum Cathode Current		
Peak	6.0	6.0 Amperes
Average	1.5	1.5 Amperes
Maximum Averaging Time	5	5 Seconds
Fault	120	120 Amperes
Maximum Duration	0.1	0.1 Seconds
Maximum Negative Control-Grid Voltage		
Before Conduction	500	500 Volts
During Conduction	10	10 Volts
Maximum Positive Control-Grid Current		
Average, averaging time—one cycle	0.010	0.010 Amperes
Maximum Frequency	400	400 Cycles per Second

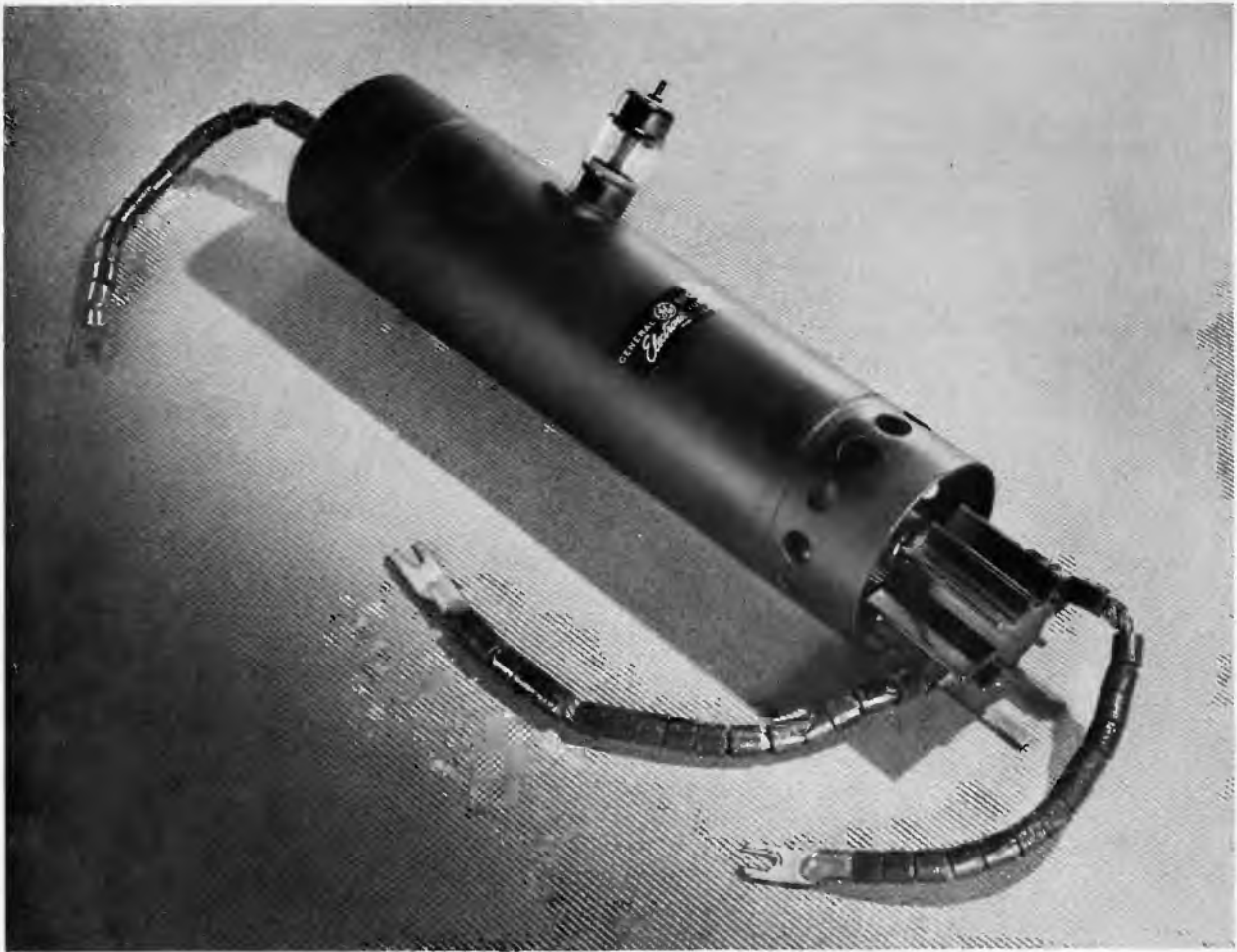
* The tube may be started and satisfactory operation will result between -40 C and +80 C. For maximum life the condensed mercury temperature after warm-up should be as specified.

TYPICAL CONTROL CHARACTERISTICS
 SHADED AREA SHOWS RANGE OF CHARACTERISTIC





ELECTRONIC COMPONENTS DIVISION
GENERAL  ELECTRIC
Schenectady 5, N. Y.



THYRATRON

The GL-414 is a three-electrode, mercury-vapor, metal thyatron with negative control characteristic. This tube is designed for industrial use in welder-control and grid-control-rectifier applications.

TECHNICAL INFORMATION

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	... μf
Control Grid-to-Cathode Capacitance.....		6.5	... μf
Deionization Time, approximate			
$E_b = 120$ v d-c; $I_b = 12.5$ a d-c; $R_g = 1000$ ohms			
$E_{oc} = -20$ 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

TECHNICAL INFORMATION (CONT'D)

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

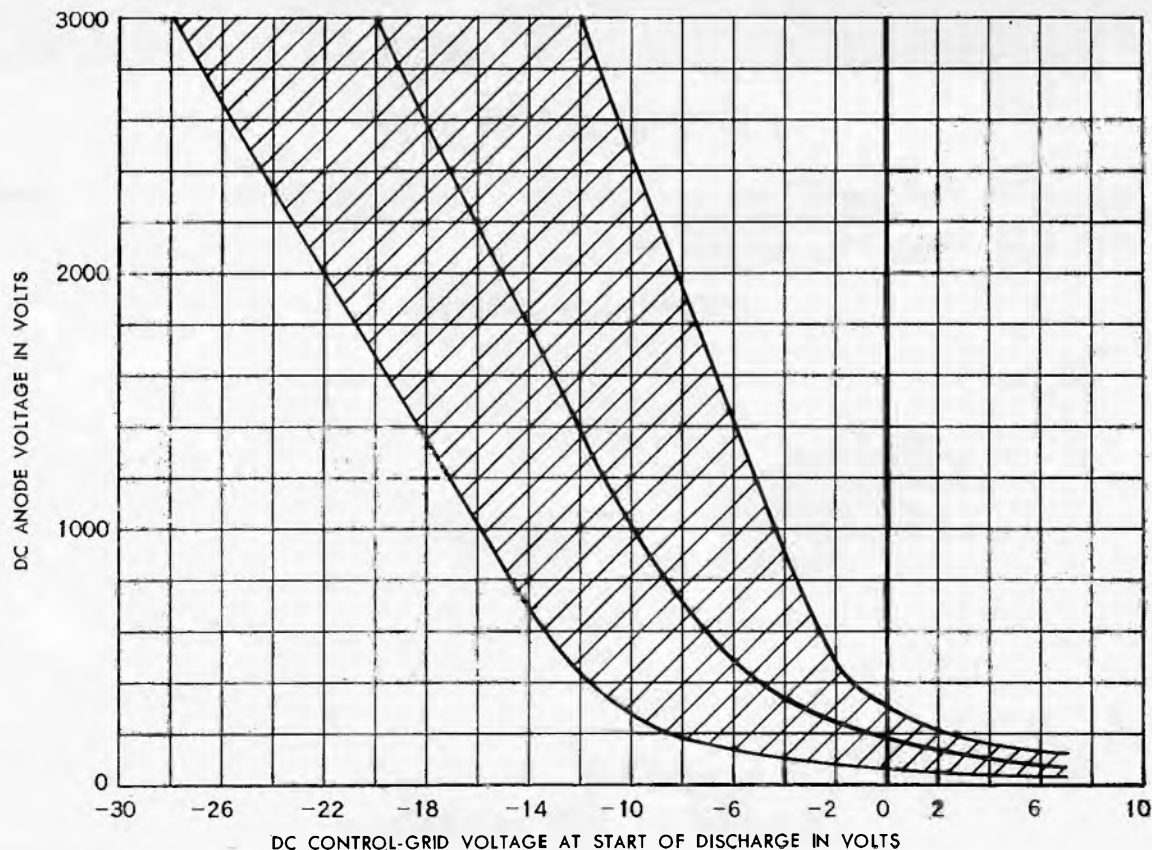
Average 1.0 1.0 Amperes

Averaging Time 1 1 Cycle

Condensed-Mercury Temperature Limits +40 to +80 +40 to +80 C

CONTROL CHARACTERISTIC

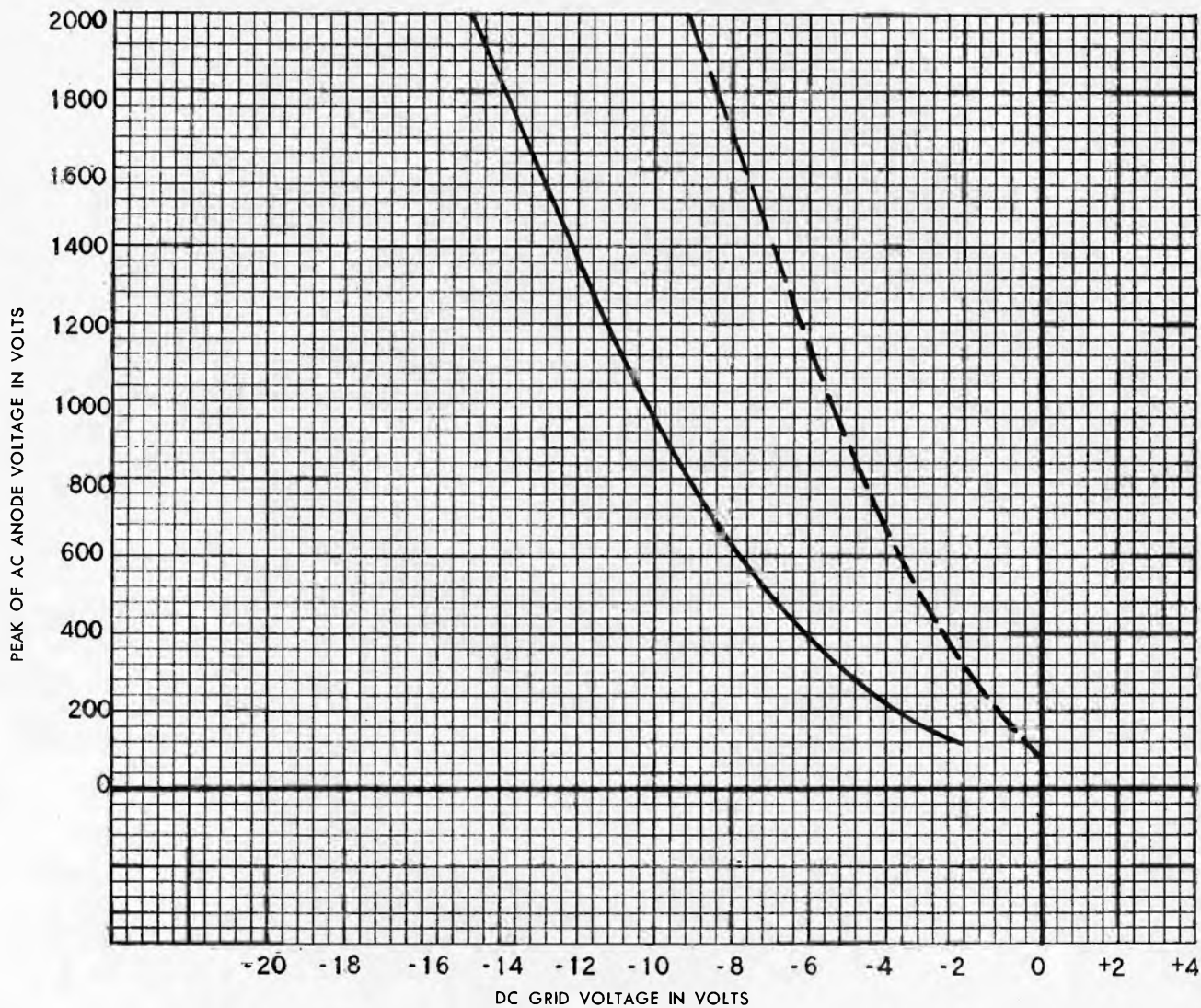
SHADED AREA SHOWS RANGE OF CHARACTERISTIC
CONDENSED-MERCURY TEMPERATURE +40 TO +80 C
 $E_r = 4.75-5.25$ VOLTS



TYPICAL VARIATION OF CONTROL CHARACTERISTIC

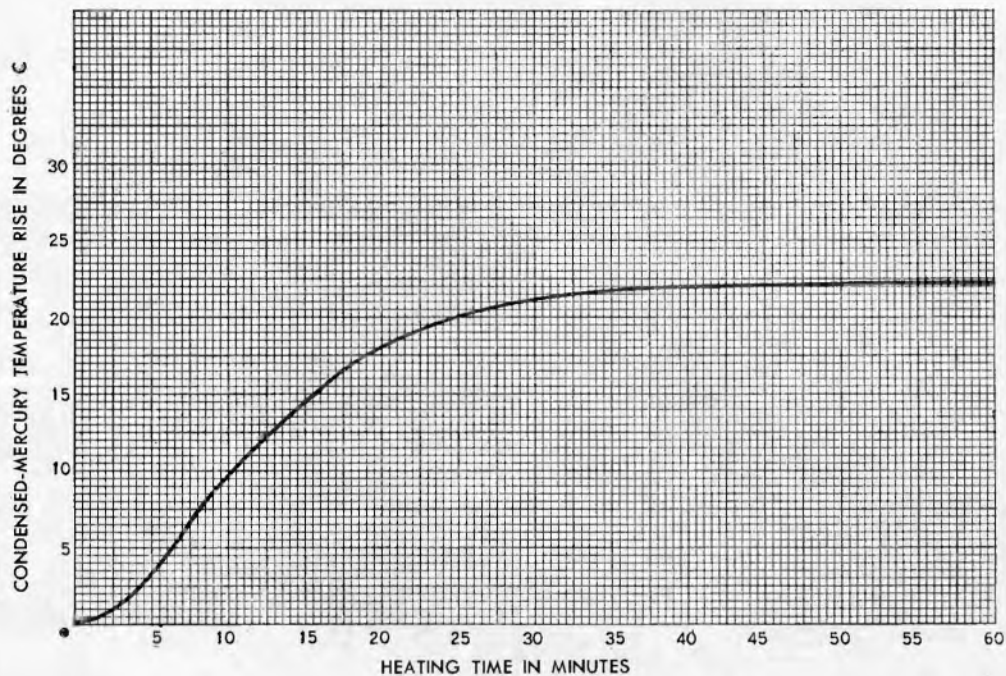
WITH A HEATER PHASE VARIATION OF 180 DEGREES
 CONDENSED-MERCURY TEMPERATURE +40 C, $E_f = 5.0$ VOLTS

- HEATER VOLTAGE OUT OF PHASE WITH ANODE VOLTAGE
 CHARACTERISTICS SAME WITH DC ANODE VOLTAGE
- HEATER VOLTAGE IN PHASE WITH ANODE VOLTAGE



RATE OF RISE OF CONDENSED-MERCURY
TEMPERATURE ABOVE AMBIENT

$E_f = 4.75$ VOLTS

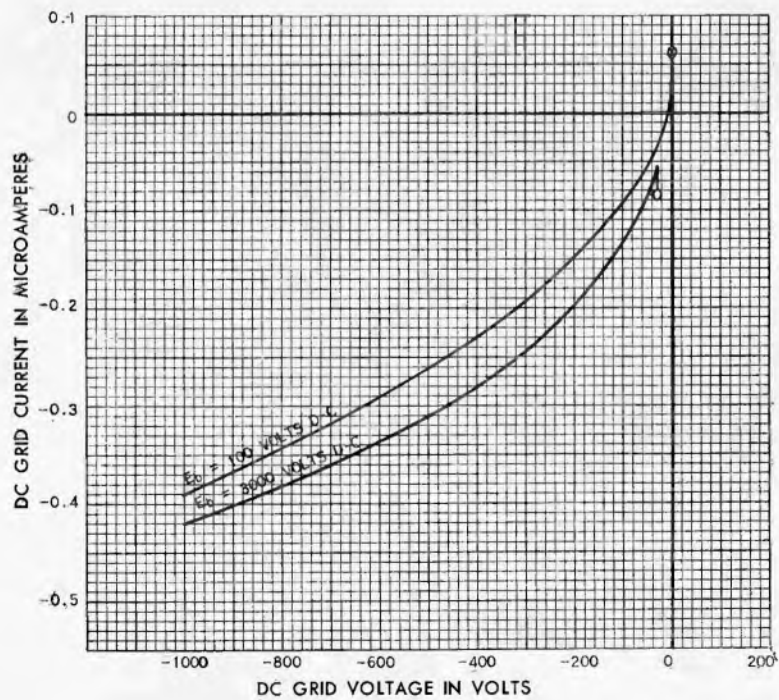


K-69087-72A215

3-19-48

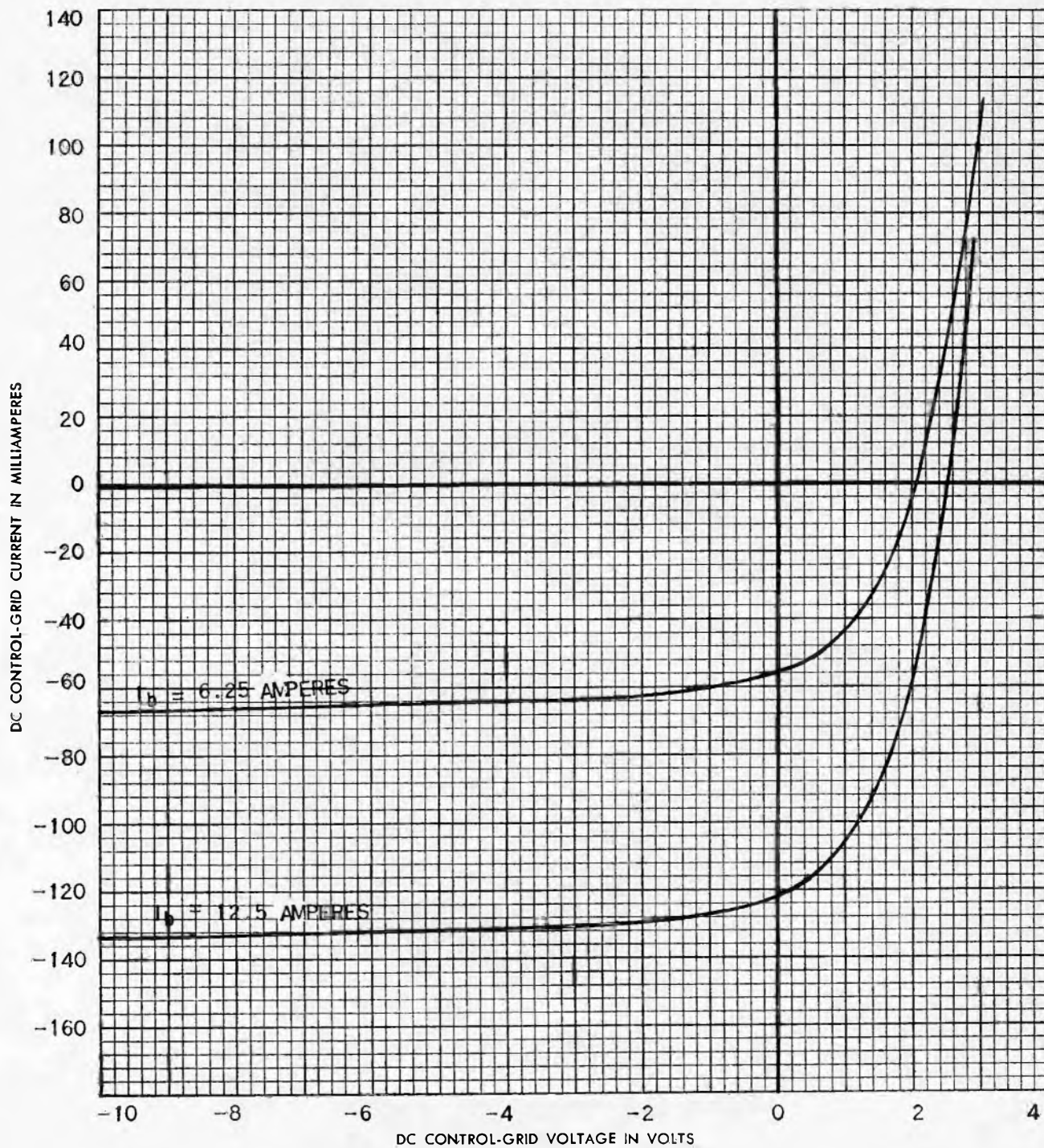
TYPICAL GRID CURRENT BEFORE ANODE CONDUCTION

$E_f = 5.0$ VOLTS 0—CONDUCTION STARTS

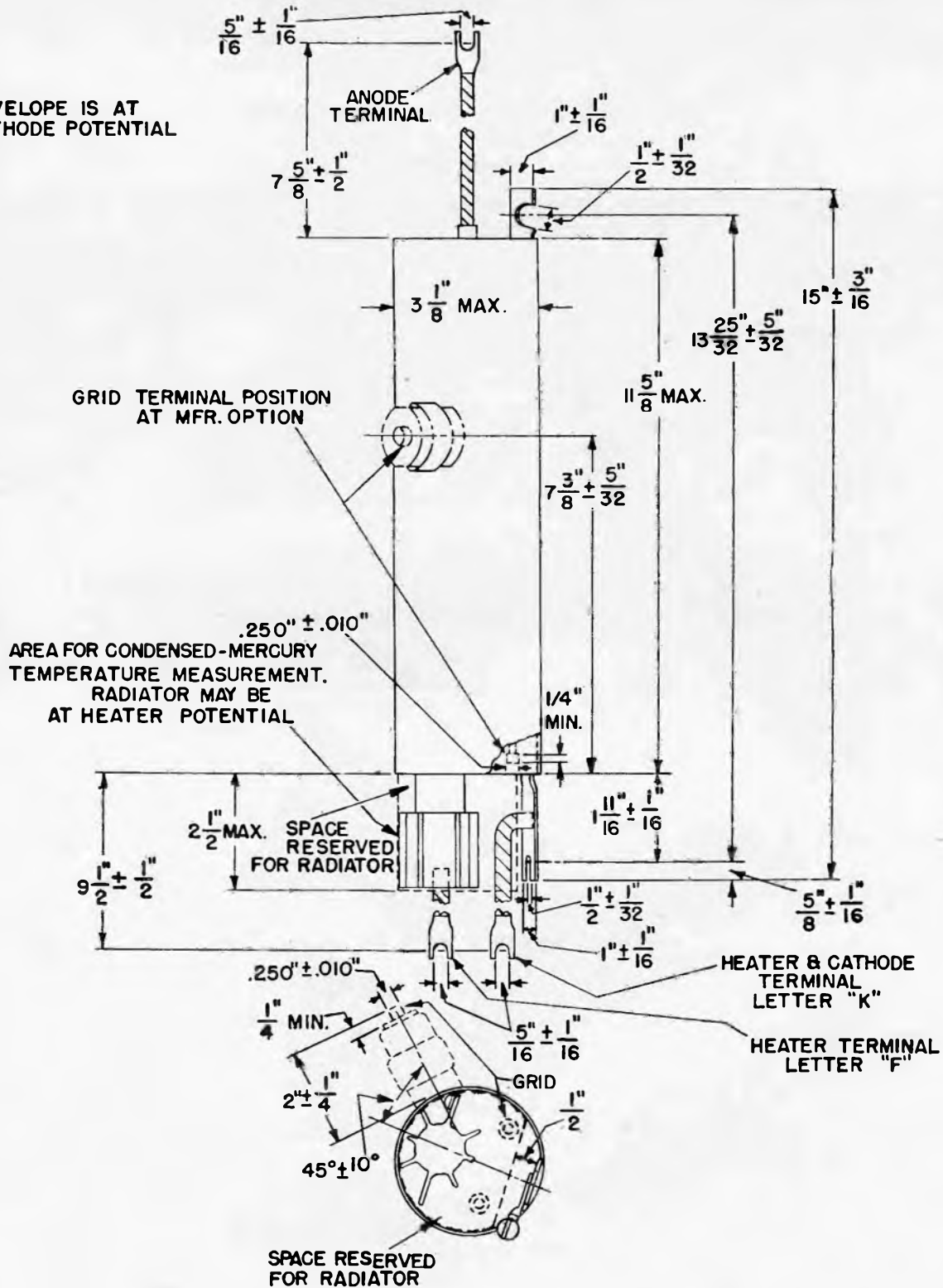


K-59087-72A221

4-13-48

TYPICAL CONTROL-GRID CHARACTERISTICS
DURING ANODE CONDUCTION $E_f = 5.0$ VOLTS AC

ENVELOPE IS AT
CATHODE POTENTIAL



N21531AZ

8-16-48

ELECTRONIC COMPONENTS DIVISION

GENERAL ELECTRIC

Schenectady 5, N. Y.

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THYRATRON

DESCRIPTION

The GL-502-A is a four-electrode inert-gas-filled all-metal thyatron with negative control characteristics. Small in size, light in weight, and with a control characteristic independent of ambient temperature over a wide range, minus 55 to plus 90 C, the tube is designed particularly for those control applications where high peak and average currents and relatively high-frequency ratings rather than long life are desired.

The metal envelope which eliminates the necessity for any external shielding together with the small size permits compact circuit design. Another feature of this tube is its high control sensitivity which is made possible by the low grid current. Since the grid-to-anode capacitance is only about two-tenths of a micromicrofarad, line-voltage surges have little effect on the GL-502-A.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Heater voltage.....	5.7	6.3	7.0	volts
Heater current at 6.3 volts.....		0.6	0.66	amperes
Cathode heating time.....	10			seconds
Anode-to-control-grid capacitance.....		0.2		uuf

◆ Technical information completely revised.



GENERAL  ELECTRIC

Supersedes ETI-134B dated 3-47

TECHNICAL INFORMATION (CONT'D)

Electrical Data (Cont'd)

	Minimum	Bogey	Maximum
Control-grid-to-cathode and shield-grid capacitance		2.5	uuf
Deionization time, approximate			
$I_b = 100$ ma, $R_g = 1000$			
$E_{rc} = -250$ v		10	microseconds
$E_{cc} = -15$ v		150	microseconds
Ionization time, approximate		0.5	microseconds
Anode voltage drop		8	volts
Critical grid current, anode voltage = 460 RMS			
$E_c =$ Cutoff			2 microamperes

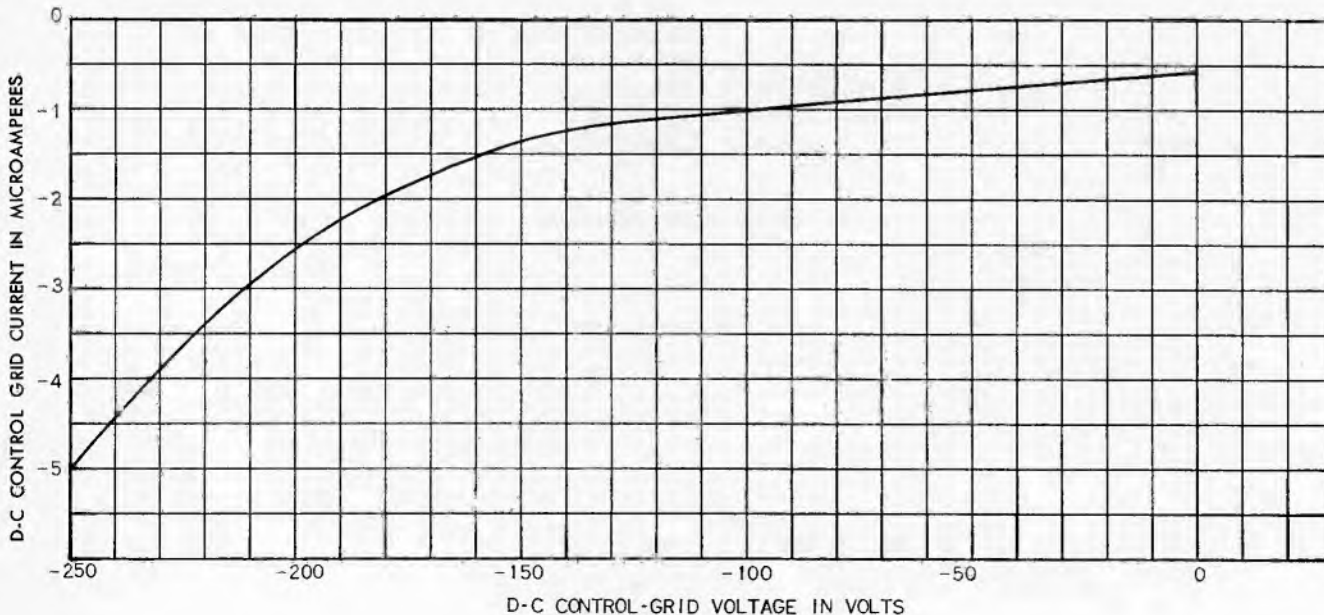
Mechanical Data

Type of cooling—convection	
Mounting position—any	
Net weight, maximum	2 ounces

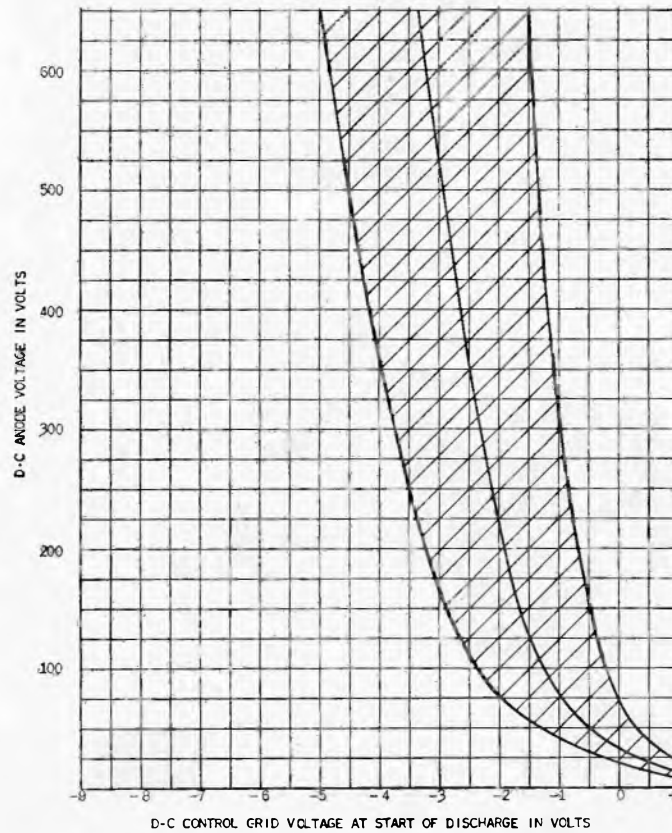
MAXIMUM RATINGS, Absolute Values

Maximum peak anode voltage		
Inverse	360	1300 volts
Forward	180	650 Volts
Maximum Cathode Current		
Peak	1.0	1.0 amperes
Average	0.2	0.1 amperes
Surge (maximum duration 0.1 second)	10	10 amperes
Maximum averaging time	30	30 seconds
Maximum negative control-grid voltage		
Before conduction	250	250 volts
During conduction	10	10 volts
Maximum positive control-grid current		
Average (averaging time, one cycle)	0.01	0.01 amperes
Maximum negative shield-grid voltage		
Before conduction	100	100 volts
During conduction	5	5 volts
Maximum positive shield-grid current		
Average (averaging time, one cycle)	0.01	0.01 amperes
Maximum heater-cathode voltage limits	-100 to +25	-100 to +25 volts
Ambient temperature limits	-55 to +90	-55 to +90 C

▲ GL-502A MAXIMUM GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION
SHIELD GRID VOLTAGE = 0 VOLTS
 $E_p = 0-650$ VOLTS D-C $E_f = 6.3$ VOLTS



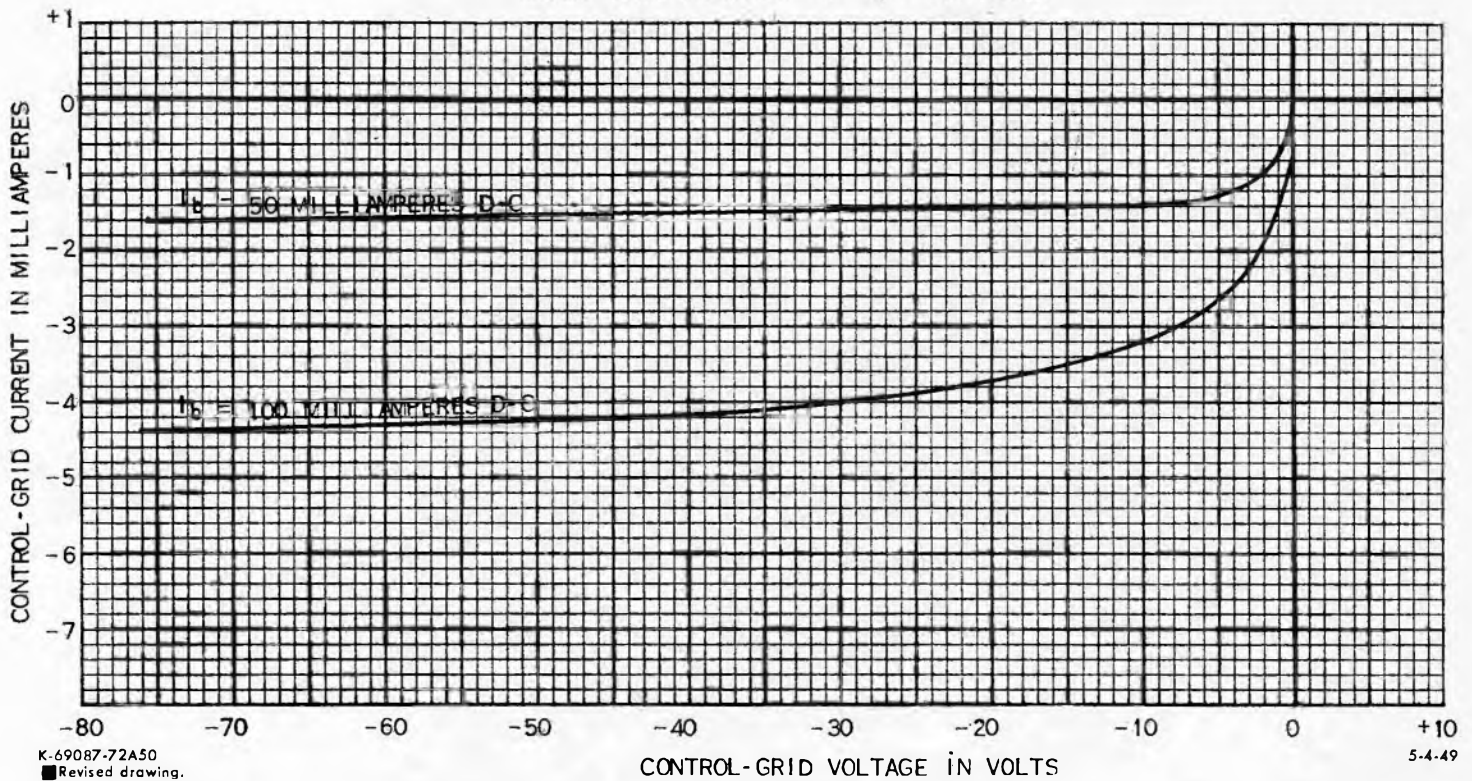
▲ GL-502A TYPICAL CONTROL CHARACTERISTICS
 SHADED AREA SHOWS RANGE OF CHARACTERISTIC
 SHIELD GRID VOLTAGE = 0



K-69087-72A31
 ▲ New drawing

5-4-49

■ GL-502A
 TYPICAL GRID CHARACTERISTICS
 DURING ANODE CONDUCTION
 SHIELD GRID VOLTAGE = 0 $E_f = 6.3$ VOLTS



K-69087-72A50
 ■ Revised drawing.

5-4-49

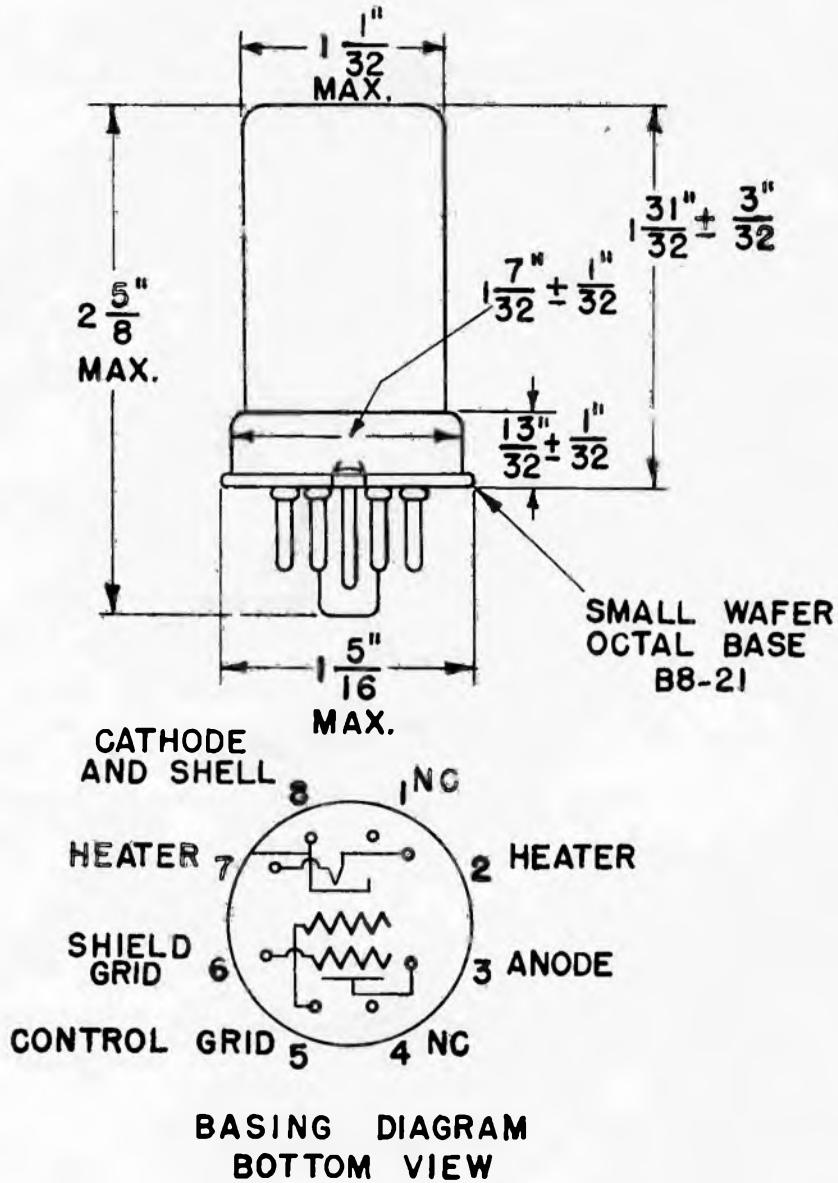
GL-502-A

ETI-134C

PAGE 4

10-49

■ OUTLINE GL-502-A THYRATRON



N-21524AZ
■ Revised drawing

2-28-49

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



THYRATRON

TRIODE TYPE

MERCURY-VAPOR

NEGATIVE CONTROL CHARACTERISTIC

The GL-5557 is a three-electrode mercury-vapor thyratron with negative control characteristic. This tube is designed for relay or control circuits where relatively little grid power is available.

TECHNICAL INFORMATION

GENERAL

Electrical	Minimum	Bogey	Maximum
Cathode—Filamentary			
Filament Voltage	2.38	2.5	2.62 Volts
Filament Current	4.6	5.0	5.4 Amperes
Heating Time	5.0	—	— Seconds
Anode-to-Control-Grid Capacitance, typical	—	2.5	— μf
Control-Grid-to-Cathode Capacitance, typical	—	7.0	— μf
Deionization Time, approximate	—	1000	— Microseconds
Ionization Time, approximate	—	10	— Microseconds
Anode Voltage Drop, typical	—	16	— Volts
Mechanical			
Type of Cooling—Convection			
Mounting Position—Vertical, Base Down			
Net Weight, maximum			3.5 Ounces

GENERAL  ELECTRIC

Supersedes ETI-118D dated 9-51

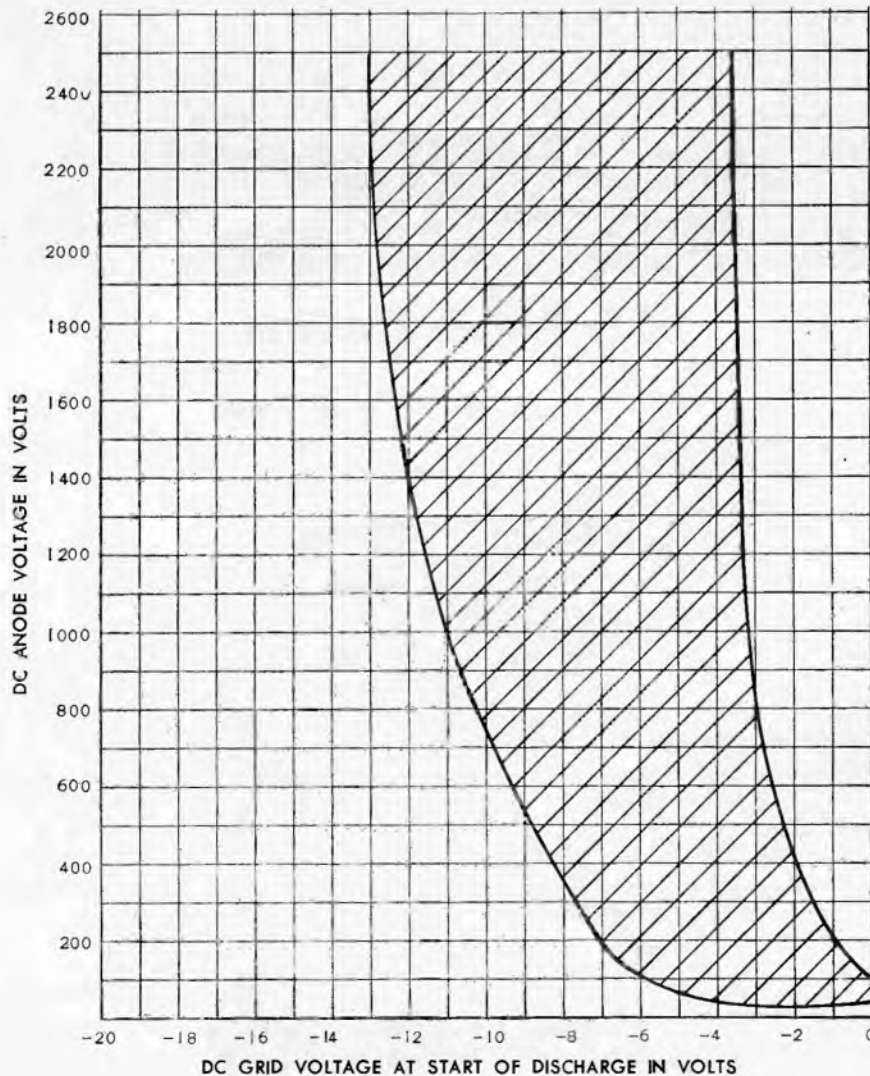
TECHNICAL INFORMATION (CONT'D)

□ MAXIMUM RATINGS

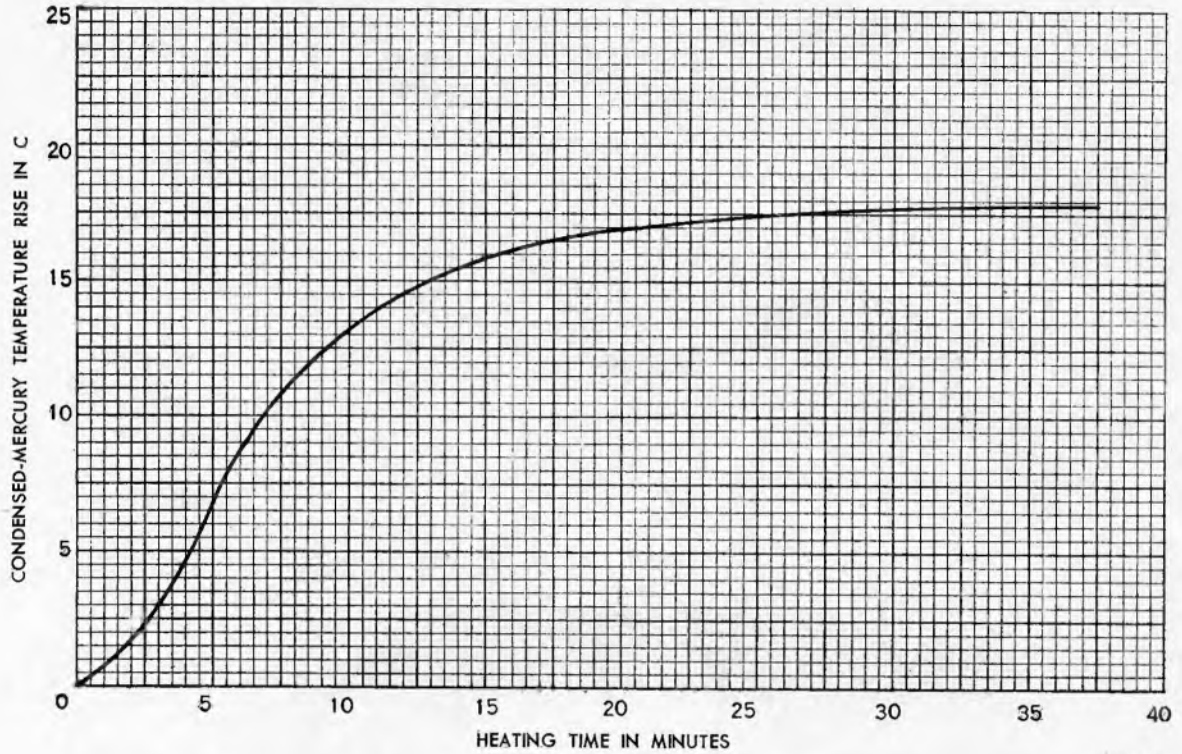
Maximum Peak Anode Voltage			
Inverse	1250	5000	10,000 Volts
Forward	1250	2500	5000 Volts
Maximum Cathode Current			
Peak	3.0	2.0	1.0 Amperes
Average	1.0	0.5	0.25 Amperes
Maximum Averaging Time	15	15	15 Seconds
Fault	40	40	40 Amperes
Maximum Duration	0.1	0.1	0.1 Seconds
Maximum Negative Control-Grid Voltage			
Before Conduction	500	500	500 Volts
During Conduction	10	10	10 Volts
Maximum Positive Control-Grid Current			
Anode Positive	0.05	0.05	0.05 Amperes
Maximum Frequency	150	150	150 Cycles per Second
Condensed-Mercury Temperature Limits ..	+40 to +90	+40 to +80	+40 to +60 C

□ Denotes an addition.

TYPICAL CONTROL CHARACTERISTIC
 SHADED AREA SHOWS RANGE OF CHARACTERISTICS
 CONDENSED MERCURY TEMPERATURE 40 C-80 C
 $E_f = 2.37$ TO 2.63 VOLTS



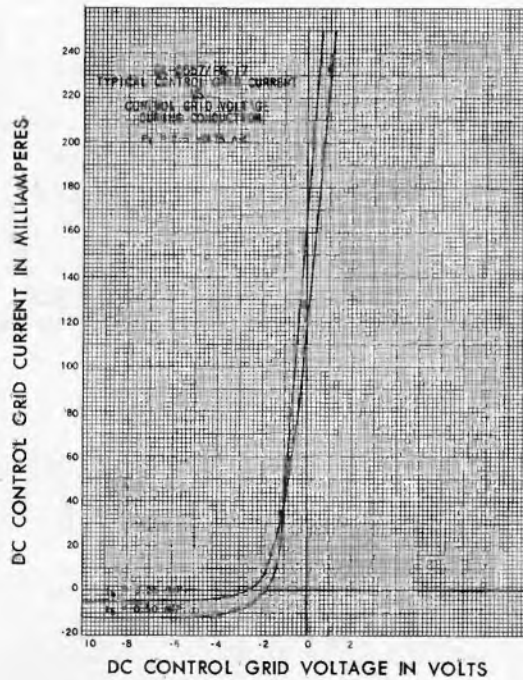
RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE ABOVE AMBIENT
 $E_r = 2.37$ VOLTS



N-21528ZA

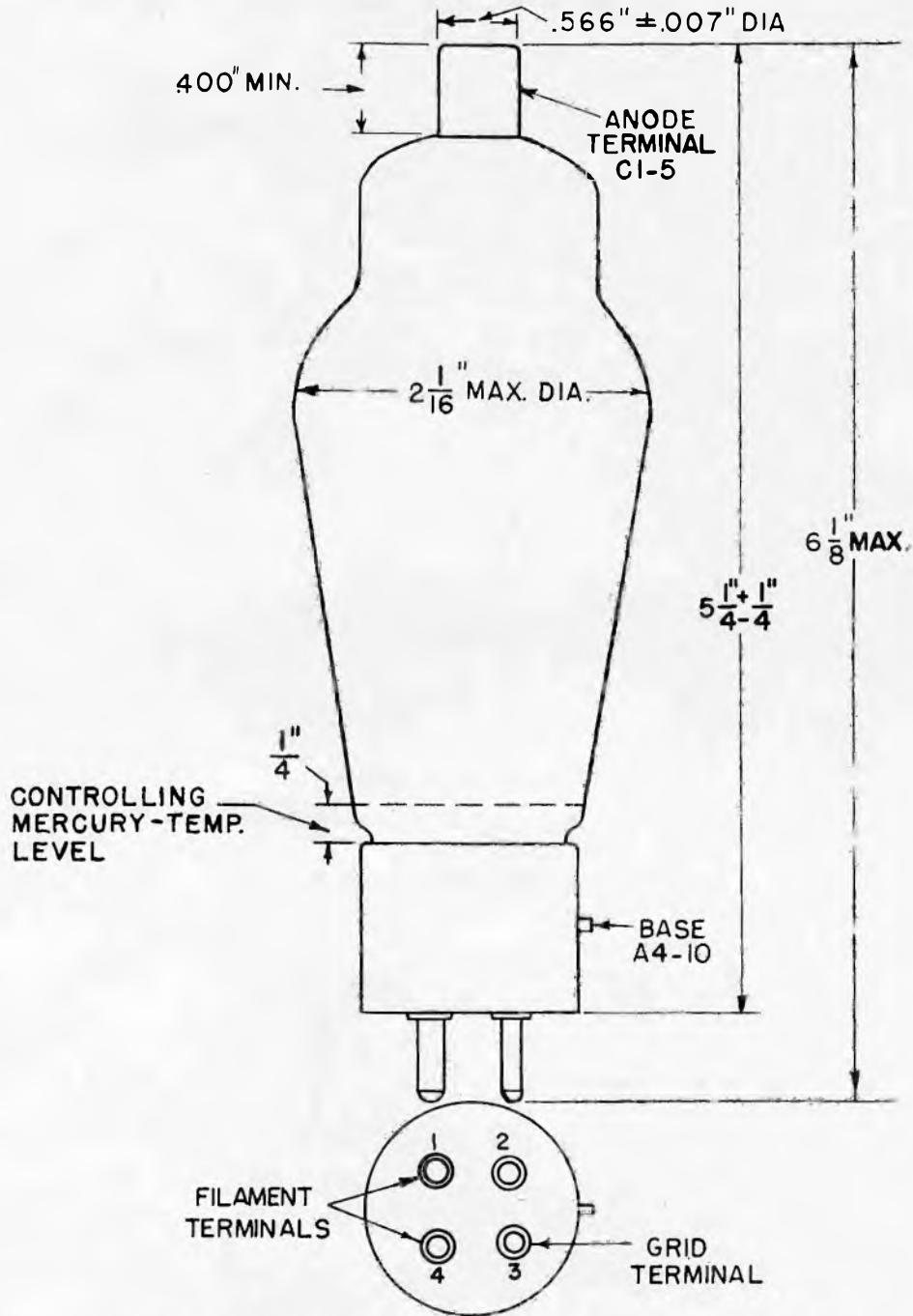
3-11-47

TYPICAL CONTROL GRID CURRENT
 VS.
 CONTROL GRID VOLTAGE
 DURING CONDUCTION
 $E_r = 2.5$ VOLTS AC



K-69087-72A135

4-29-47



K-4373365—Outline revised

6-30-53

ELECTRONIC COMPONENTS DIVISION

GENERAL  ELECTRIC

Schenectady 5, N. Y.



THYRATRON

DESCRIPTION

The GL-5559/FG-57 is a negative-control mercury-vapor tube for use where it is desired to actuate the tube with a change in negative grid voltage.

It requires relatively little grid power and is suitable for use in relay circuits where current flow is desired in the absence of grid excitation.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Heater voltage	4.75	5.0	5.25	volts
Heater current		4.5	4.9	amperes
Cathode heating time required	300			seconds
Anode-to-control-grid capacitance, typical		2.5		uuf
Control-grid-to-cathode capacitance, typical		10		uuf
Deionization time, approximate		1000		microseconds
Ionization time, approximate		10		microseconds
Anode voltage drop, typical		18		volts
Approximate control characteristics				
Anode voltage	60	100	1000	volts
Control-grid voltage	0	-1.75	-6.5	volts



GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

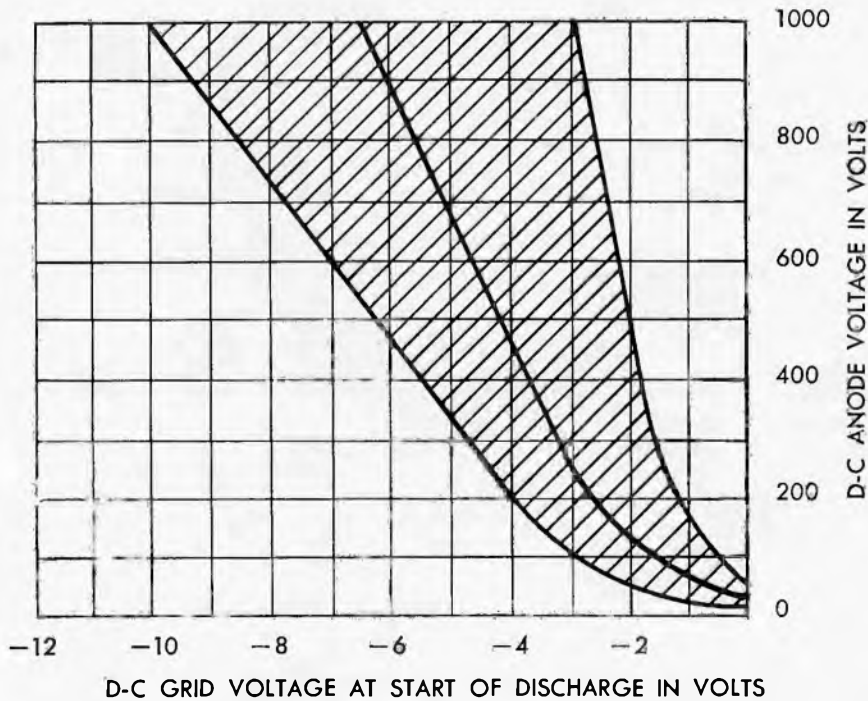
Mechanical Data

Type of Cooling—Convection
 Mounting position—vertical, base down
 Net weight, maximum 4.5 ounces

MAXIMUM RATINGS, Absolute Values

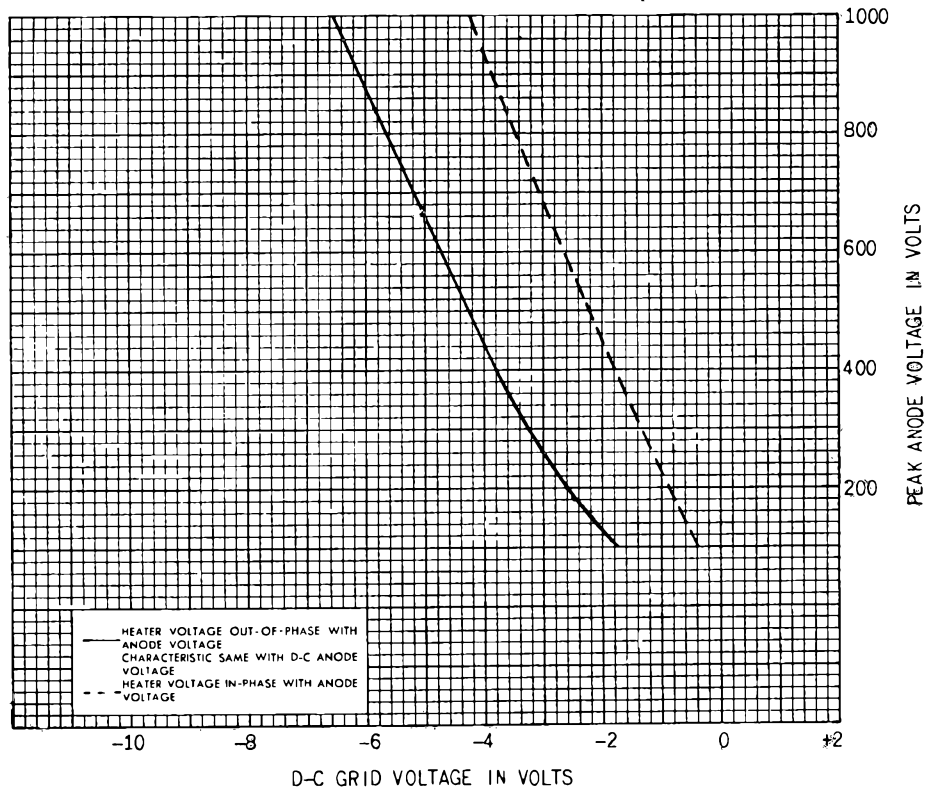
Maximum peak anode voltage
 Inverse 1000 volts
 Forward 1000 volts
 Maximum cathode current
 Peak 15 amperes
 Average 2.5 amperes
 Surge (maximum duration 0.1 second) 200 amperes
 Maximum averaging time 15 seconds
 Maximum negative control-grid voltage
 Before conduction 500 volts
 During conduction 10 volts
 Maximum positive control-grid current
 Anode positive 0.25 ampere
 Maximum frequency 150 cycles per second
 Condensed-mercury temperature limits +40 to +80

THYRATRON GL-5559/FG-57
 TYPICAL CONTROL CHARACTERISTICS
 SHADED AREA SHOWS RANGE OF CHARACTERISTICS
 CONDENSED MERCURY TEMPERATURE 40 C



GL-5559/FG-57

TYPICAL VARIATION OF CONTROL CHARACTERISTIC WITH A HEATER PHASE VARIATION OF 180 DEGREES
CONDENSED-MERCURY TEMPERATURE 40 C $E_f = 5.0$ VOLTS

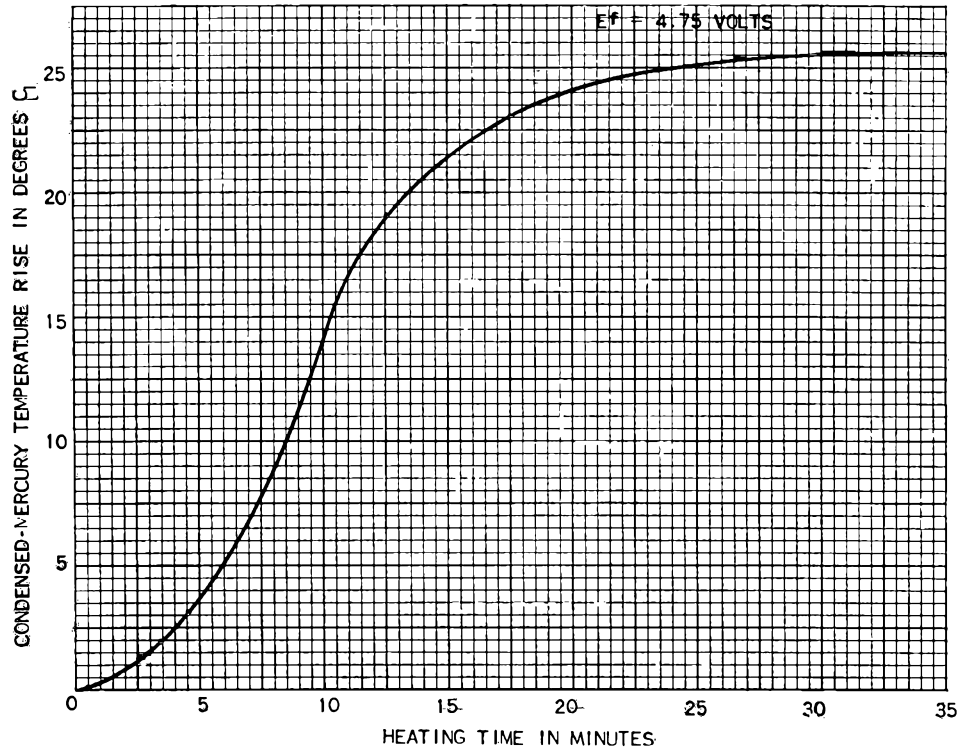


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GL-5559/FG-57

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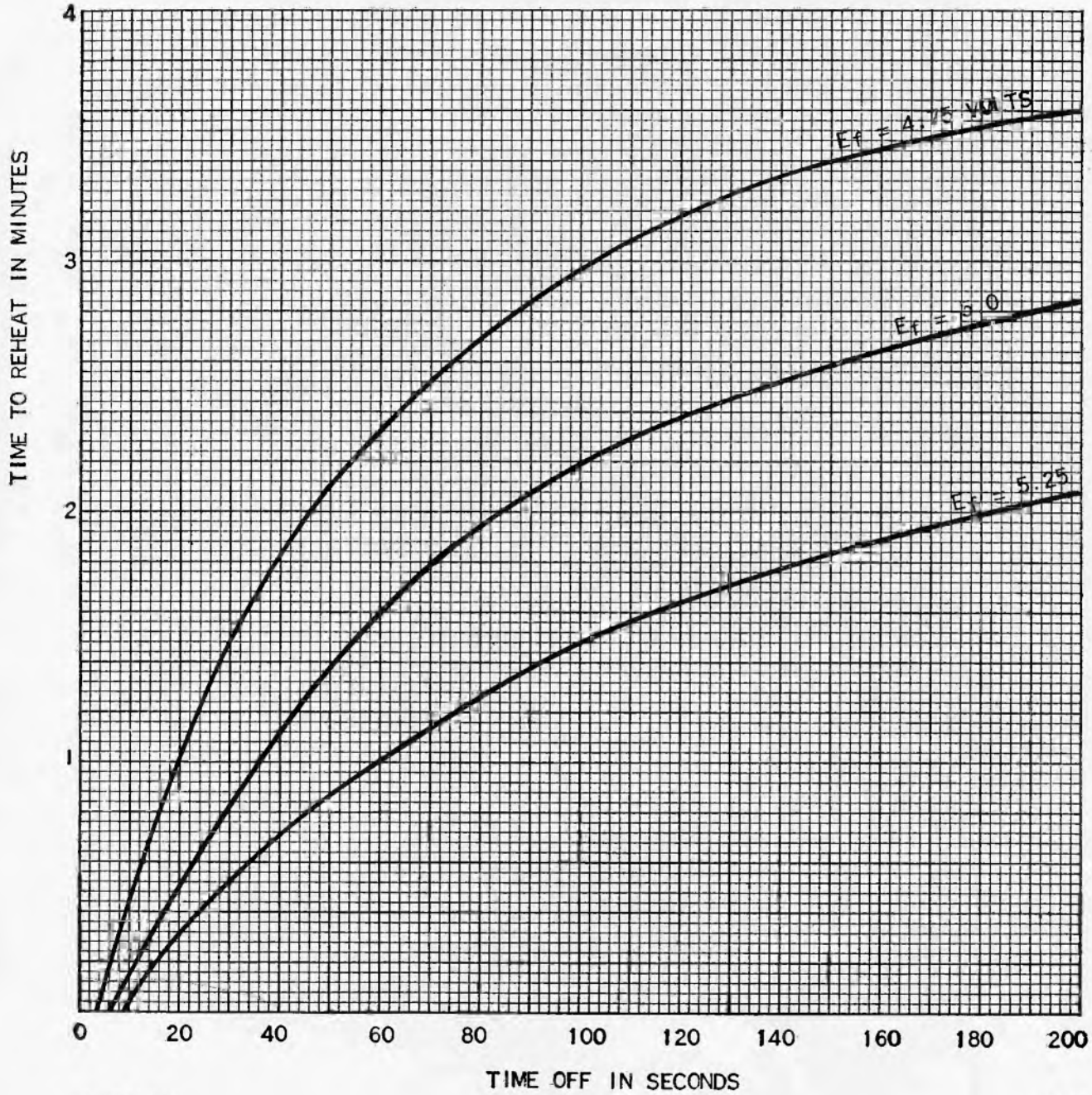
RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE ABOVE AMBIENT



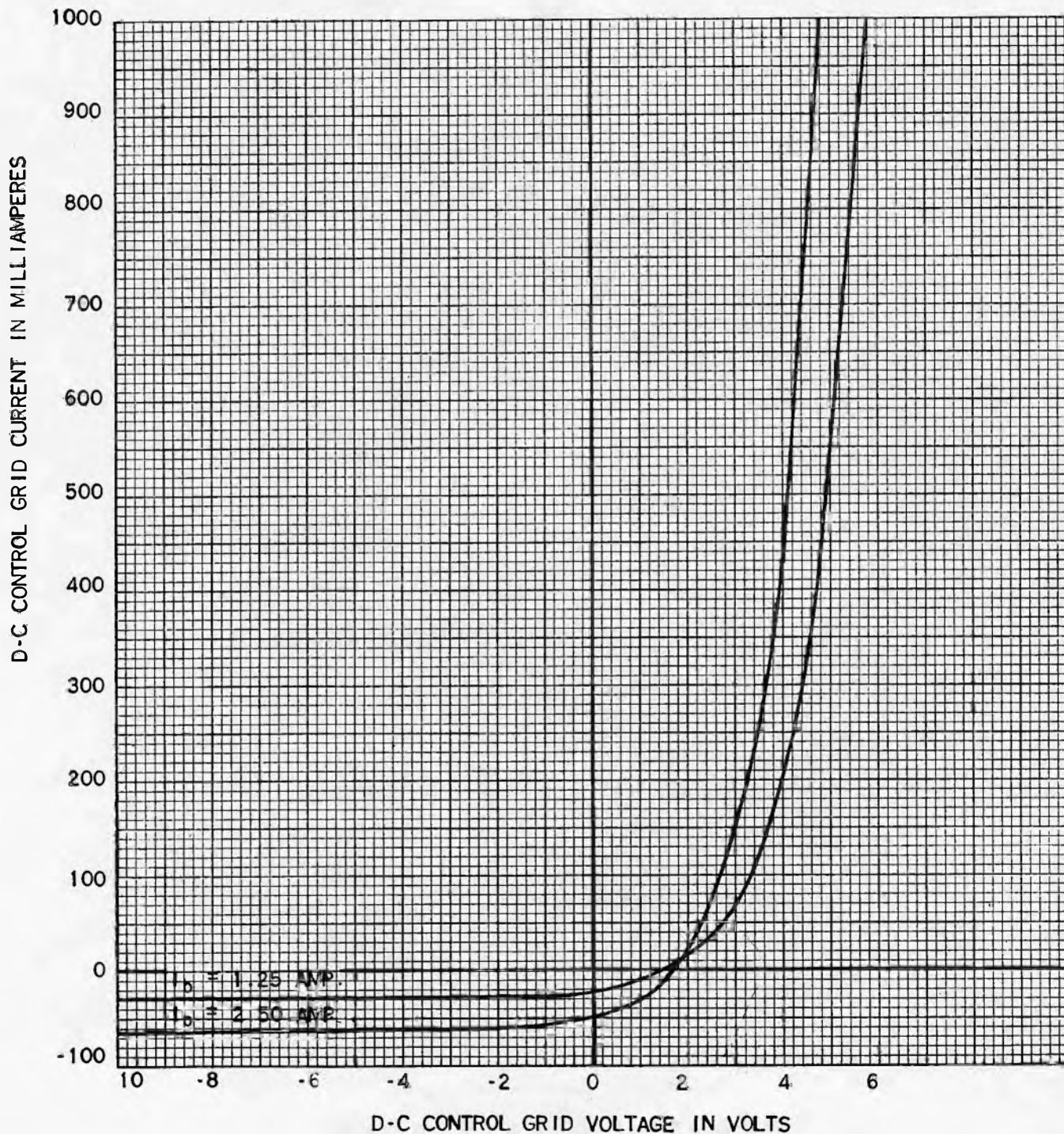
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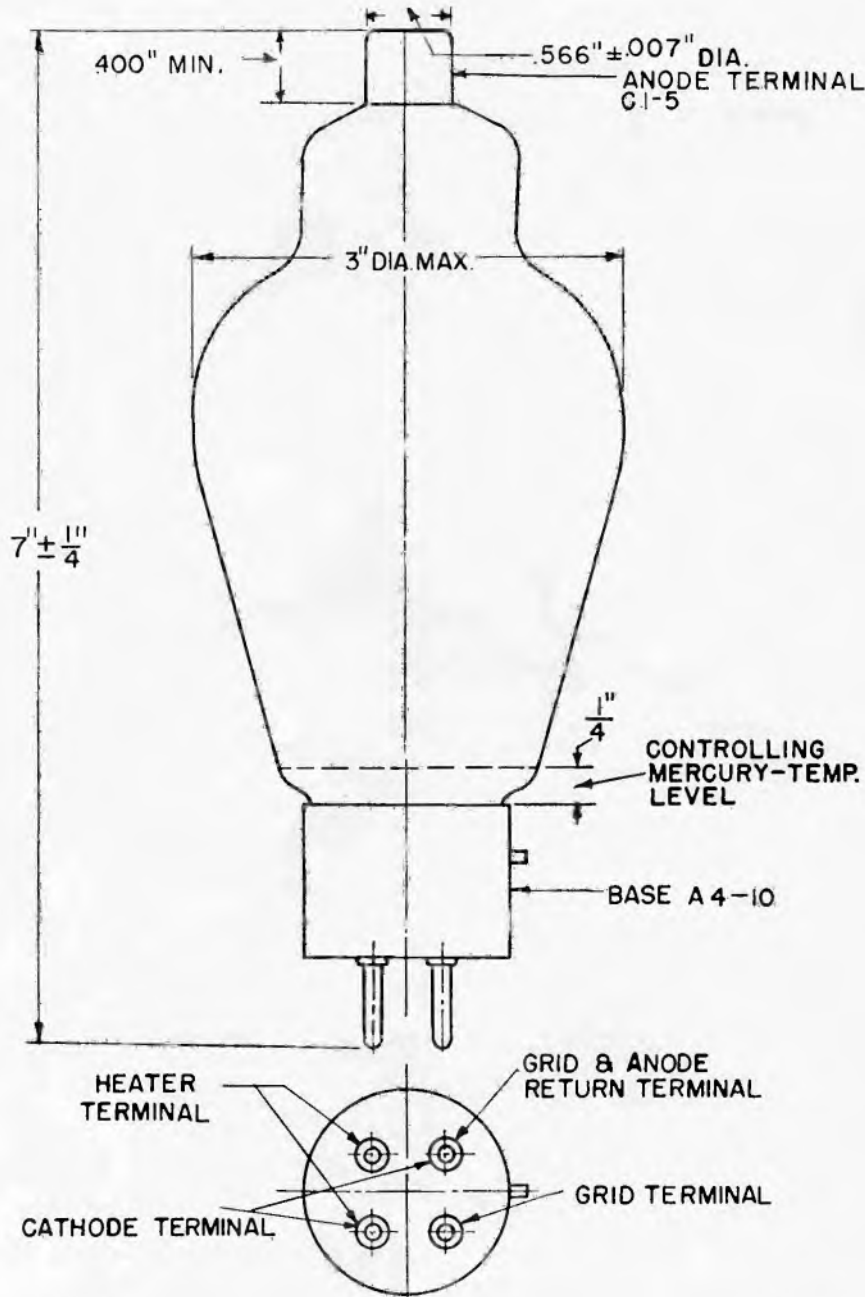
▲ GL-5559/FG-57
CATHODE REHEATING CURVE
ANODE VOLTAGE = 0



▲ GL-5559/FG-57
TYPICAL CONTROL GRID CURRENT
VS.
CONTROL GRID VOLTAGE DURING CONDUCTION
 $E_f = 5.0$ VOLTS A-C



■ OUTLINE
GL-5559/FG-57 THYRATRON



K-4373343
■ Revised drawing

8-29-47

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



THYRATRON

DESCRIPTION

The GL-5560/FG-95 is a four-electrode mercury-vapor thyatron with negative control characteristic. This tube is designed for applications where

the available grid power is very small and where it is desired to actuate the grid from a high-impedance source.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Heater voltage	4.75	5.0	5.25	volts
Heater current		4.5	4.9	amperes
Cathode heating time required	300			seconds
Anode-to-control-grid capacitance, typical		0.2		uuf
Control-grid-to-cathode capacitance, typical		4.4		uuf
Deionization time, approximate		1000		microseconds
Ionization time, approximate		10		microseconds
Anode voltage drop, typical		16		volts
Approximate control characteristics				
Anode voltage	100	1000		volts
Shield-grid voltage	0	0		volts
Control-grid voltage	+1.0	-9.0		volts



GENERAL  ELECTRIC

Supersedes ETI-125B dated 10-47

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Type of cooling—convection

Mounting position—vertical, base down

Net weight, maximum 6.5 ounces

MAXIMUM RATINGS, ABSOLUTE VALUES

Maximum peak anode voltage

Inverse 1000 volts

Forward 1000 volts

Maximum cathode current

Peak *30 15 amperes

Average *0.5 2.5 amperes

Surge (maximum duration 0.1 seconds) 200 amperes

Maximum averaging time 15 seconds

Maximum negative control-grid voltage

Before conduction 1000 volts

During conduction 10 volts

Maximum positive control-grid current

Anode positive 0.25 amperes

Maximum negative shield-grid voltage

Before conduction 300 volts

During conduction 5 volts

Maximum positive shield-grid current

Anode positive 0.25 amperes

Maximum frequency

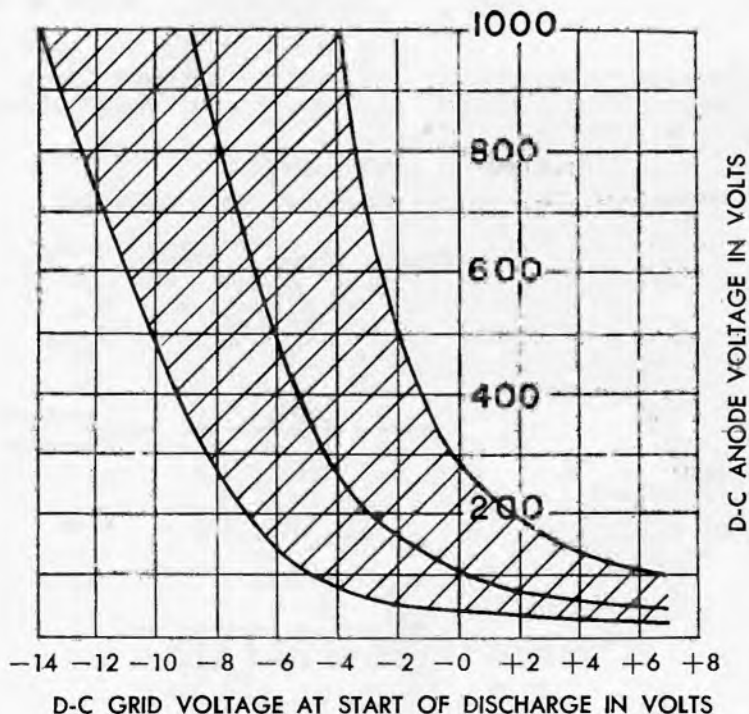
. 150 cycles per second

Condensed-mercury temperature limits

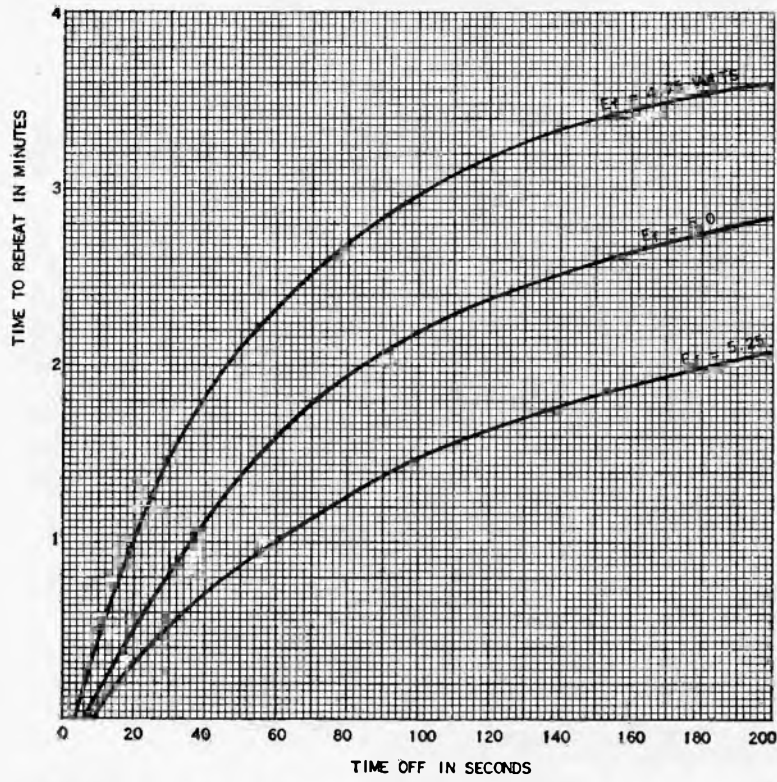
. +40 to +80 C

* These ratings apply with Heater Voltage 5.5 ± 5% volts, only when the 5560 is used for ignitor firing.

THYRATRON GL-5560/FG-95 TYPICAL CONTROL CHARACTERISTICS
 SHADED AREA SHOWS RANGE OF CHARACTERISTICS
 CONDENSED MERCURY TEMPERATURE 40 C
 SHIELD-GRID VOLTAGE ZERO



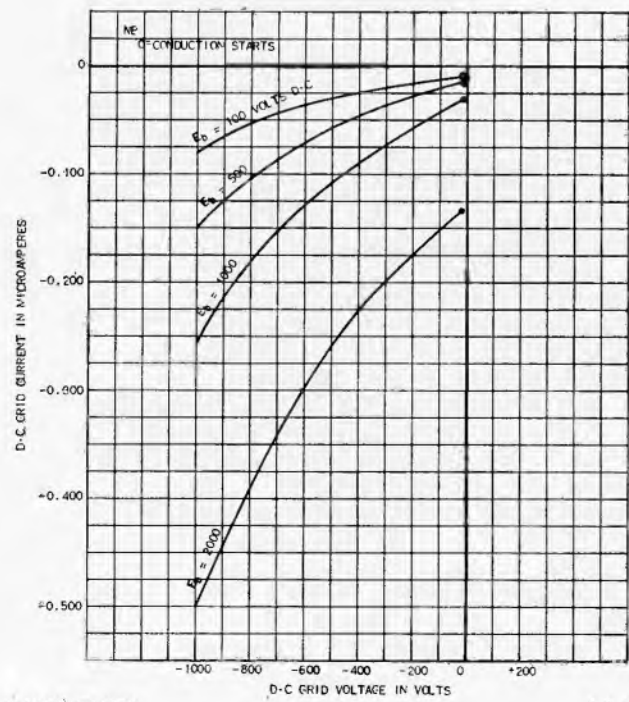
▲ GL-5560/FG-95
CATHODE REHEATING CURVE
ANODE VOLTAGE = 0



K-69087-72A184
▲New drawing.

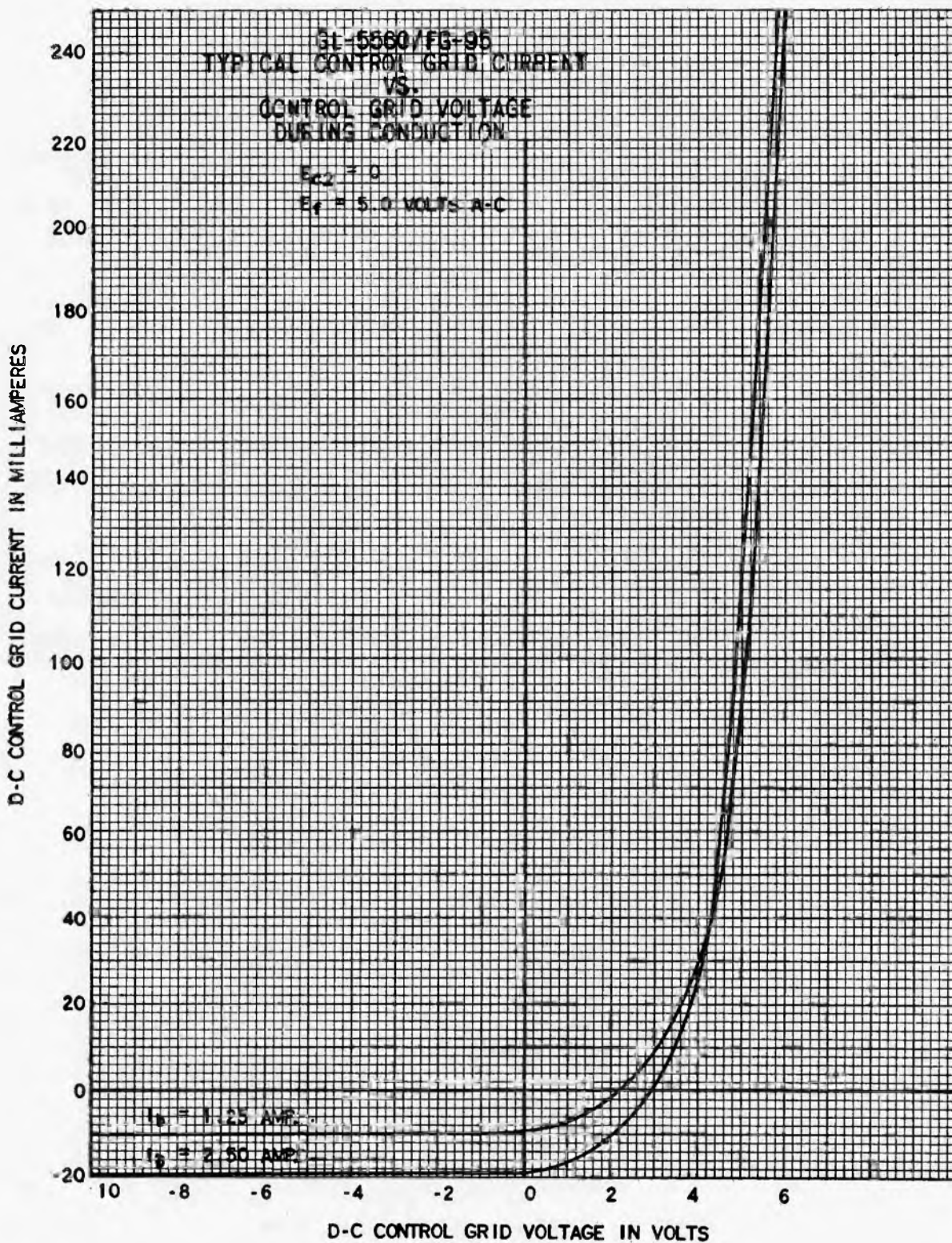
4-8-48

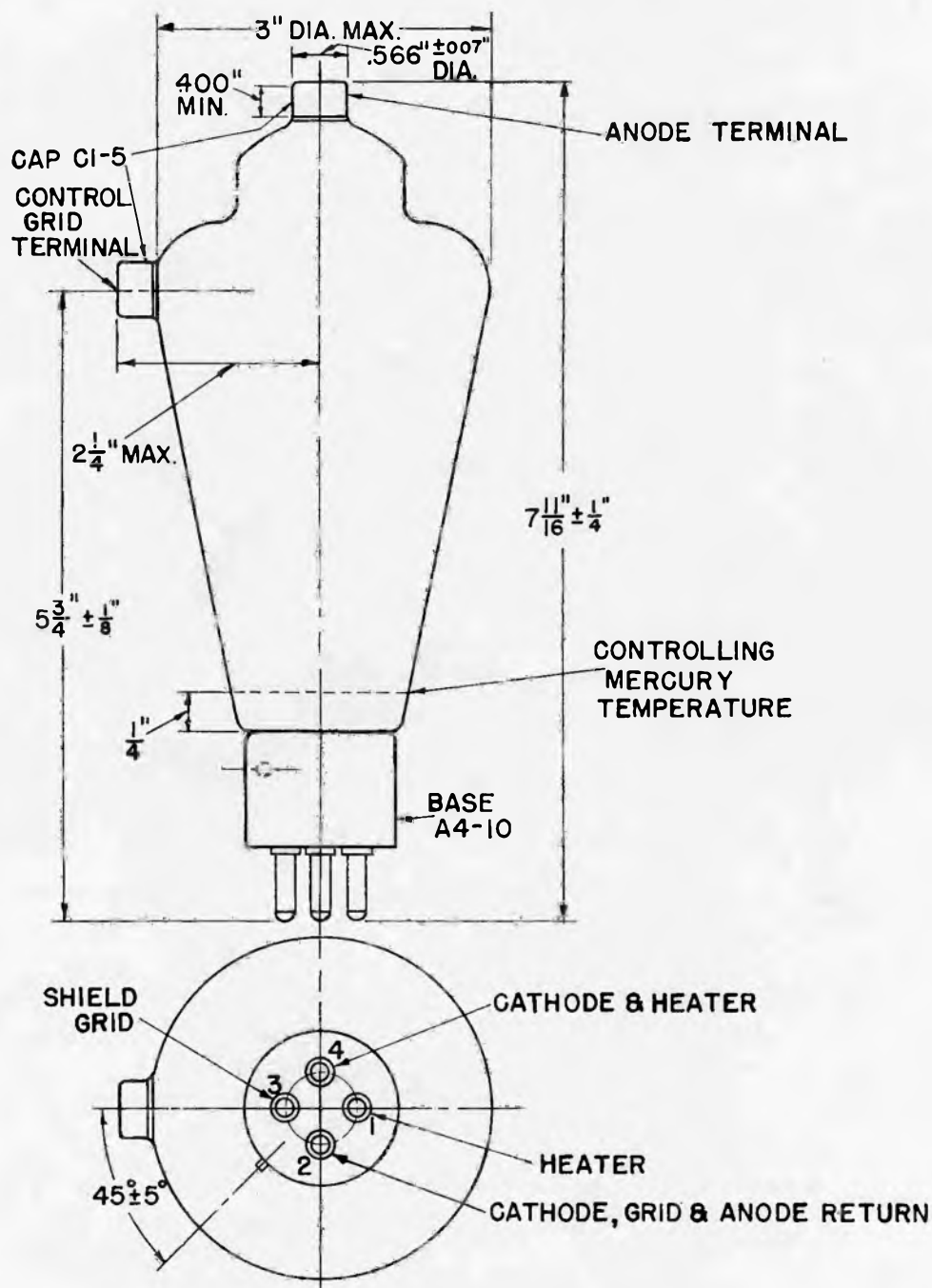
▲ GL-5560/FG-95
AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION



K-69087-72A283
▲New drawing.

4-6-49





K-495590

9-28-45

OUTLINE
GL-5560/FG-95 THYRATRON

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



THYRATRON

DESCRIPTION

The GL-5720/FG-33 is a three-electrode mercury-vapor thyratron with a positive control characteristic. This offers the advantage of a tube that will operate only with a positive voltage on

the grid and is ideally suited for applications which require that no current flow in the absence of grid excitation.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Heater voltage.....	4.75	5.0	5.25 volts
Heater current at 5.0 volts.....		4.5	4.9 amperes
Cathode heating time required.....	300		seconds
Anode-to-control-grid capacitance.....		2.7	uuf
Control-grid-to-cathode capacitance.....		8.0	uuf
Deionization time			
$E_b = 120$ v d-c; $I_b = 2.5$ a d-c; $R_g = 1000$ ohms			
$E_{cc} = -500$ v d-c.....		80	microseconds
$E_{cc} = +1$ v d-c.....		820	microseconds
Ionization time			
$E_b = 100$ volts; $I_b = 15$ amp., $E_c = +15$ v.....		10	microseconds
Anode voltage drop.....		16	volts
Critical grid current at $E_p = 220$ v a-c.....			1000 microamperes

◆ Revised.



GENERAL  ELECTRIC

Supersedes ETI-120A dated 4-48

TECHNICAL INFORMATION (CONT'D)

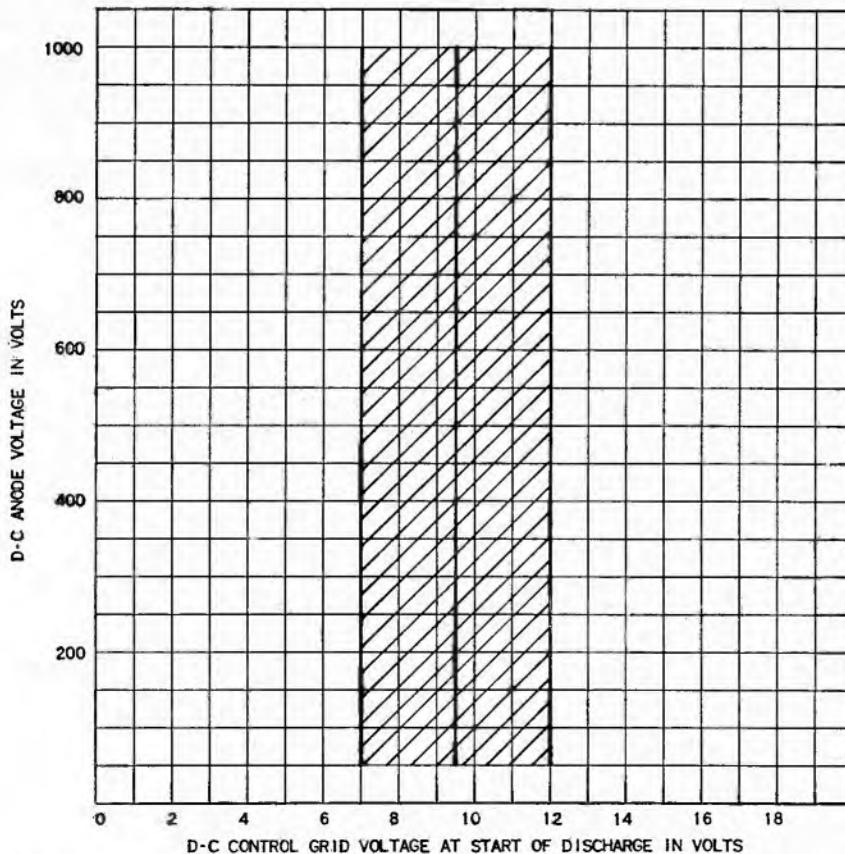
Mechanical Data

Type of cooling	convection
Equilibrium condensed-mercury Temperature rise above ambient	
At full load, approximate	37 C
At no load, approximate	26 C
Mounting position	vertical, base down
Net weight, maximum	5 ounces
Shipping weight, approximate	7 pounds

MAXIMUM RATINGS, Absolute Values

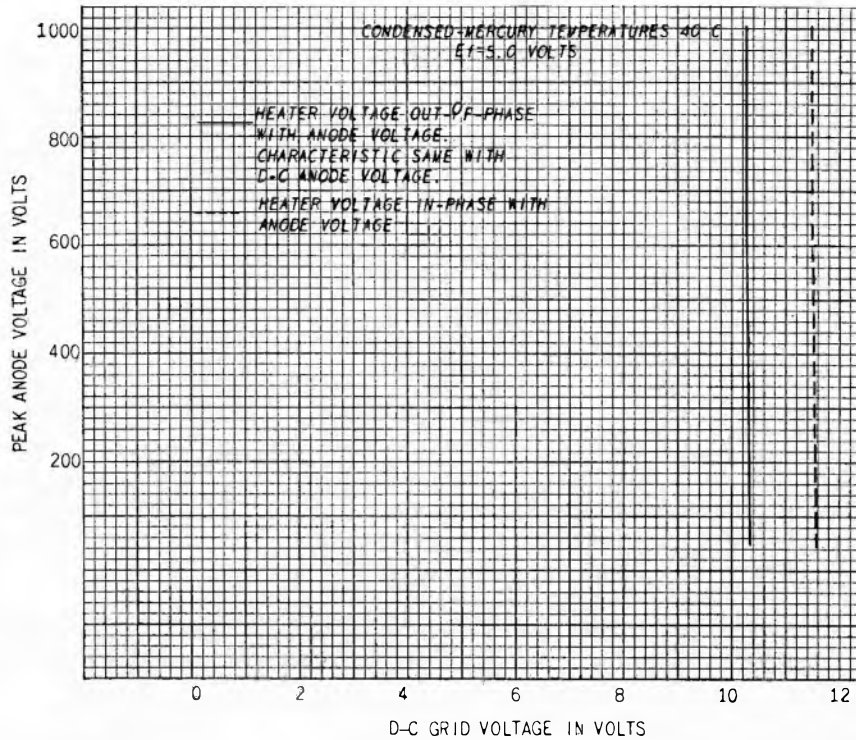
Maximum peak anode voltage	
Inverse	1000 volts
Forward	1000 volts
Maximum cathode current	
Peak	15.0 amperes
Average	2.5 amperes
Surge (maximum duration 0.1 second)	200 amperes
Maximum averaging time	15 seconds
Maximum negative control-grid voltage	
Before conduction	500 volts
During conduction	10 volts
Maximum positive control-grid current	
Average (averaging time one cycle)	0.25 ampere
Maximum frequency	150 cycles per second
Condensed-mercury temperature limits	+35 to +80 C

GL-5720/FG-33 TYPICAL CONTROL CHARACTERISTICS
 SHADED AREA SHOWS RANGE OF CHARACTERISTICS
 CONDENSED-MERCURY TEMPERATURE 40C - 80C
 $E_i = 4.75-5.25$ VOLTS



GL-5720/FG-33

TYPICAL VARIATION OF CONTROL CHARACTERISTIC WITH A HEATER PHASE VARIATION OF 180 DEGREES

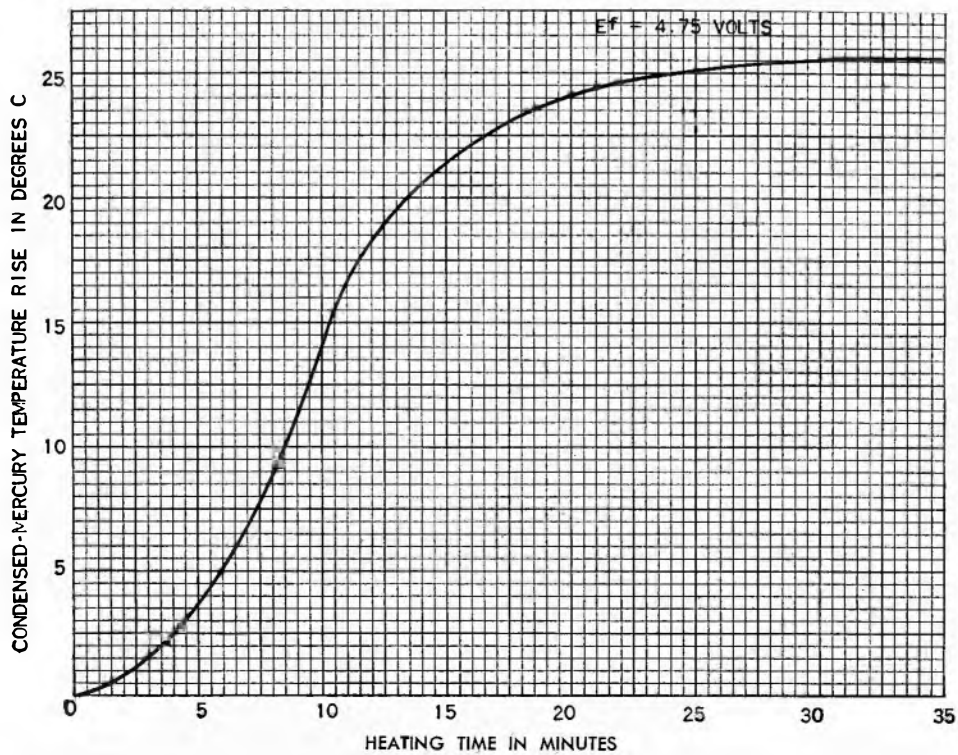


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GL-5720/FG-33

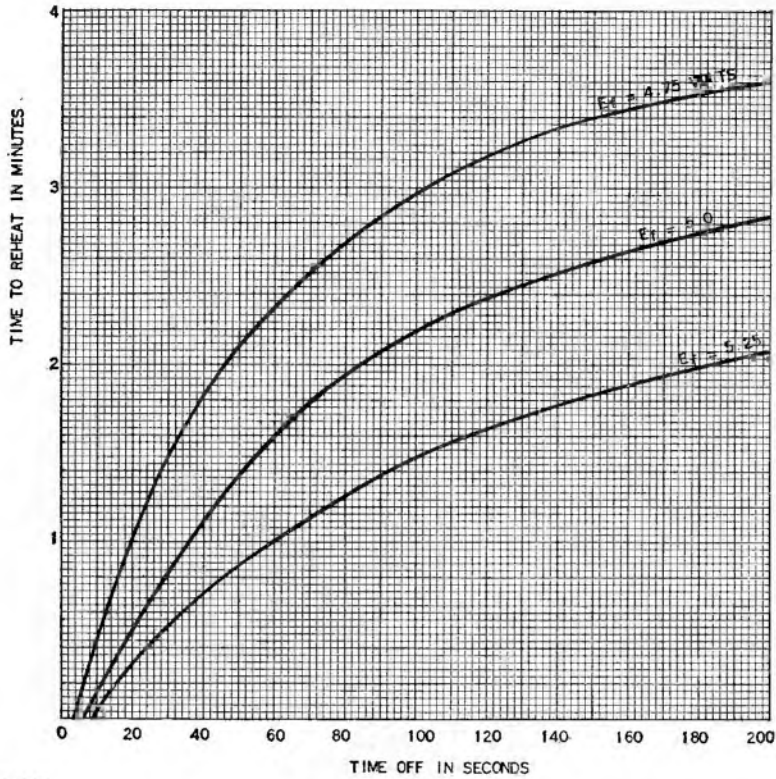
RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE ABOVE AMBIENT



N-21529ZA

4-8-48

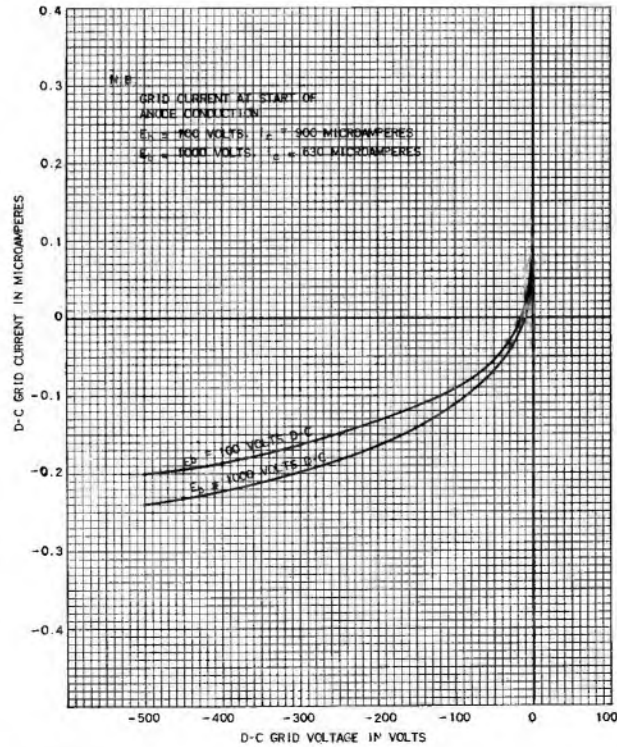
GL-5720/FG-33
CATHODE REHEATING CURVE
ANODE VOLTAGE = 0



K-69087-72A184

1-16-48

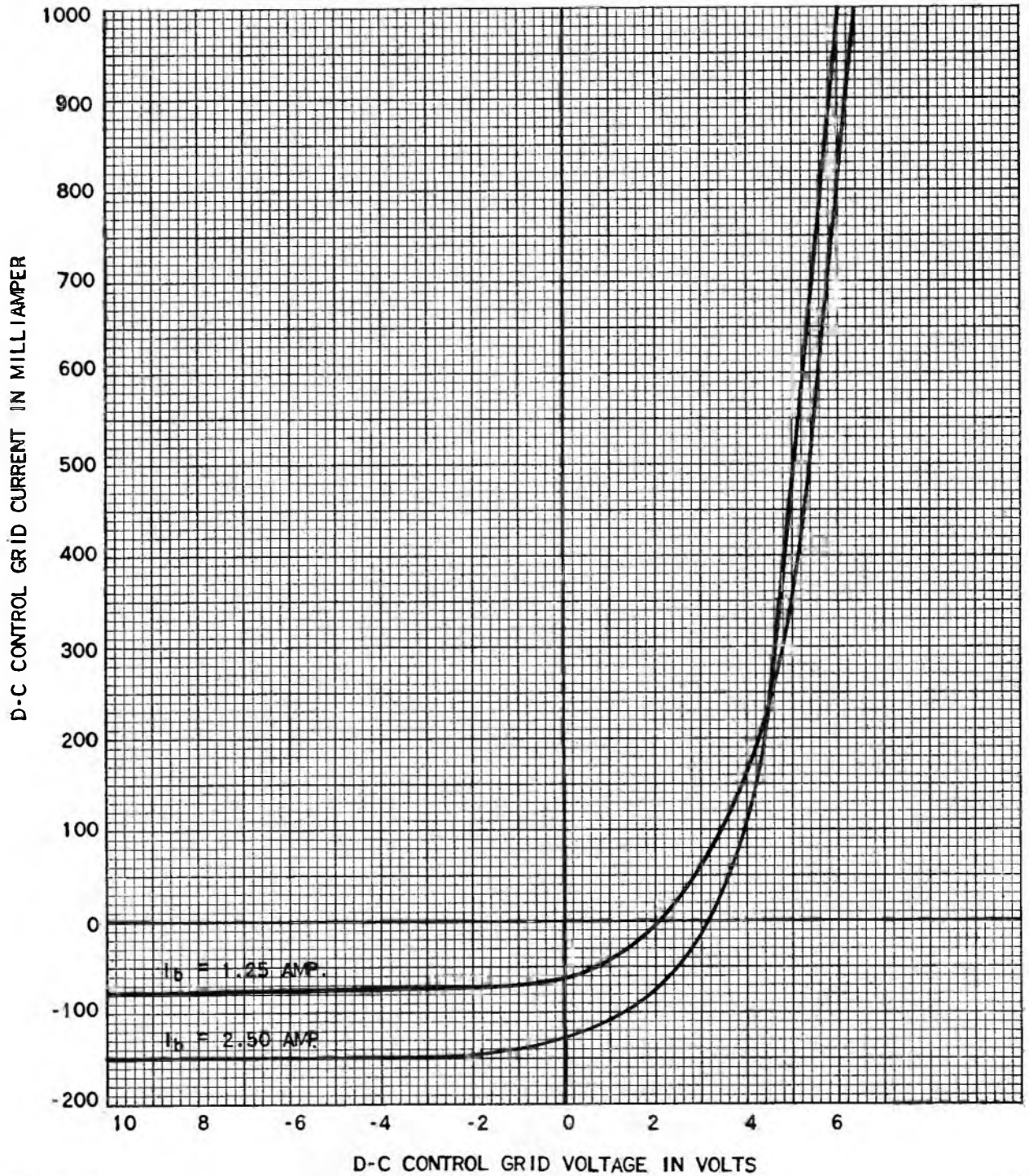
GL-5720/FG-33
AVERAGE GRID CHARACTERISTICS BEFORE ANODE CONDUCTION



K-69087-72A185

11-7-47

GL-5720/FG-33
 TYPICAL CONTROL GRID CURRENT
 VS.
 CONTROL GRID VOLTAGE DURING CONDUCTION

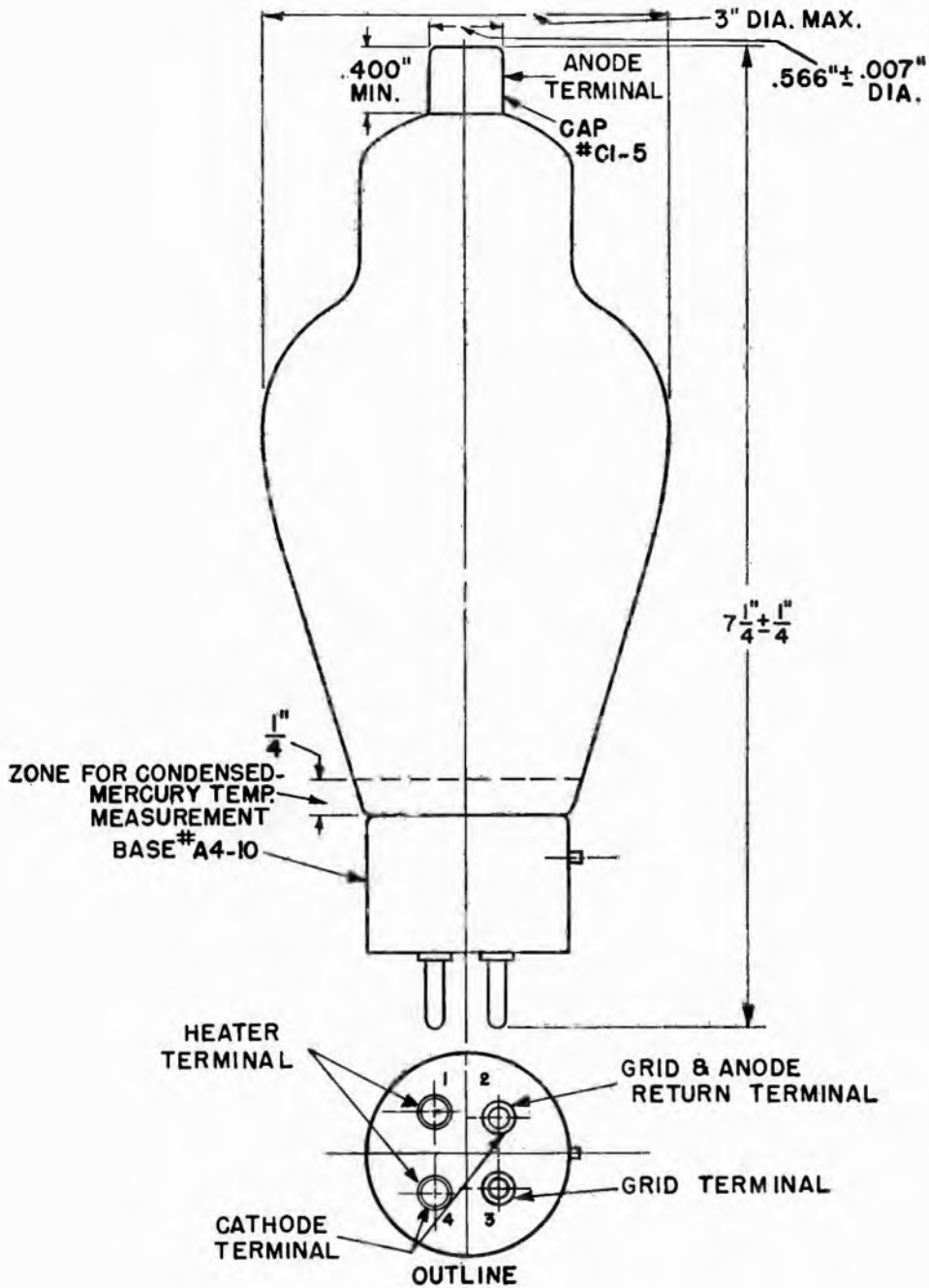


GL-5720/FG-33

ETI-120B

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THYRATRON GL-5720/FG-33

K-4373360

3-10-48

Tube Department, Electronics Division

GENERAL ELECTRIC

Schenectady, N. Y.



THYRATRON

DESCRIPTION

The GL-5728/FG-67 is a three-electrode mercury-vapor thyratron with positive control characteristic. This tube is designed for use in inverter circuits where a short deionization time is required.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Heater voltage	4.75	5.0	5.25 volts
Heater current at 5.0 volts	4.5	4.5	4.9 amperes
Cathode heating time	300		seconds
Anode-to-control-grid capacitance	3.25		micromicrofarads
Control grid—Cathode capacitance	8.90		micromicrofarads
Deionization time, approximate			
$E_b = 120$ v d-c, $I_b = 2.5$ a d-c, $R_g = 1000$ ohms			
$E_{cc} = -500$ v d-c			5 microseconds
$E_{cc} = 0$	850		microseconds
Ionization time, approximate			
$E_{bb} = 100$ volts, $i_b = 15$ amps, $e_c = +35$	15		microseconds
Anode voltage drop	16		volts
Critical grid current at $E_p = 220$ v a-c		10	microamperes

◆ Technical Information changed throughout.



GENERAL ELECTRIC

Supersedes ETI-123A dated 10-47

TECHNICAL INFORMATION (CONT'D)

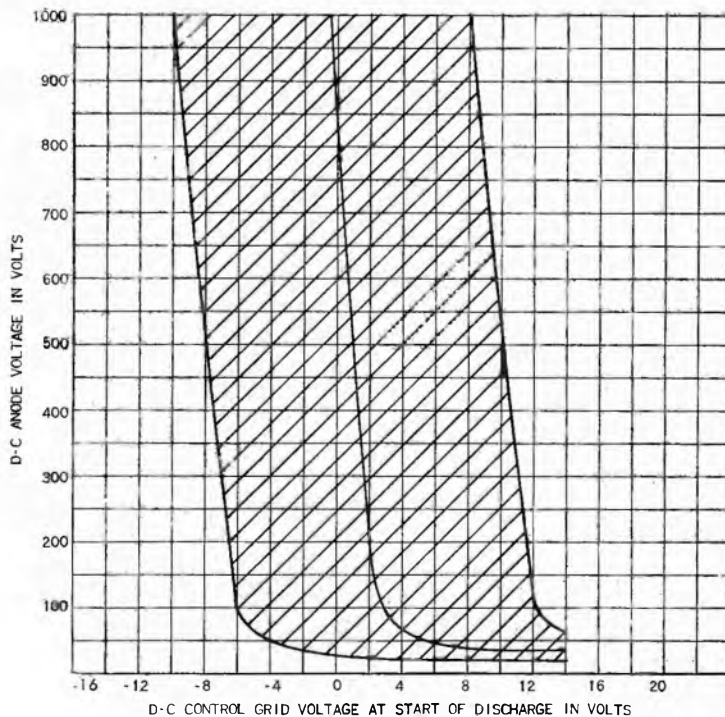
Mechanical Data

Type of cooling—Convection	
Equilibrium condensed-mercury temperature	
Rise above ambient	
At full load, approximate	31 C
At no load, approximate	25 C
Mounting position—Vertical, base down	
Net weight, maximum	5 ounces

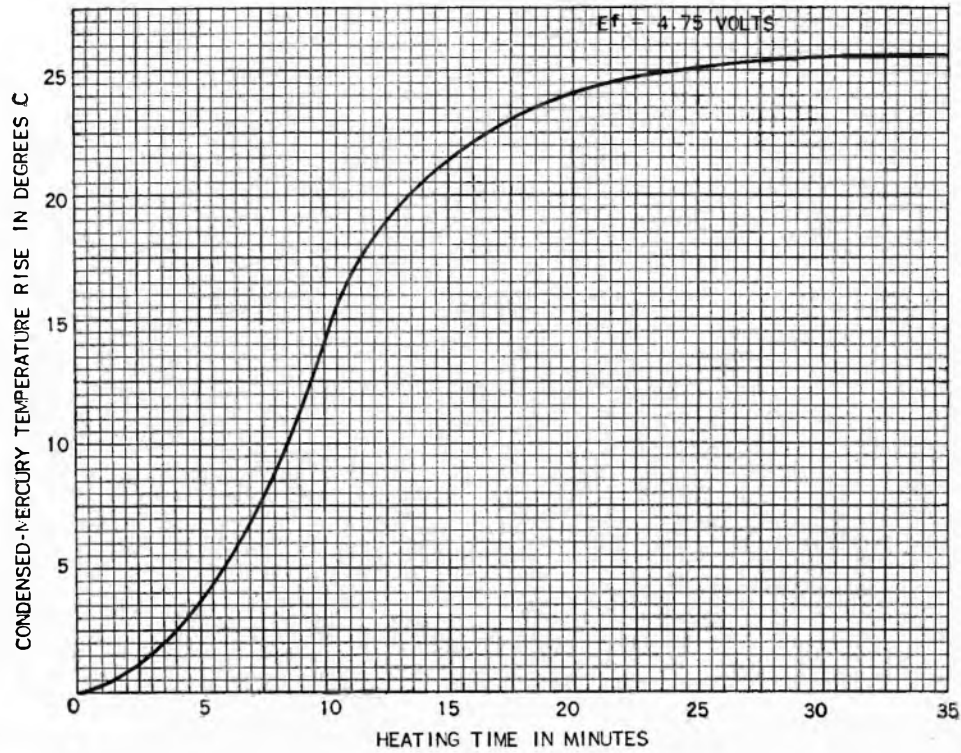
MAXIMUM RATINGS, Absolute Values

Maximum peak anode voltage	
Inverse	1000 volts
Forward	1000 volts
Maximum cathode current	
Peak	15.0 amperes
Average	2.5 amperes
Surge (maximum duration 0.1 second)	200 amperes
Maximum averaging time	15 seconds
Maximum negative control-grid voltage	
Before conduction	500 volts
During conduction	5 volts
Maximum positive control-grid current	
Average (averaging time, one cycle)	0.3 amperes
Condensed-mercury temperature limits	+40 to +80 centigrade

GL-5728/FG-67
CONTROL CHARACTERISTICS
SHADED AREA SHOWS RANGE OF CHARACTERISTIC
CONDENSED—MERCURY TEMPERATURE 40 C–80 C
 $E_i = 4.75-5.25$ VOLTS



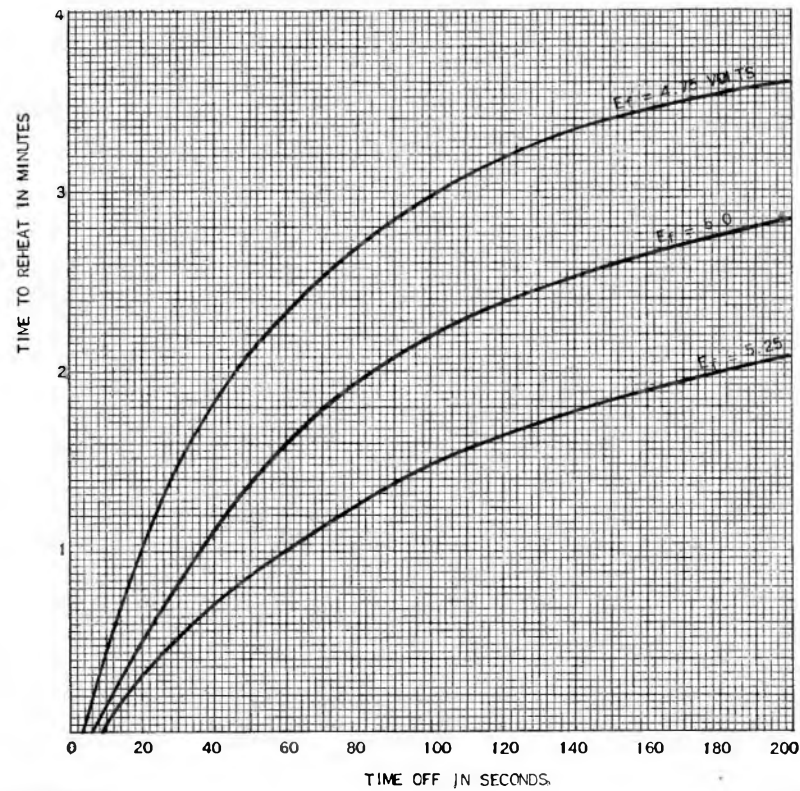
GL-5728/FG-67
 RATE OF RISE OF CONDENSED-
 MERCURY TEMPERATURE ABOVE AMBIENT
 $E_f = 4.75$ VOLTS



N-21529ZA

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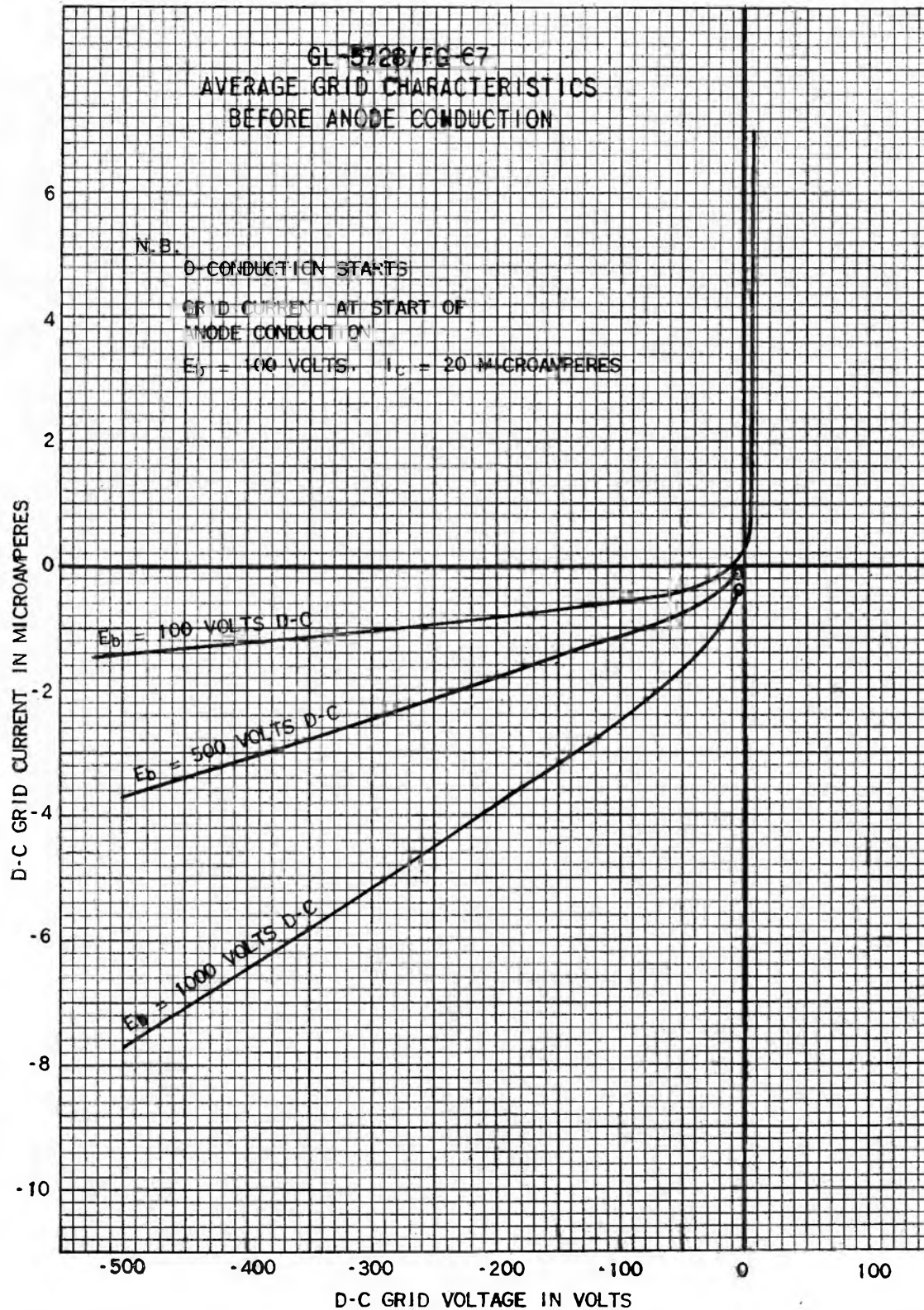
GL-5728/FG-67
 CATHODE REHEATING CURVE
 ANODE VOLTAGE = 0

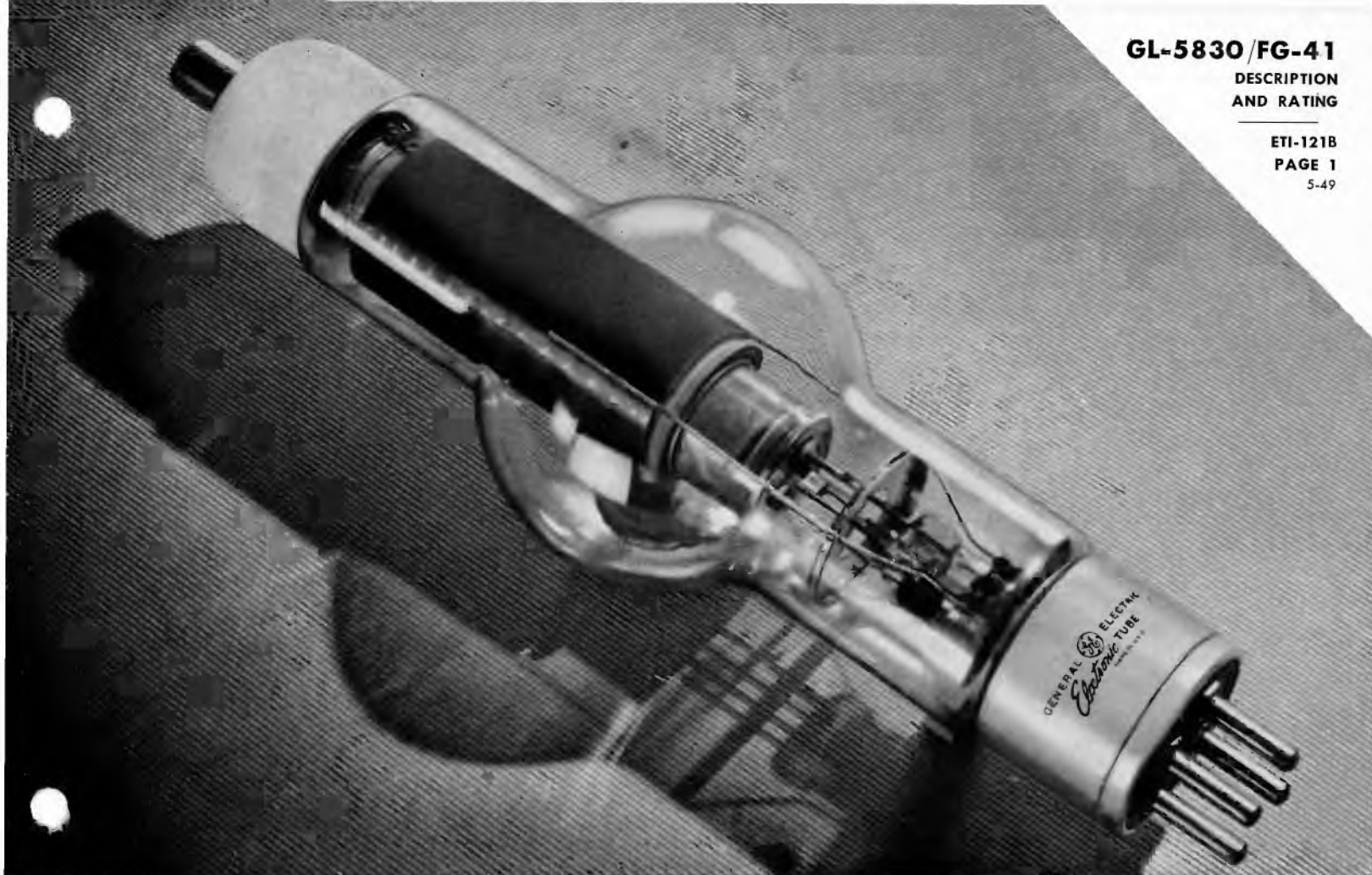


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4-8-48

GL-5728/FG-67
AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION





THYATRON

DESCRIPTION

The GL-5830/FG-41 is a three-electrode mercury-vapor thyatron with negative control characteristic. This tube is designed for grid control rectifier application of relatively high voltage and current.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	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	micromicrofarads
Control-grid-to-cathode capacitance		18	micromicrofarads
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			
Anode voltage drop		16	volts

◆ Technical Information changed throughout.



Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-121A dated 10-47

TECHNICAL INFORMATION (CONT'D)

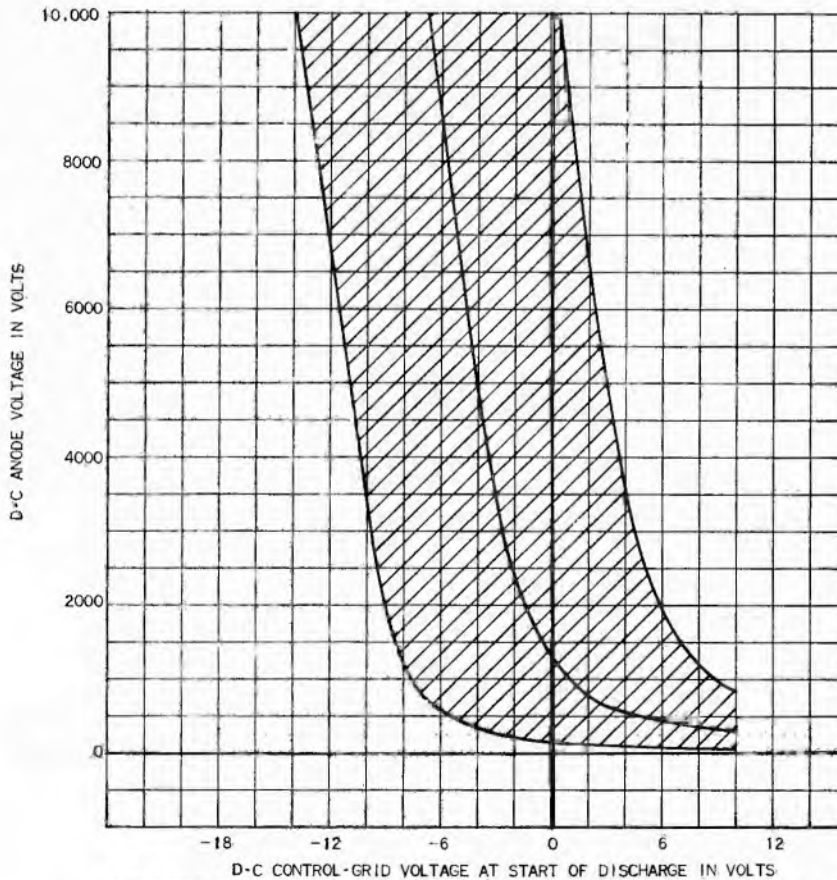
Mechanical Data

Type of cooling—convection	
Equilibrium condensed mercury temperature rise	
At full load, approximate	31 centigrade
At no load, approximate	25 centigrade
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
Surge (maximum duration 0.1 second)	1500 amperes
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 ampere
Condensed mercury temperature limits	+40 to +65 centigrade

▲ GL-5830/FG-41 THYRATRON CONTROL CHARACTERISTICS
 SHADED AREA SHOWS RANGE OF CHARACTERISTIC
 CONDENSED MERCURY TEMPERATURE 40-65 C
 $E_i = 4.75-5.25$ VOLTS



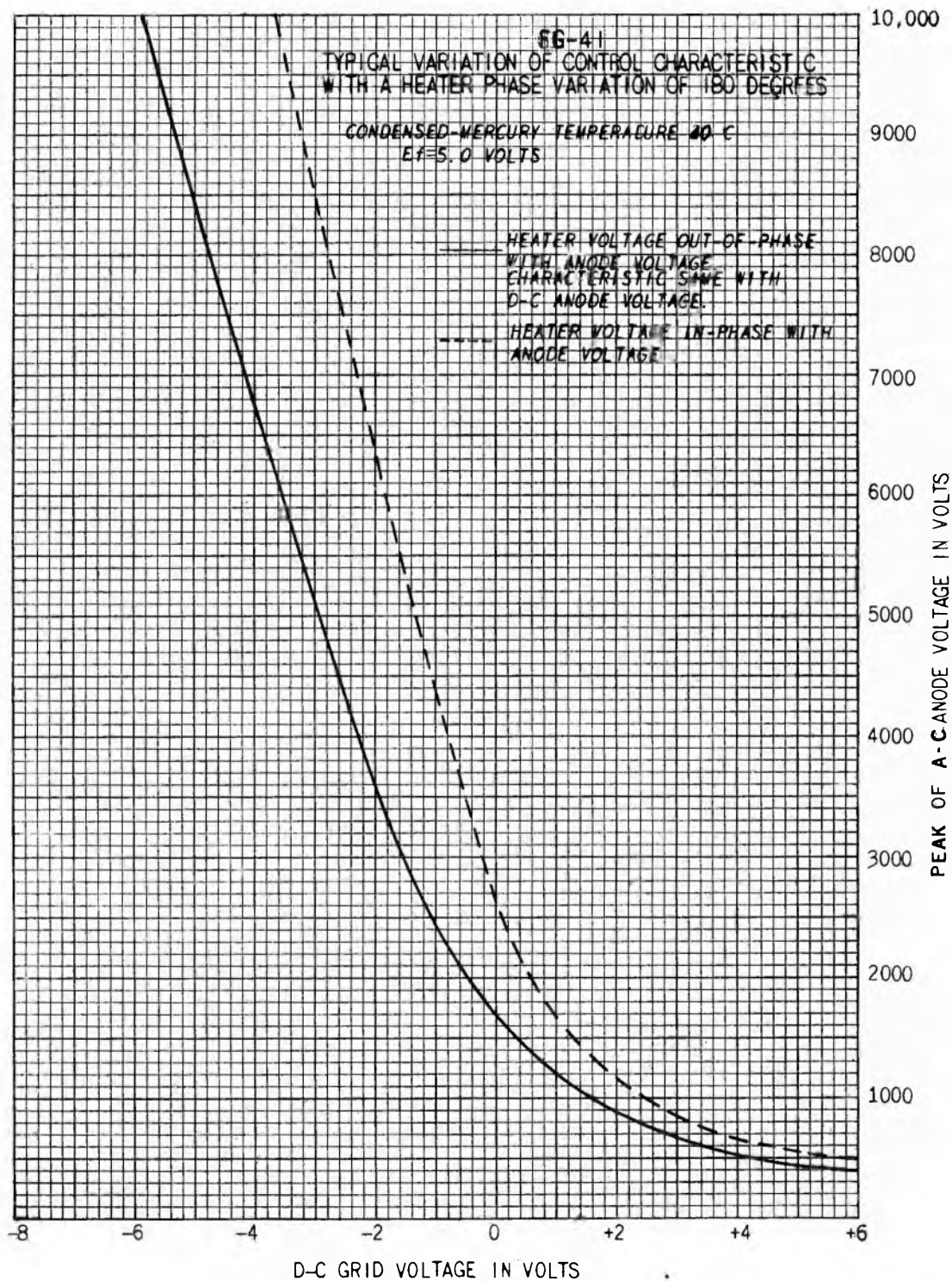
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5-4-49

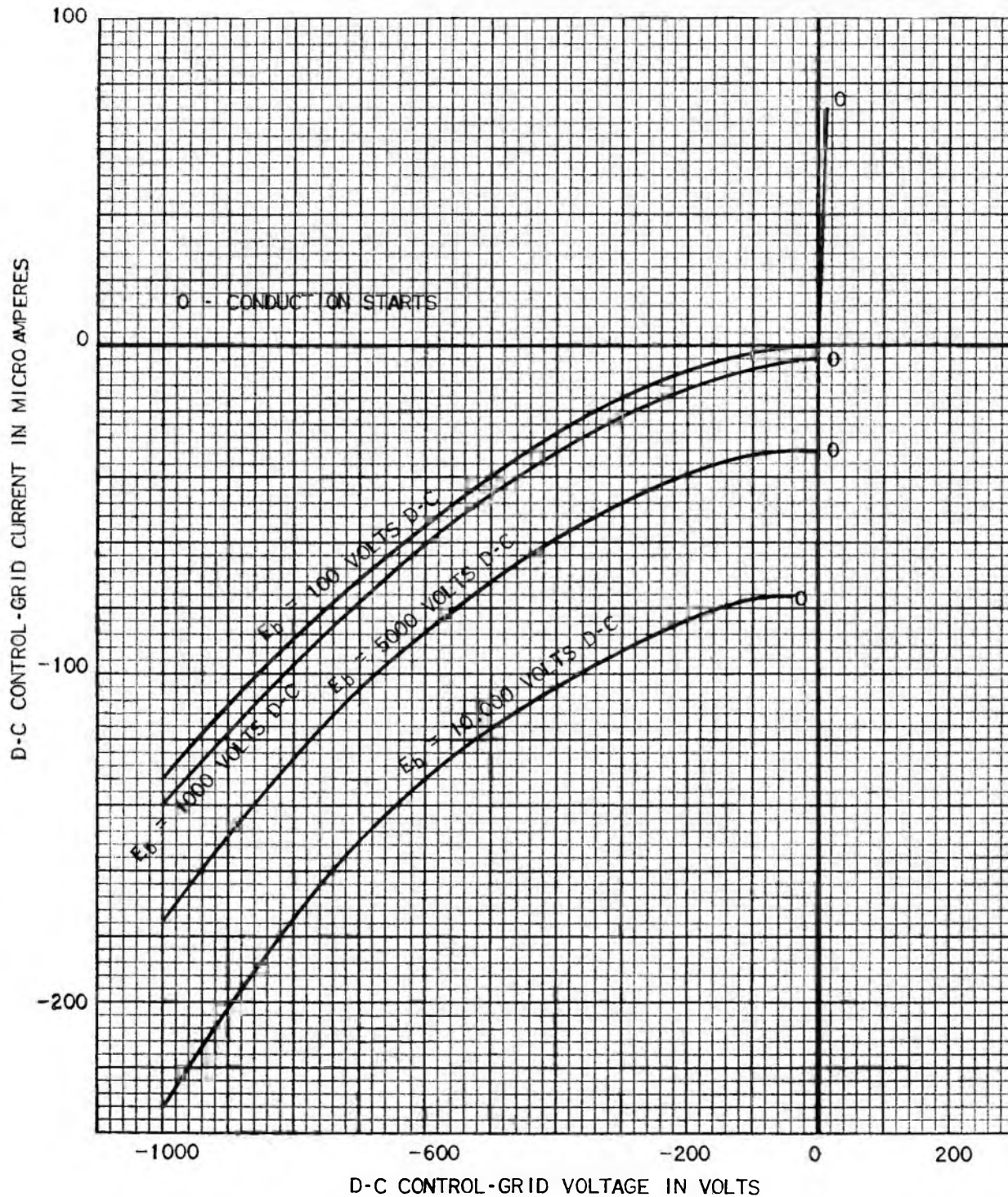
▲ Revised curve.

▲ GL-5830/FG-41

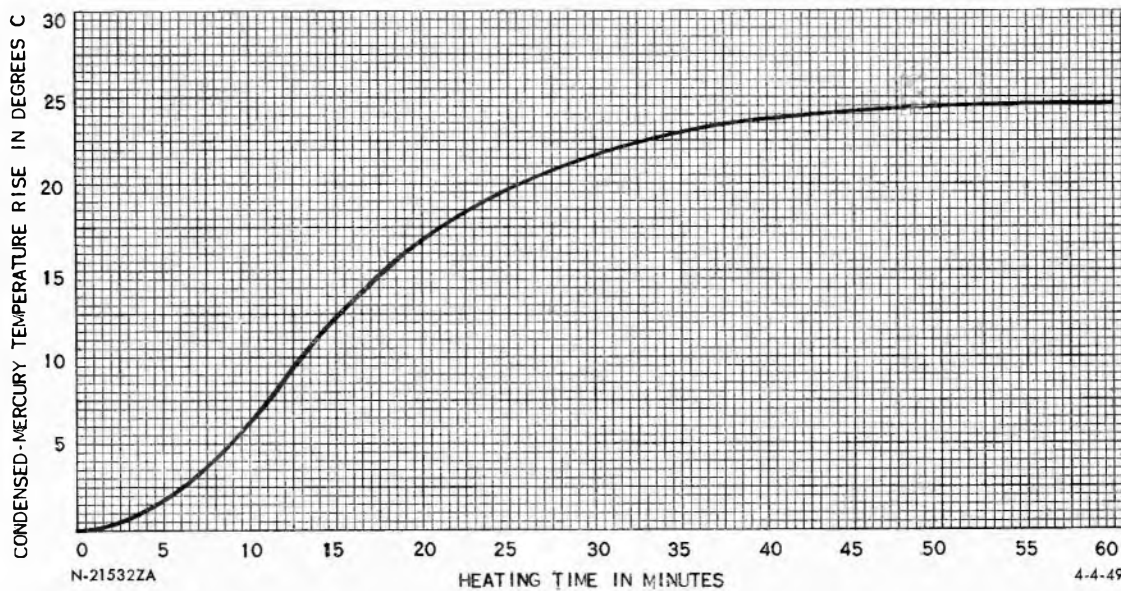
TYPICAL VARIATION OF CONTROL CHARACTERISTIC
WITH A HEATER PHASE VARIATION OF 180 DEGREES



▲ GL-5830/FG-41
AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION
 $E_i = 5.0$ VOLTS

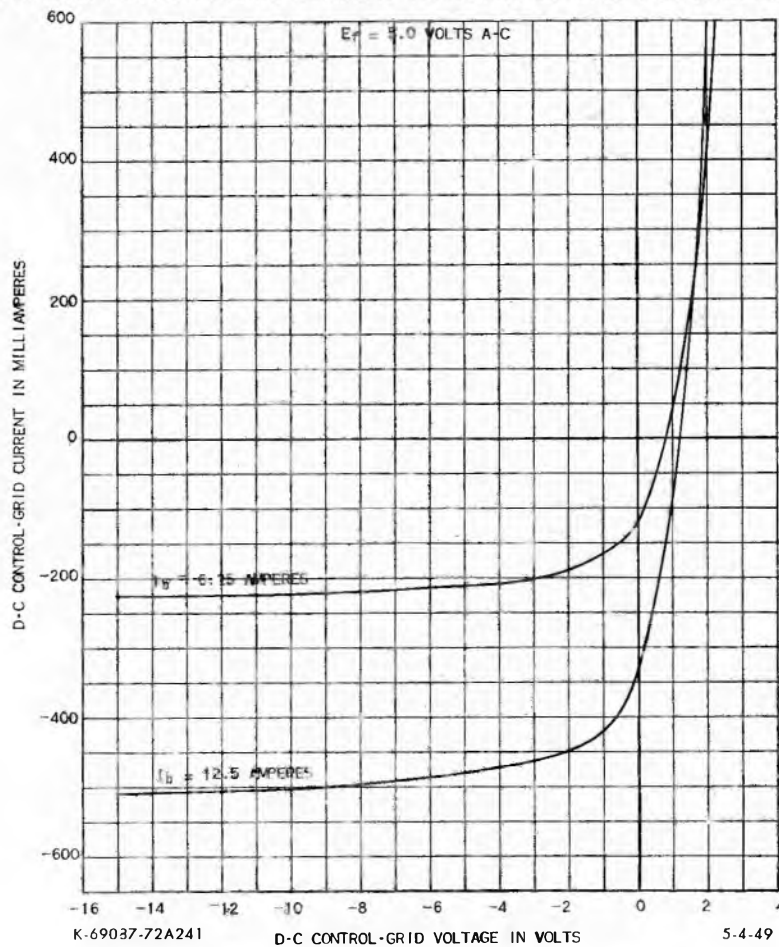


▲ GL-5830/FG-41
 RATE OF RISE OF CONDENSED MERCURY TEMPERATURE ABOVE AMBIENT
 $E_f = 4.75$ VOLTS



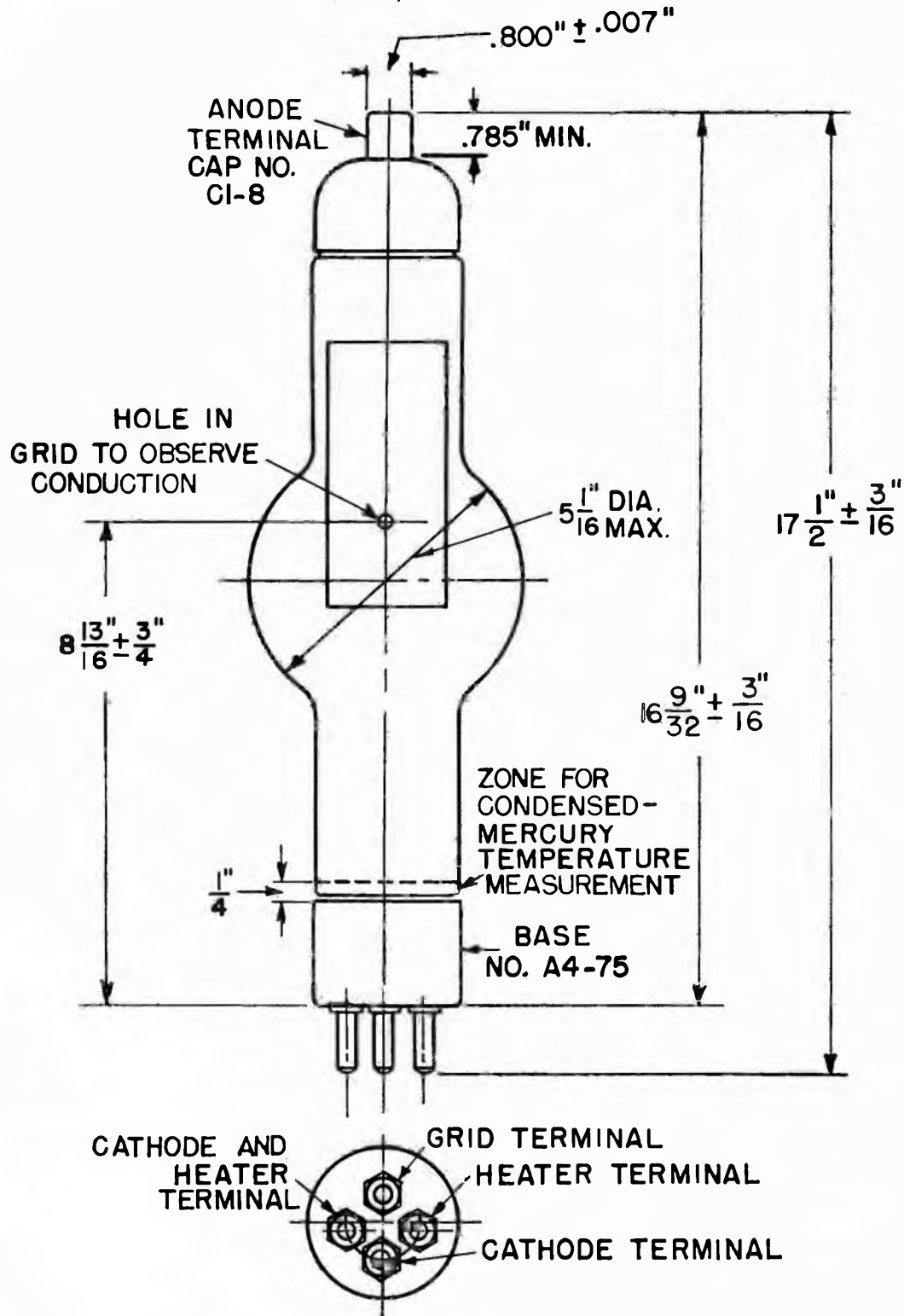
▲New curve.

▲GL-5830/FG-41 TYPICAL CONTROL-GRID CURRENT VS CONTROL-GRID VOLTAGE DURING CONDUCTION



▲New curve.

■ OUTLINE
GL-5830/FG-41 THYRATRON



K-5182056

5-4-49

■ Revised outline.

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



THYRATRON

DESCRIPTION

The GL-5545 is a three-electrode, inert-gas-filled thyratron with a negative control characteristic. This tube is designed primarily for all control applications. The GL-5545 combines the desirable temperature characteristic of gas tubes, maximum

ratings over a wide temperature range, with the long life of mercury tubes. Another feature useful in industrial applications is the quick-heating cathode—only one minute is required for the cathode to reach operating temperature.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical Data

	Minimum	Bogey	Maximum
Filament voltage	2.37	2.5	2.63 volts
Filament current at 2.5 volts		21	23 amperes
Cathode heating time required	60		seconds
Anode-to-control-grid capacitance		0.8	micromicrofarad
Control-grid-to-cathode capacitance		45	micromicrofarads
Deionization time, approximate			
$E_c = -250$		50	microseconds
$E_c = -12$		500	microseconds
Ionization time		10	microseconds
Anode voltage drop, typical		16	volts



GENERAL ELECTRIC

Supersedes ETI-275B dated 8-48

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Type of cooling	convection
Mounting position	any
Net weight, maximum	12 ounces

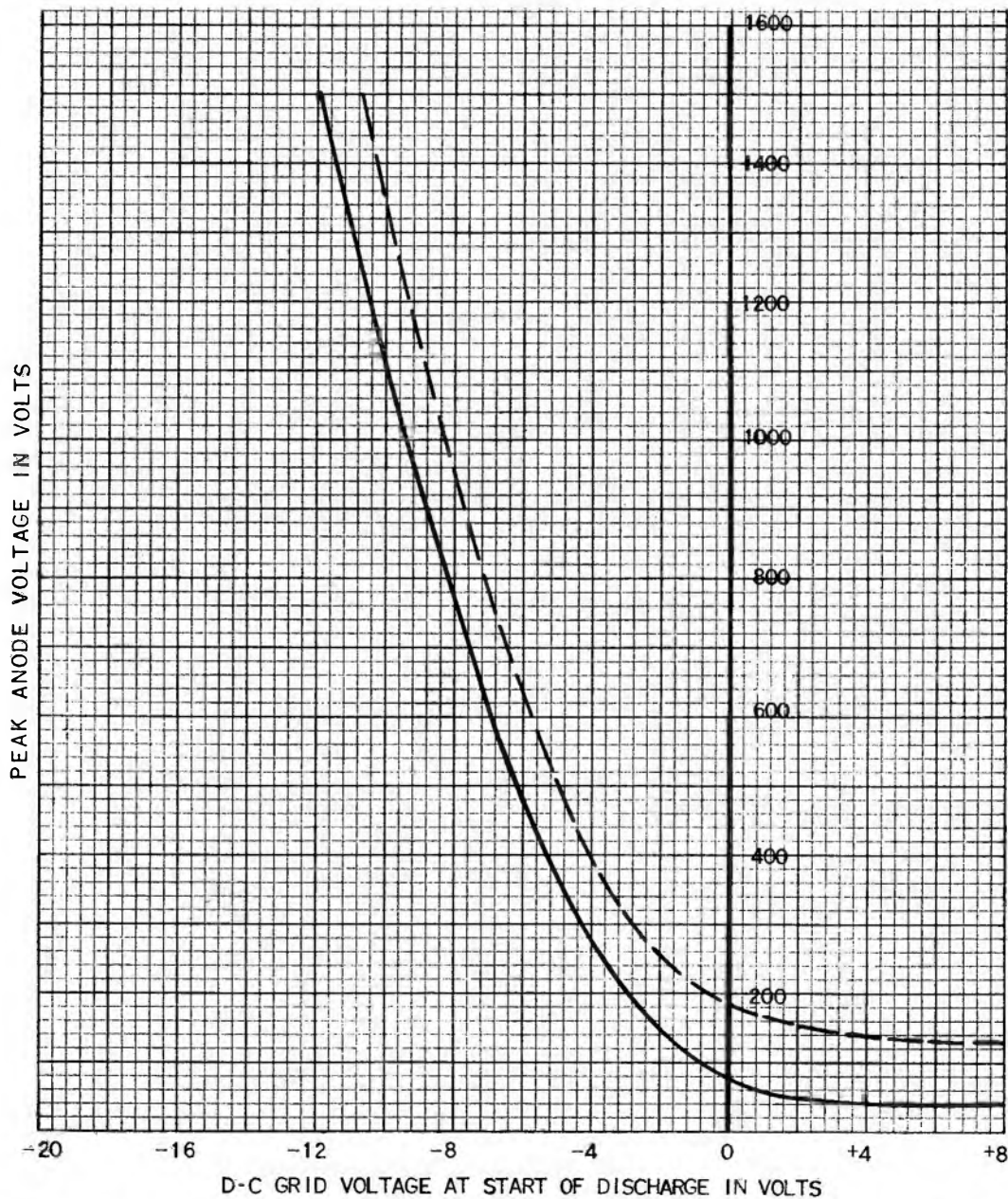
MAXIMUM RATINGS, Absolute Values

Maximum peak anode voltage	
Inverse	1500 volts
Forward	1500 volts
Maximum cathode current	
Peak	80 amperes
Average	6.4 amperes
Surge (maximum duration 0.1 second)	1120 amperes
Maximum averaging time	15 seconds
Maximum negative control-grid voltage	
Before conduction	250 volts
During conduction	10 volts
Maximum positive control-grid current	
Anode positive	0.20 ampere
Anode negative	0.10 ampere
Commutation factor*	130
Ambient temperature limits	- 55 to + 70 centigrade

* Commutation factor is the product of the rate of current decay in amperes-per-microsecond just prior to commutation and the rate of inverse voltage rise in volts-per-microsecond just after commutation.

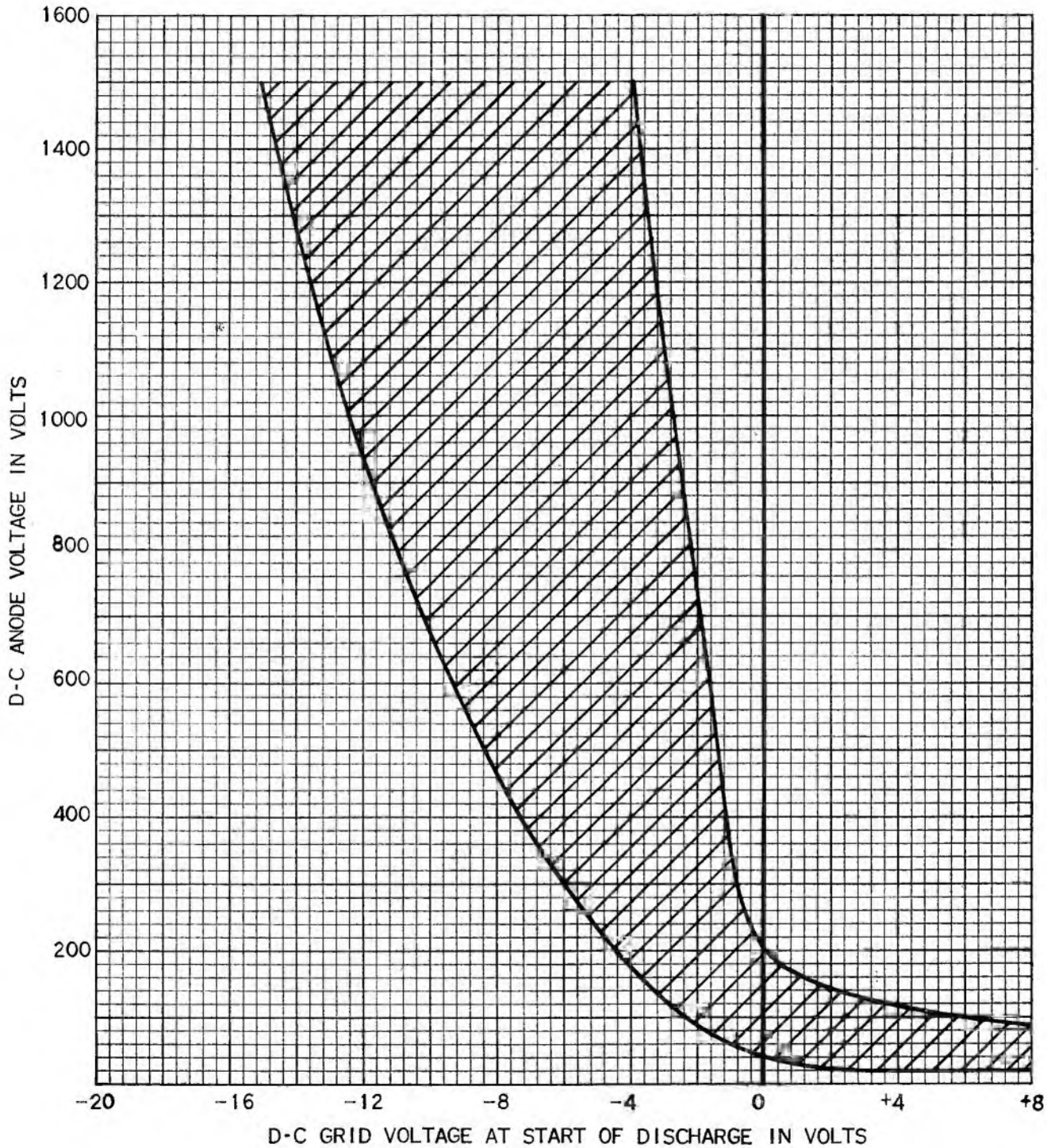
GL-5545
 TYPICAL VARIATION OF CONTROL CHARACTERISTIC
 WITH A FILAMENT PHASE VARIATION OF 180 DEGREES
 ($E_f = 2.5$ VOLTS)

———— VOLTAGE OF FILAMENT TERMINAL NEAREST GRID TERMINAL IS OUT-OF-PHASE WITH ANODE VOLTAGE
 (CHARACTERISTIC SAME WITH D-C ANODE VOLTAGE)
 - - - - - FILAMENT PHASE REVERSED

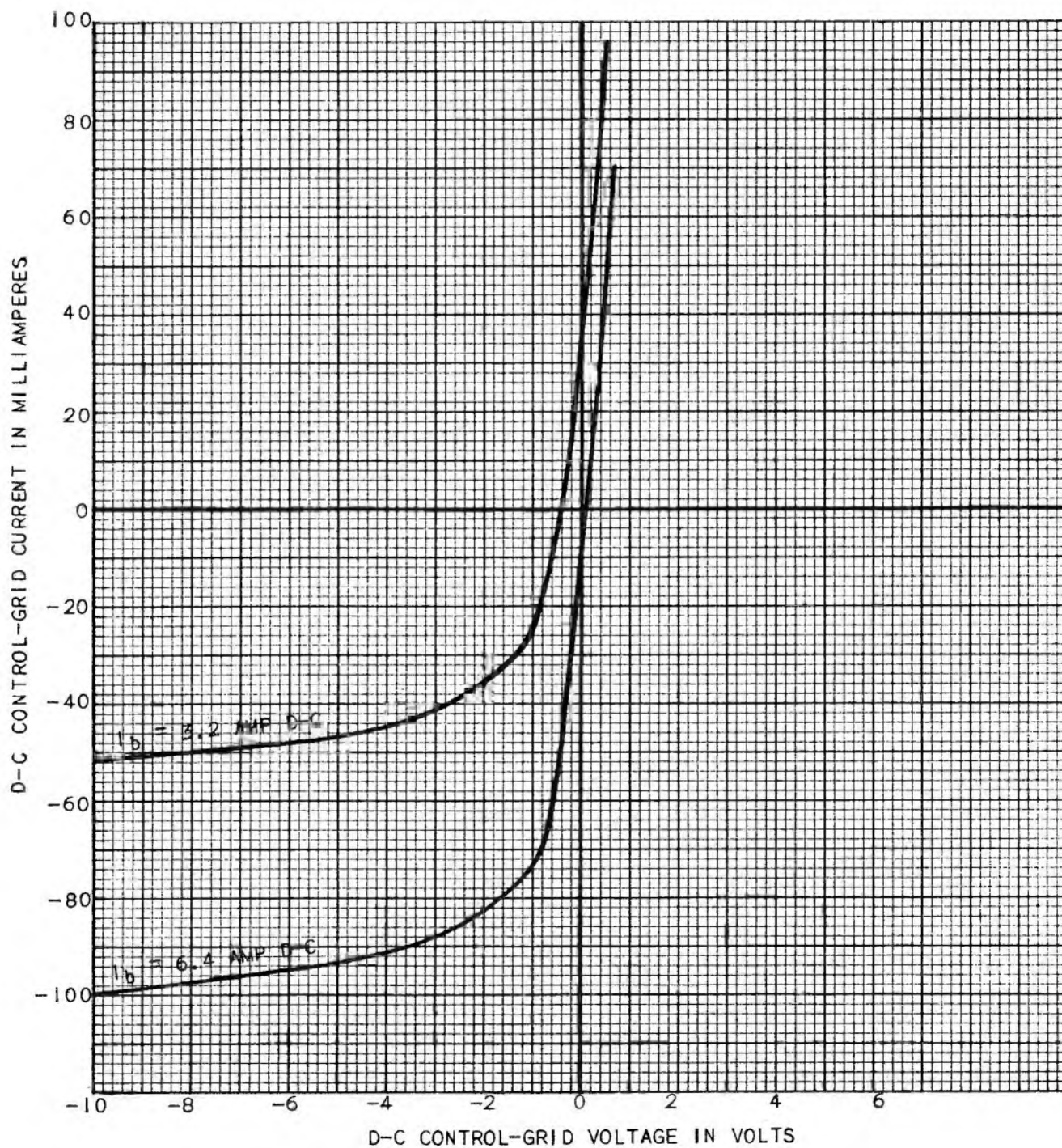


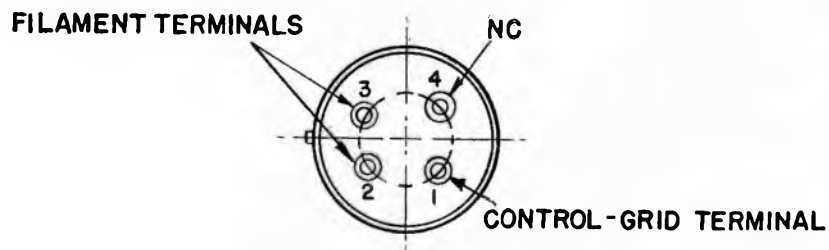
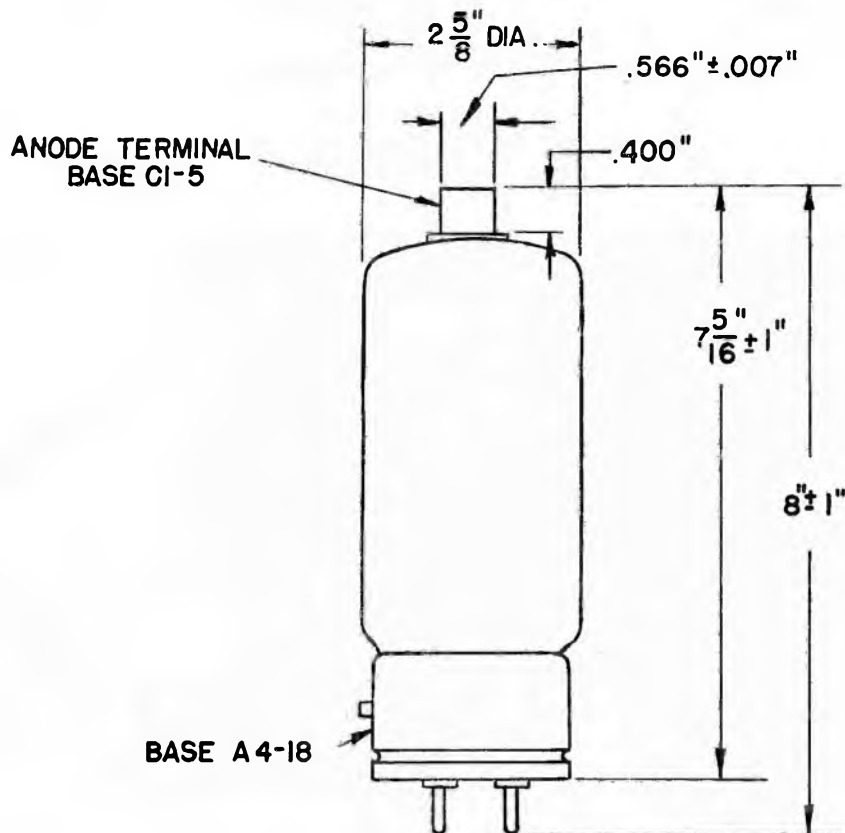
GL-5545 TYPICAL CONTROL CHARACTERISTIC

(SHADED AREA SHOWS RANGE OF CHARACTERISTIC)



◆ GL-5545
TYPICAL CONTROL-GRID CURRENT
VS
CONTROL-GRID VOLTAGE
DURING CONDUCTION
 $E_f = 2.5$ VOLTS A-C





BOTTOM VIEW OF BASE

N-21525AZ

2-3-48

OUTLINE
GL-5545 THYRATRON

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



THYRATRON

DESCRIPTION

The GL-2D21 is a four-electrode inert-gas-filled thyatron with negative control characteristic designed for use in relay applications. Features of this tube are a high control ratio essentially independent of temperature over a wide range, low grid-anode capacitance, and very low grid current. The 2D21 is not appreciably affected by line-

voltage surges because of its low capacitance, and the low grid current allows it to be used with a high value of resistance in the grid circuit with resultant high circuit sensitivity. This thyatron, in a high-sensitivity circuit, can be operated directly from a high-vacuum phototube.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

MAXIMUM RATINGS, Absolute Values

Maximum peak anode voltage	
Inverse	1300 volts
Forward	650 volts
Maximum cathode current	
Peak	0.5 ampere
Average	0.1 ampere
Surge (maximum duration 0.1 seconds)	10 amperes
Maximum averaging time	30 seconds
Maximum negative control-grid voltage	
Before conduction	-100 volts
During conduction	-10 volts

TECHNICAL INFORMATION (CONT'D)

Maximum positive control-grid current	
Anode positive	0.01 ampere
Anode negative	0.01 ampere
Maximum negative shield-grid voltage	
Before conduction	-100 volts
During conduction	-10 volts
Maximum positive shield-grid current	
Anode positive	0.01 ampere
Anode negative	0.01 ampere
Maximum heater-cathode voltage	
Heater negative	-100 volts
Heater positive	25 volts
Ambient temperature limits	-75 to +90 centigrade

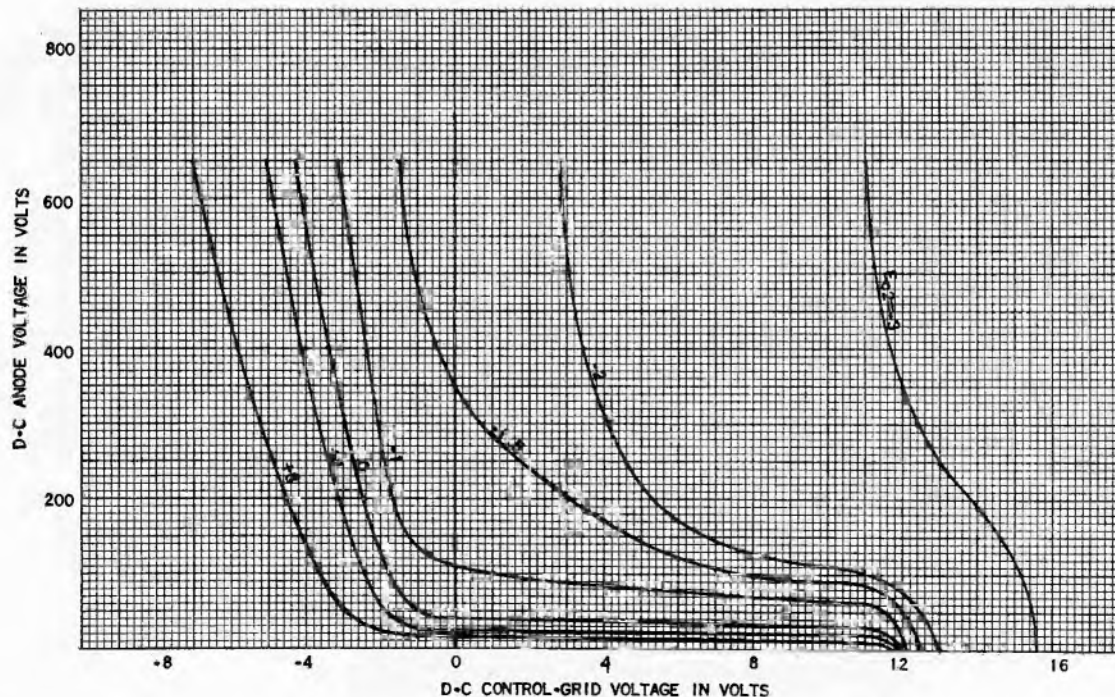
GENERAL

Electrical Data	Minimum	Bogey	Maximum
Heater voltage	5.7	6.3	6.9 volts
Heater current ($E_f = 6.3$ volts)		0.60	0.66 ampere
Cathode heating time required	10		seconds
Anode-to-control-grid capacitance, typical		0.026	uuf
Control-grid-to-cathode and shield-grid capacitance, typical		2.4	uuf
Deionization time, approximate			
$E_{bb} = 125$ v d-c, $I_b = 0.1$ amp d-c (a) $E_{c1} = -100$ v d-c		35	microseconds
(b) $E_{c1} = -11$ v d-c		75	microseconds
Ionization time, approximate		0.5	microseconds
Anode voltage drop, typical		8	volts
Critical grid current, $E_{bb} = 460$ v rms		0.5	microamperes

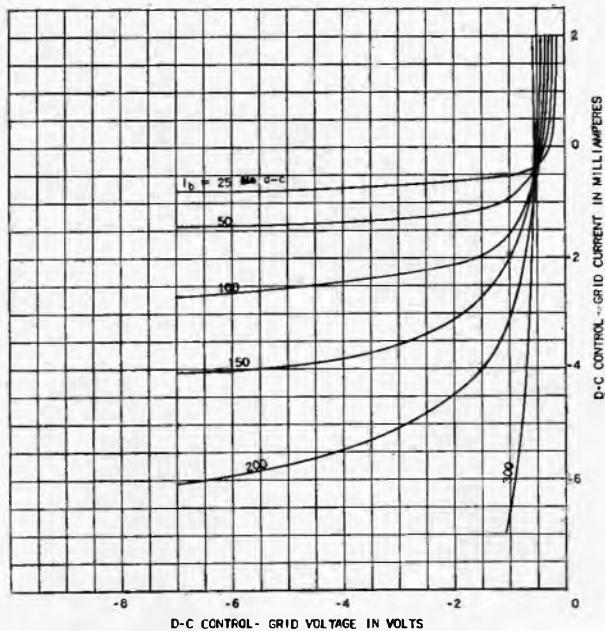
Mechanical Data

Type of cooling—Air		
Mounting position—Any		
Net weight, maximum	0.3	ounce

GL-2D21
AVERAGE CONTROL CHARACTERISTICS
 $E_f = 6.3$ VOLTS
GRID RESISTOR = 0.1 MEGOHM



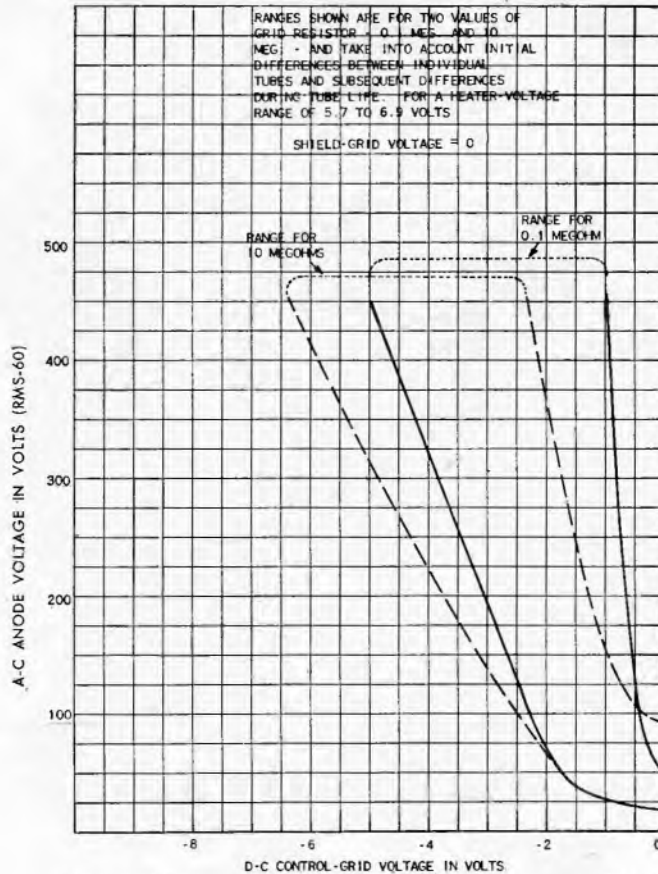
GL-2D21
 AVERAGE GRID CHARACTERISTICS DURING ANODE CONDUCTION
 $E_f = 6.3$ VOLTS
 SHIELD-GRID VOLTS = 0



K-69087-72A1.53

5-15-47

GL-2D21
 OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE

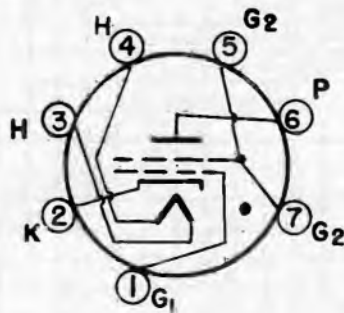
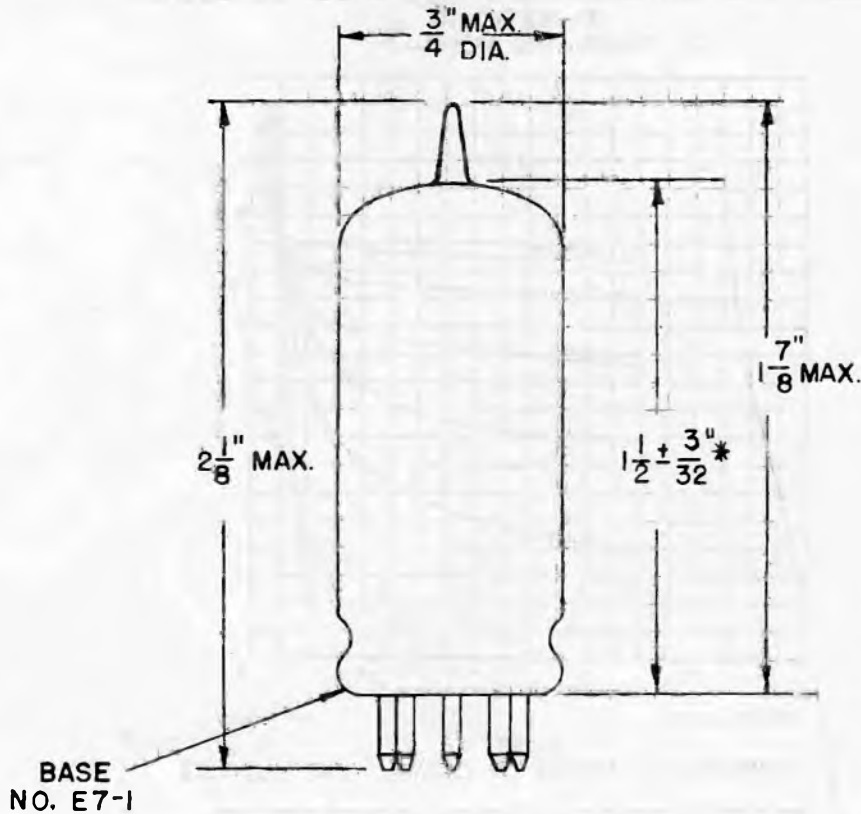


K-69087-72A1.55

6-19-47

GL-2D21

ETI-279
PAGE 4
4-48



* MEASURED FROM BASE SEAT TO BULB-TOP LINE AS DETERMINED BY RING GAGE OF 7/16" I.D.

N-15099AZ

3-26-47

OUTLINE
GL-2D21

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



THYRATRON

DESCRIPTION

The GL-5544 is a three-electrode, inert-gas-filled thyatron with a negative control characteristic. This tube is designed primarily for all control applications. The GL-5544 combines the desirable temperature characteristic of gas tubes,

maximum ratings over a wide temperature range, with the long life of mercury tubes. Another feature useful in industrial applications is the quick-heating cathode—only one minute is required for the cathode to reach operating temperature.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 3

Electrical Data

	Minimum	Bogey	Maximum
Filament voltage	2.37	2.5	2.63 volts
Filament current		12	13.5 amperes
Cathode heating time required	60		seconds
Anode-to-control-grid capacitance, typical		0.8	micromicrofarad
Control-grid-to-cathode capacitance, typical		45	micromicrofarads
Deionization time, approximate			
$E_c = -250$		40	microseconds
$E_c = -12$		400	microseconds
Ionization time, approximate		10	microseconds
Anode voltage drop, typical		16	volts



TECHNICAL INFORMATION (CONT'D)

Mechanical Data

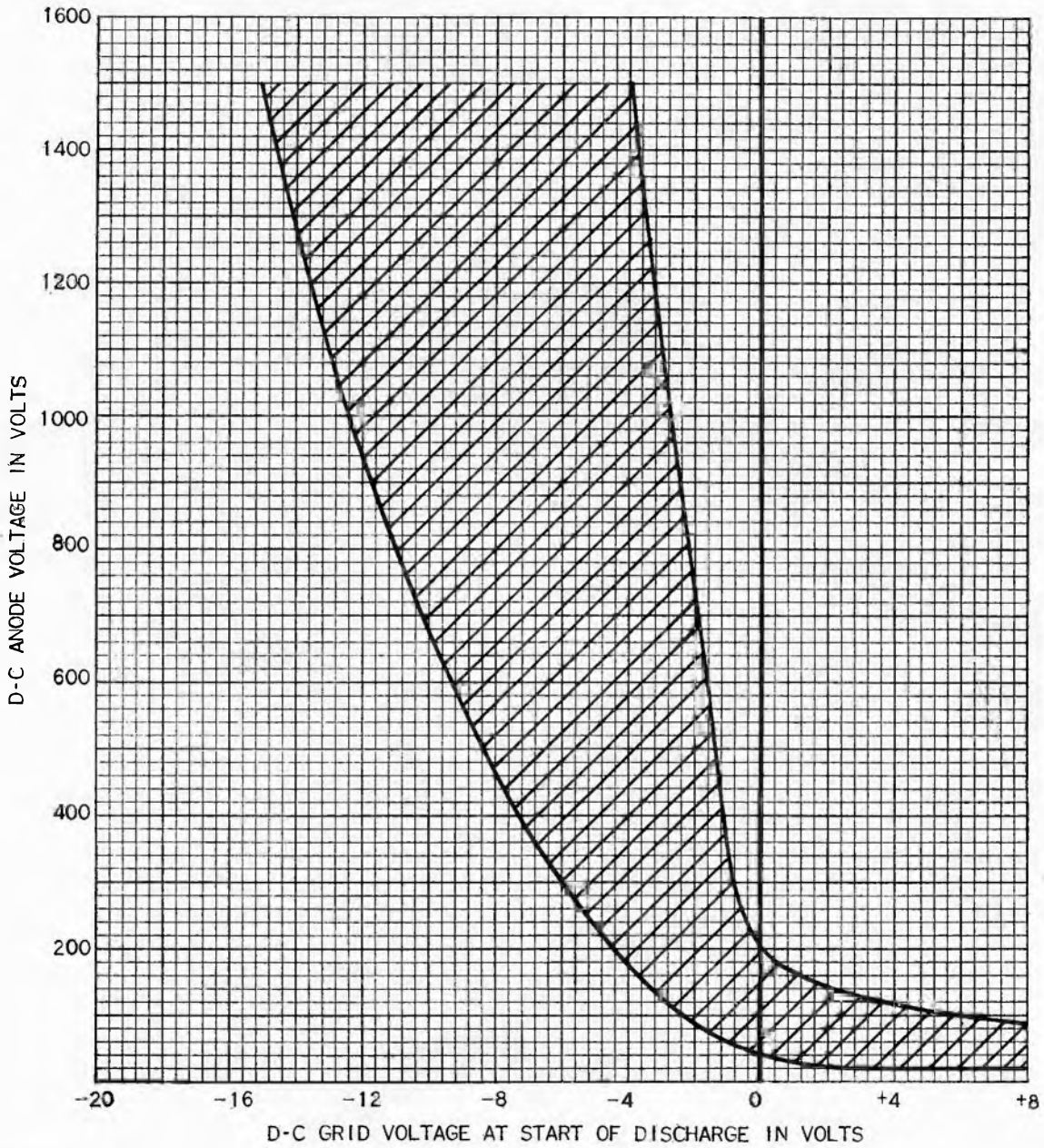
Type of cooling	convection
Mounting position	any
Net weight, maximum	11 ounces

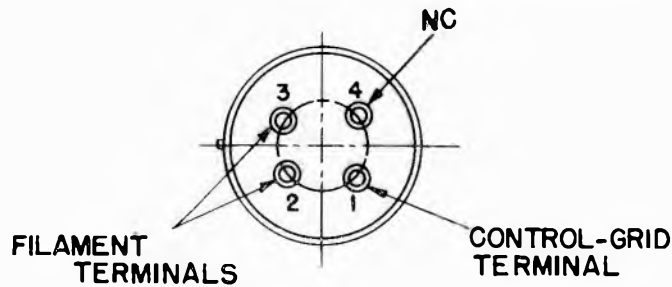
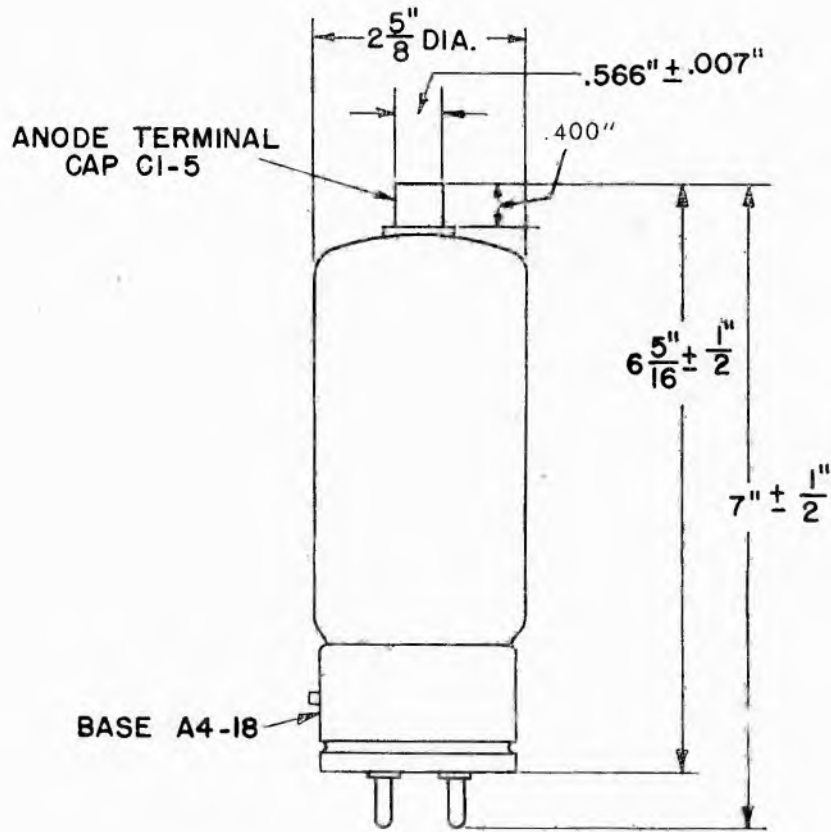
MAXIMUM RATINGS, Absolute Values

Maximum peak anode voltage	
Inverse*	1500 volts
Forward	1500 volts
Maximum cathode current	
Peak	40 amperes
Average	3.2 amperes
Surge (maximum duration 0.1 second)	560 amperes
Maximum averaging time	15 seconds
Maximum negative control-grid voltage	
Before conduction	250 volts
During conduction	10 volts
Maximum positive control-grid current	
Average (averaging time, one cycle)	0.20 ampere
Commutation Factor*	130
Ambient temperature limits	
	-55 to +70 Centigrade

* Commutation factor is the product of the rate of current decay in amperes-per-microsecond just prior to commutation and the rate of inverse voltage rise in volts-per-microsecond just after commutation.

GL-5544
TYPICAL CONTROL CHARACTERISTICS
SHADED AREA SHOWS RANGE OF CHARACTERISTICS





BOTTOM VIEW OF BASE

K-69087-1A147

OUTLINE
GL-5544 THYRATRON

10-26-48

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



THYRATRON

DESCRIPTION

The GL-5632 is a three-electrode inert-gas-filled thyratron with negative control characteristic designed for ignitor firing, and for motor-speed and welding control.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 3

Electrical Data

Filament voltage 2.5 volts - 2.5
 Filament current, $E_f = 2.5$ volts 9 ± 2 amperes
 Minimum cathode heating time 30 seconds
 Anode-to-control-grid capacitance 2 uuf
 Control grid—cathode capacitance 14 uuf
 Deionization time, approximate 1 millisecond
 Anode voltage drop 10 volts

*0-100 - 6.0
 -40 - +80*

*125v dr.
 8v peak
 2.5 amp*



TECHNICAL INFORMATION (CONT'D)

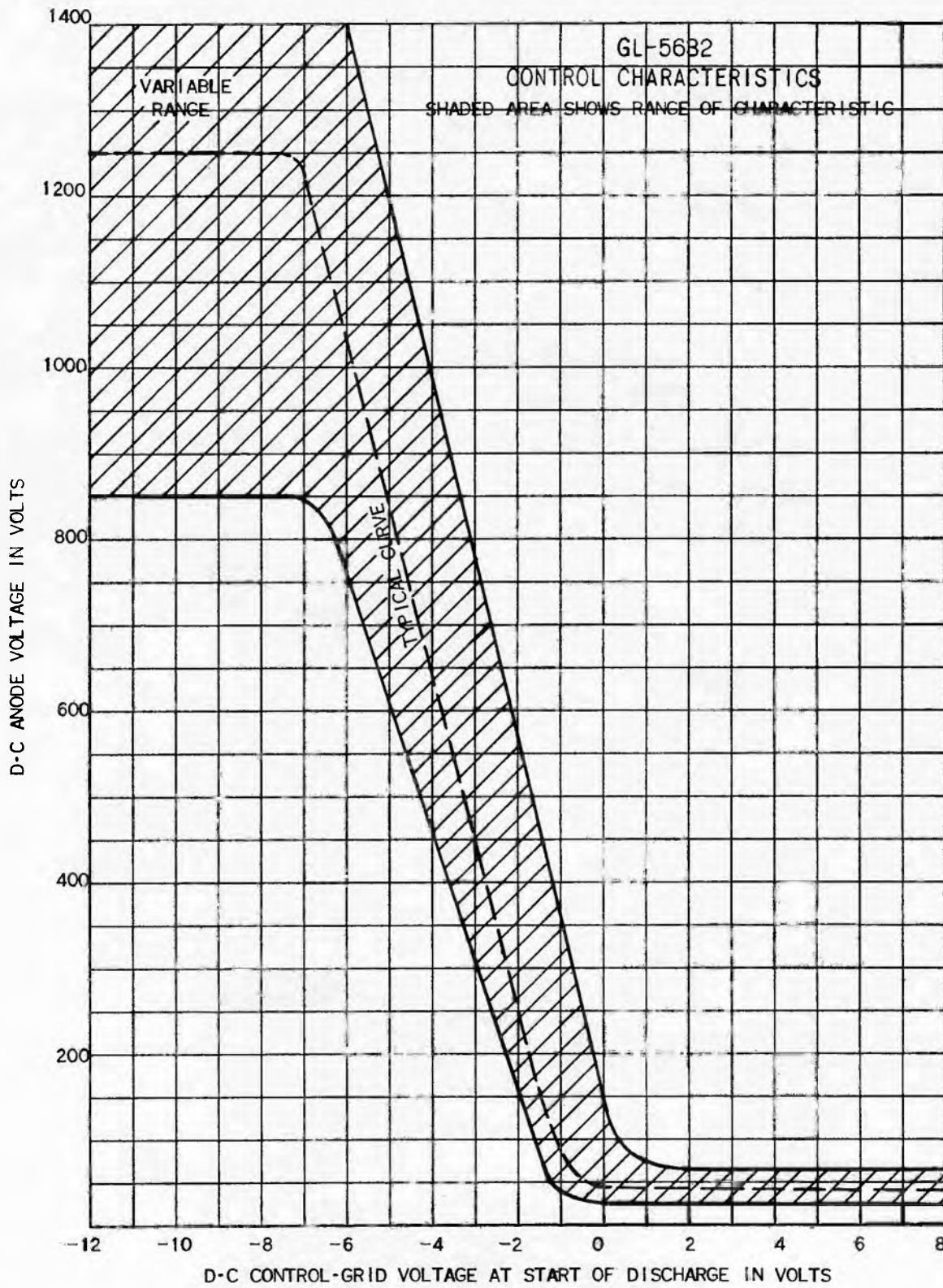
Mechanical Data

Type of cooling	convection
Mounting position	any
Net weight, maximum	6 ounces

MAXIMUM RATINGS, Absolute Values

Maximum peak anode voltage	
Inverse	1250 volts -- 125 ⁰
Forward	750 volts
Maximum cathode current	
Peak .....	.30 amperes -- 30
Average	2.5 amperes -- 2.5
Surge (maximum duration 0.1 second)	300 amperes
Overload, less than 3 seconds	3.7 amperes
Maximum negative control-grid voltage	
Before conduction	100 volts
During conduction	10 volts
Maximum positive control-grid current	
Average (averaging time, one cycle)	0.1 ampere
Commutation factor*	0.67
Ambient temperature limits	-55 to +70 C -- 40 -- + 90

* Commutation factor is the product of the rate of current decay in amperes-per-microsecond just prior to commutation and the rate of inverse voltage rise in volts-per-microsecond just after commutation.



GL-5632

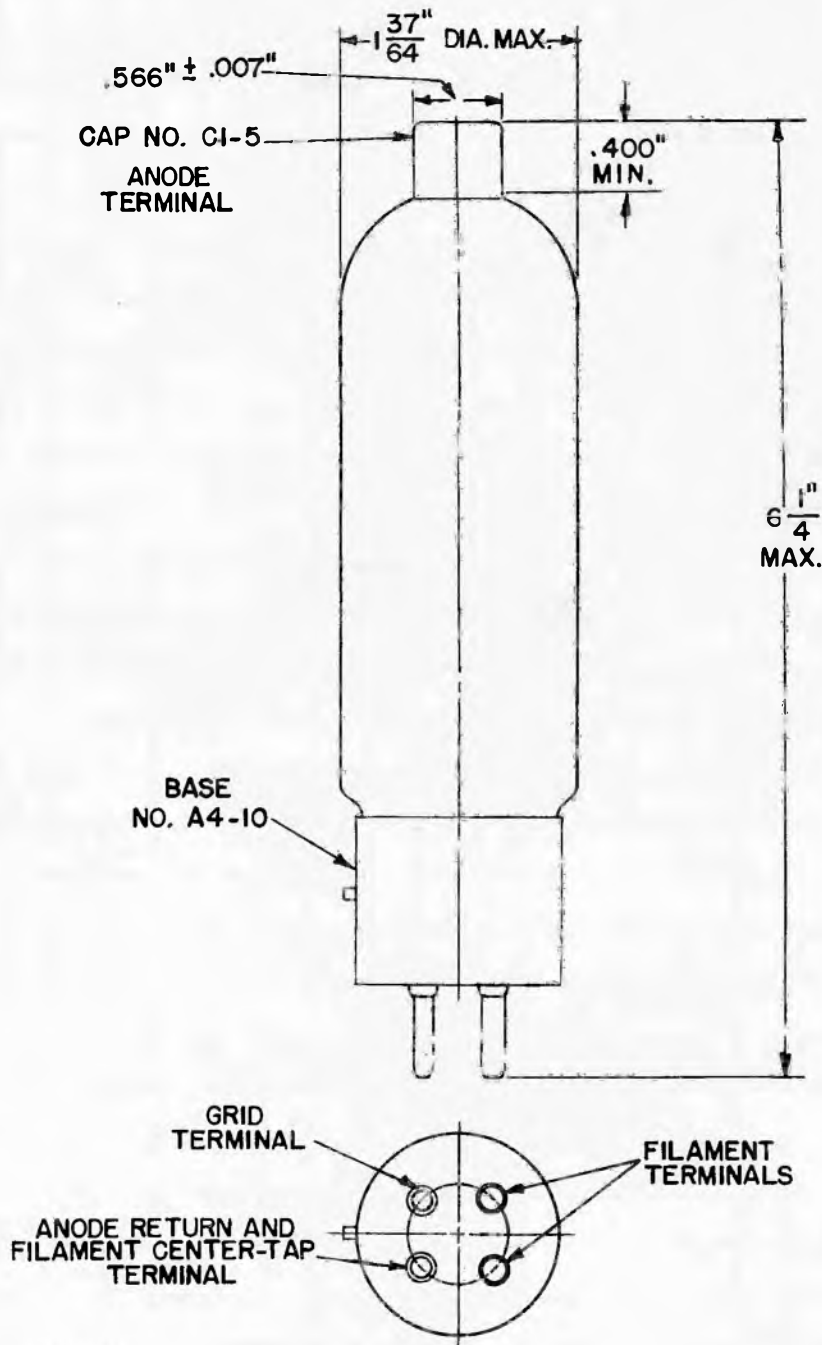
ETI-292

PAGE 4

12-48

(Page 4 only, revised 8-50)

■ OUTLINE THYRATRON GL-5632



N-15124AZ
■ Revised drawing.

4-28-50

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



H Y D R O G E N T H Y R A T R O N

**PULSING SERVICE
INTEGRAL GAS RESERVOIR**

**POSITIVE CONTROL
TRIODE TYPE**

The GL-5948 is a hydrogen thyatron for pulsing applications which require a tube that will give dependable operation under the stringent operating conditions encountered in radar modulator and other pulsing service.

The ability of this tube to carry high peak currents and to withstand voltages as high as 25,000 volts combine with the short deionization time to assure satisfactory tube performance in the class of service for which this thyatron is designed. The tube is also suitable for operation without negative bias; a feature which adapts it for use in

service requiring zero-bias operation with positive triggering pulses. Another advantage which ensures freedom from failure due to gas cleanup is the use of a hydrogen reservoir within the tube to supply gas to compensate for what is consumed during operation. This reservoir also enables the user to adjust the pressure within the tube to the most suitable value for the service desired.

The tube ratings make it especially suitable for pulsing magnetron and other oscillators with power inputs up to 12.5 megawatts.

GENERAL  ELECTRIC

TECHNICAL INFORMATION

GENERAL

Electrical	Minimum	Bogey	Maximum
Cathode—Indirectly Heated			
The Cathode is tied to the Heater Midpoint			
Heater Voltage	6	6.3	6.6 Volts
Heater Current, $E_r = 6.3$ Volts	27	30	33 Amperes
Cathode and Reservoir Heating Time	15	...	Minutes
Reservoir Heater Voltage*	2.5	4.5	5.5 Volts
Reservoir Heater Current, $E_r = 4.5$ Volts	3	4.5	6 Amperes
Direct Interelectrode Capacitance			
Grid to Anode	...	45	uuf
Grid to Cathode	...	50	uuf
Anode Current Time Jitter	...	0.01	0.02 Microseconds
Deionization Time, approximate	...	50	Microseconds
Ionization Time, approximate†	...	...	1 Microsecond
Anode Voltage Drop	...	400	Volts
Grid Drive‡	...	...	...
Pulse Duration	...	...	10 Microseconds
Mechanical			
Type of Cooling—Convection			
Cooling of Anode Lead by Forced Convection Permissible, but there shall be no Air Blast Directly on Bulb.			
Mounting Position—Vertical, Base Down			
Net Weight, approximate	...	4¾	Pounds

MAXIMUM RATINGS, Absolute Values

Maximum Peak Anode Voltage			
Inverse §	...	25,000	Volts
Forward ¶, minimum supply voltage = 5,000 volts d-c	...	25,000	Volts
Maximum Cathode Current			
Peak	...	1,000	Amperes
Average	...	1.0	Amperes
Maximum Averaging Time	...	1	Cycles
Operation Factor Δ	...	9.0 x 10 ⁹	
Maximum Negative Control-Grid Voltage			
Before Conduction	...	650	Volts
Maximum Rate of Rise of Anode Current	...	5,000	Amperes per Microsecond
Ambient Temperature Limits	...	-50 to +75	C

* 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 ± 5 percent. Applications involving operation at other conditions will necessitate the redetermination of the optimum reservoir voltage.

† 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 = 700 volts minimum, 2,000 volts maximum, above 0; time of rise = 0.35 microseconds 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 = 50 to 200 ohms.

§ The minimum inverse anode voltage permissible is 5 percent of the peak forward voltage, and the maximum is 5,000 volts during the first 25 microseconds following the anode pulse exclusive of a spike of 0.05 microseconds 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 18,000 volts peak. The power-supply filter should be designed to limit the rate of application of this voltage to 450,000 volts per second.

Δ The peak forward anode voltage x pulse repetition rate x peak anode current.

□ Denotes an addition.

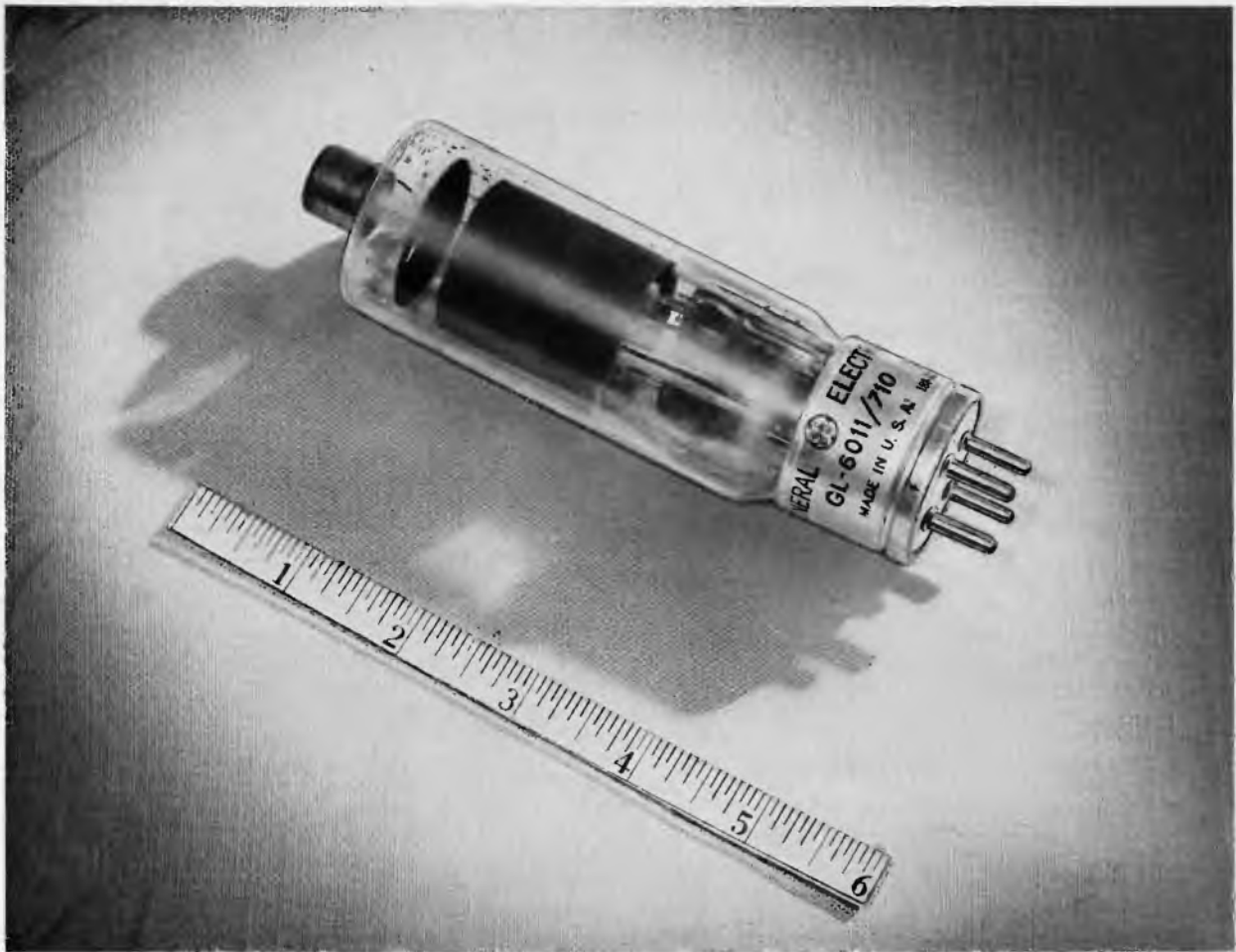
□ X-RAY WARNING NOTICE

If the GL-5948 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.



THYATRON

TRIODE TYPE NEGATIVE CONTROL CHARACTERISTICS

The GL-6011/710 is a three-electrode, inert-gas and mercury-vapor thyatron with negative control characteristics for use in all control applications. The GL-6011/710 combines the desirable temperature characteristic of gas tubes, maximum ratings over a wide temperature range, with the long life of

QUICK-HEATING CATHODE INERT-GAS AND MERCURY-VAPOR

mercury tubes. Another feature is a quick-heating filamentary-type cathode—only 20 seconds are required for the cathode to reach operating temperature. Because of these features the GL-6011/710 is especially suitable for service in ignitor-firing, regulated-rectifier, and similar industrial applications.

GENERAL

Electrical

Cathode—Filamentary

	Minimum	Bogey	Maximum	
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	—	μf
Control-Grid to Cathode Capacitance	—	12	—	μf
Deionization Time, approximate	—	1000	—	Microseconds
Ionization Time, approximate	—	10	—	Microseconds
Anode Voltage Drop	—	15	—	Volts
Critical Grid Current, $E_p = 220$ v d-c.	—	—	10	Microamperes

TECHNICAL INFORMATION

GENERAL  ELECTRIC

†Supersedes pages 1 and 2 dated 8-56

TECHNICAL INFORMATION (Cont'd)

Mechanical

⊕Mounting Position—Any Position from Vertical, Base Down, to Horizontal

Equilibrium Condensed-Mercury Temperature Rise Above Ambient		
At Full Load, approximate	30	C
At No Load, approximate	25	C
Net Weight, maximum	5	Ounces

MAXIMUM RATINGS, Absolute Values

Maximum Peak Anode Voltage		
Inverse	1500	Volts
Forward	1500	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 Control-Grid Voltage		
Before Conduction	500	Volts
During Conduction	10	Volts
Maximum Positive Control-Grid Current *		
Average	0.25	Amperes
Averaging Time	1	Cycle
Condensed-Mercury Temperature Limits	-40 to +80	C

* The anode and grid-circuit returns should be made to pin No. 2. However, they can be made to the center tap of the filament transformer.

⊕Denotes a change.

Electronics Department

GENERAL ELECTRIC

The 5663 is a four-electrode inert-gas-filled thyatron with a negative control characteristic which is independent of ambient temperature over a wide range. The small size and lightweight construction are features which especially adapt the tube to control and relay applications where space and weight are important factors.

MAXIMUM RATINGS, Absolute Values

Maximum Peak Anode Voltage		
Inverse	500	Volts
Forward	500	Volts
Maximum Cathode Current		
Peak	100	Milliamperes
Average	20	Milliamperes
Surge (maximum duration 0.1 second)	1	Ampere
Maximum Averaging Time	15	Seconds
Maximum Negative Control-Grid Voltage		
Before Conduction	200	Volts
During Conduction	10	Volts
Maximum Positive Control-Grid Current		
Average, Averaging Time One Cycle	2	Milliamperes
Maximum Negative Shield-Grid Voltage		
Before Conduction	100	Volts
During Conduction	5	Volts
Maximum Positive Shield-Grid Current		
Average, Averaging Time One Cycle	2	Milliamperes
Maximum Heater-Cathode Voltage Limits	-90 to +25	Volts
Ambient Temperature Limits	-55 to +90	C

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Heater Voltage	5.7	6.3	7.0	Volts
Heater Current, $E_f = 6.3$		0.150	0.180	Amperes
Cathode Heating Time Required	10			Seconds
Anode-to-Control-Grid Capacitance		0.1		uuf
Control-Grid-to-Cathode-and-Shield-Grid Capacitance		1.5		uuf

Electrical Data (Cont'd)

Minimum Bogey Maximum

Deionization Time, $E_{cc} = -6$ volts

$R_g = 10,000$ ohms, $I_b = 20$ ma

Ionization Time, approximate

35

0.5

Microseconds

Microseconds

Anode Voltage Drop, typical

11

Volts

Critical Grid Current, at

$E_{bb} = 220$ v rms, $E_c =$ cut-off

2

Microamperes

Mechanical Data

Type of Cooling - Convection

Mounting Position - Any

Net Weight, maximum

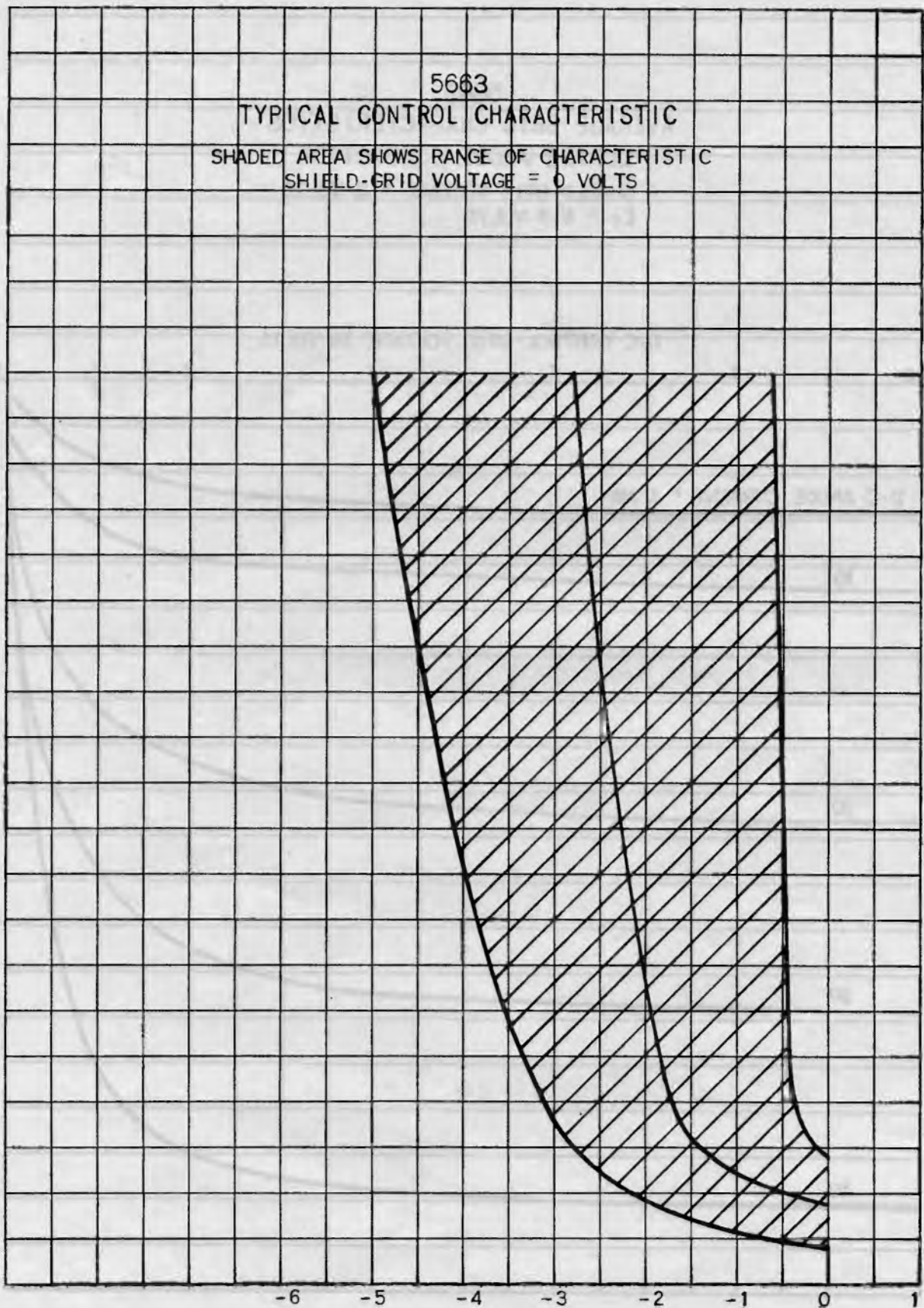
0.3

Ounce

5663

TYPICAL CONTROL CHARACTERISTIC

SHADED AREA SHOWS RANGE OF CHARACTERISTIC
SHIELD-GRID VOLTAGE = 0 VOLTS



D-C CONTROL-GRID VOLTAGE AT START OF DISCHARGE IN VOLTS

D-C ANODE VOLTAGE IN VOLTS

THE COMPUTER-19510 (REVISED) IN PART 11-1962

5663

AVERAGE GRID CHARACTERISTICS
DURING ANODE CONDUCTION

SHIELD-GRID VOLTAGE = 0 VOLTS
 $E_f = 6.3$ VOLTS

D-C CONTROL-GRID VOLTAGE IN VOLTS

D-C ANODE CURRENT = 5 MA

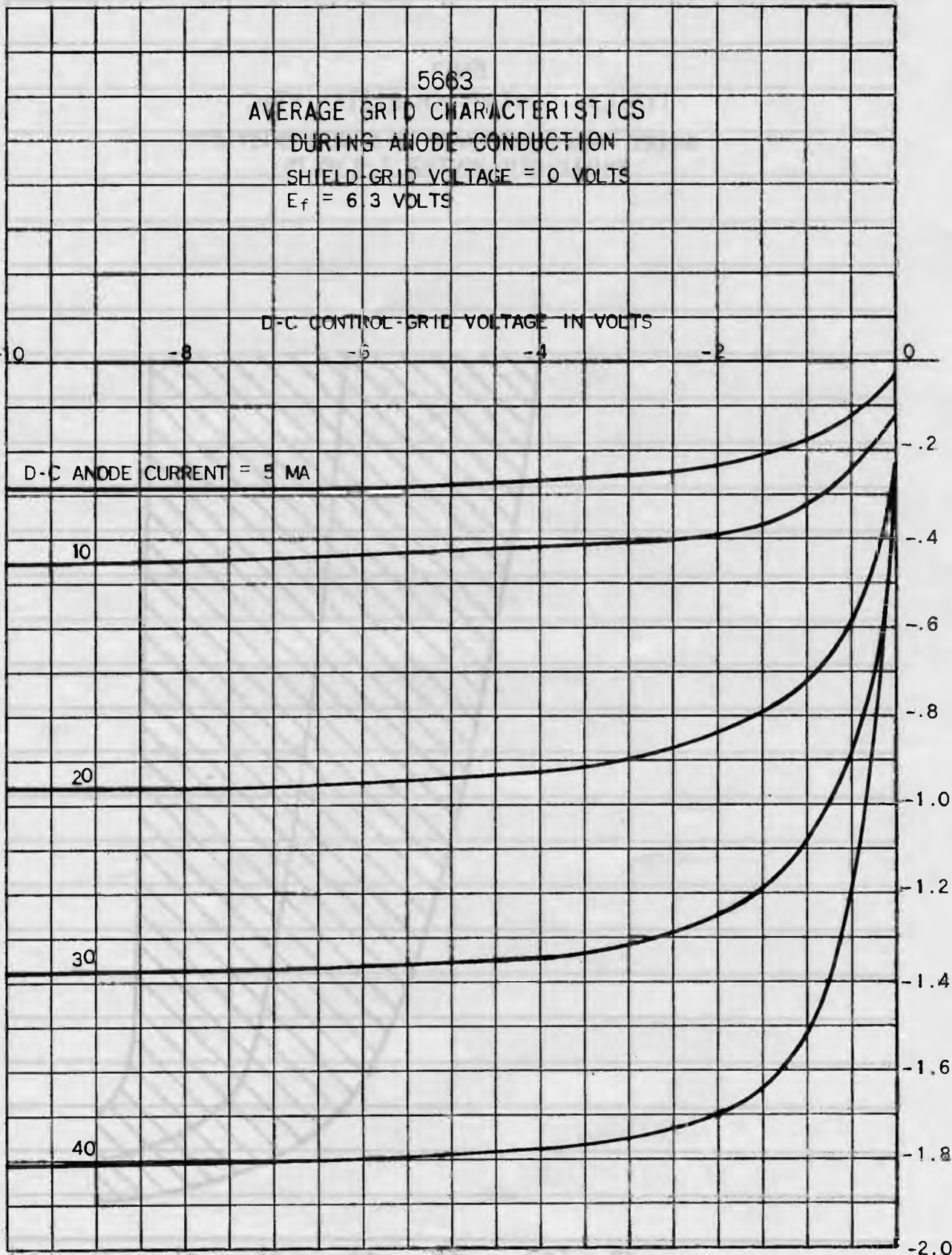
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20

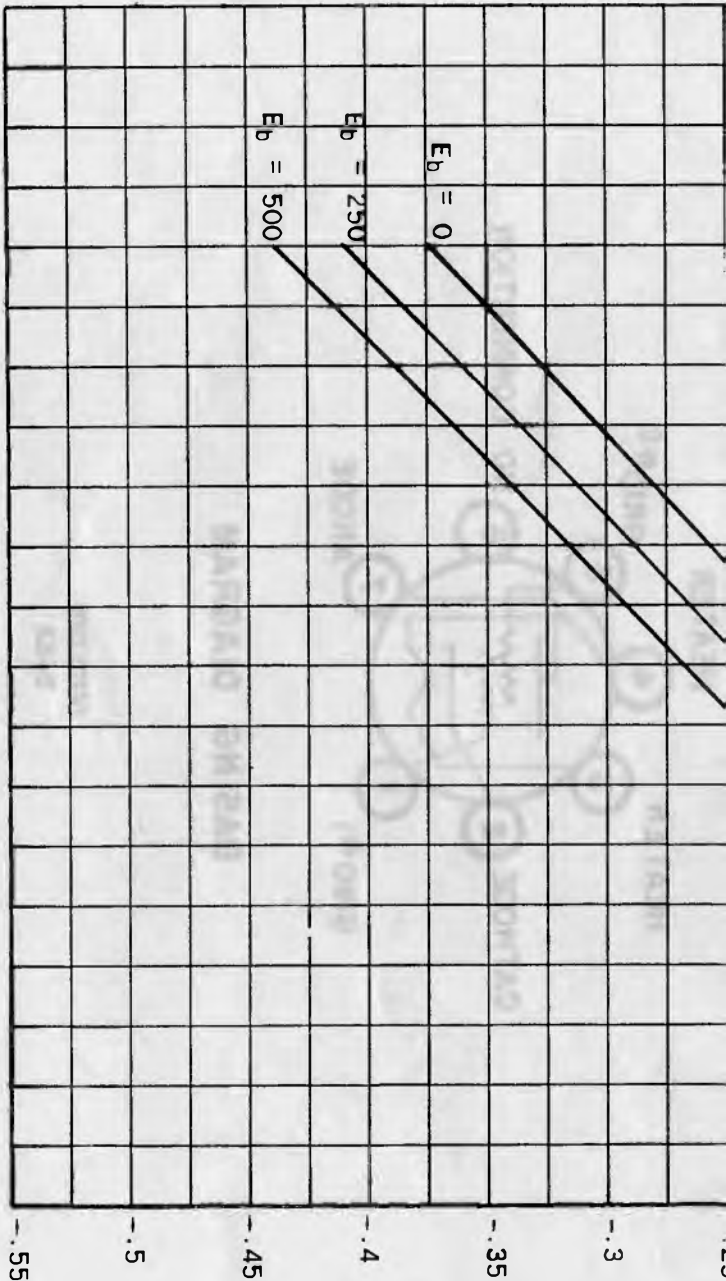
30

40

D-C CONTROL-GRID CURRENT IN MILLIAMPERES



D-C CONTROL-GRID VOLTAGE AT START OF DISCHARGE IN VOLTS



D-C CONTROL-GRID CURRENT IN

5663

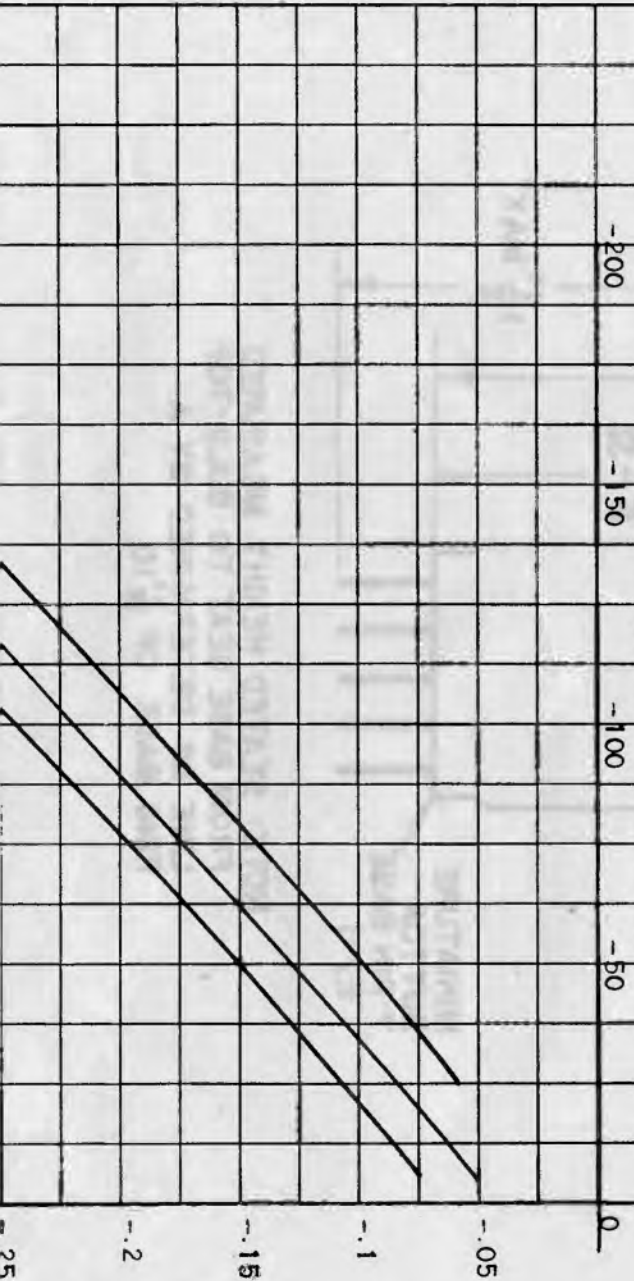
AVERAGE GRID CHARACTERISTICS

BEFORE ANODE CONDUCTION

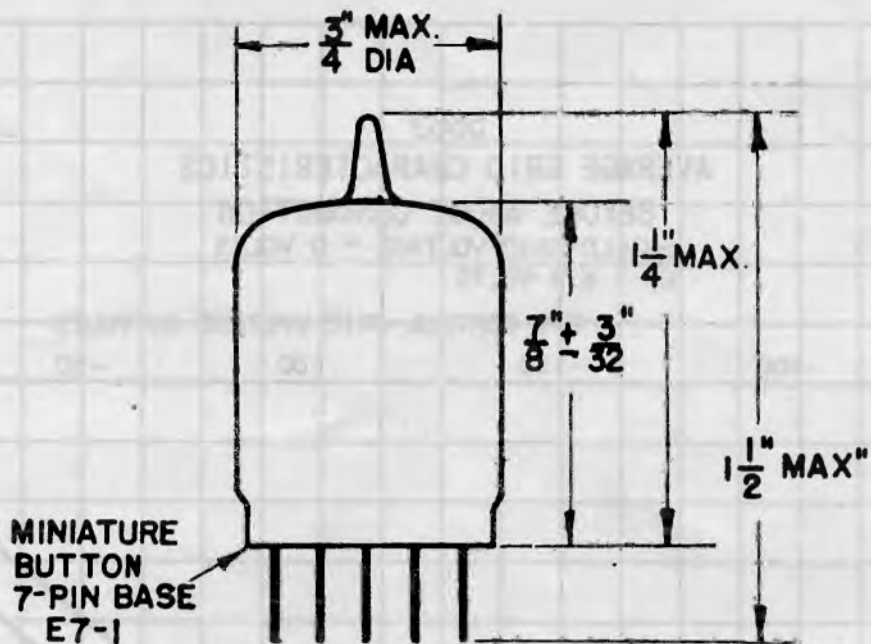
SHIELD-GRID VOLTAGE = 0 VOLTS

$E_f = 6.8$ VOLTS

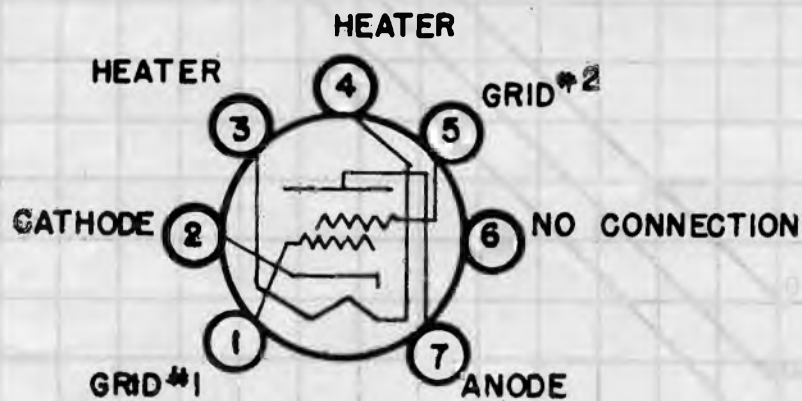
D-C CONTROL GRID VOLTAGE IN VOLTS



MILLIAMPERES



NOTE: SEATED HEIGHT MEASURED
 FROM BASE SEAT TO BULB-TOP
 LINE AS DETERMINED BY A
 RING GAGE OF $\frac{7}{16}$ " ID



BASING DIAGRAM

OUTLINE
 5663



THYRATRON

DESCRIPTION

The GL-5855 is a three-electrode inert-gas-filled thyatron with negative control characteristic for control applications. The high commutation factor, 200, permits this tube to be used in motor control without the need for snubber circuits and without the occurrence of gas clean-up. Other features of this tube are its ability to operate at maximum

ratings over a wide temperature range and its quick-heating cathode. Only one minute is required for the cathode to reach operating temperature. Because of these and other design features the GL-5855 is well suited for use in general control circuits.

TECHNICAL INFORMATION

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Heater voltage	2.37	2.5	2.63	volts
Heater current at 2.5 volts		34	37	amperes
Heating time required	60			seconds
Anode-to-control-grid capacitance, typical		50		uuf
Control-grid-to-cathode capacitance, typical		25		uuf
Deionization time, approximate		1000		microseconds
Ionization time, approximate		10		microseconds
Anode voltage drop, typical		16		volts



TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Type of cooling—convection
 Mounting position—any
 Net weight, maximum 2½ pounds

MAXIMUM RATINGS, Absolute Values

Maximum peak anode voltage
 Inverse 1500 volts
 Forward 1500 volts

Maximum cathode current
 Peak 150 amperes
 Average 12.5 amperes
 Surge (maximum duration 0.1 second) 2000 amperes
 Maximum averaging time 15 seconds

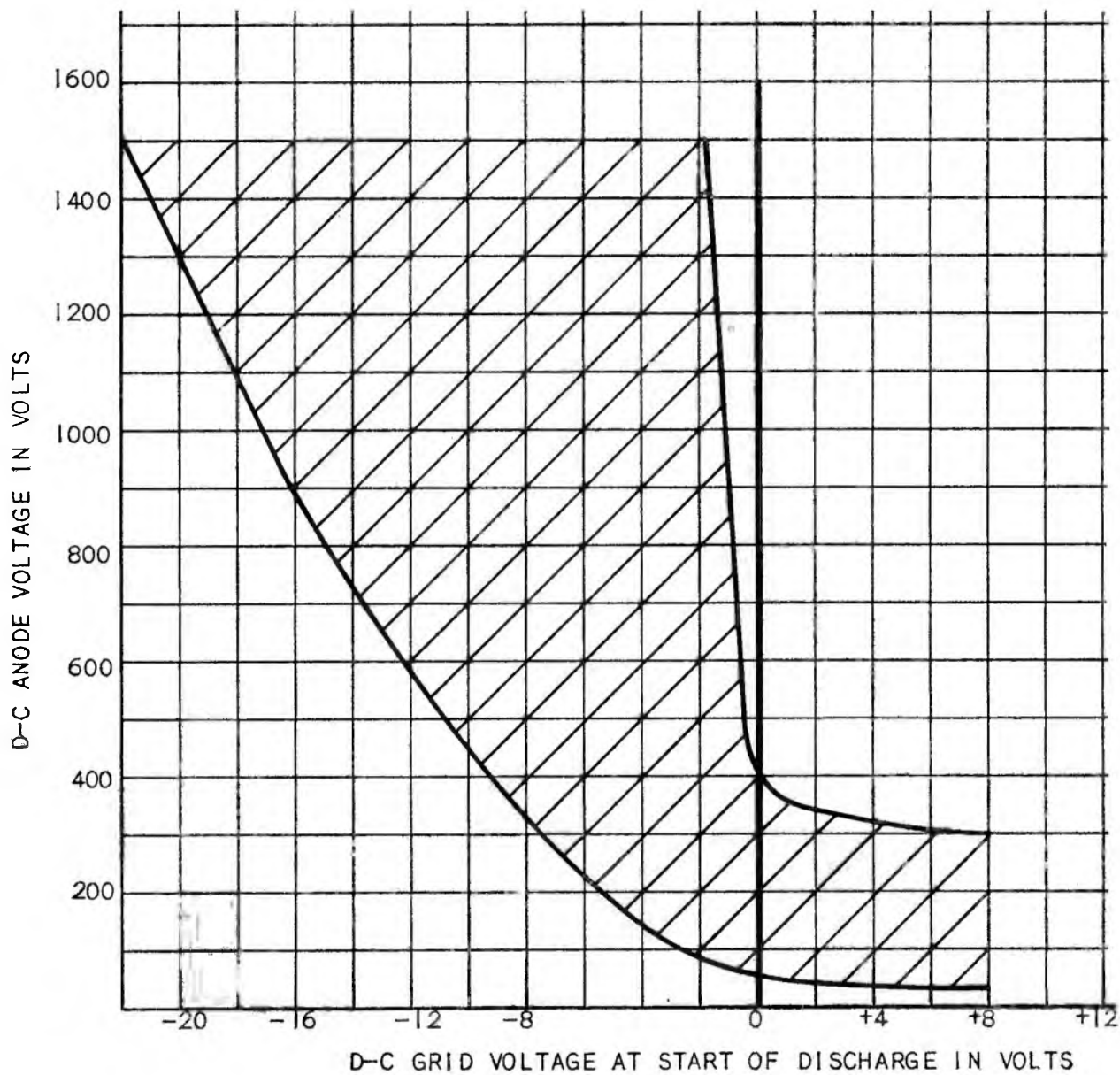
Maximum negative control-grid voltage
 Before conduction 250 volts
 During conduction 10 volts

Maximum positive control-grid current
 Average (averaging time one cycle) 0.5 ampere

Commutation factor* 200
 Ambient temperature limits -55 to +70 C

* Commutation factor is the product of the rate of current decay in amperes-per-microsecond just prior to commutation and the rate of inverse voltage rise in volts-per-microsecond just after commutation.

GL-5855
 CONTROL CHARACTERISTIC
 SHADED AREA SHOWS RANGE OF CHARACTERISTIC



GL-5855

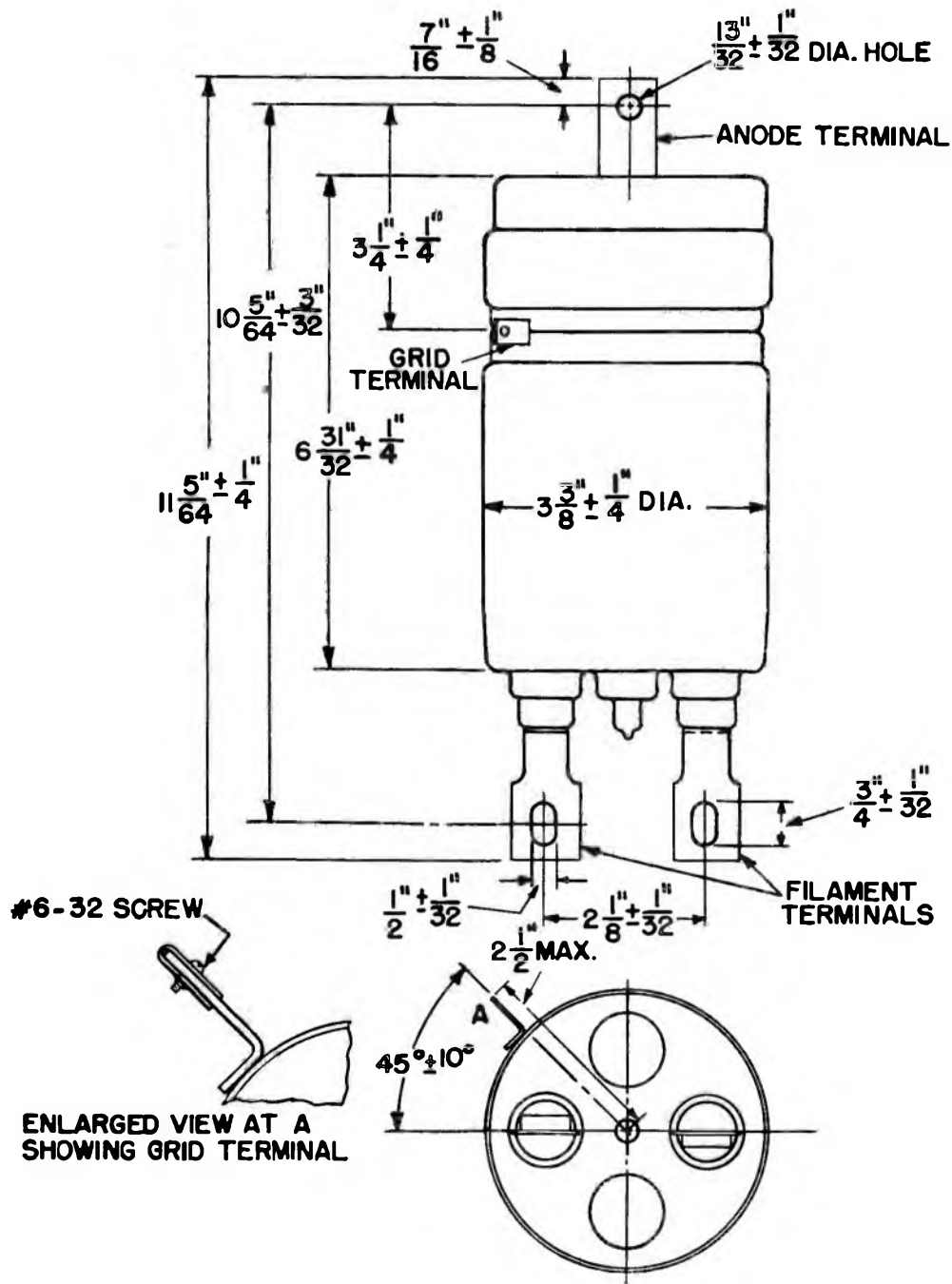
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PAGE 4

3-51

OUTLINE

GL-5855



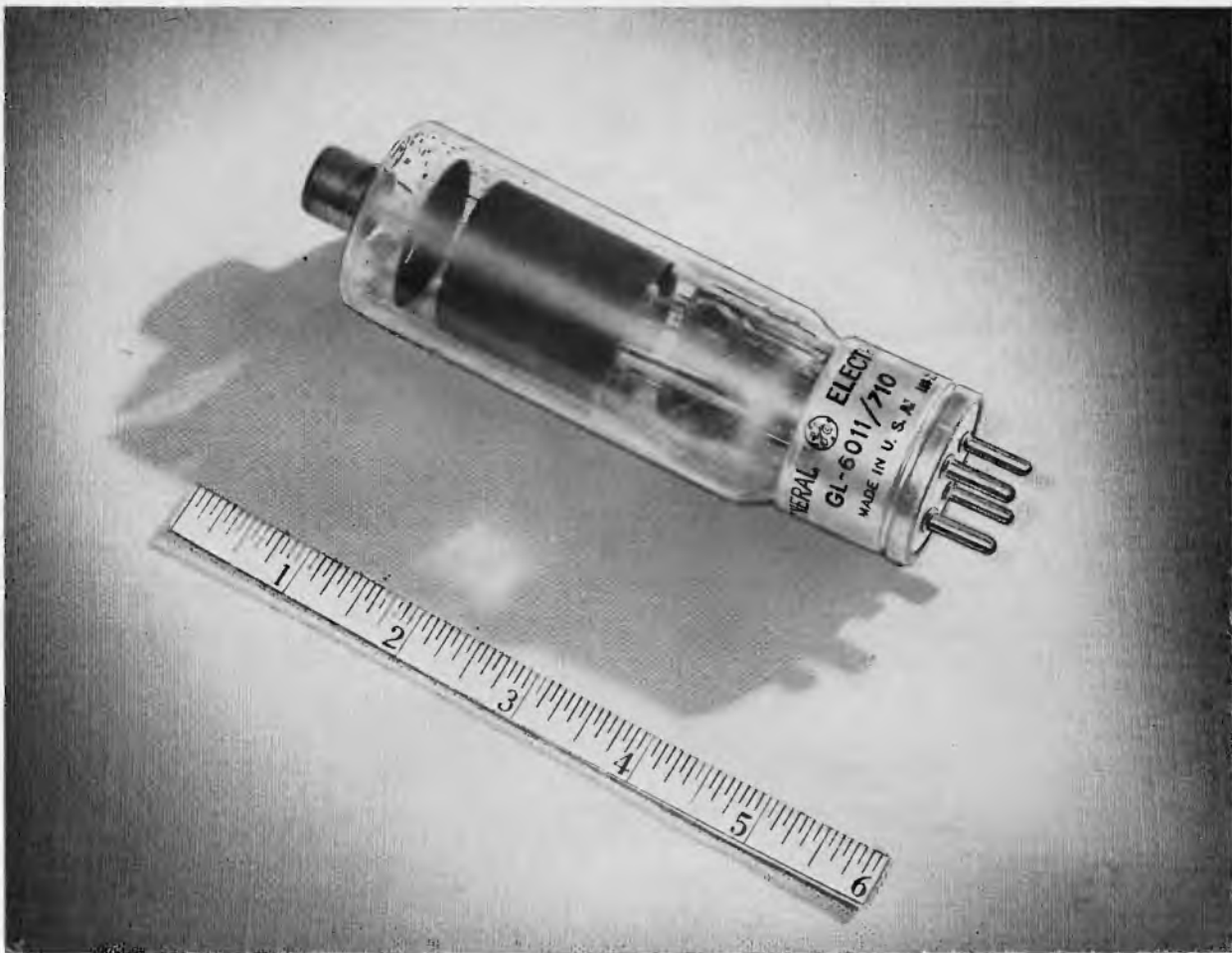
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Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



THYRATRON

TRIODE TYPE NEGATIVE CONTROL CHARACTERISTICS

The GL-6011/710 is a three-electrode, inert-gas and mercury-vapor thyratron with negative control characteristics for use in all control applications. The GL-6011/710 combines the desirable temperature characteristic of gas tubes, maximum ratings over a wide temperature range, with the long life of

QUICK-HEATING CATHODE INERT-GAS AND MERCURY-VAPOR

mercury tubes. Another feature is a quick-heating filamentary-type cathode—only 20 seconds are required for the cathode to reach operating temperature. Because of these features the GL-6011/710 is especially suitable for service in ignitor-firing, regulated-rectifier, and similar industrial applications.

GENERAL

*Electrical

Cathode—Filamentary

	Minimum	Bogey	Maximum	
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	—	μf
Control-Grid to Cathode Capacitance	—	12	—	μf
Deionization Time, approximate	—	1000	—	Microseconds
Ionization Time, approximate	—	10	—	Microseconds
Anode Voltage Drop	—	15	—	Volts
Critical Grid Current, $E_p = 220$ v d-c.	—	—	10	Microamperes

TECHNICAL INFORMATION

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†Supersedes pages 1 and 2 dated 12-57

TECHNICAL INFORMATION (Cont'd)

Mechanical

⊕Mounting Position—Any Position from Vertical, Base Down, to Horizontal

Equilibrium Condensed-Mercury Temperature Rise Above Ambient

At Full Load, approximate.....	30	°C
At No Load, approximate.....	25	C
Net Weight, maximum.....	5	Ounces

MAXIMUM RATINGS, Absolute Values

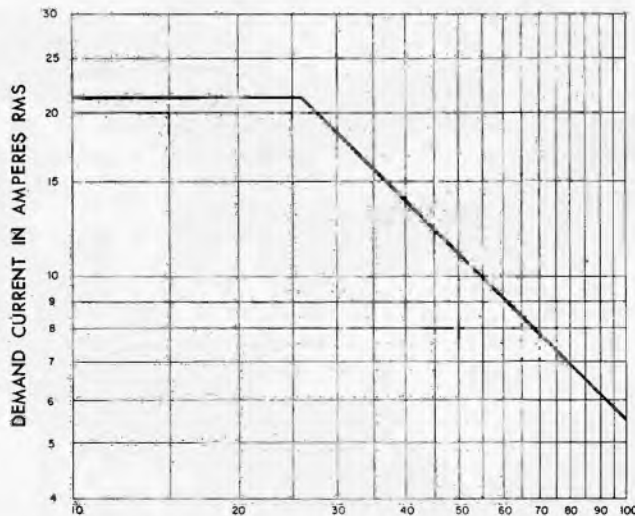
Maximum Peak Anode Voltage		
Inverse.....	1500	Volts
Forward.....	1500	Volts
Maximum Cathode Current *		
Peak.....	30	Amperes
Average.....	2.5	Amperes
Maximum Averaging Time.....	5	Seconds
Fault.....	250	Amperes
Maximum Duration.....	0.1	Seconds
Maximum Negative Control-Grid Voltage		
Before Conduction.....	500	Volts
During Conduction.....	10	Volts
Maximum Positive Control-Grid Current *		
Average.....	0.25	Amperes
Averaging Time.....	1	Cycle
Condensed-Mercury Temperature Limits.....	-40 to +80	C

* The anode and grid-circuit returns should be made to pin No. 2. However, they can be made to the center tap of the filament transformer.

⊕Denotes a change.

SINGLE-PHASE ELECTRONIC-WELDER RATING

MAX PEAK FORWARD AND INVERSE ANODE VOLTAGE=1500 VOLTS
 DEMAND CURRENT MEASURED WITH FULL CONDUCTION DURING EACH HALF CYCLE
 AVERAGING TIME=5 SECONDS



DUTY CYCLE IN PERCENTAGE (2 TUBES IN INVERSE PARALLEL)

RECTIFIERS**Recommended Types and Selection Chart**

Classification	Anode*			Cathode		Tube Type
	Average Amperes	Peak Amperes	Peak Inverse Volts	Volts	Amperes	
Half-wave, Mercury vapor	1.25	5.0	10,000	5.0	7.5	GL-872-A (Jumbo 4-pin base, A4-29) GL-8008 (Super-jumbo 4-pin base, A4-18)
	2.5	10.0	15,000	5.0	10.0	GL-575-A (Jumbo 4-pin base, A4-29) GL-673 (Super-jumbo 4-pin base, A4-18)
		15.0	5000	5.0	4.5	GL-5558
	4.0	16.0	10,000	5.0	10.0	GL-5561 (Welder-control Service)
	5.0	20.0	20,000	5.0	19.0	GL-869-B
	6.4	40.0	3000	5.0	10.0	GL-5561 (Continuous Service)
	10.0	40.0	22,000	5.0	30.0	GL-857-B
Half-wave, High-vacuum	75.0	450	16,000	5.0	65.0	GL-870-A
	1.25	5.0	75,000	16.0	19.1	GL-5973 (See Kenatron Section)

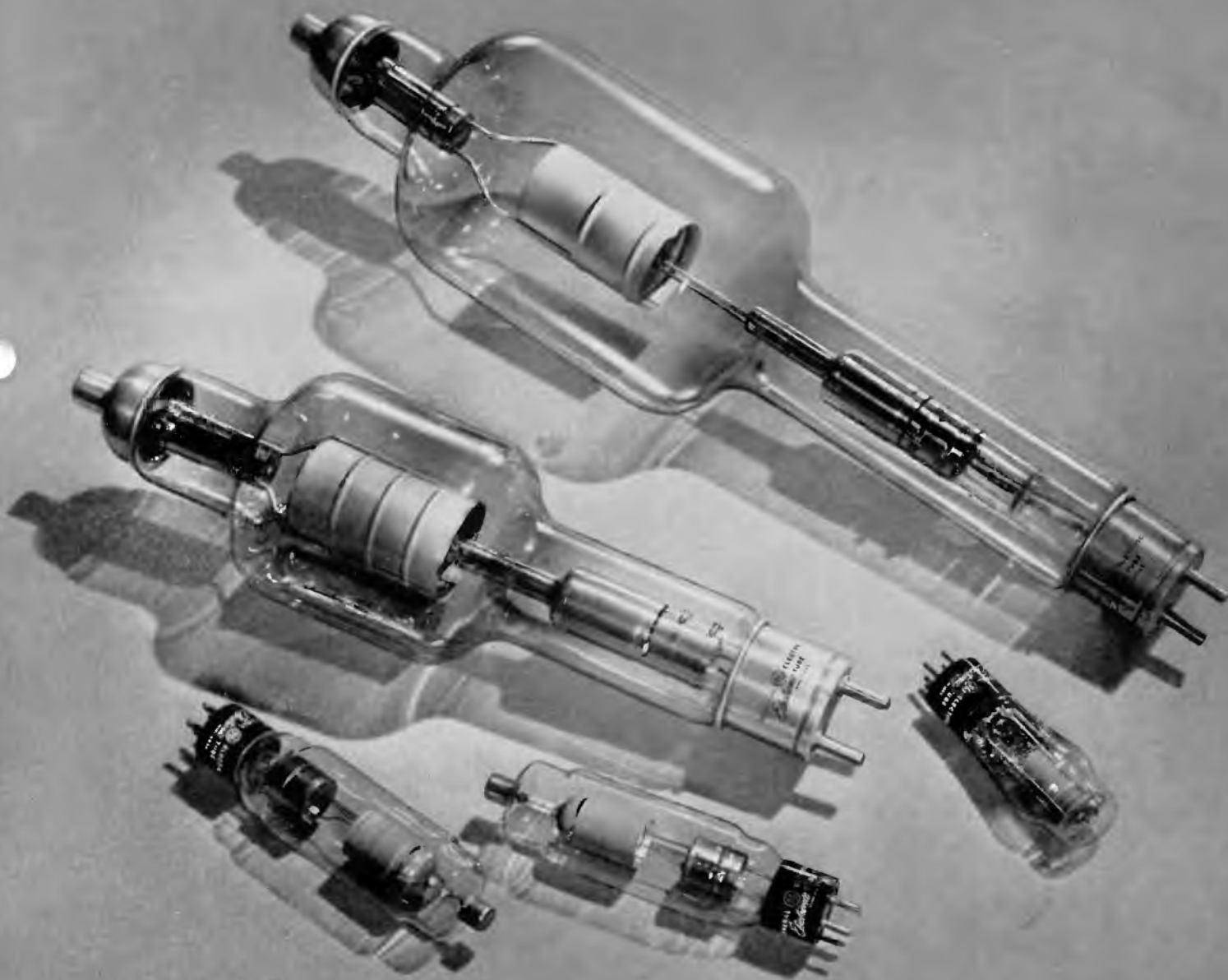
* Values listed are maximum values and do not apply for all types of application. Refer to data sheet for detailed information.

ELECTRONIC COMPONENTS DIVISION
GENERAL  **ELECTRIC**
 Schenectady 5, N. Y.

KENOTRONS

GENERAL  ELECTRIC

KENOTRONS



DESCRIPTION

The kenotron is a high-vacuum thermionic tube in which no means is provided for controlling the unidirectional current flow.

The succeeding paragraphs describe the funda-

mentals of operation, ratings, classes of tubes, applications, maintenance and operation as well as the qualities which render these tubes particularly useful to industry.

FUNDAMENTALS OF THE KENOTRON

A kenotron consists of two electrodes, an anode and a hot cathode, located in spaced relationship within an evacuated container. Due to the elevated temperature of the cathode, negatively charged electrons are emitted from its surface and will flow to the anode (or plate) only when the anode is at a positive potential with respect to the cathode. Since the flow of electrons constitutes an electric current and takes place in one direction only in a kenotron, this tube is particularly useful for application to rectifier circuits. When an alternating voltage is applied to a kenotron and the resulting pulsating unidirectional current is used to charge a capacitor which in turn supplies the load circuit, a nearly uniform supply of direct current is obtained.

Kenotrons have no rotating parts and are therefore quiet in operation. They occupy a relatively small space and are light in weight considering the amount of power which they are rated to handle.

Kenotrons possess advantages over gas or vapor-filled tubes when very high voltages are to be rectified as the high degree of vacuum to which they are exhausted results in practically perfect insulation on the inverse cycle when the anode is negative. Since a kenotron does not depend on an internal vapor pressure for its operation, it is less sensitive to changes in ambient temperatures than gas- or vapor-filled tubes. The use of pure-tungsten or thoriated-tungsten filaments as the source of electrons permits a minimum of delay between the application of filament voltage and plate voltage.

DEFINITIONS OF HIGH-VACUUM TUBE RATINGS

General

When the terms used in the rating of high-vacuum tubes are considered, it is important to realize that the application of the limits and values given for a particular tube depends upon the operating conditions. Any nominal rating can apply only to one set of conditions and not to all the conditions encountered in practice.

The cathode or filament information is given in

terms of normal heating voltage. A current figure to indicate transformer rating, is also given. The filament or cathode, except in unusual cases, should always be operated at this rated voltage rather than at rated current and the voltage should be adjusted so that the normal fluctuation in line voltage averages around this point. Normally, when this is done, a plus or minus variation of five per cent heating voltage is allowable.

KENOTRON RATINGS

In addition to filament voltage and filament current ratings, maximum ratings are given for peak inverse voltage, peak anode current and average anode current for rectifier operation.

The maximum peak inverse voltage is the highest instantaneous voltage that a kenotron will safely withstand in the direction opposite to that in which it is designed to pass current.

The maximum peak anode current is the highest instantaneous current which the filament is designed to deliver at full rated filament voltage.

The maximum average anode current is the highest average or d-c value of current which the tube is rated to carry at full rated filament voltage and beyond which the tube may be damaged due to excessive plate dissipation.

Some types of kenotrons are given additional

maximum ratings for surge limiting operation which include filament voltage, peak forward anode voltage, average anode dissipation, and a peak anode current minimum. Under this type of operation the tube is used to limit a surge usually of short duration.

The maximum peak forward voltage is the highest instantaneous voltage that a kenotron will safely withstand in the direction in which the tube is designed to carry current.

The maximum average anode dissipation is the highest average wattage which may be expended in the anode under this type of operation.

The peak anode current minimum is intended as a guide to indicate the instantaneous anode current which may be expected under typical operating conditions.

CLASSES OF KENOTRONS

Kenotrons may be divided into two general classes:

1. Radiation - cooled kenotrons (sometimes cooled by immersion in oil) usually of the glass-

envelope type.

2. Water-cooled kenotrons with anodes which are cooled externally by water circulation through a water jacket surrounding the anode.

In general kenotrons are useful in any application involving the rectification of alternating current to provide a direct-current supply or for the suppression of intermittent high-voltage surges. The kenotron finds its greatest usefulness where the requirements call for high voltage at low current or where the range of ambient temperature variations is wide.

A typical example is the kenotron used in air filter applications. The kenotrons supply the high voltages necessary to filter the air by electrical precipitation. The air is ionized and the negatively charged dust particles adhere to plates positively charged by the kenotrons.

The kenotron is less efficient at low voltages than gas- or vapor-filled rectifier tubes, but will operate satisfactorily at peak inverse voltages far in excess of those for which gas- and vapor-filled tubes are designed.

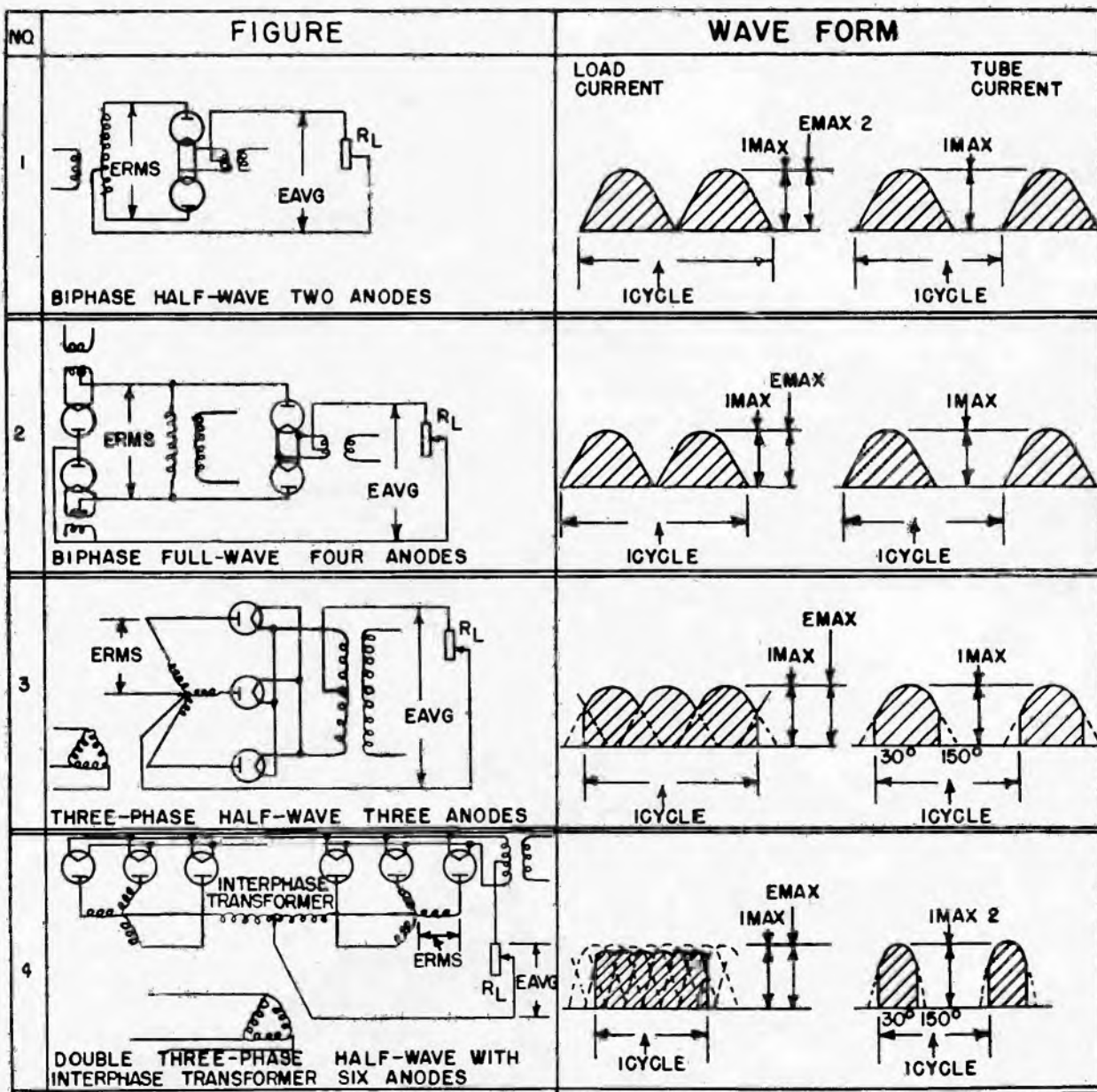
When selecting a tube type for a particular application, consideration must be given to the

ability of the tube to withstand the open circuit or inverse voltage, as well as to its ability to pass sufficient overload current in the forward direction without overheating. Electrons flow to the plate with very high velocities so that time-lag effects are negligible for rectification voltages, even at the highest power supply frequencies used in practice.

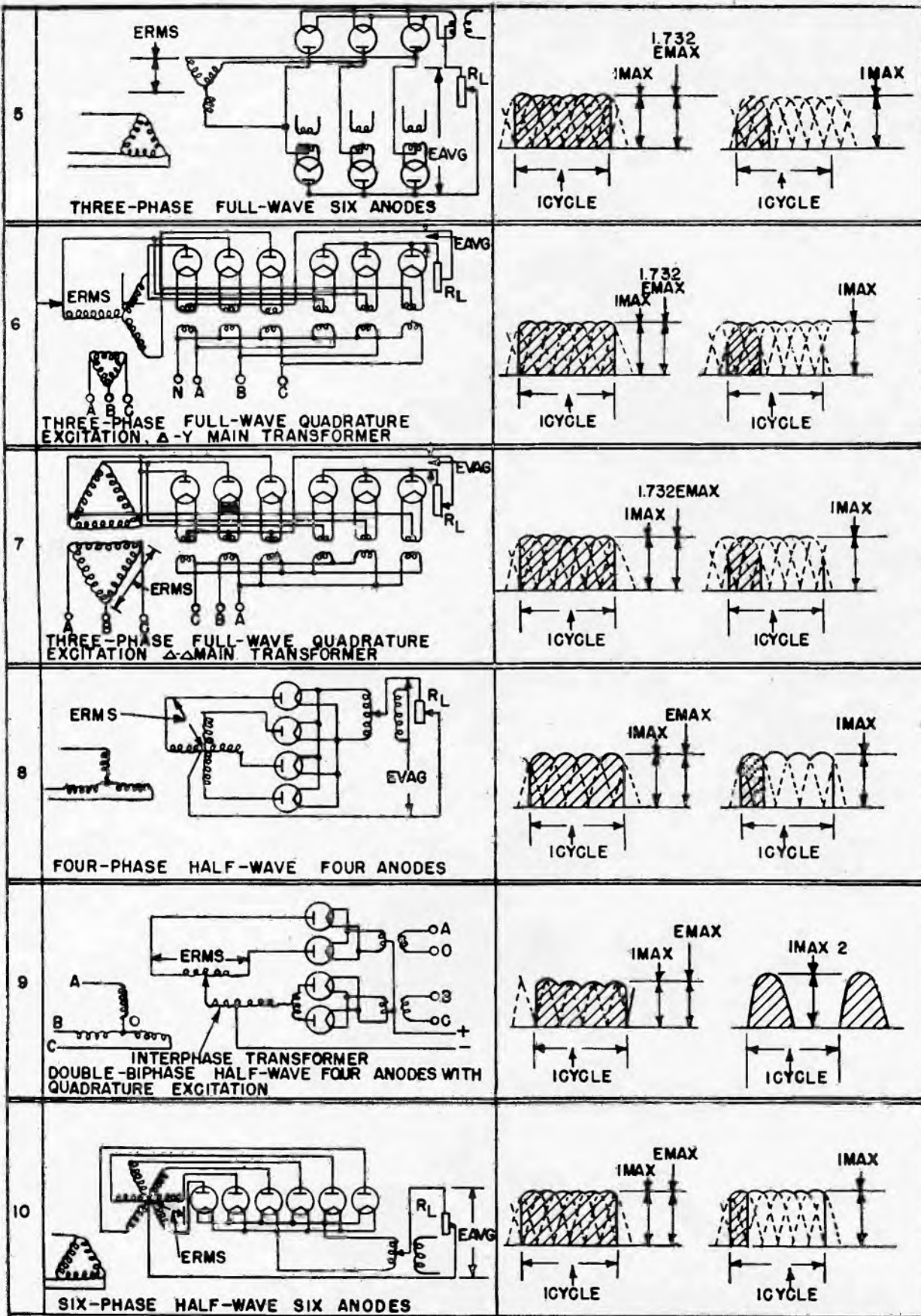
The kenotron rectifier provides a means of obtaining a higher voltage d-c supply than can be conveniently obtained by other methods. The stability of these tubes with regard to power supply frequency and their small size and quietness of operation are added advantages.

A number of rectifier circuits in which kenotron tubes may be used are shown in Figs. 1-10.

#Circuits shown in ETI-140 are examples of possible tube applications and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company.



APPLICATION CIRCUITS (CONT'D)



USEFUL RATIOS

FIG. NO.	TUBE I (AVG) LOAD I (AVG)	E-AVG	E-INVERSE	I-AVG
1	0.500	0.318 E-MAX 0.450 E-RMS	E-MAX 3.140 E-AVG	0.636 I-MAX
2	0.500	0.636 E-MAX 0.900 E-RMS	E-MAX 1.570 E-AVG	0.636 I-MAX
3	0.333	0.827 E-MAX 1.170 E-RMS	$\sqrt{3}$ E-MAX 2.090 E-AVG	0.827 I-MAX
4	0.167	0.827 E-MAX 1.170 E-RMS	$\sqrt{3}$ E-MAX 2.090 E-AVG	0.827 I-MAX
5	0.333	1.650 E-MAX 2.340 E-RMS	$\sqrt{3}$ E-MAX 1.050 E-AVG	0.955 I-MAX
6	0.333	1.650 E-MAX 2.340 E-RMS	$\sqrt{3}$ E-MAX 1.050 E-AVG	0.955 I-MAX
7	0.333	0.955 E-MAX 1.340 E-RMS	E-MAX 1.050 E-AVG	0.955 I-MAX
8	0.250	0.900 E-MAX 1.274 E-RMS	2.220 E-AVG	0.900 I-MAX
9	0.250	0.318 E-MAX 0.450 E-RMS	3.140 E-AVG	0.318 I-MAX
10	0.167	0.955 E-MAX 1.350 E-RMS	2.090 E-AVG	0.955 I-MAX

APPLICATION CIRCUITS (CONT'D)

When a kenotron is placed in series with an alternating-voltage supply and the resulting pulsating current used to charge a condenser which in turn supplies a load, only one-half of the alternating voltage is used. Such a circuit while satisfactory in some cases is not efficient. In general, multiphase circuits utilizing both half cycles of the alternating voltage (fullwave operation) yield a higher average output voltage and current for a given tube size. The variation in the d-c output voltage known as the ripple is also considerably reduced with multiphase circuits. In some circuits tubes are operated in series to obtain higher average d-c output voltages than could be obtained with a single tube

without exceeding the maximum rated peak inverse voltage of the kenotron. In other applications tubes are operated in parallel to provide greater d-c output current without exceeding the current rating of the kenotrons.

The circuits shown in Figs. 1-10 as well as variations of them will be found useful in such applications as air filters, cable testing, smoke precipitators, radio transmitters, x-ray and other electro-physical and electro-chemical uses requiring high direct voltage at moderate currents.

Fig. 11 shows a circuit for testing high-voltage cable where extremely high voltage direct current is required.

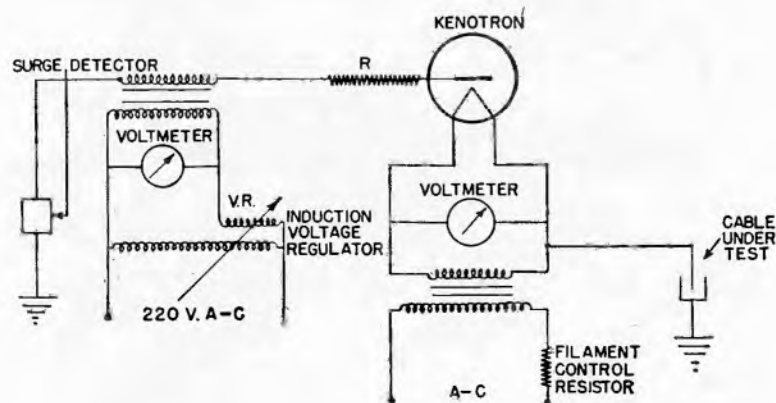


Fig. 11—Circuit for High-Voltage Cable Tester

INSTALLATION

Cooling

Free circulation of cool air around the glass bulb should be maintained. High temperature air from other apparatus should be prevented from circulating around the tubes. If desired the tubes may be immersed in a tank of oil with the transformers.

Electrical

Filament power should be supplied from a filament lighting transformer insulated for the proper voltage, and provided with a secondary midtap for the plate circuit return lead. The filament excitation supply must be provided with suitable

resistors or other regulating devices to apply the power to the filament gradually and to adjust it accurately during operation. The filament voltage should be measured directly at the filament terminals.

The installation of all wires and connections should be made so that they do not lie on or close to the glass of the kenotron. An air space of approximately the length of the tube should be maintained between the bulb and any metallic body during operation. Otherwise, corona discharge may develop and result in puncture of the glass bulb.

OPERATION

Kenotrons should be operated within the maximum ratings given in the Technical Information* in order to obtain maximum tube life and performance.

The ratings given in the Technical Information* prescribe two limiting operating conditions. The first, the maximum peak inverse voltage, is a value determined by the insulation between electrodes of the tube. This is the highest voltage that the tube will insulate on the half cycle when no currents are passing through the tube. Line surges, circuit capacitance, wave form distortion and the maximum peak voltage of the applied alternating voltage may cause the inverse voltage to exceed the maximum peak voltage rating.

The second limiting value is the power dissipation of the anode which is determined by the d-c load current almost regardless of the voltage across the load. As the design of the circuit especially the amount of capacitance in the circuit, is a major factor in determining the amount of current available in a given rectifier, oscilloscope measurements of this current should be made if any doubt exists as to the magnitude. If the kenotron is to be operated at full peak current ratings, it will be necessary to maintain exactly the rated filament voltage. If

the peak current to be drawn is less than the full rated value, the allowable filament voltage regulation increases as the value of the peak current decreases.

The following tabulation shows the reduction of the maximum peak current with reduced filament voltage:

Filament Voltage % of Rated	Maximum Peak Current % of Rated
100	100
95	65
90	40
85	25
80	10

Excessive anode temperature is an indication of abnormal voltage drop in the tube and is usually caused by low filament temperature. Filament voltage greater than the rated value, while increasing the maximum peak current available, will result in decreased tube life.

Careful handling and conservative operation will be amply repaid by longer and more uniform tube life.

**Note: The ratings and characteristics of a particular tube are given under Technical Information on the Description and Rating Sheet for that tube.*

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



KENOTRON

PLATE DISSIPATION—800 WATTS
THORIATED-TUNGSTEN FILAMENT
RECTIFIER AND LIMITER DIODE

LOW VOLTAGE DROP
20 AMPERES AT 75 KILOVOLTS
1.25 AMPERES DC AT 40 KILOVOLTS

The GL-5973 is a two-electrode high-vacuum tube for use as a rectifier or surge-limiting diode. Design features include a thoriated-tungsten filament and a low voltage drop which enable the tube to carry high average currents.

In rectifier service the tube will operate at average currents as high as 1.25 amperes at 40,000 volts and one ampere at higher voltages. In limiter

service ratings as high as 20 amperes at 75,000 volts apply. These ratings make the tube particularly suitable for use in radar as a charging diode to supply d-c power to magnetrons or as a limiter to restrict fault currents. Other applications include high-voltage power supplies in cable-testing service and smoke precipitators.

TECHNICAL INFORMATION

GENERAL

Electrical	Minimum	Bogey	Maximum
Filament Voltage	15.2	16	16.8 Volts
Filament Current at 16 Volts	18.0	19.1	20.2 Amperes
Filament Starting Current	—	—	30 Amperes
Filament Cold Resistance	—	0.1	— Ohms
Filament Heating Time, before applying plate voltage	30	—	— Seconds
Tube Voltage Drop, $I_b = 5$ amperes	850	950	1050 Volts
Interelectrode Capacitance	—	14	— $\mu\mu\text{f}$

GENERAL  ELECTRIC

TECHNICAL INFORMATION (Cont'd)

Mechanical

Maximum Glass Temperature*	300 C
Maximum Base Temperature	150 C
Mounting Position—Vertical, Base Down	
Net Weight, approximate	3 Pounds

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Rectifier Service

Maximum Ratings, Absolute Values

Peak Inverse Voltage	75 Kilovolts
Plate Current	
Peak	5 Amperes
Average	
Peak Inverse Voltage = 40 Kilovolts or Less	1.25 Amperes
Peak Inverse Voltage = more than 40 Kilovolts	1.00 Amperes
Average Plate Dissipation	
Peak Inverse Voltage = 40 Kilovolts or Less†	850 Watts
Peak Inverse Voltage = more than 40 Kilovolts‡	800 Watts

Limiter Service

Maximum Ratings, Absolute Values

Peak Inverse Voltage	75 Kilovolts
Peak Plate Current	20 Amperes
Average Plate Dissipation‡	800 Watts

*Where tubes are enclosed or operated in close proximity to each other, forced-air cooling may be required to limit bulb and base temperatures to the allowable maximum.

†Maximum observed temperature of 1010 C at any point on the anode.

‡Maximum observed temperature of 985 C at any point on the anode.

□ Denotes an addition.

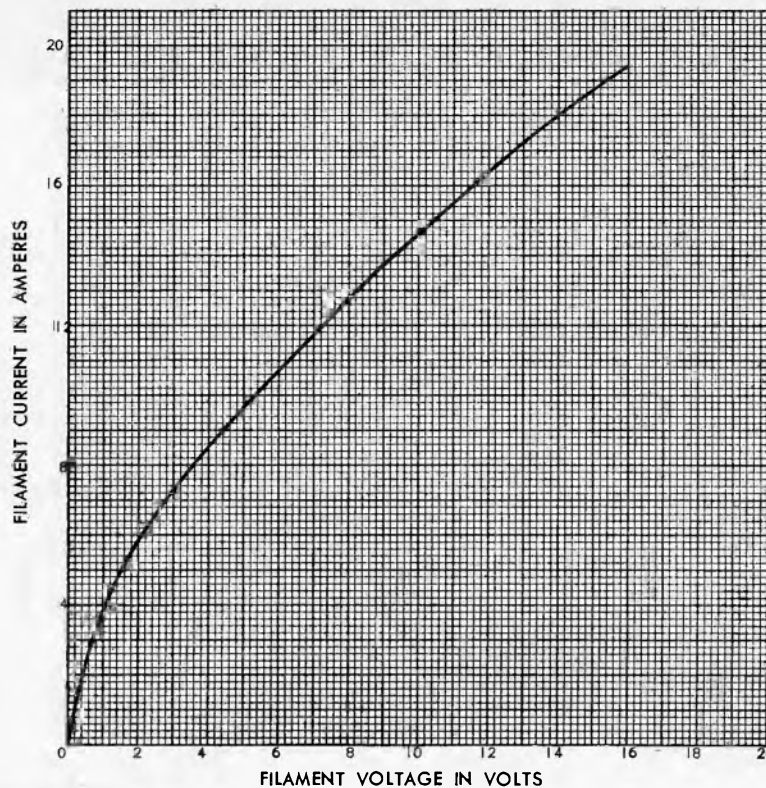
□ X-RAY WARNING NOTICE

If the GL-5973 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.

TYPICAL FILAMENT CURRENT CHARACTERISTIC

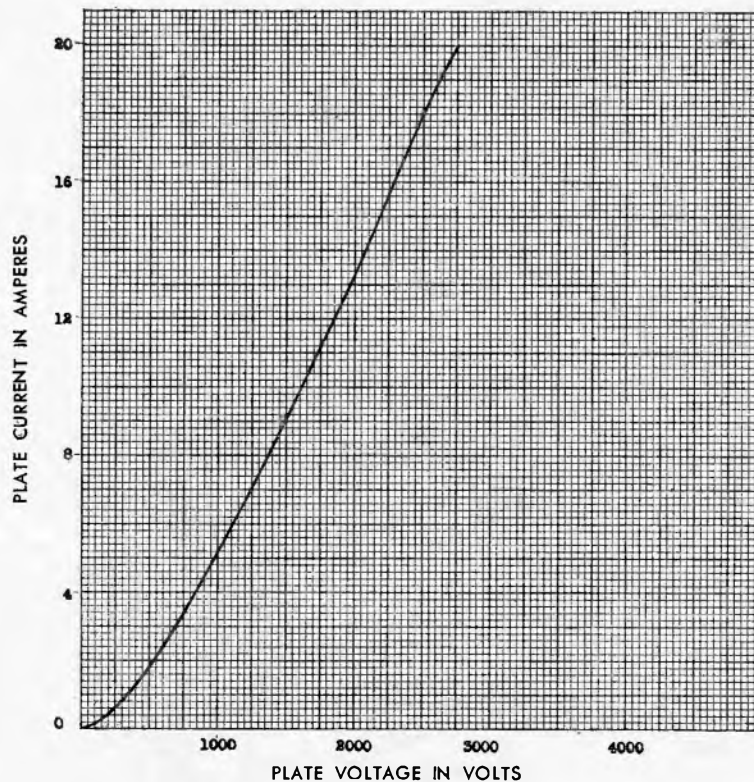


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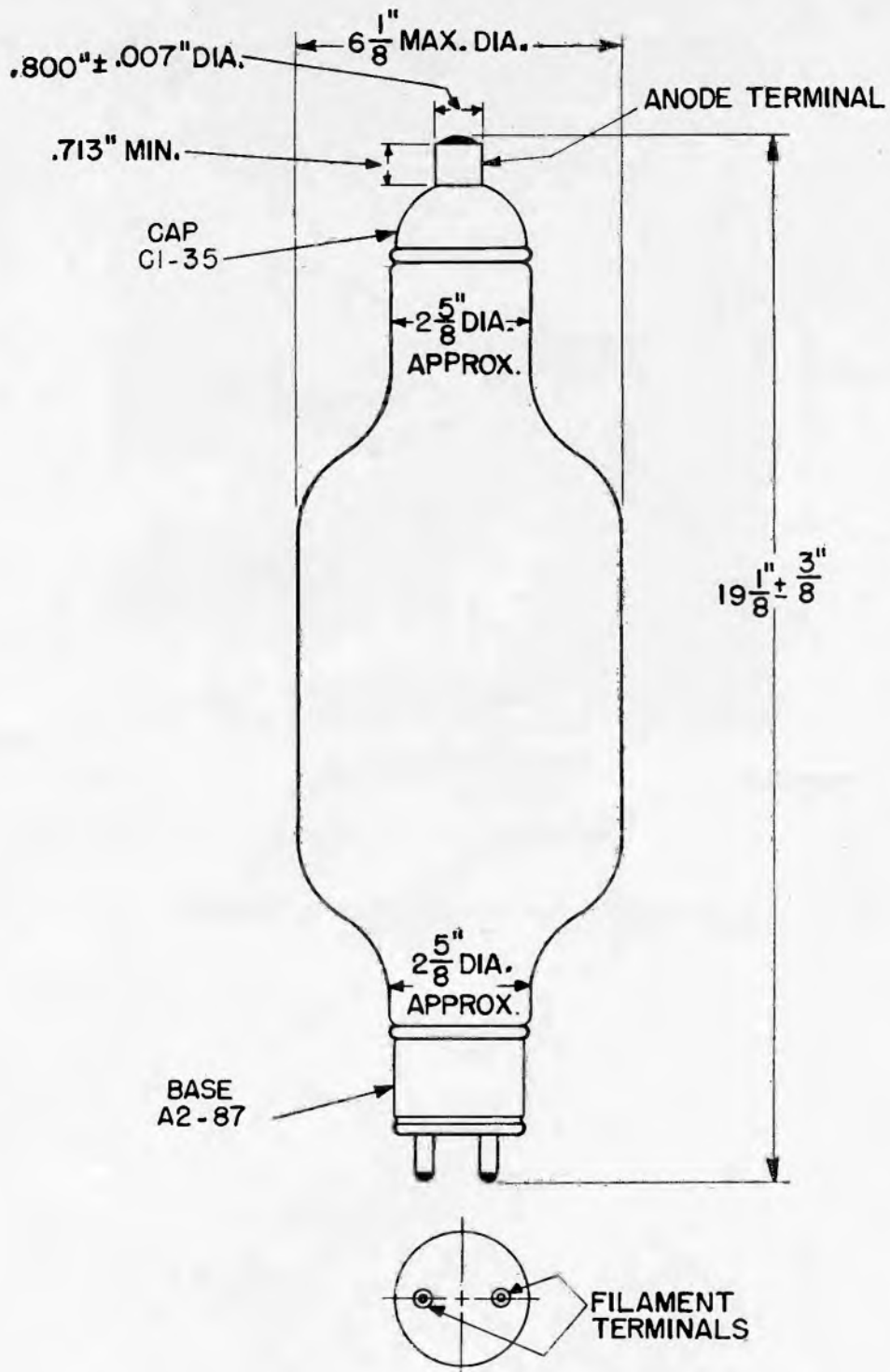
TYPICAL PLATE CHARACTERISTIC

$E_f = 16$ VOLTS



K-69087-72A381

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N-21009AZ

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KENOTRON

DESCRIPTION

The GL-5741/FP-85-A is a two-electrode tube designed for use as a rectifier. The cathode is a pure-tungsten filament-cooled. The anode is a radi- ment.

RECOMMENDED FOR REPLACEMENT ONLY—USE GL-8020 FOR NEW APPLICATIONS

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes.....	2
Electrical Data	
Cathode—Filamentary type, pure tungsten	
Filament voltage.....	10.0 volts
Filament current.....	5.0 amperes
Voltage drop ($I_b = 100$ milliamperes).....	280 volts
Interelectrode capacitance, plate-filament.....	1.8 micromicrofarads
Mechanical Data	
Base—A4-10	
Maximum over-all dimensions	
Length.....	8 inches
Diameter.....	2 $\frac{5}{8}$ inches
Net weight, approx.....	3 $\frac{1}{2}$ ounces
Shipping weight, approx.....	3 pounds
Mounting position.....	vertical, with base down
Maximum glass temperature.....	150 C

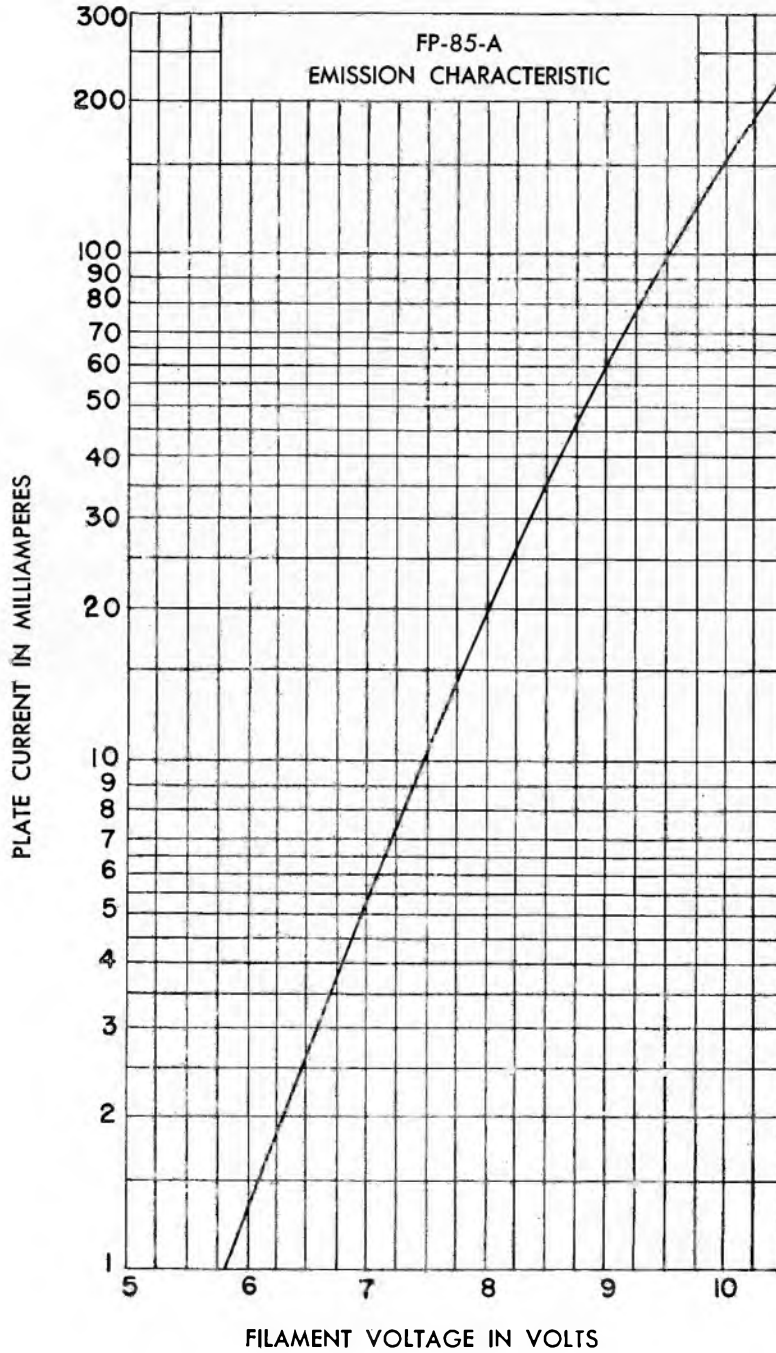


GENERAL  ELECTRIC

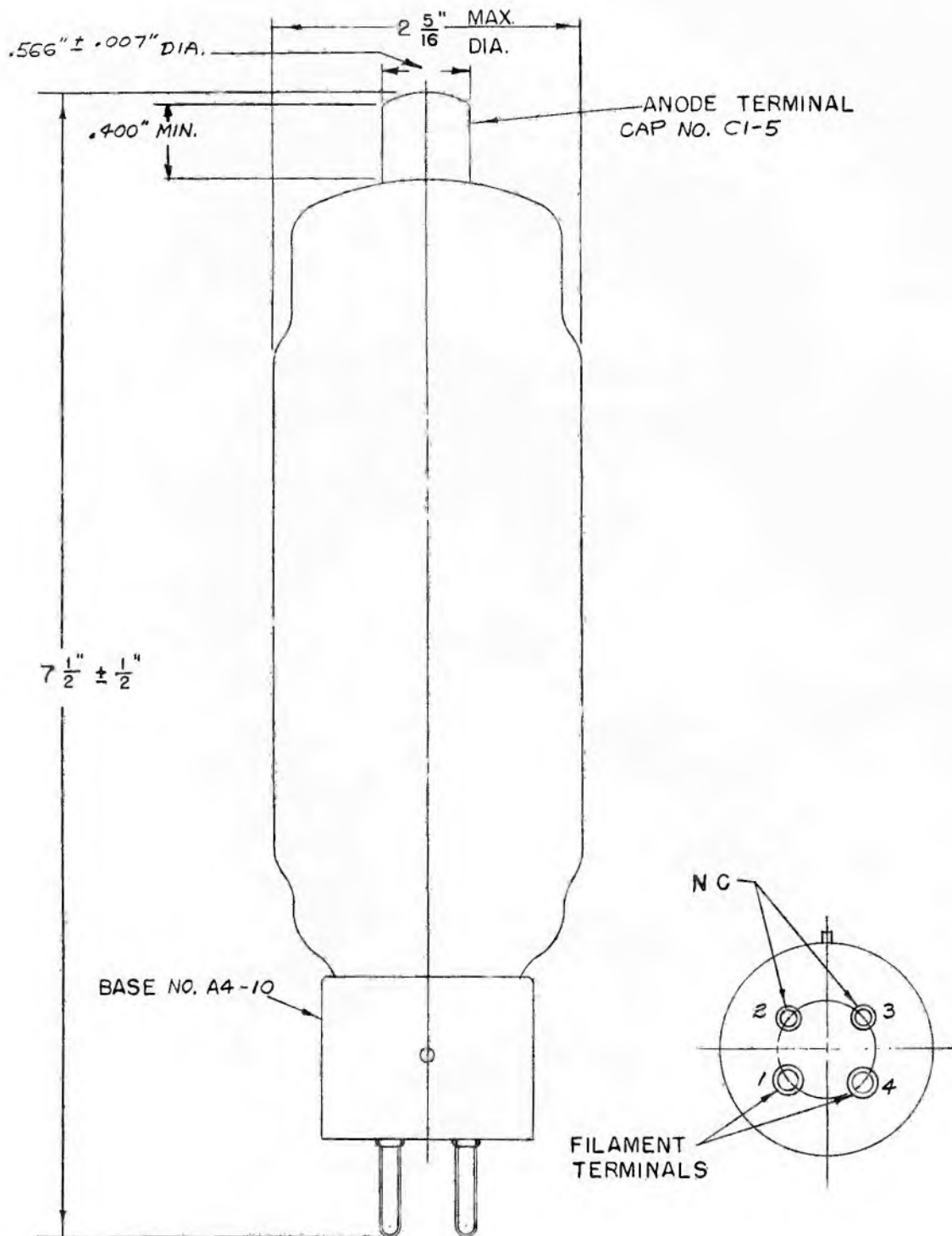
TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS—Absolute Values

Maximum peak inverse voltage	20,000	volts
Maximum peak anode current	100	milliamperes
Average anode current	20	milliamperes



◆ OUTLINE
GL-5741 / FP-85-A KENOTRON



K-8639604
◆ New drawing.

5-24-48

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.

SPECIFICATIONS

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-286.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	See Note	Test Conditions	Limits		
			Min.	Max	Units
Heater Current		$E_a = 6.3$ volts a-c	275	325	Milliampere a-c
Plate Current		$E_b = 100$ volts d-c	13	19	Milliampere d-c
* Plate Current		Field Strength = 90 gauss; $E_b = 100$ volts d-c	.....	100	Microampere d-c
Field Strength Sensitivity	1 1, 2	Field Strength Sensitivity	50 1.75	60	gauss Milliampere per gauss

Note 1: $E_b = 100$ volts d-c; the field strength is adjusted for a plate current of 8.0 milliamperes.

Note 2: The sensitivity of this point is equal to $\Delta I_p / \Delta H$ (H = field strength) for small variations of H .

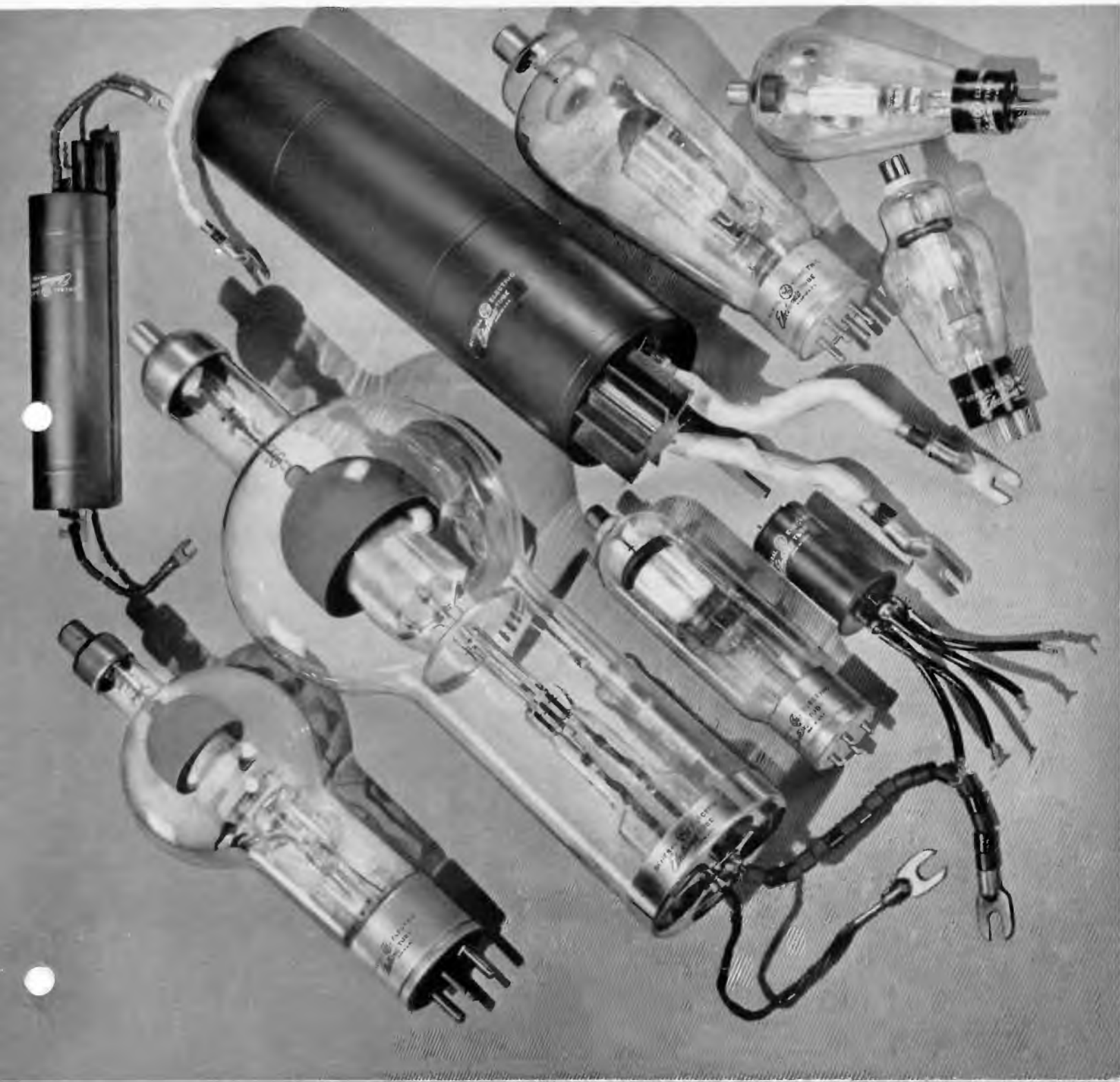
* Not more than 10 per cent of the tubes may be outside the limits shown for this test.

PHANOTRONS

GENERAL  ELECTRIC

Supersedes ETI-146 dated 4-45.
Only change on page 6

PHANOTRONS



DESCRIPTION

A phanotron is a thermionic gas tube in which no means is provided for controlling the current flow.

The gas used may be one of the inert gases such as argon, xenon, or helium, or the vapor pressure of a few drops of mercury. The presence of this gas neutralizes, by ionization, the electron space-charge around the cathode created by the electrons emitted from it. This space-charge, which is negative in effect and tends to drive the electrons back into the cathode, is one of the limitations on the amount of current a high-vacuum electronic tube can carry. Another limitation is the ability of the cathode to emit the electrons which comprise the unidirectional current flow. This factor, however, can be controlled by design of an electron emitting source satisfactory for the size of tube required.

The absence of space-charge and its accompany-

ing losses in the phanotron allows larger electrode spacing and smaller-size electrodes for a given current-carrying capacity than is possible with high-vacuum tubes. The elimination of space-charge also permits the use of an electron-emitting cathode of higher efficiency and much larger current-carrying capabilities than otherwise could be used. A gas-filled tube therefore, can carry much higher current than a high-vacuum tube of corresponding dimensions. The vapor pressure, however, is sufficiently low so that the anode can withstand, when negative, the voltages for which the tube is designed.

The phanotron in its most usual form of a half-wave rectifier has two electrodes, an anode and a cathode, although an additional anode may be added if a full-wave rectifier is desired. Since the phanotron will conduct in one direction only, it is most generally used in rectifier circuits.

RATINGS

The ratings of gas-discharge tubes are given in terms of fundamental conditions on the tube itself rather than in terms of any circuit constants. Values for a particular tube are given on the individual tube descriptive sheets, (i.e., in terms of actual anode voltage and current.)

The Maximum Peak Inverse Voltage

is a rating which is common to both phanotrons and thyratrons. It is the highest instantaneous voltage that the tube will safely stand in the direction opposite to that in which it is designed to pass current and depends upon operation within the specified temperature range and within the surge current rating. It should be emphasized that the maximum rating of the tube refers to the actual inverse voltage and not to the calculated values. A cathode-ray oscilloscope or spark gap connected across the tube is useful in determining the actual peak inverse voltage.

The Maximum Instantaneous Anode Current

is the highest instantaneous current that a tube can safely conduct under normal operating conditions in the direction of normal current flow.

The ability of a given tube to conduct this instantaneous current without excessive voltage drop will depend upon cathode heating and condition of the emitting surface.

The Maximum Surge Current

rating is a measure of the ability of a tube to withstand extremely high transient currents; it is also a measure of the stiffness of the anode circuit in which the tube will operate satisfactorily at rated temperature and with maximum peak inverse voltage applied. This rating is intended to form a basis for equipment design in limiting the abnormal currents that occur during short-circuit conditions. It does not mean that the tube can be subjected to repeated

short circuits without the probability of a reduction in life and the possibility of a failure.

The Maximum Average Anode Current

is a rating based on tube heating. It is the highest average current which can be carried continuously through the tube. In the case of a rapidly repeating duty cycle, this may be measured on a d-c meter. Otherwise, it is necessary to calculate the average current over a period not to exceed a definite interval of time which is specified for each design of tube. For example, in a two-tube, 60-cycle rectifier feeding into an inductive load (so that the tube conducts approximately half of the time with a square wave) a tube with maximum instantaneous anode current of 15 amperes, a maximum average current of 2.5 amperes and an integration period of 15 seconds, can carry a series of 15-ampere, 180-degree blocks of current (half the time) for 5 seconds out of each 15 seconds, or a series of 7.5-ampere, 180-degree blocks of current (half the time) for 10 seconds out of each 15 seconds.

In addition to the above ratings, there are a number of other tube characteristics. The voltage drop from anode to cathode is a characteristic which becomes important when the anode supply voltage is low, as it then becomes a large part of the working voltage. The typical voltage drop which may be encountered is included in the tube ratings, and the maximum in the Specifications. This includes the effect of temperature, change during tube life, and variation between individual tubes.

Condensed-Mercury Temperature

is the temperature which controls the mercury-vapor pressure and hence many of the tube characteristics. This is measured on the bulb just above the base, the point where the mercury vapor is condensing within the tube.

Satisfactory tube operation depends upon operating within the specified temperature limits. When the tube is being heated it must be remembered that the *heating time* specified refers only to the

cathode. Sufficient heating must also be allowed to bring the condensed-mercury temperature within limits.

CLASSES OF TUBES

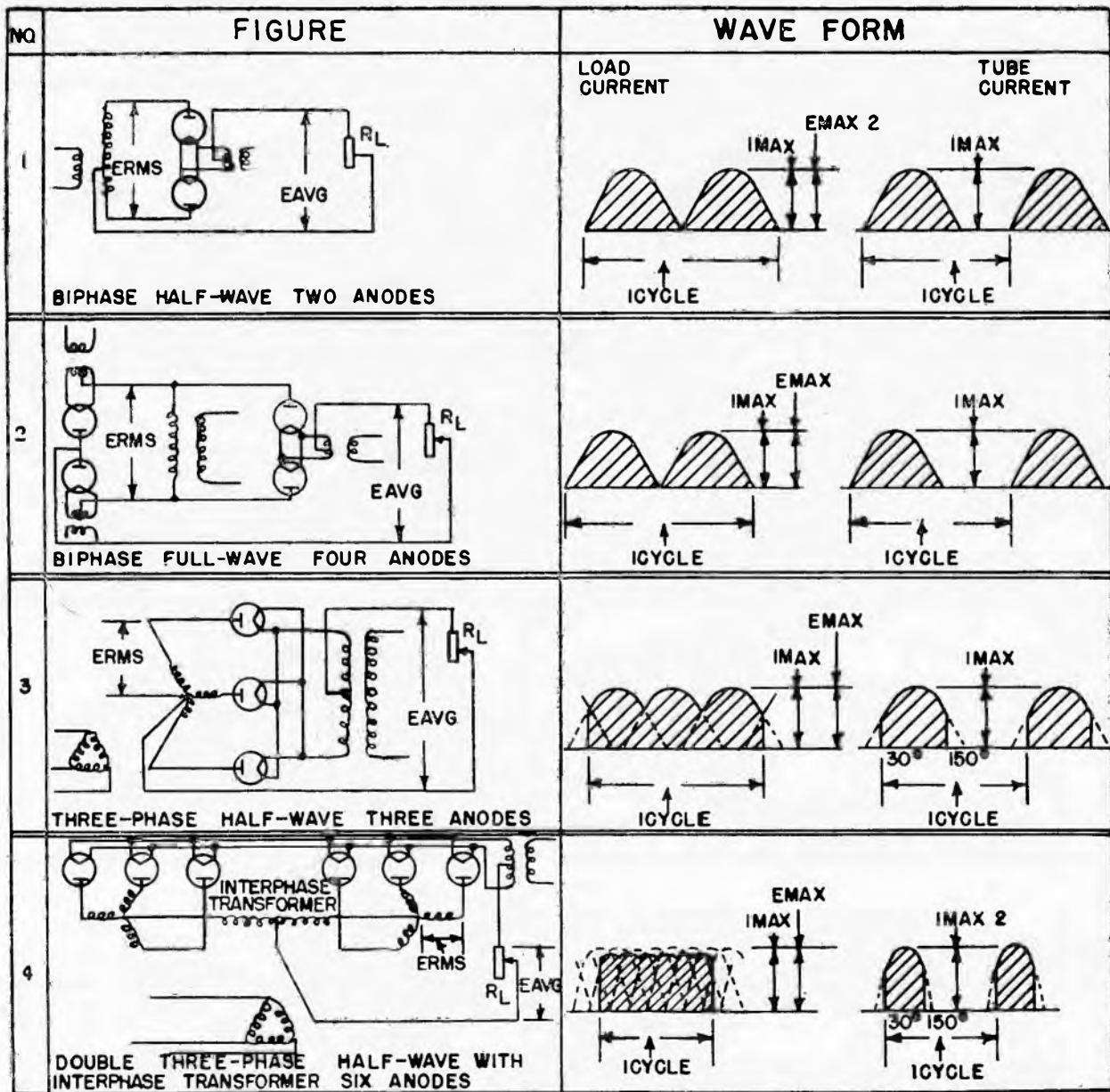
Phanotrons are built in both glass and metal envelopes. The higher voltage tubes use glass construction for ease of insulation. Metal-envelope tubes are adapted for panel mounting whereas the smaller glass tubes are designed for applications where a socket mounting is desirable.

Mercury-vapor phanotrons are available for those applications where the temperature can easily be controlled. Where a wide range of ambient temperature will be encountered, inert-gas-filled tubes should be used.

APPLICATION CIRCUITS#

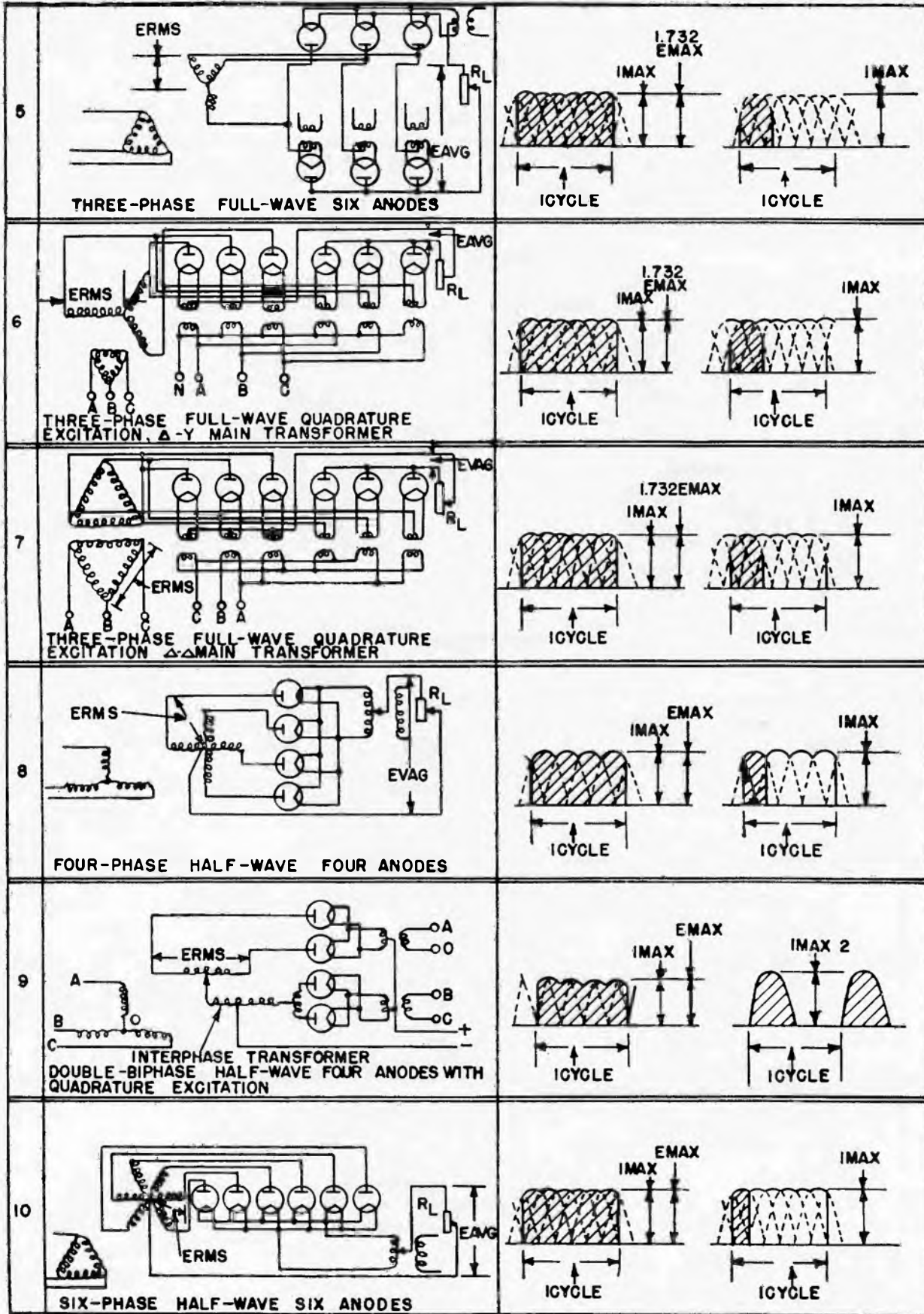
Phanotrons are designed to cover a very wide range of voltages and currents and as a result are suitable for use as rectifiers in many types of electronic applications. In addition to electronic control applications, phanotrons may be used in cir-

cuits where it is desired to supply d-c power for other electronic tubes. Figs. 1 to 10 below illustrate some of the more typical rectifier circuits as well as companion wave forms and useful conversion ratios.



Circuits shown in ETI-146 are examples of possible tube applications and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company.

APPLICATION CIRCUITS (CONT'D)



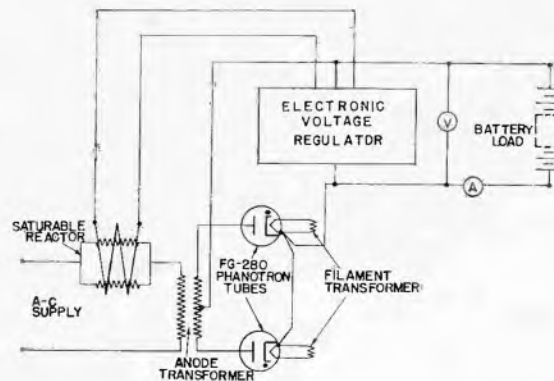
USEFUL RATIOS

FIG. NO.	TUBE I (AVG) LOAD I (AVG)	E-AVG	E-INVERSE	I-AVG
1	0.500	0.318 E-MAX 0.450 E-RMS	E-MAX 3.140 E-AVG	0.636 I-MAX
2	0.500	0.636 E-MAX 0.900 E-RMS	E-MAX 1.570 E-AVG	0.636 I-MAX
3	0.333	0.827 E-MAX 1.170 E-RMS	$\sqrt{3}$ E-MAX 2.090 E-AVG	0.827 I-MAX
4	0.167	0.827 E-MAX 1.170 E-RMS	$\sqrt{3}$ E-MAX 2.090 E-AVG	0.827 I-MAX
5	0.333	1.650 E-MAX 2.340 E-RMS	$\sqrt{3}$ E-MAX 1.050 E-AVG	0.955 I-MAX
6	0.333	1.650 E-MAX 2.340 E-RMS	$\sqrt{3}$ E-MAX 1.050 E-AVG	0.955 I-MAX
7	0.333	0.955 E-MAX 1.340 E-RMS	E-MAX 1.050 E-AVG	0.955 I-MAX
8	0.250	0.900 E-MAX 1.274 E-RMS	2.220 E-AVG	0.900 I-MAX
9	0.250	0.318 E-MAX 0.450 E-RMS	3.140 E-AVG	0.318 I-MAX
10	0.167	0.955 E-MAX 1.350 E-RMS	2.090 E-AVG	0.955 I-MAX

APPLICATION CIRCUITS (CONT'D)

Another important application of the phanotron is to supply d-c power for automatic battery charging equipment designed to give voltage regulation over a wide range with a relatively constant current at a set limit. A battery charging circuit is shown in Fig. 11. In circuit design tubes are selected for

specific applications by consideration of the ratings, including peak and average currents to be conducted and peak inverse voltages applied. When a tube has been chosen for the application, the Specifications should be consulted to determine the limits of operation.



K-9033806

2-10-45

Fig. 11—Circuit for Phanotron Battery Charger

INSTALLATION

Mechanical

Phanotrons should be mounted in sockets or supports of good quality with connections of sufficient current-carrying capacity, and should be operated

only in a vertical position. A shock-absorbing mounting must be used if the tube is to be subjected to excessive vibration or shock.

Electrical

The cathode should be operated preferably from an a-c source, and must assume operating temperature before electron current is drawn.

An appreciable glow, when plate voltage is not applied, is an indication that the tube is exposed to radio frequency. Such a condition should be corrected; otherwise the tube life and performance will be adversely affected.

Thermal

When a mercury-vapor phanotron is first placed in operation, it is necessary to distribute the mercury properly before anode voltage is applied. This is usually accomplished by applying filament voltage long enough to distill the mercury into the cool-

ing chamber of the tube. The location of the cooling chamber is indicated on the outline drawing by the words "controlling mercury temperature."

The design of equipment should allow the tube to operate within the condensed-mercury temperature limits over the range of ambient temperatures to be encountered.

When mercury-vapor tubes are subjected to low ambient temperatures or when it is desired to reduce the mercury-heating time some form of heat-conserving enclosure should be used. This may be provided with thermostatically controlled shutters and/or heaters to bring the condensed-mercury temperature within the operating range. Heaters should be located so that the normal condensed-mercury region always remains the coolest portion of the tube enclosure.

OPERATION

Cathode Circuit

The cathode voltage should not deviate from the rated* value by more than five per cent. Filament voltage should be set so that voltage fluctuations give an average value equal to the rated filament voltage. Too low a filament voltage may result in a very short life or perhaps immediate failure due to loss of emission. Too high a voltage will shorten the life of the cathode somewhat. During stand-by periods the filament should be operated at normal voltage.

▲ Where quadrature filament excitation is specified, the filament voltage should be 90 ± 30 degrees out of phase with the anode voltage.

Anode Circuit

The peak inverse voltage applied to the anode should never exceed the rated* value. In the usual single-phase circuits, the peak inverse voltage, for sine-wave conditions may be taken as the total anode-transformer secondary voltage (rms value) multiplied by 1.4. The relations between the peak inverse voltage, the direct voltage, and the rms value of alternating voltage depend largely upon the individual characteristics of the rectifier circuit and the power supply. Line surges, keying surges or any other transient or wave-form distortion may raise the actual peak voltage to a value higher than that calculated from the sine-wave voltages of the transformer.

▲ Additional information not previously included.

The instantaneous anode current experienced is affected largely by the characteristics of the output circuit, including a filter if one is used. The instantaneous tube current of full-wave rectifiers using a highly inductive output circuit may approach the d-c reading in the load circuit. If the output circuit is highly capacitive with respect to the tube, the instantaneous current in the tube may be many times the load current. Analysis of the individual circuit is necessary.

The average anode current must not exceed the rated value. With a steady load this may be read directly on a d-c meter. In the case of fluctuating loads, however, the reading should be averaged over a period not exceeding the time shown under *Technical Information.

The duration of the surge current shall not be greater than the time shown on the Technical Information.*

The voltage drop from anode to cathode is so low that it has little effect on the complete circuit except when the anode voltage used is low; hence variations of tube voltage drop with life are not readily apparent. Where uninterrupted service is desired, the tube drop should be checked at regular intervals by means of a cathode-ray oscilloscope or other suitable means. This drop is one criterion of tube condition and a rapid rise from one test to the next may determine failure.

*Note: The Ratings And Characteristics Of A Particular Tube Are Given Under Technical Information On The Description And Rating Sheet For That Tube.

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



PHANOTRON

HALF-WAVE MERCURY-VAPOR

The GL-575-A is a half-wave, mercury-vapor inverse voltages, and to conduct at relatively low rectifier tube designed to withstand high peak applied voltages.

TECHNICAL INFORMATION

GENERAL

Electrical	Minimum	Bogey	Maximum	
<input type="checkbox"/> Cathode—Filamentary				
Filament Voltage	4.75	5.0	5.25	Volts
<input type="checkbox"/> Filament Current at 5.0 Volts	9.0	10.0	11.5	Amperes
Heating Time	30			Seconds
Anode Voltage Drop, typical		10		Volts
⊕Critical Anode Voltage			100	Volts
Mechanical				
Type of Cooling—Convection				
Equilibrium Condensed-Mercury Temperature Rise Above Ambient				
At Full Load, approximate			20	C
At No Load, approximate			12	C
Mounting Position—Vertical, Base Down				
Net Weight, maximum			13	Ounces

GENERAL  ELECTRIC

Supersedes ETI-244C dated 10-50

TECHNICAL INFORMATION (CONT'D)

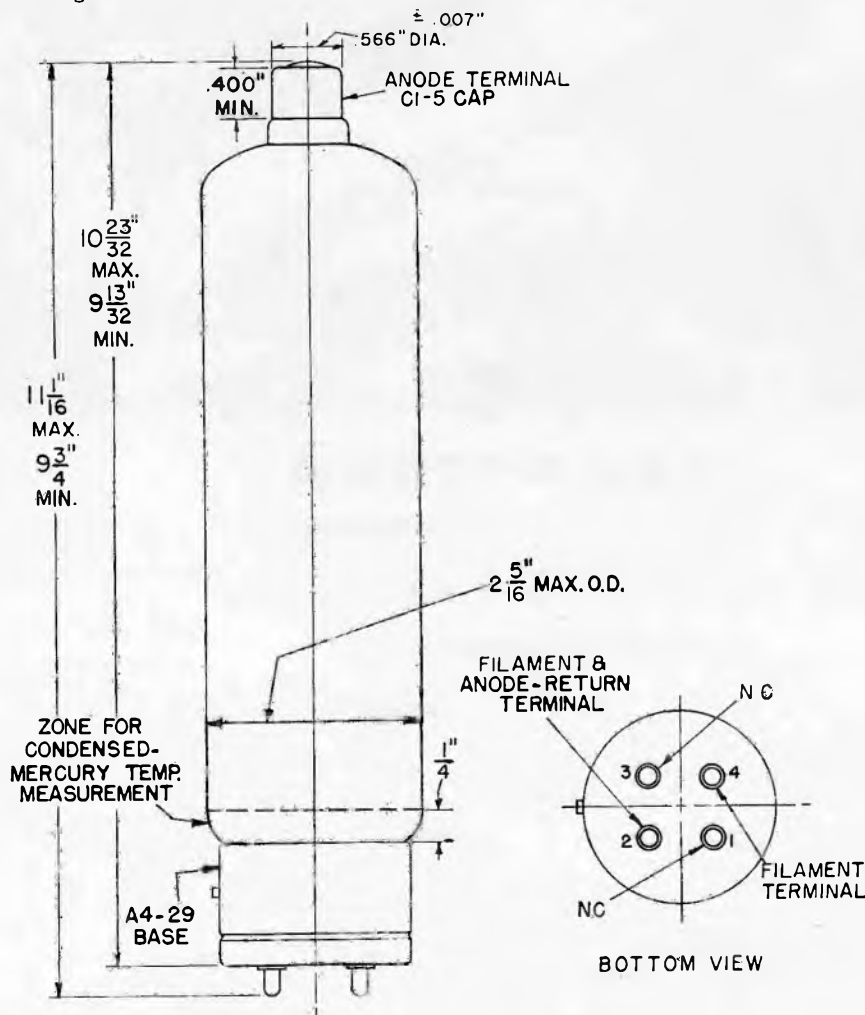
MAXIMUM RATINGS, Absolute Values

Maximum Peak Inverse Anode Voltage.....	10,000	15,000	Volts
Maximum Cathode Current			
□ Peak			
Quadrature Operation.....	10.0	10.0	Amperes
In Phase Operation.....	7.0	6.0	Amperes
□ Average			
Quadrature Operation.....	2.5	2.5	Amperes
In Phase Operation.....	1.75	1.5	Amperes
Fault.....	100	100	Amperes
Maximum Duration.....	0.1	0.1	Seconds
Maximum Averaging Time.....	20	20	Seconds
Frequency.....	150	150	Cycles per Second
Condensed-Mercury Temperature Limits*.....	+20 to +60	+20 to +50	C

*Maximum temperature ratings for intermediate peak inverse voltages may be determined by linear interpolation. When this is done lower current rating applies.

□ Denotes an addition.

⊕ Denotes a change.



N-21500AZ—Outline revised.

12-30-57



PHANOTRON

HALF-WAVE

MERCURY-VAPOR

The GL-673 is a half-wave, mercury-vapor rectifier tube designed to withstand high peak inverse voltages, and to conduct at relatively low applied voltages.

TECHNICAL INFORMATION

GENERAL

Electrical

	Minimum	Bogey	Maximum
Cathode—Filamentary			
Filament Voltage.....	4.75	5.0	5.25 Volts
<input type="checkbox"/> Filament Current, at 5.0 Volts.....	9.0	10.0	11.5 Amperes
Heating Time.....	30	—	— Seconds
Anode Voltage Drop, typical.....	—	10	— Volts
⊕Critical Anode Voltage.....	—	—	100 Volts

Mechanical

Type of Cooling—Convection	
Equilibrium Condensed-Mercury Temperature Rise over Ambient	
At Full Load, approximate.....	20 C
At No Load, approximate.....	12 C
Base—Super-Jumbo 4-Pin Bayonet, A4-18.	
Cap—Medium Metal, C1-5.	
Mounting Position—Vertical, Base Down	
⊕Net Weight, approximate.....	13 Ounces

GENERAL  ELECTRIC

Supersedes ETI-243B dated 10-50

TECHNICAL INFORMATION (CONT'D)

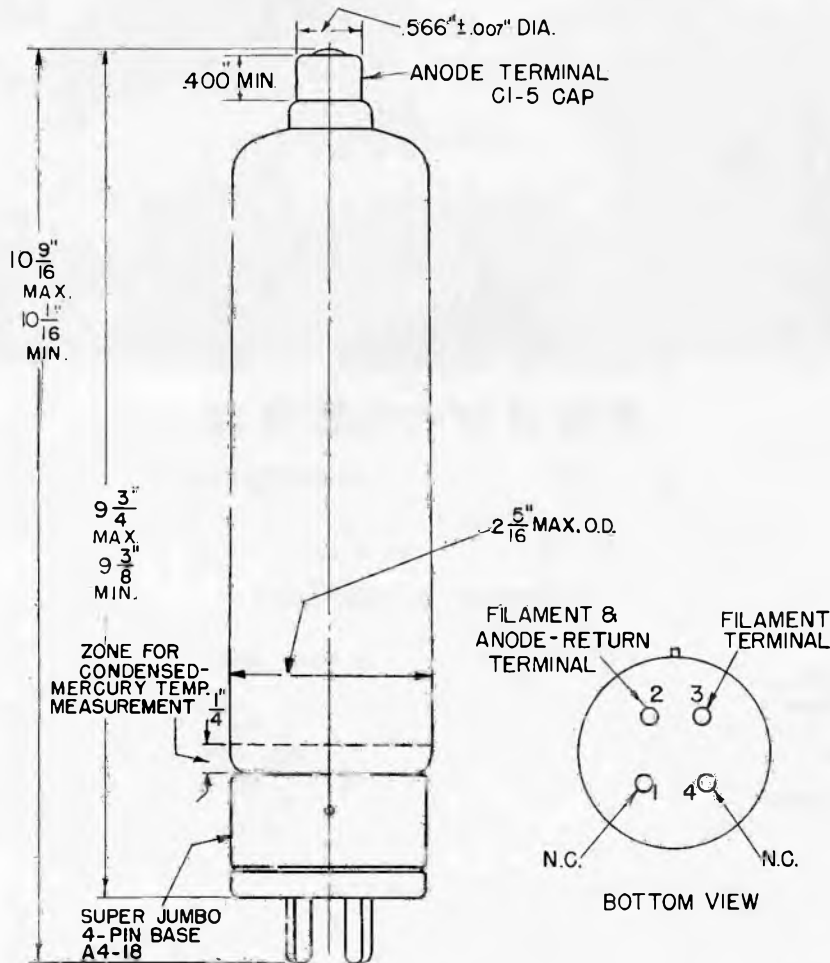
MAXIMUM RATINGS, Absolute Values

Maximum Peak Inverse Anode Voltage.....	10,000	15,000 Volts
Maximum Cathode Current		
□ Peak		
Quadrature Operation.....	10.0	10.0 Amperes
In Phase Operation.....	7.0	6.0 Amperes
□ Average		
Quadrature Operation.....	2.5	2.5 Amperes
In Phase Operation.....	1.75	1.5 Amperes
⊕ Fault.....	100	100 Amperes
Maximum Duration.....	0.1	0.1 Seconds
Maximum Averaging Time.....	20	20 Seconds
Condensed-Mercury Temperature Limits*.....	+20 to +60	+20 to +50 C
Maximum Frequency.....	150	150 Cycles per Second

*Maximum temperature ratings for intermediate peak inverse voltages may be determined by linear interpolation. When this is done lower current rating applies.

□ Denotes an addition.

⊕ Denotes a change.



N-21501AZ—Outline revised

12-30-57

ELECTRONIC COMPONENTS DIVISION



Schenectady 5, N. Y.

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PHATRON

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.

TECHNICAL INFORMATION

GENERAL

Electrical	Minimum	Bogey	Maximum
<input type="checkbox"/> Filament Voltage	4.75	5	5.25 Volts
<input type="checkbox"/> Filament Current at 5 Volts	—	30	33 Amperes
Cathode Heating Time	60	—	— Seconds
Anode Voltage Drop	—	15	— Volts
<input type="checkbox"/> Critical Anode Voltage	—	—	100 Volts
Mechanical			
Type of Cooling—Convection or Forced Air			
<input type="checkbox"/> 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			
<input type="checkbox"/> Net Weight, maximum			3.5 Pounds

TECHNICAL INFORMATION (CONT'D)

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

□ Denotes an addition.

@ Denotes a change.

□ X-RAY WARNING NOTICE

If the GL-857-B 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:

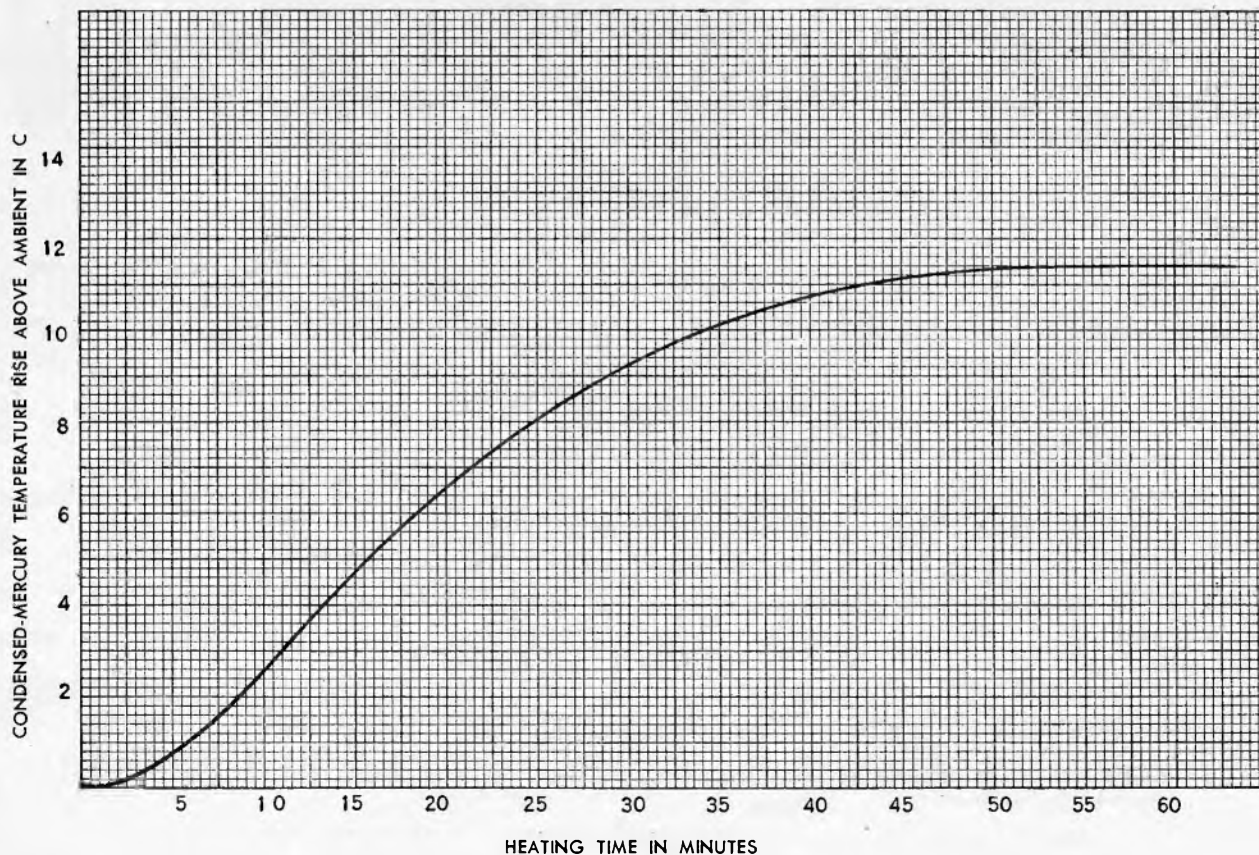
(a) *X-Ray Protection Design*, Handbook No. 50. National Bureau of Standards, Washington, D. C.

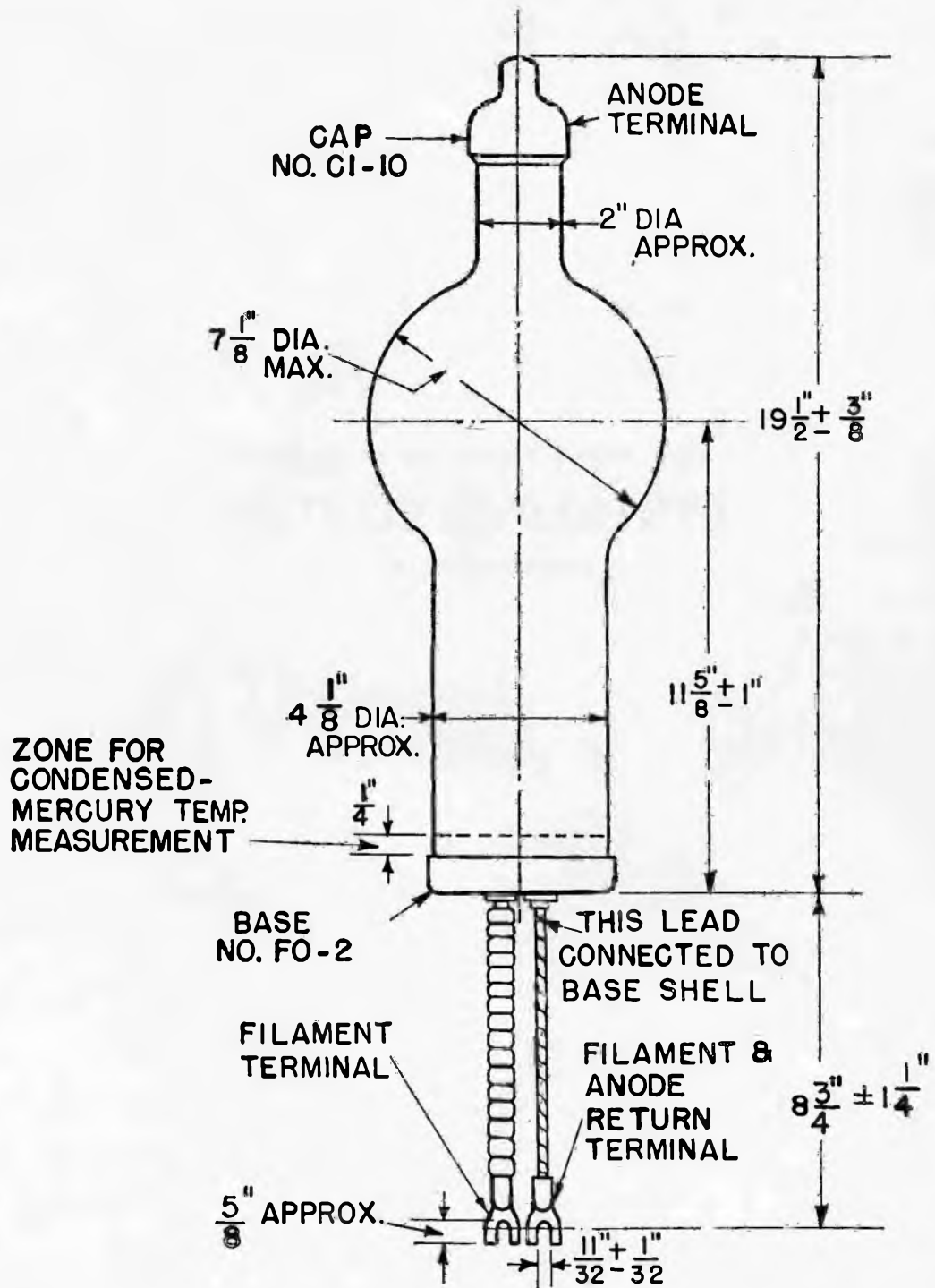
(b) *X-Ray Protection*, Handbook No. 60. National Bureau of Standards, Washington, D. C.

The above references are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

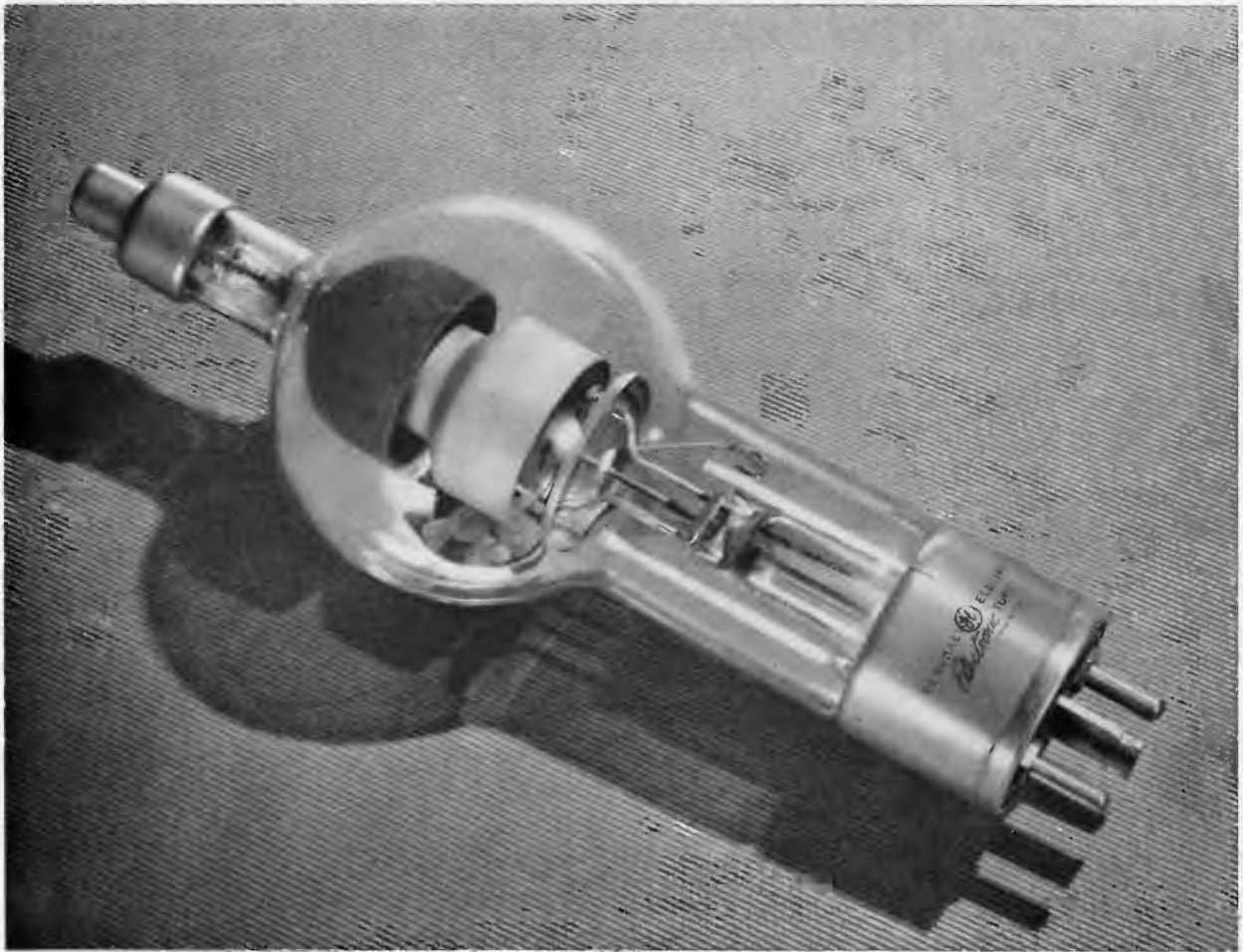
RATE OF RISE OF
CONDENSED-MERCURY TEMPERATURE

$E_r = 4.75$ VOLTS





ELECTRONIC COMPONENTS DIVISION
GENERAL  ELECTRIC
Schenectady 5, N. Y.



PHATRON

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 re-

quired. The cathode is designed for economical, long-life operation.

TECHNICAL INFORMATION

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

TECHNICAL INFORMATION (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

Denotes an addition.

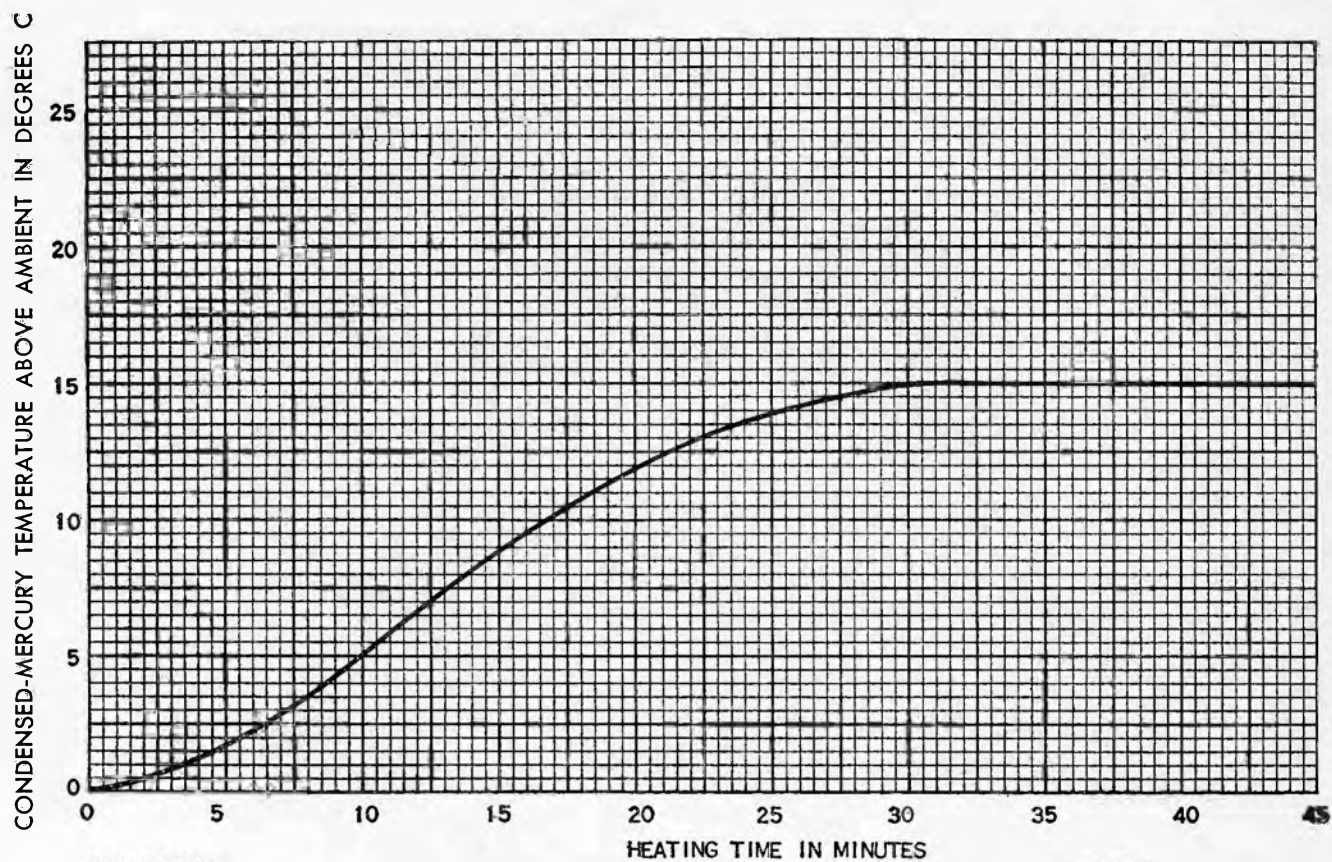
X-RAY WARNING NOTICE

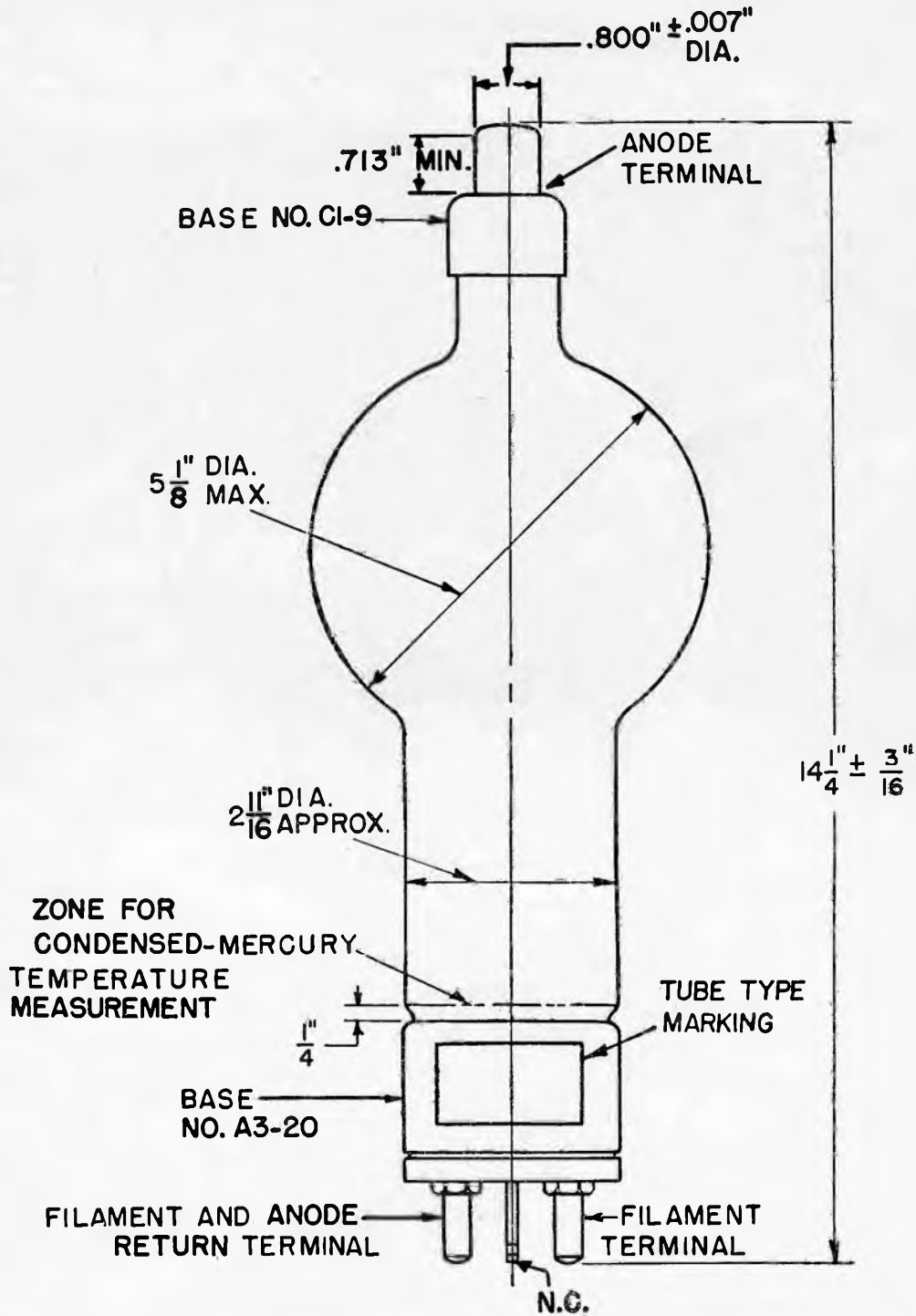
If the GL-869-B is operated at anode voltages in excess of 16 kilovolts, x-ray radiation shielding may be necessary to protect the user against possible danger of personal injury from prolonged exposure at close range. For further information consult the following references or other standard texts on 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.

RATE OF RISE OF
CONDENSED-MERCURY TEMPERATURE
 $E_f = 4.75$ VOLTS





K-4909011

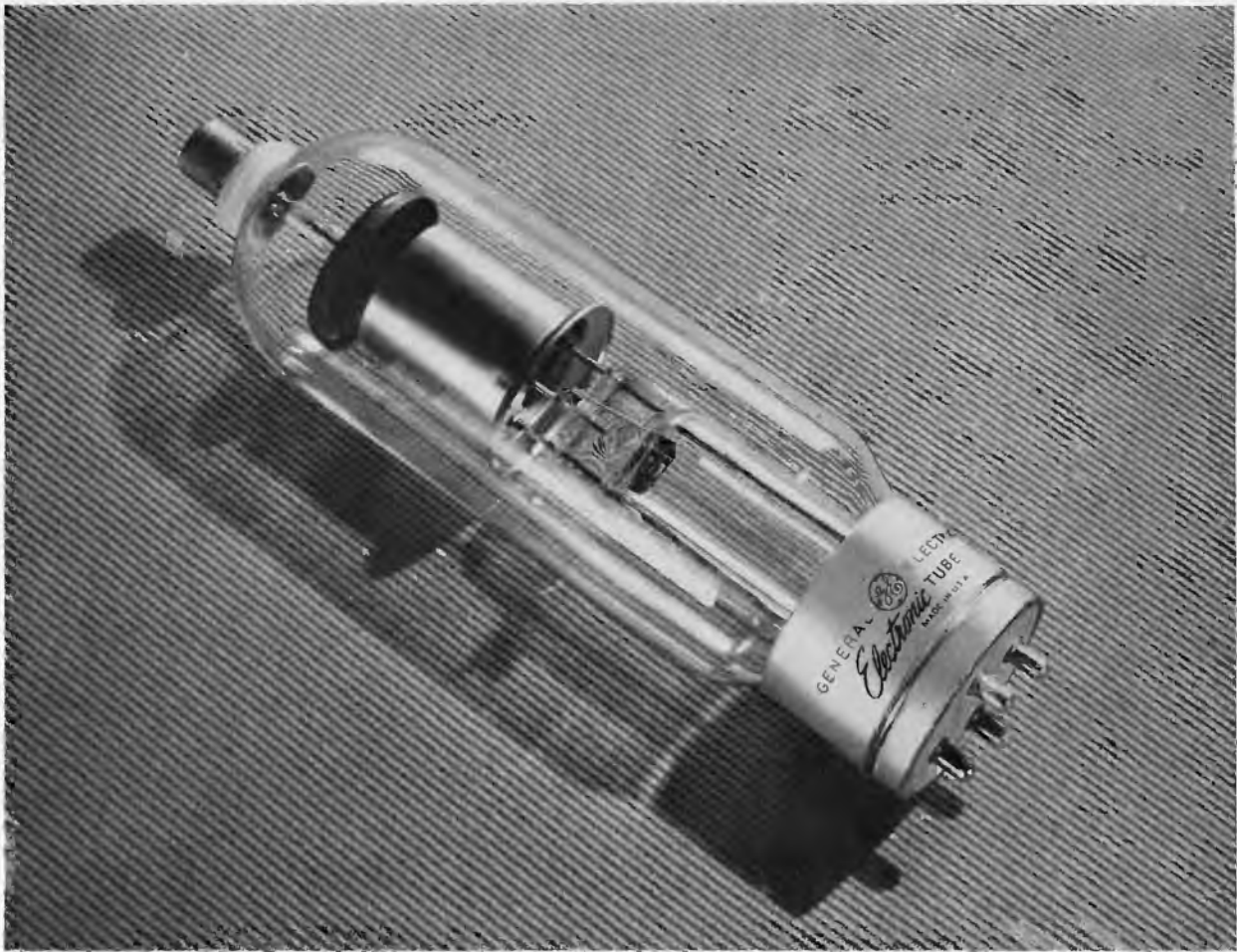
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ELECTRONIC COMPONENTS DIVISION

GENERAL  ELECTRIC

Schenectady 5, N. Y.

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U.S.A.



PHANOTRON

The GL-872-A is a mercury-vapor, half-wave rectifier for use in high-voltage rectifier circuits.

TECHNICAL INFORMATION

GENERAL

Electrical	Minimum	Bogey	Maximum
Filament Voltage	4.75	5.0	5.25 Volts
Filament Current at 5.0 Volts		7.5	8.0 Amperes
Cathode Heating Time Required	30		Seconds
Anode Voltage Drop, typical		15	Volts
Critical Anode Voltage			50 Volts
Mechanical			
Type of Cooling—Convection			
Equilibrium Condensed-Mercury-Temperature Rise Above Ambient			
At Full Load, approximate . . . . .			.20 C
At No Load, approximate . . . . .			.14 C
Mounting Position—Vertical, Base Down			
Net Weight, maximum . . . . .			.75 Ounces

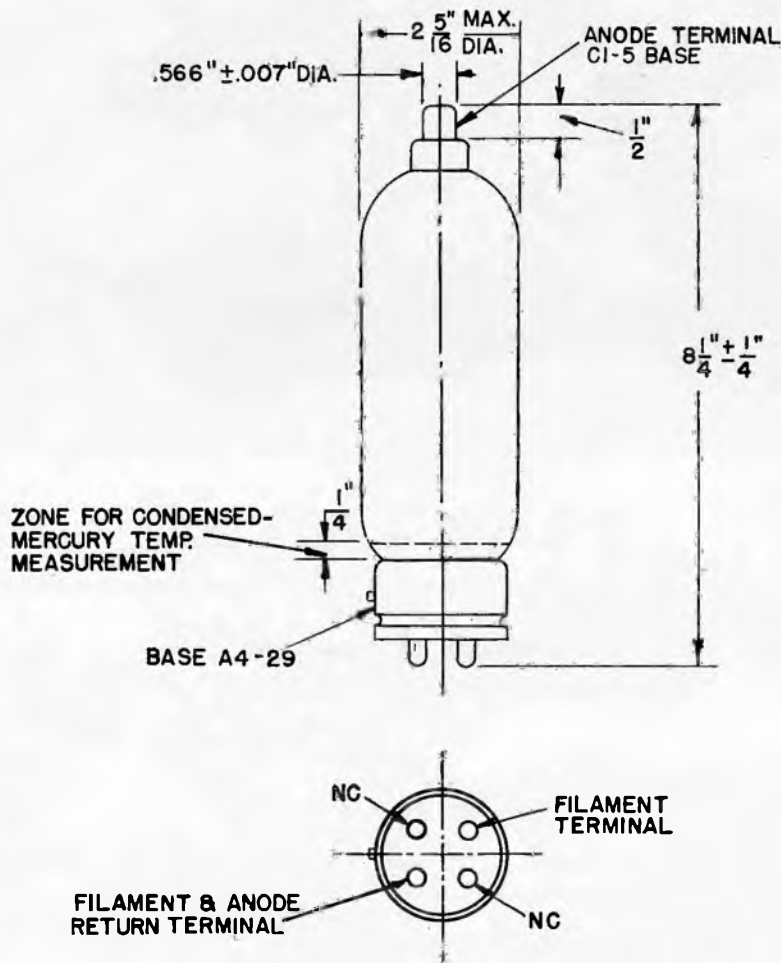
GENERAL  ELECTRIC

Supersedes ETI-155B dated 3-50

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS, Absolute Values

Maximum Peak Inverse Anode Voltage.....	5000	10,000	Volts
Maximum Cathode Current			
Peak.....	5.0	5.0	Amperes
Average.....	1.25	1.25	Amperes
Maximum Averaging Time.....	15	15	Seconds
Surge.....	50	50	Amperes
Maximum Duration.....	0.2	0.2	Seconds
Maximum Frequency.....	150	150	Cycles per Second
Condensed-Mercury Temperature Limits.....	+20 to +70	+20 to +60C	



K-8639375

8-2-49



PHANOTRON

DESCRIPTION

The GL-5558/FG-32 is a half-wave, mercury-vapor rectifier for converting alternating current to direct current. It is adapted to applications where rectification of higher currents at lower frequencies and voltages is desired than is possible with high-vacuum tubes. In comparison with high-vacuum

tubes the GL-5558/FG-32 has a relatively low and constant voltage drop which is an advantage in low-voltage rectifier applications as it allows more efficient utilization of power and results in lower circuit losses.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Cathode—Indirectly heated			
Heater voltage	4.75	5.0	5.25 volts
Heater current at 5 volts	—	4.5	4.9 amperes
Cathode heating time	5	—	— minutes
Anode voltage drop	—	15	— volts
Critical anode voltage	—	—	50 volts

♦ Completely revised.


Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-147B dated 10-47

TECHNICAL INFORMATION (CONT'D)

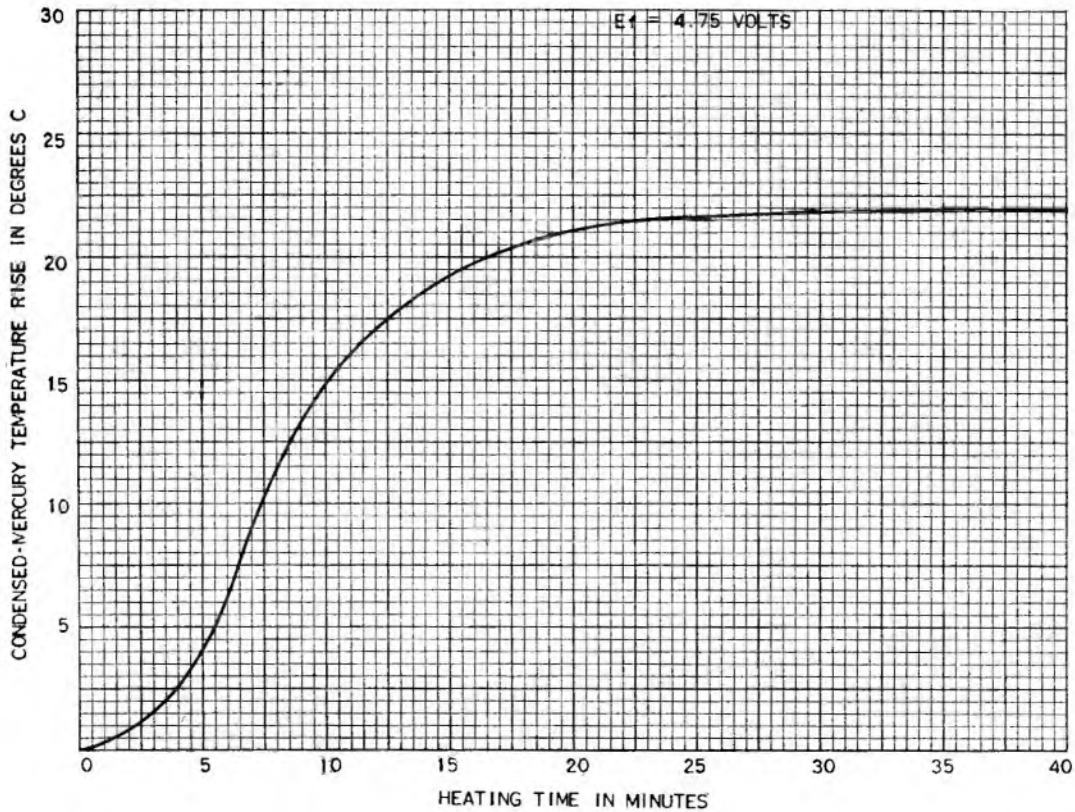
Mechanical Data

Type of cooling—Convection	
Equilibrium condensed-mercury-temperature rise above ambient	
At full load, approximate	28 C
At no load, approximate	22 C
Mounting position—Vertical, base down	
Net weight, maximum	5 ounces

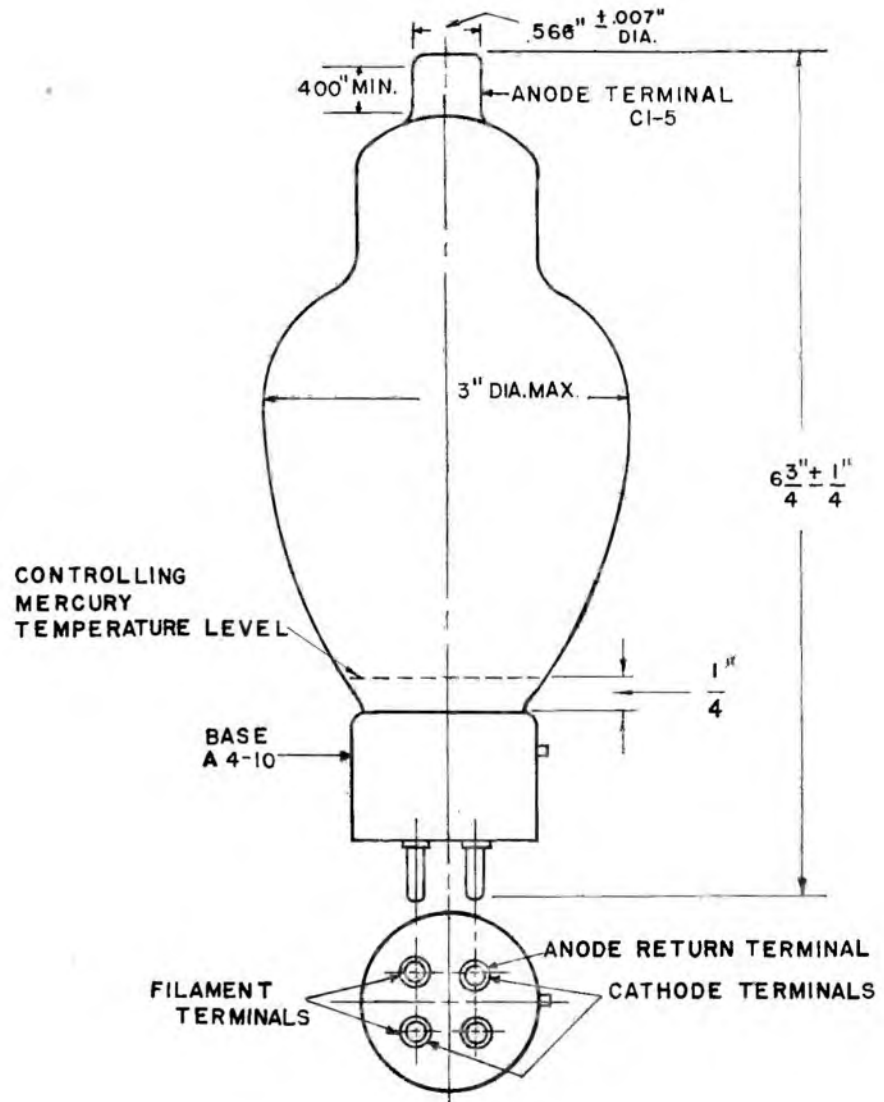
MAXIMUM RATINGS, Absolute Values

Maximum peak inverse anode voltage	2000	5000 volts
Condensed-mercury temperature limits	+30 to +80	+30 to +60 C
Maximum cathode current		
Peak	15	15 amperes
Average	2.5	2.5 amperes
Surge (maximum duration 0.1 second)	200	200 amperes
Maximum averaging time	15	15 seconds
Maximum frequency	150	150 cycles per sec.

GL-5558/FG-32
 RATE OF RISE OF CONDENSED-
 MERCURY TEMPERATURE ABOVE AMBIENT



OUTLINE
GL-5558 / FG-32 PHANOTRON



K-4373333

10-15-45

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



PHANOTRON

DESCRIPTION

The GL-8008 is a half-wave, mercury-vapor rectifier tube designed to withstand high peak inverse voltages and to conduct at relatively low applied

voltages. The ratings are the same as those for the 872-A. The 8008, however, has a Super-Jumbo push-type base.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL DESIGN

Electrical Data	Minimum	Bogey	Maximum
Filament voltage	4.75	5.0	5.25 volts
Filament current at 5.0 volts	7.5	8.0	amperes
Cathode heating time required	.30		seconds
Anode voltage drop, typical		15	volts
Critical anode voltage			50 volts

Mechanical Data

Type of cooling—Convection	
Equilibrium condensed-mercury-temperature rise above ambient	
At full load, approximate	20 C
At no load, approximate	14 C
Mounting position—Vertical, base down	
Net weight, maximum	7.5 ounces

◆ Technical information completely revised.



GENERAL  ELECTRIC

Supersedes ETI-256 dated 12-45

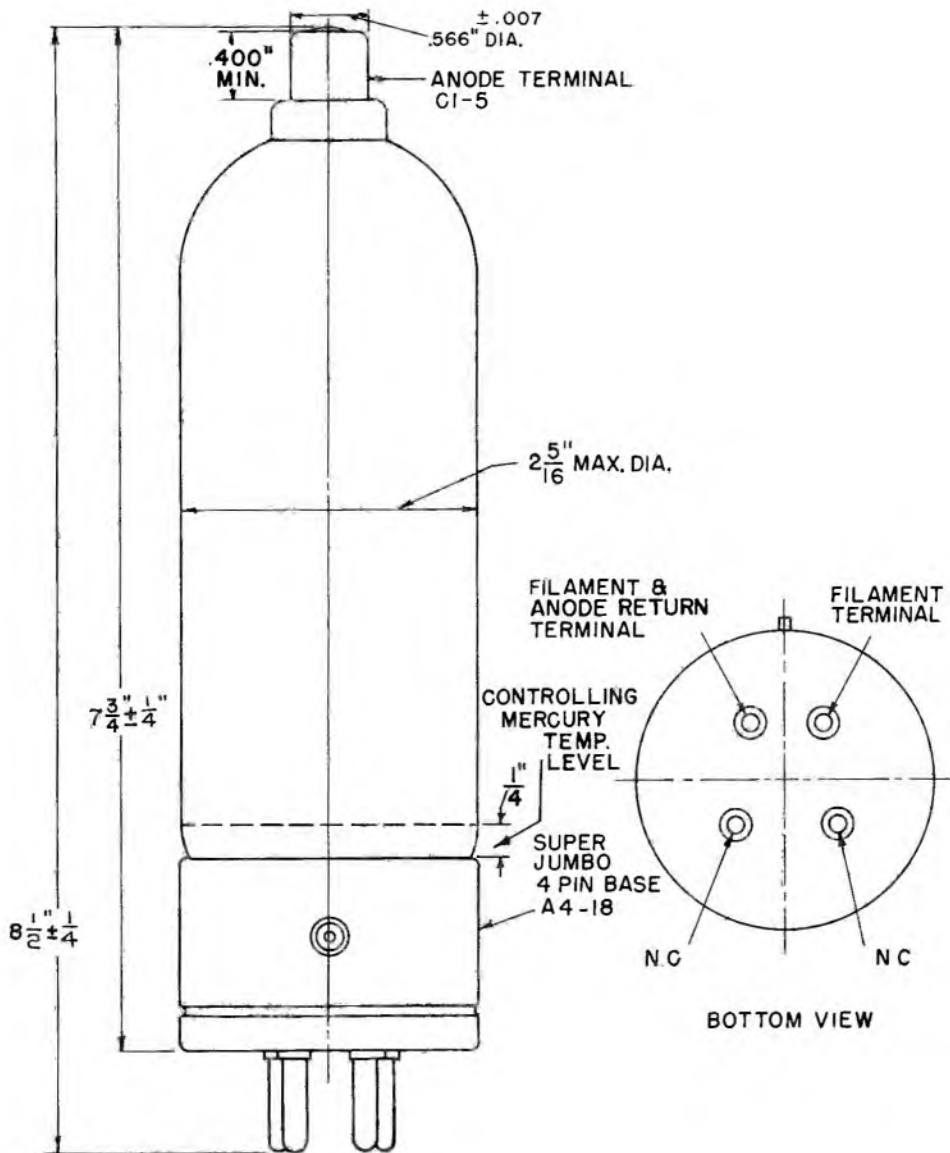
TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS, Absolute Values

Maximum peak inverse anode voltage	5000	10,000	volts
Maximum cathode current			
Peak	5.0	5.0	amperes
Average	1.25	1.25	amperes
Surge (maximum duration 0.2 second)	50	50	amperes
Maximum averaging time	15	15	seconds
Maximum frequency	150	150	cycles per second
Condensed-mercury temperature limits	+20 to +70	+20 to +60	C

OUTLINE

◆ GL-8008 PHANOTRON



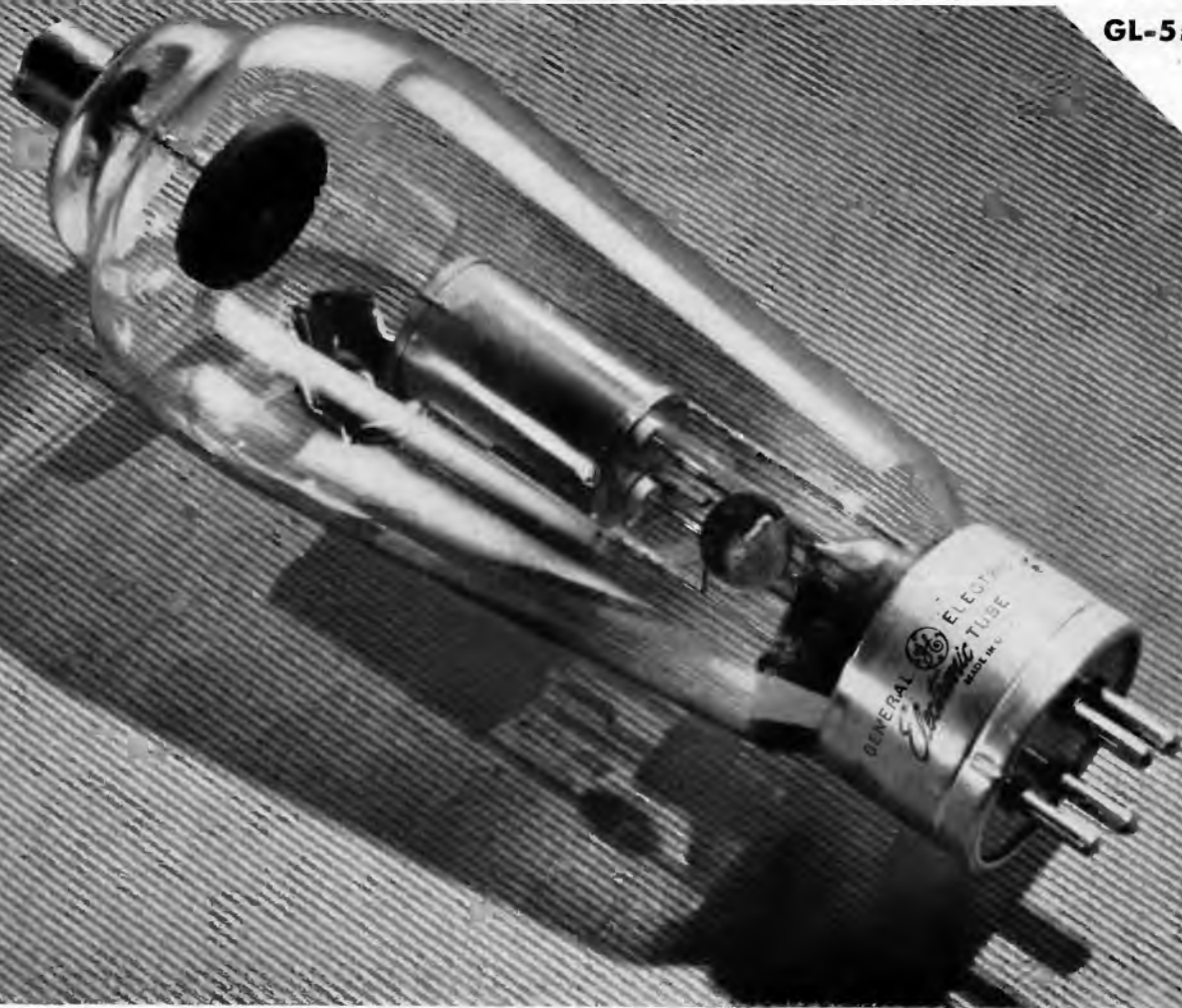
N-21502AZ
◆ Drawing revised.

9-7-45

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PHANOTRON

DESCRIPTION

The GL-5561/FG-104 is a half-wave, mercury-vapor rectifier for converting alternating current to direct current. It is suitable for applications where rectification of higher currents at lower frequencies and voltages is desired than is possible with high-vacuum

tubes. In comparison with high-vacuum tubes, the GL-5561/FG-104 has a low and constant voltage drop which is an advantage in low-voltage rectifier applications since it allows more efficient utilization of power and results in lower circuit losses.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes	2			
Electrical	Minimum	Bogey	Maximum	
Heater voltage	4.75	5.0	5.25	volts
Heater current		10.0	10.75	amperes
Cathode heating time required	300			seconds
Anode voltage drop, typical		15		volts
Critical anode voltage			50	volts
Mechanical Data				
Type of cooling—convection				
Mounting position—vertical, base-down				
Net weight, maximum	1			pound

GENERAL ELECTRIC

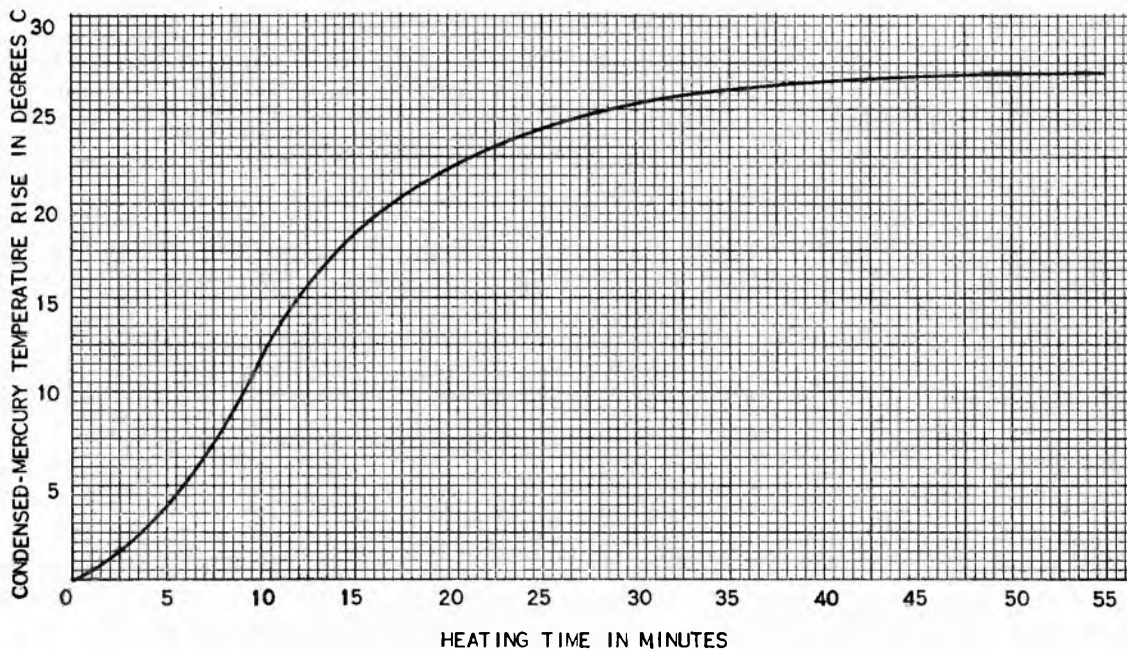
Supersedes ETI-148A dated 10-47

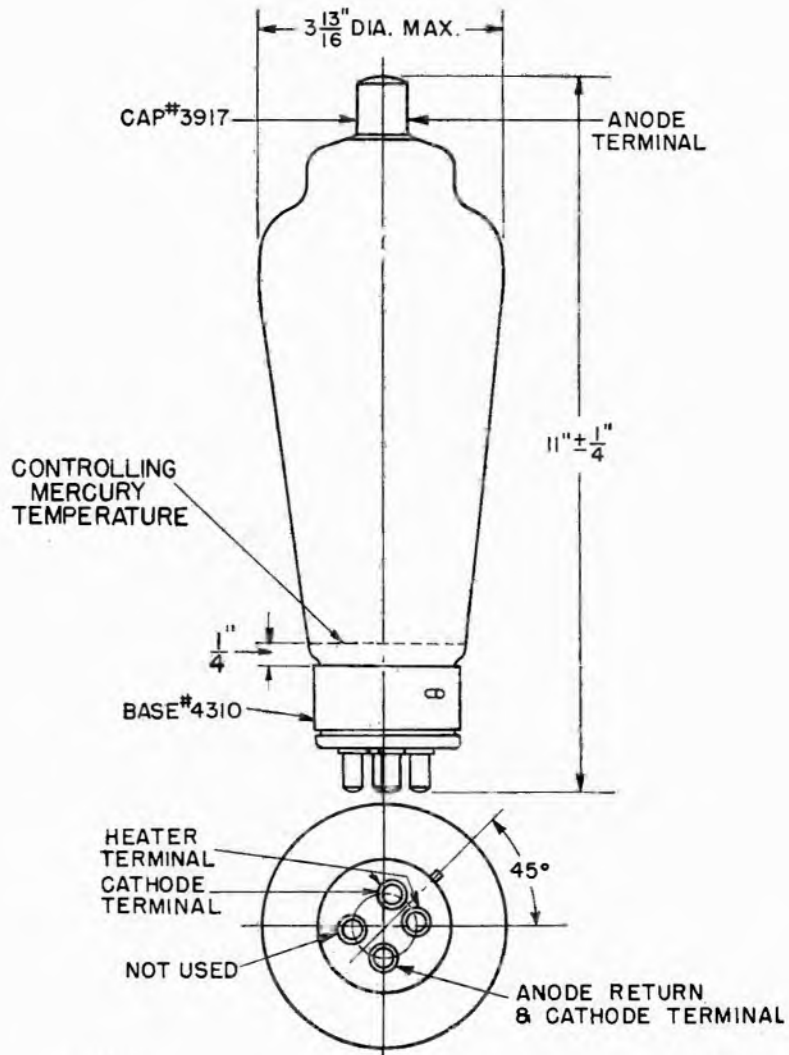
TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS

	Continuous Service	Welder-Control Service
Maximum peak inverse anode voltage	3000	10,000 volts
Maximum anode current		
Instantaneous	40	16 amperes
Average	6.4	4 amperes
Surge anode current, for design only	400	160 amperes
Duration of surge current	0.1	0.1 second
Maximum time of averaging current	15	15 seconds
Temperature limits, condensed mercury	+40 to +80	+25 to +50 centigrade

GL-5561/FG-104
RATE OF RISE OF CONDENSED-MERCURY TEMPERATURE ABOVE AMBIENT





K-4955993

8-5-44

OUTLINE GL-5561/FG-104

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



PHANOTRON

DESCRIPTION

The FG-166 half-wave, all-metal mercury-vapor rectifier is capable of carrying peak currents as high as 75 amperes. It is suitable for rectifiers that supply 125 or 250 to 600 volts in capacities of 15 to 50 kilowatts. The sturdy all-metal construction combines mechanical strength with simplicity of design.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 2

Electrical

Cathode—Filamentary type

Filament voltage 2.5 volts

Filament current, approx 100 amperes

Filament heating time, typical 2 minutes

Optimum phase of filament voltage with respect
to anode voltage 90 degrees

Peak voltage drop 9 volts

Rise of tube temperature above ambient without forced-air circulation

Average anode current 0 amperes
Condensed mercury temperature 30 centigrade

Temperature of side of tube 100 centigrade

Average anode current 20 amperes
Condensed mercury temperature 35 centigrade

Temperature of side of tube 150 centigrade



GENERAL  ELECTRIC

Supersedes ETI-149 dated 4-45

TECHNICAL INFORMATION (CONT'D)

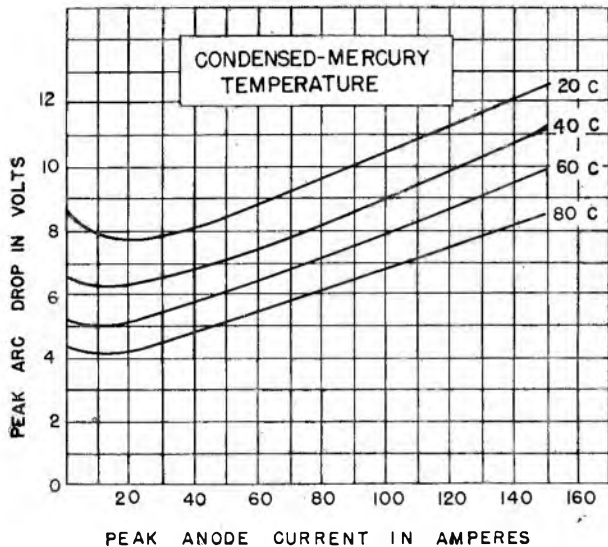
Mechanical

Net weight, approx.	5.5 pounds
Shipping weight, approx.	14 pounds
Mounting position	vertical, with radiator down

MAXIMUM RATINGS

Maximum peak anode voltage	
20 to 60 C condensed mercury	1500 volts
20 to 70 C condensed mercury	800 volts
Maximum anode current	
Instantaneous	75 amperes
Average	20 amperes
Surge, for design only	750 amperes
Maximum time of averaging current	30 seconds
Temperature limits, condensed mercury	+40 to +60 centigrade

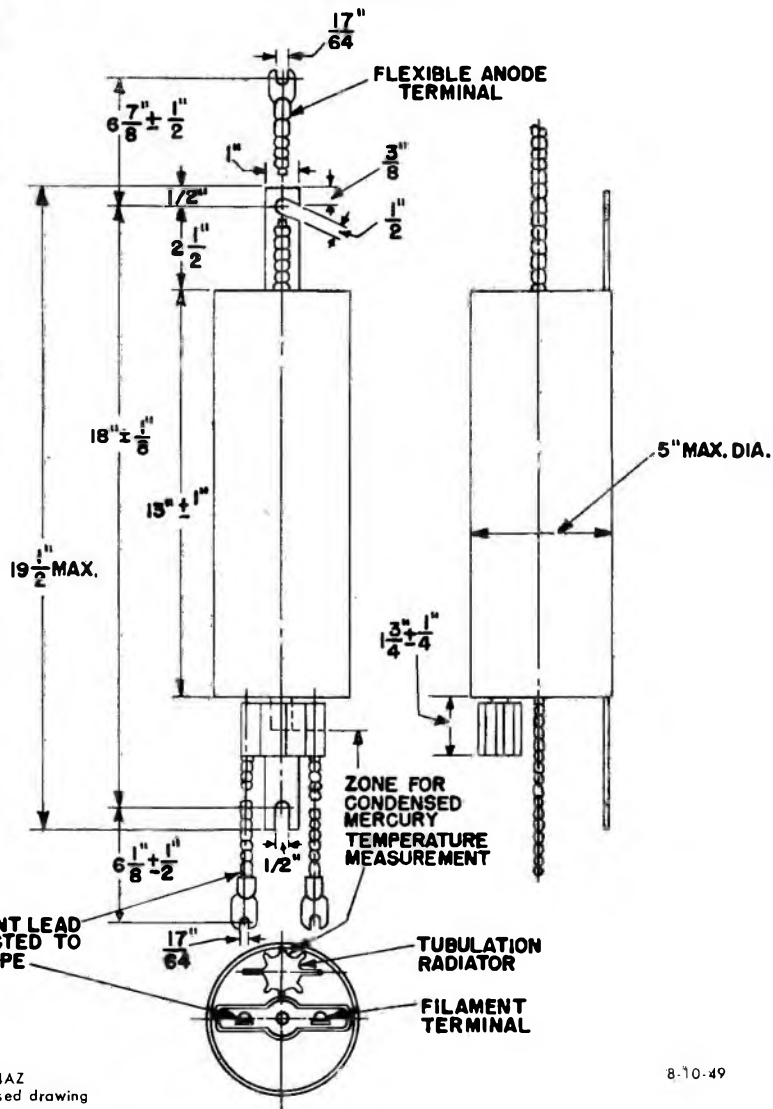
◆ OUTLINE
PHANOTRON FG-166



FG-166 PHANOTRON
PEAK DROP VS PEAK ANODE CURRENT.
AVERAGE VALUES MEASURED FROM FILAMENT TRANSFORMER
MIDTAP TO ANODE

K-6917484

2-10-45



N21.544AZ
◆ Revised drawing

8-10-49

Tube Divisions, Electronics Department

GENERAL ELECTRIC
Schenectady, N. Y.



PHANOTRON

DESCRIPTION

The FG-190 is a gas-filled all-metal tube for use as a full-wave rectifier at low voltages. The use of gas imposes a voltage limitation and tubes of this type

will not carry as high a voltage as mercury tubes of comparable size. They can, however, be operated in much lower ambient temperatures.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes	3
Electrical	
Cathode—Filamentary type	
Heater voltage	2.5 volts
Heater current, approx.	12 amperes
Heating time, typical.	5 seconds
Voltage drop, typical.	8 volts
Pick-up voltage, either anode, typical	14 volts
Mechanical	
Net weight, approx.	6 ounces
Shipping weight, approx.	4 pounds
Mounting position	vertical, with leads down

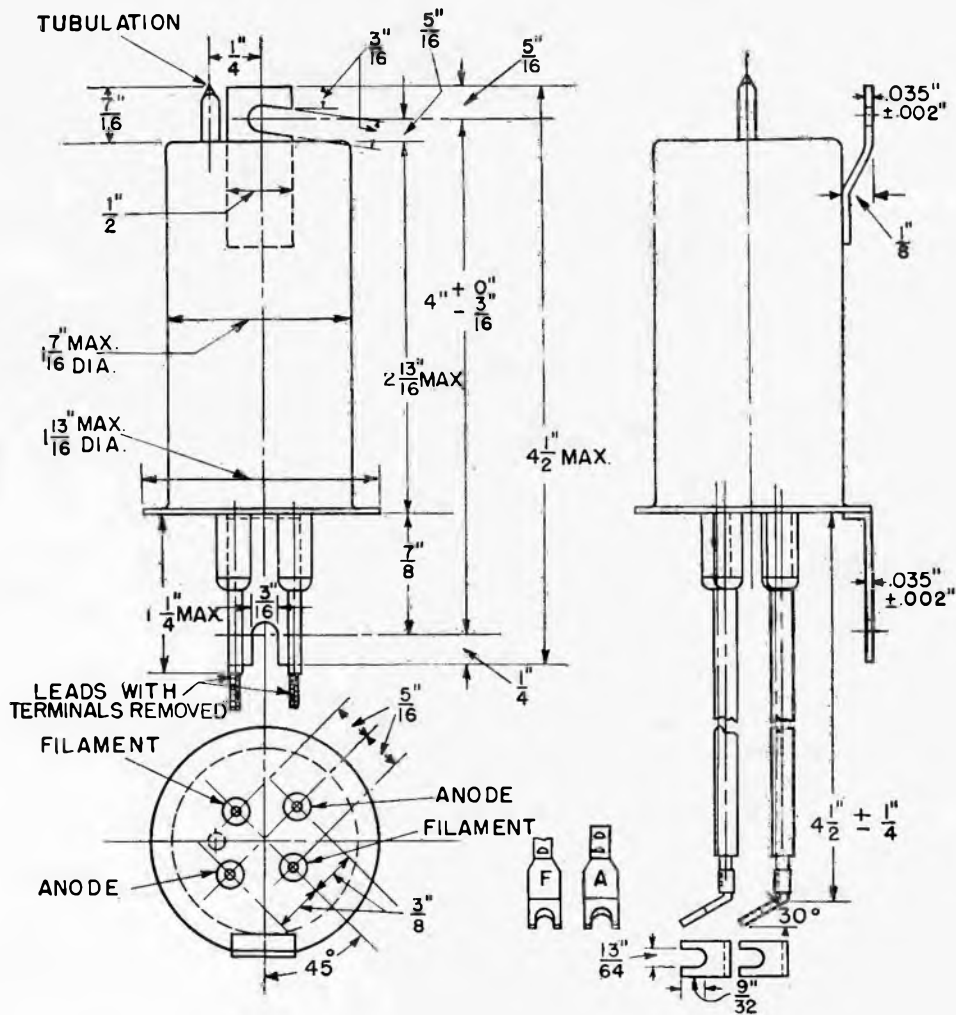

Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS

Maximum peak inverse anode voltage.....	175 volts
Maximum instantaneous anode current	
25 cycles and above.....	5 amperes
Below 25 cycles.....	2.50 amperes
Average anode current.....	1.25 amperes
Surge anode current, for design only.....	20 amperes
Duration of surge current.....	0.1 second
Maximum time of averaging current.....	15 seconds
Ambient temperature limits.....	-20 to +50 centigrade



OUTLINE
FG-190 PHATRON

K-5300039

7-13-44

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



PHANOTRON

DESCRIPTION

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. Economy of operation and high over-all efficiency result from several unique design features incorporated in this tube. The design of cathode allows the further advantage of operation with either in-phase or quadrature filament excita-

tion. In quadrature operation the filament and anode voltages are ninety plus or minus thirty degrees out of phase with each other. Such an arrangement, allowing uniform utilization of the cathode, results in greater uniformity of characteristics than is possible with other methods, and in long tube life.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage.....	4.75	5	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

◆ Technical Information changed throughout.


Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-154A dated 4-48

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Type of cooling—Convection or forced air

Equilibrium condensed-mercury-temperature rise above ambient

At full load, approximate 15 C

At no load, approximate 20 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 degrees 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

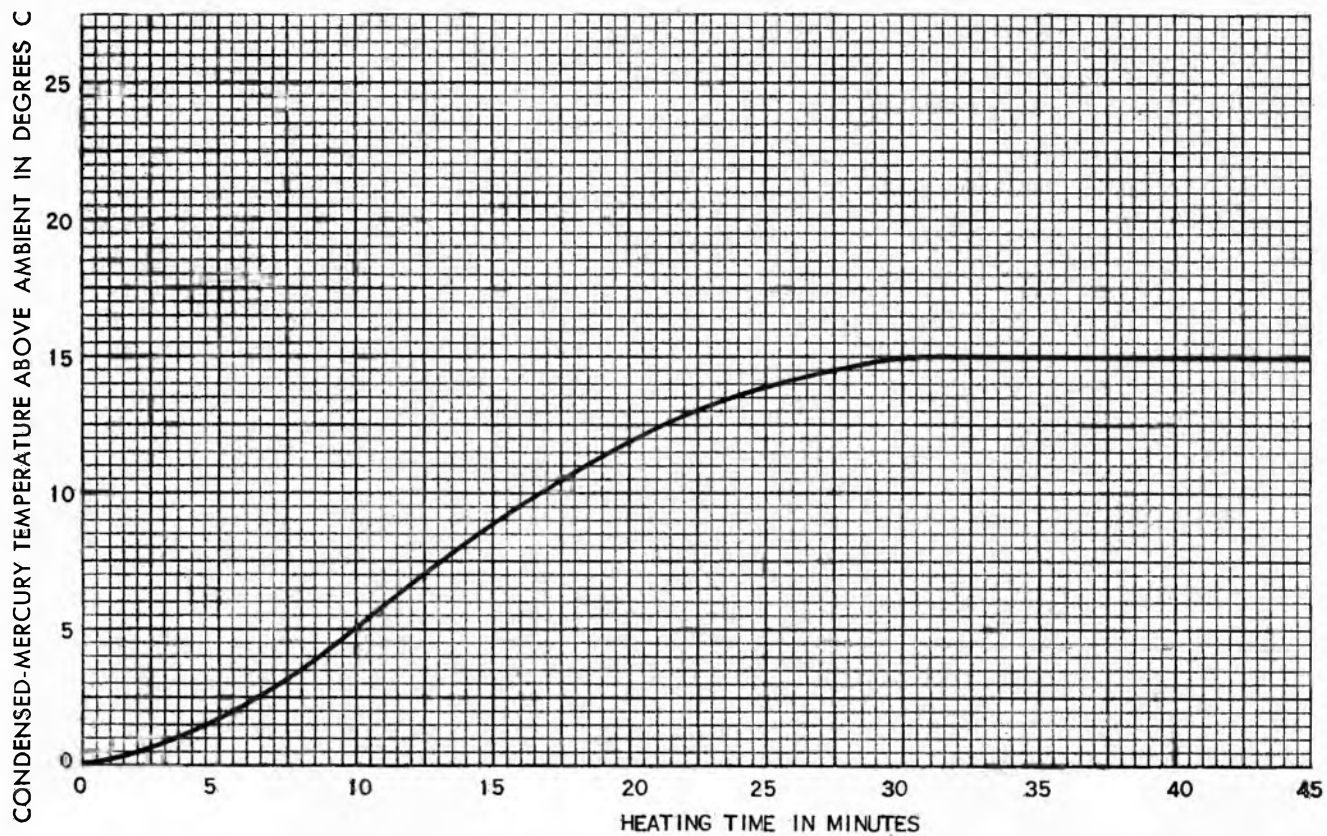
Quadrature operation 5 5 2.5 amperes

Surge (maximum duration 0.1 second) 100 100 100 amperes

Maximum averaging time 30 30 30 seconds

Maximum frequency 150 150 150 cycles per second

▲ GL-869-B
RATE OF RISE OF
CONDENSED-MERCURY TEMPERATURE
 $E_i = 4.75$ VOLTS



K-69087 72A133

2-17-49

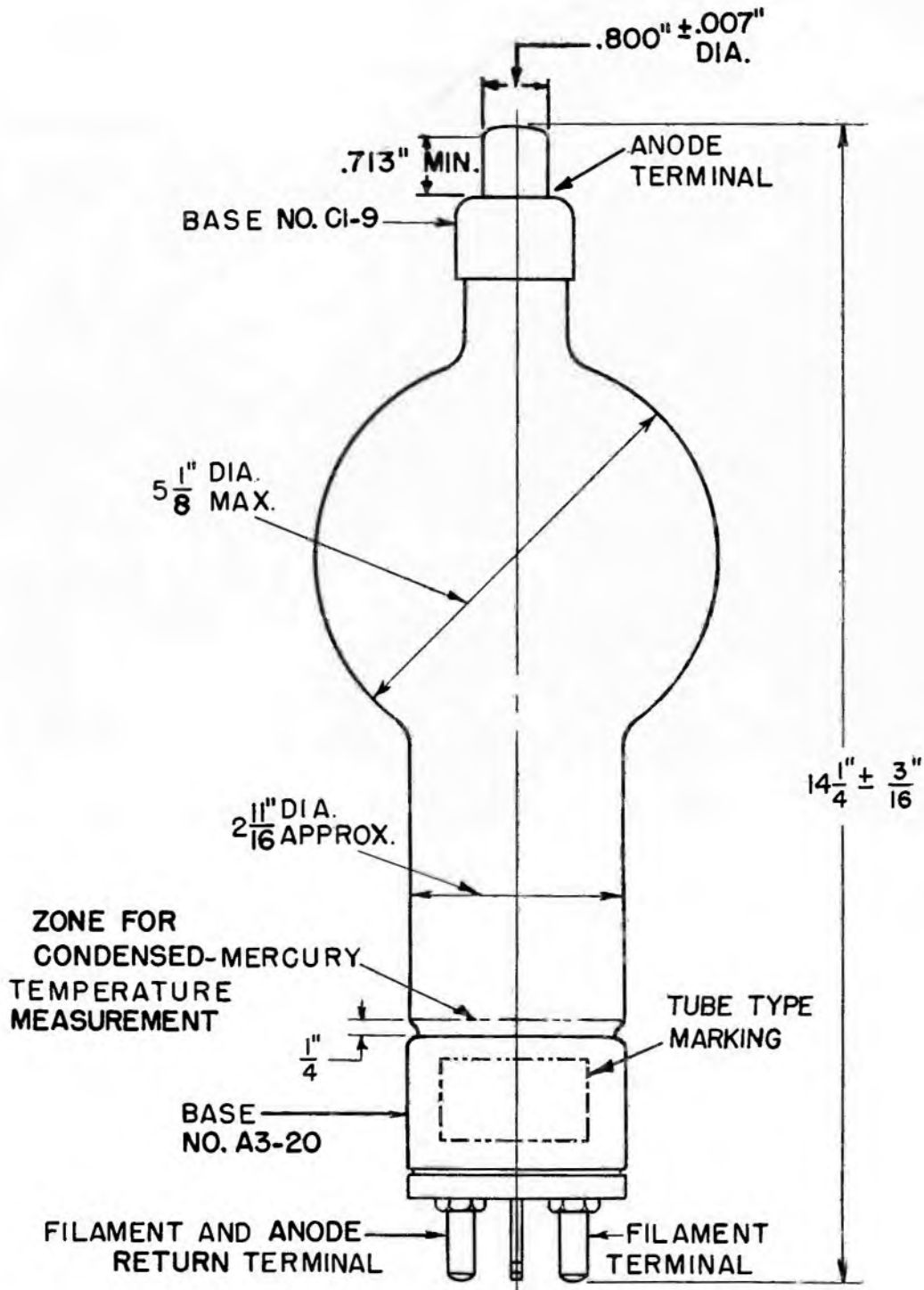
▲ New curve.

GL-869-B

ETI-154B

PAGE 4

5-49



■ OUTLINE
GL-869-B PHANTOTRON

K-4909011

■ Revised outline.

2-17-49

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



PHATRON

DESCRIPTION

The GL-872-A/872 is a half-wave, mercury-vapor rectifier tube designed to withstand high peak inverse voltages, and to conduct at relatively low applied voltages.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 2

Electrical

Cathode—Filamentary type

Filament voltage 5.0 volts

Filament current, approximate 7.5 amperes

Transformer power for design purposes 50 watts

Heating time, typical 30 seconds

Peak voltage drop, typical 10 volts

Mechanical

Type of cooling convection

Net weight 1/2 pound

Shipping weight, approximate 3 pounds

Mounting position vertical, base down



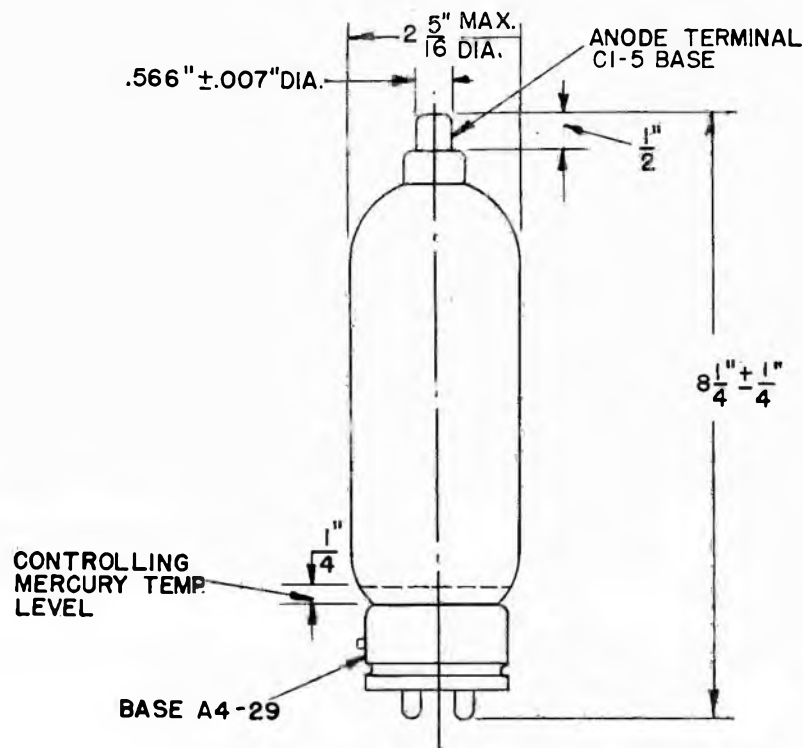
GENERAL  ELECTRIC

Supersedes ETI-155 dated 4-45

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS

Maximum peak inverse anode voltage		
150 cycles or less	.....	5,000 volts
Corresponding condensed-mercury temperature limits	.....	20-70 centigrade
Maximum peak inverse anode voltage		
150 cycles or less	.....	10,000 volts
Corresponding condensed-mercury temperature limits	.....	20-60 centigrade
Maximum anode current		
Instantaneous, 25 cycles and above	.....	5.0 amperes
Average	.....	1.25 amperes
Surge, for design only	.....	.50 amperes
Maximum time of averaging current	.....	.15 seconds
Maximum time of surge anode current	.....	.02 second



K-8639375

3-17-47

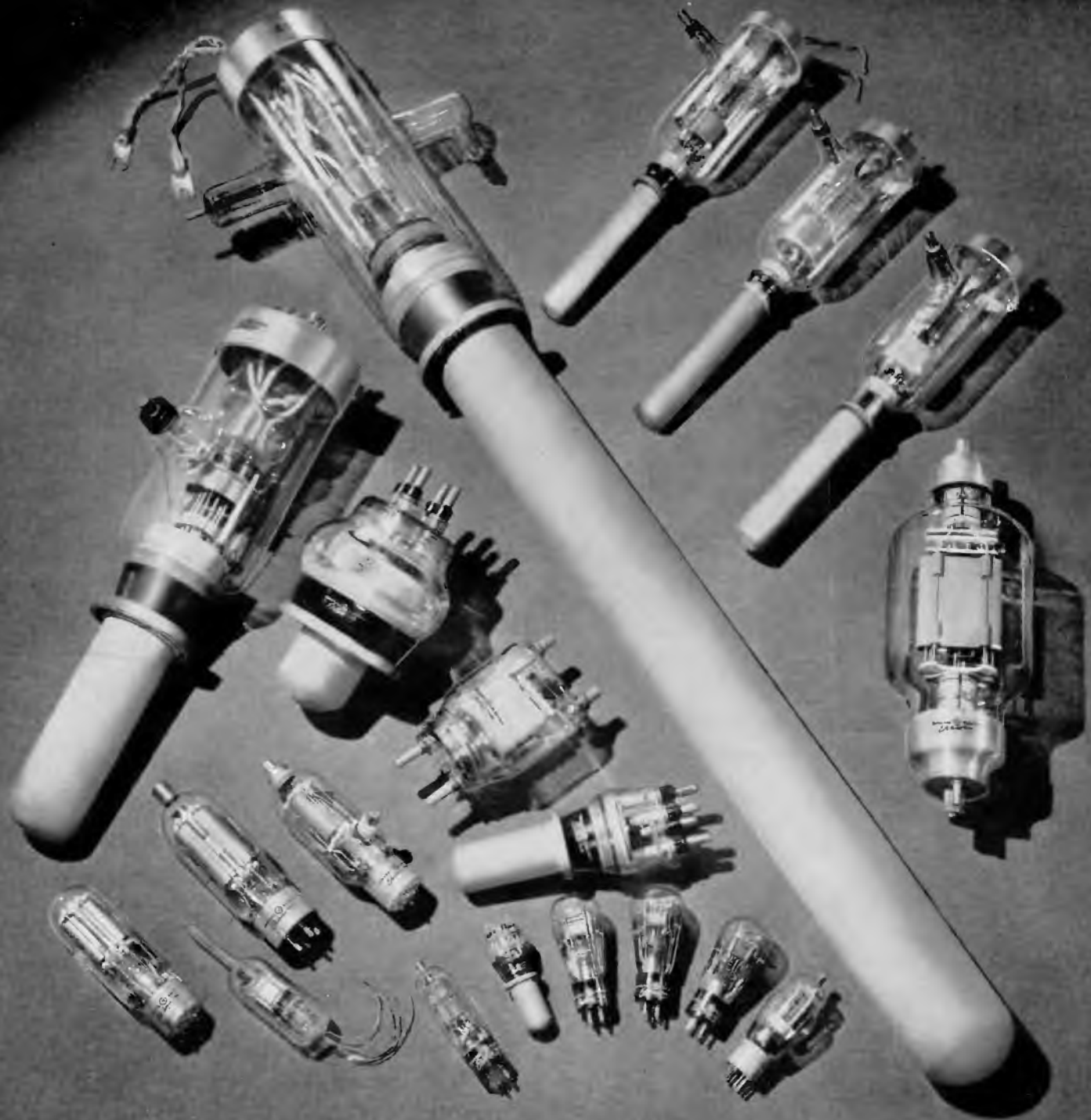
OUTLINE
GL-872-A/872 PHANTOTRON

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.

PLIOTRONS

GENERAL  ELECTRIC

PILOTRONS



DESCRIPTION

A plotron is a high-vacuum thermionic tube in which one or more electrodes are employed to control the unidirectional current flow.

The succeeding paragraphs will describe the fun-

damentals of operation, ratings, classes of tubes, applications, maintenance and operation as well as other qualities which render these tubes particularly useful to industry.

FUNDAMENTALS OF THE PLOTTRON

The plotron is a high-vacuum tube similar to the two-electrode kenotron. The difference lies in the addition of a grid or grids to control current flow to the anode (or plate). In a kenotron rectifier the amount of current which can be passed through the tube at a given positive plate voltage is limited by the building up of a negative space charge around the filament or cathode, caused by the electrons which are leaving it. If a positively charged grid is now interposed between filament and plate, this negative space charge is partially neutralized and more current is allowed to flow to the plate at the same plate potential. Conversely, if the grid is negatively charged, the current is decreased. If the grid is made sufficiently negative, the current flow can be completely cut off. Between the cutoff value of grid voltage and the maximum positive value of grid potential to which it is safe to go, the control of the grid over the plate current is continuous. Since the grid is located closer to the filament than is the plate, a given change in grid potential has a greater effect on plate current than an equal change of plate potential. Thus, the plotron can be used to amplify voltage variations. If the variations of grid potential are maintained in the negative region, substantially no electrons can flow to the grid, so

that it is possible to control considerable amounts of power in the plate circuit with the expenditure of very small amounts of power in the grid circuit. The plotron can, therefore, be used as a very sensitive device.

Since the plotron can amplify power, it is possible to make it generate sustained oscillations by feeding back a fraction of the power in the plate circuit to the grid circuit. Such an arrangement is commonly termed an oscillator.

From the foregoing discussion, it can be seen that plotrons may be used in a variety of ways. No one design is best fitted for all of these uses, each is designed for particular types of service, and a wide variety is available.

Since a plotron is exhausted to a high degree of vacuum, its operation is not limited by the vapor pressure of a condensable medium within and the permissible range of ambient temperature is thereby increased. Unlike gas- or vapor-filled grid-controlled tubes, the plotron is designed to control both the starting and stopping of plate current and may be used to generate or control very high frequencies. It is, therefore, possible to obtain continuous control of plate current even with a positive d-c plate potential.

DEFINITIONS OF HIGH-VACUUM TUBE RATINGS

General

When the terms used in the rating of high-vacuum tubes are considered, it is important to realize that the application of the limits and values given for a particular tube depends upon the operating conditions. Any nominal rating can apply to one set of conditions and not to all the conditions encountered in practice.

For certain high-vacuum tubes two sets of ratings are given one designated as CCS (Continuous Commercial Service) and the other as ICAS (Intermittent Commercial and Amateur Service).

The former are for use in applications where the prime consideration is reliability of performance and long life. The latter can be used in applications where the service is intermittent in nature, i.e., where the operating period does not exceed five minutes and where this period of operation is followed by a standby period of at least the same duration. Although ICAS ratings are higher than those recommended for CCS and permit the use of greater power they do result in a decrease in tube life below what may be expected with CCS operation.

The cathode or filament information is given in terms of normal heating voltage. A current figure to indicate transformer rating is also given. The filament or cathode, except in unusual cases, should always be operated at this rated voltage rather than at rated current and the voltage should be adjusted so that the normal fluctuation in line voltage averages around this point. Normally, when this is done a plus or minus variation of five per cent heating voltage is allowable.

The maximum plate voltage of a plotron is the highest d-c plate voltage which the plotron can safely withstand. Equipment using these tubes should be so designed and operated that under no conditions will this value of plate voltage be exceeded. It is, therefore, desirable, when selecting a plotron for a particular application to determine the changes in filament voltage and plate voltage that may be caused by line voltage fluctuation, load variation and manufacturing variations in the associated apparatus. Then, choose an average value of plate voltage so that under the usual operating conditions, the maximum rating will not be exceeded.

The grid ratings are given in terms of the maximum grid voltage and grid current that may be used for a particular class of service.

The plate dissipation rating is determined by the safe operating temperature of the plate which in turn is usually determined by the degree of evacuation possible with the anode material used.

In addition to these ratings there are a number of other tube characteristics. The amplification factor is the ratio of change in plate voltage to a change in control-electrode voltage under such conditions that the plate current remains unchanged and all other electrode voltages remain constant. It is a measure of the effectiveness of control-electrode voltage relative to that of the plate voltage upon the plate current.

The grid-plate transconductance is the quotient of the in-phase component of the alternating current of the plate by the alternating voltage of the

grid, all other electrode voltages being maintained constant.

The resonant frequency is the frequency of the grid-plate circuit with the grid and plate of the tube connected together through the shortest possible lead.

The ratings for a particular pliotron are given on the Description and Rating Sheet for that tube.

Classes of Pliotrons

There are three general classes of pliotrons:

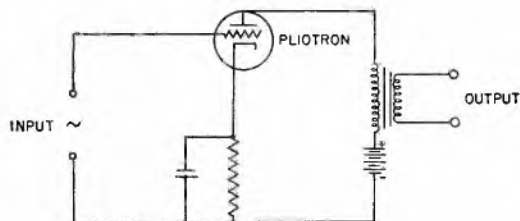
1. Radiation-cooled pliotrons, usually of the glass-envelope type.
2. Forced-air-cooled pliotrons which usually have a radiator to aid in dissipating heat. Such tubes are cooled by an air flow directed against the radiator.
3. Water-cooled pliotrons in which the plate is cooled directly by a flow of water.

APPLICATION CIRCUITS#

Pliotrons are useful in most applications requiring the generation or amplification of audio- or radio-frequency voltages, as well as in many applications which require accurate measurement of small signal voltages and their amplification for control purposes.

The great majority of pliotron applications are covered by six classes of operation designated as Class A audio-frequency, Class AB audio-frequency, Class B audio-frequency, Class B radio-frequency, Class C radio-frequency plated-modulated, and Class C radio-frequency amplifier and oscillator. All pliotrons are not necessarily recommended for each class of service. Some tubes are designed for only one or two classes of service while others may be rated for all types of service.

A Class A amplifier is an amplifier in which the grid bias and alternating grid voltages are such that plate current in a specific tube flows at all times. This class of service gives a large ratio of power amplification but with relatively low efficiency and low output. A typical single tube Class A amplifier is shown in Fig. 1.



K-9033523

Fig. 1—Single Tube Amplifier, Class A

11-15-44

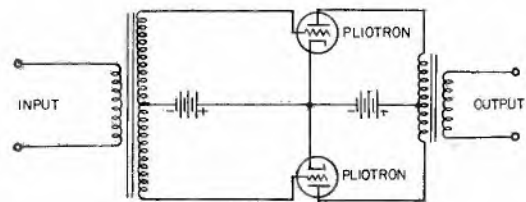
A Class AB audio-frequency amplifier is an amplifier in which the grid bias and alternating

Circuits shown in ETI-156 are examples of possible tube applications and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company.

grid voltages are such that plate current in a specific tube flows for appreciably more than half but less than the entire electrical cycle. This class of service produces a ratio of power amplification and an efficiency intermediate between a Class A and a Class B amplifier. (See Fig. 2.)

A Class B audio-frequency amplifier is an amplifier in which the grid bias is equal approximately to the cutoff value so that for a specific tube, plate current flows for approximately one-half of each cycle with an alternating grid voltage applied. In this service two tubes are used in a "balanced" circuit, each tube conducting only half of the time. This class of service gives a relatively large ratio of power amplification with medium efficiency and output.

Fig. 2 illustrates a typical push-pull circuit which may be used in Class A, AB or Class B amplifier operation.



K-9033526

11-15-44

Fig. 2—Circuit Diagram of Push-pull Amplifier

A Class B radio-frequency amplifier is an amplifier in which the plate is supplied with unmodulated direct voltage, and the grid is excited by modulated radio-frequency voltage. Such an amplifier gives a relatively large ratio of power amplification with medium efficiency and output.

A Class C radio-frequency amplifier—plate modulated, is an amplifier with the plate supply

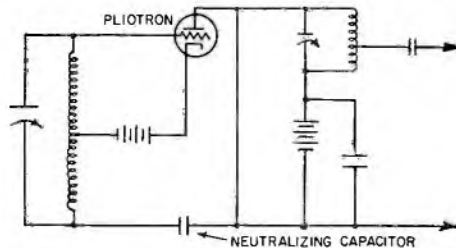
Fig. 2—Terman, F. E., *Radio Engineering*, P.305; McGraw-Hill Book Co., Inc., 1937

voltage modulated so that the tube output is modulated radio-frequency. For this type of service the grid bias is approximately the same as for a Class C amplifier or oscillator. Assuming a value, P, of plate input power to be modulated, the amount of audio-frequency power to be supplied is equal to $\frac{m^2 P}{2}$

where m is the modulation factor. For further information consult the Description and Rating Sheet for the particular type tube in question.

A Class C radio-frequency amplifier or oscillator has the grid bias appreciably greater than the cut-off value so that the plate current in each tube is zero when no alternating grid voltage is applied, and so that the plate current in a specific tube flows for appreciably less than one-half of each cycle when an alternating grid voltage is applied. Such an amplifier gives high efficiency and output with a relatively low ratio of power amplification.

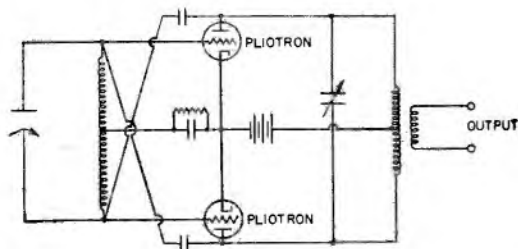
A typical example of a Class C amplifier is given in Fig. 3 which illustrates a direct-coupled Class C amplifier with fixed bias, capacitively coupled load and Rice neutralization (which is a method of neutralizing the effects of the interelectrode capacitance of the tube). Fig. 4 illustrates a neutralized Class C push-pull amplifier with grid-leak bias and an inductively coupled load.



K-9033524

11-15-44

*Fig. 3—Direct-coupled Class C Amplifier with Fixed Bias, Capacitively Coupled Load and Rice Neutralization



K-9033527

11-15-44

*Fig. 4—Neutralized Class C Push-pull Amplifier with Grid Leak Bias and Inductively Coupled Load

When selecting a tube for a particular application and consequently a particular class of service, it is, of course, necessary to be certain that the requirements of the application are within the maximum ratings of the tube as given in the Descrip-

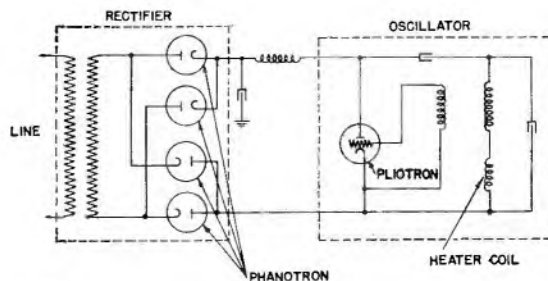
tion and Rating Sheet. The maximum ratings should not be exceeded if satisfactory performance and life are to be realized. The typical values given are not to be considered as ratings, because the tube may be used at any suitable condition within the maximum ratings to secure the required output. The output values are approximate tube outputs, i.e., tube input minus the plate loss. When useful output is calculated, circuit losses must be subtracted from tube output. For this reason the typical values of power output are not to be considered as ratings. The approximate values of grid driving power shown under typical operating conditions are calculated values for a particular instance only and do not include power lost in the circuit or in the bias resistors.

It is advisable to provide sufficient driving power in excess of the circuit losses plus the minimum tube requirements in order to cover the different conditions of operation in the particular application. This is particularly true when the frequency is above that at which full plate input may be employed. It is of course understood that at all times the driving power must be such as not to exceed the maximum allowable peak grid voltage or the maximum d-c grid current. In general, radio-frequency circuits should be arranged to prevent parasitic oscillations so that the tube will not be subjected to excessive voltages and currents. The arrangement of apparatus adjacent to the pliotrons, particularly in the case of high-power or high-frequency applications, should be such that the glass envelope is not subjected to concentrated voltage stress.

The above considerations in the design of radio-frequency circuits, such as the electronic heating and diathermy circuits to follow, will be repaid by increased operating efficiency.

The electronic heating (or induction heating) circuits illustrated in Figs. 5 and 6 are typical of applications in which pliotrons are used extensively.

In the coupled-grid circuit, Fig. 5, the voltage is developed across a coil inductively coupled to a portion of the resonant circuit. By proper connections this voltage can be phased nearly 180 degrees, but due to the resistance inherent in any inductance, this phasing must be corrected in many cases by adding a phase-correcting capacitor.



K-9033804

2-2-45

Fig. 5—Basic Coupled-grid Oscillator Circuit as Used for Induction Heating

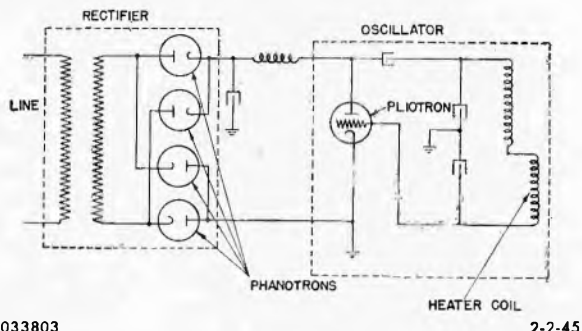
*Reference for Figs. 3 and 4—Terman, F. E., *Radio Engineering*, P-322, McGraw-Hill Book Co., Inc., 1937

In the Colpitts circuit (Fig. 6) the grid voltage is obtained by direct connection to the resonant circuit by splitting the capacitor into two series sections. If the plate-to-cathode voltage is impressed on one section (Ep), the voltage across the other

section (Eg) will always be of opposite polarity, thus giving a 180-degree phase angle.

The Colpitts circuit of Fig. 6 has the advantage of greater stability than that of Fig. 5 since the capacitance ratio which determines Ep/Eg is always fixed, thus providing a "stiffer" voltage source as well as better efficiency because the phasing is more exact. However, the coupled-grid circuit of Fig. 5 affords a ready means of adjusting the amplitude of the grid voltage which is advantageous in some cases.

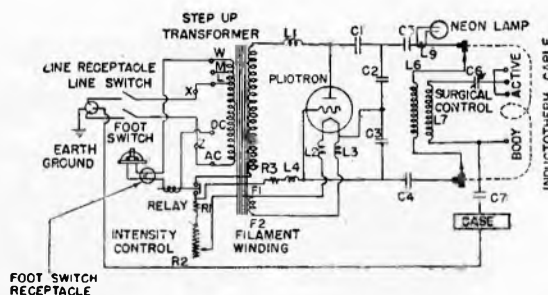
Another important use of the plotron is in diathermy. In these applications the plotron is employed in an oscillator circuit to transmit high-frequency waves which produce heat inside the human body. A circuit illustrating the use of the plotron in a diathermy application is shown in Fig. 7 below.



K-9033803

2-2-45

Fig. 6—Basic Colpitts Oscillator Circuit as Used for Induction Heating



K-9033585

(Courtesy of G. E. X-Ray Corporation)

2-2-45

Fig. 7—Circuit of Inductotherm Unit with Surgical Attachment

CONVECTION-COOLED PLOTRONS—INSTALLATION AND OPERATION

INSTALLATION

Mechanical

Mountings must be of good quality and should be so installed as to minimize danger from impact. If the set is subject to vibration, a shock-absorbing suspension must be employed.

Sets using more than one tube should provide adequate spacing between tubes so that adjacent portions of the bulbs do not operate appreciably hotter than the other sections.

Electrical

The filament should be operated preferably from an a-c source, although a d-c supply may be used. The filament supply should be designed to allow operation at rated filament voltage. The filament transformer shall have good regulation and should be designed for at least thirty per cent above rated filament wattage.

The circuits should be arranged to prevent parasitic oscillations so that the tube will not be subjected to excessive voltages and current.

The plate circuit should be provided with a protective device such as a fuse in order to prevent overheating caused by improper circuit adjustments or overloading. This device should remove the plate voltage instantly if the direct plate current reaches a value 50 per cent above normal.

In rating plotrons, certain values are given as maximum; that is the values beyond which it is unsafe to go from the viewpoint of life and performance. In order not to exceed the *maximum ratings, changes in plate and filament voltage caused by line-voltage fluctuation, load variation, and manufacturing variation of the associated apparatus must be determined. Then, an average value of plate voltage should be chosen so that under the usual operating conditions the maximum ratings will not be exceeded.

In trying out a new circuit or when adjustments are being made, the plate voltage should be reduced in order to prevent damage to the plotron or associated apparatus in case the adjustments are incorrect.

OPERATION

General

Maximum ratings and typical operating conditions are given on the Description and Rating Sheet covering the individual type of pliotron. The typical values given must not be considered as ratings, because the tube may be used at any suitable conditions within the maximum ratings.

Class C Radio-Frequency Power Amplifier and Oscillator

In this service, the plate input power is keyed, i.e., is on and off alternately in accordance with the characters of some code. During the "key-down" periods, the tube functions as an unmodulated radio-frequency power amplifier. The tube may be used also as an amplifier or oscillator without keying.

In both types of service, the ratings given are for "Key-down" conditions.

Certain methods of modulation may be applied to this class of service provided the modulation is essentially negative and the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

Grid bias for Class C service may be obtained from a grid leak, from a battery, from a rectifier of good regulation, or from a self-biasing resistor by-passed with a suitable capacitor. With the grid-leak method, the grid excitation must not be removed without also removing the plate voltage. Grid-bias values are not particularly critical, and correct circuit adjustment may be obtained with widely different values.

FORCED-AIR-COOLED PLIOTRONS—INSTALLATION AND OPERATION

INSTALLATION

Cooling

The air-cooling system for the anode consists of a blower with a suitable air duct leading to the fin cooler of the tube. The air flow required is specified on the Description and Rating Sheet for each type. The temperature of the incoming air should not exceed 45 C.

Proper cooling must be provided to limit the glass temperature to not more than 150 C at the hottest point. Usually deflecting vanes diverting the outgoing air toward the terminal seals provide sufficient cooling. In some cases it may be necessary to provide a separate cooling system. This system may consist of a blower and an air duct of suitable cross-sectional area leading to a nozzle directing the air flow.

The cooling air must not contain any foreign matter. The air-cooling systems should be properly installed to insure safe operation of the tube under all conditions and for this reason should be electrically interconnected with the filament and plate supplies to prevent the application of voltages to the tube without suitable cooling.

Electrical

Suitable meters should be provided for reading filament voltage, plate voltage and current and d-c grid current. A tube life recording meter (to read hours of operation) is also necessary.

The installation of all wires and connections must be made so that they do not lie on or close to the glass of the tube. Otherwise, severe trouble may arise from corona discharge or increased dielectric loss which will result in almost certain puncture.

The filament circuit carries a high current at low voltage. Therefore, precautions should be taken against loss of voltage and heating due to poor connections. The filament connectors particularly should be large and make good contact.

For multiphase filament tubes it is essential that the connections for each type of filament voltage supply be made according to the circuit diagram* to prevent distortion and possible failure of the filament.

The plate circuit should be provided with protective devices to prevent the tube from drawing a heavy overload.

Plate series protective resistors should also be provided to protect the tube from excessive energy dissipation during instantaneous failure of insulation, within the tube or within the transmitter.

The grid circuit should be provided with heavy conductors, carefully connected, in order to prevent overheating of the grid terminal due to r-f currents.

In Class C service, the bias voltage may be supplied by a grid leak, or by a combination of grid leak and generator, grid leak and rectifier, or grid leak and cathode-bias resistor suitably by-passed. The combination method is particularly suitable to reduce distortion, especially in plate-modulated operation. Since the grid-bias voltage for Class C service is not particularly critical, correct circuit adjustment may be obtained with values differing widely from those indicated for this service.

The circuits should be arranged to prevent parasitic oscillations so that the tube will not be subjected to excessive voltages and currents.

*Note: The ratings and characteristics of a particular pliotron are given on the Description and Rating Sheet for that tube.

OPERATION

When a new tube is first placed in operation, it should be operated without plate voltage for fifteen minutes at rated filament voltage. After this initial preheating schedule, plate voltage can be applied. Operate for fifteen minutes at approximately one-half the usual plate voltage. Full voltage may then be applied and the tube operated under the normal load conditions for a period of one hour or more. Every three months spare tubes should be given this preheating and initial operation schedule.

The filament should be operated at constant voltage rather than constant current. From the viewpoint of tube life, it is usually economically advantageous to provide good regulation of the filament voltage. For example, if the filament is operated continuously at six per cent above normal voltage, the evaporation life will be reduced to approximately one half.

When a multiphase filament-supply voltage is used, the phase voltages must all balance within

fifteen per cent during the filament starting period. During normal operation the phase voltages must never, even momentarily, exceed ten per cent unbalance.

Maximum ratings and typical operating conditions are given on the Description and Rating Sheet. The amplifier classifications used are those given in the Report of the Standards Committee of the Institute of Radio Engineers.

The output values given in the tabulation on the Description and Rating Sheet are approximate tube outputs under certain typical operating conditions. These must not be used as output ratings; circuit losses must be subtracted from the tube output in calculating the useful output.

In determining the value of plate voltage for normal operation, the line voltage fluctuation, load variation, and manufacturing variations must be estimated so that the maximum rated values will not be exceeded.

WATER-COOLED PILOTRONS—INSTALLATION AND OPERATION

INSTALLATION

Cooling

The water-cooling system for the anode consists, in general, of a source of cooling water, a water jacket, and a feed-pipe system which carries the water to and from the jacket.

Proper functioning of the water-cooling system is of the utmost importance. Even a momentary failure of the water flow will damage the tube. It is, therefore, necessary to provide a method for preventing operation of the tube during such a condition. This may be accomplished by the use of water-flow circuit breakers, or interlocks, which open the filament and plate power supplies whenever the flow is insufficient or ceases.

The rate of water flow given on the Description and Rating Sheet is usually sufficient for all types of service. Under abnormal conditions an increased rate of flow may be necessary to prevent overheating.

Distilled water is recommended for cooling because it greatly reduces the probability of scale formation on the anode during life. Scale hinders proper transfer of heat from the anode to the water. The mineral content, flow, heat dissipation, temperature, etc., of undistilled water are so varied that no specific recommendations to prevent scale can be made. In general, water which shows a hardness greater than 10 grains per gallon should not be used.

When forced-air cooling is called for on the Description and Rating Sheet a system should be used which consists of a blower with air ducts of proper cross-sectional area which supply air to suitable air nozzles. In certain of the larger tubes (such as the 862-A and the 898-A both the bulb and the stem must be air cooled. In these tubes the nozzle which

supplies air to the filament stem is incorporated in the base, and the nozzle which supplies air to the bulb is part of the water jacket and acts as a combination air nozzle and electrostatic shield.

Tubes which require forced-air cooling on the stem only have an air nozzle incorporated in the cathode base.

The system should be arranged so that the temperature of the glass is not more than 150 C at the hottest point. Even when forced-air-cooling is not called for on the Description and Rating Sheet, free circulation of air must be provided to limit the temperature of the glass to this value. When there is inadequate ventilation or where a tube is used at the higher frequencies, forced-air-cooling may be required. In such cases a small blower may be used with suitable nozzles directing the air to the areas where cooling is necessary.

Electrical

Suitable meters should be provided for reading filament voltage, plate voltage and current, and d-c grid current. A tube life recording meter (to read hours of operation) should also be provided.

The installation of all wires and connections must be made so that they do not lie on or close to the glass of the tube. Otherwise, severe trouble may arise from corona discharge or increased dielectric loss which will result in almost certain puncture.

The filament circuit carries a high current at low voltage. Therefore, the usual precautions should be taken against loss of voltage and heating due to poor connections. The filament connectors particularly should be large and make good contact.

For multiphase filament tubes it is essential that the connections for each type of filament voltage supply be made according to the circuit diagram to prevent distortion and possible failure of the filament.

The plate circuit should be provided with protective devices to prevent the tube from drawing a heavy overload. Plate series protective resistors should also be provided to protect the tube from excessive energy dissipation during instantaneous failure of insulation, within the tube or within the transmitter. The grid circuit should be provided with heavy conductors, carefully connected, in order

to prevent overheating of the grid terminal due to r-f currents.

In Class C service, the bias voltage may be supplied by a grid leak, or by a combination of grid leak and generator, grid leak and rectifier, or grid leak and cathode-bias resistor suitably by-passed. The combination method is particularly suitable to reduce distortion, especially in plate-modulated operation. Since the grid-bias voltage for Class C service is not particularly critical, correct circuit adjustment may be obtained with values differing widely from those indicated for this service.

The circuits should be arranged to prevent parasitic oscillations so that the tube will not be subjected to excessive voltages and currents.

OPERATION

When a new tube is first placed in operation, it should be operated without plate voltage for fifteen minutes at rated filament voltage. After this initial pre-heating schedule, plate voltage can be applied. Operate for fifteen minutes at approximately one-half the usual plate voltage. Full voltage may then be applied and the tube operated under the normal load conditions for a period of one hour or more. Every three months spare tubes should be given the preheating and initial operation schedule discussed above.

The filament should be operated at constant voltage rather than constant current. From the viewpoint of tube life, it is usually economically advantageous to provide good regulation of the filament voltage. For example, if the filament is operated continuously at 6 per cent above normal voltage, the evaporation life will be reduced to approximately one-half.

When a three-phase or six-phase a-c filament-supply voltage is used, the phase voltages must all balance within 15 per cent during the filament starting period. During normal operation the phase voltages must never, even momentarily, exceed 10 per cent unbalance.

Maximum ratings and typical operating conditions for each recommended class of service are given on the Description and Rating Sheet. The amplifier

classifications used are those given in the Report of the Standards Committee of the Institute of Radio Engineers.

The output values given in the tabulation on the Description and Rating Sheet are approximate tube outputs under certain typical operating conditions. These must not be used as output ratings; circuit losses must be subtracted from the tube output in calculating the useful output.

The approximate anode dissipation may be calculated from the following expression:

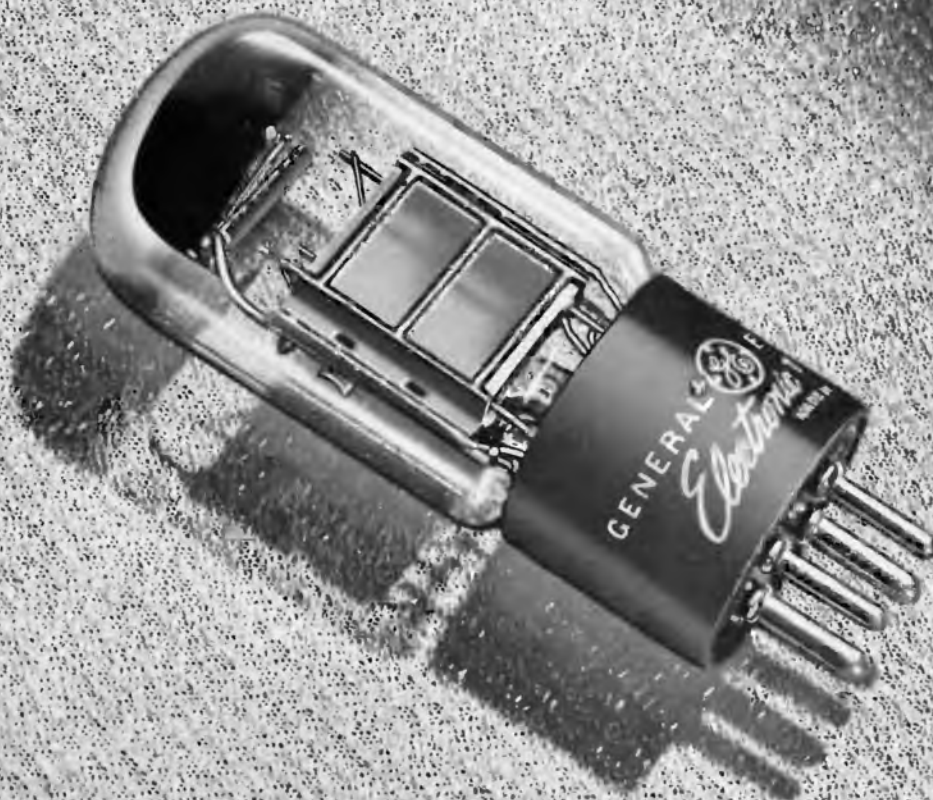
$$P \text{ (kilowatts)} = \frac{n(T_2 - T_1)}{(4)}$$

in which (T_1) is the known initial temperature of the cooling water in degrees centigrade, (T_2) the temperature of the water at the water jacket outlet in degrees centigrade, and (n) the water flow in gallons per minute.

In determining the value of plate voltage for normal operation, the line voltage fluctuation, load variation, and manufacturing variations must be estimated so that the maximum rated values will not be exceeded.

**Note: The ratings and characteristics of a particular pliotron are given on the Description and Rating Sheet for that tube.*

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-5742/PJ-7 is a three-electrode tube designed for use as a class A, B, or C amplifier. The anode is capable of dissipating 10 watts, and

cooling is accomplished by radiation. The cathode is a thoriated-tungsten filament. Maximum ratings apply up to 6 megacycles.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Filament voltage.....	4.5 volts
Filament current.....	1.1 amperes
Amplification factor, $E_b = 350$ v, $I_b = 4.5$ ma, $E_f = 4.5$ v.....	.30
Interelectrode capacitances	
◆ Grid-plate.....	6.8 uuf
◆ Grid-cathode.....	2.5 uuf
◆ Plate-cathode.....	2.0 uuf

◆ Revised

GENERAL  ELECTRIC

Supersedes ETI-157A dated 12-48


Electronic
TUBE

TECHNICAL INFORMATION (CONT'D)

Mechanical

Mounting position—vertical, base down	
Maximum glass temperature	150 C
Net weight, approximate	2 ounces

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS A1

Maximum ratings, absolute values

D-c plate voltage	350 max volts
Plate dissipation	7.5 max watts

Typical operation

D-c plate voltage	350 volts
D-c grid voltage	-6 volts
Peak a-f grid voltage	6 volts
D-c plate current	2.8 milliamperes
Load resistance	40,000 ohms
Power output	0.08 watt

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values

D-c plate voltage	350 max volts
D-c plate current	35 max milliamperes
Plate input	12 max watts
Plate dissipation	10 max watts

Typical operation

Unless otherwise specified, values are for 2 tubes

D-c plate voltage	350 volts
D-c grid voltage	-10 volts
D-c plate current	64 milliamperes
Power output, approximate	4 watts

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

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

Maximum ratings, absolute values

D-c plate voltage	300 max volts
D-c grid voltage	-100 max volts
D-c plate current	40 max milliamperes
D-c grid current	15 max milliamperes
Plate input	12 max watts
Plate dissipation	10 max watts

Typical operation

D-c plate voltage	300 volts
D-c grid voltage	-40 volts
D-c plate current	35 milliamperes
D-c grid current, approximate	8 milliamperes
Power output, approximate	5 watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulations*

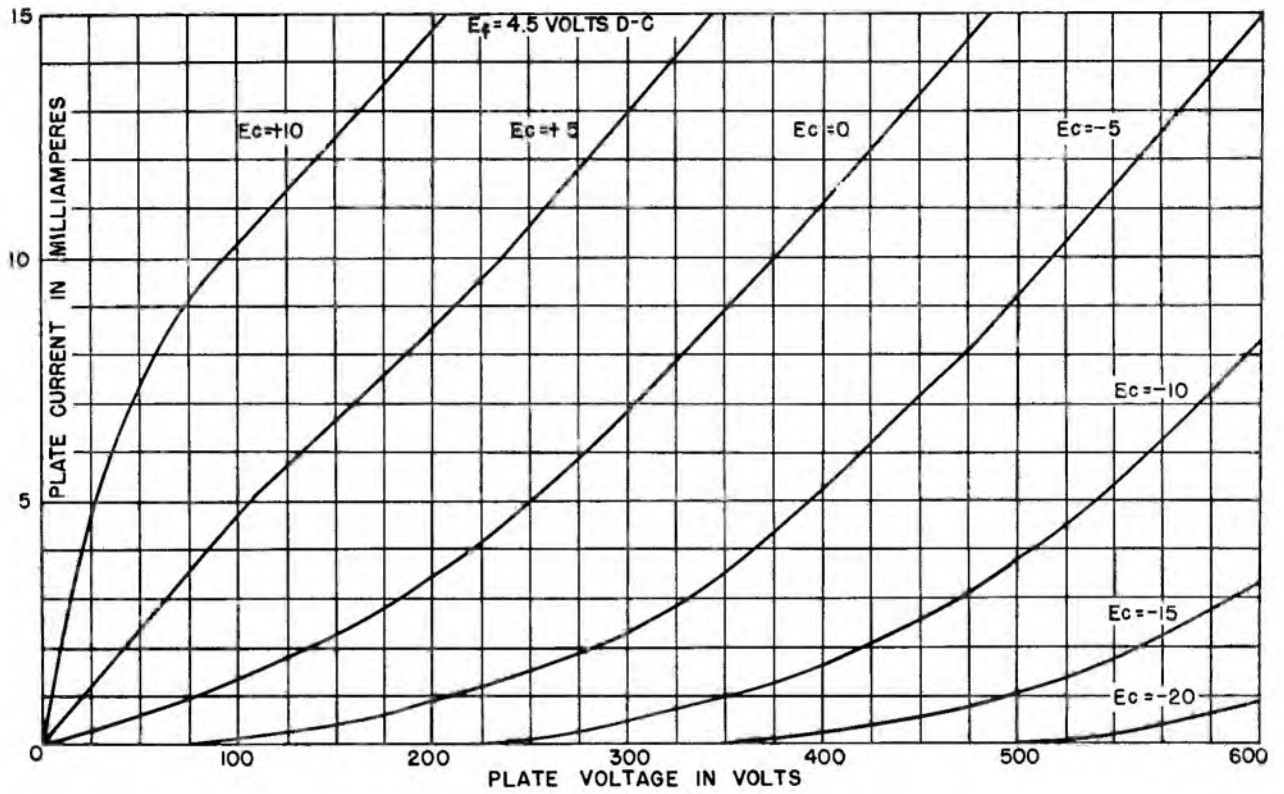
Maximum ratings, absolute values

D-c plate voltage	350 max volts
D-c grid voltage	-100 max volts
D-c plate current	40 max milliamperes
D-c grid current	15 max milliamperes
Plate input	14 max watts
Plate dissipation	10 max watts

Typical operation

D-c plate voltage	350 volts
D-c grid voltage	-25 volts
D-c plate current	35 milliamperes
D-c grid current, approximate	5 milliamperes
Power output	6 watts

* Modulation, essentially negative, may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

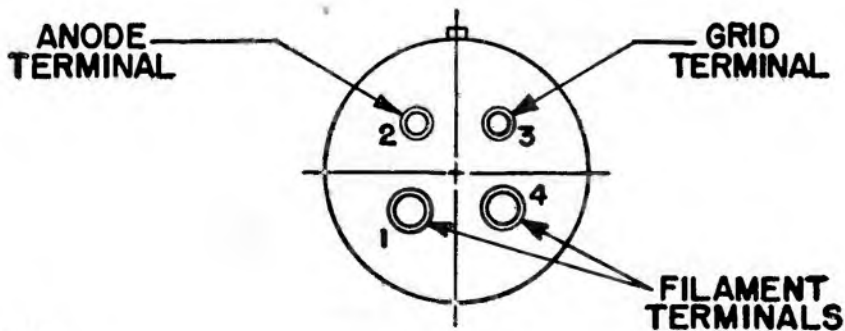
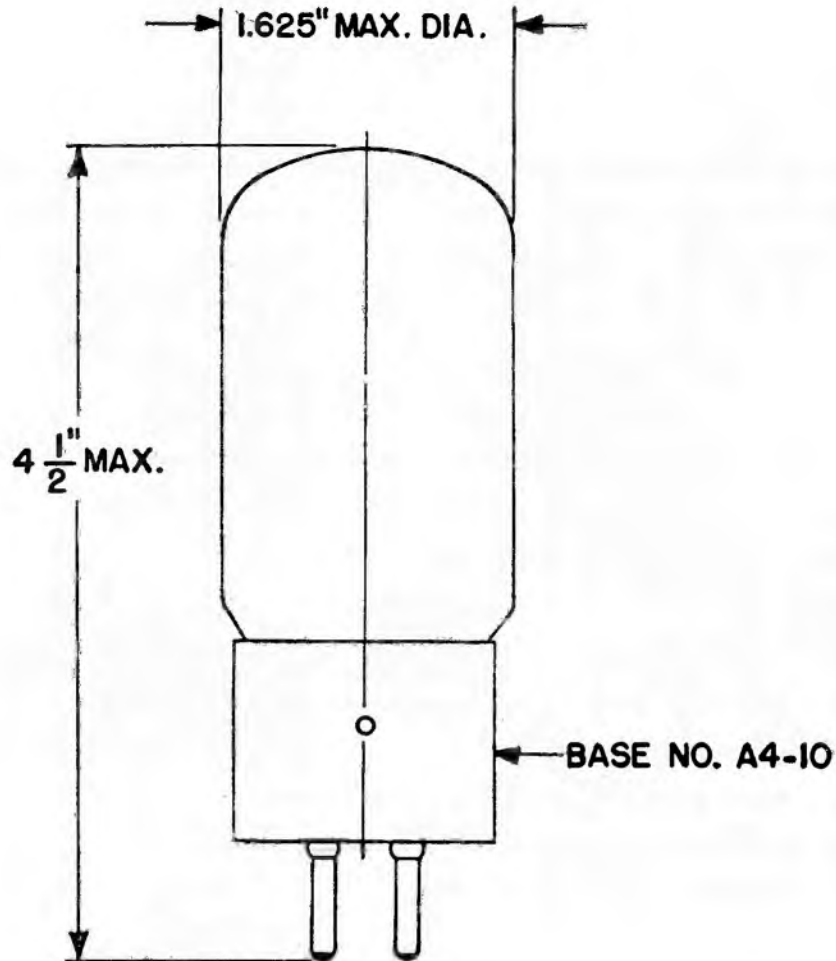


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GL-5742/PJ-7 AVERAGE STATIC CHARACTERISTICS

◆ OUTLINE GL-5742/PJ-7 PIOTRON



N-21216AZ
†Revised

11-18-49

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-5556/PJ-8 is a high-vacuum tube designed for use in amplification and relay applications. The low grid power and uniformity of

characteristics are particularly valuable in many control applications.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 3

Electrical

Filament voltage 4.5 volts
 Filament current 1.1 amperes
 Amplification factor, $E_b = 350$ v, $I_b = 19$ ma, $E_g = -20$ v, $E_f = 4.5$ v 8.5
 Grid-plate transconductance 1330 micromhos
 Direct interelectrode capacitance
 ◆ Grid-plate 6.7 micromicrofarads
 ◆ Grid-cathode 2.3 micromicrofarads
 ◆ Plate-cathode 2.2 micromicrofarads

◆ Revised.

GENERAL  ELECTRIC


Electronic
 TUBE

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

CLASS A AUDIO-FREQUENCY AMPLIFIER AND MODULATOR

Maximum ratings, absolute values	
D-c plate voltage	350 volts
Plate dissipation	7.5 watts
Typical operation	
D-c plate voltage	350 volts
D-c grid voltage	-30 volts
Peak grid swing, approx	30 volts
D-c plate current	.9 milliamperes
Plate resistance	8700 ohms
Load resistance	18,000 ohms
Plate power output, 5% second harmonic	0.6 watts

CLASS B RADIO-FREQUENCY POWER AMPLIFIER

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

Maximum ratings, absolute values	
D-c plate voltage	350 volts
D-c plate current	.40 milliamperes
Plate input	14 watts
Plate dissipation	10 watts
Typical operation	
D-c plate voltage	350 volts
D-c grid voltage	-40 volts
D-c plate current	.32 milliamperes
Peak r-f grid input	90 volts
†Driving power, approx	0.1 watt
Plate power output	.2 watts

CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR, PLATE MODULATED

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

Maximum ratings, absolute values	
D-c plate voltage	350 volts
D-c grid voltage	-150 volts
D-c plate current	.40 milliamperes
D-c grid current, approx	.10 milliamperes
Plate input	14 watts
Plate dissipation	7 watts
Typical operation	
D-c plate voltage	300 volts
D-c grid voltage	-100 volts
D-c plate current	.30 milliamperes
D-c grid current, approx	.2 milliamperes
Peak r-f grid input voltage, approx	140 volts
Driving power, approx	0.3 watts
Plate power output	.4 watts

CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Key-down conditions per tube without modulation*

Maximum ratings, absolute values	
D-c plate voltage	350 volts
D-c grid voltage	-150 volts
D-c plate current	.40 milliamperes
D-c grid current, approx	.10 milliamperes
Plate input	14 watts
Plate dissipation	10 watts
Typical operation	
D-c plate voltage	350 volts
D-c grid voltage	-80 volts
D-c plate current	.35 milliamperes
D-c grid current, approx	.2 milliamperes
Peak r-f grid input voltage, approx	130 volts
Driving power, approx	0.25 watts
Plate power output, approx	.6 watts

† At crest of audio-frequency cycle.

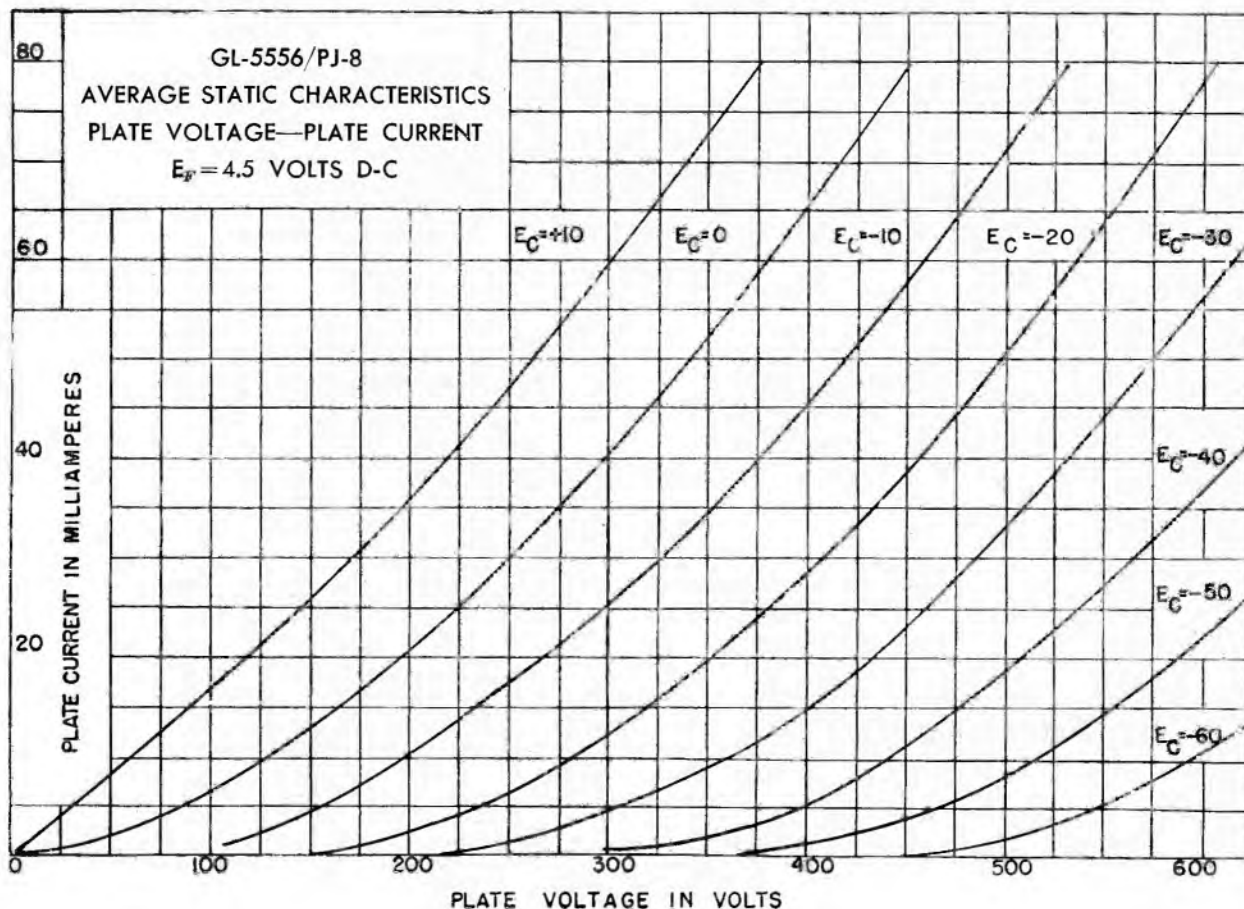
* Modulation, essentially negative, may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

APPLICATION NOTES

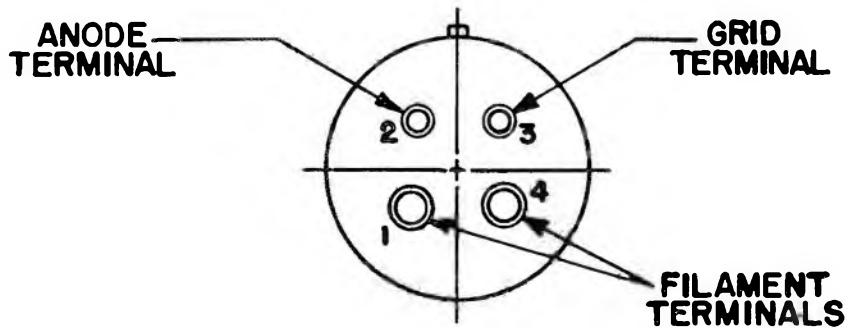
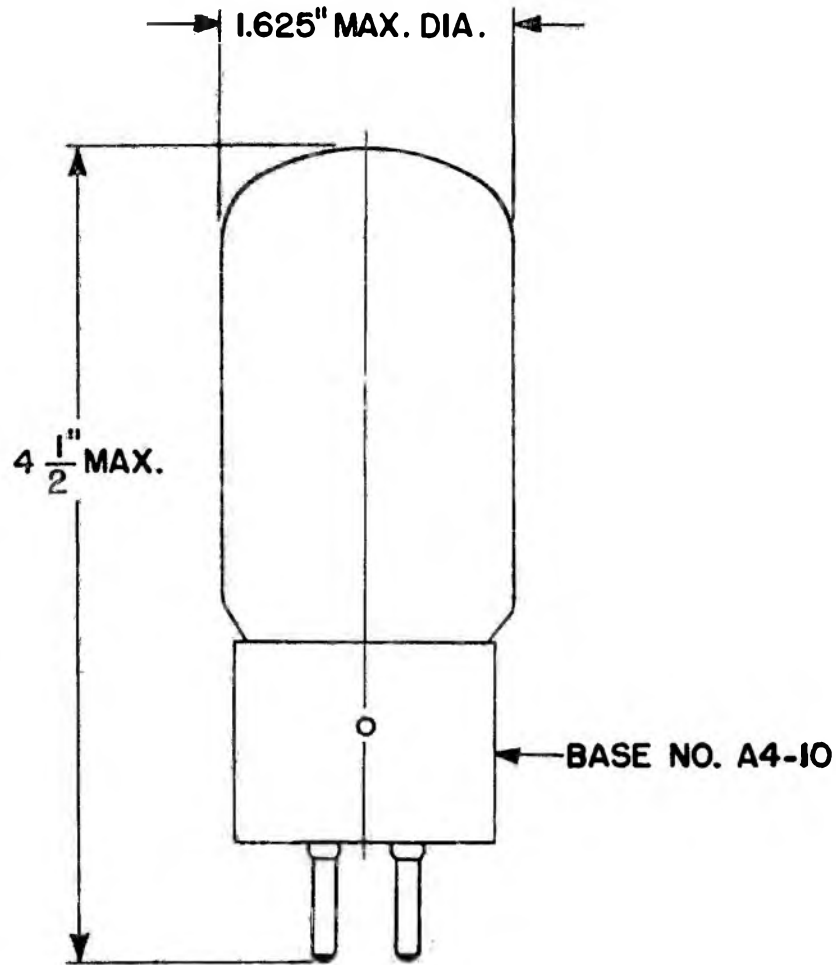
The GL-5556/PJ-8 can be operated at frequencies as high as six megacycles, and may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised (other maximum ratings are the same as shown under TECHNICAL INFORMATION). The tabulation below shows highest percentage of maximum plate voltage and power input that can be used up to thirty megacycles for the various classes of service. Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	6	15	30 megacycles
Max permissible percentage of max. rated plate voltage and plate input			
Class B, r-f	100	85	70 per cent
Class C, plate modulated or unmodulated	100	75	50 per cent

The normal value of grid leak, when the GL-5556/PJ-8 is used as an oscillator or r-f power amplifier (Class C), is in the neighborhood of 10,000 ohms, although this may be replaced by a suitable fixed bias. If self-bias is used, the cathode should be approximately 2000 ohms.



OUTLINE GL-5556/PJ-8 PILOTRON



N-21216AZ
Revised

11-19-49

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-5743/PJ-21 is a three-electrode tube designed for use as a class A amplifier. The anode is capable of dissipating 7.5 watts and cooling is accomplished by radiation. The cathode is a thoriated-tungsten filament.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Filament voltage	4.5 volts
Filament current	1.1 amperes
Amplification Factor, $E_b = 350$ v, $I_b = 19.5$ ma, $E_f = 4.5$ v.	3
Interelectrode capacitances	
Grid-plate	7.5 uuf
Grid-filament	3.0 uuf
Plate-filament	4.0 uuf



GENERAL  ELECTRIC

Supersedes ETI-159 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Mechanical

Mounting position—vertical, base down

Maximum glass temperature.....150 C

Net weight, approximate.....2 ounces

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS A

Maximum ratings, absolute values

D-c plate voltage.....350 max volts

Plate dissipation.....7.5 max watts

Typical operation

D-c plate voltage.....350 volts

D-c grid voltage.....83 volts

Peak a-f grid voltage.....83 volts

D-c plate current.....19.5 milliamperes

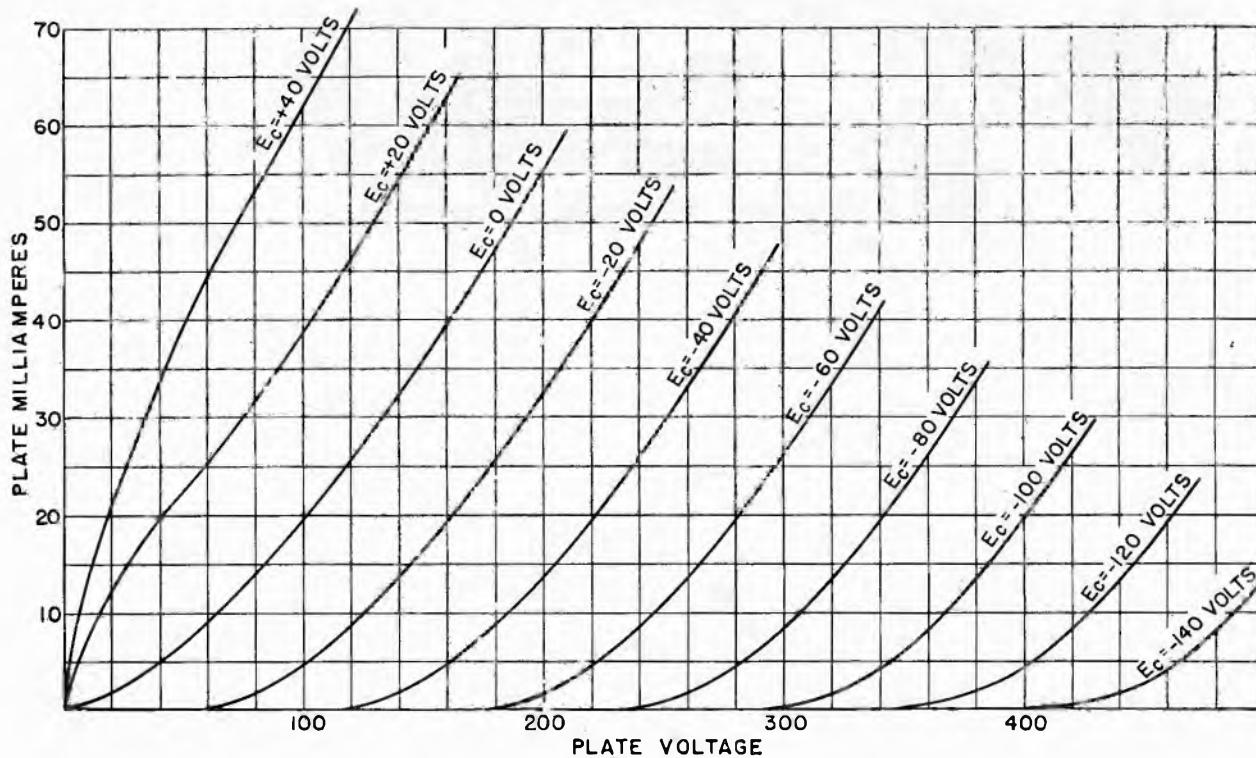
Load resistance.....7500 ohms

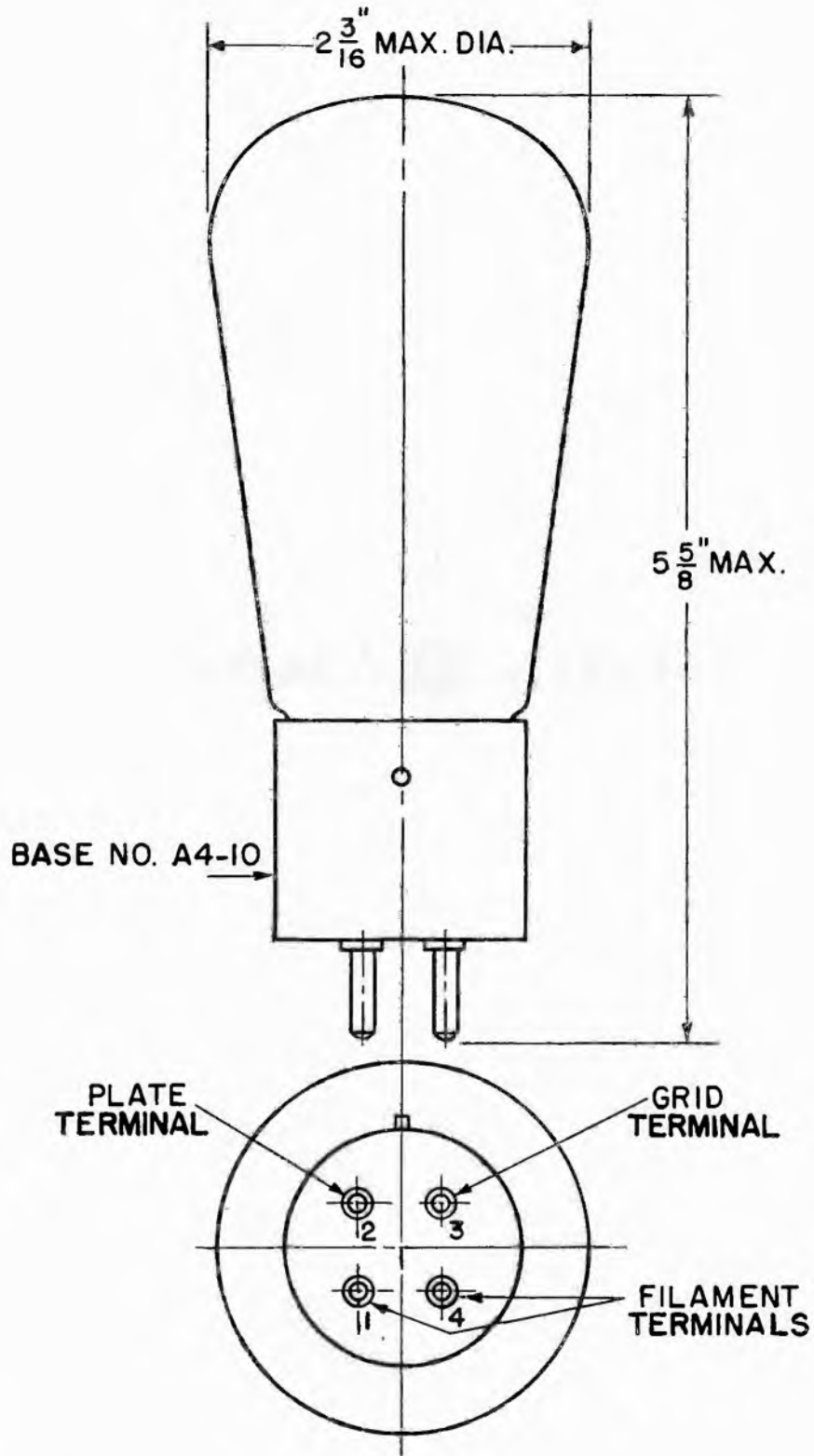
Power output.....1.7 watts

GL-5743/PJ-21 AVERAGE PLATE CHARACTERISTICS

$I_f = 1.1$ AMPERES D-C

($E_f = 4.5$ VOLTS, APPROX.)



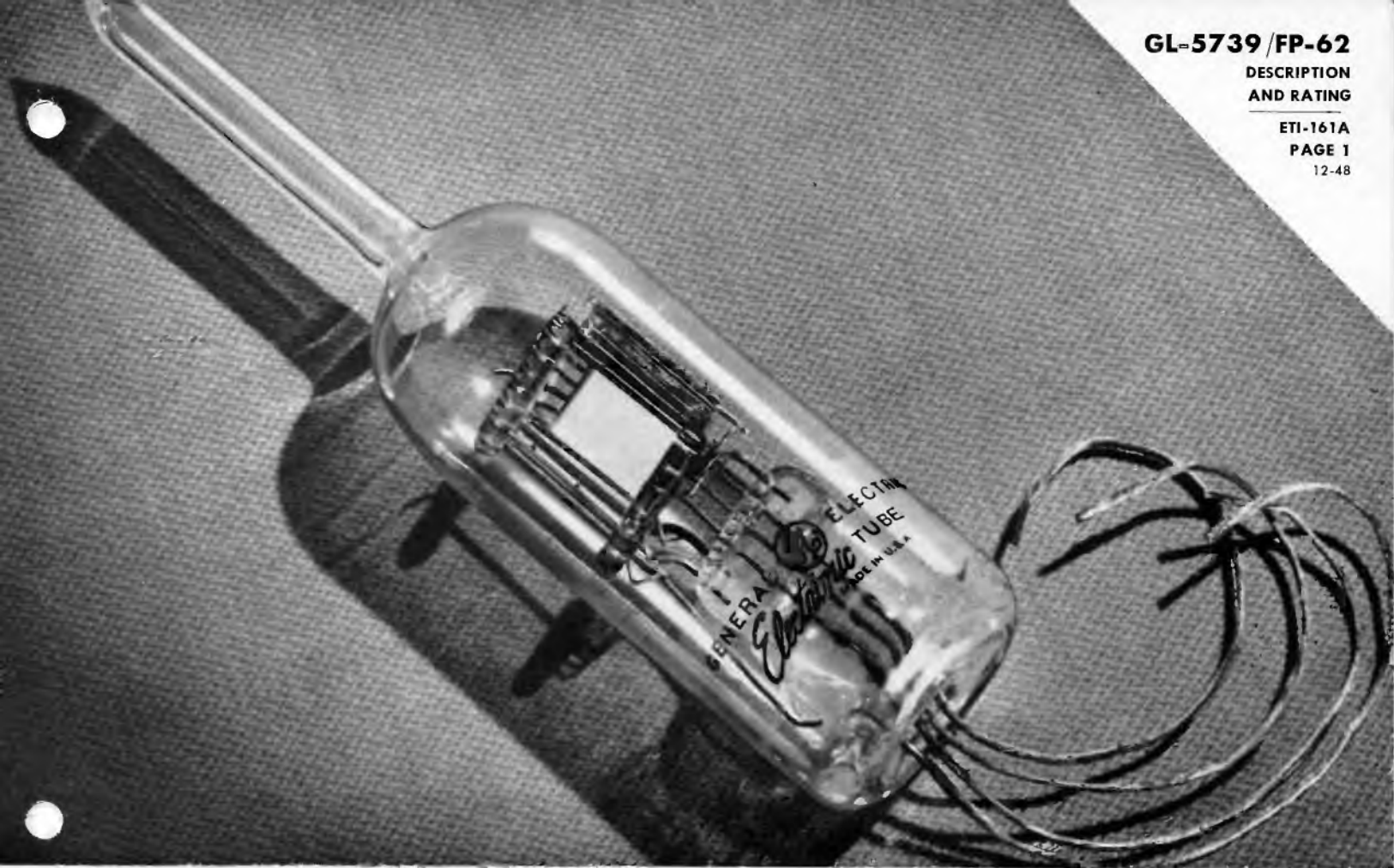


K-3846047

5-25-48

OUTLINE GL-5743/PJ-21 PIOTRON

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-5739/FP-62 is an ionization gage which will accurately and conveniently measure gas pressures over a range of from 100 microns to as low as 0.001 micron. This plotron is not only sufficiently sturdy for general use but is designed to be sufficiently sensitive for the most delicate measurements.

Leakage in the collector circuit, the limiting feature in some gages, has been entirely eliminated by special construction.

This gage has a high sensitivity characteristic and, since the parts are rigidly mounted, it will hold its calibration to a very close degree.

TECHNICAL INFORMATION

GENERAL CHARACTERISTICS

Number of electrodes 3

Electrical

Filament—pure tungsten

Normal voltage, approx. 4.5 volts

Normal current, approx. 1.48 amperes

Maximum current 1.68 amperes

Normal operating conditions

Collector voltage -22.5 volts

Grid voltage 112.5 volts

Grid current 10 milliamperes

Average sensitivity, collector current per micron of pressure of dry air at normal operating conditions, approximate 40 microamperes


Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-161 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Mechanical

Bulb material	hard glass
Maximum "bake-out" temperature	500 centigrade

TYPICAL CALIBRATION

Grid voltage	112½ volts
Collector or plate voltage	-22¼ volts
Grid current	10 milliamperes
	Collector Current in Microamperes per Micron Pressure
Gas	
Helium	5.6
Neon	9.0
*Nitrogen	39.5
Argon	54.0

* The value given for nitrogen is correct for dry air since the oxygen cleans up when the filament is lighted.

INSTALLATION AND OPERATION

INSTALLATION: The GL-5739/FP-62 is of hard glass and may be used on either hard- or soft-glass systems. When it is sealed to a soft-glass system a graded seal must be used. The gage is furnished exhausted and sealed off and with a tubulation for sealing it into the system. The gage should be kept in this form until it is ready to be used. The end of the tubulation is then cut off and the gage sealed into the system, care being taken that no constriction is formed between the bulb and the system. For accurate results, the gage should be placed as near as possible to the point at which the pressure is to be measured. The gage should be mounted with its axis vertical. The stem may be either up or down, whichever is more convenient. Since, in sealing the gage into the system, the end of the tubulation is cut off and air is let in, it is necessary to exhaust and degas the gage before it can be used. For this reason the gage is furnished unbaked to permit its being baked out.

Where high voltages are used in the system and where there is a possibility of a gaseous discharge to the electrodes of the gage, a wire or guard ring should be inserted in the seal when sealing to the system. This wire or guard ring should then be well grounded.

Care should be taken against shorting the leads while anyone is working around the system. The entire collector circuit should be well insulated to prevent the introduction of external sources of leakage. The glass around the collector lead should be clean so that there will be no leakage at that point.

For working at low pressures it is necessary to degas the gage thoroughly. At these low pressures the gas occluded from the metal parts and from

the glass may cause the gage to read higher than the actual pressure in the system. Before the gage is used, it should be degassed as follows:

1. Bake out with the rest of the system (do not exceed 500 C).
2. Connect the grid and plate leads to the positive 500-volt d-c supply.
3. Bombard at 1000 C plate temperature for 20 minutes. This is accomplished by regulating the filament voltage to give approximately 40 to 80 milliamperes total current.

Note: Only a d-c voltage supply should be used in this operation.

OPERATION: Measurements are taken with the gage by placing a positive voltage on the grid and a negative voltage on the collector. The filament voltage is increased until the grid current reaches the desired value. The negative current to the collector is then a measure of the gas pressure.

The calibration curve of the gage is nearly a straight line, especially at pressures below one micron. By checking a few points of collector current and gas pressure against a McLeod gage, the curve can be plotted and extrapolated down to zero current at zero pressure. Typical calibrations for various gases are shown on page 2.

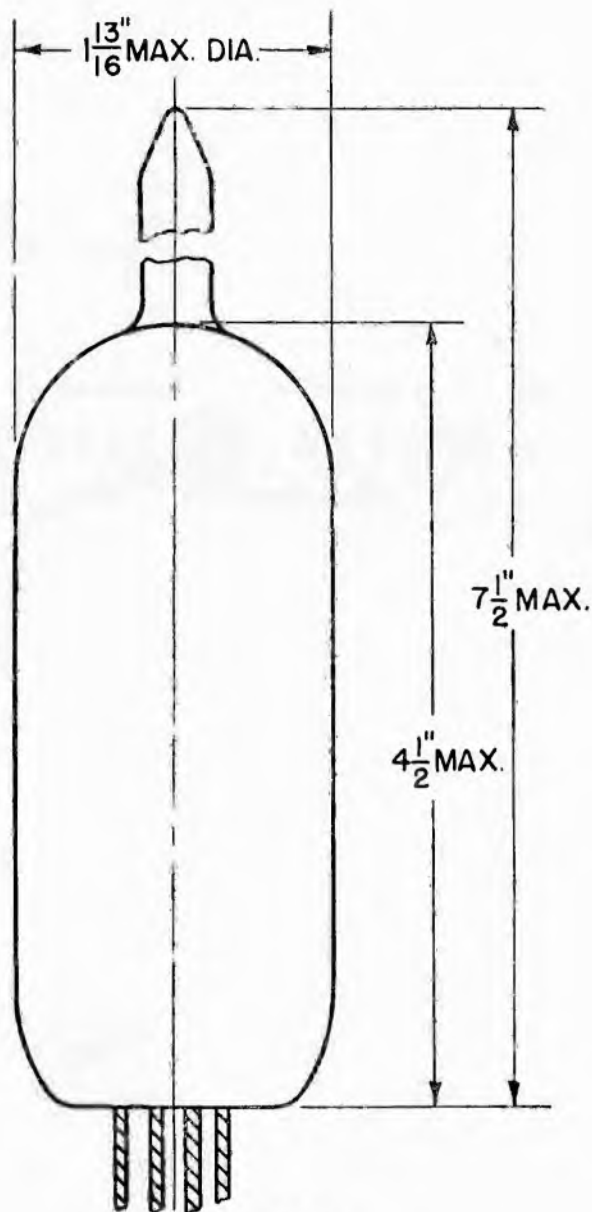
It can reasonably be expected that, as long as the arrangement of the electrodes of the gage remains unchanged, the calibration will also remain constant. Excessive overheating during degassing or rough handling may warp or change the relative positions of the electrodes. Leakage arising in the collector circuit can also cause a change in the calibration. This, however, can be detected by looking for a residual leakage current with the filament cold.

OPERATING NOTES

The filament should not be lighted until the pressure has been reduced to a low value. Care should be taken during bombardment that the gas evolved does not cause the current to increase steadily until the filament burns out or the electrodes are warped. A series resistor will be found satisfactory for avoiding such trouble. As a further precaution, bombardment should not begin until the pressure is below one micron.

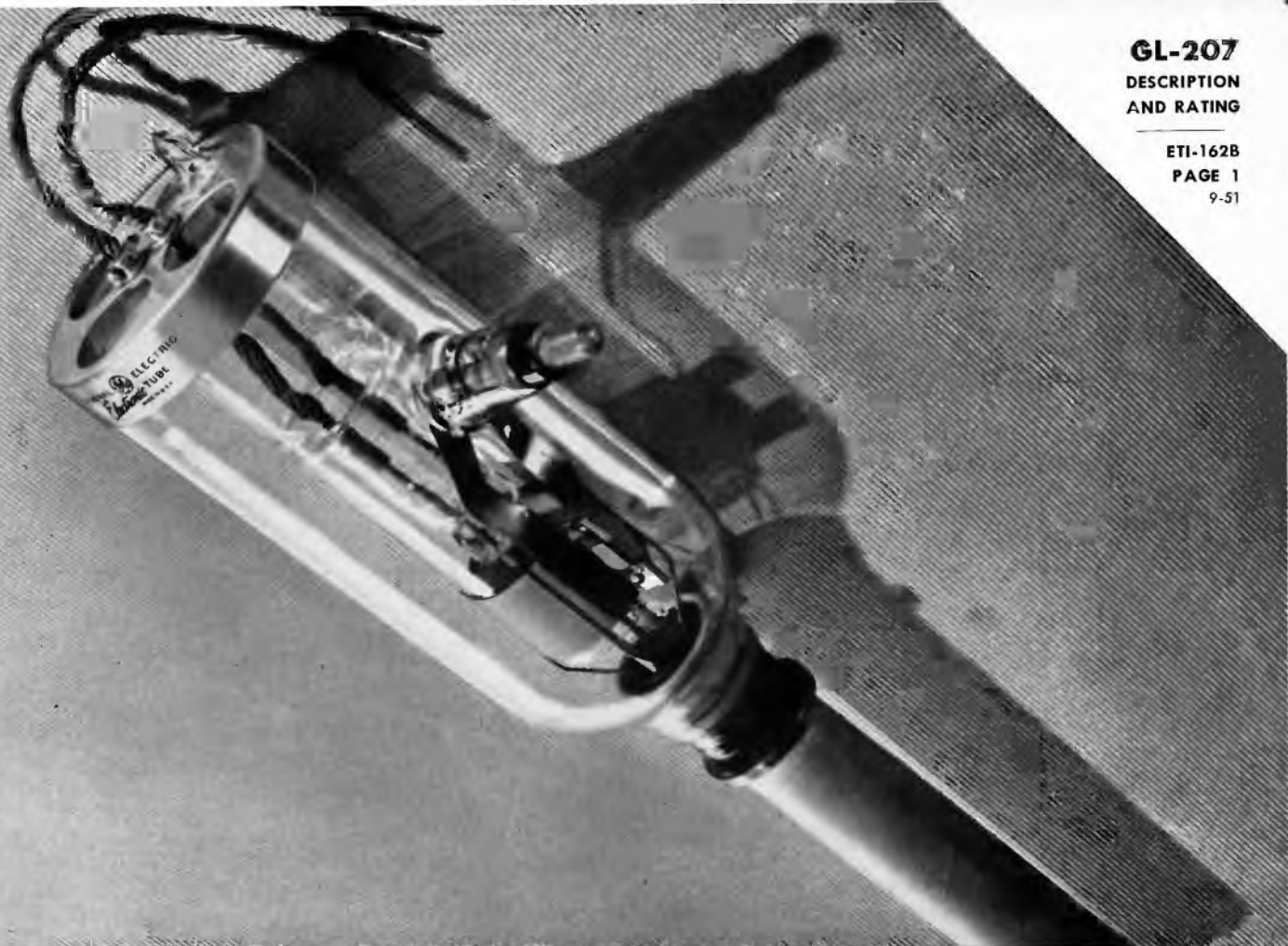
In taking readings at extremely low pressures, there are two sources of inaccuracy which may be

present. The gage will clean up the gas slowly and give too low a reading. Furthermore, the rate of flow, or rather drift of gas, at low pressure is slow and the gage may read high or low depending on which way the pressure is changing. For best results it is recommended that the filament be turned off and the system allowed to equalize for several minutes. Following this period of equalization the filament should again be lighted and a reading taken as soon as possible.



OUTLINE
GL-5739/FP-62 PLIOTRON

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-207 is a three-electrode vacuum tube designed for use as a radio-frequency power amplifier, oscillator, or Class B modulator. The plate is water-cooled and capable of dissipating

6.6 to 10 kilowatts, depending on the service in which the tube is used. The cathode is a pure-tungsten filament. Maximum ratings apply up to 1.6 megacycles.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical Data

Filament voltage (A-c or D-c)	22 volts
Filament current .....	.52 amperes
Filament starting current, maximum	100 amperes
Filament cold resistance	0.03 ohm
Amplification factor	20
Direct interelectrode capacitances, approximate	
Grid-plate .....	.27 uuf
Grid-filament .....	.18 uuf
Plate-filament	2.0 uuf

◆Revised.


Electronic
 TUBE

GENERAL  ELECTRIC

Supersedes ETI-162A dated 8-48

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position—vertical, filament end up

Type of cooling—water

Water flow on anode 3-8 gallons per minute

Maximum outgoing water temperature 70 C

Maximum glass temperature* 150 C

Net weight, approximate 3 pounds

Shipping weight, approximate 10 pounds

* In installations where circulation of free air is restricted, or at the higher frequencies, forced-air cooling may be necessary to prevent this limit from being exceeded.

**MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS
AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B****Maximum Ratings, Absolute Values**

D-c plate voltage	15000 max volts
Maximum signal d-c plate current**	2 max amperes
Maximum signal plate input**	20 max kilowatts
Plate dissipation**	7.5 max kilowatts

Typical Operation

Unless otherwise specified, values are for two tubes

D-c plate voltage	6000	10000	12500	volts
D-c grid voltage χ	-210	-410	-575	volts
Peak a-f grid-to-grid voltage	1520	2140	2300	volts
Zero signal d-c plate current	0.5	0.5	0.4	ampere
Maximum signal d-c plate current	2.5	3.2	2.8	amperes
Effective load resistance, plate to plate	4200	6400	10000	ohms
Maximum signal driving power, approximate	190	380	400	watts
Maximum signal power output, approximate	8	20	22.5	kilowatts

** Averaged over any audio-frequency cycle of sine-wave form.

 χ For d-c filament supply.**RADIO-FREQUENCY POWER AMPLIFIER—CLASS B TELEPHONY**

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

Maximum Ratings, Absolute Values

D-c plate voltage	15000 max volts
D-c plate current	1 max ampere
Plate input	15 max kilowatts
Plate dissipation	10 max kilowatts

Typical Operation

D-c plate voltage	6000	10000	14000	volts
D-c grid voltage χ	-225	-440	-650	volts
Peak r-f grid voltage	400	600	730	volts
D-c plate current	0.62	0.93	1.0	ampere
Driving power, approximate***	72	16	0	watts
Power output, approximate	1	2.5	4	kilowatts

*** At crest of audio-frequency cycle with modulation factor of 1.0.

 χ For d-c filament supply.**PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER—CLASS C TELEPHONY**

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

Maximum Ratings, Absolute Values

D-c plate voltage	10000 max volts
D-c grid voltage	-3000 max volts
D-c plate current	1 max ampere
D-c grid current	0.2 max ampere
Plate input	10 max kilowatts
Plate dissipation	6.6 max kilowatts

Typical Operation

D-c plate voltage	6000	8000	10000	volts
D-c grid voltage#	-1200	-1600	-2000	volts
Peak r-f grid voltage	1860	2300	2660	volts
D-c plate current	0.76	0.78	0.75	ampere
D-c grid current, approximate	0.15	0.14	0.07	ampere
Driving power, approximate	280	325	185	watts
Power output, approximate	3.5	5	6	kilowatts

For a-c filament supply.

TECHNICAL INFORMATION (CONT'D)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without modulation ¶

Maximum Ratings, Absolute Values

D-c plate voltage	15000 max volts
D-c grid voltage	-3000 max volts
D-c plate current	2 max amperes
D-c grid current	0.2 max ampere
Plate input	30 max kilowatts
Plate dissipation	10 max kilowatts

Typical Operation

D-c plate voltage	8000	10000	12000	volts
D-c grid voltage †	-1000	-1200	-1600	volts
Peak r-f grid voltage	1730	2050	2650	volts
D-c plate current	1.10	1.33	1.67	amperes
D-c grid current, approximate	0.17	0.12	0.09	ampere
Driving power, approximate	295	245	235	watts
Power output, approximate	6.5	10	15	kilowatts

¶ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

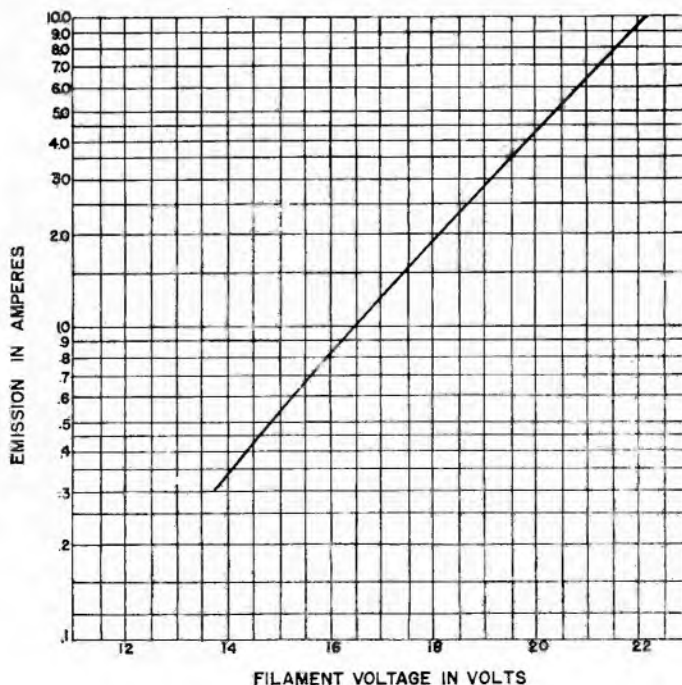
† Obtained from fixed supply, by grid resistor, or by cathode resistor. For a-c filament supply.

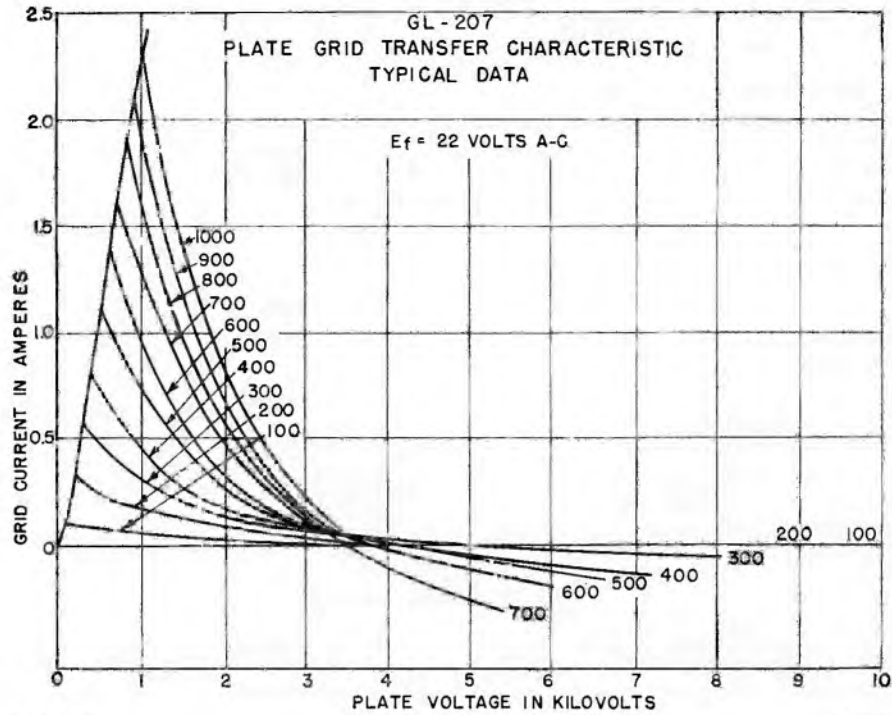
APPLICATION NOTES

Maximum ratings apply up to 1.6 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	1.6	7.5	20 megacycles			
Percentage of maximum rated plate voltage and plate input						
Class B	100	85	76 per cent			
Class C plate modulated	100	85	75 per cent			
Class C unmodulated	100	75	50 per cent			
Plate series protective resistors						
Series resistor	.25	50	200	250	275	300 ohms
Maximum power output of rectifier	16	40	100	250	640	1600 kilowatts

GL-207 FILAMENT EMISSION CHARACTERISTICS



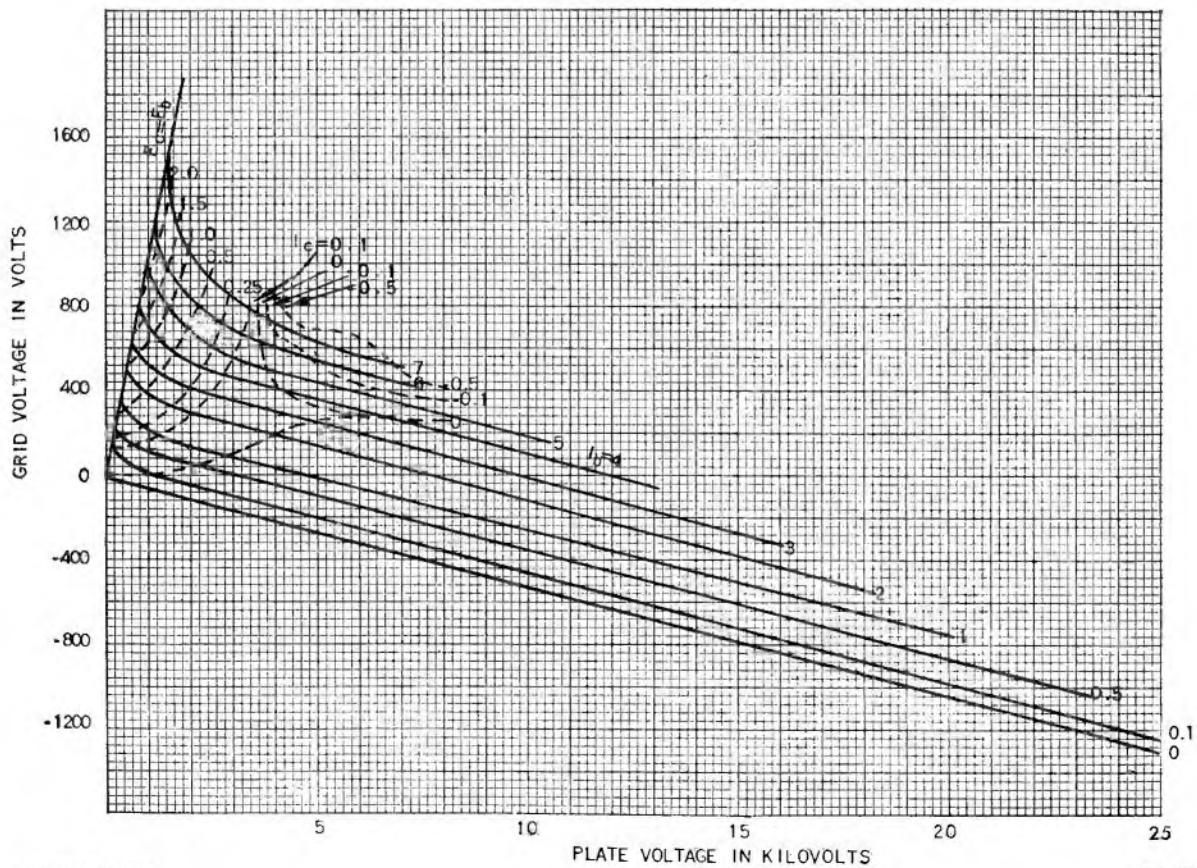


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GL-207

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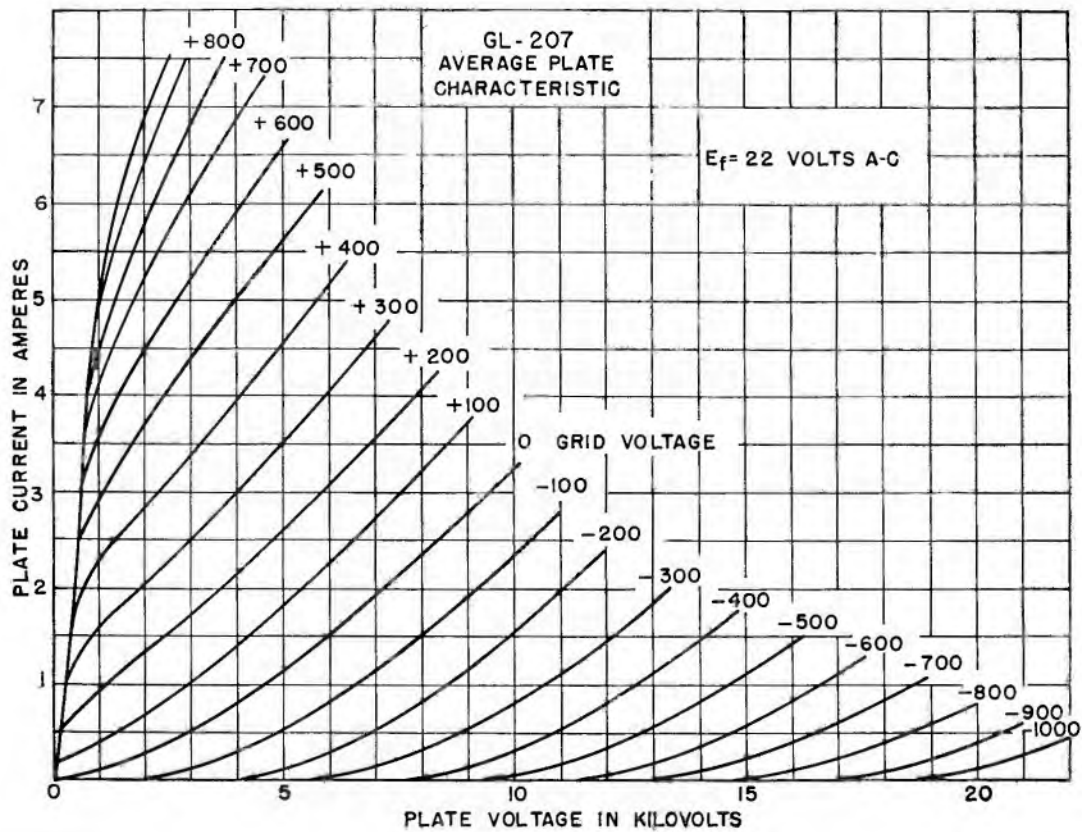
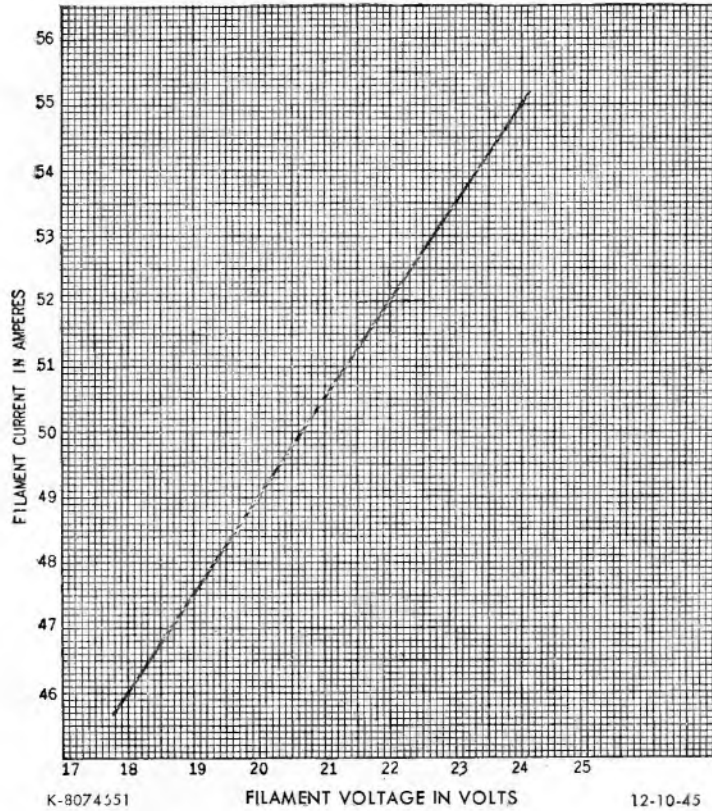
CHARACTERISTICS
 $E_f = 22$ VOLTS A-C

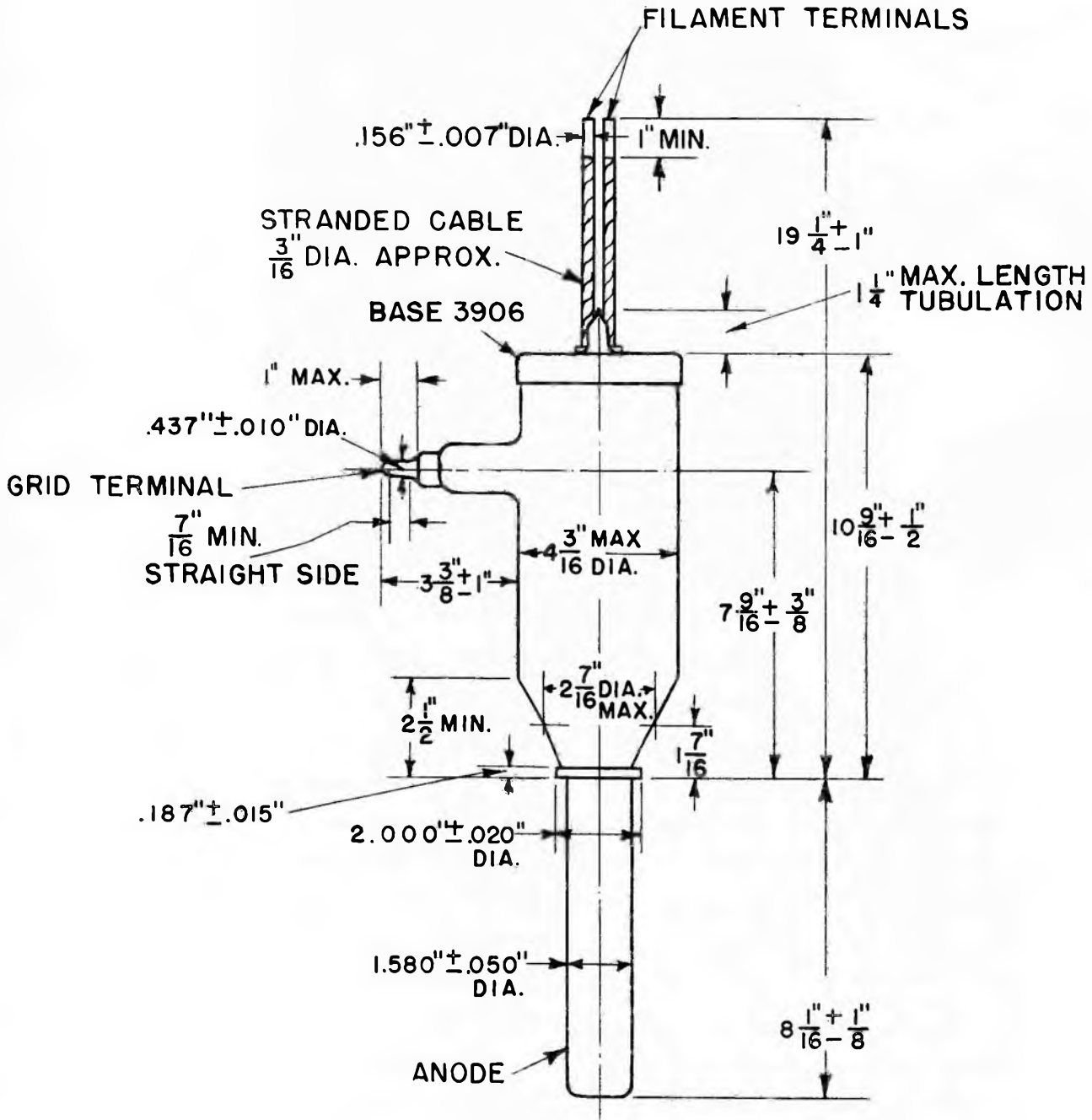


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GL-207 FILAMENT CHARACTERISTIC
(COLD RESISTANCE OF FILAMENT = 0.03 OHMS)





OUTLINE
GL-207 PIOTRON

K-5182095

7-27-45

Tube Department, Electronics Division

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The FP-285 is a high-vacuum tube suitable for use as an oscillator and radio-frequency amplifier in high-frequency circuits.

This tube is especially satisfactory when used to generate the ultra-high frequencies required in short-wave therapy equipment. The hazard of stem puncture, a common fault in some tubes used in such applications, has been eliminated by bringing the plate and grid leads out through the side

wall of the cathode stem. Low plate-to-filament capacitance and good insulation, especially important features in tubes for high-frequency service, are assured by the use of a special insulator which supports the mount and holds the clamp and supports away from the plate.

These, together with the other design features inherent in pliotrons of this type, result in economical, dependable operation and long life.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage	9.5	10	10.5 volts
Filament current at bogey voltage	3.1	3.25	3.4 amperes
Amplification factor, $I_b = 75$ ma d-c, $E_c = 0$ and -50 volts d-c	10.8	12.0	13.2
Interelectrode capacitances			
Grid-plate	11.8	13.5	15.2 uuf
Grid-filament	5.0	6.0	7.0 uuf
Plate-filament	3.75	5.0	6.25 uuf

†Completely revised.



GENERAL  ELECTRIC

Supersedes ETI-164 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position—vertical, or horizontal with plane of electrodes vertical

Net weight, approximate. 8 ounces

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation*

Maximum ratings, absolute values

A-c plate voltage, rms	1500 max	volts
D-c plate voltage, filtered or pulsating	1350 max	volts
D-c grid voltage	—400 max	volts
D-c plate current	200 max	milliamperes
D-c grid current	50 max	milliamperes
Plate input	270 max	watts
Plate dissipation	100 max	watts

Typical operation

D-c plate voltage, filtered or pulsating	750	1000	1250	volts
D-c grid voltage	—100	—150	—200	volts
D-c plate current	200	200	200	milliamperes
D-c grid current	30	30	30	milliamperes
Power output	100	140	180	watts

* Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

Maximum ratings apply up to 20 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	20	50	80	megacycles
Percentage of maximum rated plate voltage and plate input	100	75	50	per cent

APPLICATION NOTES

The tube may be mounted either vertically, with base up or down, or horizontally, with the filament in a vertical plane. The metal shell must not be connected to any part of the circuit.

The normal value of grid leak, when the tube is used as an oscillator or r-f power amplifier (Class C), is in the neighborhood of 5000 ohms, although this may be replaced by a suitable fixed bias. If self-bias is used, the cathode resistor should be

approximately 1000 ohms. In some cases, to minimize the danger of overloads, a combination of grid leak and partial self-bias may be desirable. The values should be chosen so that the plate loss at the worst condition is limited to the maximum rating.

The following table indicates the tube output obtainable at various wavelengths when the tube is operated within the maximum allowable conditions in a properly designed circuit.

Wavelength		A-c Plate Voltage, Volts	Minimum Plate Output, Watts	Maximum Plate Output, Approx Watts
Meters	Megacycles			
15	20	1500	170	200
10	30	1350	150	180
7.5	40	1250	140	160
6	50	1150	110	130
5	60	1000	80	100
4	75	750	40	60

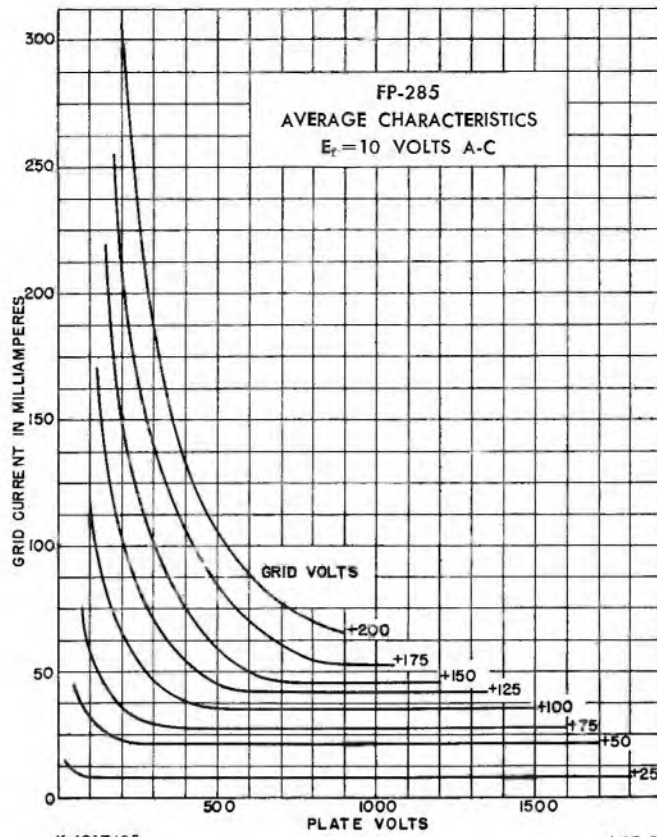


Fig. 1

FP-285
AVERAGE PLATE CHARACTERISTICS
 $E_f = 10$ VOLTS A-C

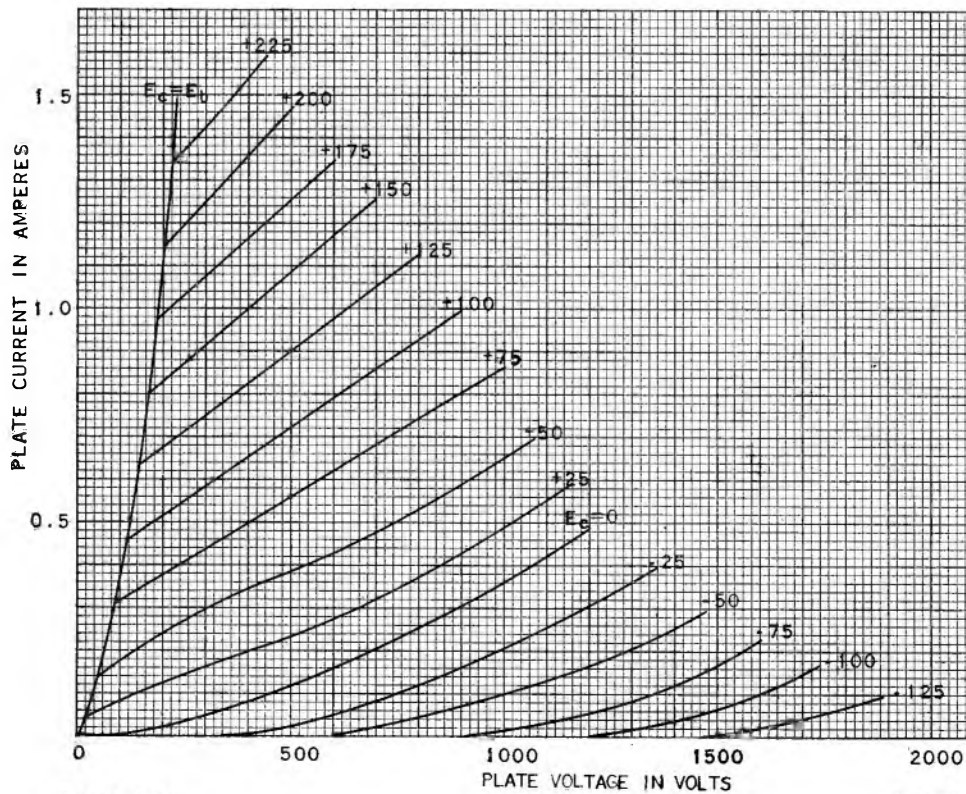
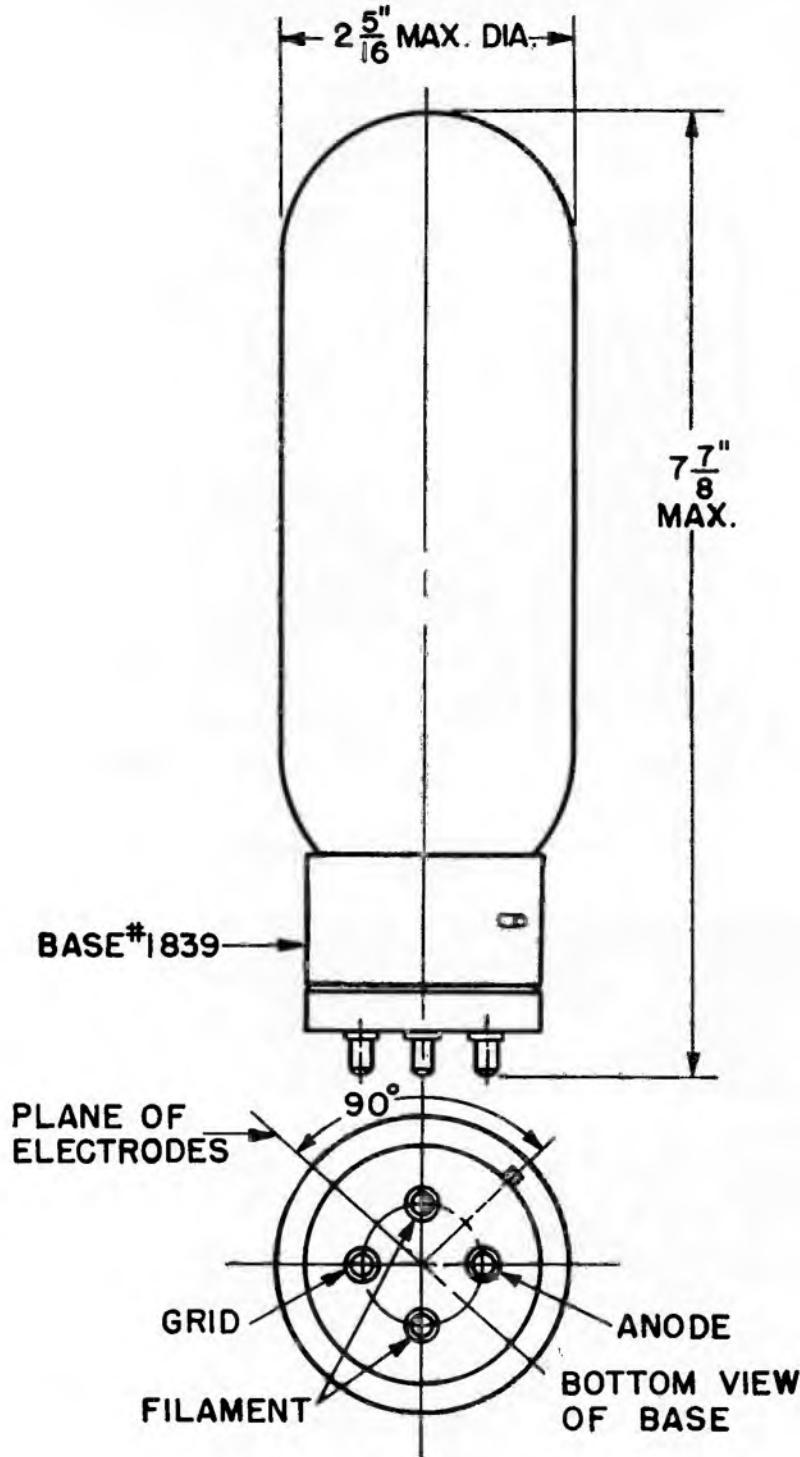


Fig. 2

OUTLINE
FP-285 PLIOTRON



K-5302946

8-7-45

Tube Divisions, Electronics Department

GENERAL  **ELECTRIC**

Schenectady, N. Y.

GL-807DESCRIPTION
AND RATING

ETI-165A

PAGE 1

3-50

(Pages 1 thru
4 revised
5-51)**PLIOTRON****DESCRIPTION**

The GL-807 is a five-electrode transmitting tube for use as an amplifier, modulator, and oscillator. The anode can dissipate 30 watts, and cooling is

accomplished by radiation. The cathode is the indirectly heated type. Maximum ratings apply up to 60 megacycles.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Heater Voltage.....	5.7	6.3	6.9	volts
Heater Current at Bogey Voltage.....	0.81	0.9	0.99	ampere
Amplification Factor, G ₁ -G ₂ , E _b = E _{c2} = 250 v, E _c = -10 v.....		8		
Direct Interelectrode Capacitances.....				
Grid-Plate (With External Shield).....	—	—	0.2	uuf
Input.....	10	12	14	uuf
Output.....	5.3	7	8.7	uuf
Mechanical Data				
Mounting Position—Any.....				
Net Weight, approximate.....			2.5	ounces

◆ Technical information revised.

Supersedes ETI-165 dated 4-45

GENERAL  **ELECTRIC**


Electronic
TUBE

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS AB1 (TRIODE CONNECTED)

Maximum ratings, absolute values		CCS	ICAS	
D-c plate and grid—No. 2 voltage		400 max	400 max	volts
Maximum signal d-c plate plus grid—No. 1 current*		125 max	125 max	milliamperes
Maximum signal d-c plate plus grid—No. 2 input*		50 max	50 max	watts
Plate plus grid—No. 2 dissipation*		25 max	30 max	watts
Typical operation		CCS	ICAS	
Unless otherwise specified, values are for two tubes				
D-c plate and grid—No. 2 voltage		400	400	volts
D-c grid—No. 1 voltage†		-45	-45	volts
Peak a-f grid—No. 1-to-grid-No. 1 voltage‡		90	90	volts
Zero—signal d-c plate plus grid—No. 2 current		60	60	milliamperes
Maximum—signal d-c plate plus Grid—No. 2 current		140	140	milliamperes
Effective load resistance, plate to plate		3000	3000	ohms
Maximum—signal driving power, approximate		0	0	watts
Maximum—signal power output, approximate		15	15	watts

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS AB2

Maximum ratings, absolute values		CCS	ICAS	
D-c plate voltage		600 max	750 max	volts
D-c grid—No. 2 voltage		300 max	300 max	volts
Maximum signal d-c plate current*		120 max	120 max	milliamperes
Maximum signal plate input*		60 max	90 max	watts
Maximum signal grid—No. 2 input*		3.5 max	3.5 max	watts
Plate dissipation*		25 max	30 max	watts
Typical operation		CCS	ICAS	
Unless otherwise specified, values are for two tubes				
D-c plate voltage	400	500	600	750 volts
D-c grid—No. 2 voltage	300	300	300	300 volts
D-c grid—No. 1 voltage**	-25	-29	-30	-32 volts
Peak A-F grid No. 1 to grid No. 1 voltage	78	86	78	92 volts
Zero—signal d-c plate current	90	72	60	52 milliamperes
Maximum—signal d-c plate current	240	240	200	240 milliamperes
Zero—signal d-c grid—No. 2 current	2.0	0.9	0.7	0.5 milliamperes
Maximum—signal d-c grid—No. 2 current	15	12	16	17 milliamperes
Effective load resistance, plate to plate	3200	4240	6400	6950 ohms
Maximum—signal driving power, approximate***	0.2	0.2	0.1	0.2 watts
Maximum—signal power output, approximate	55	75	80	120 watts

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum ratings, absolute values		CCS	ICAS	
D-c plate voltage		600 max	750 max	volts
D-c grid—No. 2 voltage		300 max	300 max	volts
D-c plate current		80 max	90 max	milliamperes
Plate input		37.5 max	45 max	watts
Grid—No. 2 input		2.5 max	2.5 max	watts
Plate dissipation		25 max	30 max	watts
Typical operation		CCS	ICAS	
D-c plate voltage	400	500	600	750 volts
D-c grid—No. 2 voltage	250	250	250	300 volts
D-c grid—No. 1 voltage**	-25	-25	-25	-35 volts
Peak R-F grid—No. 1 voltage	30	30	20	27 volts
D-c plate current	75	75	62.5	60 milliamperes
D-c grid—No. 2 current	4	4	3	3 milliamperes
D-c grid—No. 1 current, approximate	0	0	0	0 milliamperes
Driving power, approximate//	0.25	0.25	0.2	0.12 watts
Power output, approximate	9	12.5	12.5	15 watts

TECHNICAL INFORMATION (CONT'D)

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

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

Maximum ratings, absolute values	CCS			ICAS	
	D-c plate voltage.....	475 max			600 max	volts
D-c grid—No. 2 voltage.....	300 max			300 max	volts
D-c grid—No. 1 voltage.....	—200 max			—200 max	volts
D-c plate current.....	83 max			100 max	milliamperes
D-c grid—No. 1 current.....	5 max			5 max	milliamperes
Plate input.....	40 max			60 max	watts
Grid—No. 2 input.....	2.5 max			2.5 max	watts
Plate dissipation.....	16.5 max			25 max	watts
Typical operation	CCS			ICAS	
D-c plate voltage.....	375	400	475	600	volts
D-c grid—No. 2 voltage.....	225	225	225	275	volts
D-c grid—No. 1 voltage**.....	—75	—80	—85	—90	volts
Peak R-F grid—No. 1 voltage.....	90	95	110	115	volts
D-c plate current.....	80	80	83	100	milliamperes
D-c grid—No. 2 current.....	5	5.75	5	6.5	milliamperes
D-c grid—No. 1 current, approximate.....	3	3.5	4	4	milliamperes
Driving power, approximate.....	0.25	0.3	0.4	0.4	watts
Power output, approximate.....	17.5	22.5	27.5	42.5	watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation †

Maximum ratings, absolute values	CCS			ICAS	
	D-c plate voltage.....	600 max			750 max	volts
D-c grid—No. 2 voltage.....	300 max			300 max	volts
D-c grid—No. 1 voltage.....	—200 max			—200 max	volts
D-c plate current.....	100 max			100 max	milliamperes
D-c grid No. 1 current.....	5 max			5 max	milliamperes
Plate input.....	60 max			75 max	watts
Grid—No. 2 input.....	3.5 max			3.5 max	watts
Plate dissipation.....	25 max			30 max	watts
Typical operation	CCS			ICAS	
D-c plate voltage.....	400	500	600	750	volts
D-c grid—No. 2 voltage.....	250	250	250	250	volts
D-c grid—No. 1 voltage**.....	—45	—45	—45	—45	volts
Peak r-f grid—No. 1 voltage.....	65	65	65	65	volts
D-c plate current.....	100	100	100	100	milliamperes
D-c grid—No. 2 current.....	7.5	6	7	6	milliamperes
D-c grid—No. 1 current, approximate.....	3.5	3.5	3.5	3.5	milliamperes
Driving power, approximate.....	0.2	0.2	0.2	0.2	watts
Power output, approximate.....	25	30	40	50	watts

*Averaged over any audio-frequency cycle of sine-wave form.

†The type of input coupling network used should not introduce too much resistance in the grid—No. 1 circuit. Transformer or impedance coupling devices are recommended. When the grid—No. 1 is operated in the negative region with fixed bias, the d-c grid—No. 1 circuit resistance should not exceed 100,000 ohms. For higher values of d-c grid—No. 1 circuit resistance, cathode bias is required. Under no circumstances should the total d-c grid—No. 1 circuit resistance exceed 0.5 megohms.

‡The driver stage should be capable of supplying the No. 1 grids of the class AB stage with the specified driving voltage at low-distortion.

**When the tube is operated at its maximum ratings and the grid is driven positive, the total d-c grid—No. 1 circuit resistance should not exceed 30,000 ohms. If additional bias is required, it must be supplied by a cathode resistor or a fixed supply. When the tube is operated at less than maximum ratings, the d-c grid—No. 1 circuit resistance may be as high as 100,000 ohms.

***Driver stage should be capable of supplying the No. 1 grids of the class AB stage with the specified driving power at low distortion. The effective resistance per grid—No. 1 circuit of the class AB stage should be kept below 500 ohms and the effective impedance at the highest response frequency should not exceed 700 ohms.

//At crest of audio-frequency cycle with modulation factor of 1.0.

¶Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

GL-807

ETI-165A

PAGE 4

3-50

(Pages 1 thru 4 revised 5-51)

TECHNICAL INFORMATION (CONT'D)

Maximum ratings apply up to 60 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

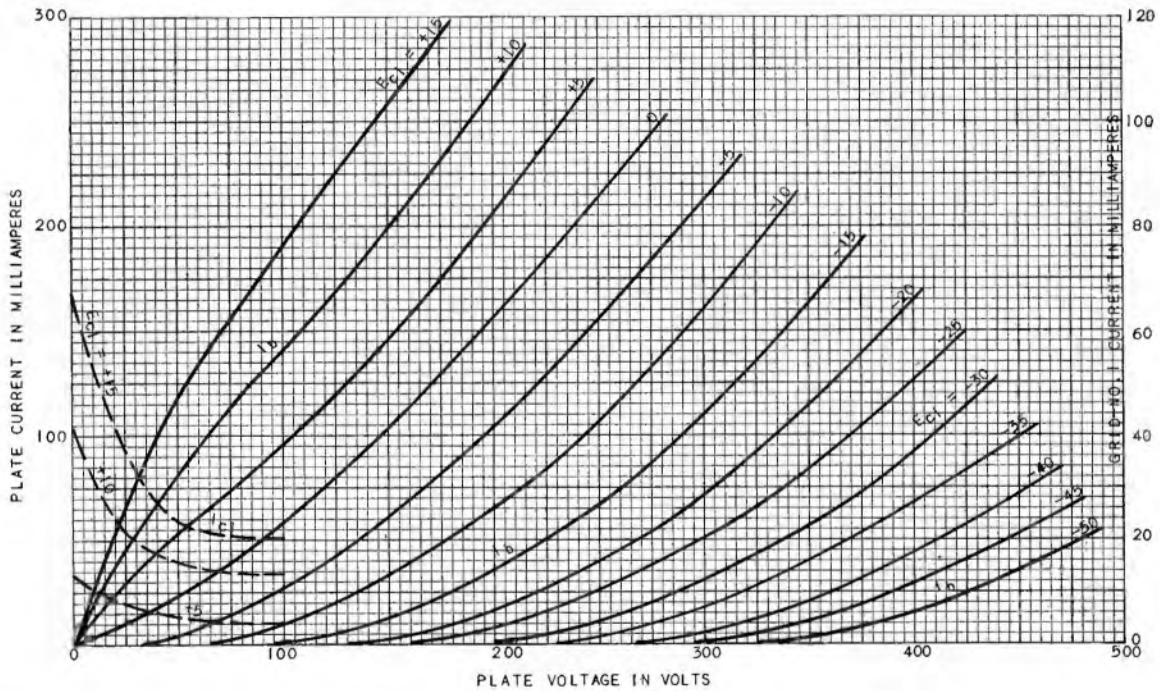
Frequency	60	80	125 megacycles
Percentage of maximum rated plate			
Voltage and plate input			
Class B	100	90	75 per cent
Class C plate modulated	100	80	55 per cent
Class C unmodulated	100	80	55 per cent

◆ GL-807

AVERAGE PLATE CHARACTERISTICS

TRIODE CONNECTION

GRID NO. 2 CONNECTED TO PLATE, $E_f = 6.3$ VOLTS



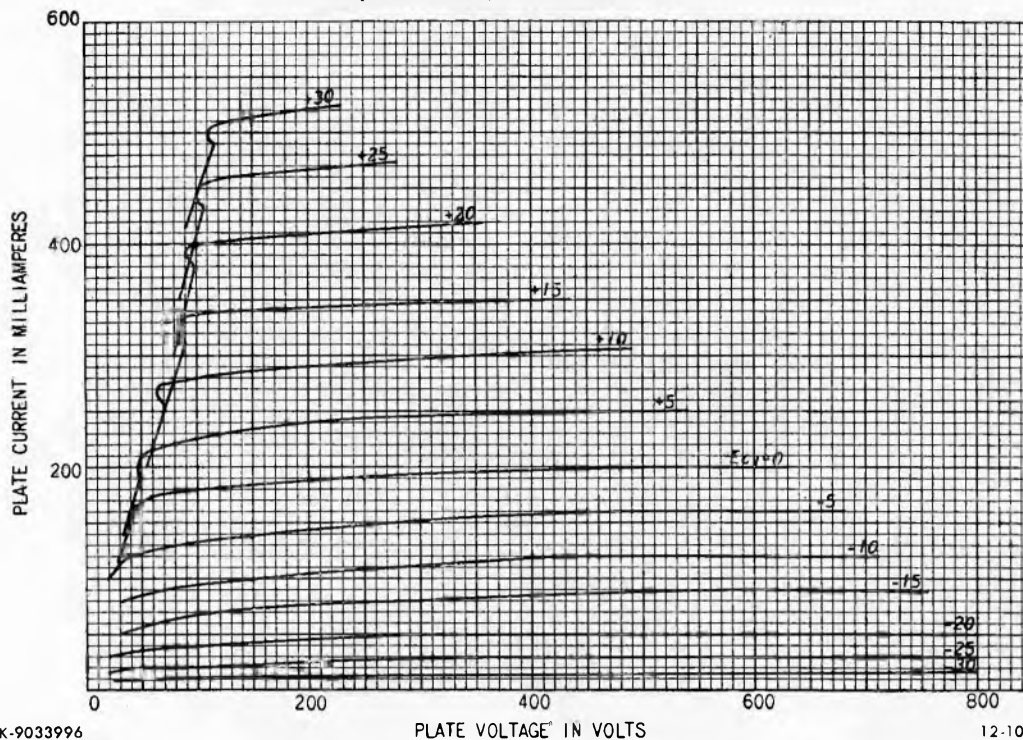
K-69087-72A369

†New Drawing.

4-18-50

*GL-807 AVERAGE PLATE CHARACTERISTICS WITH E_{c1} AS VARIABLE

($E_r = 6.3$ VOLTS, SCREEN VOLTS = 250)

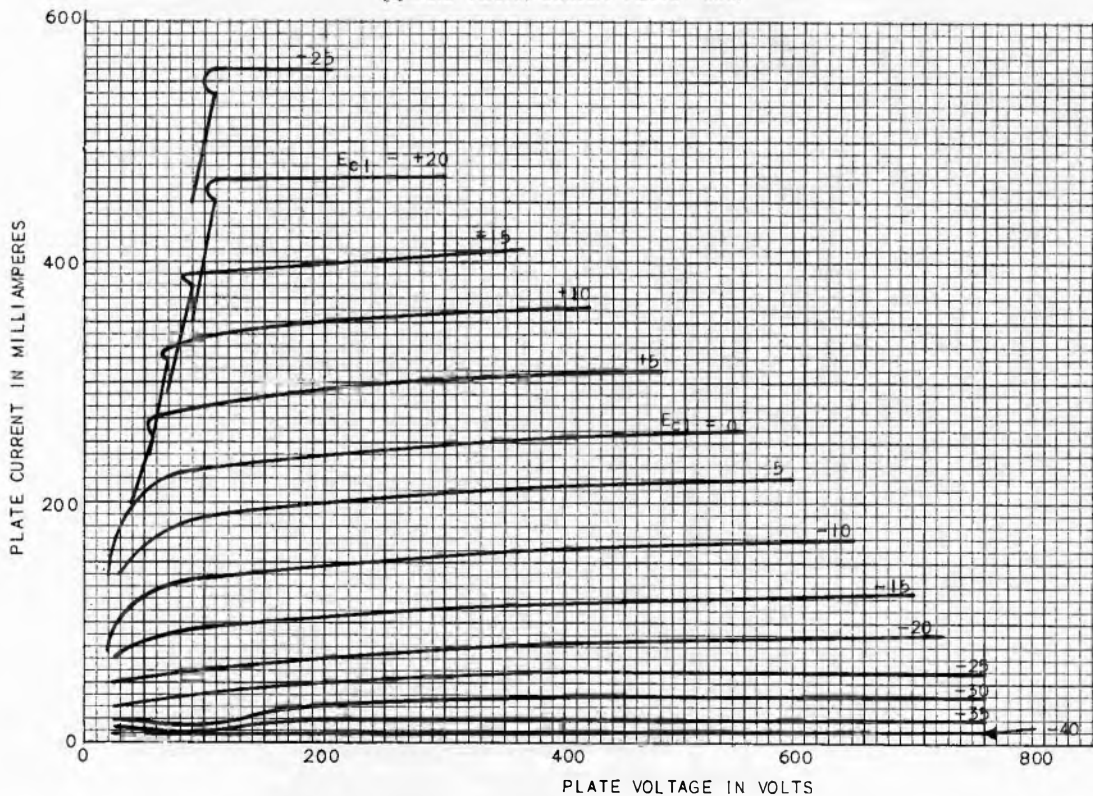


K-9033996
 *New Drawing.

12-10-45

*GL-807 AVERAGE PLATE CHARACTERISTICS WITH E_{c1} AS VARIABLE

($E_r = 6.3$ VOLTS, SCREEN VOLTS = 300)



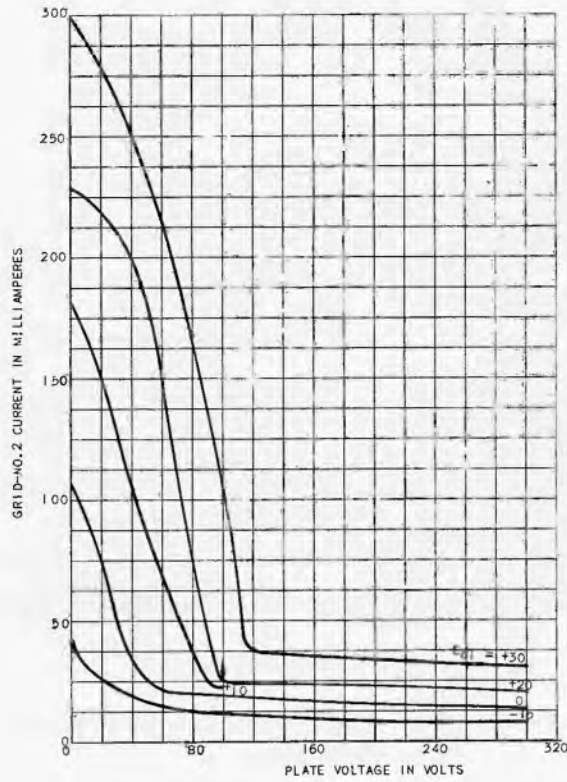
K-69087-72A363
 *New Drawing.

PLATE VOLTS

3-30-50

♦GL-807 AVERAGE CHARACTERISTICS

($E_f = 6.3$ VOLTS, SCREEN VOLTS = 300)



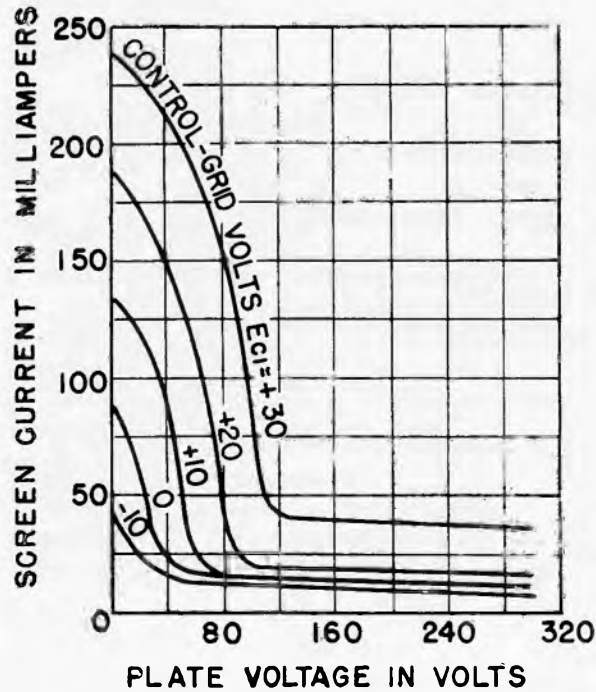
K-69087-72A370

4-20-50

♦Revised Drawing.

♦GL-807 AVERAGE CHARACTERISTICS

($E_f = 6.3$ VOLTS, SCREEN VOLTS = 250)



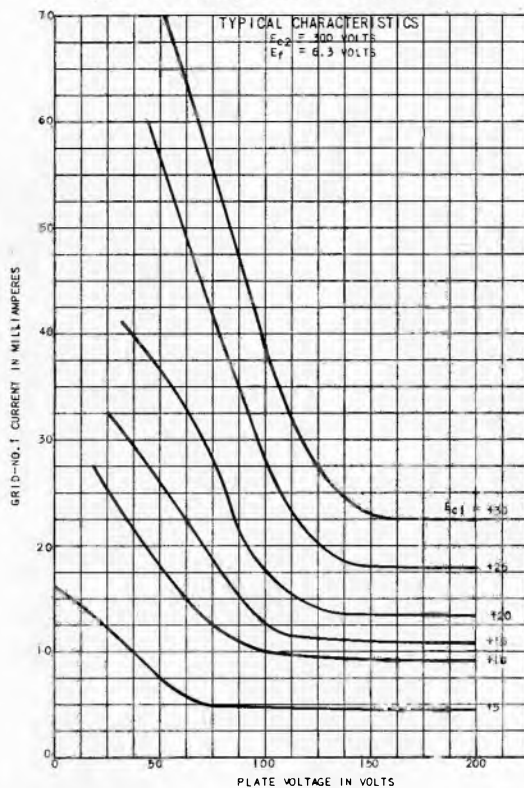
K-9033963

10-8-45

♦New Drawing.

♦GL-807 TYPICAL CHARACTERISTICS

($E_f = 6.3$ VOLTS, SCREEN VOLTS = 300)



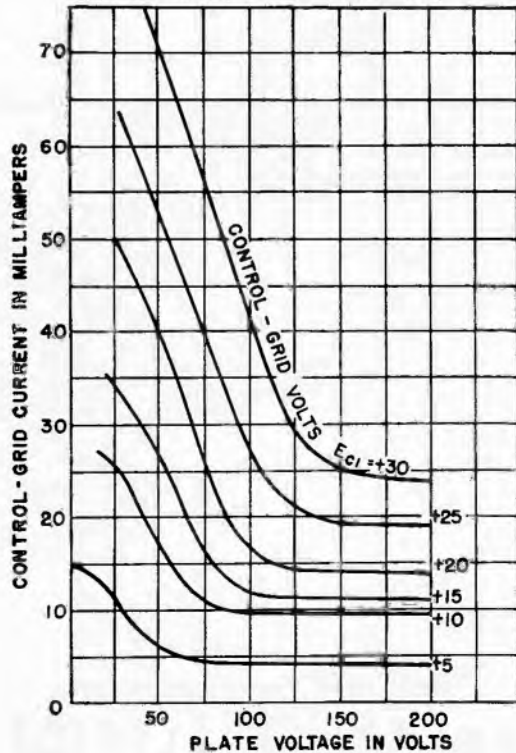
K-69087-72A371

♦Revised Drawing.

4 20-50

♦GL-807 TYPICAL CHARACTERISTICS

($E_f = 6.3$ VOLTS, SCREEN VOLTS = 250)

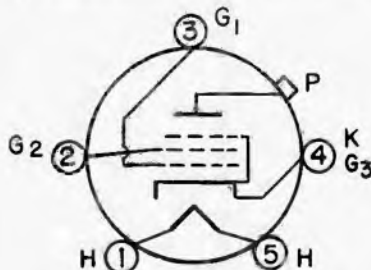
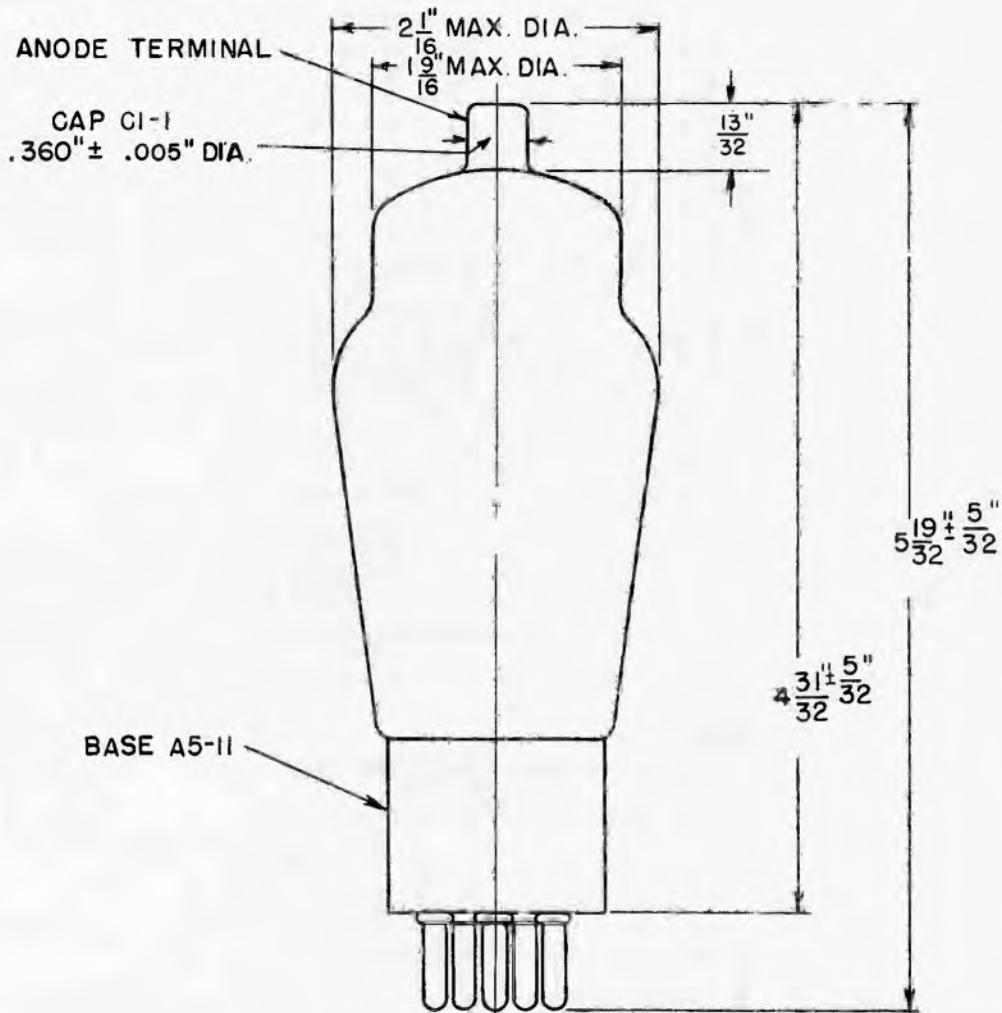


K-9033956

♦New Drawing.

10-8-45

◆OUTLINE
GL-807 PIOTRON



BASING DIAGRAM

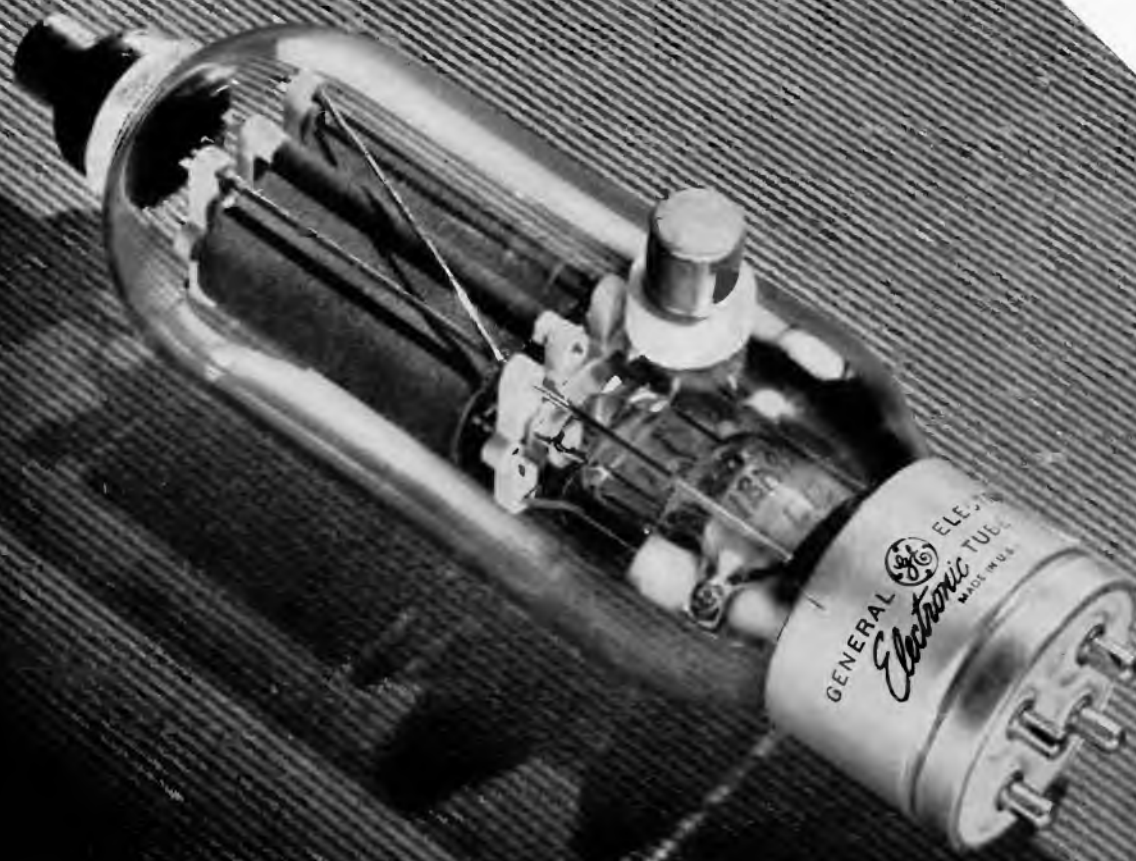
K-8639602
◆Revised Drawing.

3-30-50

Tube Divisions, Electronics Department

GENERAL  **ELECTRIC**

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-810 is a three-electrode high-mu tube with a typical power output of 575 watts (ICAS) for Class C telegraph service. Because of its high permeance the tube can be operated at high plate efficiency with low driving power and relatively low plate voltage. The heavy duty filament, shielded at each end, conserves input power by

eliminating bulb bombardment and stray electrons. The plate and grid leads are brought out to terminals at the top and side of the bulb, respectively—a design which provides very short internal leads, low internal lead inductance, and permits compact high-frequency circuits. Maximum ratings apply up to 30 megacycles.

▲ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Filament voltage.....	10 volts
Filament current.....	4.5 amperes
Amplification factor.....	36
Interelectrode capacitances	
Grid-plate.....	4.8 uuf
Grid-filament.....	8.7 uuf
Plate-filament.....	12 uuf

▲ Ratings completely revised.

GENERAL  ELECTRIC

Supersedes ETI-166 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position..... Vertical, base down; or horizontal, pins 1 and 2 in vertical plane

Net weight, approximate..... 8 ounces

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum Ratings, Absolute Values	CCS*	ICAS†
D-c plate voltage.....	2500 max	2750 max volts
Maximum signal d-c plate current†.....	250 max	250 max milliamperes
Maximum signal plate input†.....	425 max	510 max watts
Plate dissipation†.....	125 max	175 max watts
Typical Operation		
Unless otherwise specified, values are for two tubes		
D-c plate voltage.....	2000	2250 volts
D-c grid voltage**.....	-50	-60 volts
Peak A-F grid-to-grid voltage.....	345	380 volts
Zero signal d-c plate current.....	60	70 milliamperes
Maximum signal d-c plate current.....	420	450 milliamperes
Effective load resistance, plate to plate.....	11000	11600 ohms
Maximum signal driving power, approximate.....	10	13 watts
Maximum signal power output, approximate.....	590	725 watts

†Averaged over any audio-frequency cycle of sine-wave form.

**For a-c filament supply.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum Ratings, Absolute Values	CCS*	ICAS†
D-c plate voltage.....	2000 max	2500 max volts
D-c plate current.....	185 max	185 max milliamperes
Plate input.....	185 max	225 max watts
Plate dissipation.....	125 max	175 max watts
Typical Operation		
D-c plate voltage.....	1500	2000
D-c grid voltage**.....	-50	-65
Peak R-F grid voltage.....	110	100
D-c plate current.....	115	93
D-c grid current, approximate.....	2	2
Driving power, approximate††.....	6	4
Power output, approximate.....	60	60

††At crest of audio-frequency cycle with modulation factor of 1.0.

**For a-c filament supply.

TECHNICAL INFORMATION (CONT'D)

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

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

Maximum Ratings, Absolute Values	CCS*		ICAS†
	D-c plate voltage.....	1600 max		2000 max volts
D-c grid voltage.....	-500 max		-500 max volts
D-c plate current.....	210 max		250 max milliamperes
D-c grid current.....	70 max		75 max milliamperes
Plate input.....	335 max		500 max watts
Plate dissipation.....	85 max		125 max watts
Typical Operation	CCS*		ICAS†
Dc- plate voltage.....	1250	1600	2000 volts
D-c grid voltage			
From a fixed supply of.....	-200	-200	-350 volts
From a grid resistor of.....	4000	4000	5000 ohms
Peak R-F grid voltage.....	370	370	550 volts
D-c plate current.....	210	210	250 milliamperes
D-c grid current, approximate.....	50	50	70 milliamperes
Driving power, approximate.....	17	17	35 watts
Power output, approximate.....	180	250	380 watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without modulation¶

Maximum Ratings, Absolute Values	CCS*		ICAS†
	D-c plate voltage.....	2000 max		2500 max volts
D-c grid voltage.....	-500 max		-500 max volts
D-c plate current.....	250 max		300 max milliamperes
D-c grid current.....	70 max		75 max milliamperes
Plate input.....	500 max		750 max watts
Plate dissipation.....	125 max		175 max watts
Typical Operation	CCS*		ICAS†
D-c plate voltage.....	1500	2000	2500 volts
D-c grid voltage			
From a fixed supply of.....	-120	-160	-180 volts
From a grid resistor of.....	3000	4000	3000 ohms
From a cathode resistor of.....	415	550	500 ohms
Peak r-f grid voltage.....	280	330	350 volts
D-c plate current.....	250	250	300 milliamperes
D-c grid current, approximate.....	40	40	60 milliamperes
Driving power, approximate.....	10	12	19 watts
Power output, approximate.....	275	375	575 watts

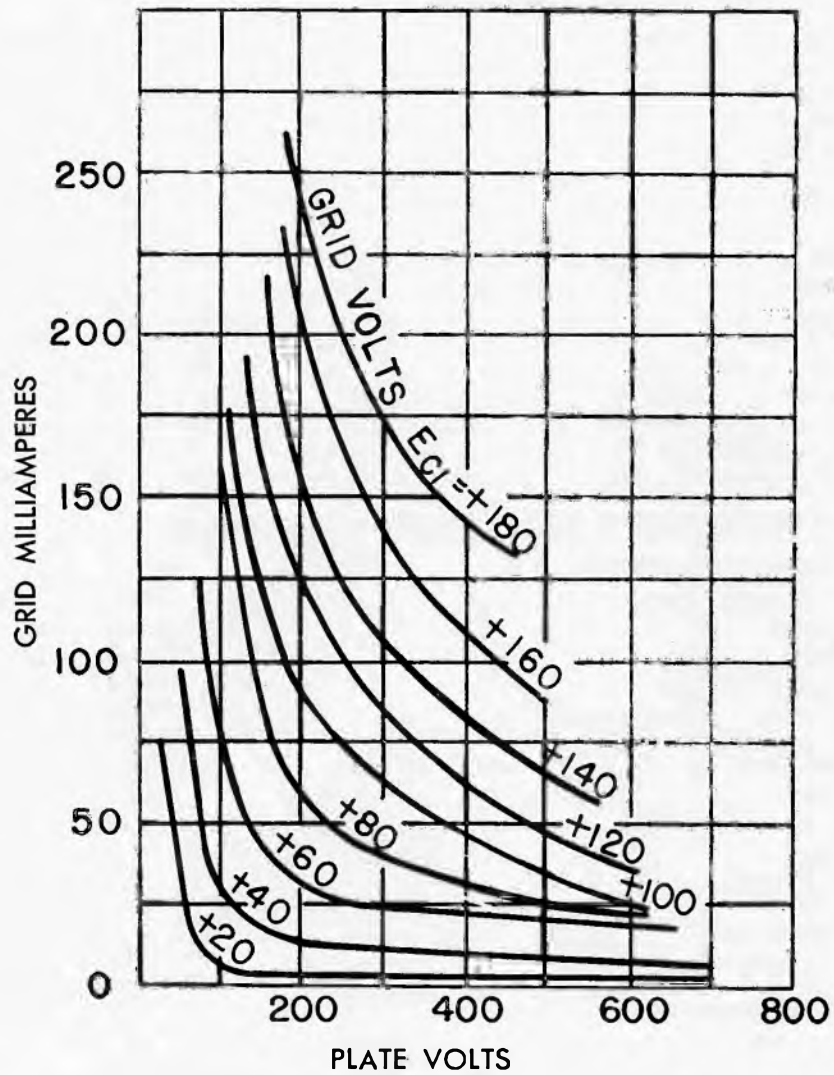
¶ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

Maximum ratings apply up to 30 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency.....	30	60	100 megacycles
Percentage of Maximum Rated Plate Voltage and Plate Input			
Class B.....	100	80	80 per cent
Class C plate modulated.....	100	70	50 per cent
Class C unmodulated.....	100	70	50 per cent

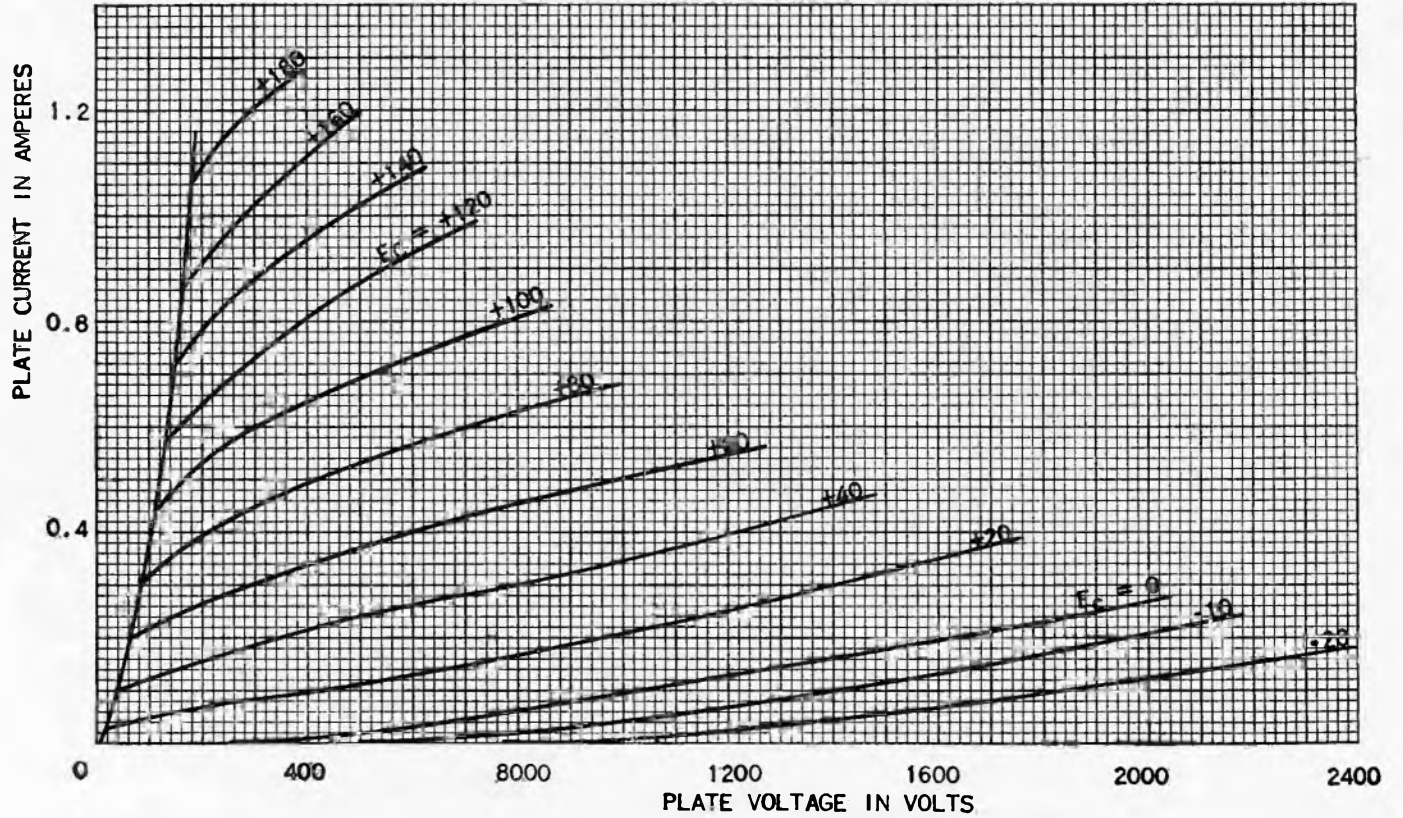
* Continuous commercial service.

† Intermittent commercial and amateur service.



GL-810 TYPICAL CHARACTERISTICS (E_r = 10 VOLTS D-C)

▲ GL-810
AVERAGE PLATE CHARACTERISTICS
 $E_f = 10$ VOLTS D-C



K-69087-72A103

▲ New drawing;

2-6-47

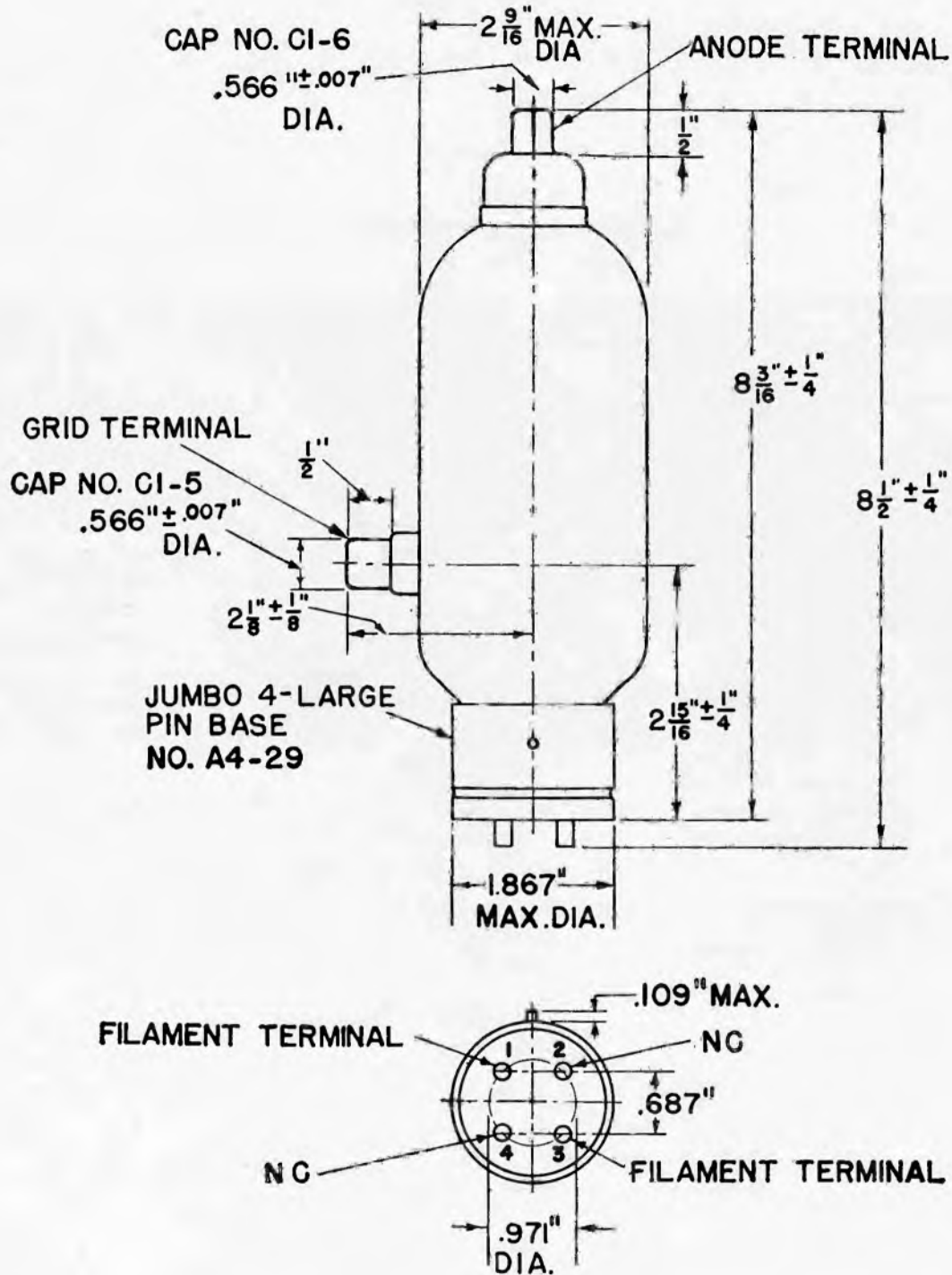
GL-810

ETI-166A

PAGE 6

10-49

■ OUTLINE
GL-810



K-9033819
■ Revised drawing.

8-12-48

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-833-A is a three-electrode tube designed for use as a modulator, amplifier, and oscillator. The anode is capable of dissipating 450 watts. Forced-air cooling of the envelope is required at

maximum ratings. The tube can be operated at reduced ratings without forced-air cooling. The cathode is a thoriated-tungsten filament. Maximum ratings apply up to 20 megacycles.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Filament Voltage	9.5	10	10.5	volts
Filament Current at Bogey Voltage	9.4	10	10.6	amperes
Amplification Factor, $E_c = -20$ v, $I_b = 200$ ma	31.5	35	38.5	
Interelectrode Capacitances				
Grid—Plate	5.5	6.3	7.1	uuf
Grid—Filament	10.1	12.3	14.5	uuf
Plate—Filament	6.4	8.5	10.6	uuf

Mechanical Data

Mounting Position	Vertical, or horizontal with the plane of the electrodes vertical
Required Air Flow to Envelope	40 cubic feet per min
Maximum Glass Temperature	145 C
Net Weight, approximate	1.025 pounds



GENERAL  ELECTRIC

Supersedes ETI-167 dated 4-45

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum Ratings, Absolute Values	Natural Cooling		Forced-air Cooling		
	CCS	ICAS	CCS	ICAS	
	D-c plate voltage	3000 max	3300 max	4000 max		4000 max	volts
Maximum signal d-c plate current*	500 max	500 max	500 max	500 max	milliamperes
Maximum signal plate input*	1125 max	1300 max	1600 max	1800 max	watts
Plate dissipation*	300 max	350 max	400 max	450 max	watts

Typical Operation	Natural Cooling		Forced-air Cooling		
	CCS	ICAS	CCS	ICAS	
	<i>Unless otherwise specified, values are for two tubes</i>				
D-c plate voltage	3000	3300	4000	4000	volts
D-c grid voltage	-70	-80	-100	-100	volts
Peak a-f grid-to-grid voltage	400	440	480	510	volts
Zero-signal d-c plate current	100	100	100	100	milliamperes
Maximum signal d-c plate current	750	780	800	900	milliamperes
Effective load resistance, plate to plate	9500	10500	12000	11000	ohms
Maximum signal driving power, approximate	20	30	29	38	watts
Maximum signal power output, approximate	1650	1900	2400	2700	watts

* Averaged over any audio-frequency cycle of sine-wave form.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum Ratings, Absolute Values	Natural Cooling		Force-air Cooling		
	CCS	ICAS	CCS	ICAS	
	D-c plate voltage	3000 max	3300 max	4000 max		4000 max	volts
D-c plate current	300 max	300 max	300 max	300 max	milliamperes
Plate input	450 max	525 max	600 max	675 max	watts
Plate dissipation	300 max	350 max	400 max	450 max	watts

Typical Operation	CCS		ICAS		
	CCS	ICAS	CCS	ICAS	
	D-c plate voltage	3000	3300	4000		4000	volts
D-c grid voltage	-70	-100	-120	-120	volts
Peak r-f grid voltage	90	110	120	130	volts
D-c plate current	150	150	150	150	milliamperes
D-c grid current, approximate	2	2	2	3	milliamperes
Driving power, approximate**	10	11	14	21	watts
Power output, approximate	150	200	225	250	watts

**At the crest of the audio-frequency cycle with a modulation factor of 1.0.

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

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

Maximum Ratings, Absolute Values	Natural Cooling		Forced-air Cooling		
	CCS	ICAS	CCS	ICAS	
	D-c plate voltage	2500 max	3000 max	3000 max		4000 max	volts
D-c grid voltage	-500 max	-500 max	-500 max	-500 max	volts
D-c plate current	400 max	400 max	450 max	450 max	milliamperes
D-c grid current	100 max	100 max	100 max	100 max	milliamperes
Plate input	835 max	1000 max	1250 max	1800 max	watts
Plate dissipation	200 max	250 max	270 max	350 max	watts

Typical Operation	Natural Cooling		Forced-air Cooling		
	CCS	ICAS	CCS	ICAS	
	D-c plate voltage	2500	3000	3000		4000	volts
D-c grid voltage	-300	-240	-300	-325	volts
Peak r-f grid voltage	460	410	490	520	volts
D-c plate current	335	335	415	450	milliamperes
D-c grid current, approximate	75	70	85	90	milliamperes
Driving power, approximate	30	26	37	42	watts
Power output, approximate	635	800	1000	1500	watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation ¶

Maximum Ratings, Absolute Values	Natural Cooling		Forced-air Cooling		
	CCS	ICAS	CCS	ICAS	
D-c plate voltage	3000 max	3300 max	4000 max	4000 max	volts
D-c grid voltage	-500 max	-500 max	-500 max	-500 max	volts
D-c plate current	500 max	500 max	500 max	500 max	milliamperes
D-c grid current	100 max	100 max	100 max	100 max	milliamperes
Plate input	1250 max	1500 max	1800 max	2000 max	watts
Plate dissipation	300 max	350 max	400 max	450 max	watts

Typical Operation	CCS	ICAS	CCS	ICAS	
D-c plate voltage	3000	3000	4000	4000	volts
D-c grid voltage	-200	-160	-200	-225	volts
Peak r-f grid voltage	360	310	375	415	volts
D-c plate current	415	335	450	500	milliamperes
D-c grid current, approximate	55	70	75	95	milliamperes
Driving power, approximate	20	20	26	35	watts
Power output, approximate	1000	800	1440	1600	watts

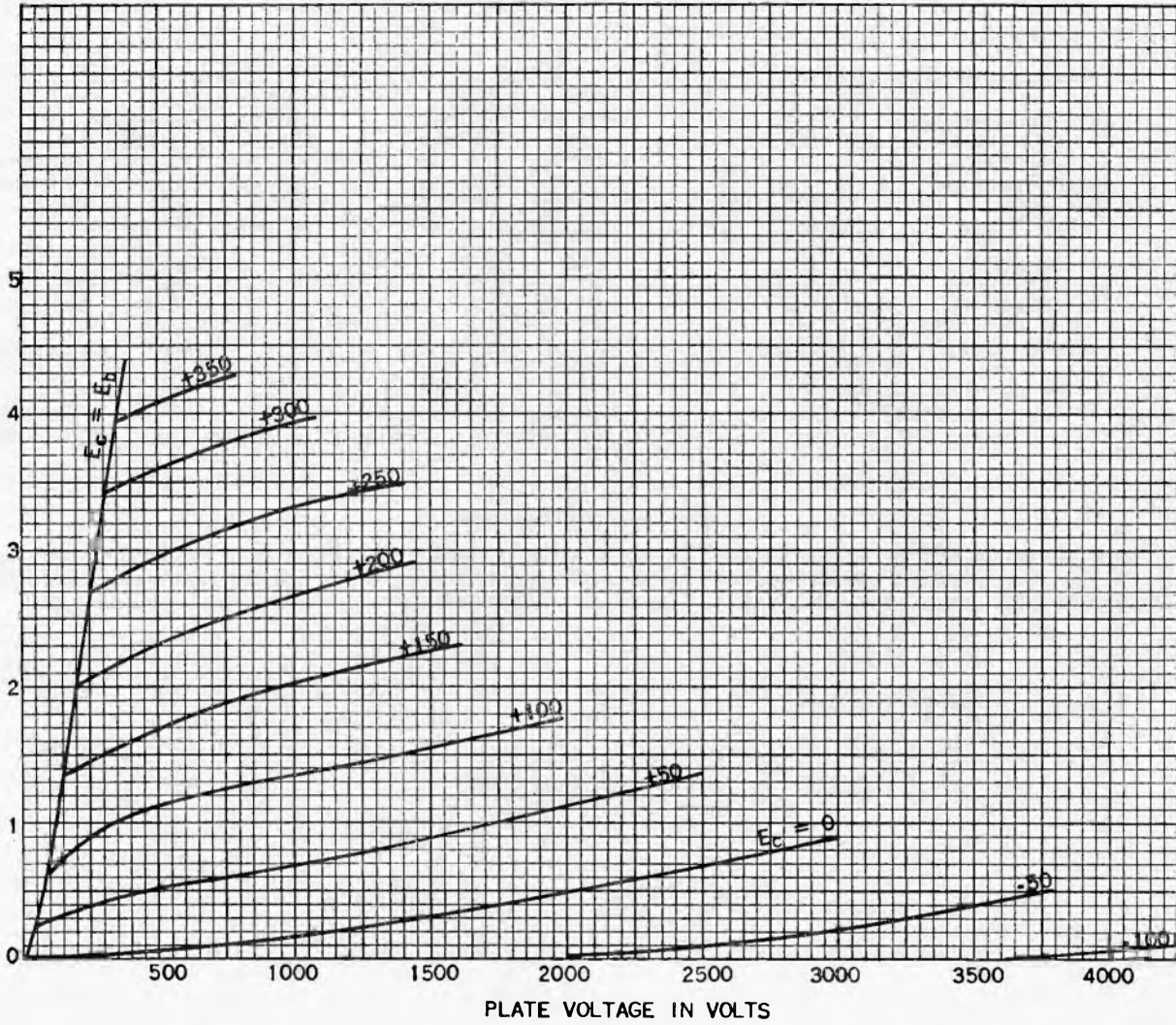
¶ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of carrier conditions.

APPLICATION NOTES

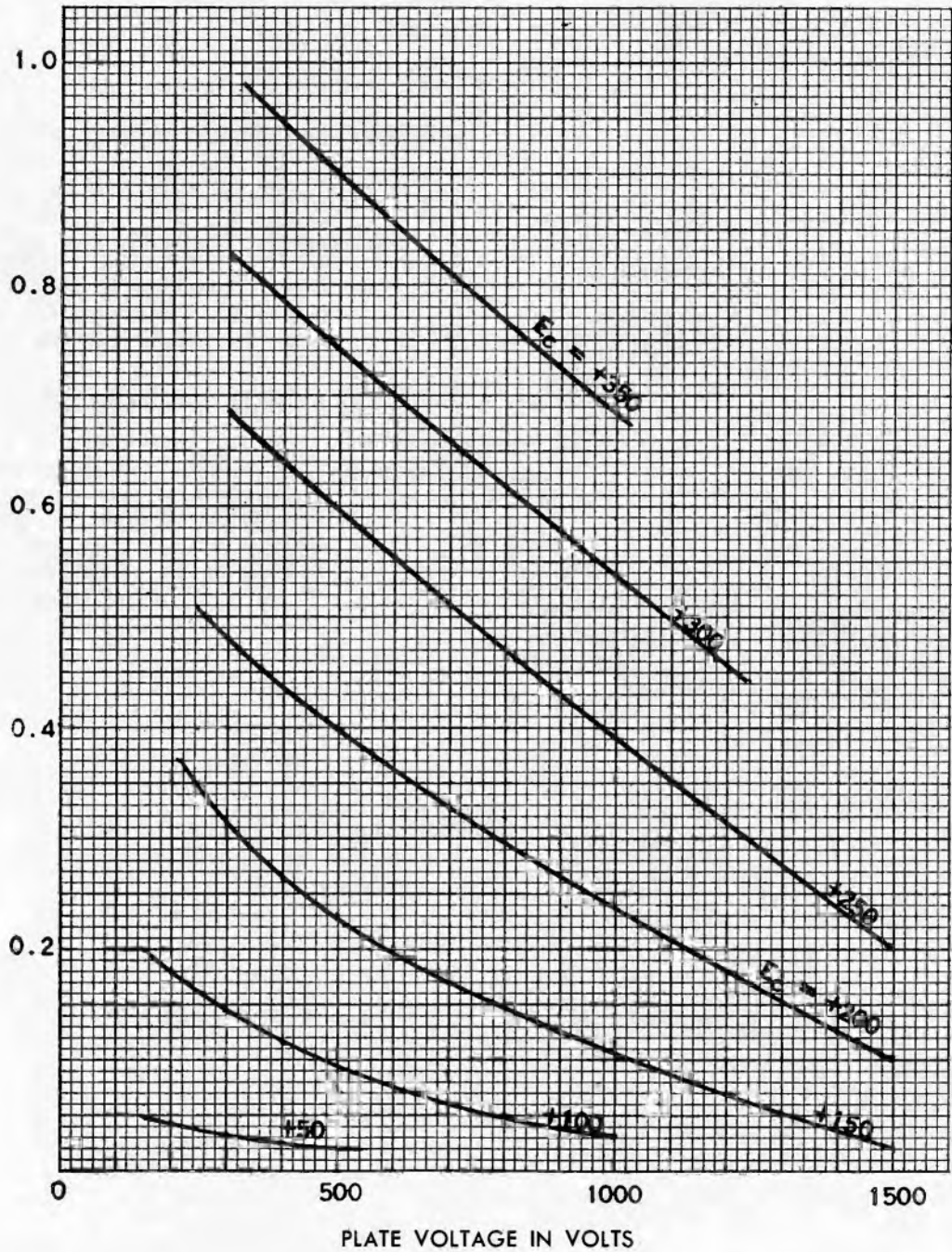
Maximum ratings apply up to 20 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and plate input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	Natural Cooling			Forced Air Cooling		
	30	50	75	20	50	75 megacycles
Percentage of maximum rated plate Voltage and plate input						
Class B	100	98	94	100	97	93 per cent
Class C plate modulated	100	90	72	100	83	65 per cent
Class C unmodulated	100	90	72	100	83	65 per cent

GL-833-A AVERAGE PLATE CHARACTERISTICS ($E_f = 10$ VOLTS A-C)

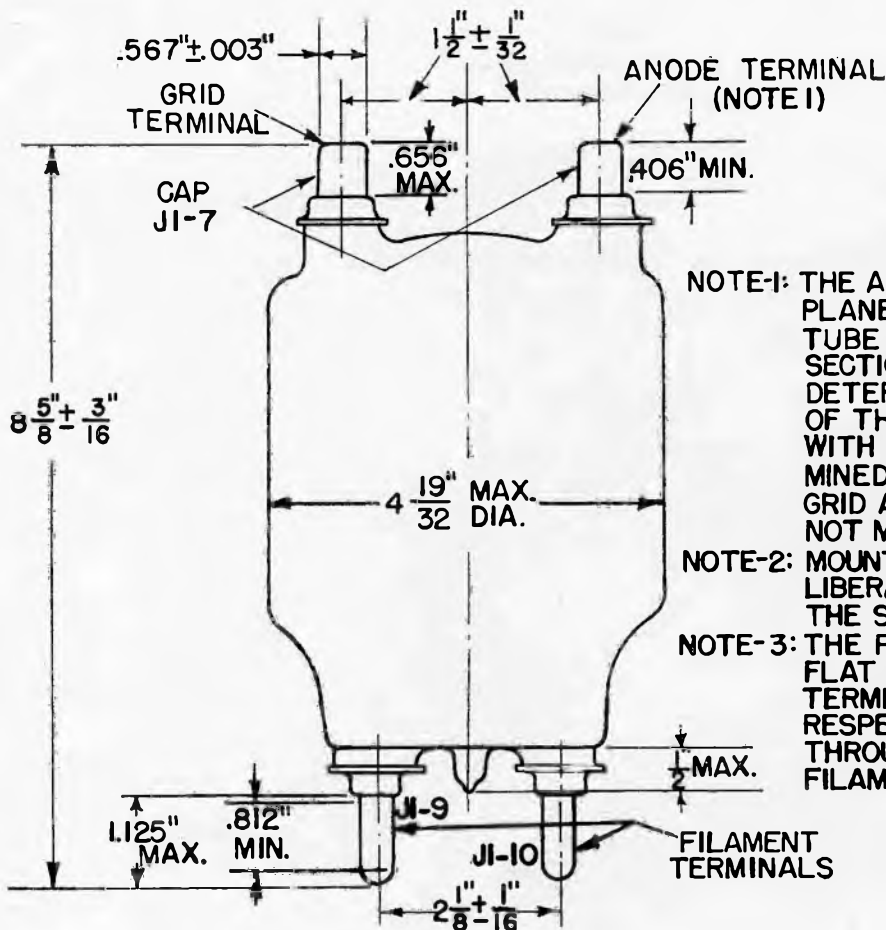


GL-833-A
TYPICAL CHARACTERISTICS
 $E_f = 10$ VOLTS A-C



GL-833-A

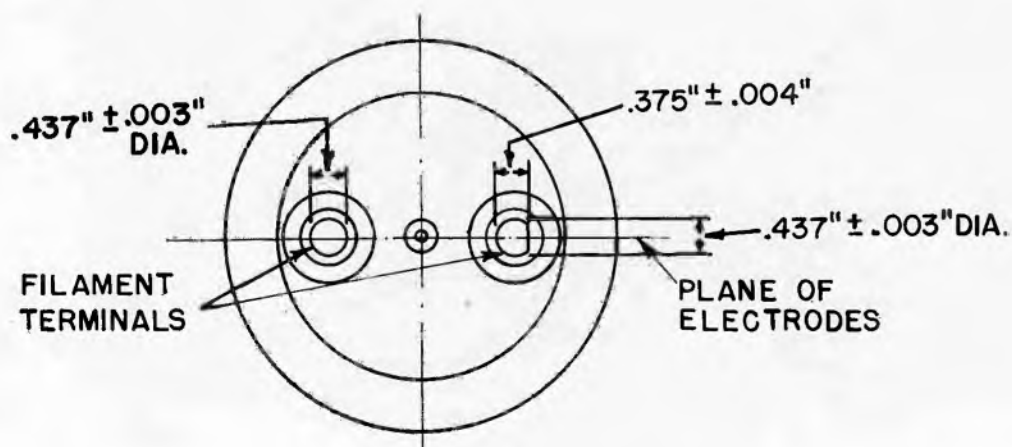
ETI-167A
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NOTE-1: THE ANGLE FORMED ON A PLANE NORMAL TO THE TUBE AXIS BY THE INTERSECTION OF THE PLANE DETERMINED BY THE AXES OF THE FILAMENT TERMINALS WITH THE PLANE DETERMINED BY THE AXES OF THE GRID AND PLATE CAPS IS NOT MORE THAN 5°.

NOTE-2: MOUNTING SHOULD PROVIDE LIBERAL CLEARANCE FOR THE SEAL-OFF TIP.

NOTE-3: THE PLANE THROUGH THE FLAT SIDE OF THE FILAMENT TERMINAL IS $90^\circ \pm 7^\circ$ WITH RESPECT TO THE PLANE THROUGH THE AXES OF THE FILAMENT TERMINALS.



K-6966950

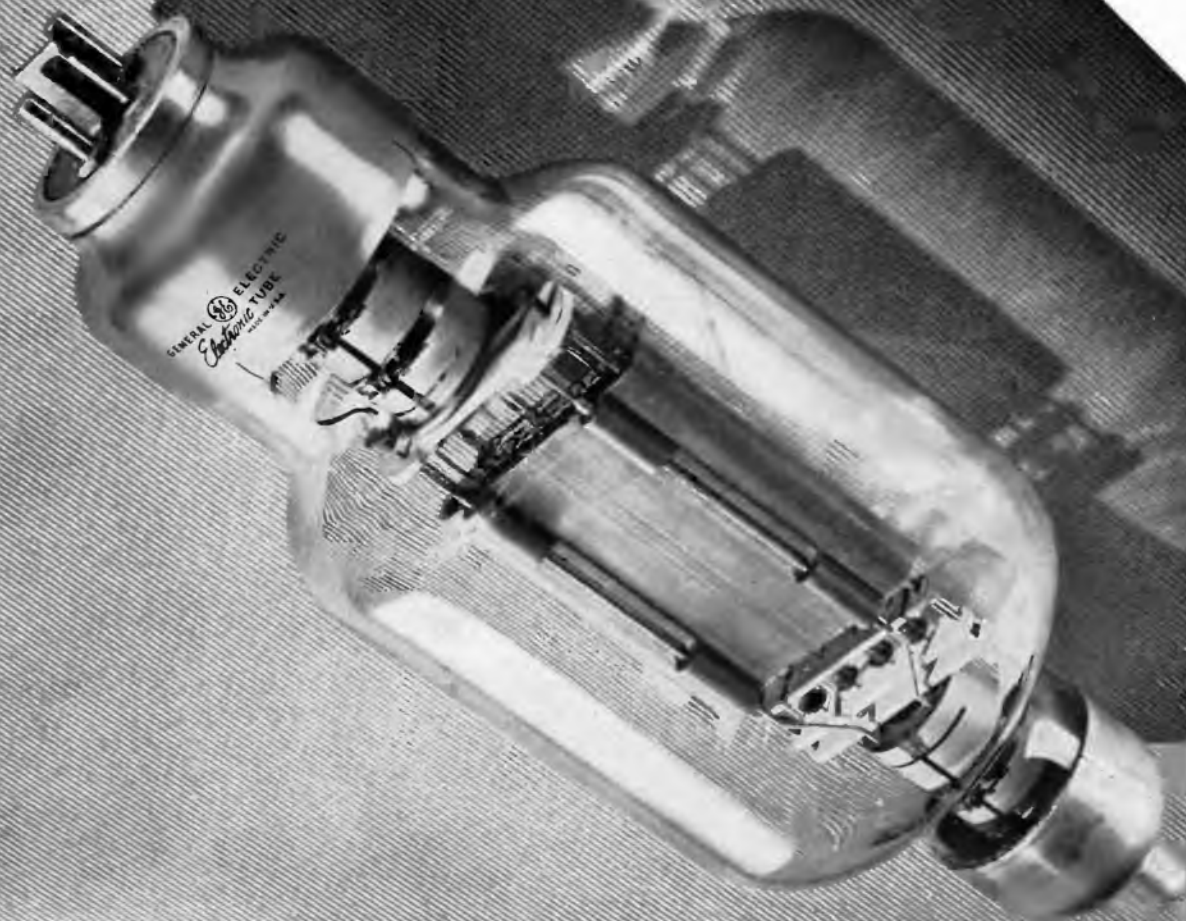
GL-833-A OUTLINE

9-3-48

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-851 is a three-electrode, general purpose oscillator, or Class B modulator. The plate of this tube designed for use as a radio-frequency amplifier, tube is capable of dissipating 500 to 750 watts.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes	3
Electrical	
Filament voltage	11 volts
Filament current	15.5 amperes
Average characteristics	
Amplification factor, $I_b = 300$ ma	20.5
Grid-plate transconductance	15000 micromhos
Direct interelectrode capacitances	
Grid plate	47 micromicrofarads
Input	25.5 micromicrofarads
Output	4.5 micromicrofarads
Frequency for maximum ratings	3 megacycles
Mechanical	
Type of cooling	convection
Maximum ambient temperature	60 centigrade
Net weight, approx.	3 pounds
Mounting position	vertical, filament base (large) up or horizontal, filament in vertical plane (on edge)
Shipping weight, approx.	9 pounds


Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-168 dated 4-45

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

	Typical Operation			Maximum Ratings
CLASS A AUDIO-FREQUENCY AMPLIFIER AND MODULATOR				
D-c plate voltage	1500	2000	2500	2500 volts
Plate dissipation				600 watts
D-c grid voltage	-49	-65	-92	volts
Peak grid swing, approx.	44	60	87	volts
D-c plate current	0.175	0.270	0.240	ampere
Plate resistance	1800	1500	1600	ohms
Load resistance	3700	3100	5000	ohms
Plate power output, 5 per cent second harmonic	46	100	160	watts

CLASS B AUDIO-FREQUENCY POWER AMPLIFIER (TWO TUBES)

D-c plate voltage	2000	2500	3000	3000 volts
Max signal plate current, per tube*				1 ampere
D-c max signal plate input, per tube*				2250 watts
Plate dissipation, per tube*				750 watts
D-c grid voltage	-85	-111	-135	volts
Peak a-f grid input voltage	250	245	245	volts
Zero signal plate current	0.12	0.12	0.11	ampere
Max signal plate current	1.7	1.4	1.2	amperes
Max signal plate input*	3400	3500	3600	watts
Max signal driving power, approx.	20	12	6	watts
Effective load resistance, plate-to-plate	2600	4000	5600	ohms
Max signal plate power output	2200	2300	2400	watts

CLASS B RADIO-FREQUENCY POWER AMPLIFIER

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

D-c plate voltage	1500	2000	2500	2500 volts
D-c grid voltage	-60	-85	-110	volts
D-c plate current	0.62	0.475	0.39	0.750 ampere
Plate input				1100 watts
Plate dissipation				750 watts
Peak r-f grid input voltage	300	280	270	volts
Driving power, approx†	40	25	20	watts
Plate power output	275	300	325	watts

CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—PLATE-MODULATED

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

D-c plate voltage	1500	2000	2000	volts
D-c grid voltage	-250	-300	-500	volts
D-c plate current	0.9	0.85	1	ampere
D-c grid current, approx.	0.15	0.125	0.200	ampere
Plate input			1800	watts
Plate dissipation			500	watts
Peak r-f grid input voltage, approx.	475	525	volts	
Driving power, approx.	75	65	volts	
Plate power output	900	1250	watts	

CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Key-down conditions per tube without modulation‡

D-c plate voltage	1500	2000	2500	2500 volts
D-c grid voltage	-150	-200	-250	-500 volts
D-c plate current	0.9	0.9	0.9	1 ampere
D-c grid current, approx.	0.15	0.12	0.1	0.200 ampere
Plate input				2500 watts
Plate dissipation				750 watts
Peak r-f grid input voltage, approx.	375	425	450	volts
Driving power, approx.	55	50	45	watts
Plate power output	900	1250	1700	watts

* Averaged over any audio-frequency cycle.

† At crest of audio-frequency cycle.

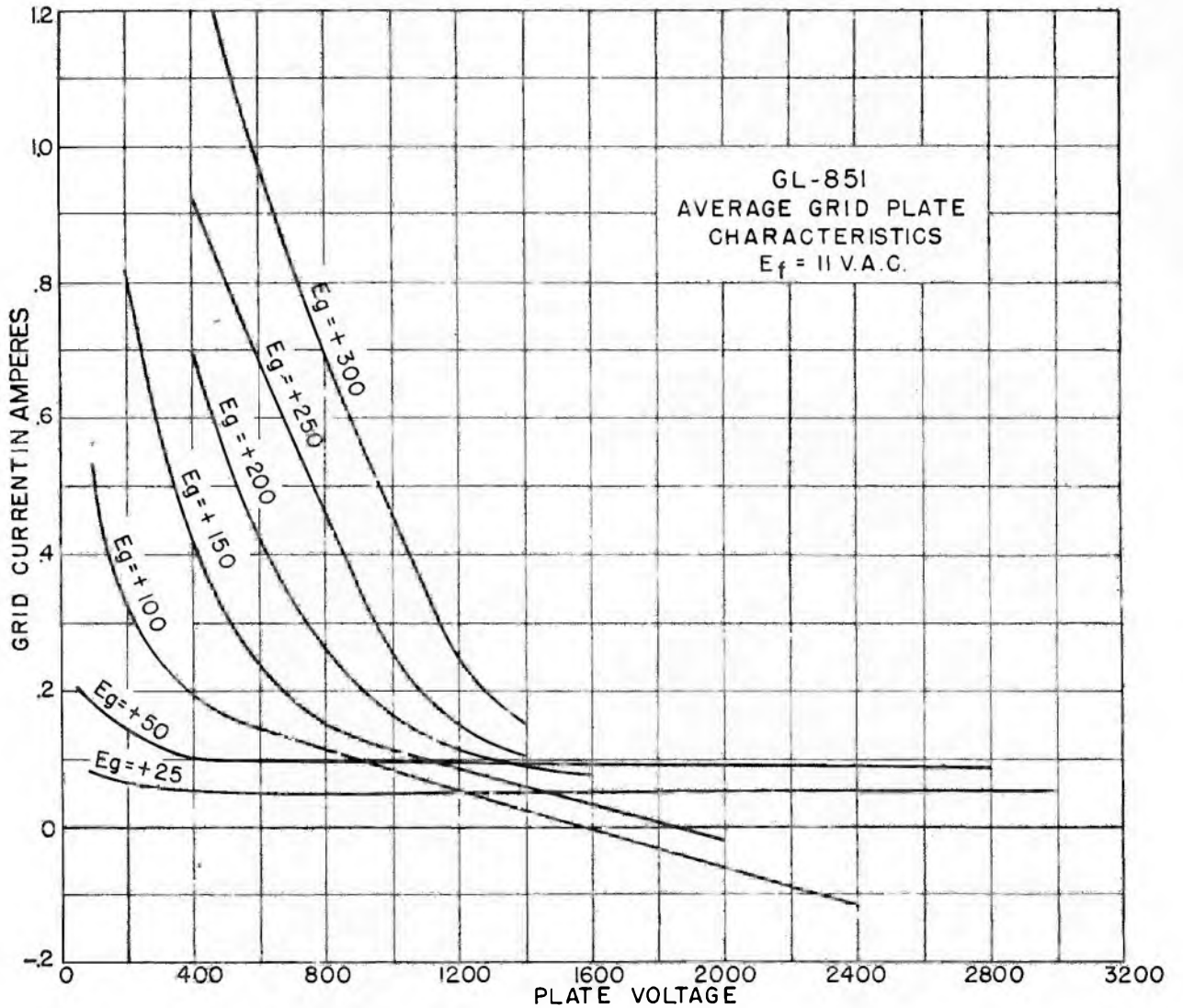
‡ Modulation, essentially negative, may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

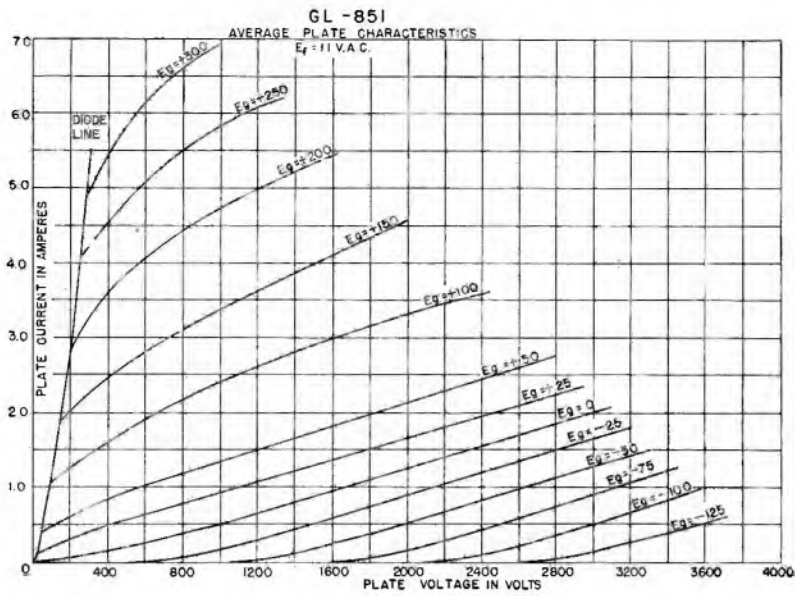
APPLICATION NOTES

GL-851 can be operated at maximum ratings in all classes of service at frequencies as high as 3 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised. (Other maximum ratings are the same as shown under TECHNICAL

INFORMATION.) The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used up to 15 mc for the various classes of service. Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	3	7	15 megacycles
Maximum permissible percentage of maximum rated plate voltage and plate input:			
Class B telephony	100	88	76 per cent
Class C telephony, plate-modulated	100	75	50 per cent
Class C telegraphy, plate-modulated	100	75	50 per cent

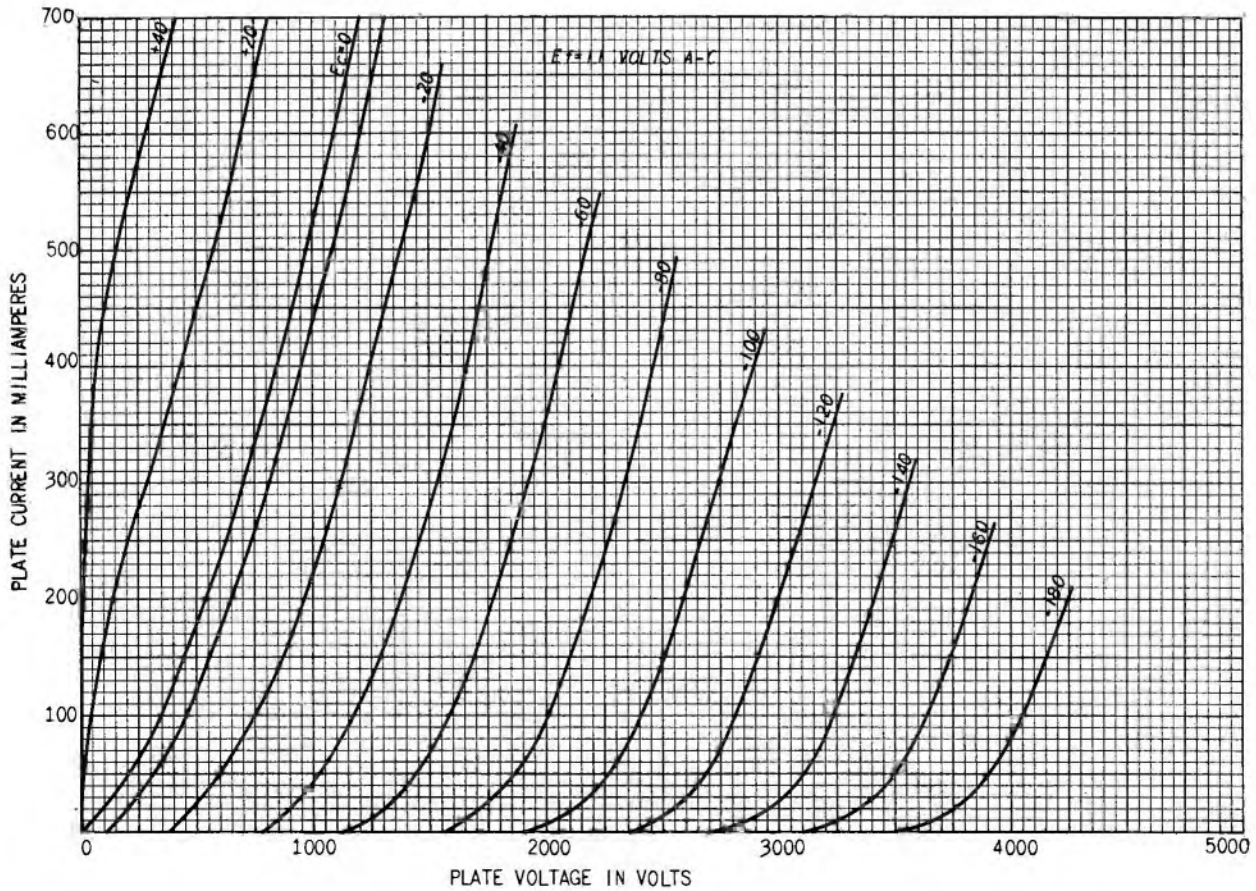




K-6966441

11-2-44

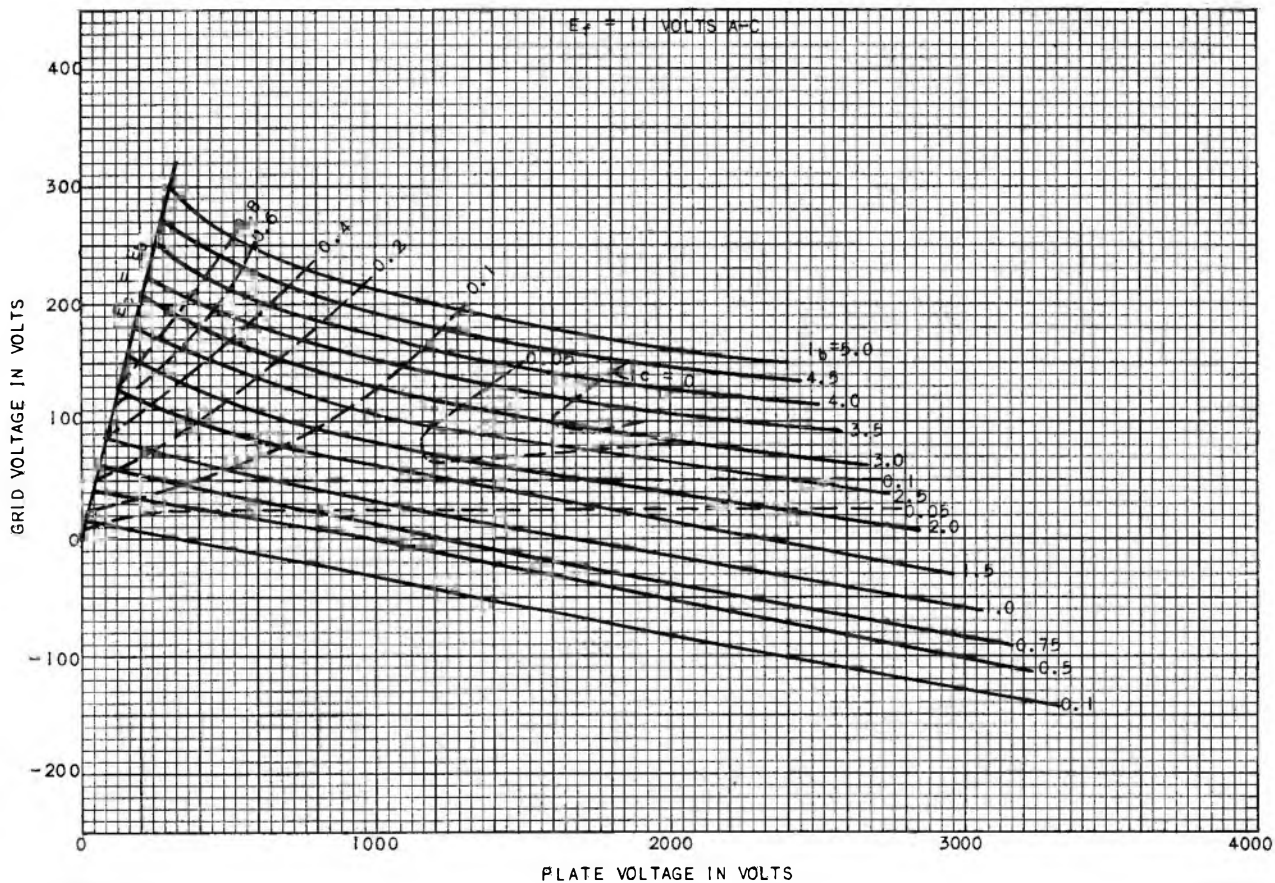
GL-851
AVERAGE PLATE CHARACTERISTICS



K-9186105

12-10-45

◆ GL-851
 CONSTANT-CURRENT CHARACTERISTICS



K-69087-72A404

9-14-50

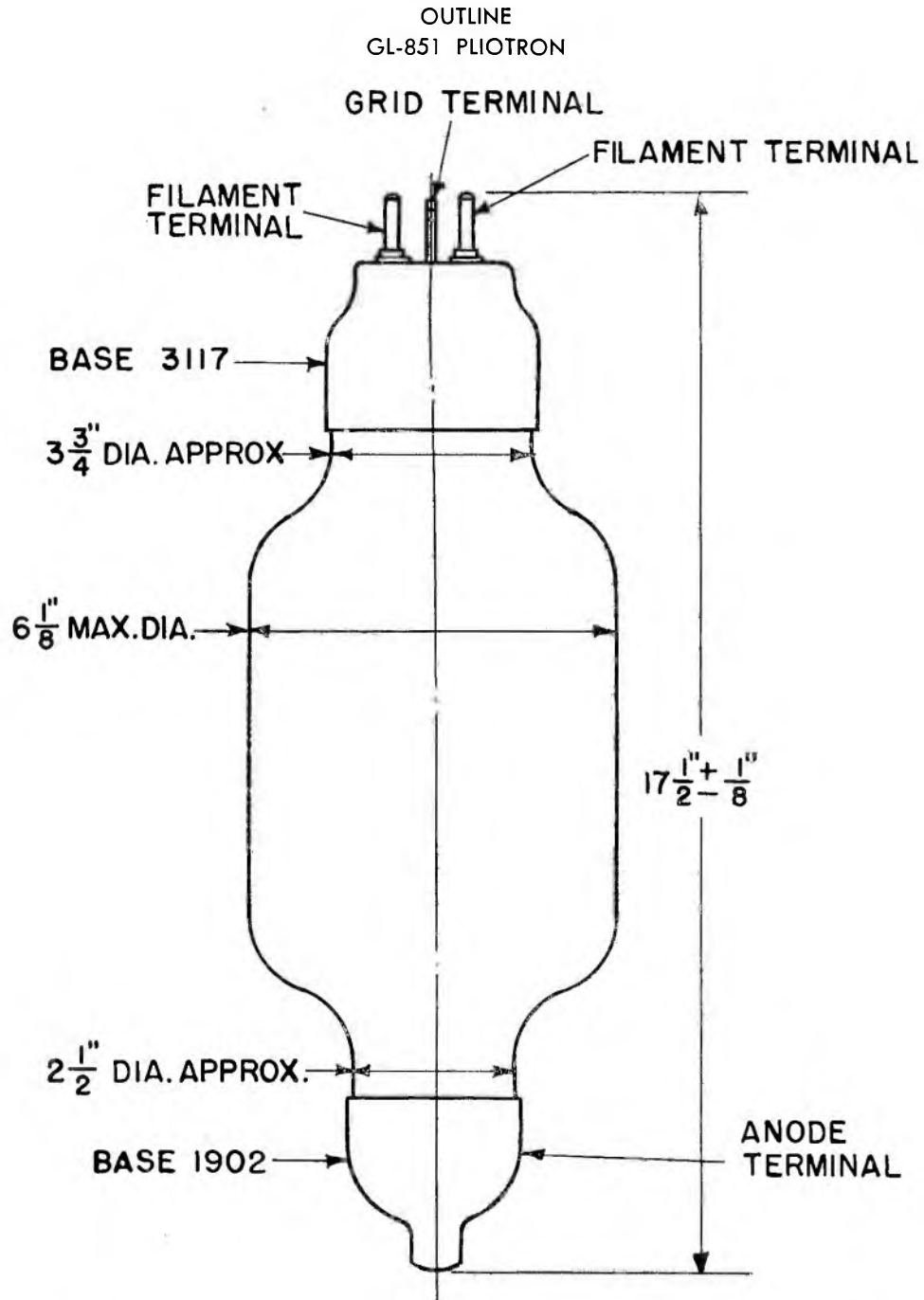
◆New drawing.

GL-851

ETI-168A

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K-2636625

9-23-44

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-862-A is a three-electrode power tube designed for use as a radio-frequency amplifier, oscillator, or Class B modulator. The plate is water-cooled and is capable of dissipating 50 to 100 kilowatts, depending upon the class of service in which the tube is used.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage		33	34.6 volts
Filament current at bogey voltage	199	207	215 amperes
Filament starting current			360 amperes
Filament cold resistant		0.018	ohms
Amplification factor, $I_b = 3$ amperes, $E_c = -50$ volts d-c		45	
Interelectrode capacitances			
Grid-plate	54	69.5	85 uuf
Grid-filament	43	53	63 uuf
Plate-filament	3.0	4.5	6.0 uuf

†Completely revised.



GENERAL  ELECTRIC

Supersedes ETI-169 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position—vertical, anode down

Type of cooling—water and forced air

Water flow on anode 15–25 GPM

Maximum outgoing water temperature 70 C

Air flow

To bulb 15 CFM

To stem 3 CFM

Gasket—Cat. No. 5182028P1

Net weight, approximate 30 pounds

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER—CLASS B

Maximum ratings, absolute values

D-c plate voltage	15,000 max	volts
Maximum signal d-c plate current*	7.5 max	amperes
Maximum signal plate input*	100 max	kilowatts
Plate dissipation*	50 max	kilowatts

Typical operation

Unless otherwise specified, values are for two tubes

D-c plate voltage	12,000	volts
D-c grid voltage	0	volts
Peak a-f grid-to-grid voltage	2000	volts
Zero-signal d-c plate current	3	amperes
Maximum signal d-c plate current	13	amperes
Effective load resistance, plate to plate	1800	ohms
Maximum signal driving power, approximate	450	watts
Maximum signal power output, approximate	90	kilowatts

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum ratings, absolute values

D-c plate voltage	20,000 max	volts
D-c plate current	5 max	amperes
Plate input	100 max	kilowatts
Plate dissipation	75 max	kilowatts

Typical operation

D-c plate voltage	12,000	15,000	18,000	volts
D-c grid voltage	–100	–150	–200	volts
D-c plate current	2.8	3.5	4.2	amperes
Peak r-f grid voltage	500	625	750	volts
Driving power, approximate†	0.5	0.75	1.1	kilowatts
Power output, approximate	11	17.5	25	kilowatts

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

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

Maximum ratings, absolute values

D-c plate voltage	12,000 max	volts
D-c grid voltage	–3000 max	volts
D-c plate current	5 max	amperes
D-c grid current, approximate	1.25 max	amperes
Plate input	60 max	kilowatts
Plate dissipation	50 max	kilowatts

Typical operation

D-c plate voltage	8000	10,000	12,000	volts
D-c grid voltage	–700	–750	–800	volts
D-c plate current	4	4.5	5	amperes
D-c grid current, approximate	1	1	1	amperes
Peak r-f grid voltage, approximate	1700	1850	2000	volts
Driving power, approximate	1.7	1.85	2	kilowatts
Power output, approximate	24	34	45	kilowatts

TECHNICAL INFORMATION (CONT'D)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR— CLASS C TELEGRAPHY

Key-down conditions per tube without modulation †

Maximum ratings, absolute values

D-c plate voltage	20,000 max	volts
D-c grid voltage	-3000 max	volts
D-c plate current	10 max	amperes
D-c grid current, approximate	1 max	ampere
Plate input	200 max	kilowatts
Plate dissipation	100 max	kilowatts

Typical operation

D-c plate voltage	12,000	15,000	18,000	volts
D-c grid voltage	-800	-900	-1000	volts
D-c plate current	6.25	7.5	8.33	amperes
D-c grid current, approximate	0.8	0.85	0.9	amperes
Peak r-f grid voltage, approximate	2050	2300	2550	volts
Driving power, approximate	1.6	2	2.4	kilowatts
Power output, approximate	50	75	100	kilowatts

* Averaged over any audio-frequency cycle.

† At crest of audio-frequency cycle.

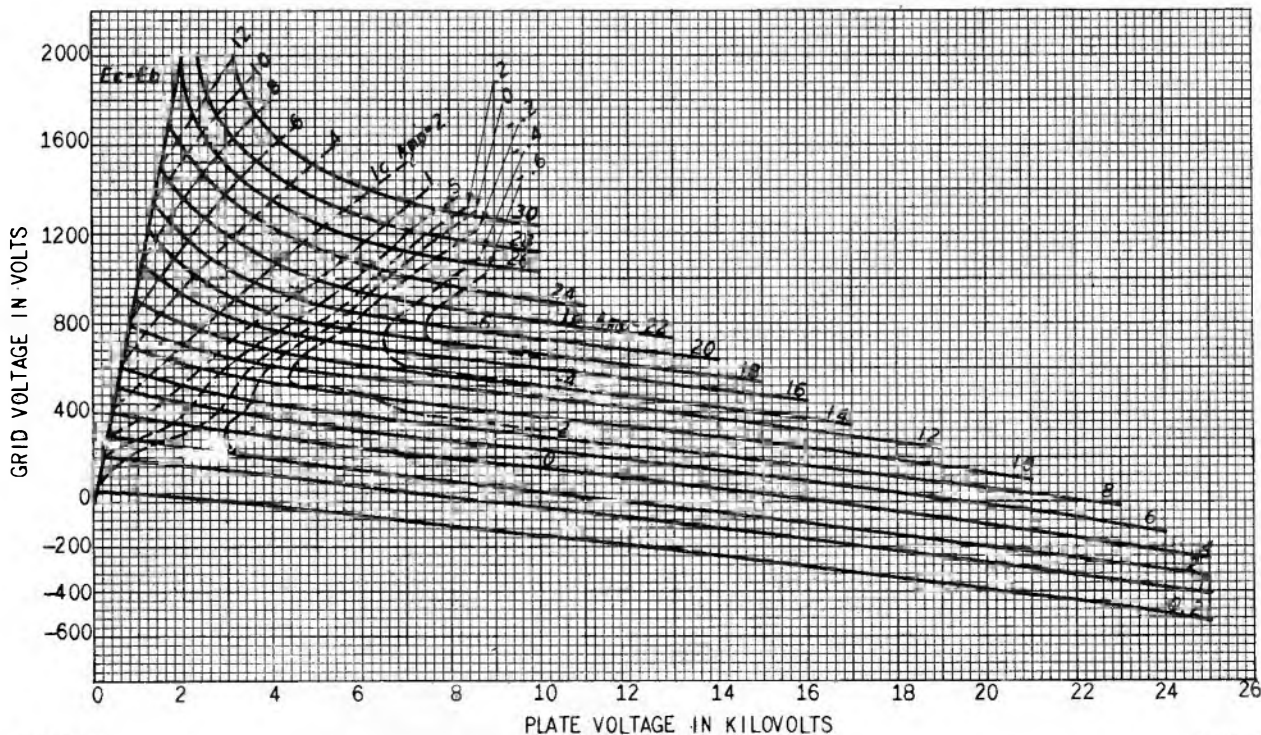
‡ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

APPLICATION NOTES

Plate Series Protective Resistors (see paragraph describing plate circuit under Installation in the Instructions.)

Series resistor	10	20	40	50	ohms
Maximum power output of rectifier	100	250	640	1600	kilowatts

◆ GL-862-A CHARACTERISTICS ($E_c = 33$ VOLTS A-C)



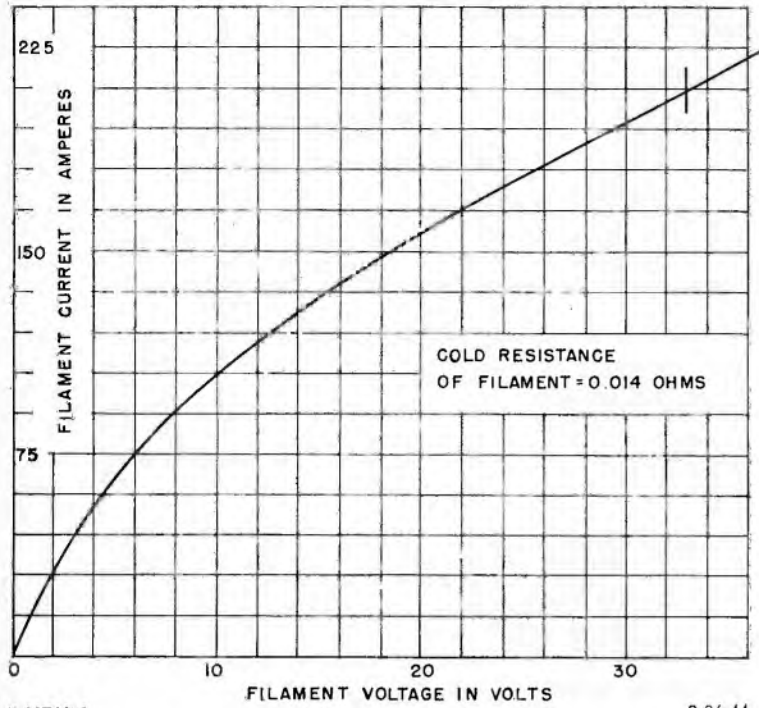
GL-862-A

ETI-169A

PAGE 4

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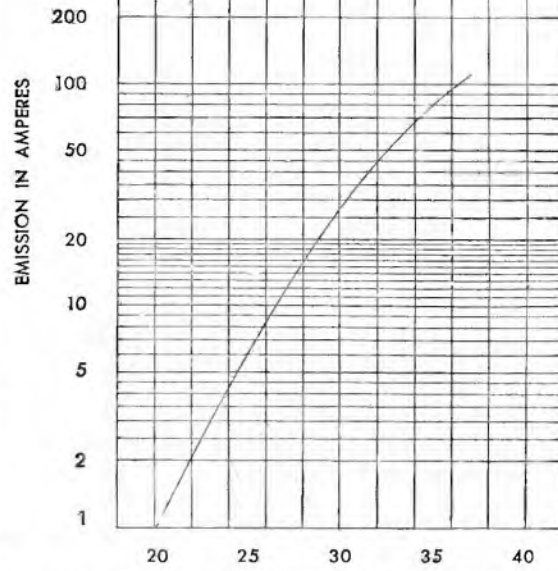
GL-862-A FILAMENT CHARACTERISTICS



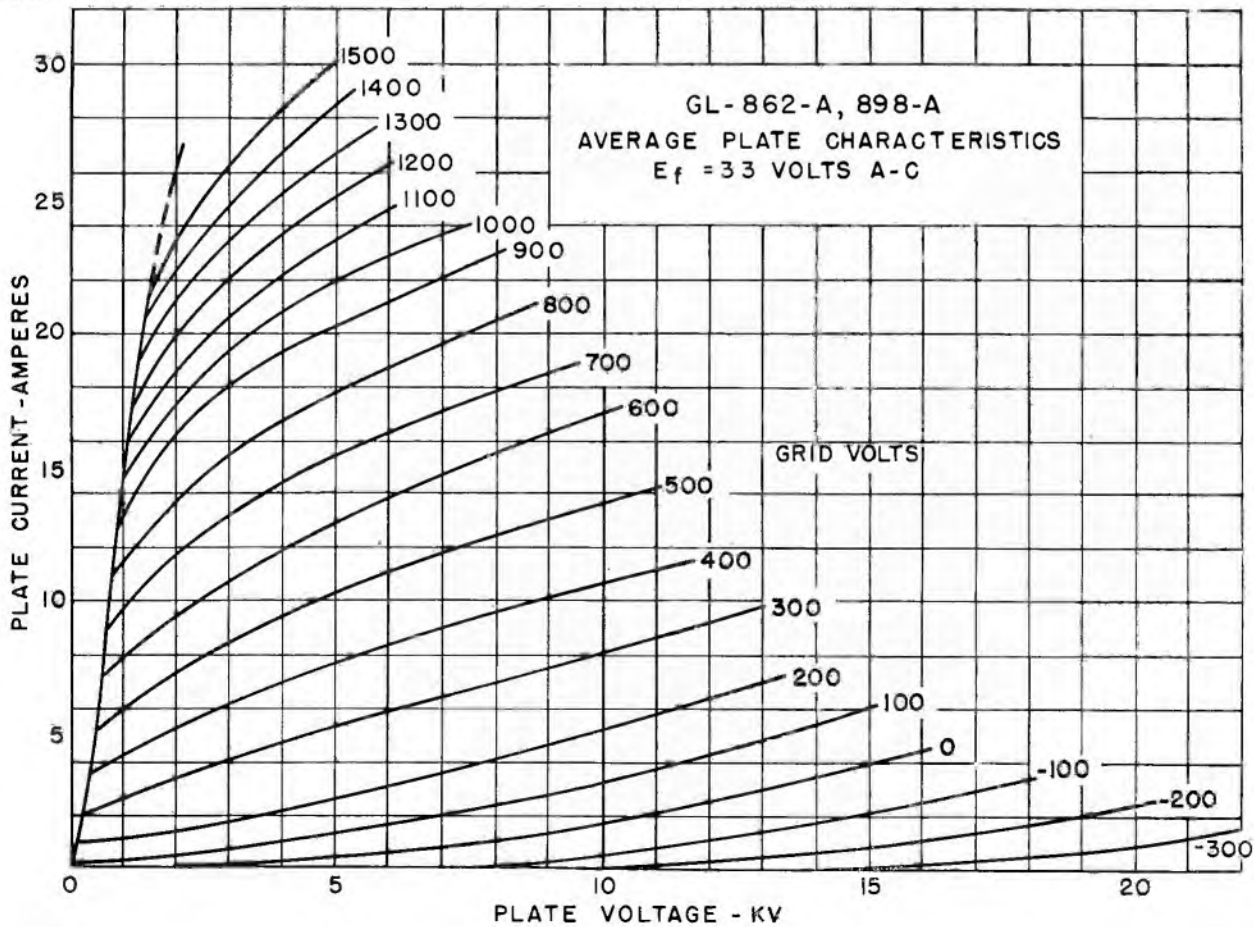
K-8074623

9-26-44

GL-898-A EMISSION CHARACTERISTIC

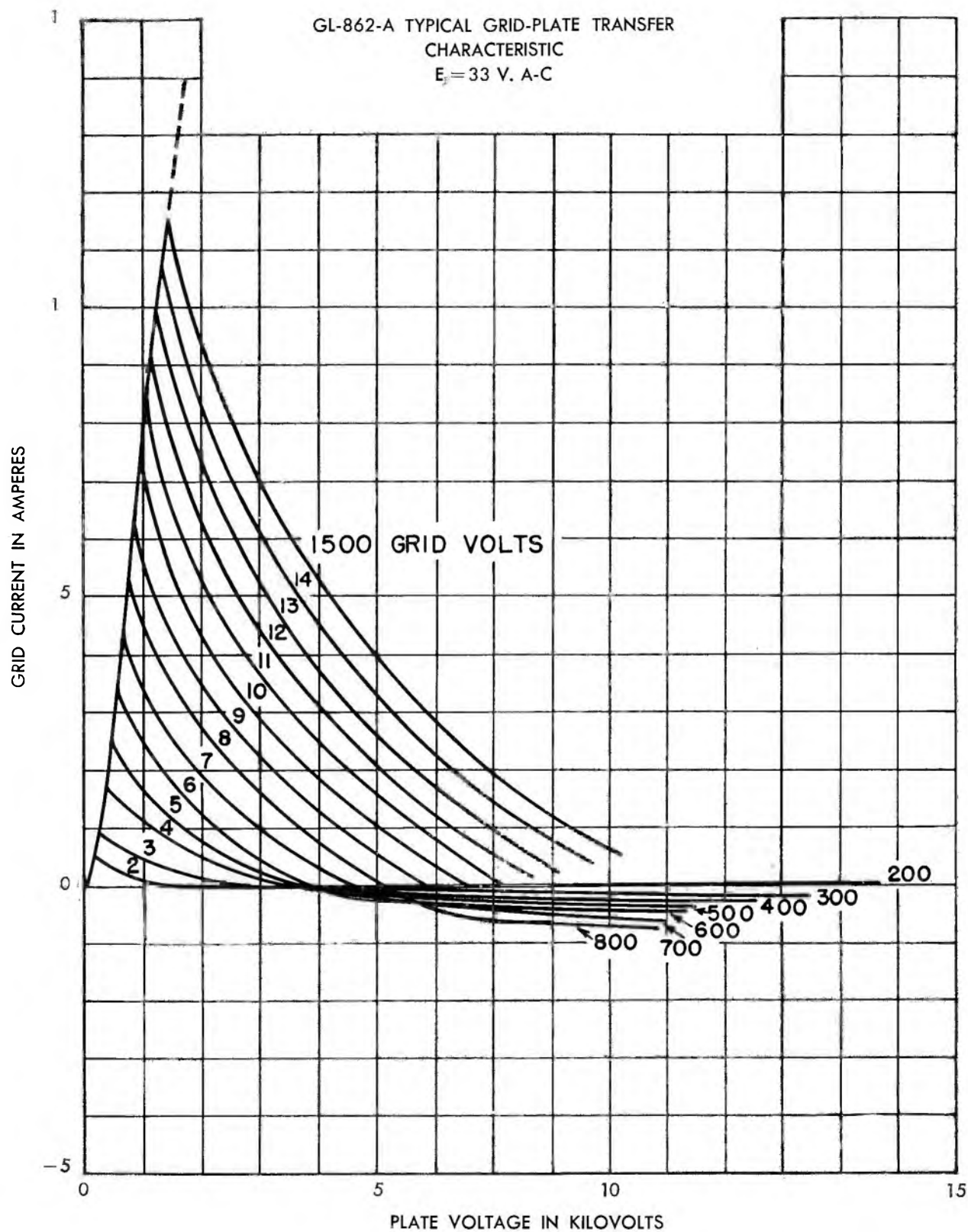


FILAMENT VOLTAGE IN VOLTS (SINGLE-PHASE FILAMENT EXCITATION)
K-8074655 1-9-46



K-6966423

1-9-46



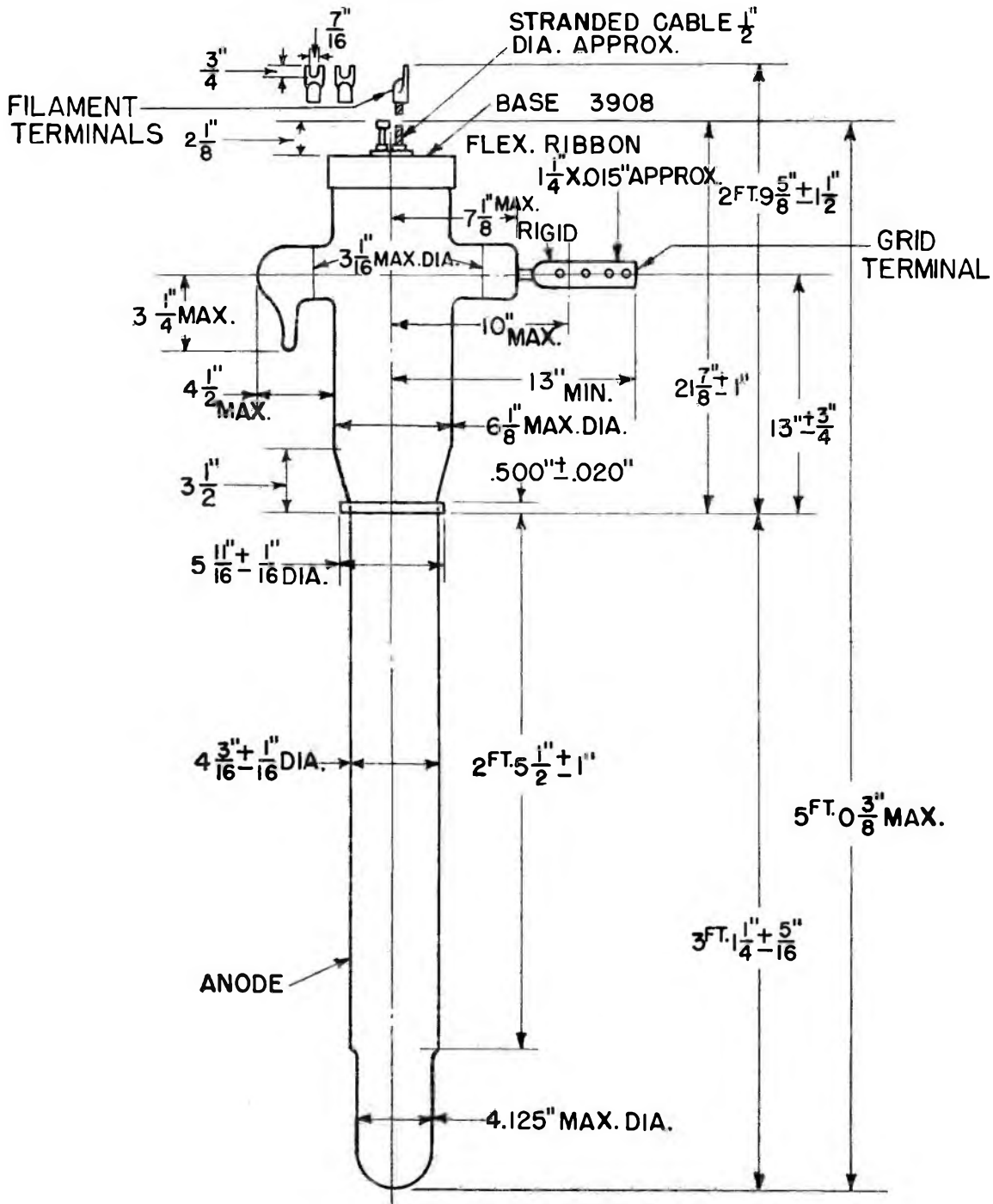
GL-862-A

ETI-169A

PAGE 6

5-51

◆ OUTLINE GL-862-A PIOTRON



K-3846052
Revised.

6-7-45

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-880 is a three-electrode tube designed for use as a radio-frequency amplifier, oscillator, or Class B modulator. The anode is water-cooled

and capable of dissipating 20 kilowatts. The cathode is a pure-tungsten filament. Maximum ratings apply up to 25 megacycles.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage		12.6	13.2 volts
Filament current	300	320	330 amperes
Filament starting current			480 amperes
Filament cold resistance		0.003	ohms
Amplification factor, $I_b = 2.0$ amp, $E_c = 100$ v	17	20	23
Interelectrode capacitances			
Grid—Plate	21	24	27 uuf
Grid—Filament	28.8	35	41.2 uuf
Plate—Filament	1.0	2.0	3.0 uuf

◆ Technical Information changed throughout.



GENERAL  ELECTRIC

Supersedes ETI-170A dated 12-48

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position—Vertical, anode down	
Type of cooling—Water and forced air	
Water flow on anode	20 gpm
Maximum outgoing water temperature	70 C
Air flow (to bulb and seals)*	20 cfm
Maximum glass temperature	150 C
Gasket Type No. JTC-11	
Net weight, approximate	7 pounds

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values		CCS†
D-c plate voltage	10,500 max	volts
Maximum signal d-c plate current‡	5 max	amperes
Maximum signal plate input‡	40 max	kilowatts
Plate dissipation‡	15 max	kilowatts
Typical operation	CCS†	CCS†
Unless otherwise specified, values are for two tubes		
D-c plate voltage	7500	10,000 volts
D-c grid voltage	-340	-450 volts
Peak a-f grid-to-grid voltage	1450	1680 volts
Zero signal d-c plate current	1.0	1.0 amperes
Maximum signal d-c plate current	6.7	7.0 amperes
Effective load resistance, plate to plate	2300	3100 ohms
Maximum signal driving power, approximate	490	540 watts
Maximum signal power output, approximate	31.5	46 kilowatts

* From a 3-inch diameter nozzle.

† Continuous Commercial Service.

‡ Averaged over any audio-frequency cycle of sine-wave form.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum ratings, absolute values		CCS†
D-c plate voltage	10,500 max	volts
D-c plate current	4.0 max	amperes
Plate input	32.0 max	kilowatts
Plate dissipation	20.0 max	kilowatts
Typical operation	CCS†	CCS†
D-c plate voltage	7500	10,000 volts
D-c grid voltage	-340	-460 volts
Peak r-f grid voltage	570	595 volts
D-c plate current	3.3	2.75 amperes
D-c grid current, approximate	0.013	0.009 amperes
Driving power, approximate§	1250	900 watts
Power output, approximate	8	9 kilowatts

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

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

Maximum ratings, absolute values		CCS†
D-c plate voltage	10,500 max	volts
D-c grid voltage	-1200 max	volts
D-c plate current	3.6 max	amperes
D-c grid current	0.8 max	amperes
Plate input	36 max	kilowatts
Plate dissipation	12 max	kilowatts
Typical operation	CCS†	CCS†
D-c plate voltage	7500	10,000 volts
D-c grid voltage	-1000	-1200 volts
Peak r-f grid voltage	1560	1840 volts
D-c plate current	3.0	3.6 amperes
D-c grid current, approximate	0.57	0.64 amperes
Driving power, approximate	850	1100 watts
Power output, approximate	16.0	27.0 kilowatts

TECHNICAL INFORMATION (CONT'D)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation π

Maximum ratings, absolute values	CCS†	CCS†	
D-c plate voltage.....	10,500	15,000 <input type="checkbox"/> max	volts
D-c grid voltage.....	-1200	-1600 <input type="checkbox"/> max	volts
D-c plate current.....	6.0	4.5 <input type="checkbox"/> max	amperes
D-c grid current.....	0.8	1.0 <input type="checkbox"/> max	amperes
Plate input.....	60	67.5 <input type="checkbox"/> max	kilowatts
Plate dissipation.....	20	20.0 <input type="checkbox"/> max	kilowatts
Typical operation	CCS†	CCS†	CCS†
D-c plate voltage.....	7500	10,000	10,000 volts
D-c grid voltage.....	-600	-800	-1000 volts
Peak r-f grid voltage.....	1250	1460	1830 volts
D-c plate current.....	4.8	4.5	6.0 amperes
D-c grid current, approximate.....	0.79	0.78	0.8 amperes
Driving power, approximate.....	920	1000	1500 watts
Power output, approximate.....	24.0	33.0	40.00 kilowatts

† Continuous Commercial Service.

§ At crest of audio-frequency cycle with modulation factor of 1.0.

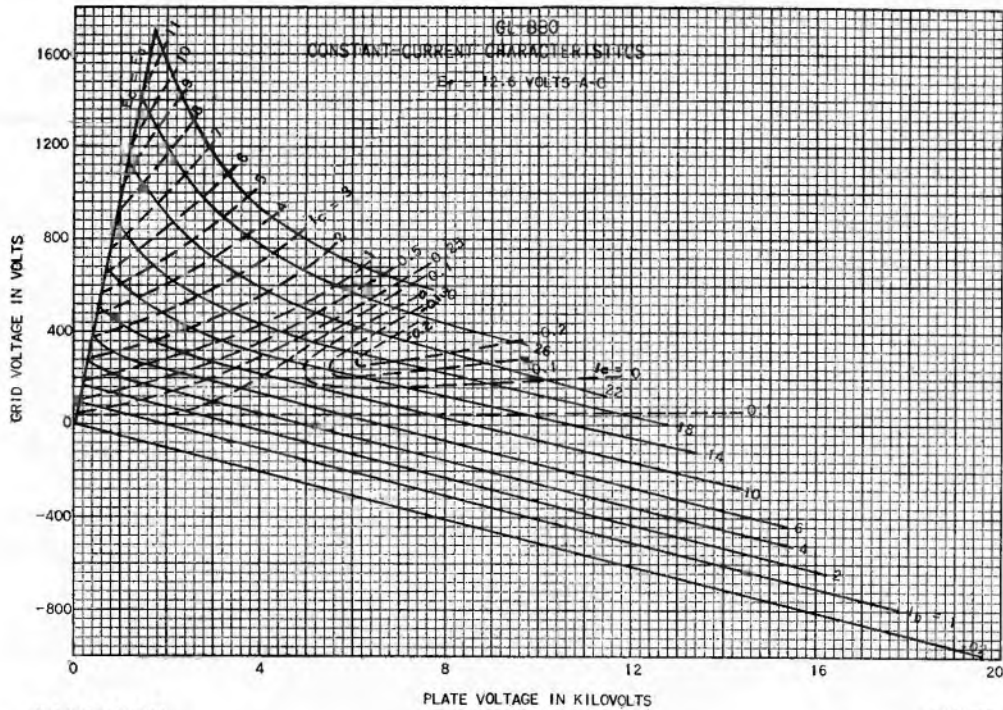
π Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

These ratings apply only at a frequency of 1500 kilocycles or less.

Maximum ratings apply up to 25 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

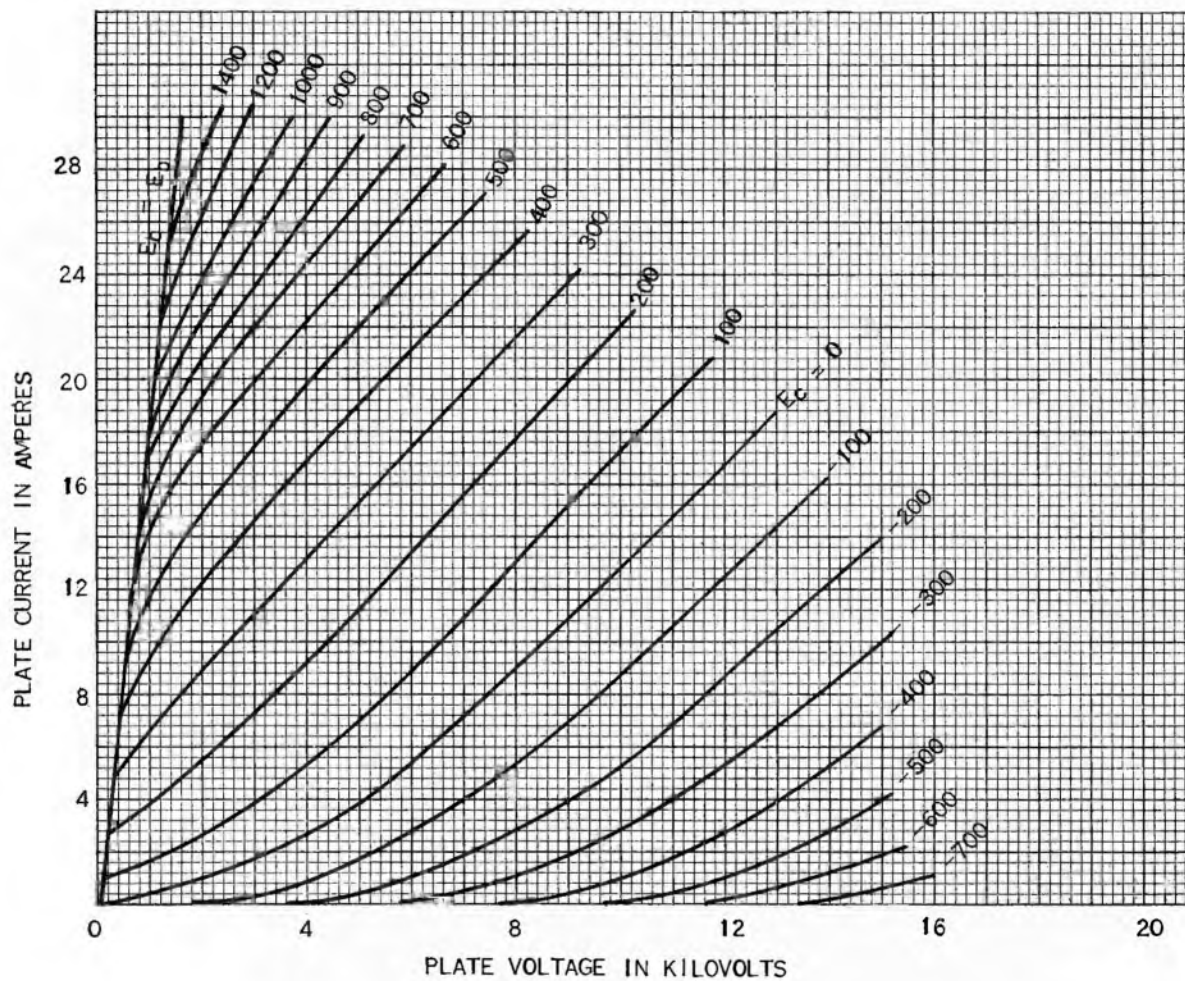
Frequency.....	25	50	100 megacycles
Percentage of maximum rated plate			
Voltage and plate input			
Class B—Maximum plate voltage.....	100	80	60 per cent
Maximum plate input.....	100	94	75 per cent
Class C—Plate modulated.....	100	72	45 per cent
Class C—Unmodulated.....	100	75	50 per cent

■ GL-880
CONSTANT CURRENT CHARACTERISTICS
 $E_i = 12.6$ VOLTS A-C



▲ GL-880

PLATE CHARACTERISTICS

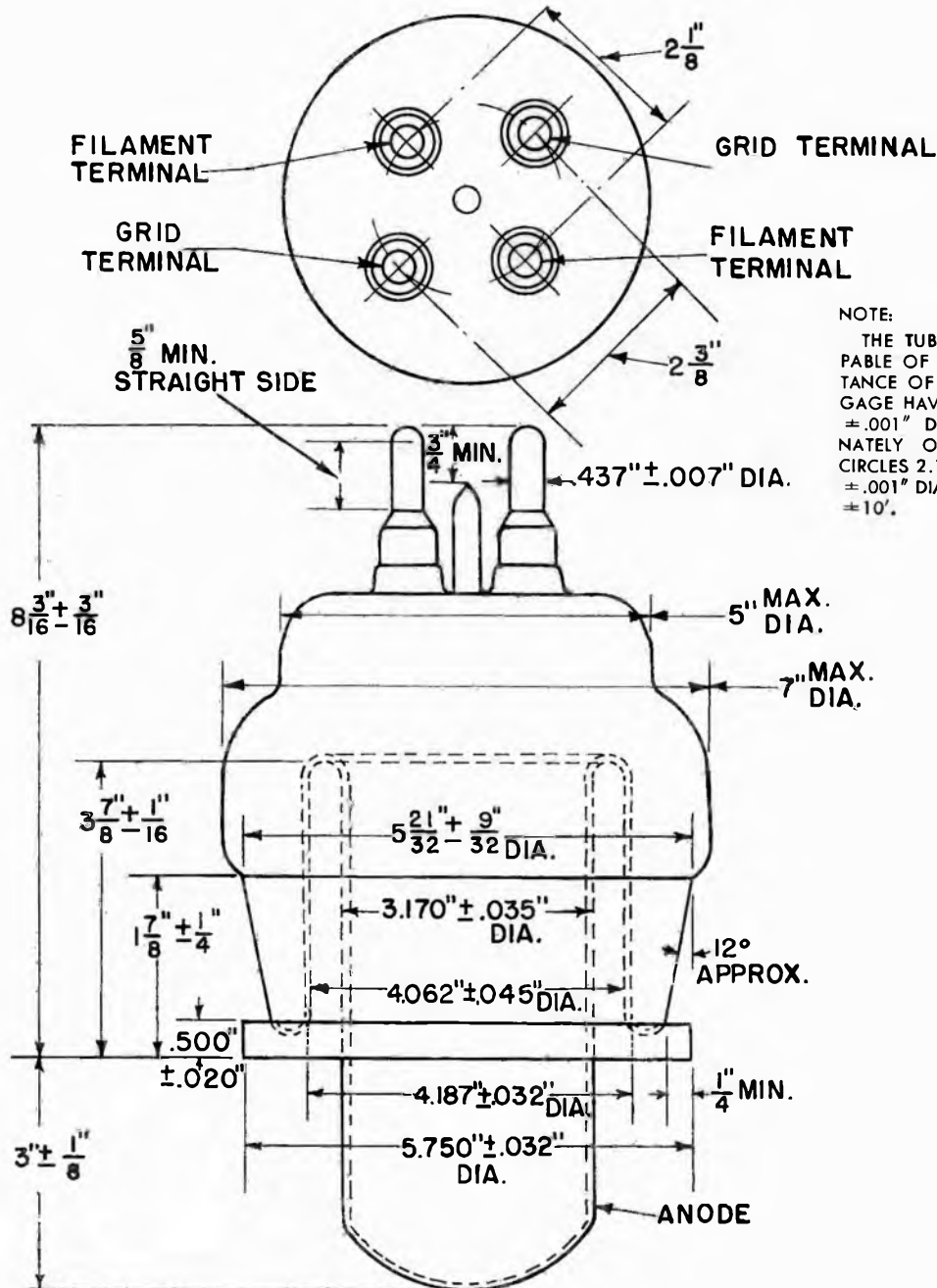
 $E_f = 12.6$ VOLTS A-C

K-69087-72A243

7-21-48

▲ New curve.

■ OUTLINE
GL-880 PIOTRON



NOTE:

THE TUBE BASE SHALL BE CAPABLE OF ENTERING TO A DISTANCE OF $\frac{5}{8}$ " IN A FLAT PLATE GAGE HAVING FOUR HOLES $.536 \pm .001$ " DIA. ARRANGED ALTERNATELY ON TWO CONCENTRIC CIRCLES $2.125 \pm .001$ " AND $2.375 \pm .001$ " DIA. AT ANGLES OF $90^\circ \pm 10'$.

K-5965320

8-1B-45

■ Revised outline.

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-889-A is a three-electrode power tube designed for use as a radio-frequency, amplifier, oscillator, or Class B modulator. The plate is water-cooled and is capable of dissipating 5

kilowatts, depending upon the class of service. The design of the mount and terminal connections minimizes lead inductance and makes the tube particularly suitable for high-frequency applications.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage	—	11.0	11.5 volts
Filament current at bogey voltage	110	120	128 amperes
Filament starting current	—	—	180 amperes
Filament cold resistance	—	0.008	— ohm
Amplification factor, at $I_b = 1.0$ amp.			
$E_c = -100$ volts	17	21	25
Interelectrode capacitance			
Grid-plate	15	17.5	20 micromicrofarads
Grid-filament	19.2	23.3	27.4 micromicrofarads
Plate-filament	1.8	2.7	3.6 micromicrofarads

◆ Completely revised



GENERAL  ELECTRIC

Supersedes ETI-171 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position	vertical, anode down
Type of cooling	water and forced air
Water flow on anode	6 gallons per minute
Maximum outgoing water temperature	70 centigrade
Air flow* (to bulb)	15 cubic feet per minute
Maximum glass temperature	150 centigrade
Net weight, approximate	2 pounds

*Air to be directed at the top of tube from a 3-inch-diameter nozzle.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values	CCS*		
D-c plate voltage	8500	maximum volts	
Maximum signal d-c plate current †	2	maximum amperes	
Maximum signal plate input †	12	maximum kilowatts	
Plate dissipation †	5	maximum kilowatts	
Typical operation	CCS*		
Unless otherwise specified, values are for two tubes			
D-c plate voltage	5000	6000	7500 volts
D-c grid voltage	-180	-230	-300 volts
Peak a-f grid-to-grid voltage	1460	1680	1700 volts
Zero signal d-c plate current	0.4	0.4	0.4 ampere
Maximum signal d-c plate current	3.2	3.6	3.2 amperes
Effective load resistance, plate-to-plate	2520	3680	5000 ohms
Maximum signal driving power, approximate	170	180	150 watts
Maximum signal power output, approximate	8.8	12	15 kilowatts

†Averaged over any audio-frequency cycle of sine-wave form.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum ratings, absolute values	CCS*	
D-c plate voltage	8500	maximum volts
D-c plate current	1.0	maximum ampere
Plate input	7.5	maximum kilowatts
Plate dissipation	5	maximum kilowatts
Typical operation	CCS*	
D-c plate voltage	6000	7500 volts
D-c grid voltage	-250	-300 volts
Peak r-f grid voltage	460	500 volts
D-c plate current	0.9	0.9 ampere
D-c grid current, approximate	0.003	0.005 ampere
Driving power, approximate	95	80 watts
Power output, approximate	1.5	2 kilowatts

|| At crest of audio-frequency cycle with modulation factor of 1.0.

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

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

Maximum ratings, absolute values	CCS**	
D-c plate voltage	6000	maximum volts
D-c grid voltage	1000	maximum volts
D-c plate current	1.0	maximum ampere
D-c grid current	0.25	maximum ampere
Plate input	6	maximum kilowatts
Plate dissipation	3	maximum kilowatts

TECHNICAL INFORMATION (CONT'D)

Typical operation	CCS*	
D-c plate voltage	5000	6000 volts
D-c grid voltage	-800	-900 volts
Peak r-f grid voltage	1300	1420 volts
D-c plate current	0.9	1.0 ampere
D-c grid current, approximate	0.12	0.1 ampere
Driving power, approximate	155	140 watts
Power output, approximate	2.75	4 kilowatts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down Conditions Per Tube Without Amplitude Modulation

Maximum ratings, absolute values	CCS*	
D-c plate voltage	8500	maximum volts
D-c grid voltage	-1000	maximum volts
D-c plate current	2	maximum amperes
D-c grid current	0.25	maximum ampere
Plate input	16	maximum kilowatts
Plate dissipation	5	maximum kilowatts
Typical operation	CCS*	
D-c plate voltage	5000	7500 volts
D-c grid voltage	-500	-600 -800 volts
Peak r-f grid voltage	1200	1460 1830 volts
D-c plate current	1.5	1.8 2 amperes
D-c grid current, approximate	0.19	0.21 0.24 ampere
Driving power, approximate	220	290 400 watts
Power output, approximate	5	7 10 kilowatts

Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

**CCS—Continuous commercial service.

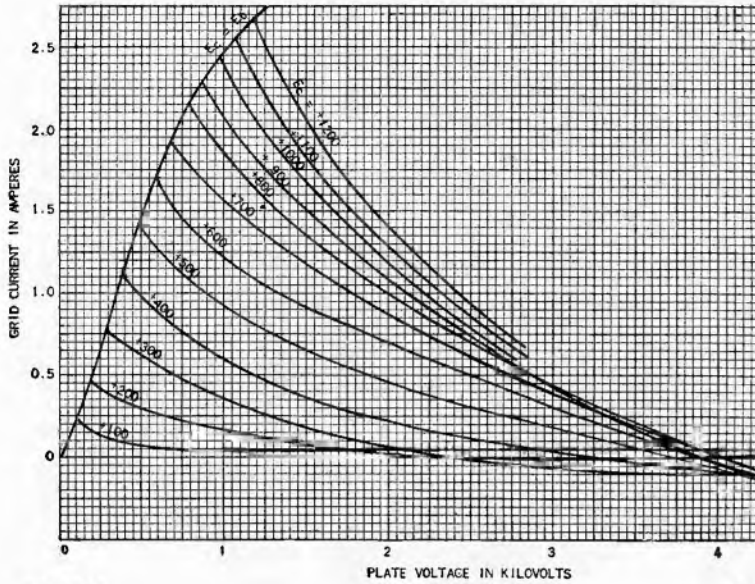
APPLICATION NOTES

*GL-889-A can be operated at maximum ratings in all classes of service at frequencies as high as 50 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised. (Other maximum ratings are the same as shown under TECHNICAL INFORMATION.)

The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used up to 150 megacycles for the various classes of service. Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	50	100	150 megacycles
Percentage of maximum rated plate voltage and plate input			
Class B	100	83	72 per cent
Class C plate modulated	100	75	60 per cent
Class C unmodulated—maximum plate voltage	100	78	65 per cent
Class C unmodulated—maximum plate input	100	70	50 per cent

◆GL-889-A
TYPICAL GRID-PLATE TRANSFER CHARACTERISTIC
 $E_f = 11$ VOLTS A-C

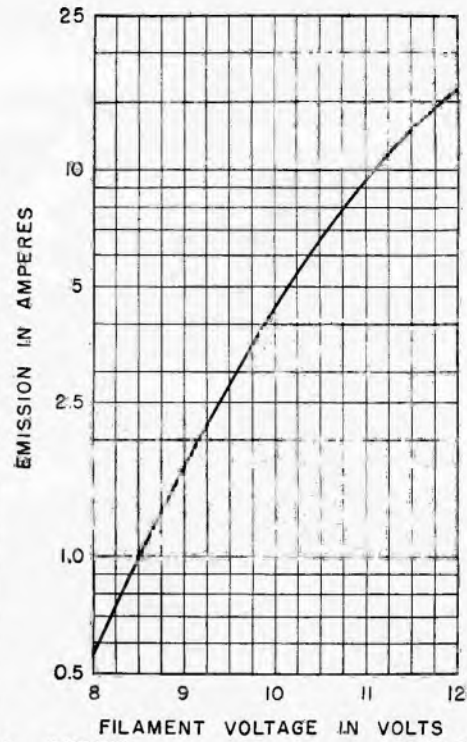


K-8074636
Revised

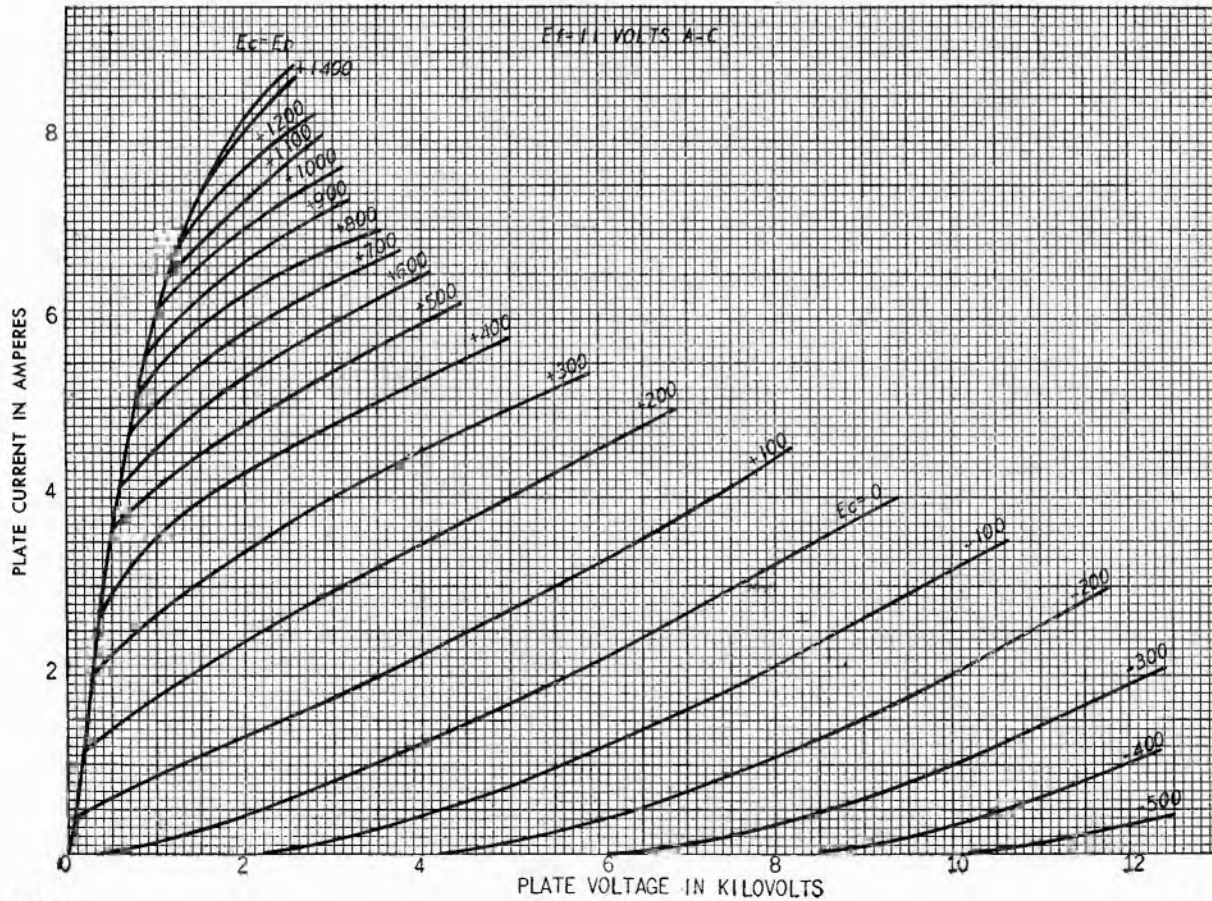
3-5-48

K-8074633
Not previously included.

12-10-45



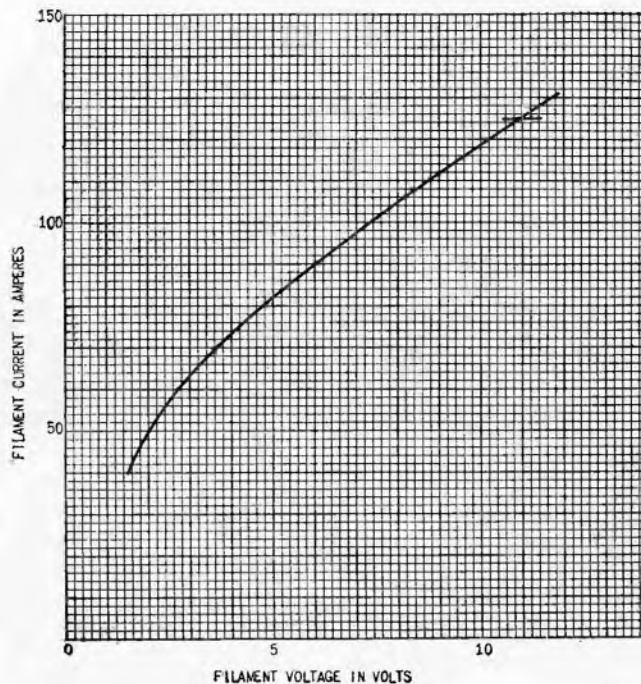
◆GL-889-A
AVERAGE PLATE CHARACTERISTIC



K-8074635
Revised

3-5-48

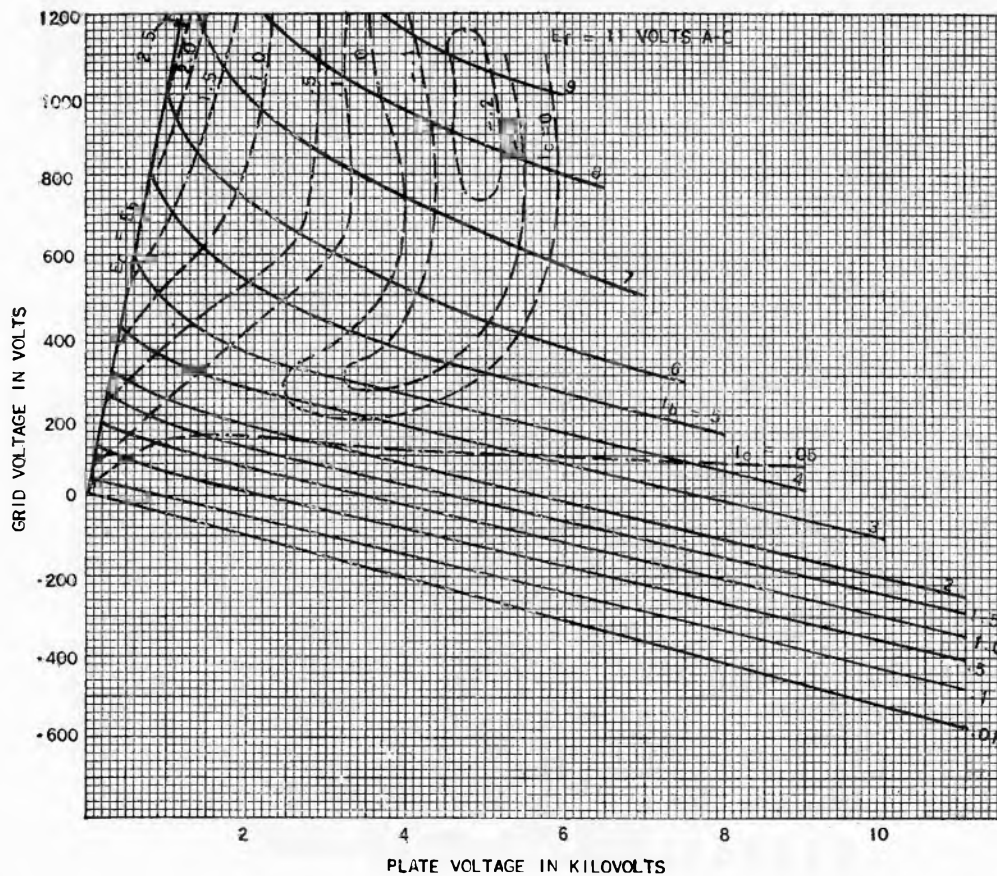
■ GL-889-A AVERAGE FILAMENT CHARACTERISTICS
COLD RESISTANCE = 0.008 OHM



K-8074634
■ Not previously included

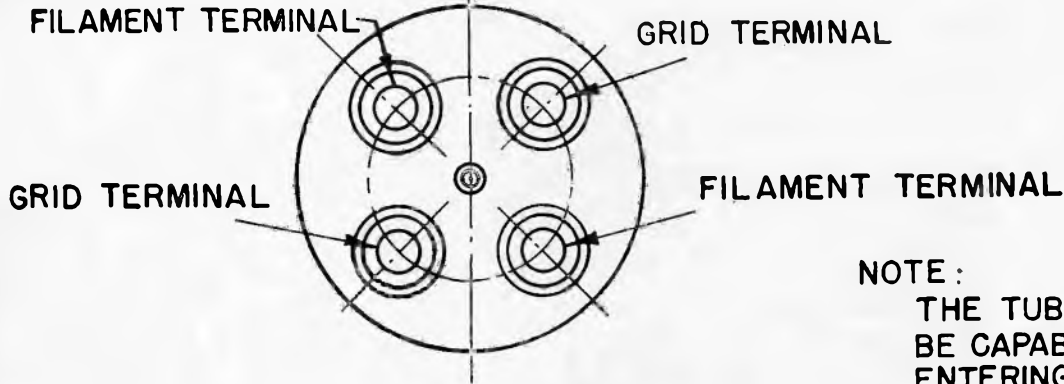
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◆ GL-889-A CHARACTERISTIC



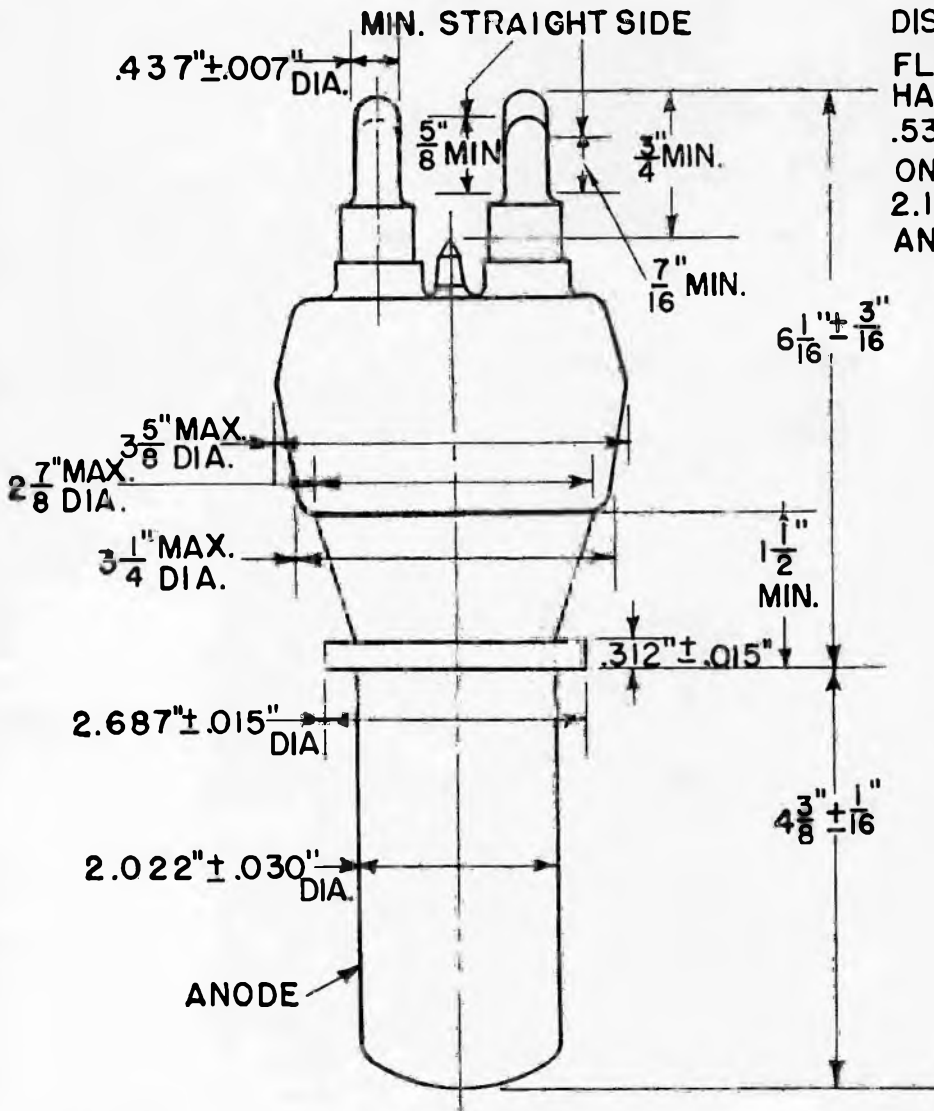
K-8074637
◆ Revised

3-5-48



NOTE :

THE TUBE BASE SHALL BE CAPABLE OF ENTERING TO A DISTANCE OF $\frac{5}{8}$ " IN A FLAT PLATE GAUGE HAVING FOUR HOLES $.536 \pm .001$ " DIA. ARRANGED ON A CIRCLE OF $2.125 \pm .001$ " DIA. AT ANGLES OF $90^\circ \pm 10'$

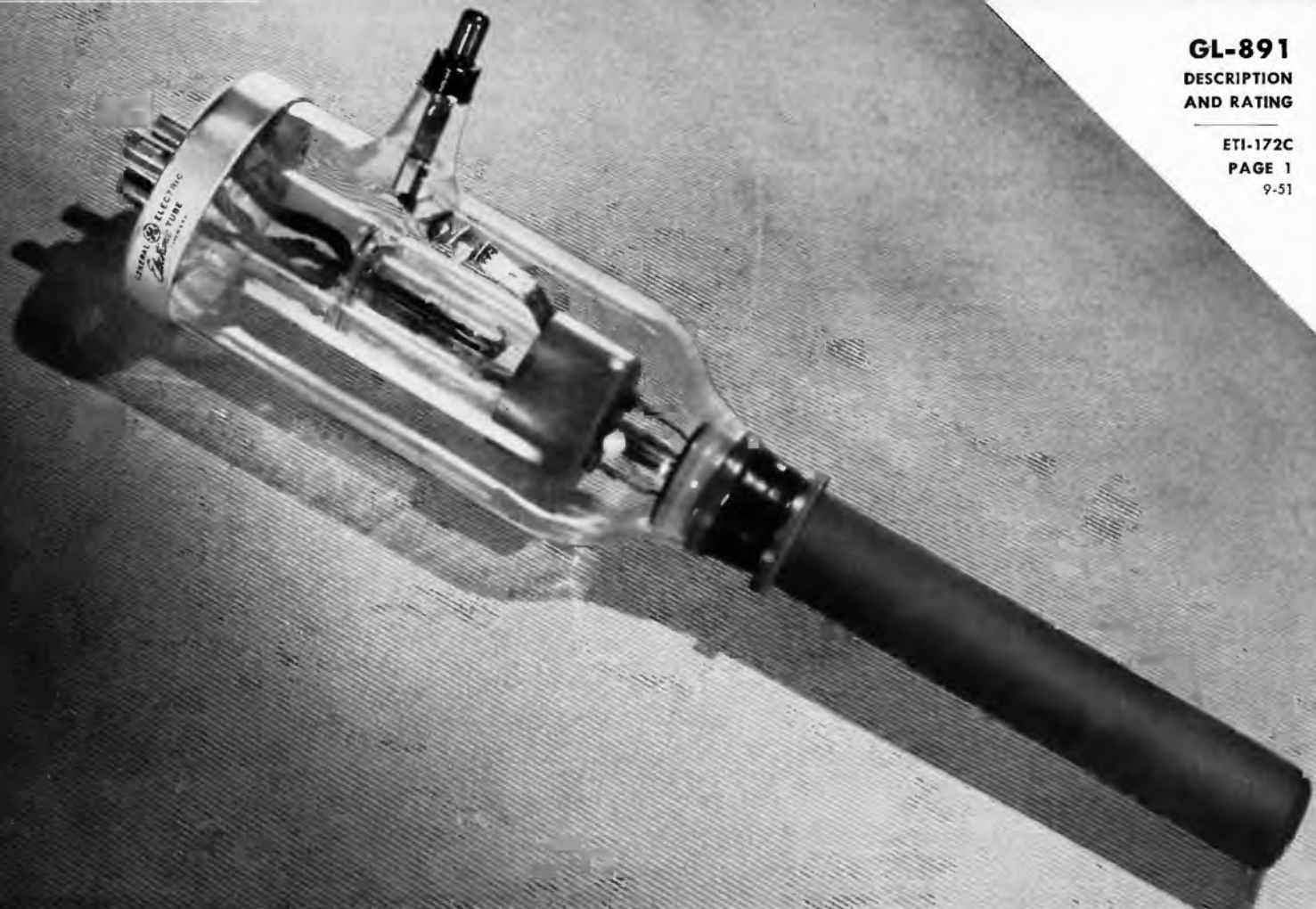


K-3344713

GL-889-A OUTLINE

3-16-45

Electronics Department
GENERAL ELECTRIC
 Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-891 is a three-electrode transmitting tube of the double-filament type for use as a radio-frequency power amplifier, oscillator, Class A modulator and Class B modulator. The construction of the filament permits operation from two-phase or single-phase alternating-current as well as from

direct current, for all classes of service. The plate is water-cooled and is capable of dissipating 6 kilowatts, depending on the service in which the tube is used. The GL-891 can be operated at maximum ratings at frequencies as high as 1.6 megacycles and up to 20 megacycles at reduced ratings.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage	—	22	23 volts
Filament current at bogey voltage	57	60	62 amperes
Filament starting current	—	—	120 amperes
Filament cold resistance	—	0.031	— ohm
Amplification factor			
$E_c = -500$ volts, $I_b = 0.75$ ampere	7.6	8.5	9.4
Interelectrode capacitances:			
Grid-plate	24	27	31 micromicrofarads
Grid-filament	15	19	23 micromicrofarads
Plate-filament	1	2	3 micromicrofarads


Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-172B dated 8-50

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position			vertical, anode down
Type of cooling			water
Water flow on anode	3	—	8 gallons per minute
Maximum outgoing water temperature	—	—	70 °centigrade
Maximum glass temperature	—	—	150 °centigrade
Net weight, approximate	—	—	3½ pounds

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values			CCS*
D-c plate voltage			15,000 volts maximum
Maximum signal d-c plate current †			2.0 amperes maximum
Maximum signal plate input †			20,000 watts maximum
Plate dissipation †			5,000 watts maximum

Typical operation (unless otherwise specified, values are for two tubes).				CCS*
D-c plate voltage	6,000	10,000	12,500	volts
D-c grid voltage	-630	-1,100	-1,450	volts
Peak a-f grid-to-grid voltage	2,060	3,060	3,760	volts
Zero signal d-c plate current	0.5	0.5	0.4	amperes
Maximum signal d-c plate current	2.5	2.4	2.5	amperes
Effective load resistance, plate-to-plate	5,000	10,000	12,000	ohms
Maximum signal driving power, approximate	110	225	245	watts
Maximum signal power output, approximate	8,000	16,000	22,000	watts

*Continuous Commercial Service.

†Averaged over any audio-frequency cycle of sine-wave form.

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

(Key-down Conditions Per Tube Without Amplitude Modulation)

Maximum ratings, absolute values				CCS*
D-c plate voltage			12,000	volts maximum
D-c grid voltage			-3,000	volts maximum
D-c plate current			2.0	amperes maximum
D-c grid current			0.15	ampere maximum
Plate input			18,000	watts maximum
Plate dissipation			6,000	watts maximum

Typical operation				CCS*
D-c plate voltage	8,000	10,000		volts
D-c grid voltage	-1,800	-2,000		volts
Peak r-f grid voltage	2,400	2,700		volts
D-c plate current	1.15	1.33		amperes
D-c grid current, approximate	0.09	0.14		ampere
Driving power, approximate	215	375		watts
Power output, approximate	6,500	10,000		watts

*Continuous Commercial Service.

||Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115% of the carrier conditions.

APPLICATION NOTES

GL-891 can be operated at maximum ratings in all classes of service at frequencies as high as 1.6 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised. (Other maximum ratings are the same as shown under MAXIMUM RATINGS

and TYPICAL OPERATING CONDITIONS.) The tabulation shows the highest percentage of maximum plate voltage and power input that can be used up to 20 mc for the various classes of service. Special attention should be given to adequate ventilation of the bulb at these frequencies.

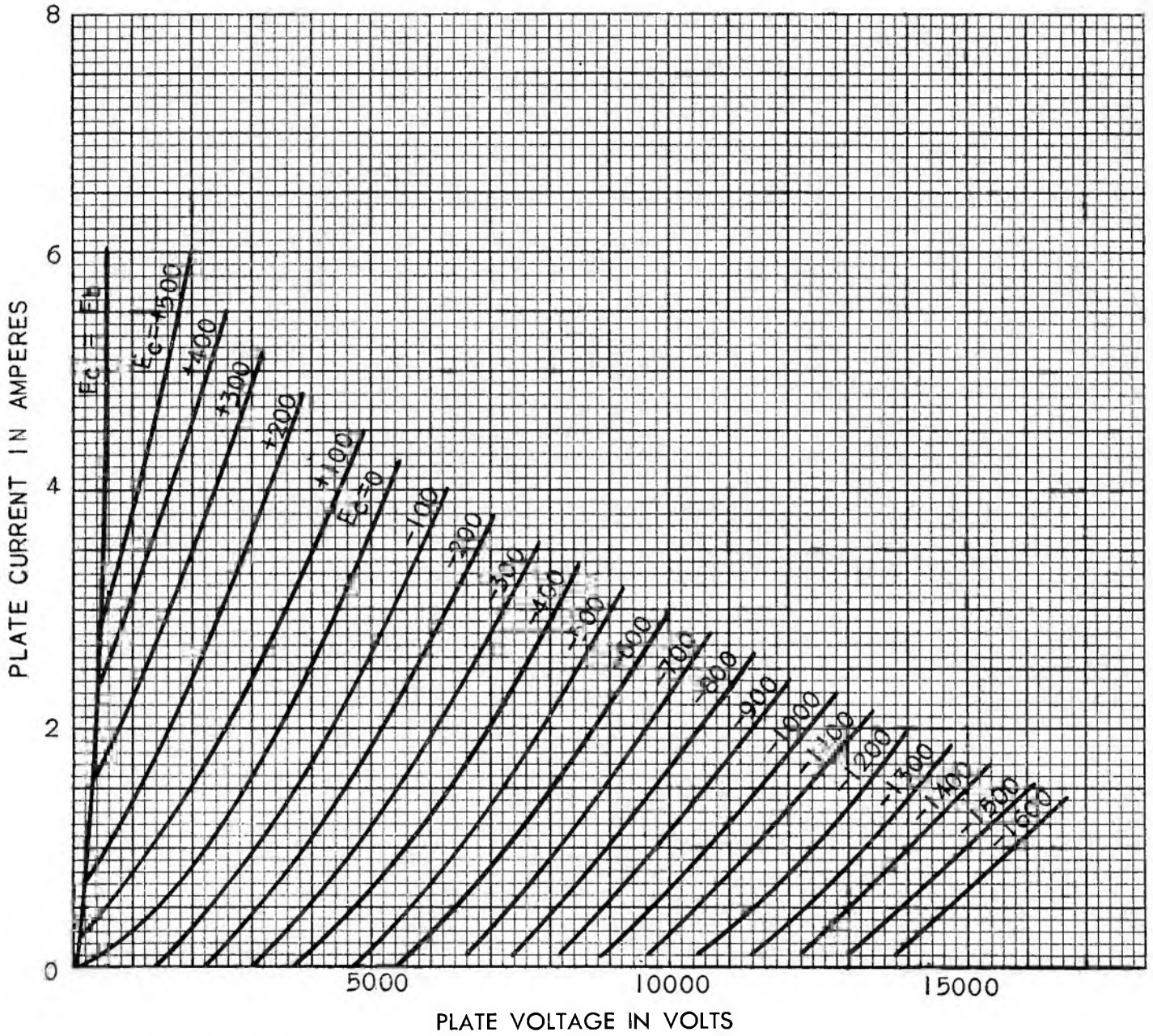
Frequency	1.6	7.5	20 megacycles
Percentage of maximum rated plate voltage and plate input, Class C, unmodulated	100	75	50 per cent

◆ GL-891

AVERAGE PLATE CHARACTERISTICS

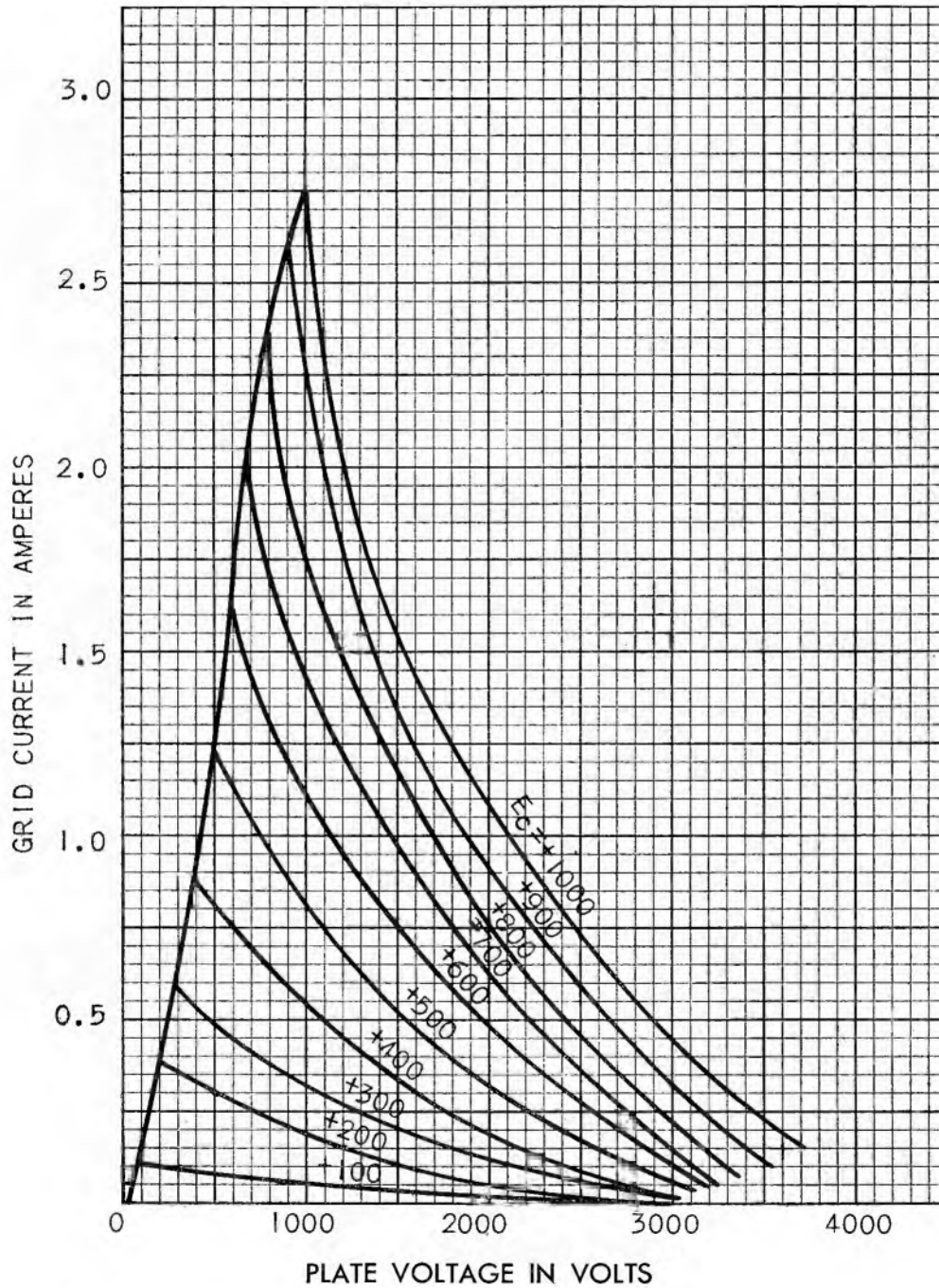
$E_f = 22$ VOLTS A-C

SINGLE-PHASE EXCITATION

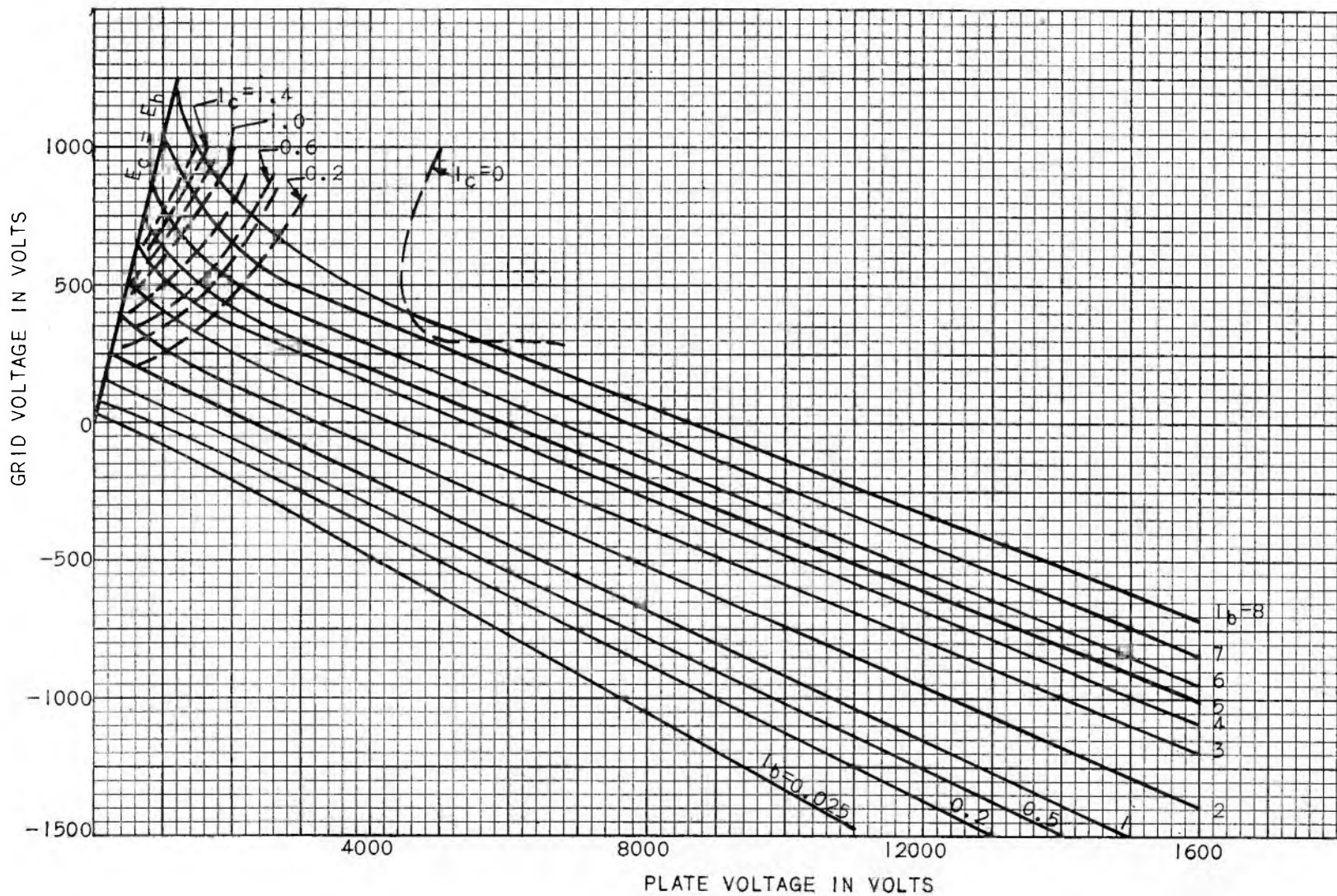


K-69087-72A104
◆ Revised drawing.

◆ GL-891
AVERAGE GRID-PLATE TRANSFER CHARACTERISTICS
 $E_f = 22$ VOLTS A-C
SINGLE-PHASE EXCITATION



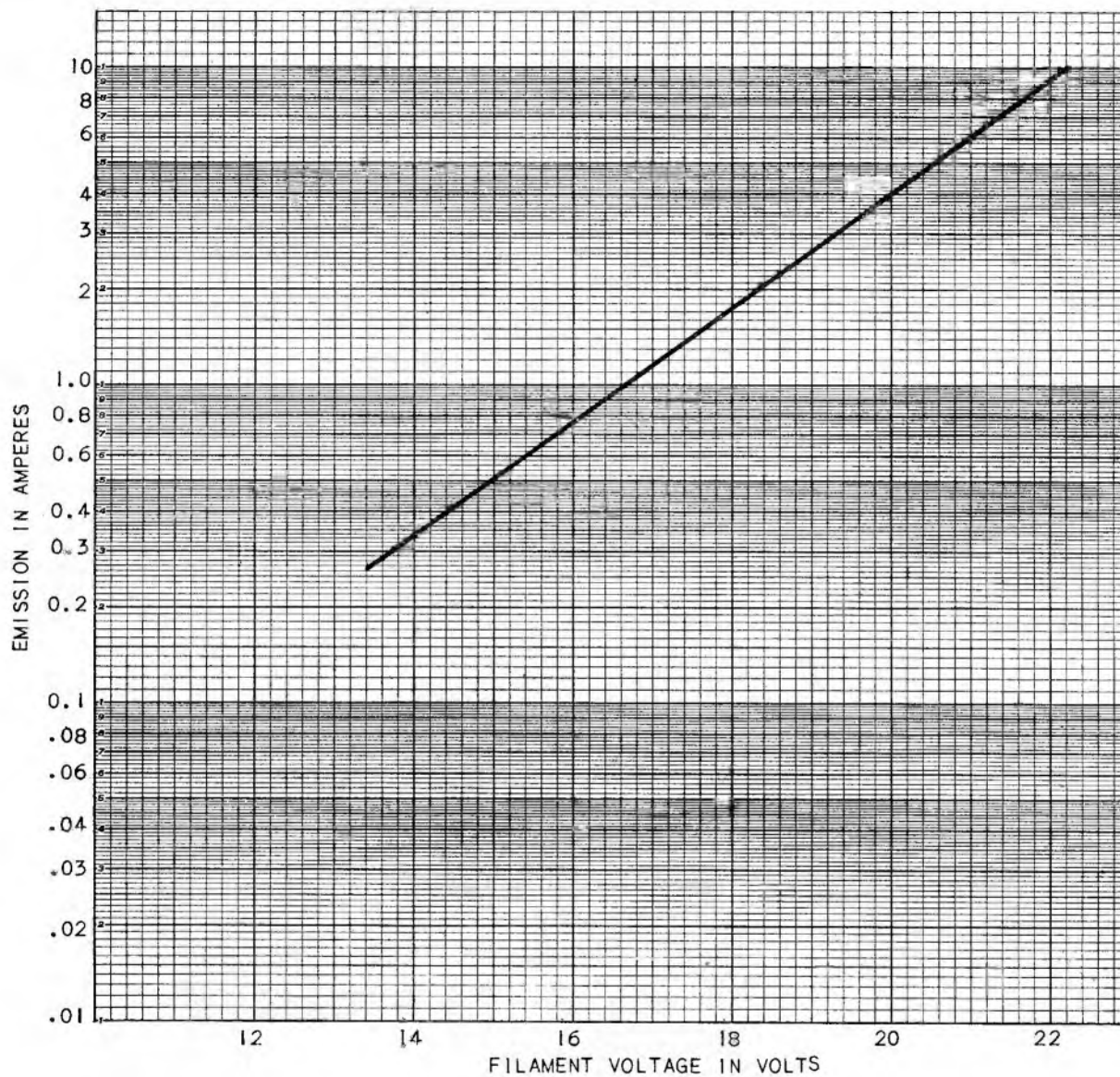
◆ GL-891
 AVERAGE CONSTANT-CURRENT CHARACTERISTICS
 $E_f = 22$ VOLTS A-C
 SINGLE-PHASE EXCITATION



K-69087-72A447
 ◆ Revised drawing.

1-11-51

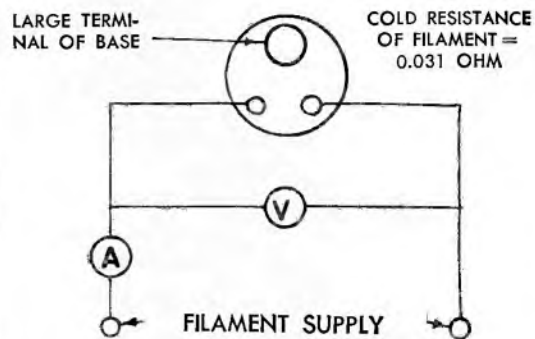
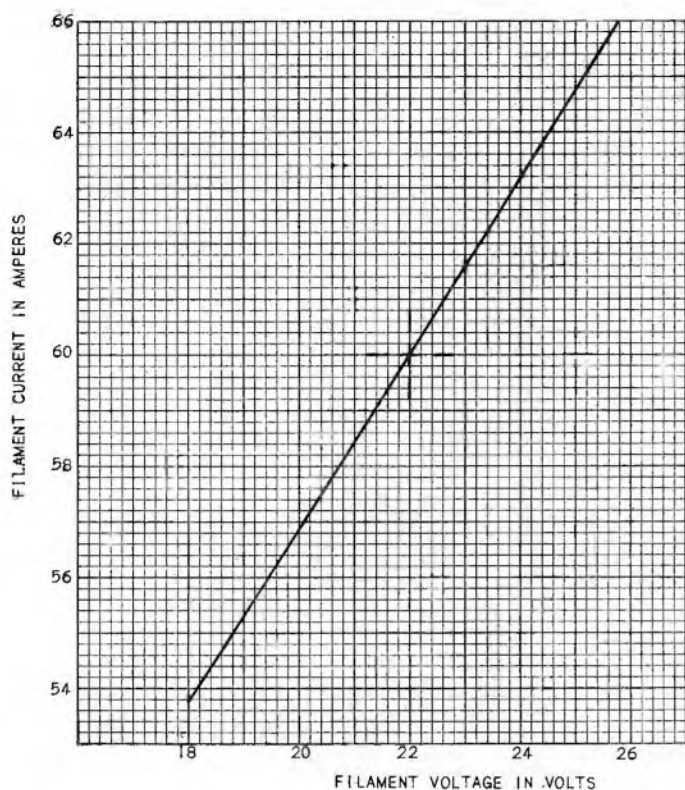
◆ GL-891 AVERAGE FILAMENT EMISSION CHARACTERISTIC



K-69087-72A448
◆ Revised drawing.

1-11-51

◆ GL-891 AVERAGE FILAMENT CHARACTERISTIC

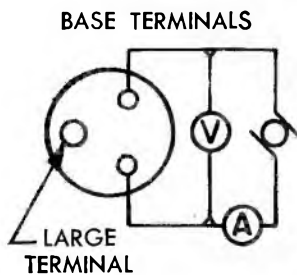


K-59087-72A441
 †Revised drawing.

1-11-51

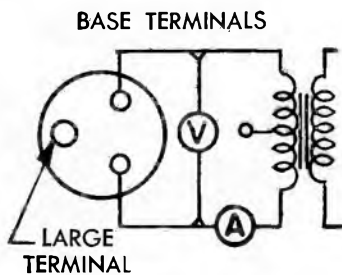
GL-891 FILAMENT CONNECTIONS

WITH D-C
 EXCITATION



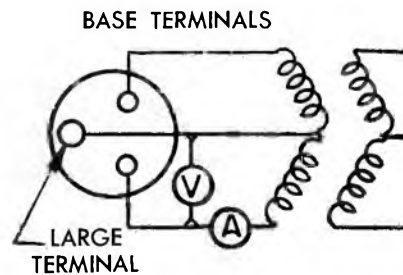
V = 22 VOLTS
 A = 60 AMPERES

WITH SINGLE-PHASE
 A-C EXCITATION



V = 22 VOLTS
 A = 60 AMPERES

WITH TWO-PHASE
 A-C EXCITATION



V = 11 VOLTS
 A = 60 AMPERES

K-9033547

12-1-44



PLIOTRON

DESCRIPTION

The 892 is a three-electrode pliotron of the double-filament type for use as a radio-frequency power amplifier, oscillator, and Class B modulator. The construction of the filament permits operation

from two-phase or single-phase alternating current as well as from direct current, for all classes of service. The plate is water-cooled and is capable of dissipating 6.6 to 10 kilowatts.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 3

Electrical

Cathode—filamentary, two-unit type

Excitation 1-phase a-c, 2-phase a-c, or d-c

Voltage, per unit 11 volts

Current 60 amperes

Amplification factor 50

Direct interelectrode capacitances

Grid-plate 30 micromicrofarads

Grid-filament 20 micromicrofarads

Plate-filament 1.5 micromicrofarads

Frequency for maximum ratings 1.6 megacycles


Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

Mechanical

Type of cooling	water	
Maximum outlet temperature	70	centigrade
Water flow	3 to 8	gallons per minute
Gasket	cat. no. 5182028P3	
Net weight, approximate	3	pounds
Shipping weight, approximate	10	pounds

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

CLASS B AUDIO-FREQUENCY POWER AMPLIFIER (TWO TUBES)

D-c plate voltage	15000	volts
Max-signal d-c plate current*	2.0	amperes
Max-signal plate input*	20	kilowatts
Plate dissipation	7.5	kilowatts

Typical operation:

Unless otherwise specified, values are for 2 tubes.

D-c plate voltage	6000	10000	12500	volts
D-c grid voltage†	0	-90	-170	volts
Peak a-f grid-to-grid voltage	1200	1620	1530	volts
Zero-signal d-c plate current	0.5	0.5	0.4	ampere
Max-signal d-c plate current	2.5	3.2	2.8	amperes
Load resistance (per tube)	1050	1600	2500	ohms
Effective load resistance (plate-to-plate)	4200	6400	10000	ohms
Max-signal driving power, approximate	415	525	420	watts
Max-signal power output, approximate	8	20	22	kilowatts

CLASS B RADIO-FREQUENCY POWER AMPLIFIER

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

D-c plate voltage	15000	volts
D-c plate current	1.0	amperes
Plate input	15	kilowatts
Plate dissipation	10	kilowatts

Typical operation:

D-c plate voltage	6000	10000	14000	volts
D-c grid voltage†	0	-100	-190	volts
Peak r-f grid voltage	300	470	510	volts
D-c plate current	0.67	0.93	0.95	amperes
Driving power°, approximate	65	50	30	watts
Power output, approximate	1	2.5	4	kilowatts

CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—PLATE-MODULATED

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

D-c plate voltage	10000	volts
D-c grid voltage	-3000	volts
D-c plate current	1.0	ampere
D-c grid current	0.25	ampere
Plate input	10	kilowatts
Plate dissipation	6.6	kilowatts

Typical operation:

D-c plate voltage	6000	8000	10000	volts
D-c grid voltage	-1000	-1300	-1600	volts
Peak r-f grid voltage	1675	2000	2400	volts
D-c plate current	0.77	0.75	0.72	ampere
D-c grid current, approximate	0.19	0.18	0.12	ampere
Driving power, approximate	310	350	260	watts
Power output, approximate	3.5	5	6	kilowatts

CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR

Key-down conditions per tube without modulation††

D-c plate voltage	15000 volts
D-c grid voltage	-3000 volts
D-c plate current	2.0 amperes
D-c grid current	0.25 ampere
Plate input	30 kilowatts
Plate dissipation	10 kilowatts

Typical operation:

D-c plate voltage	8000	10000	12000	volts
D-c grid voltage	-1000	-1300	-1600	volts
Peak r-f grid voltage	1800	2300	2800	volts
D-c plate current	1.1	1.4	1.64	amperes
D-c grid current, approximate	0.18	0.18	0.18	ampere
Driving power, approximate	320	400	500	watts
Power output, approximate	6.5	10	14	kilowatts

*Averaged over any audio-frequency cycle of sine-wave form.

†With d-c filament supply.

°At crest of a-f cycle with modulation factor of 1.0.

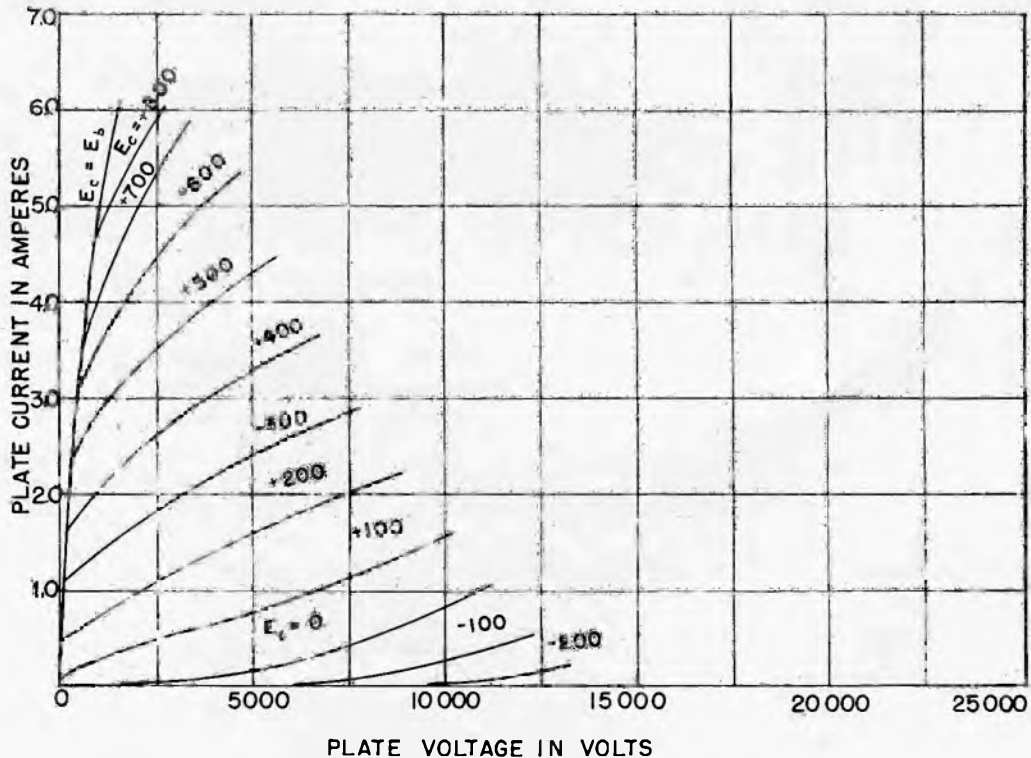
††Modulation, essentially negative, may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

APPLICATION NOTES

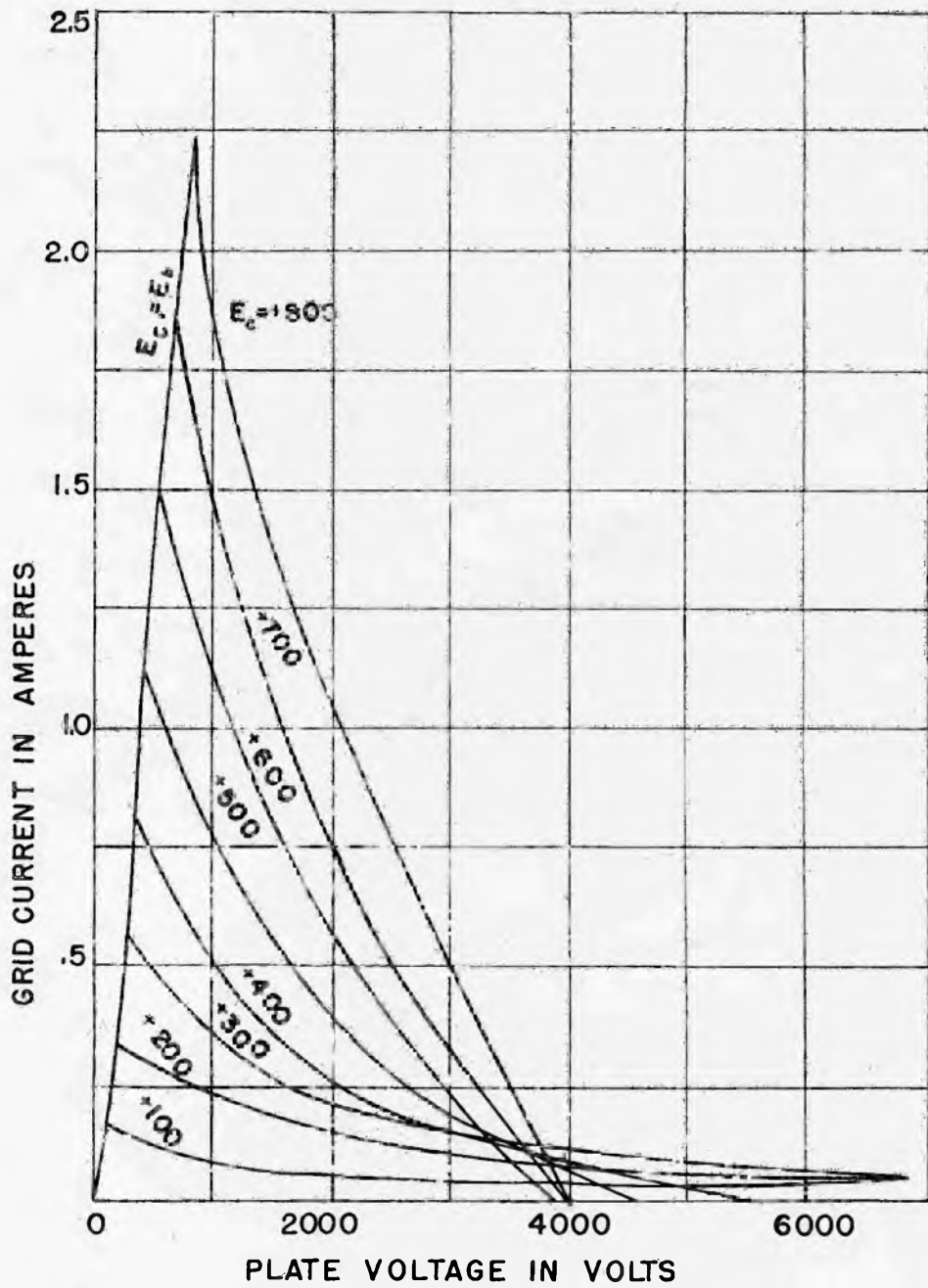
GL-892 can be operated at maximum ratings in all classes of service at frequencies as high as 1.6 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised (other maximum ratings are the same as shown under MAXIMUM RAT-

ING). The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used up to 20 mc for the various classes of service. Special attention should be given to adequate ventilation of the bulb at these frequencies.

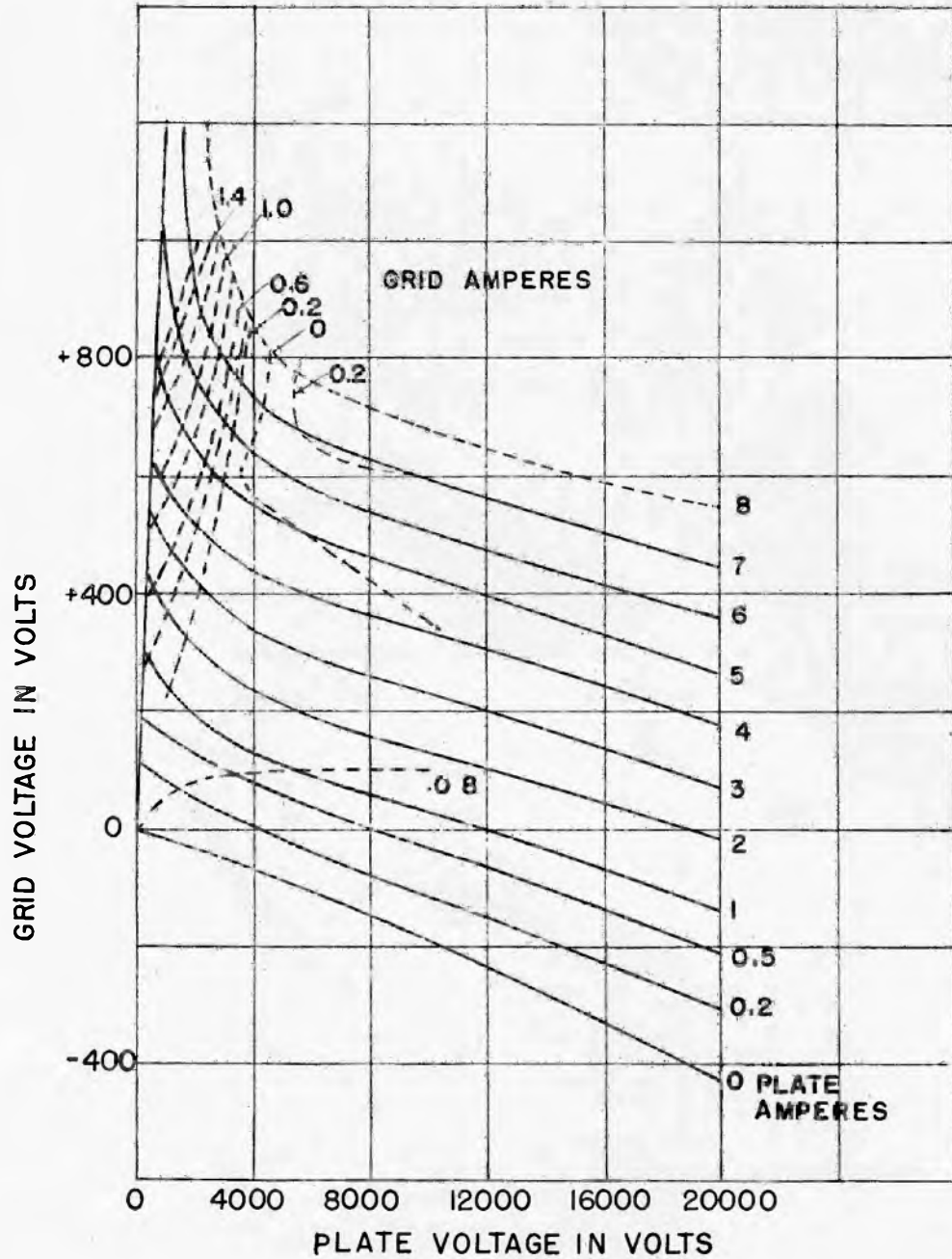
Frequency	1.6	7.5	20 megacycles
Maximum permissible percentage of maximum rated plate voltage and plate input:			
Class B telephony	100	85	76 per cent
Class C plate-modulated	100	85	75 per cent
Class C unmodulated	100	75	50 per cent



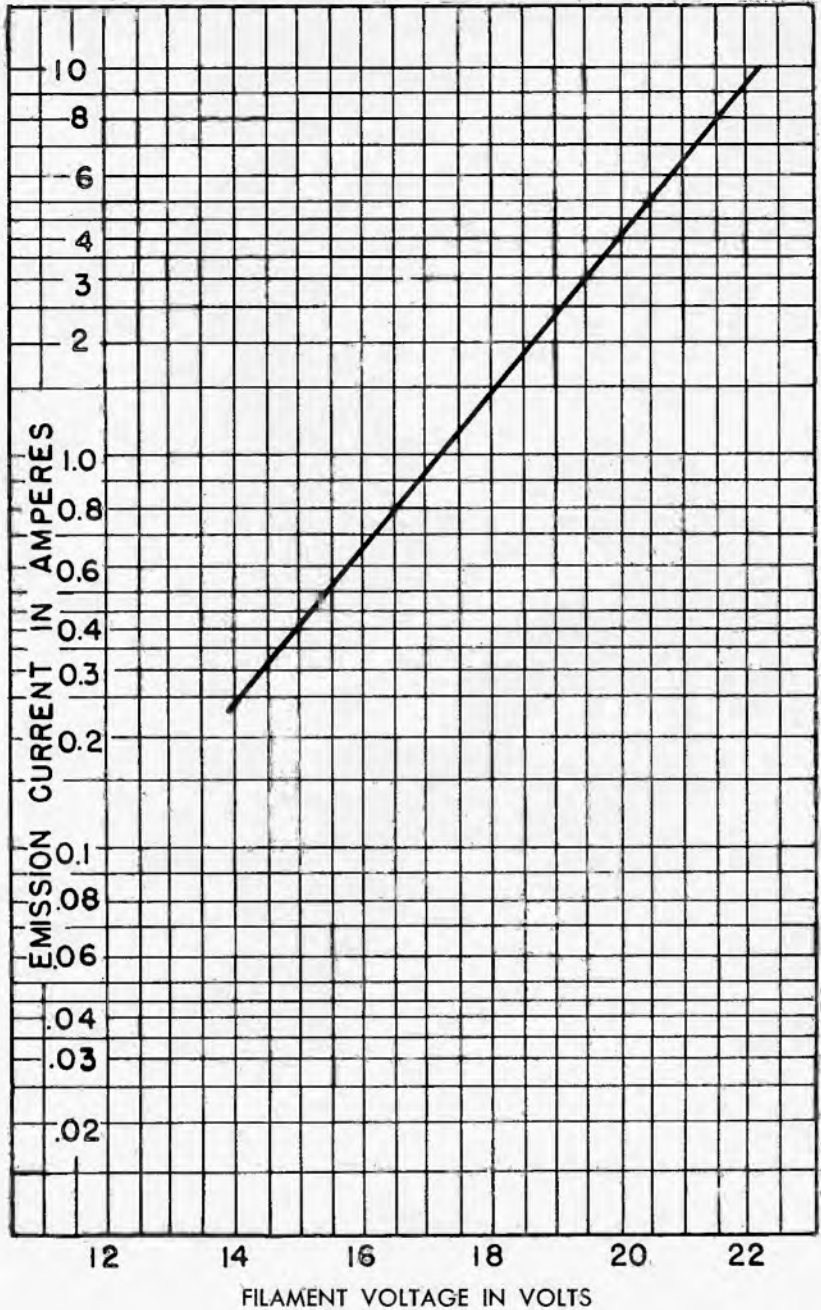
GL-892 AVERAGE PLATE CHARACTERISTICS ($E_c = 22$ VOLTS A-C)



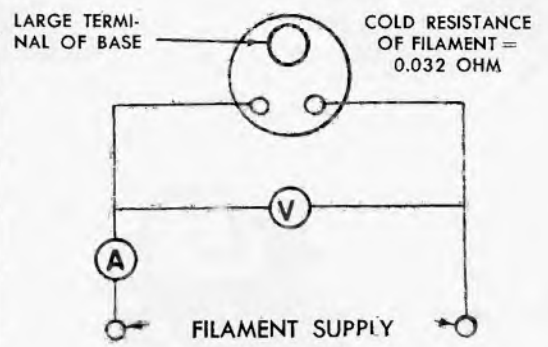
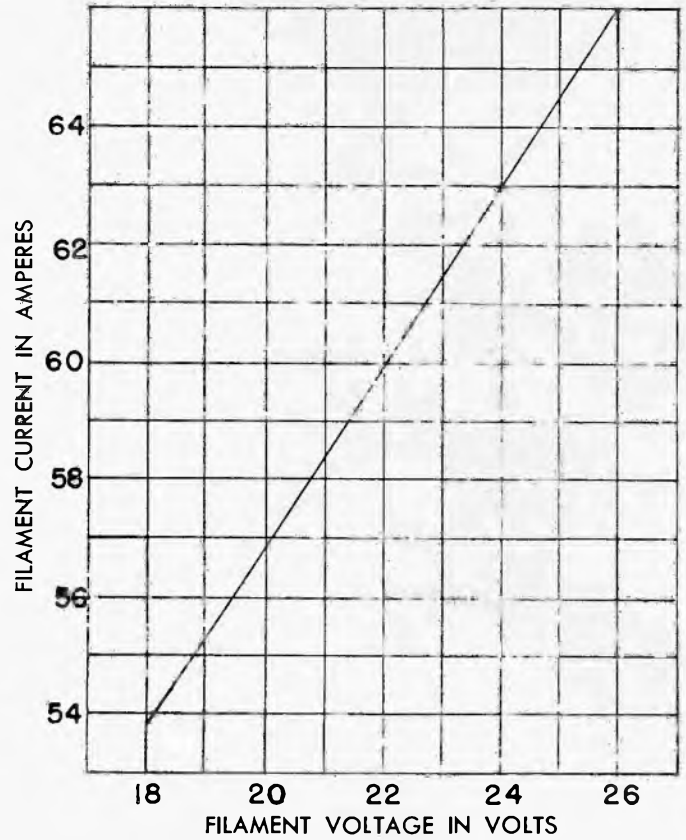
GL-892 GRID-CURRENT CHARACTERISTICS ($E_f = 22$ VOLTS A-C)



GL-892 CONSTANT CURRENT PLATE AND GRID CHARACTERISTICS ($E_f = 22$ VOLTS A-C)



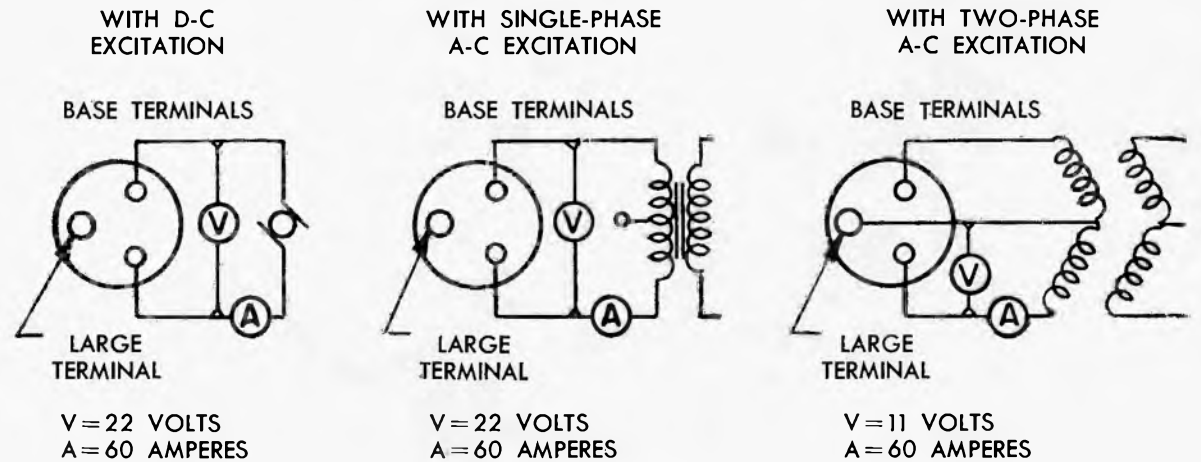
GL-892 AVERAGE FILAMENT EMISSION CHARACTERISTIC



K-8639398

11-2-44

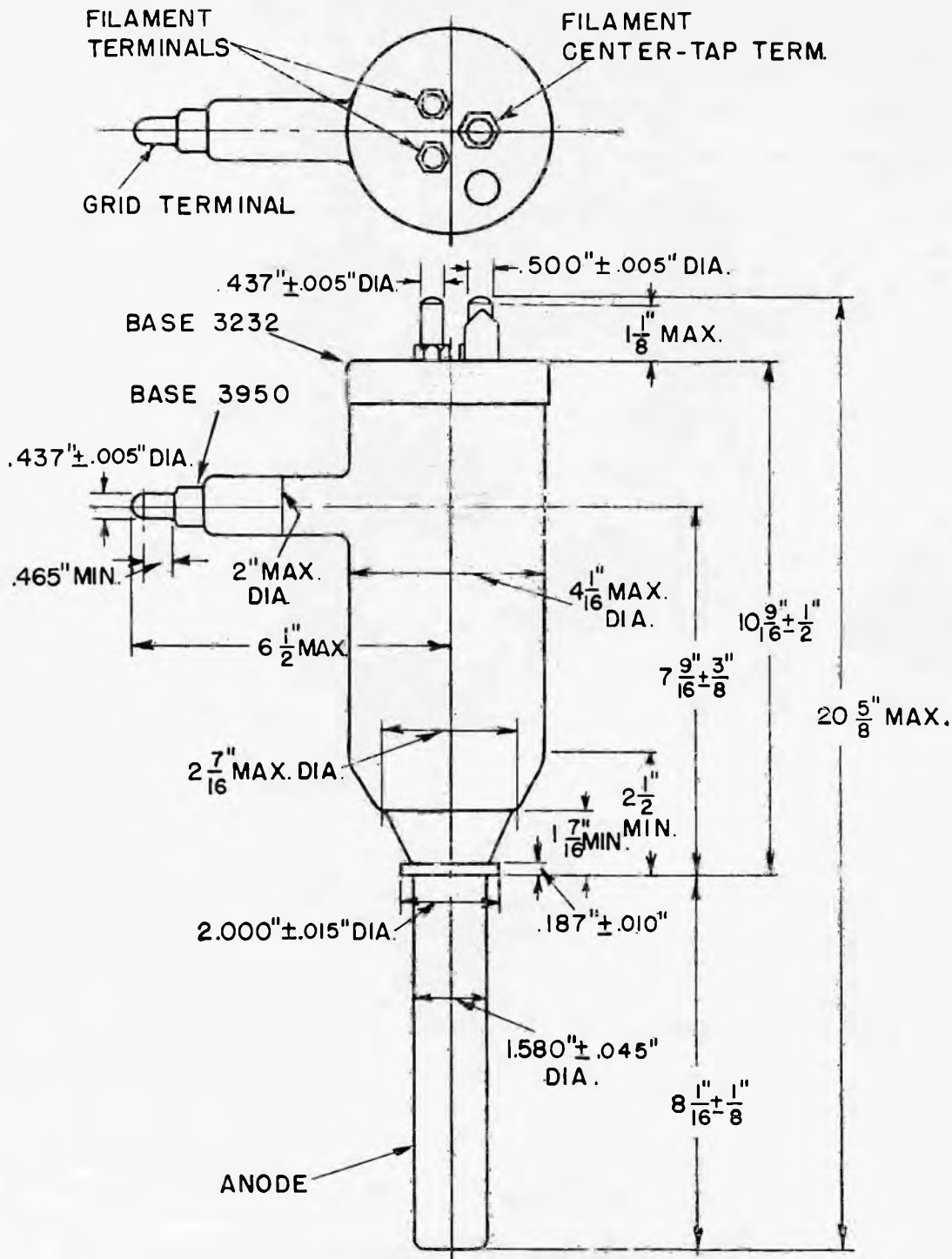
GL-892 AVERAGE FILAMENT CHARACTERISTICS



GL-892 FILAMENT CONNECTIONS

K-9033547

12-1-44



OUTLINE GL-892 PIOTRON

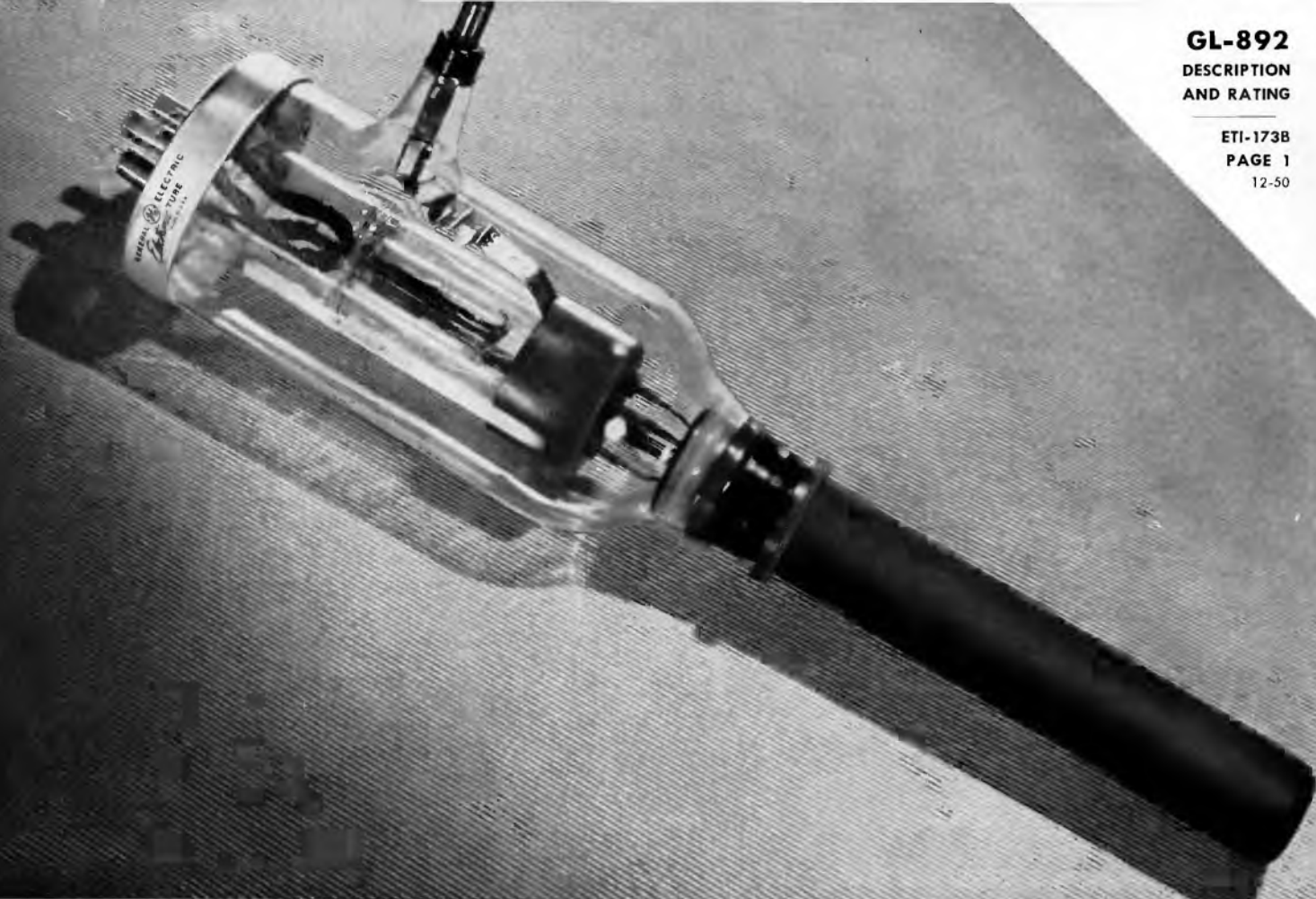
K-6966979

9-23-44

NOTE: Mounting position vertical, anode down.

Electronics Department
GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-892 is a three-electrode pliotron of the double-filament type for use as a radio-frequency power amplifier, oscillator, and Class B modulator. The construction of the filament permits operation

from two-phase or single-phase alternating current as well as from direct current, for all classes of service. The plate is water-cooled and is capable of dissipating 6.6 to 10 kilowatts.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage		22	23 volts
Filament current at bogey voltage	57	60	62 amperes
Filament starting current			120 amperes
Filament cold resistance		0.031	ohms
Amplification factor, $E_c = -50$ V, $I_b = 0.75$ A	42.5	50.0	57.5
Interelectrode capacitances			
Grid-plate	27	30	33 uuf
Grid-filament	15	20	24 uuf
Plate-filament	0.5	1.5	2.5 uuf

◆ Completely revised.


Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-173A dated 6-47

TECHNICAL INFORMATION (CONT'D)

Mechanical Data	Minimum	Bogey	Maximum
Mounting position—vertical, anode down			
Type of cooling—water			
Water flow on anode	3		8 gpm
Maximum outgoing temperature			70 C
Maximum glass temperature			150 C
Gasket—JTC gasket—1			
Net weight, approximate			3½ pounds

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER MODULATOR—CLASS B

Maximum Ratings, Absolute Values

D-c plate voltage	15,000 max	volts
Maximum signal d-c plate current †	2.0 max	amperes
Maximum signal plate input †	20,000 max	watts
Plate dissipation †	7,500 max	watts

Typical Operation

Unless otherwise specified, values are for two tubes

D-c plate voltage	6,000	10,000	12,500	volts
D-c grid voltage	0.0	-90	-170	volts
Peak a-f grid-to-grid voltage	1,000	1,380	1,370	volts
Zero signal d-c plate current	0.5	0.5	0.4	amperes
Maximum signal d-c plate current	2.6	3.3	2.8	amperes
Effective load resistance, plate to plate	4,200	6,400	10,000	ohms
Maximum signal driving power, approximate	135	240	160	watts
Maximum signal power output, approximate	8,000	20,000	22,000	watts

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum Ratings, Absolute Values

D-c plate voltage	15,000 max	volts
D-c plate current	1.0 max	ampere
Plate input	15,000 max	watts
Plate dissipation	10,000 max	watts

Typical Operation

D-c plate voltage	6,000	10,000	14,000	volts
D-c grid voltage		-100	-190	volts
Peak r-f grid voltage	230	370	440	volts
D-c plate current	0.640	0.77	0.82	amperes
D-c grid current, approximate	0.030	0.060	0.03	amperes
Driving power, approximate//	77	133	106	watts
Power output, approximate	1,000	2,500	4,000	watts

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

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

Maximum Ratings, Absolute Values

D-c plate voltage	10,000 max	volts
D-c grid voltage	-3,000 max	volts
D-c plate current	1.0 max	ampere
D-c grid current	0.3 max	ampere
Plate input	10,000 max	watts
Plate dissipation	6,600 max	watts

Typical Operation

D-c plate voltage	6,000	8,000	10,000	volts
D-c grid voltage	-1,000	-1,300	-1,600	volts
Peak r-f grid voltage	1,650	1,950	2,250	volts
D-c plate current	0.83	0.82	0.78	amperes
D-c grid current, approximate	0.28	0.24	0.23	amperes
Driving power, approximate	420	430	460	watts
Power output, approximate	3,500	5,000	6,000	watts

TECHNICAL INFORMATION (CONT'D)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation†

Maximum Ratings, Absolute Values

D-c plate voltage	15,000 max	volts
D-c grid voltage	-3,000 max	volts
D-c plate current	2.0 max	amperes
D-c grid current	0.4 max	ampere
Plate input	30,000 max	watts
Plate dissipation	10,000 max	watts

Typical Operation

D-c plate voltage	8,000	10,000	12,000	volts
D-c grid voltage	-1,000	-1,300	-1,600	volts
Peak r-f grid voltage	1,700	2,150	2,550	volts
D-c plate current	1.17	1.4	1.55	amperes
D-c grid current, approximate	0.22	0.24	0.23	amperes
Driving power, approximate	330	495	565	watts
Power output, approximate	6,500	10,000	14,000	watts

† Averaged over any audio-frequency cycle of sine-wave form.

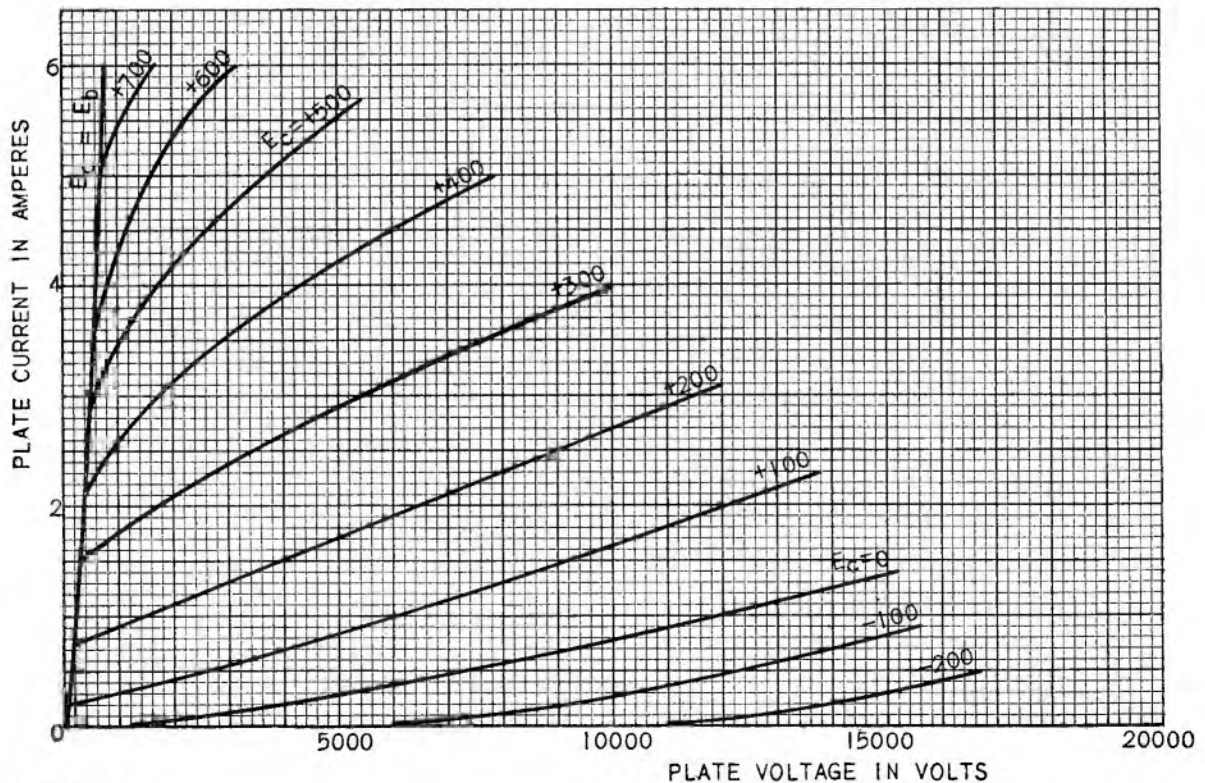
// At crest of audio-frequency cycle with modulation factor of 1.0.

‡ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

Maximum ratings apply up to 1.6 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	1.6	7.5	20.0	megacycles
Percentage of Maximum Rated Plate Voltage and Plate Input				
Class B	100	85	76	percent
Class C plate modulated	100	85	75	percent
Class C unmodulated	100	75	50	percent

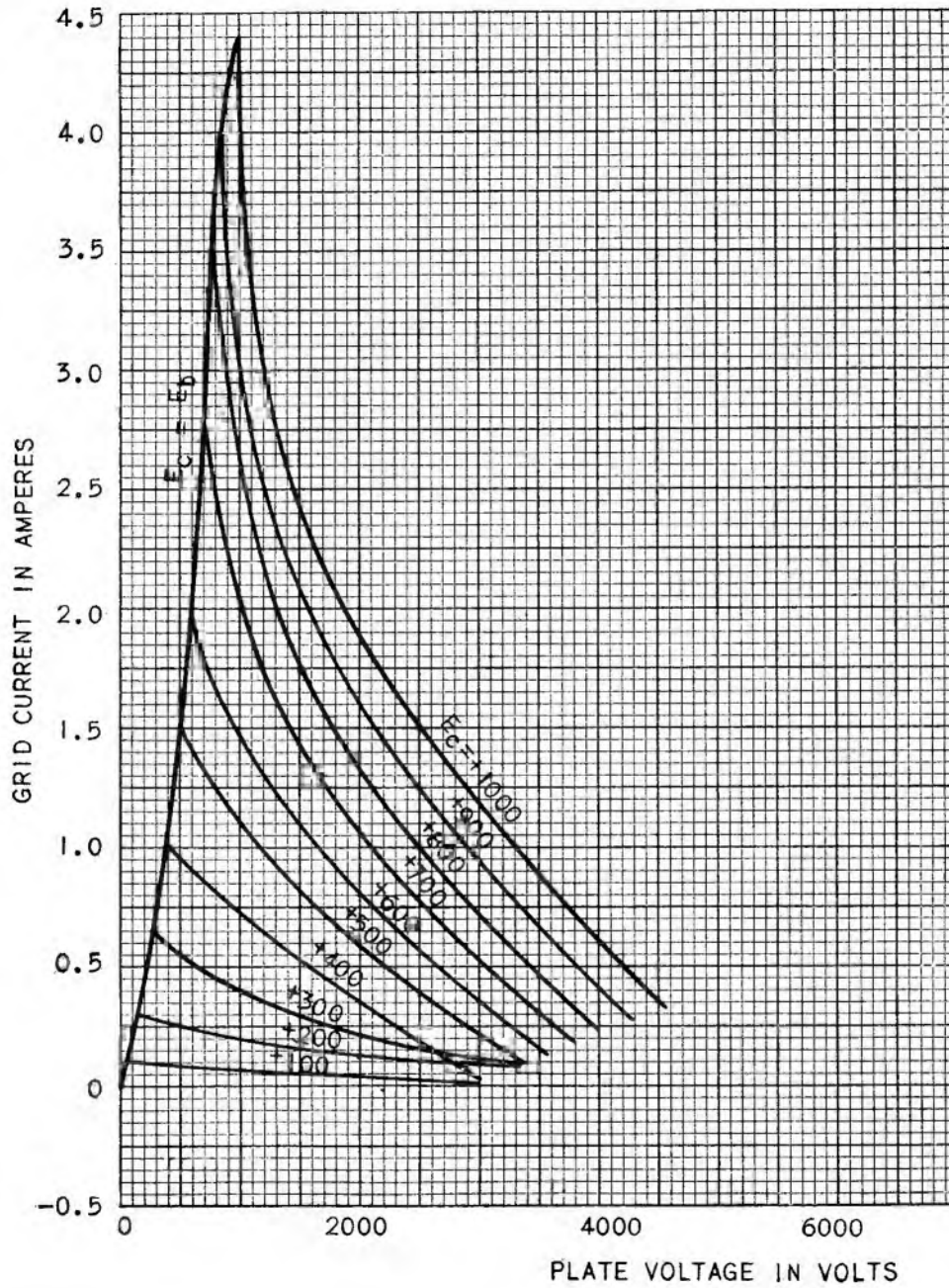
◆ GL-892 AVERAGE PLATE CHARACTERISTICS ($E_c = 22$ VOLTS A-C)



◆ GL-892

AVERAGE GRID-PLATE TRANSFER CHARACTERISTICS

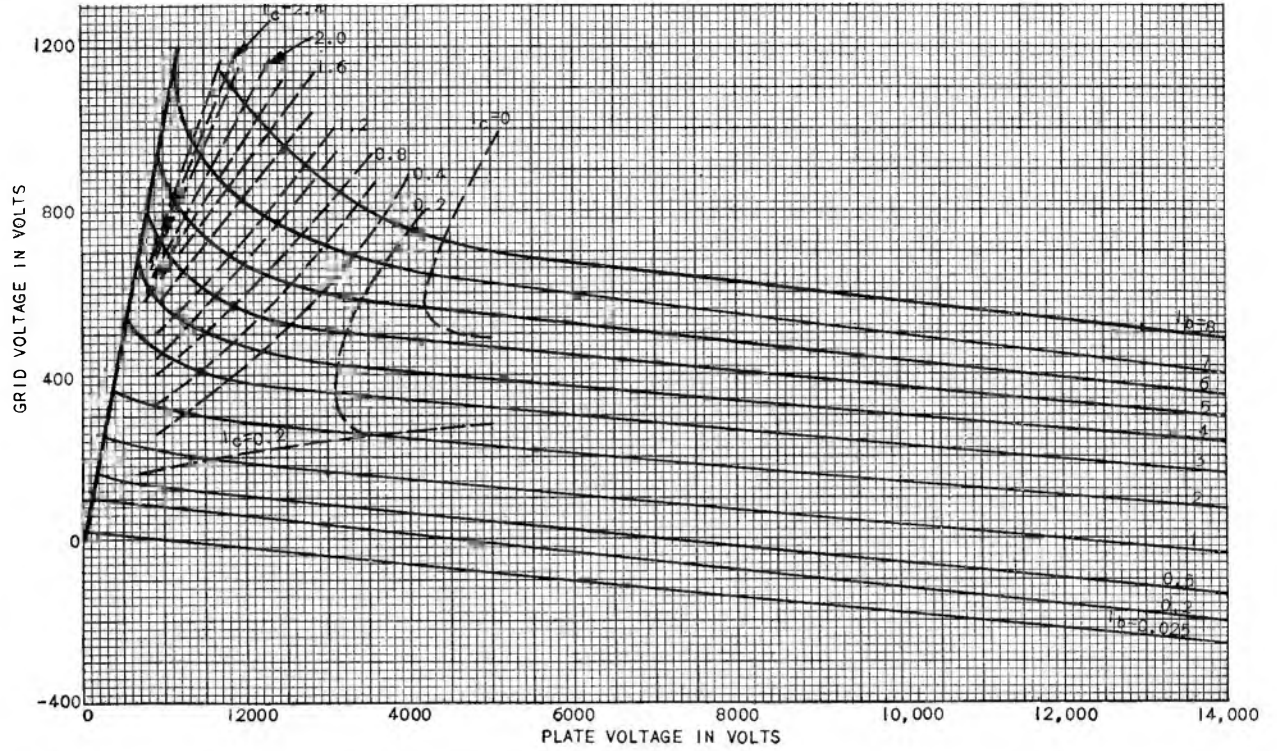
$E_f = 22$ VOLTS, A-C, SINGLE-PHASE EXCITATION



◆ GL-892

AVERAGE CONSTANT-CURRENT CHARACTERISTICS

$E_f = 22$ VOLTS A-C, SINGLE-PHASE EXCITATION

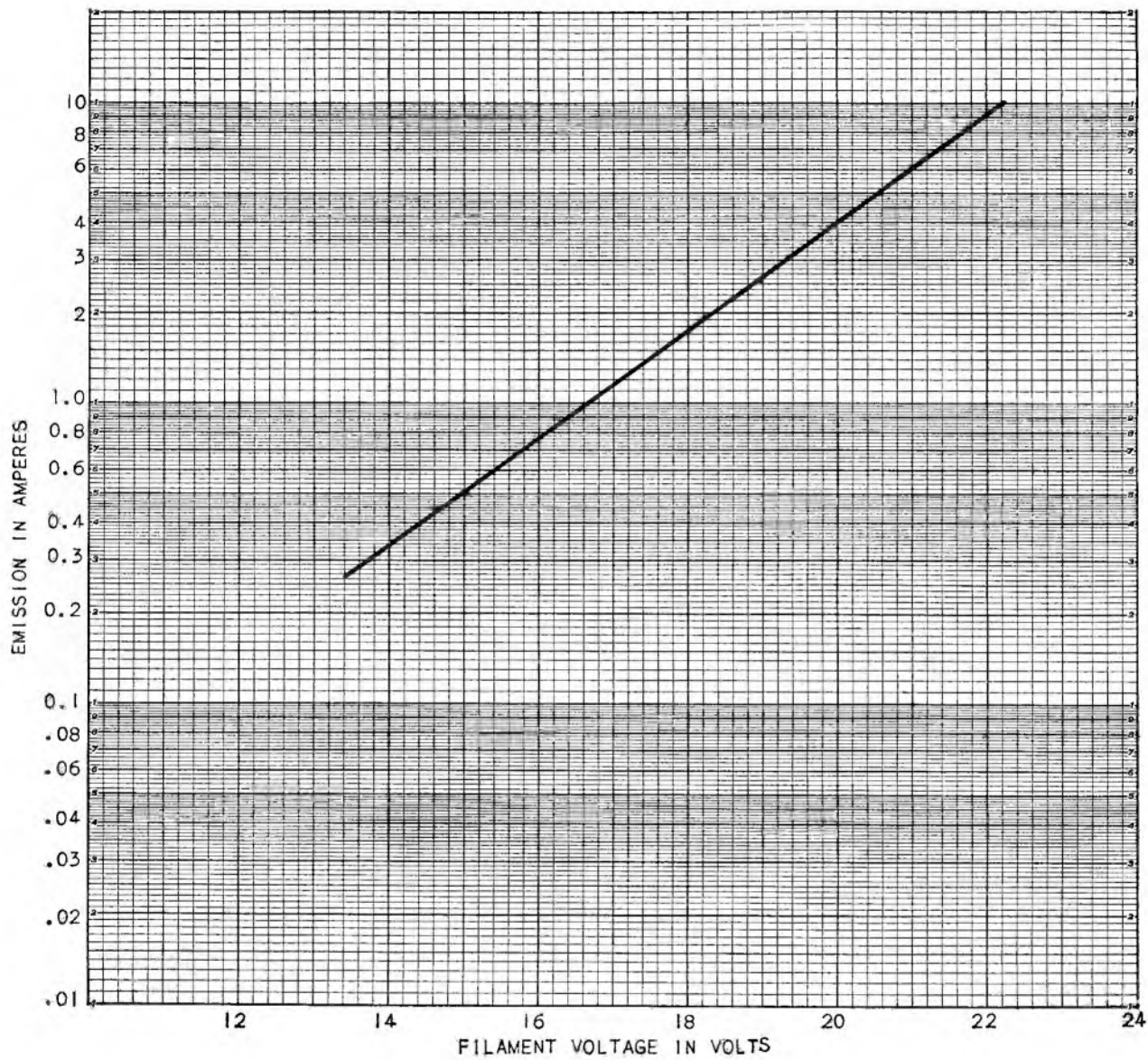


K-69087-72A443

◆ New drawing.

1-11-51

◆ GL-892 AVERAGE FILAMENT EMISSION CHARACTERISTIC

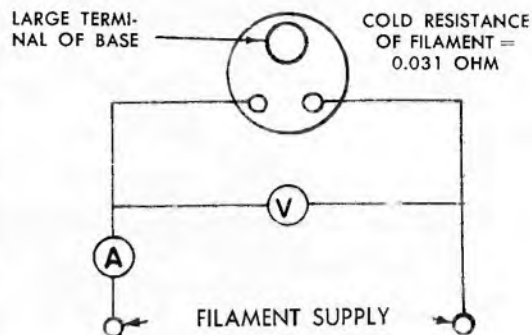
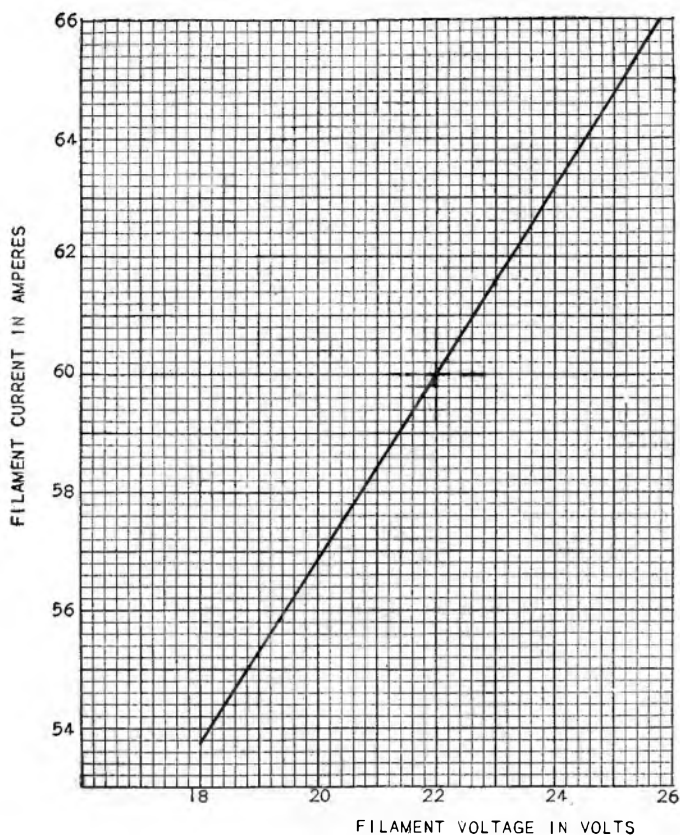


K-69087-72A448

◆ New drawing

1-11-51

◆ GL-892 AVERAGE FILAMENT CHARACTERISTICS

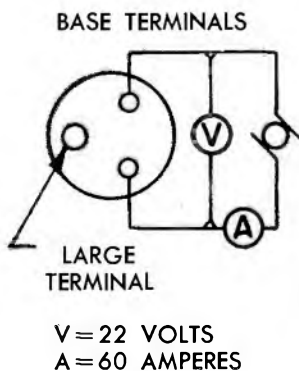


K-69087-72A441
◆ New drawing.

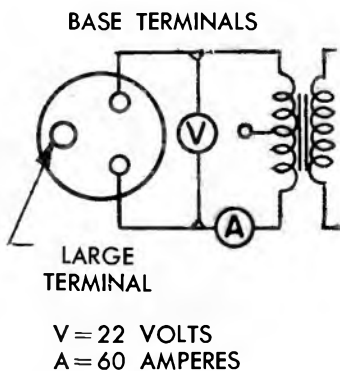
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GL-892 FILAMENT CONNECTIONS

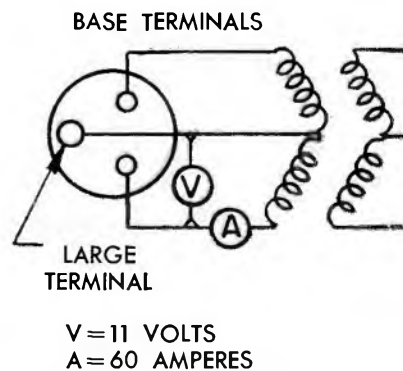
WITH D-C EXCITATION



WITH SINGLE-PHASE A-C EXCITATION



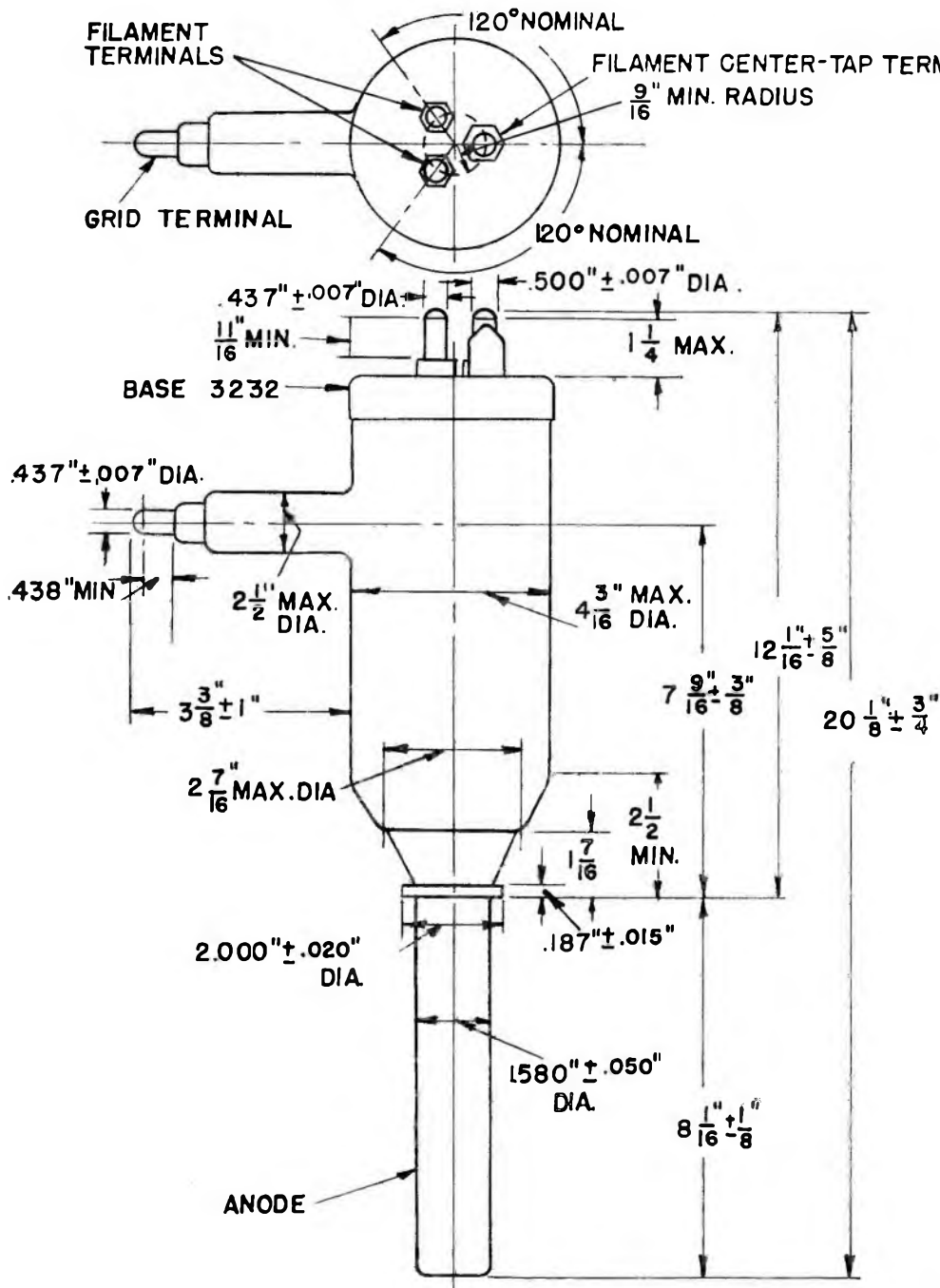
WITH TWO-PHASE A-C EXCITATION



K-9033547

12-1-44

OUTLINE GL-892 PIOTRON



K-6966979

3-11-47

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-893-A is a three-electrode tube designed for use as a radio-frequency amplifier, oscillator, or Class B modulator. The anode is water-cooled

and capable of dissipating 20 kilowatts. The cathode is a pure-tungsten filament. Maximum ratings apply up to 5 megacycles.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage (single-phase excitation)* ●		20	21 volts
Filament current at bogey voltage (Single-phase excitation)* ●	175	183	190 amperes
Filament starting current (Single-phase excitation)			275 amperes
Filament cold resistance (Single-phase excitation)		.0093	ohm
Amplification factor, $I_b = 1.0$ amp, $E_c = -100$ v.	28	34.5	41
Interelectrode capacitances			
Grid-plate	28.5	33	37.5 uuf
Grid-filament	39.5	48	56.5 uuf
Plate-filament	2.0	3.0	4.0 uuf

◆ Technical information completely revised.



GENERAL  ELECTRIC

Supersedes ETI-174A, dated 12-45

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position	vertical, anode down
Type of cooling	water and forced air
Water flow on anode	15 GPM
Maximum outgoing water temperature	70 C
Required air flow to stem*	2 CFM
Maximum glass temperature	150 C
Net weight, approximate	12 pounds

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values				CCS†
D-c plate voltage	20000 max			volts
Maximum signal d-c plate current‡	4.0 max			amperes
Maximum signal plate input‡	60 max			kilowatts
Plate dissipation‡	20 max			kilowatts
Typical operation				CCS†
Unless otherwise specified, values are for 2 tubes				
D-c plate voltage	12000	15000	18000	volts
D-c grid voltage	-260	-350	-450	volts
Peak a-f grid-to-grid voltage	1480	1560	1720	volts
Zero signal d-c plate current	0.8	0.8	0.8	ampere
Maximum signal d-c plate current	7.0	6.0	5.5	amperes
Effective load resistance, plate to plate	4000	6000	8000	ohms
Maximum signal driving power, approximate	220	190	140	watts
Maximum signal power output, approximate	52	60	70	kilowatts

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum ratings, absolute values				CCS†
D-c plate voltage	20000 max			volts
D-c plate current	2.0 max			amperes
Plate input	32 max			kilowatts
Plate dissipation	20 max			kilowatts
Typical operation				CCS†
D-c plate voltage	12000	15000	15000	volts
D-c grid voltage	-250	-340	-340	volts
Peak r-f grid voltage	350	395	450	volts
D-c plate current	1.5	1.5	2.0	amperes
D-c grid current, approximate	35	30	50	milliamperes
Driving power, approximate Δ	130	150	200	watts
Power output, approximate	6	7.5	10	kilowatts

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

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

Maximum ratings, absolute				CCS†
D-c plate voltage	12000 max			volts
D-c grid voltage	-3000 max			volts
D-c plate current	2.0 max			amperes
D-c grid current	0.4 max			ampere
Plate input	24 max			kilowatts
Plate dissipation	12 max			kilowatts
Typical operation				CCS†
D-c plate voltage	10000	10000	12000	volts
D-c grid voltage	-800	-800	-1000	volts
Peak r-f grid voltage	1200	1280	1500	volts
D-c plate current	1.5	2.0	2.0	amperes
D-c grid current, approximate	0.10	0.16	0.14	ampere
Driving power, approximate	120	210	210	watts
Power output, approximate	11	15	18	kilowatts

TECHNICAL INFORMATION (CONT'D)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation¶

Maximum ratings, absolute values	CCS†		
D-c plate voltage	20,000 max volts		
D-c grid voltage	-3000 max volts		
D-c plate current	4.0 max amperes		
D-c grid current	0.4 max amperes		
Plate input	70 max kilowatts		
Plate dissipation	20 max kilowatts		
Typical operation	CCS†		
D-c plate voltage	12,000	15,000	18,000 volts
D-c grid voltage	-800	-900	-1000 volts
Peak r-f grid voltage	1430	1520	1630 volts
D-c plate current	3.5	3.6	3.6 amperes
D-c grid current, approximate	0.26	0.25	0.21 amperes
Driving power, approximate	360	370	340 watts
Power output, approximate	30	40	50 kilowatts

*Air flow to be directed into stem through tubing in center of base. The flow of stem cooling air must continue 5 minutes after removal of filament and plate power.

⊙ See drawing filament connections and excitation circuits, K-8639686.

†CCS = Continuous commercial service.

‡Averaged over any audio-frequency cycle of sine-wave form.

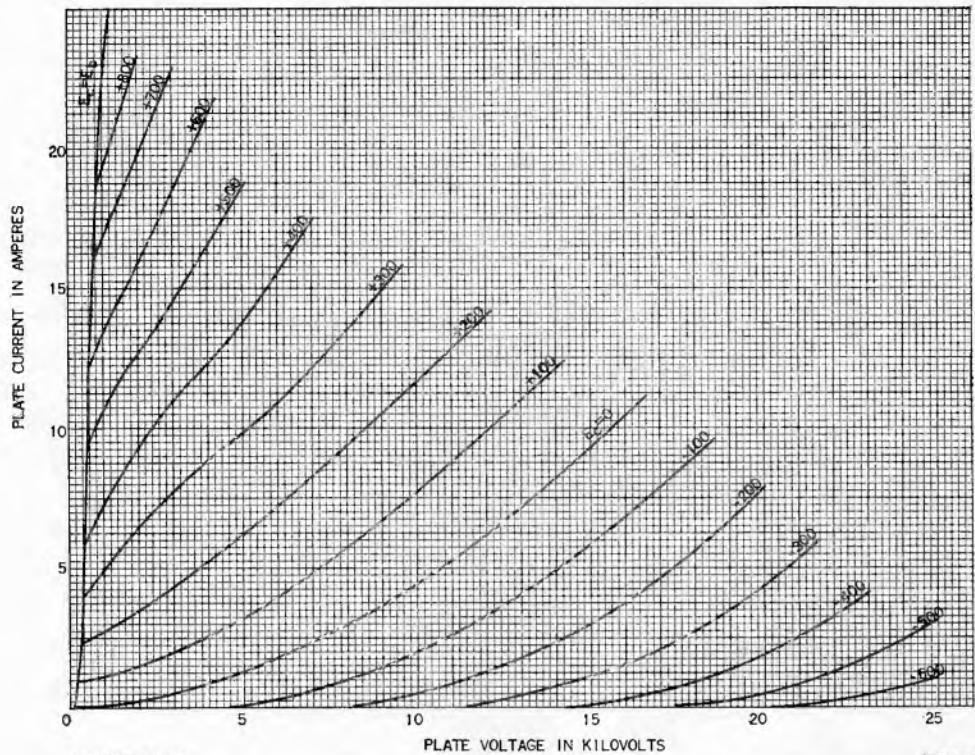
△ At crest of audio-frequency cycle with modulation factor of 1.0.

¶ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

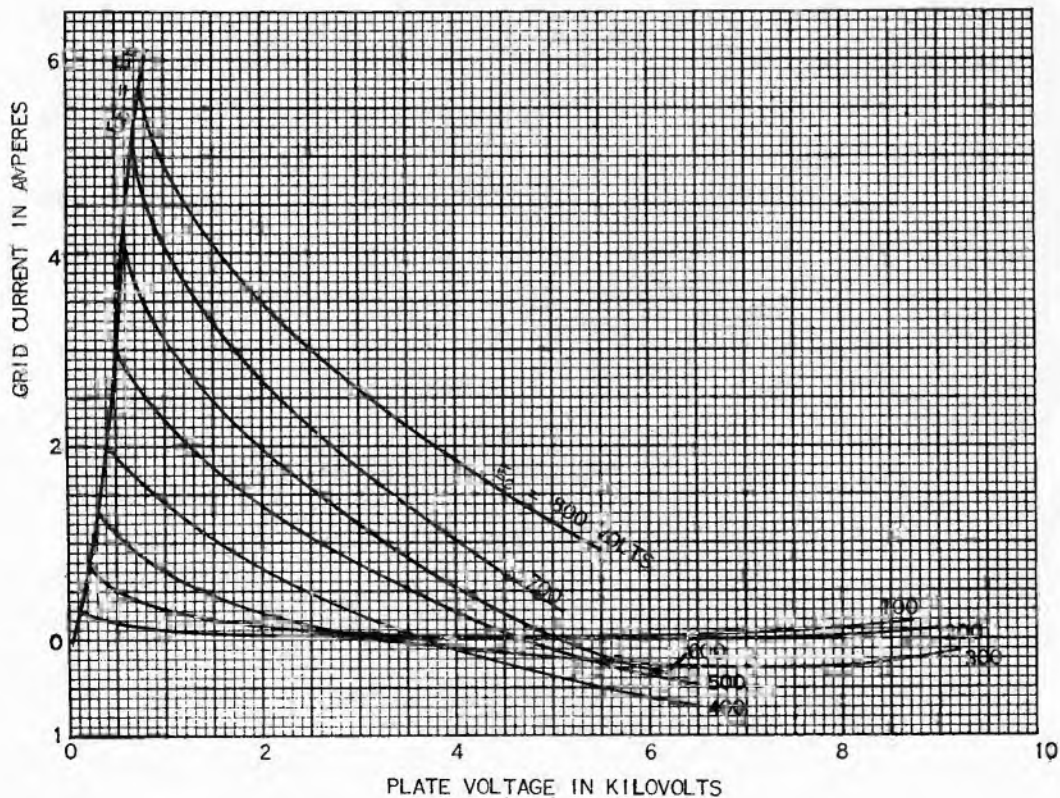
Maximum ratings apply up to 5 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	5	20	40 megacycles
Class B r-f			
Percentage of maximum rated plate voltage	100	85	65 per cent
Percentage of maximum rated plate input	100	82	73 per cent
Class C plate modulated			
Percentage of maximum rated plate voltage	100	80	64 per cent
Percentage of maximum rated plate input	100	75	64 per cent
Class C			
Percentage of maximum rated plate voltage	100	80	60 per cent
Percentage of maximum rated plate input	100	66	50 per cent

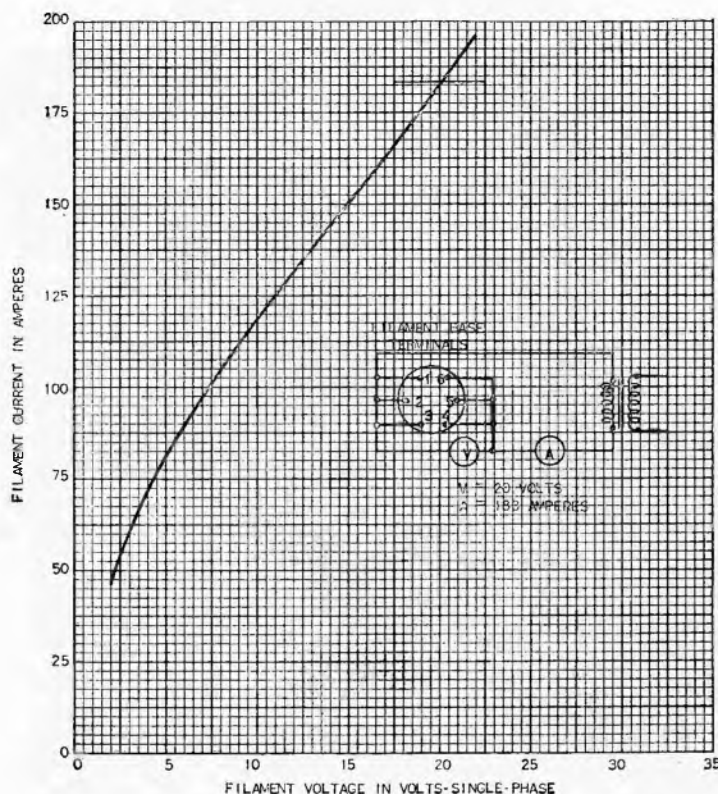
GL-893-A AVERAGE PLATE CHARACTERISTIC
 $E_f = 20$ VOLTS A-C



■ GL-893-A TYPICAL GRID-PLATE TRANSFER CHARACTERISTIC
 $E_f = 20$ VOLTS A-C



GL-893-A AVERAGE FILAMENT CHARACTERISTIC
SINGLE-PHASE CONNECTION
COLD RESISTANCE = 0.0093 OHM

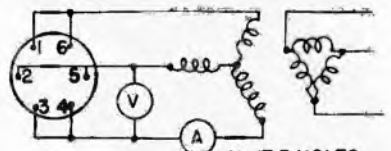


K-69087-72A287
Drawing revised

4-25-49

GL-893-A FILAMENT CONNECTIONS

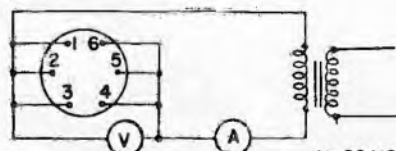
FILAMENT BASE TERMINALS



V = 17.3 VOLTS
A = 122 AMPERES

THREE-PHASE A-C FILAMENT EXCITATION

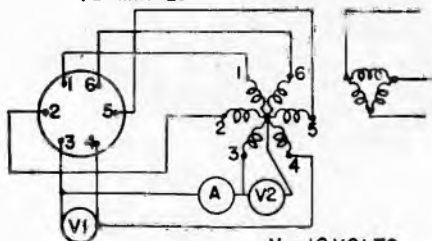
FILAMENT BASE TERMINALS



V = 20 VOLTS
A = 183 AMPERES

SINGLE-PHASE A-C FILAMENT EXCITATION

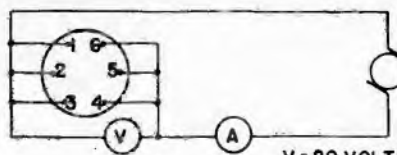
FILAMENT BASE TERMINALS



V₁ = 10 VOLTS
V₂ = 10 VOLTS
A = 61 AMPERES

SIX-PHASE A-C FILAMENT EXCITATION

FILAMENT BASE TERMINALS

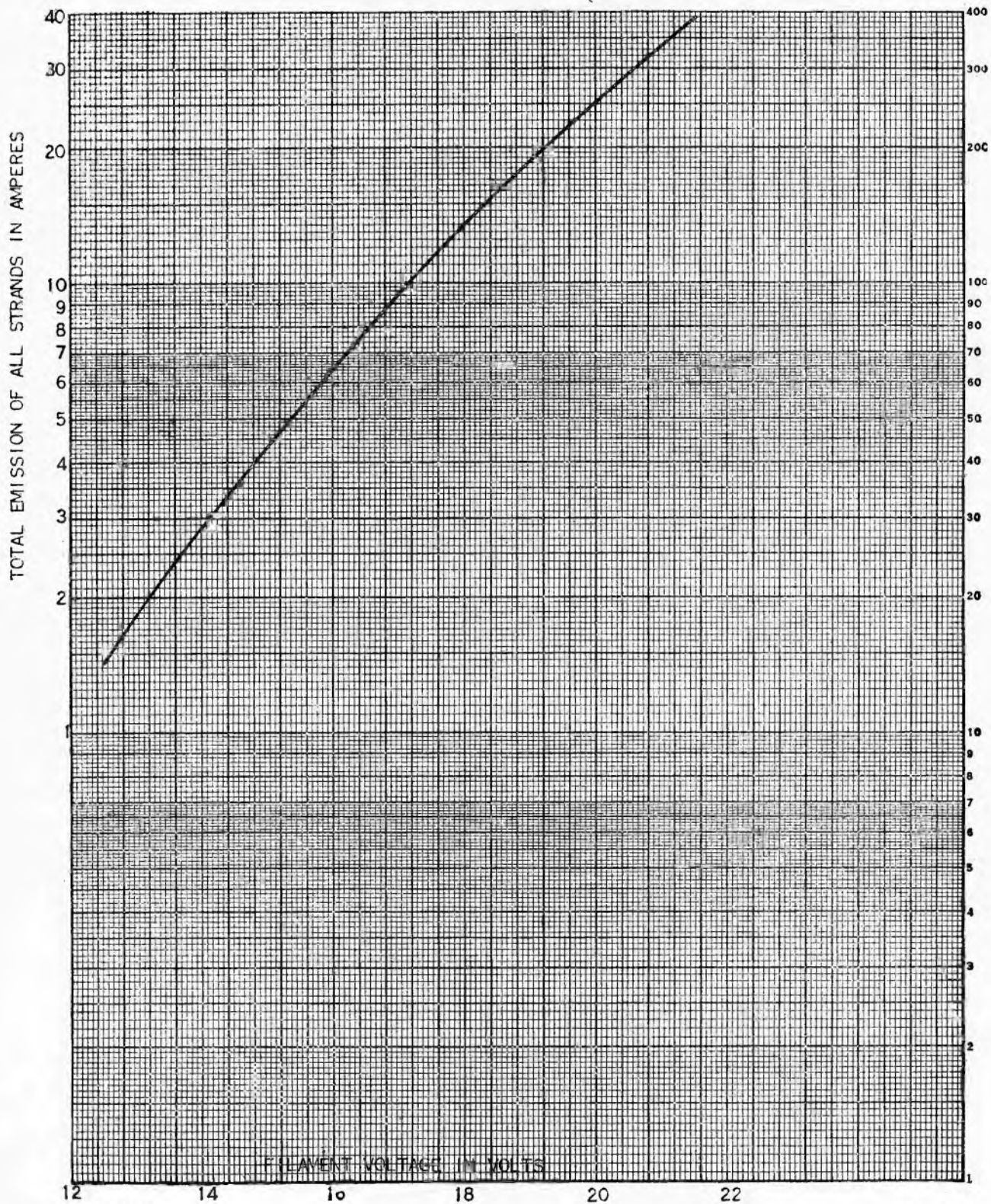


V = 20 VOLTS
A = 183 AMPERES

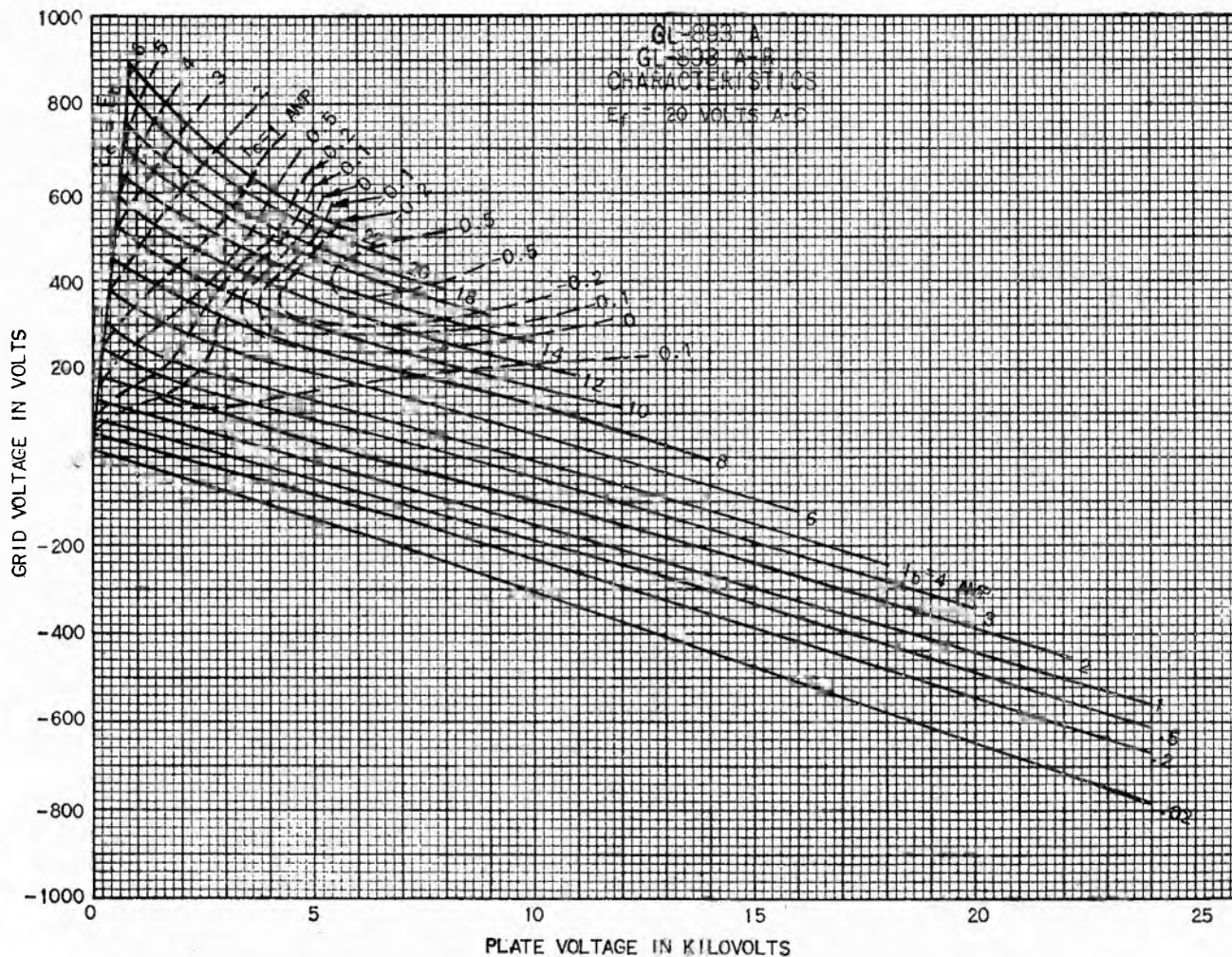
D-C FILAMENT EXCITATION

NOTE: TERMINALS MUST BE CONNECTED IN
CORRECT PHASE RELATION AS SHOWN

■ GL-893-A
AVERAGE FILAMENT EMISSION CHARACTERISTIC
SINGLE-PHASE FILAMENT CONNECTION



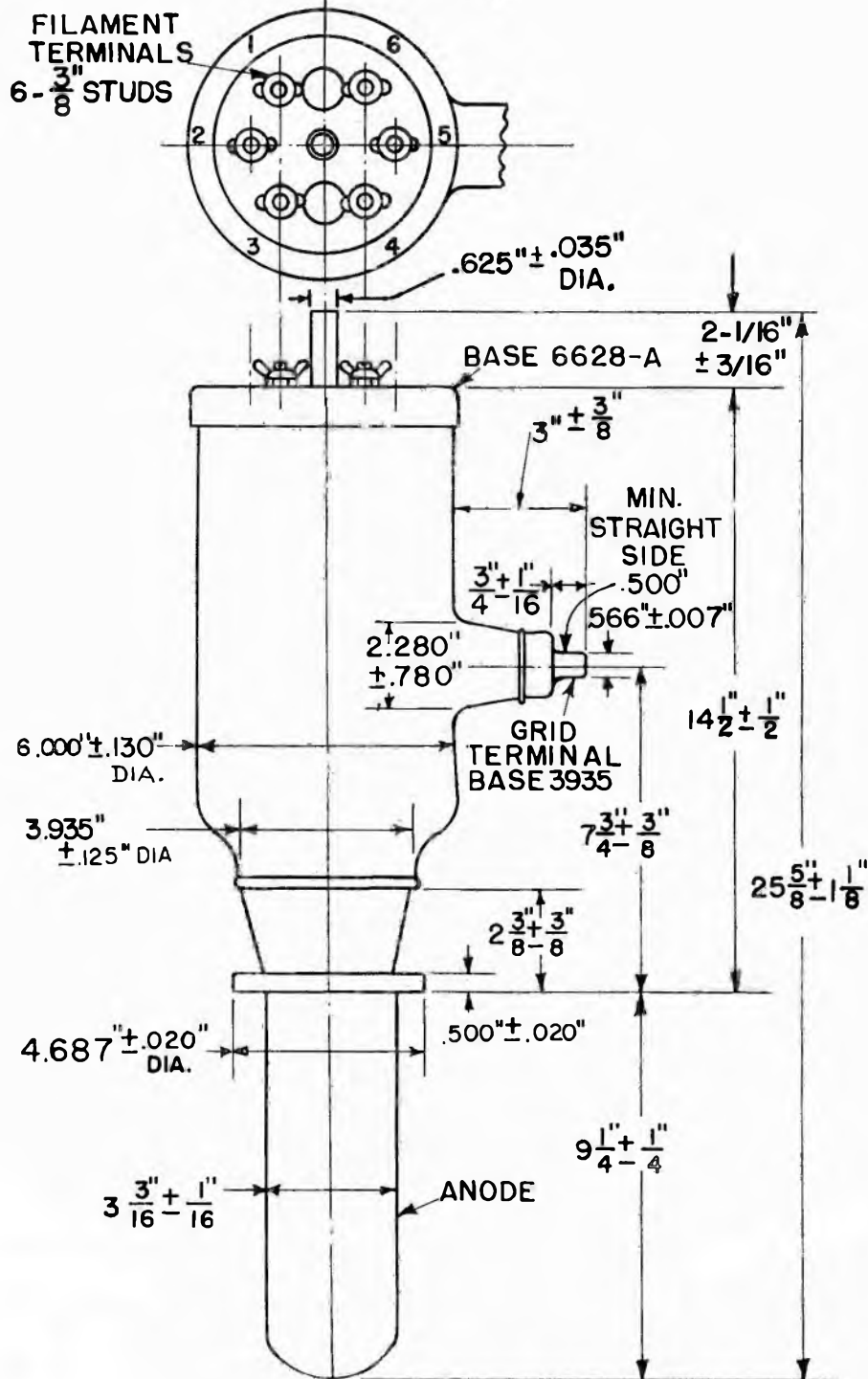
■ GL-893-A
CHARACTERISTICS
 $E_f = 20$ VOLTS A-C



K-69087-72A286
■ Drawing revised

4-25-49

GL-893-A OUTLINE



K-5344783
Drawing revised

12-8-49

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-8002 is a three-electrode transmitting tube designed for use as a radio-frequency power amplifier at high frequencies. Multiple leads for both the filament and grid connectors

minimize the inductance to these electrodes. Maximum ratings may be used up to a frequency of 150 megacycles and reduced ratings up to 300 megacycles.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes	3
Electrical	
Cathode—Filamentary	
Filament voltage	16 volts
Filament current	38 amperes
Average Characteristics	
Amplification factor	{ $E_b = 2.4$ kv, $I_b = 0.5$ amp } 21.5
Grid voltage	{ $E_g = 16$ volts } -50 volts
Direct interelectrode capacitances, approx	
Plate to grid	8.7 micromicrofarads
Grid to filament	10.2 micromicrofarads
Plate to filament	0.90 micromicrofarad
Frequency for maximum ratings	150 megacycles



GENERAL  ELECTRIC

Supersedes ETI-175 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Mechanical

Type of cooling	water and forced air
Maximum outlet temperature	70 centigrade
Water flow	0.5 to 1 gal per min
Maximum incoming air temperature	50 centigrade
Air flow to bulb from a 1-inch diam nozzle	8 cu ft per min
Gasket	Cat. no. 5182028P10
Net weight, approx	1 pound
Shipping weight, approx	5 pounds
Operating position	vertical, anode down

MAXIMUM RATINGS

CLASS B RADIO-FREQUENCY POWER AMPLIFIER

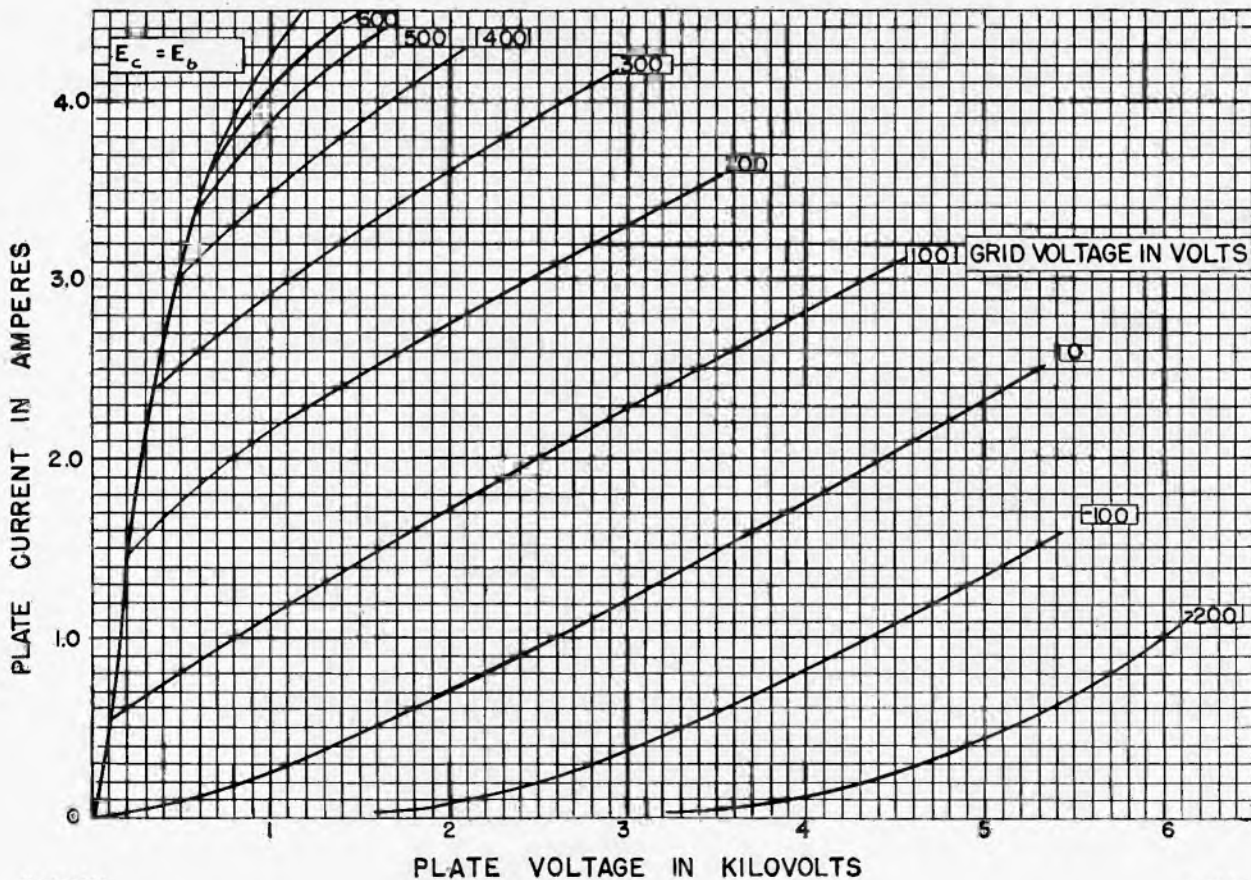
Carrier conditions per tube for use with a maximum modulation factor of 1.0

D-c plate voltage	3500 volts
D-c plate current	0.6 ampere
Plate input	1800 watts
Plate dissipation	1200 watts

CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR, PLATE MODULATED

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

D-c plate voltage	2500 volts
D-c grid voltage	-500 volts
D-c plate current	0.5 ampere
D-c grid current	0.1 ampere
Plate input	1250 watts
Plate dissipation	750 watts

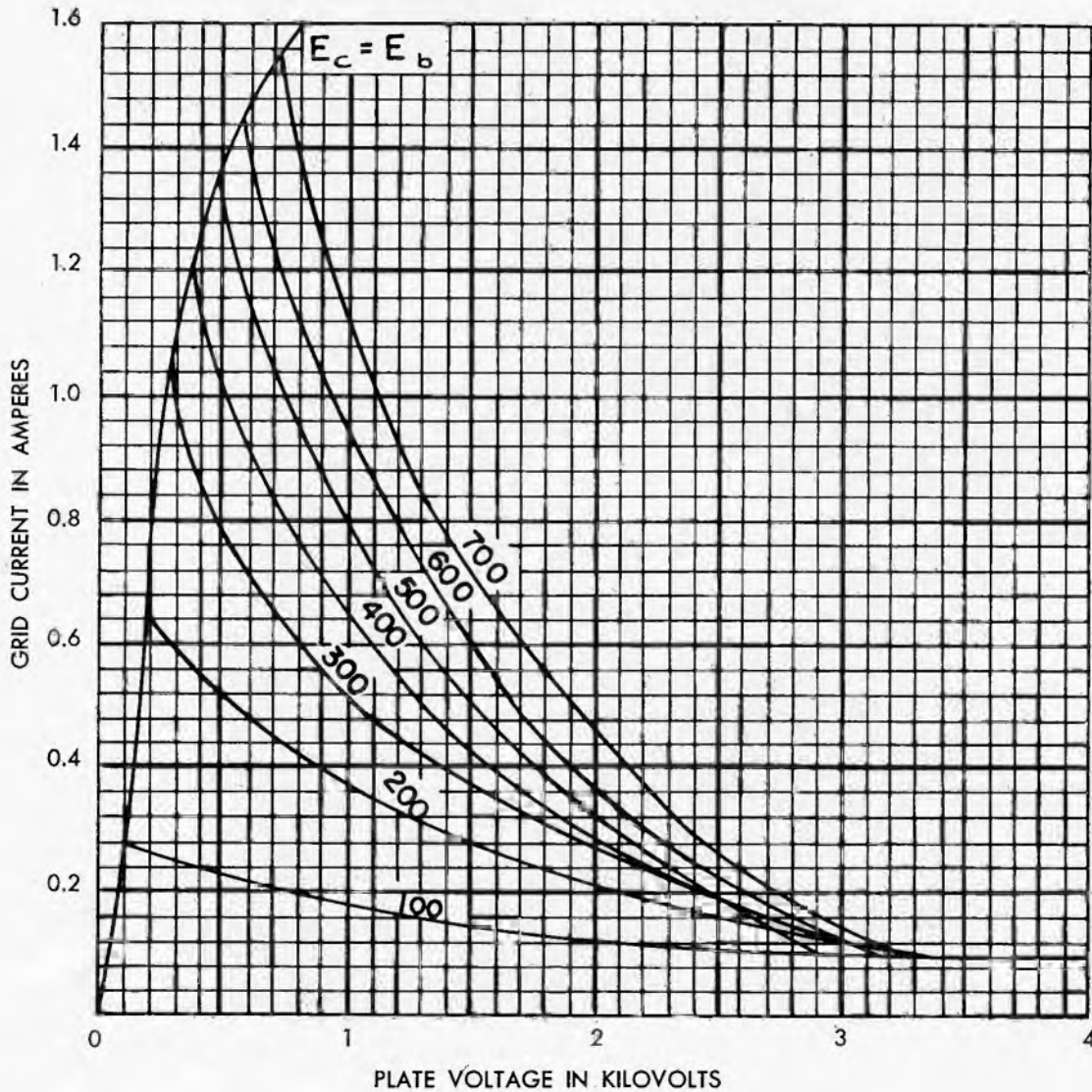


MAXIMUM RATINGS (CONT'D)

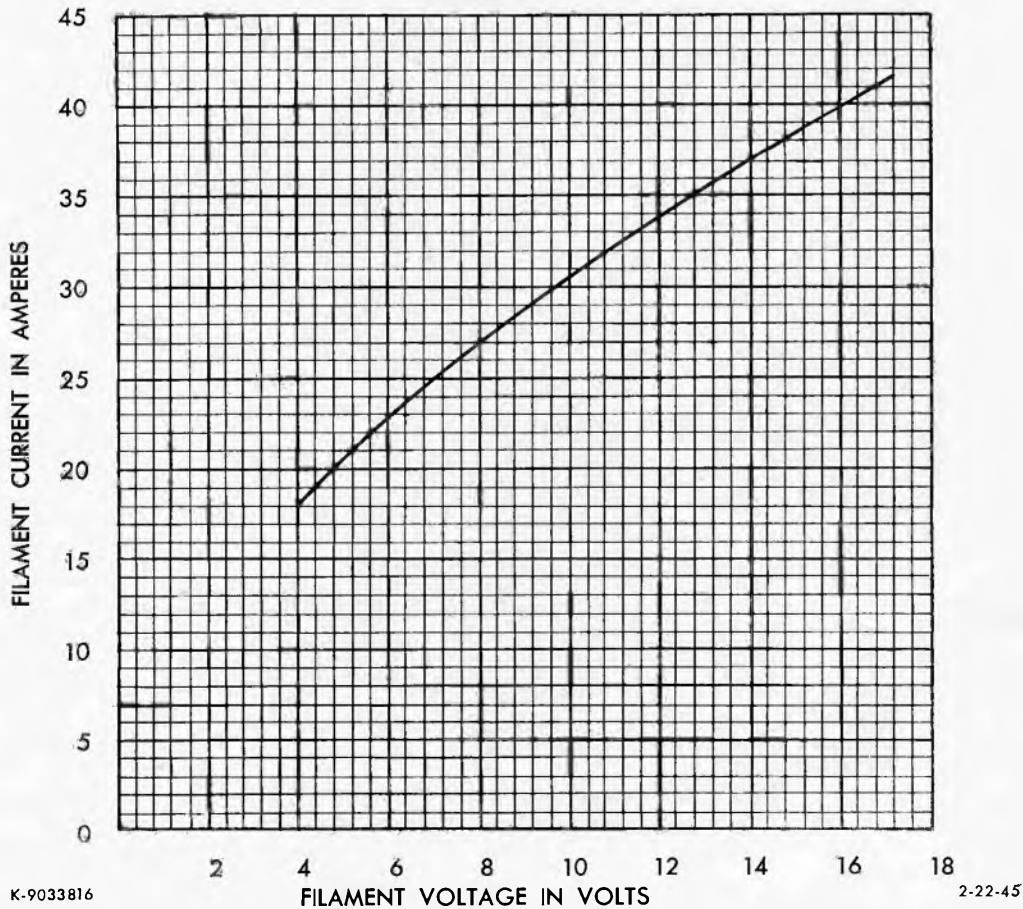
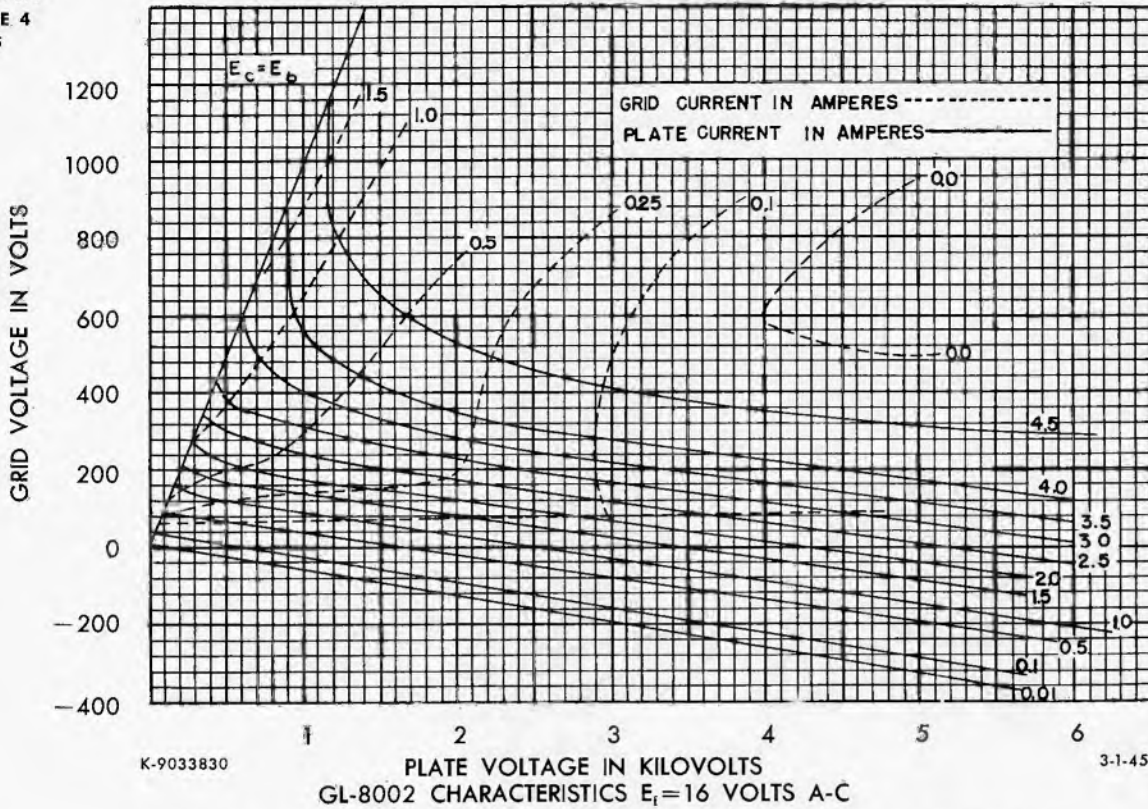
CLASS C RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR, TELEGRAPHY

Key-down conditions per tube without modulation. Essentially negative modulation may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

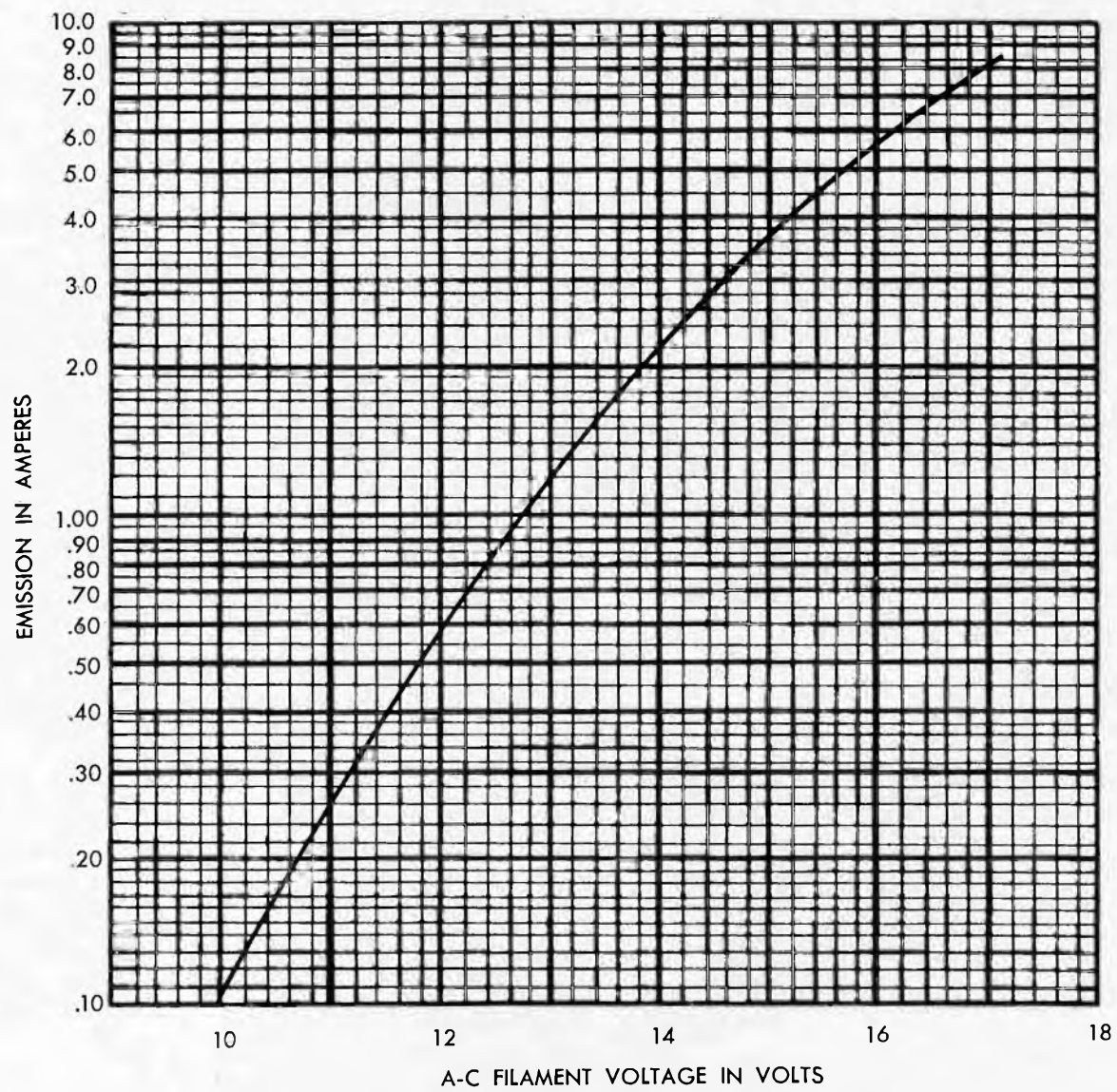
D-c plate voltage.....	3500 volts
D-c grid voltage.....	-500 volts
D-c plate current.....	1.0 ampere
D-c grid current.....	0.1 ampere
Plate input.....	3000 watts
Plate dissipation.....	1200 watts



GL-8002 TYPICAL GRID-PLATE TRANSFER CHARACTERISTICS
($E_i = 16.0$ VOLTS A-C)



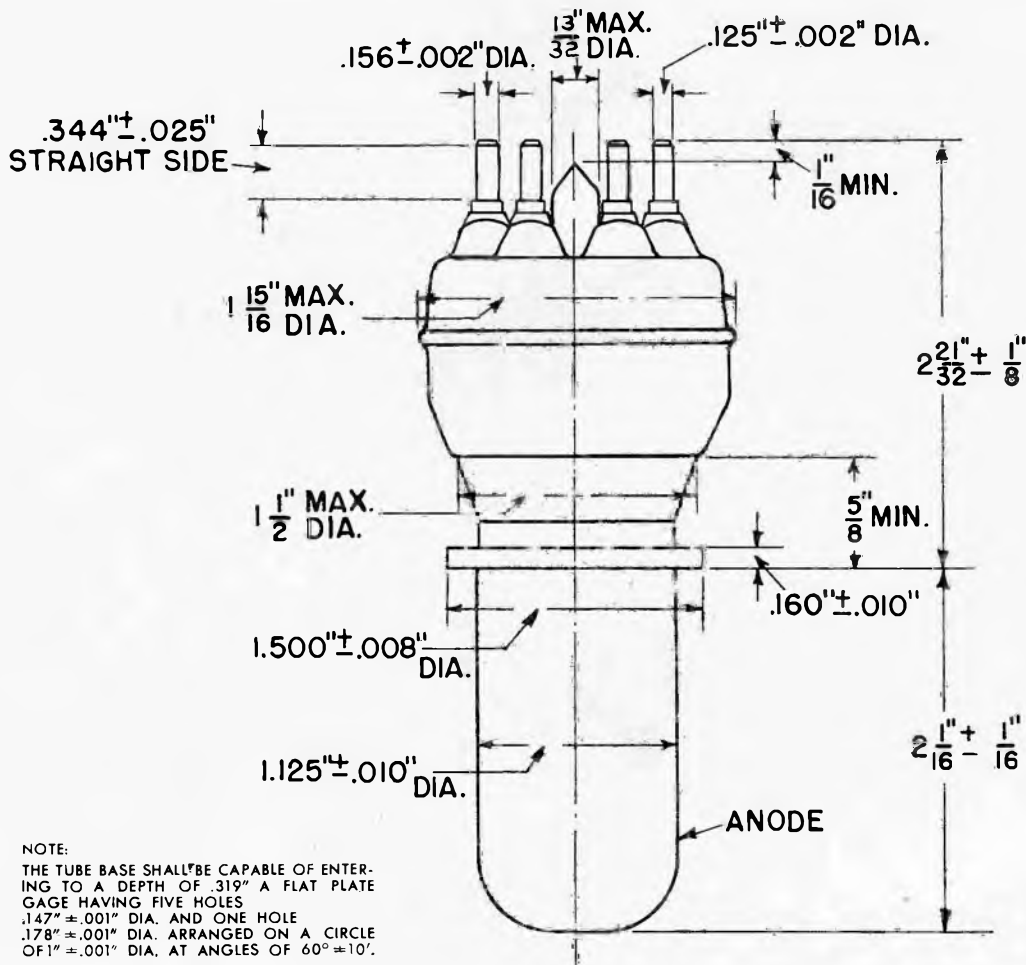
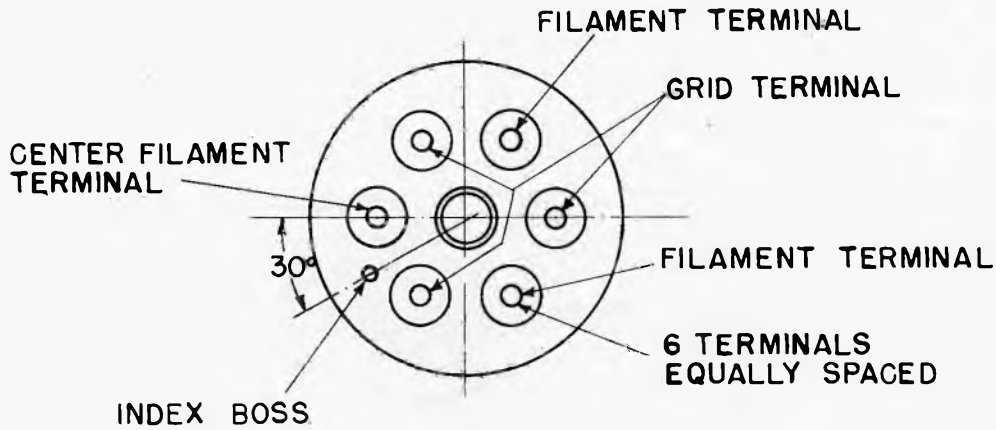
GL-8002 AVERAGE FILAMENT CHARACTERISTIC (COLD RESISTANCE OF FILAMENT = .036 OHM)



GL-8002 AVERAGE EMISSION CHARACTERISTIC

K-9033817

2-22-45



NOTE:
 THE TUBE BASE SHALL BE CAPABLE OF ENTERING TO A DEPTH OF .319\"/>

OUTLINE
 GL-8002 PILOTRON

K-6912329

8-18-45

Electronics Department
GENERAL ELECTRIC
 Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-592 is a three-electrode tube designed for use as an amplifier, oscillator or Class B modulator. The anode is capable of dissipating 200 watts for CCS conditions and 300 watts for ICAS condi-

tions. Forced-air cooling of the envelope is required. The cathode is a thoriated-tungsten filament. Maximum ratings apply up to 150 megacycles.

TECHNICAL INFORMATION

These data are for reference only. For design information, see the specifications.

GENERAL

Electrical Data	Minimum	Range	Maximum
Filament voltage.....	9.5	10.0	10.5 volts
Filament current at 10.0 volts.....	4.7	5.0	5.3 amperes
Amplification factor, $E_b = 2000$ volts; $I_b = 50$ ma d-c; $E_f = 10$ volts.....	21	25	29
Interelectrode capacitances With external shield*			
Grid-plate.....	2.9	3.3	3.7 micromicrofarads
Grid-filament.....	3.0	3.6	4.2 micromicrofarads
Plate-filament.....	0.22	0.29	0.36 micromicrofarad


Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-245A dated 6-47

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position—vertical, anode or cathode end down	
Required air flow to envelope†	15 cubic feet per minute
Maximum bulb temperature	200 centigrade
Maximum seal temperature	150 centigrade
Net weight, approximate	6 ounces

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum Ratings, Absolute Values	CCS**	ICAS**
D-c plate voltage	3500 max	3500 max volts
Maximum signal d-c plate current†	250 max	350 max milliamperes
Maximum signal plate input†	600 max	900 max watts
Plate dissipation†	200 max	300 max watts

Typical Operation	CCS**	ICAS**
Unless otherwise specified, values are for two tubes		
D-c plate voltage	2600	3000 volts
D-c grid voltage	-77	-90 volts
Peak a-f grid to grid voltage	475	540 volts
Zero signal d-c plate current	40	50 milliamperes
Maximum signal d-c plate current	390	490 milliamperes
Effective load resistance, plate to plate	14000	13250 ohms
Maximum signal driving power, approximate	16	20 watts
Maximum signal power output, approximate	670	950 watts

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

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

Maximum Ratings, Absolute Values	CCS**	ICAS**
D-c plate voltage	2600 max	3000 max volts
D-c grid voltage	-500 max	-500 max volts
D-c plate current	200 max	250 max milliamperes
D-c grid current	50 max	100 max milliamperes
Plate input	430 max	750 max watts
Plate dissipation	130 max	225 max watts

Typical Operation	CCS**	ICAS**
D-c plate voltage	2500	2800 volts
D-c grid voltage	-360	-360 volts
Peak r-f grid voltage	550	625 volts
D-c plate current	158	250 milliamperes
D-c grid current, approximate	35	60 milliamperes
Driving power, approximate	19	34 watts
Power output, approximate	300	503 watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation †

Maximum Ratings, Absolute Values	CCS**	ICAS**
D-c plate voltage	3500 max	3500 max volts
D-c grid voltage	-500 max	-500 max volts
D-c plate current	250 max	350 max milliamperes
D-c grid current	50 max	100 max milliamperes
Plate input	670 max	1000 max watts
Plate dissipation	200 max	300 max watts

Typical Operation	CCS**	ICAS**
D-c plate voltage	2600	3000 volts
D-c grid voltage	-240	-250 volts
Peak r-f grid voltage	457	520 volts
D-c plate current	230	320 milliamperes
D-c grid current, approximate	45	60 milliamperes
Driving power, approximate	18	30 watts
Power output, approximate	425	680 watts

* Tube located in center of a metal box 8 in. x 8 in. x 12 in.

† Maximum incoming air temperature 45 C. Flow directed at the side of the bulb from 2-inch diameter nozzle 3 inches from the center line of the tube. Center line of nozzle 1 7/8 in. down from top of plate terminal. An alternate method of cooling for many applications is the use of an 8-inch household fan located 10 inches from the tube and blowing air directly at the tube. When operating under full ICAS rating it is necessary to use a finned anode connector.

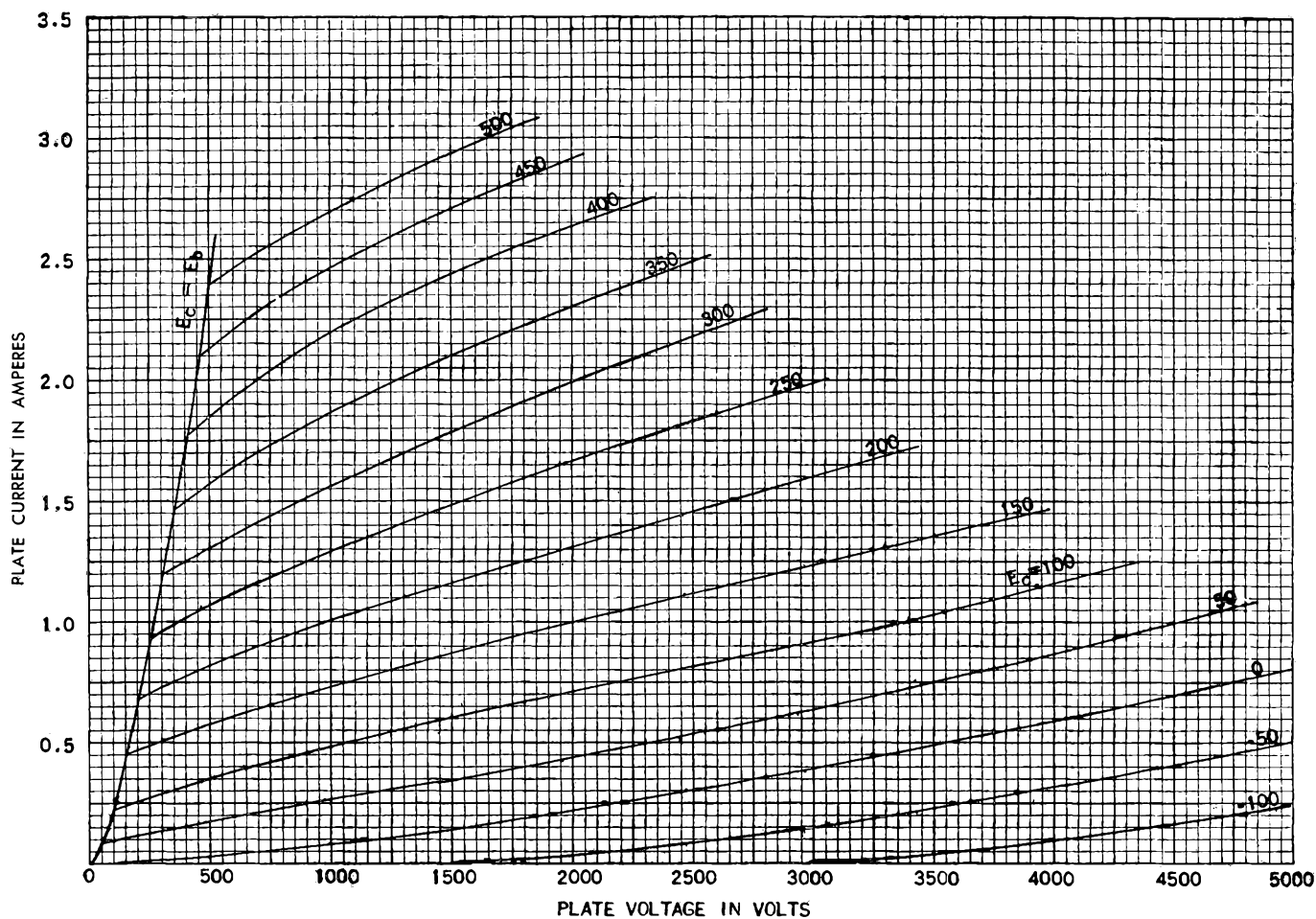
‡ Averaged over any audio-frequency cycle of sine-wave form.

¶ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

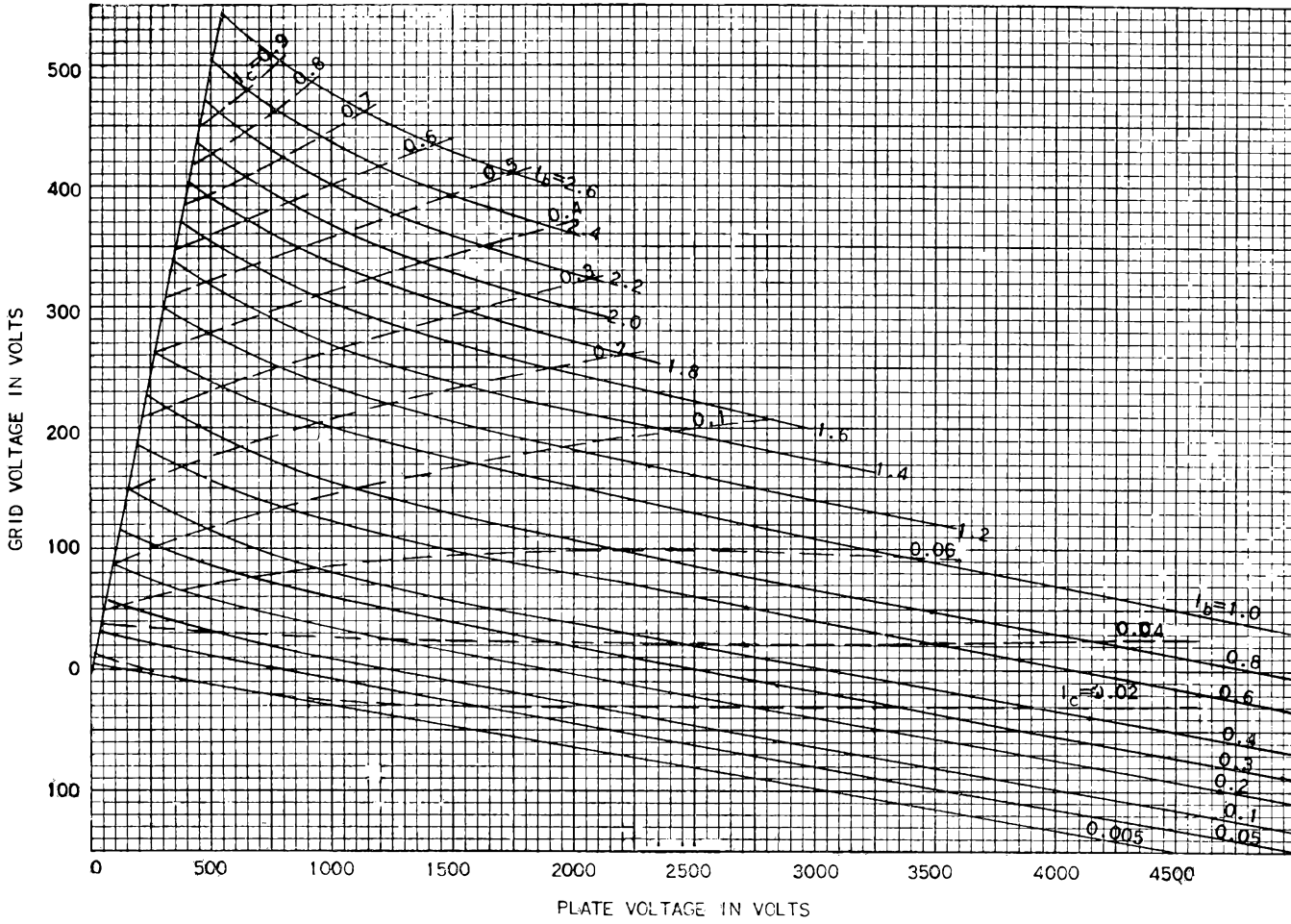
** CCS = Continuous Commercial Service.

** ICAS = Intermittent Commercial and Amateur Service.

GL-592
AVERAGE PLATE CHARACTERISTIC
($E_f = 10$ VOLTS A-C)



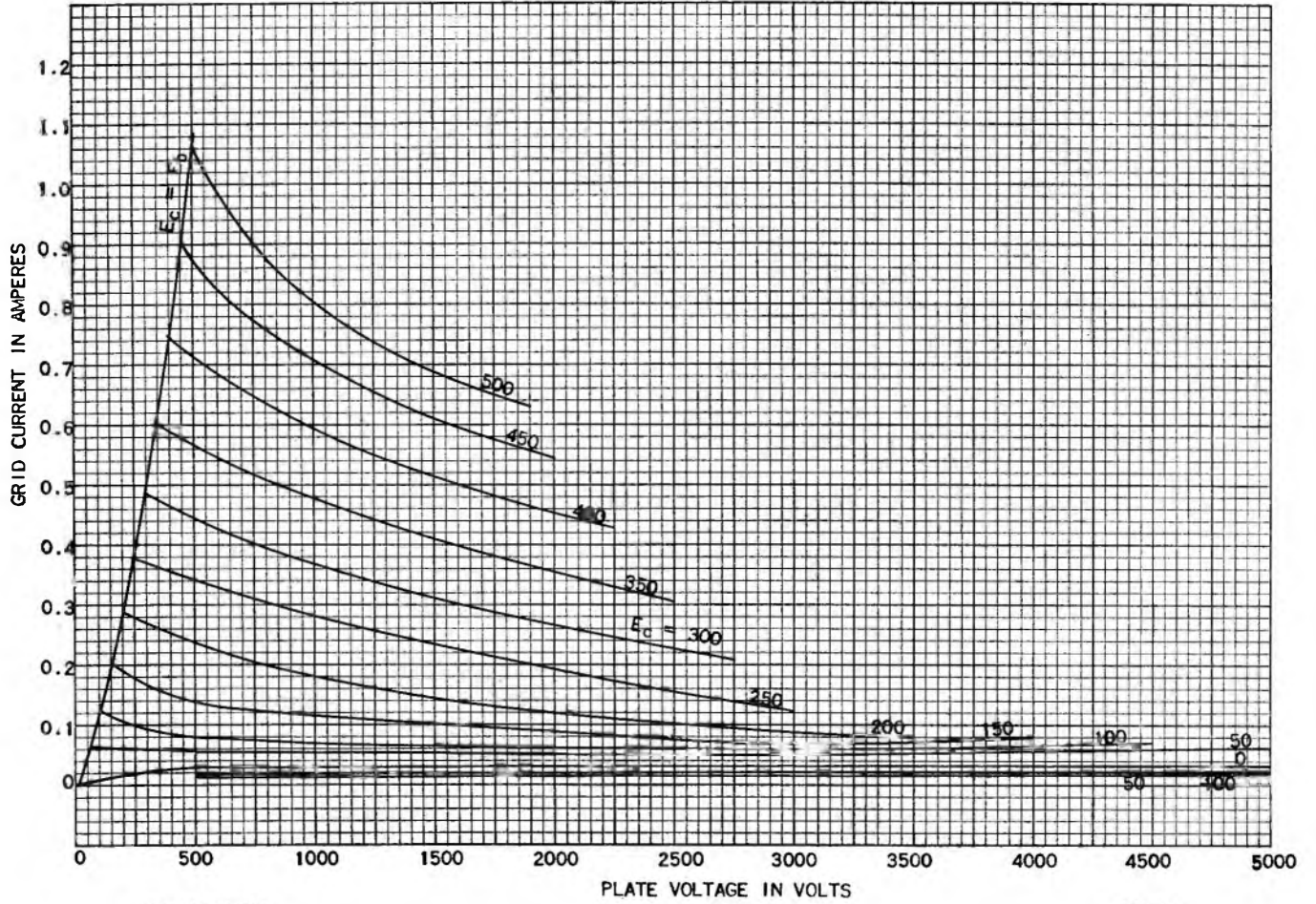
GL-592
CHARACTERISTIC CURVES
 $E_f = 10$ VOLTS A-C



K-69087-7A116

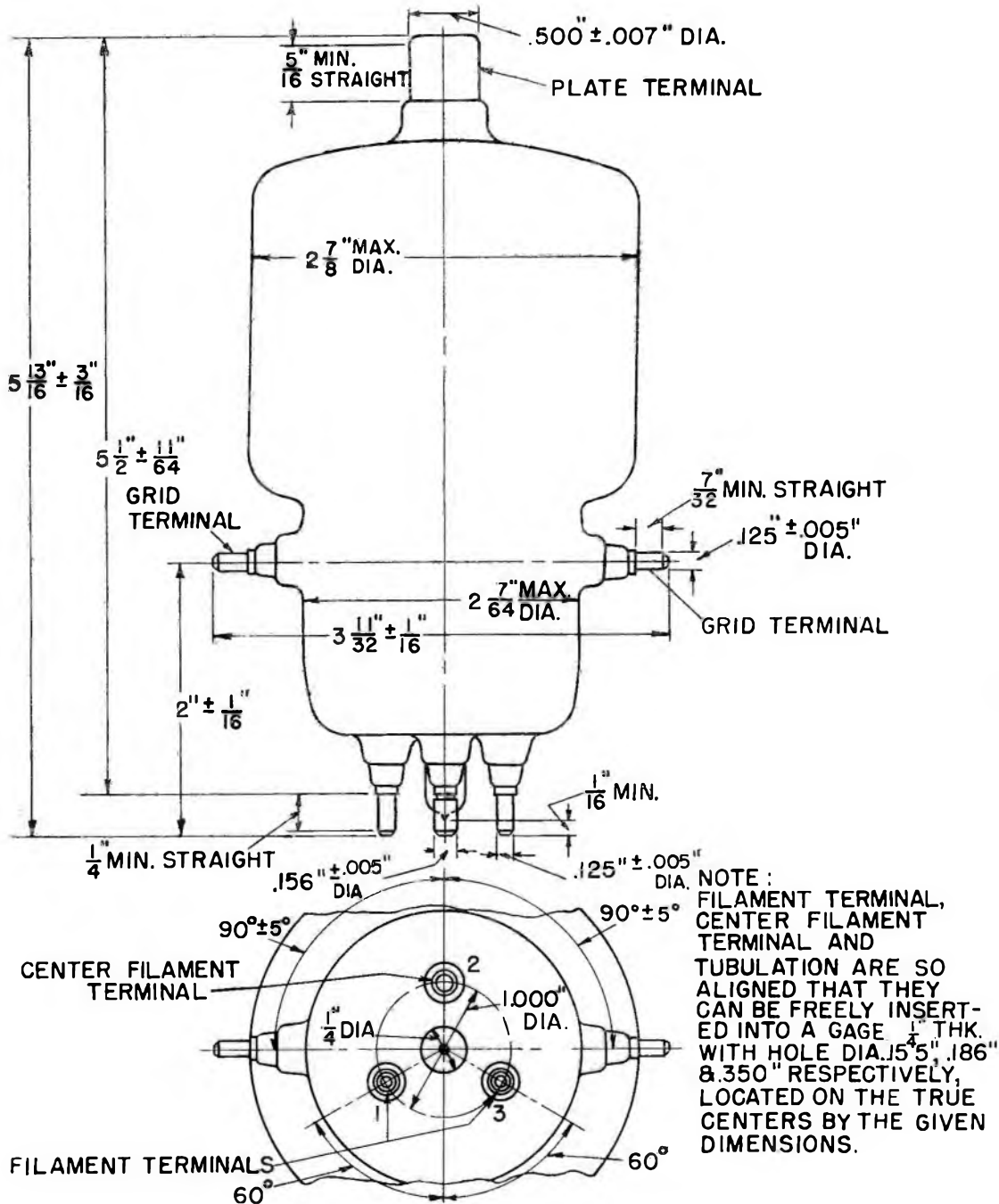
3-24-47

GL-592
TYPICAL GRID-PLATE CHARACTERISTIC
 $E_i = 10$ VOLTS A-C



K-69087-72A117

3-11-47



OUTLINE
GL-592 PIOTRON

N-21200AZ

12-7-45

Tube Divisions, Electronics Department

GENERAL ELECTRIC
Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-891-R is a three-electrode tube for use as a radio-frequency power amplifier, oscillator, Class A modulator, and Class B modulator. The construction of the filament permits operation from two-phase or single-phase alternating current, as well as from direct current, for all classes of service. The plate of the GL-891-R is air-cooled by means of a

special radiator which is fitted to the tube by the manufacturer. The plate is capable of dissipating 4 kilowatts of power, depending on the service in which the tube is used. The GL-891-R pliotron can be operated at maximum ratings at frequencies as high as 1.6 megacycles and up to 20 megacycles at reduced ratings.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage	—	22	23 volts
Filament current at bogey voltage	57	60	62 amperes
Filament starting current	—	—	120 amperes
Filament cold resistance	—	0.031	— ohm
Amplification factor			
$E_c = -500$ volts, $I_b = 0.45$ amperes	7.6	8.5	9.4
Interelectrode capacitances:			
Grid-plate	25	28	32 micromicrofarads
Grid-filament	15	19	23 micromicrofarads
Plate-filament	1.5	2.5	3.5 micromicrofarads

◆ Completely revised.



GENERAL  ELECTRIC

Supersedes ETI-246B dated 8-50

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position	vertical, anode down		
Type of cooling	forced-air		
Maximum incoming air temperature	45 C		
Required air flow on anode	100%	80%	60%
Plate dissipation—kilowatts	rating	rating	rating
Air flow—cubic feet per minute	450	380	300
Static			
Pressure—inches water	0.5	0.36	0.20
Maximum glass temperature	150 C		
Net weight, approximate	46 pounds		

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values	CCS*		
D-c plate voltage	10,000	volts maximum	
Maximum signal d-c plate current †	2.0	amperes maximum	
Maximum signal plate input †	10,500	watts maximum	
Plate dissipation †	3,500	watts maximum	
Temperature of air cooler	180	C maximum	
Typical operation (unless otherwise specified, values are for two tubes)	CCS*		
D-c plate voltage	6,000	8,000	volts
D-c grid voltage	-630	-860	volts
Peak a-f grid-to-grid voltage	2,060	2,260	volts
Zero signal d-c plate current	0.5	0.5	ampere
Maximum signal d-c plate current	2.5	2.10	amperes
Effective load resistance, plate-to-plate	5,000	8,000	ohms
Maximum signal driving power, approximate	110	50	watts
Maximum signal power output, approximate	8,000	10,000	watts

*Continuous Commercial Service.

†Averaged over any audio-frequency cycle of sine-wave form.

RADIO FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

(Key-down Conditions Per Tube Without Amplitude Modulation) †

Maximum ratings, absolute values	CCS*		
D-c plate voltage	10,000	volts maximum	
D-c grid voltage	-3,000	volts maximum	
D-c plate current	2.0	amperes maximum	
D-c grid current	0.15	ampere maximum	
Plate input	15,000	watts maximum	
Plate dissipation	4,000	watts maximum	
Temperature of air cooler	180	C maximum	
Typical operation	CCS*		
D-c plate voltage	8,000	10,000	volts
D-c grid voltage	-1,800	-2,000	volts
Peak r-f grid voltage	2,400	2,700	volts
D-c plate current	1.14	1.33	amperes
D-c grid current, approximate	0.09	0.140	ampere
Driving power, approximate	215	375	watts
Power output, approximate	6,500	10,000	watts

*Continuous Commercial Service.

†Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115% of the carrier conditions.

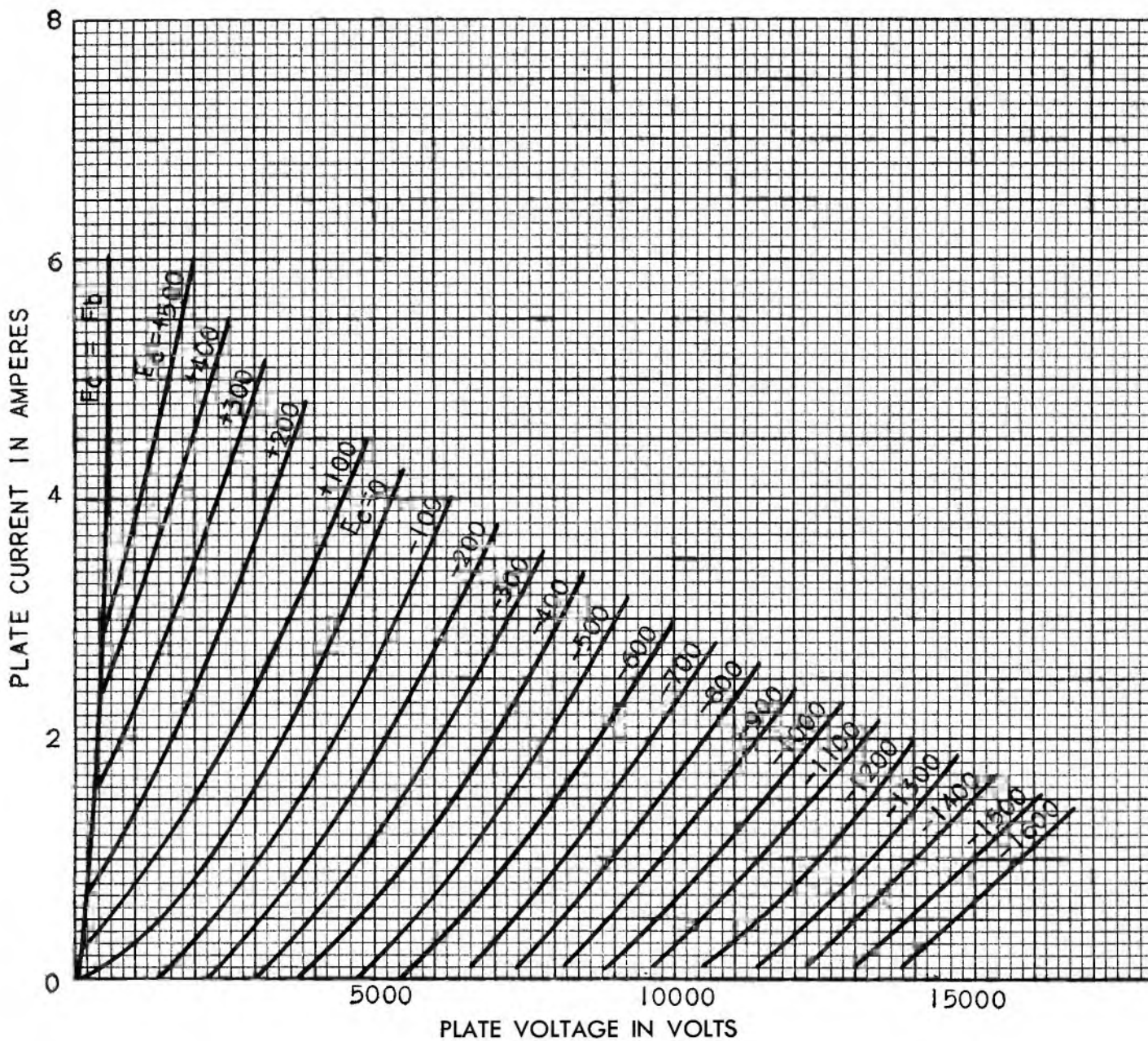
APPLICATION NOTES

GL-891-R can be operated at maximum ratings in all classes of service at frequencies as high as 1.6 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised. (Other maximum ratings are the same as shown under MAXIMUM RAT-

INGS and TYPICAL OPERATING CONDITIONS.) The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used up to 20 mc for the various classes of service. Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	1.6	7.5	20.0 megacycles
Percentage of maximum rated plate voltage and plate input, Class C unmodulated	100	75	50 percent

◆ GL-891-R
AVERAGE PLATE CHARACTERISTICS
 $E_f = 22$ VOLTS A-C
SINGLE-PHASE EXCITATION

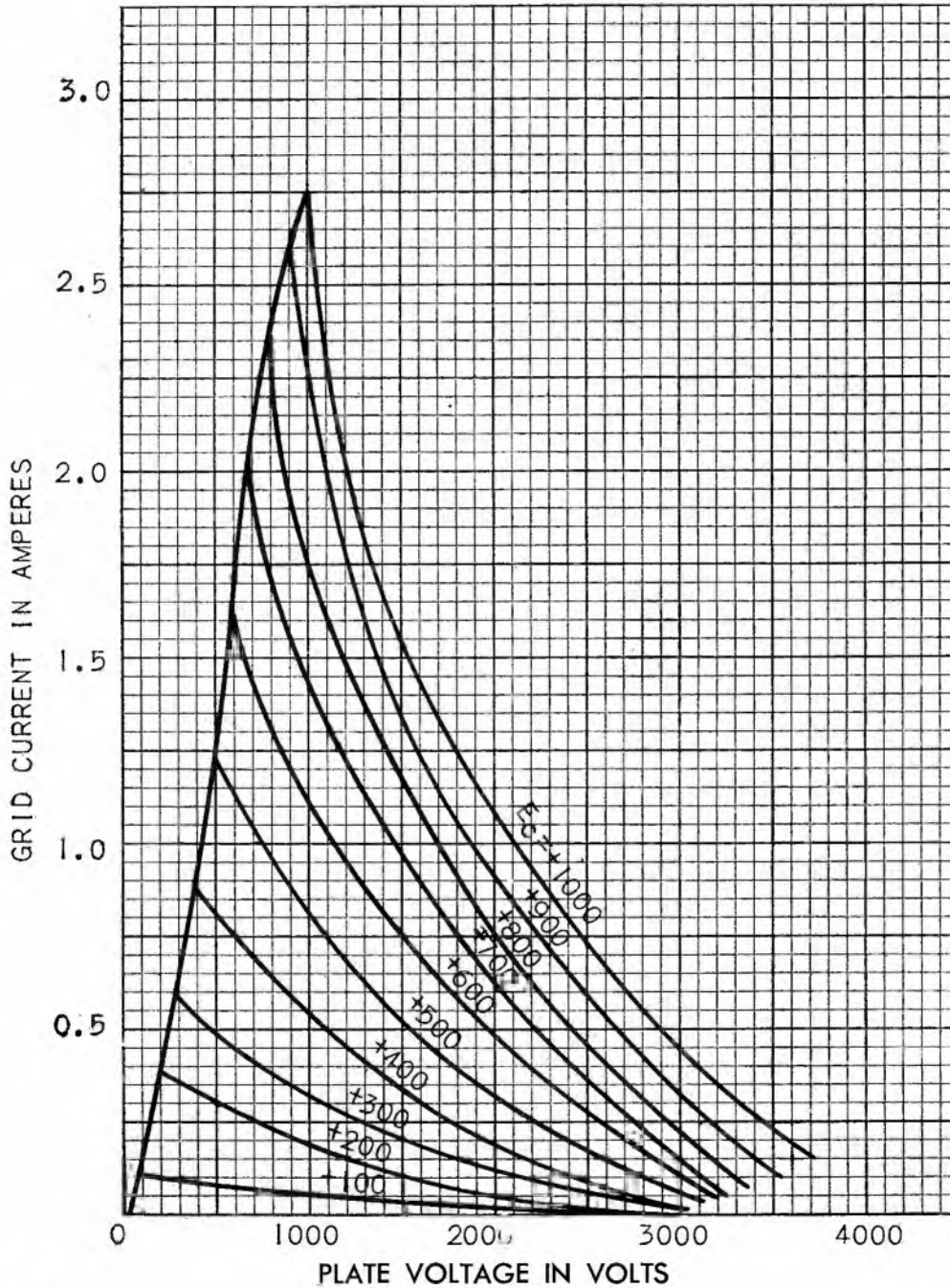


K-69087-72A104

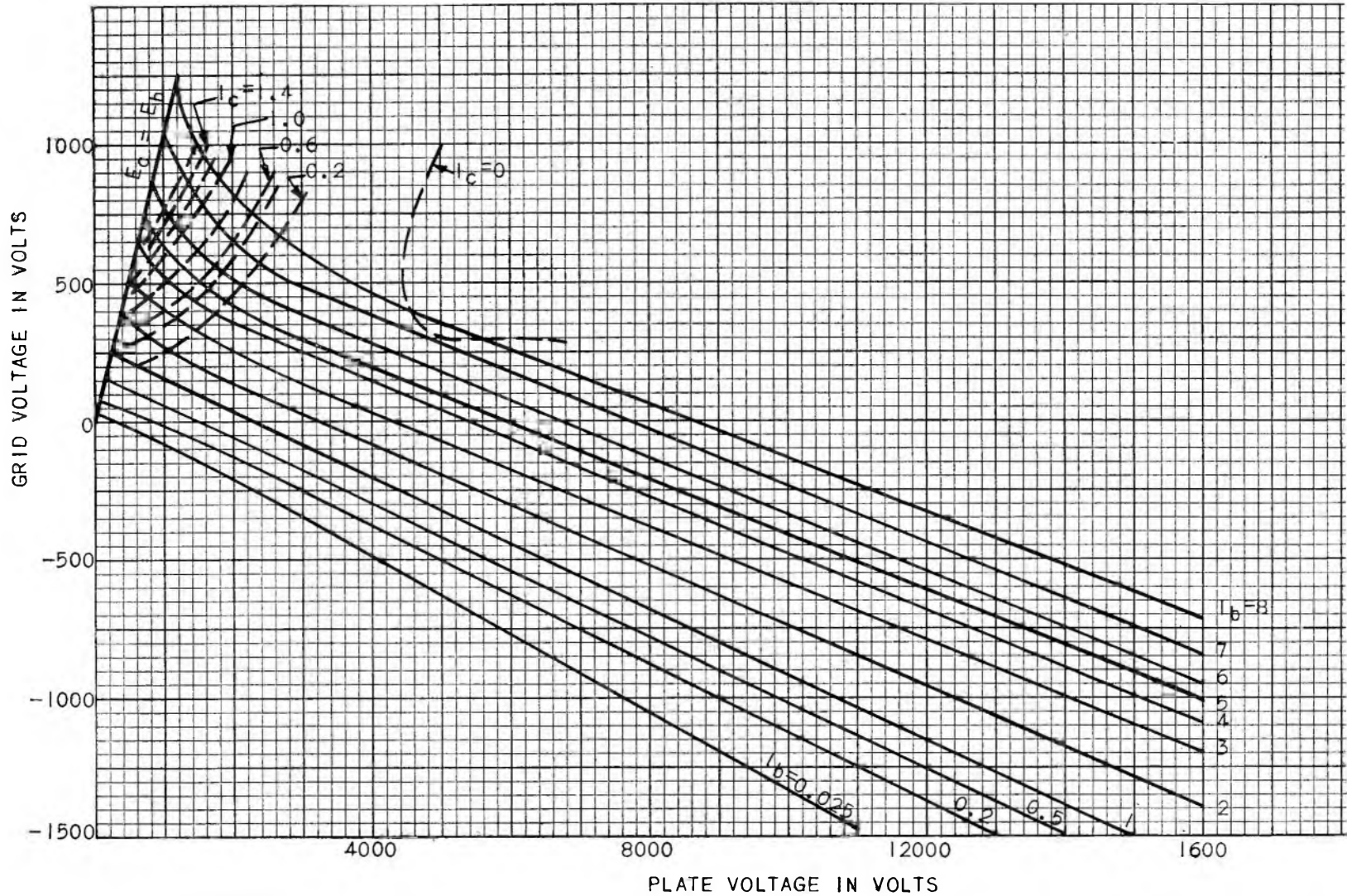
◆ Revised Drawing.

1-11-51

◆ GL-891-R
AVERAGE GRID-PLATE TRANSFER CHARACTERISTICS
 $E_r = 22$ VOLTS A-C
SINGLE PHASE EXCITATION



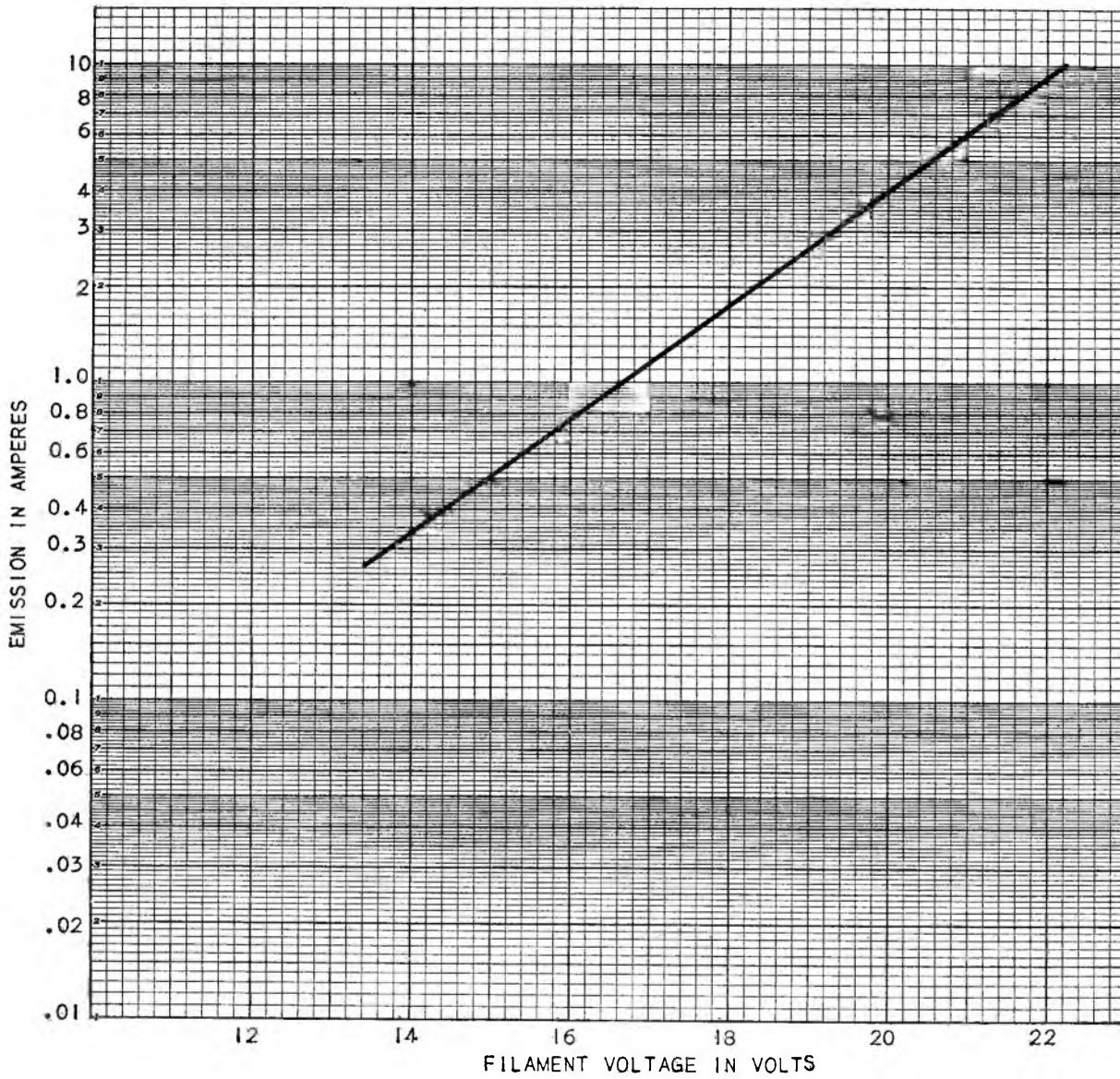
◆ GL-891-R
 AVERAGE CONSTANT-CURRENT CHARACTERISTICS
 $E_f = 22$ VOLTS A-C
 SINGLE-PHASE EXCITATION



K-69087-72A447
 ◆ Revised Drawing.

1-11-51

◆ GL-891-R AVERAGE FILAMENT EMISSION CHARACTERISTIC

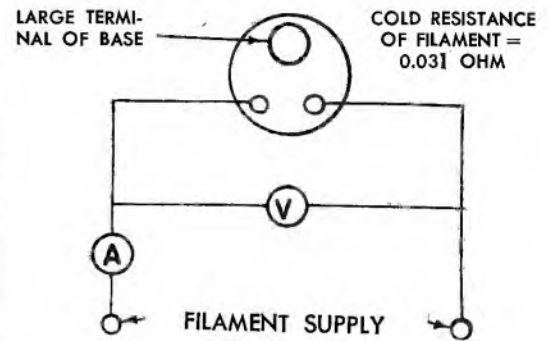
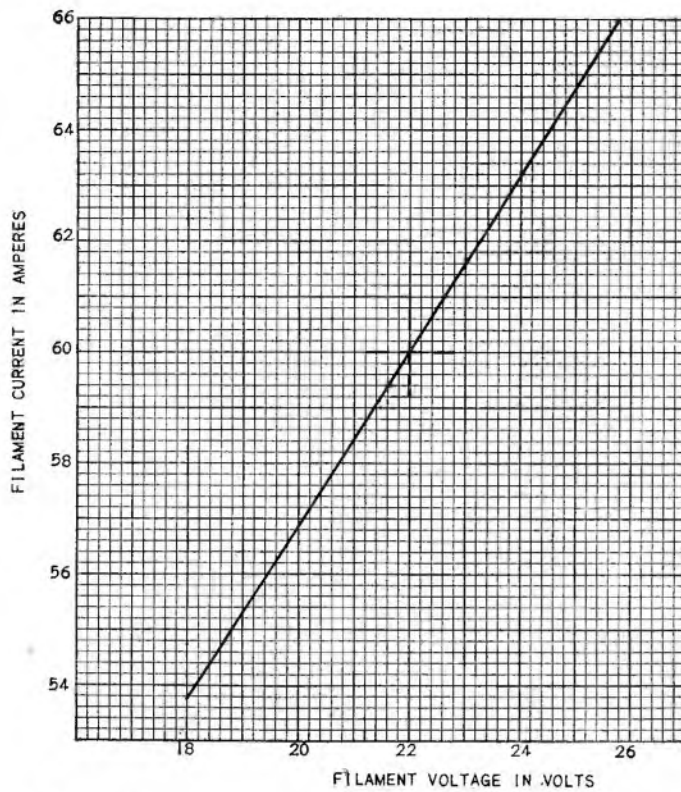


K-69087-72A448

◆ Revised Drawing

1-11-51

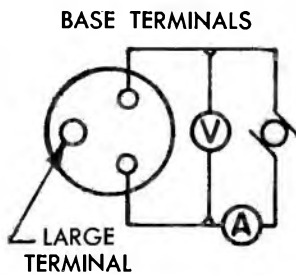
◆ GL-891-R AVERAGE FILAMENT CHARACTERISTIC



K-69087-72A441
◆ Revised drawing

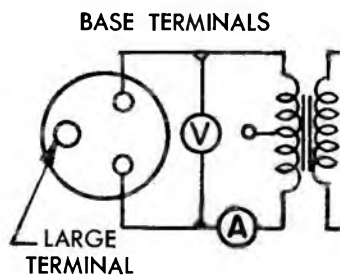
1-11-51

WITH D-C EXCITATION



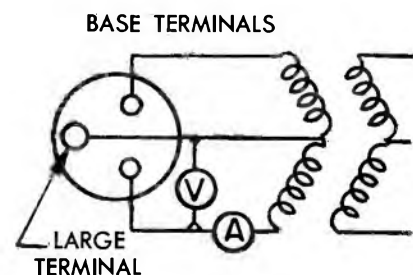
V = 22 VOLTS
A = 60 AMPERES

WITH SINGLE-PHASE A-C EXCITATION



V = 22 VOLTS
A = 60 AMPERES

WITH TWO-PHASE A-C EXCITATION

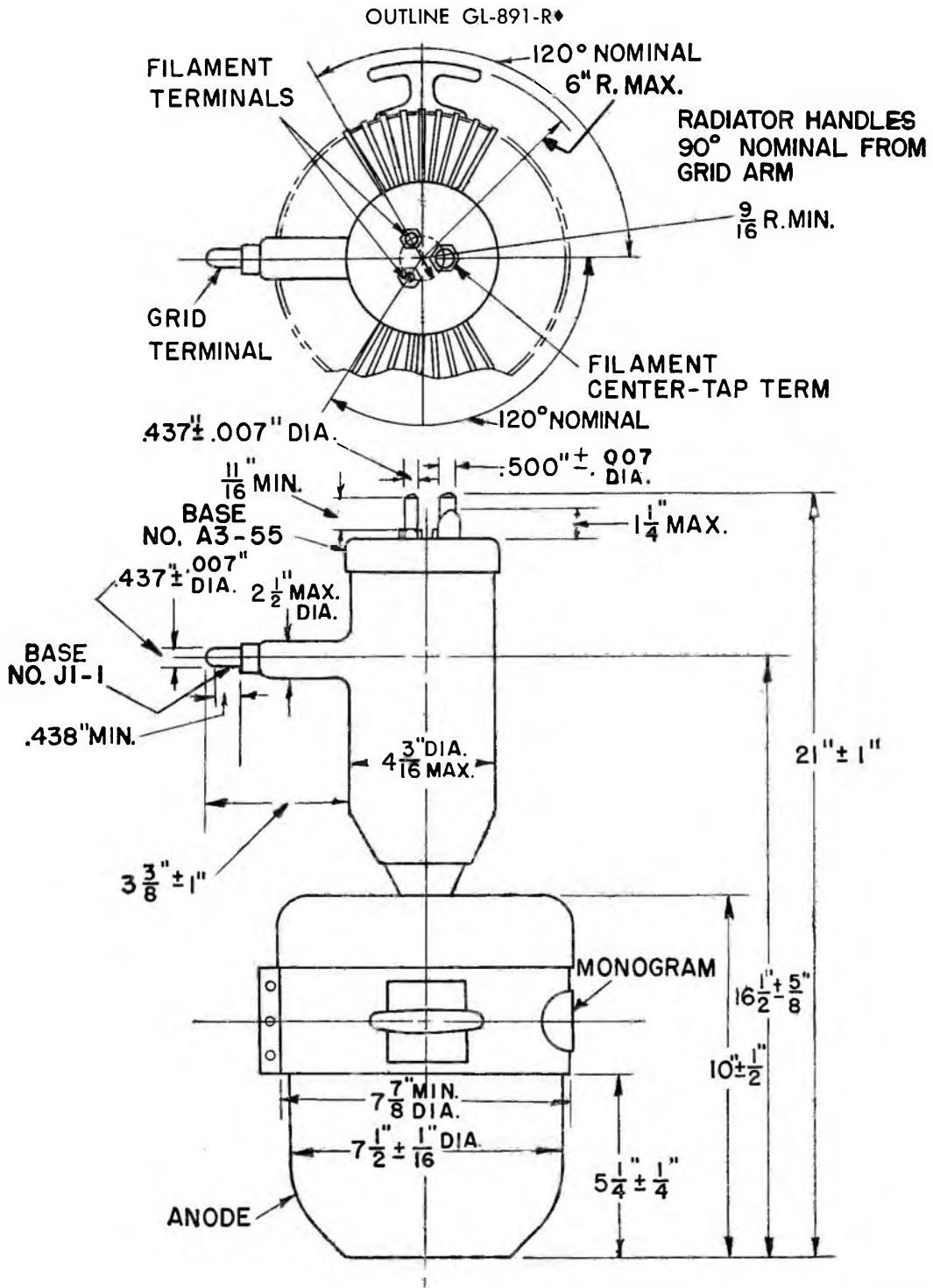


V = 11 VOLTS
A = 60 AMPERES

GL-891-R FILAMENT CONNECTIONS

K-9033547

12-1-44



K-6966980
♦ Revised.

11-11-48

Tube Department, Electronics Division

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The 892-R is a three-electrode tube for use as a radio-frequency power amplifier, oscillator, and Class B modulator. The construction of the filament permits operation from two-phase or single-phase alternating current, as well as from direct current, for all classes of service. The plate of the 892-R is air-cooled by means of a special radiator which is

fitted to the tube by the manufacturer. The plate is capable of dissipating 2 to 5 kilowatts of power, depending on the service in which the tube is used. The GL-892-R pliotron can be operated at maximum ratings at frequencies as high as 1.6 megacycles and at frequencies up to 20 megacycles at reduced ratings.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes.....	3
Electrical	
Cathode—Filamentary.....	two-unit type
Voltage per unit.....	11 volts
Current per unit.....	60 amperes
Amplification factor.....	50
Direct interelectrode capacitances, approximate	
Grid-plate.....	31 micromicrofarads
Grid-filament.....	20 micromicrofarads
Plate-filament.....	2 micromicrofarads

Mechanical

Mounting position..... vertical, anode down

Cooling: Air flow of 450 cfm normal must be started before application of any voltages and continue for at least 10 minutes after removal of voltages. See table on page 2.



GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

CLASS B AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR

	Typical Operation §	Maximum Ratings		
D-c plate voltage	6000	8000	12500	volts
Maximum signal d-c plate current	2.5	2.3	△2.0	amperes
Maximum signal plate input Δ			12	kilowatts
Plate dissipation Δ			4	kilowatts
Radiator temperature*			180	centigrade
D-c grid voltage †	0	-60		volts
Peak a-f grid-to-grid voltage	1200	1000		volts
Zero signal d-c plate current	0.5	0.5		ampere
Radiator temperature*	140	158		centigrade
Load resistance (per tube)	1050	1700		ohms
Effective load resistance, plate-to-plate	4200	6800		ohms
Maximum signal driving power, approximate	415	400		watts
Maximum signal power output, approximate	8	10.5		kilowatts

§ Unless otherwise specified, values are for two tubes.

CLASS B RADIO-FREQUENCY POWER AMPLIFIER—TELEPHONY

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

D-c plate voltage	6000	8000	12500	volts
D-c plate current	0.67	0.71	1.0	ampere
Plate input			6	kilowatts
Plate dissipation			4	kilowatts
Radiator temperature*	140	160	180	centigrade
D-c grid voltage †	0	-40		volts
Peak r-f grid voltage	300	350		volts
Driving power, approximate π	65	25		watts
Power output, approximate	1	1.7		kilowatts

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

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

D-c plate voltage	6000	8000	10000	volts
D-c grid voltage	-1000	-1300	-3000	volts
D-c plate current	0.77	0.75	1.0	ampere
D-c grid current			0.25	ampere
Plate input			10	kilowatts
Plate dissipation			2.5	kilowatts
Radiator temperature*	90	90	180	centigrade
Peak r-f grid voltage	1675	2000		volts
D-c grid current, approximate	0.19	0.18		ampere
Driving power, approximate	310	350		watts
Power output, approximate	3.5	5		kilowatts

CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—TELEGRAPHY

Key-down conditions per tube without modulation ¶

D-c plate voltage	8000	10000	12500	volts
D-c grid voltage	-1000	-1300	-3000	volts
D-c plate current	1.1	1.4	2.0	amperes
D-c grid current			0.25	ampere
Plate input			18	kilowatts
Plate dissipation			4	kilowatts
Radiator temperature*	120	160	180	centigrade
Peak r-f grid voltage	1800	2300		volts
D-c grid current, approximate	0.18	0.18		ampere
Driving power, approximate	320	400		watts
Power output approximate	6.5	10		kilowatts

MAXIMUM PLATE DISSIPATION VS AIR FLOW RATE

Air flow rate.....	400	450	500	600	700 cu ft per min
Maximum plate dissipation					
Class B, a-f.....	3700	4000	4300	4850	5300 watts
Class B, r-f.....	3700	4000	4300	4850	5300 watts
Class C, telephony.....	2300	2500	2700	3000	3300 watts
Class C, telegraphy.....	3700	4000	4300	4850	5300 watts

* Measured in thermometer well.

† With a-c filament excitation.

‡ With d-c filament excitation.

△ Averaged over any audio-frequency cycle.

π At crest of a-f cycle with modulation factor of 1.0.

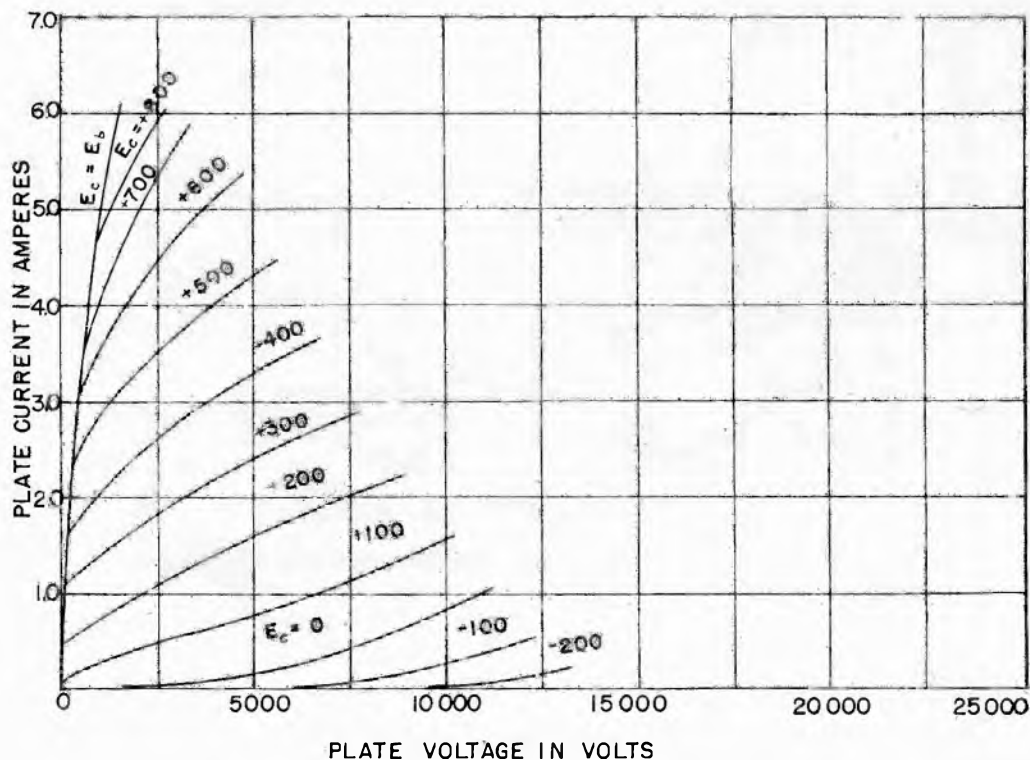
¶ Modulation, essentially negative, may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier condition.

APPLICATION NOTES

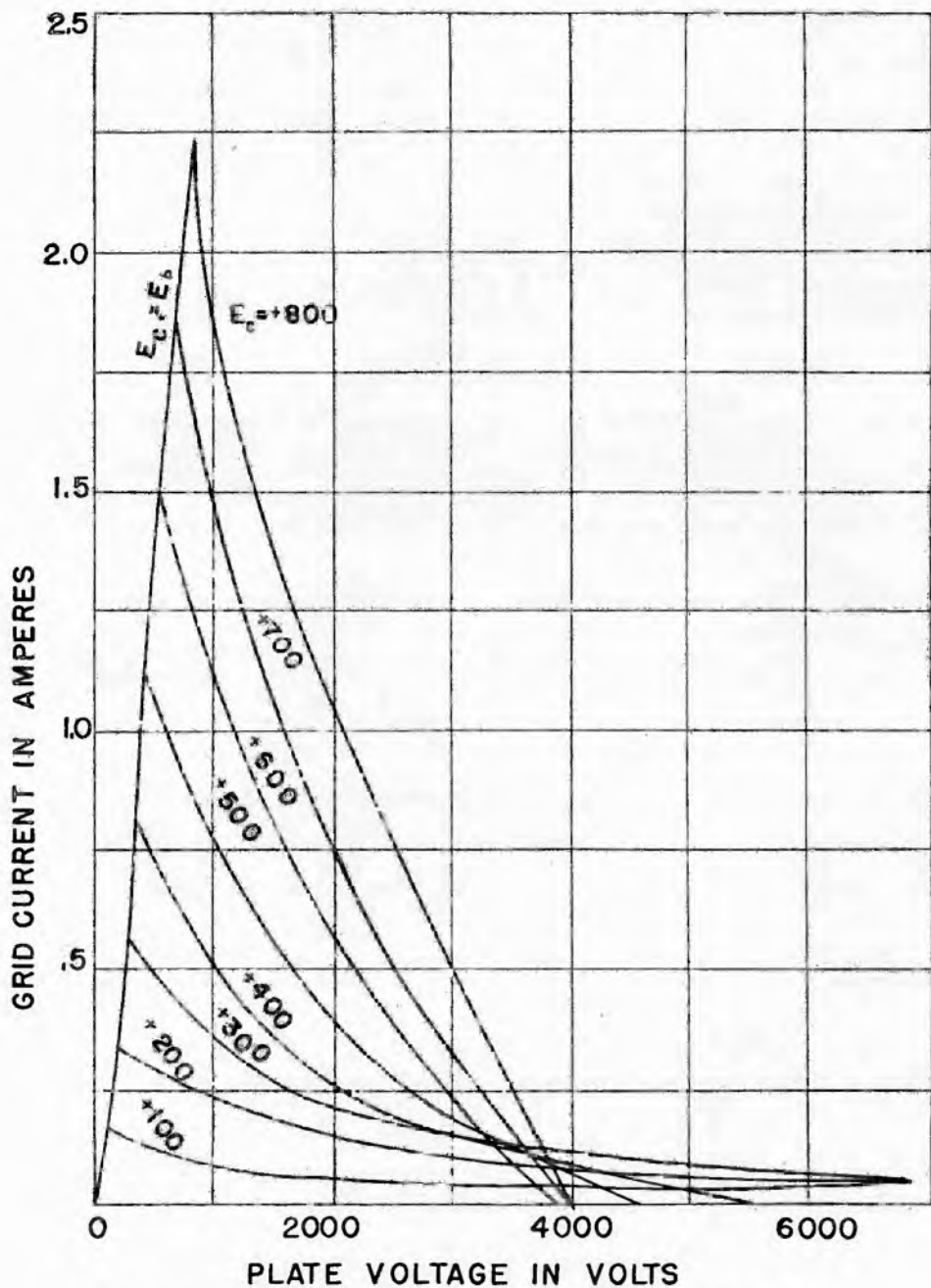
GL-892-R can be operated at maximum ratings in all classes of service at frequencies as high as 1.6 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised. (Other maximum ratings are the same as shown under MAXIMUM RAT-

INGS and TYPICAL OPERATING CONDITIONS.) The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used up to 20 mc for the various classes of service. Special attention should be given to adequate ventilation of the bulb at these frequencies.

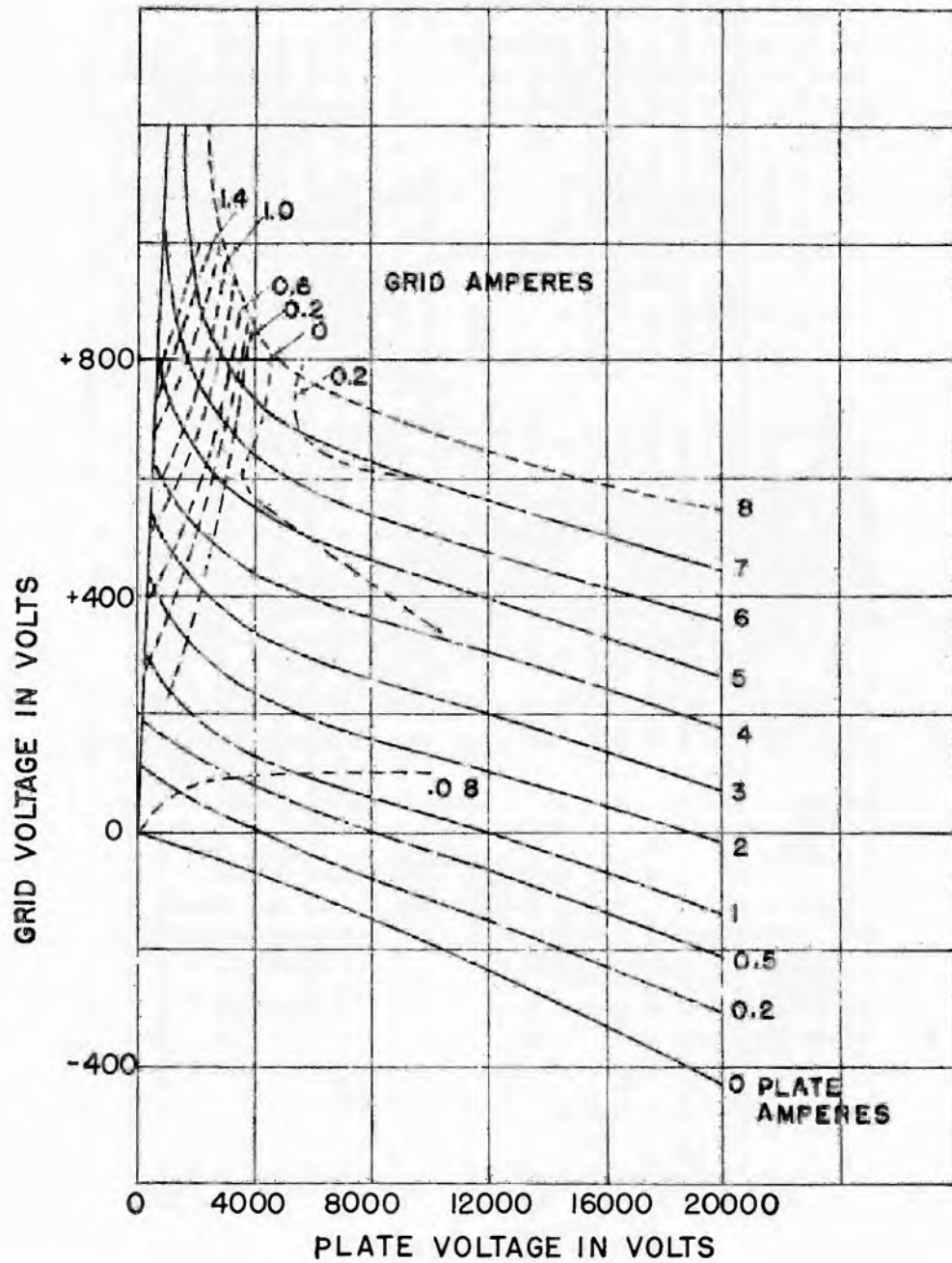
Frequency.....	1.6	7.5	20 megacycles
Maximum permissible percentage of maximum rated plate voltage and plate input			
Class B { telephony { telephony, plate modulated }.....	100	85	76 per cent
Class C, telegraphy.....	100	75	50 per cent



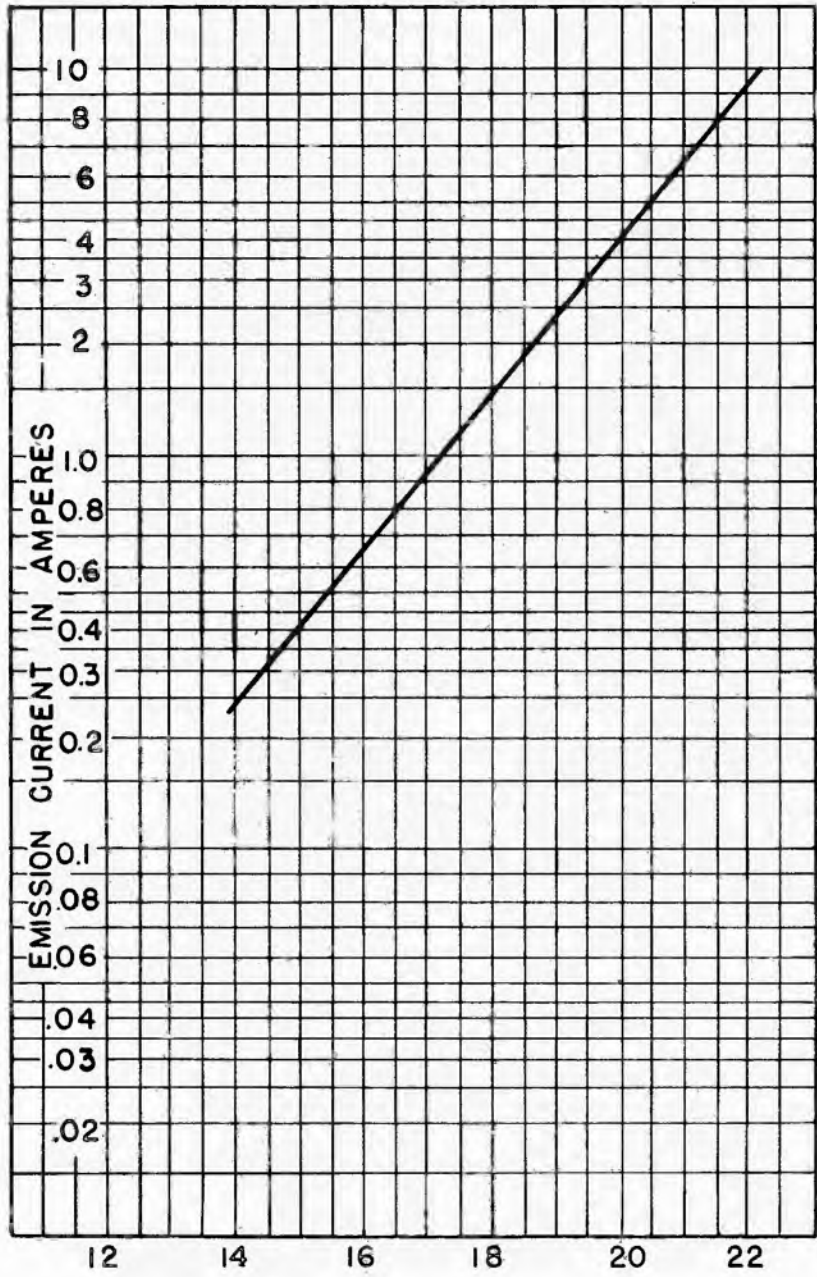
GL-892-R AVERAGE PLATE CHARACTERISTICS (E_f = 22 VOLTS A-C)



GL-892-R GRID-CURRENT CHARACTERISTICS ($E_c = 22$ VOLTS A-C)

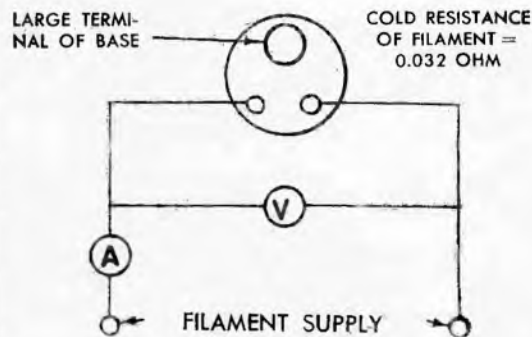
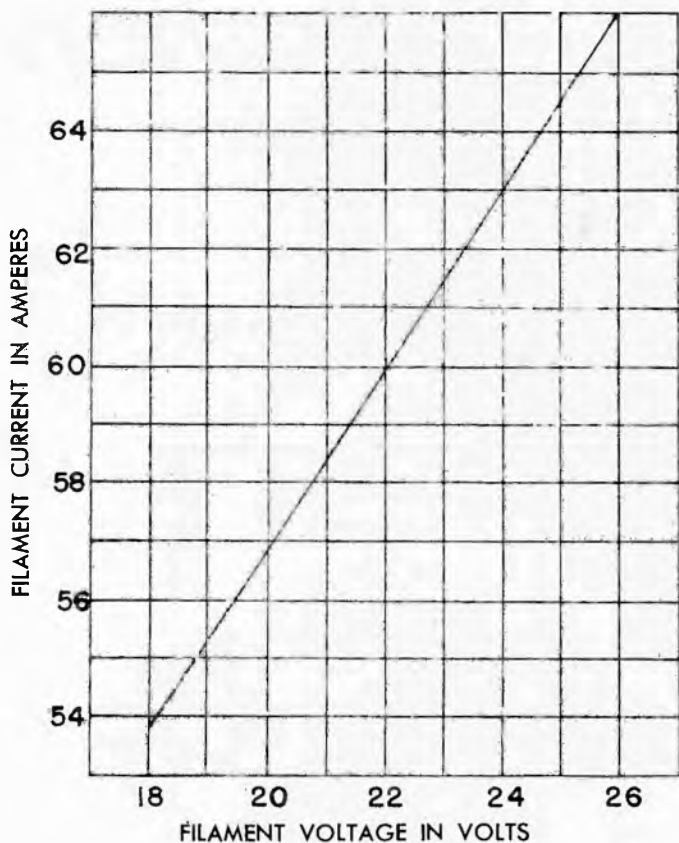


GL-892-R CONSTANT CURRENT PLATE AND GRID CHARACTERISTICS ($E_f = 22$ VOLTS A-C)



FILAMENT VOLTAGE IN VOLTS
GL-892 AVERAGE FILAMENT EMISSION CHARACTERISTIC

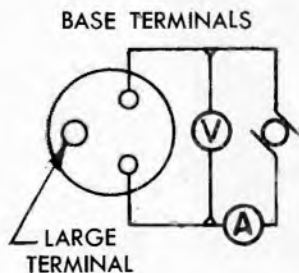
GL-892-R AVERAGE FILAMENT CHARACTERISTICS



K-8639398

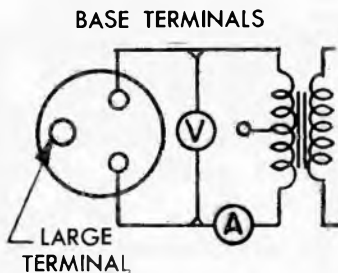
11-2-44

WITH D-C EXCITATION



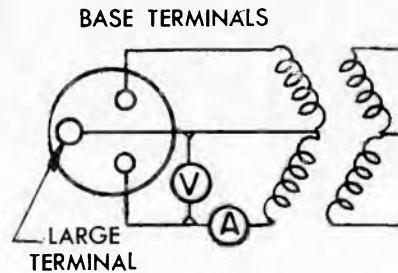
V = 22 VOLTS
A = 60 AMPERES

WITH SINGLE-PHASE A-C EXCITATION



V = 22 VOLTS
A = 60 AMPERES

WITH TWO-PHASE A-C EXCITATION

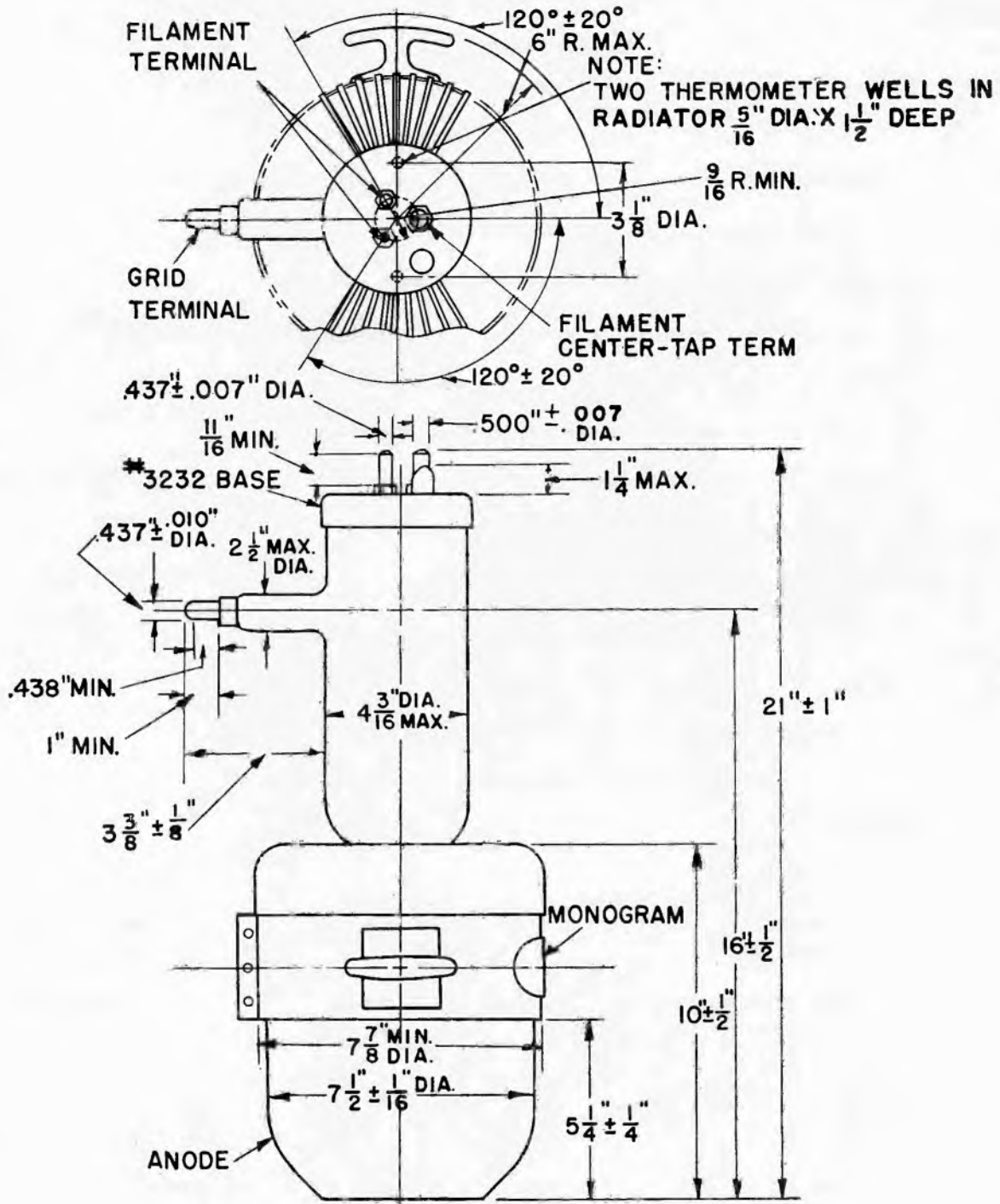


V = 11 VOLTS
A = 60 AMPERES

GL-892-R FILAMENT CONNECTIONS

K-9033547

12-1-44



OUTLINE GL-892-R PIOTRON

NOTE: Mounting position vertical, anode down.

K-6966980

11-5-45

Electronics Department
GENERAL ELECTRIC
 Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The 892-R is a three-electrode tube for use as a radio-frequency power amplifier, oscillator, and Class B modulator. The construction of the filament permits operation from two-phase or single-phase alternating current, as well as from direct current, for all classes of service. The plate of the 892-R is air-cooled by means of a special radiator which is

fitted to the tube by the manufacturer. The plate is capable of dissipating 2 to 5 kilowatts of power, depending on the service in which the tube is used. The GL-892-R pliotron can be operated at maximum ratings at frequencies as high as 1.6 megacycles and at frequencies up to 20 megacycles at reduced ratings.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage		22	23 volts
Filament current at bogey voltage	57	60	62 amperes
Filament starting current			120 amperes
Filament cold resistance		0.031	ohms
Amplification factor, $E_c = -50$ V, $I_b = 0.42$ A	42.5	50.0	57.5
Interelectrode capacitances			
Grid-plate	28	31	34 uuf
Grid-filament	15	20	24 uuf
Plate-filament	1.0	2.0	3.0 uuf

†Completely revised.



GENERAL  ELECTRIC

Supersedes ETI-247A dated 6-47

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position—vertical, anode down			
Type of cooling—forced-air			
Maximum incoming air temperature			45 C
Required air flow on anode			
Plate dissipation—watts	2400	3200	4000
Air flow—cubic feet per minute	300	380	450
Pressure—inches water	0.20	0.36	0.5
Maximum glass temperature			150 C
Net weight, approximate			46 pounds

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum Ratings, Absolute Values

D-c plate voltage	12,500 max	volts
Maximum signal d-c plate current*	2.0 max	amperes
Maximum signal plate input*	12,000 max	watts
Plate dissipation*	4,000 max	watts
Temperature of air cooler	180 max	C

Typical Operation

Unless otherwise specified, values are for two tubes

D-c plate voltage	6,000	8,000	volts
D-c grid voltage		-60	volts
Peak a-f grid-to-grid voltage	1,000	1,000	volts
Zero signal d-c plate current	0.5	0.5	amperes
Maximum signal d-c plate current	2.6	2.3	amperes
Effective load resistance, plate to plate	4,200	6,800	ohms
Maximum signal driving power, approximate	135	84	watts
Maximum signal power output, approximate	8,000	10,500	watts

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum Ratings, Absolute Values

D-c plate voltage	12,500 max	volts
D-c plate current	1.0 max	ampere
Plate input	6,000 max	watts
Plate dissipation	4,000 max	watts
Temperature of air cooler	180 max	C

Typical Operation

D-c plate voltage	6,000	8,000	volts
D-c grid voltage		-60	volts
Peak r-f grid voltage	230	320	volts
D-c plate current	0.64	0.67	ampere
D-c grid current, approximate	0.03	0.04	ampere
Driving power, approximate//	77	150	watts
Power output, approximate	1,000	1,800	watts

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

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

Maximum Ratings, Absolute Values

D-c plate voltage	10,000 max	volts
D-c grid voltage	-3,000 max	volts
D-c plate current	1.0 max	ampere
D-c grid current	0.3 max	ampere
Plate input	10,000 max	watts
Plate dissipation	2,500 max	watts
Temperature of air cooler	180 max	C

Typical Operation

D-c plate voltage	6,000	8,000	volts
D-c grid voltage	-1,000	-1,300	volts
Peak r-f grid voltage	1,650	1,950	volts
D-c plate current	0.83	0.82	amperes
D-c grid current, approximate	0.28	0.24	amperes
Driving power, approximate	420	430	watts
Power output, approximate	3,500	5,000	watts

TECHNICAL OPERATION (CONT'D)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation ¶

Maximum Ratings, Absolute Values

D-c plate voltage	12,500 max volts
D-c grid voltage	-3,000 max volts
D-c plate current	2.0 max ampere
D-c grid current	0.4 max ampere
Plate input	18,000 max watts
Plate dissipation	4,000 max watts
Temperature of air cooler	180 max C

Typical Operation

D-c plate voltage	8,000	10,000 volts
D-c grid voltage	-1,000	-1,300 volts
Peak r-f grid voltage	1,700	2,150 volts
D-c plate current	1.17	1.40 amperes
D-c grid current, approximate	0.22	0.24 amperes
Driving power, approximate	330	495 watts
Power output, approximate	6,500	10,000 watts

* Averaged over any cycle of sine-wave form.

//At crest of audio-frequency cycle with modulation factor of 1.0.

Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

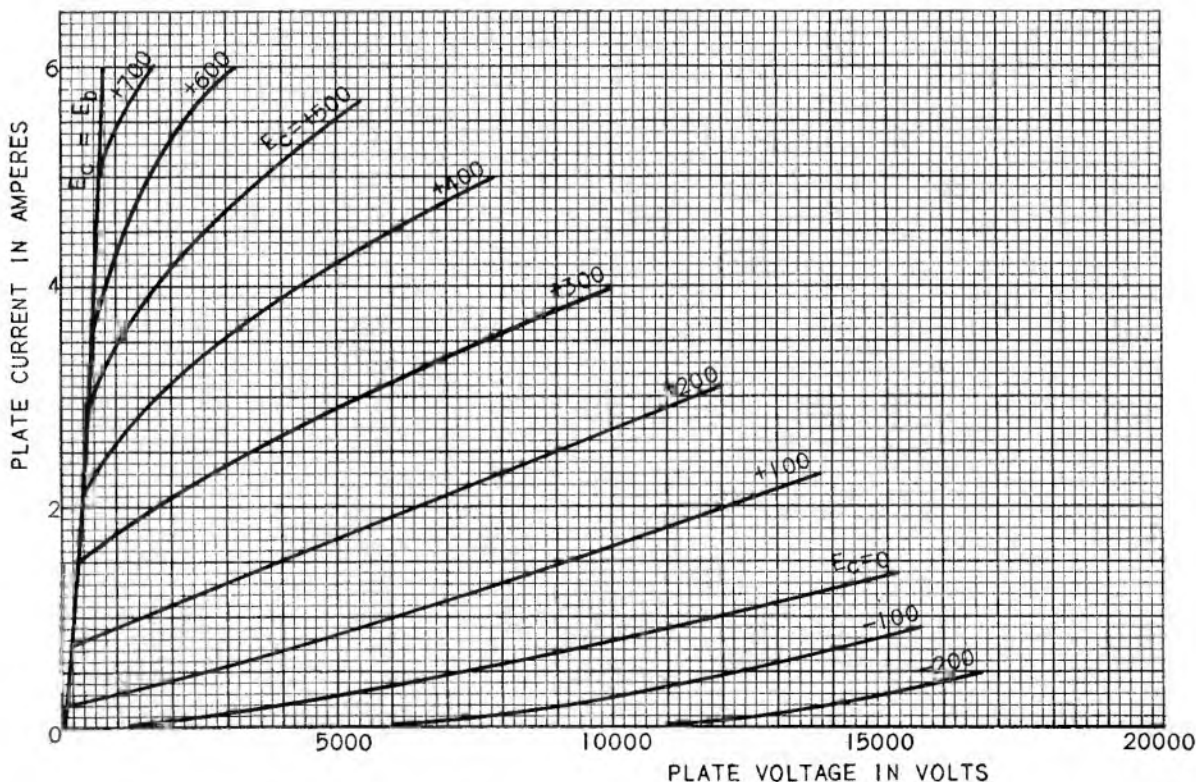
Maximum ratings apply up to 1.16 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency 1.6 7.5 20.0 megacycles

Percentage of Maximum Rated Plate Voltage and Plate Input

Class B	100	85	76 percent
Class C plate modulated	100	75	50 percent
Class C unmodulated	100	75	50 percent

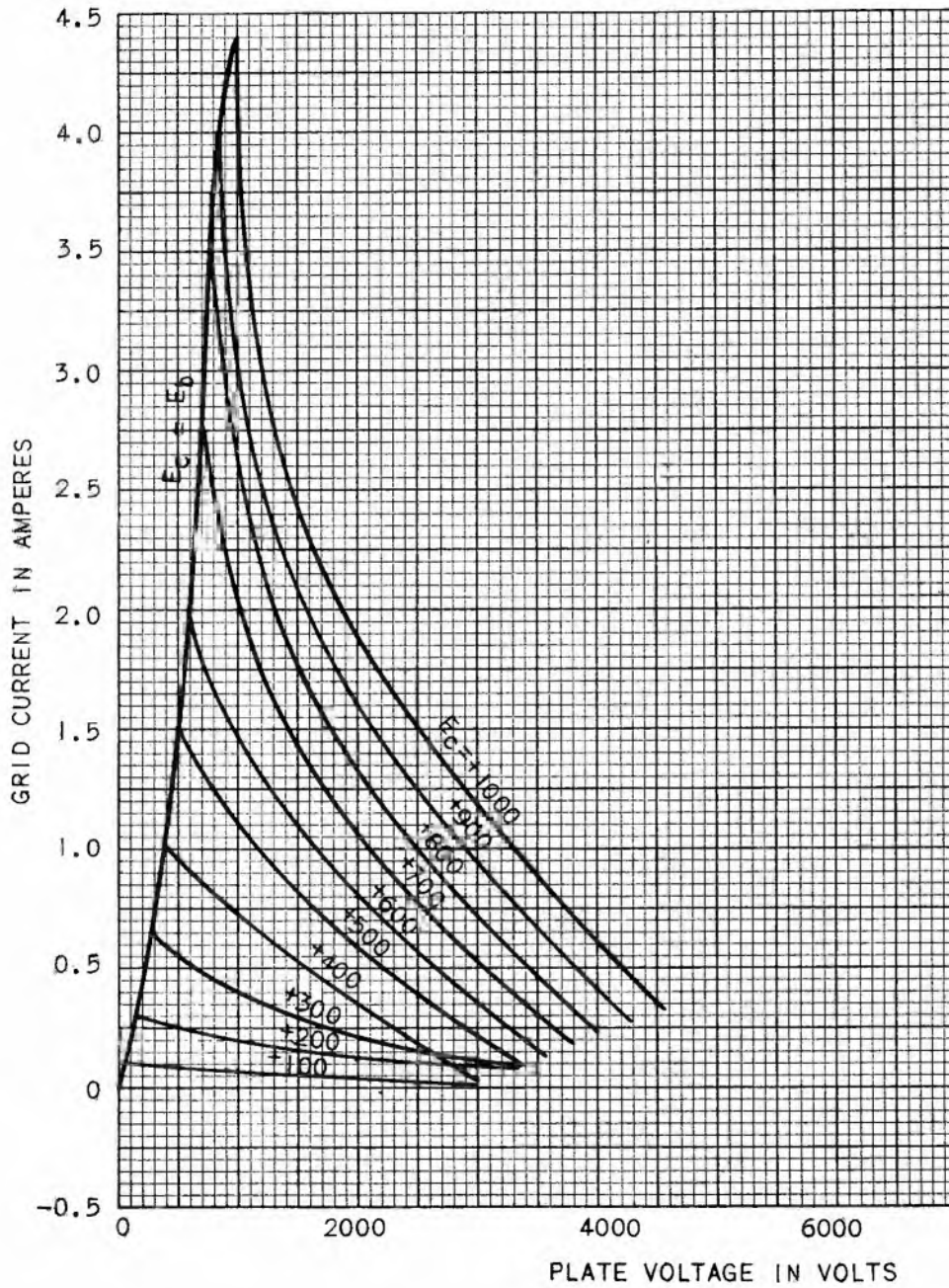
◆GL-892-R AVERAGE PLATE CHARACTERISTICS ($E_f = 22$ VOLTS A-C)



◆GL-892-R

AVERAGE GRID-PLATE TRANSFER CHARACTERISTIC

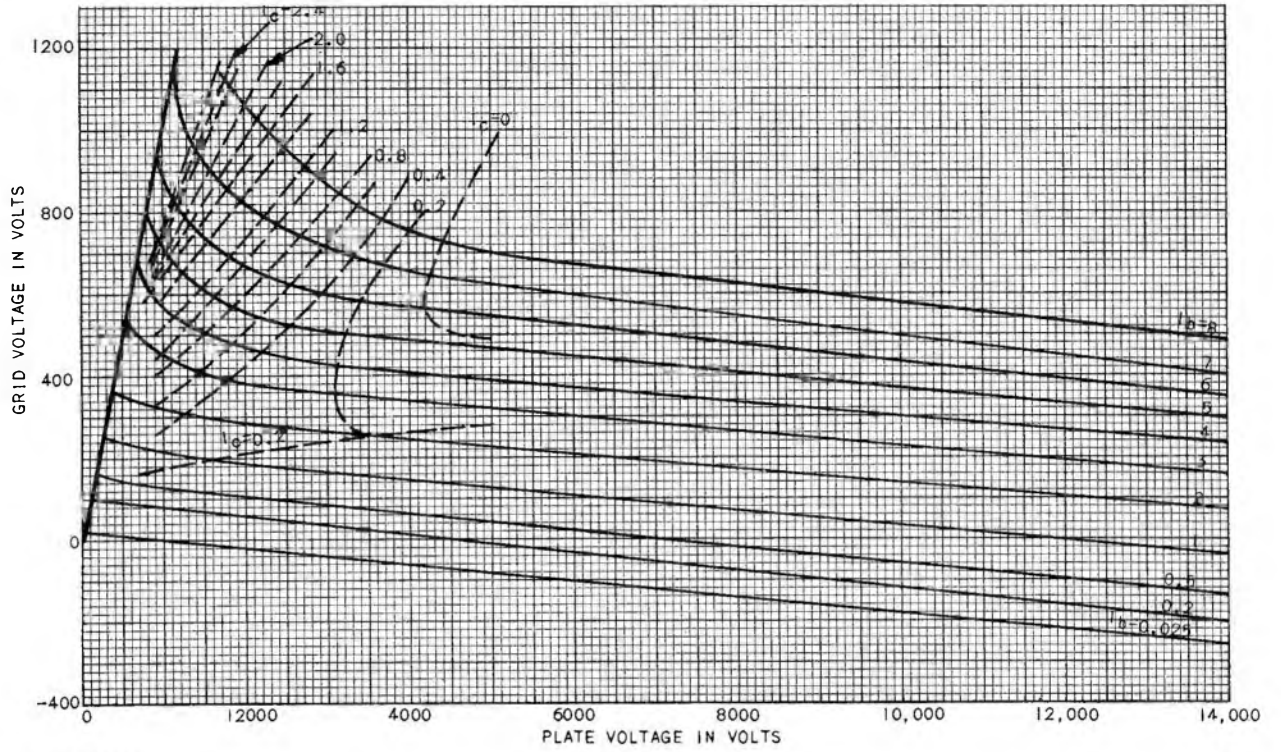
$E_c = 22$ VOLTS A-C, SINGLE-PHASE EXCITATION



◆GL-892-R

AVERAGE CONSTANT-CURRENT CHARACTERISTICS

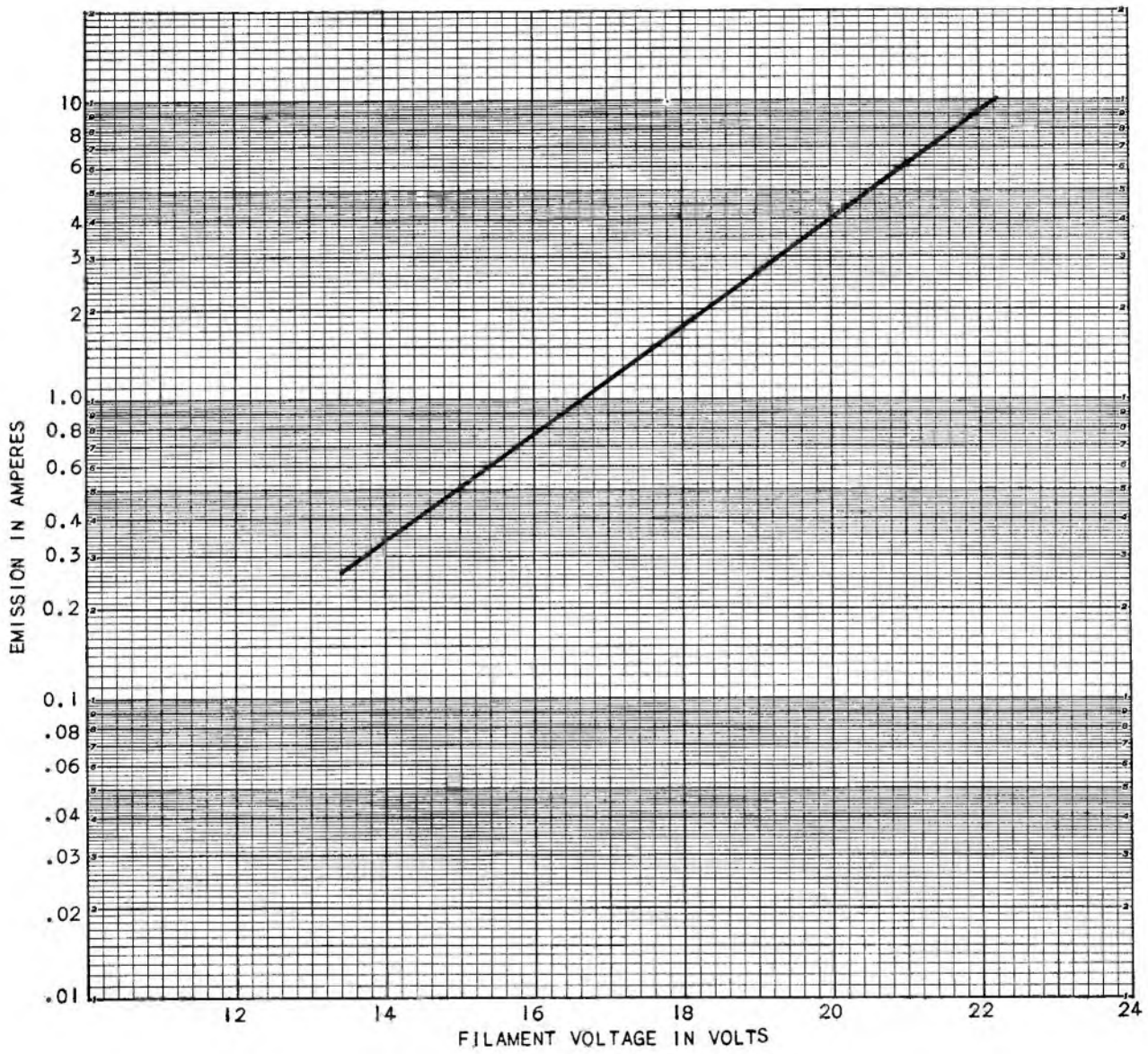
$E_f = 22$ VOLTS A-C, SINGLE-PHASE EXCITATION



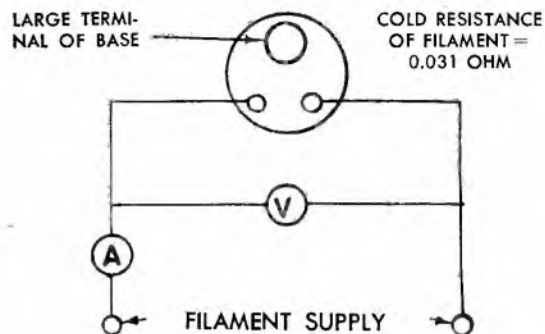
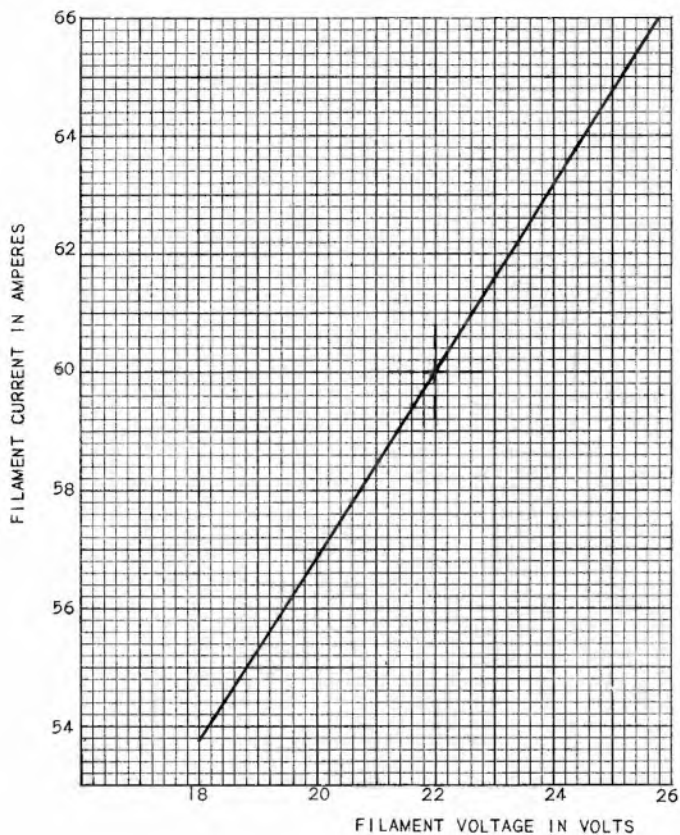
K-69087-72A443
◆New drawing.

] - 1 [- 5]

◆GL-892-R AVERAGE FILAMENT EMISSION CHARACTERISTIC



◆ GL-892-R AVERAGE FILAMENT CHARACTERISTICS



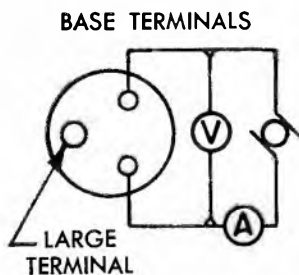
K-69087-72A441

◆ New drawing.

1-11-51

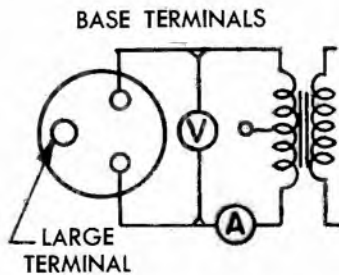
GL-892-R FILAMENT CONNECTIONS

WITH D-C EXCITATION



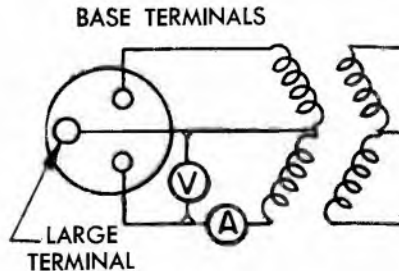
V = 22 VOLTS
A = 60 AMPERES

WITH SINGLE-PHASE A-C EXCITATION



V = 22 VOLTS
A = 60 AMPERES

WITH TWO-PHASE A-C EXCITATION

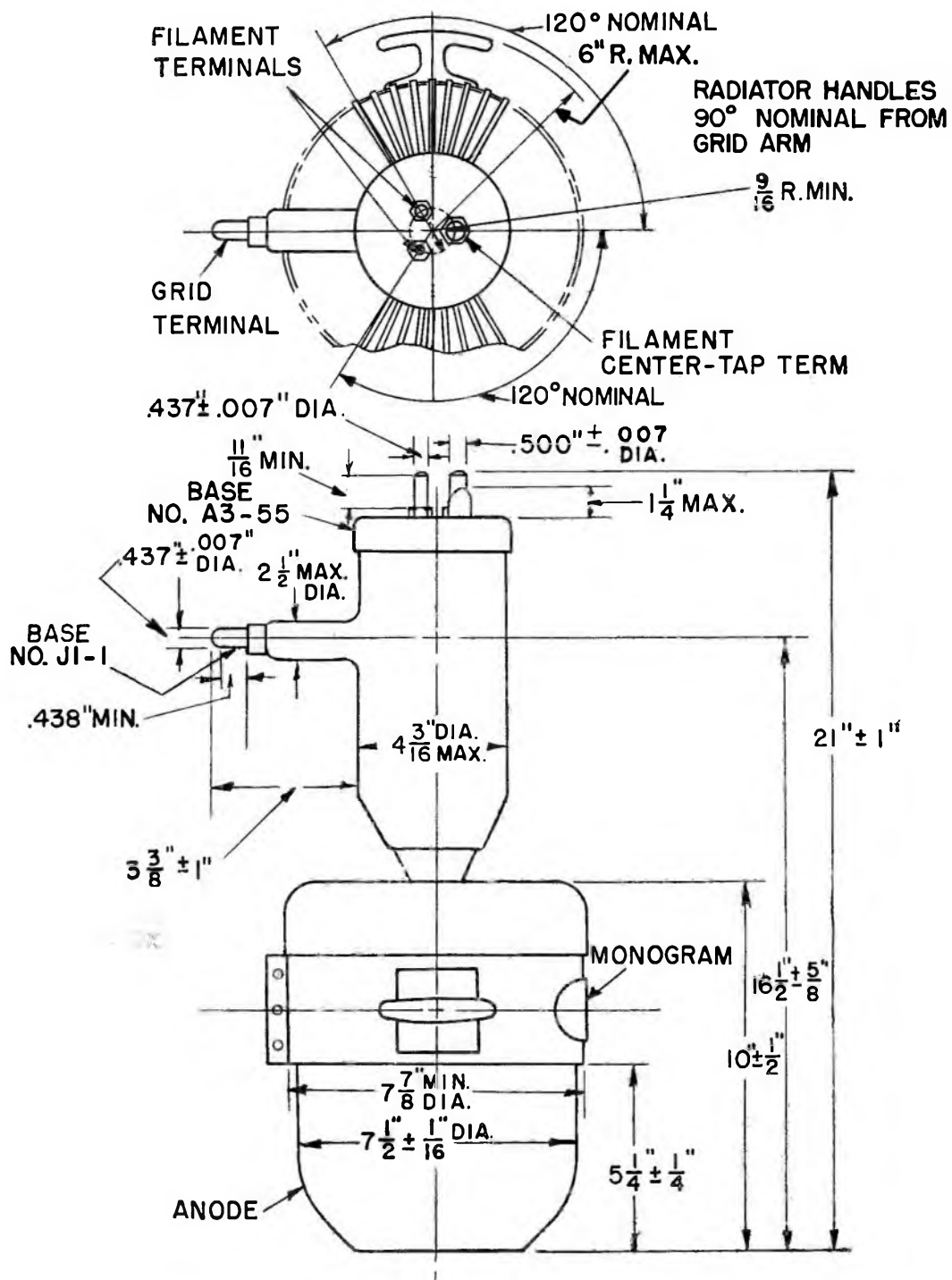


V = 11 VOLTS
A = 60 AMPERES

K-9033547

12-1-44

◆ OUTLINE GL-892-R PIOTRON



K-6966980
 ◆ Revised.

11-11-48

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-893A-R is a three-electrode tube designed for use as a radio-frequency amplifier, oscillator, or class B modulator. The anode is forced-air cooled and is capable of dissipating 20 kilowatts. The cathode is a pure-tungsten filament. Maximum ratings apply up to 5 megacycles.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage (single-phase excitation)*§		20	21 volts
Filament current at bogey voltage			
(Single-phase excitation)*§	175	183	190 amperes
Filament starting current			
(Single-phase excitation)			275 amperes
Filament cold resistance			
(Single-phase excitation)		.0093	... ohm
Amplification factor, $I_b = 1.0$ amp, $E_c = -100$ v	28	34.5	41
Interelectrode capacitances			
Grid-plate	29.8	34	38.8 uuf
Grid-filament	39.5	48	56.5 uuf
Plate-filament	2.6	3.5	4.4 uuf

◆ Technical information completely revised.



GENERAL  ELECTRIC

Supersedes ETI-248 dated 8-46

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position				vertical
Type of cooling				forced-air
Maximum incoming air temperature				45 C
Required air flow on anode				
Plate dissipation—percent of rating	100	80	60	
Air flow—cubic feet per minute	1800	1250	1000	
Static pressure—inches water	1.05	0.56	0.38	
Required air flow to stem*				2 CFM†
Maximum glass temperature				150 C
Net weight, approximate				230 pounds

**MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS
AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B**

Maximum ratings, absolute values		CCS†		
D-c plate voltage		20,000 max	volts	
Maximum signal d-c plate current‡		4.0 max	amperes	
Maximum signal plate input‡		60 max	kilowatts	
Plate dissipation		20 max	kilowatts	
Typical operation				
Unless otherwise specified, values are for 2 tubes				
		CCS†		
D-c plate voltage	12,000	15,000	18,000	volts
D-c grid voltage	-260	-350	-450	volts
Peak a-f grid-to-grid voltage	1480	1560	1720	volts
Zero signal d-c plate current	0.8	0.8	0.8	amperes
Maximum signal d-c plate current	7.0	6.0	5.5	amperes
Effective load resistance, plate to plate	4000	6000	8000	ohms
Maximum signal driving power, approximate	220	190	140	watts
Maximum signal power output, approximate	52	60	70	kilowatts

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum ratings, absolute values		CCS†		
D-c plate voltage		20,000 max	volts	
D-c plate current		2.0 max	amperes	
Plate input		32 max	kilowatts	
Plate dissipation		20 max	kilowatts	
Typical operation				
		CCS†		
D-c plate voltage	12,000	15,000	15,000	volts
D-c grid voltage	-250	-340	-340	volts
Peak r-f grid voltage	350	395	450	volts
D-c plate current	1.5	1.5	2.0	amperes
D-c grid current, approximate	35	30	50	milliamperes
Driving power, approximate	130	150	200	watts
Power output, approximate	6	7.5	10	kilowatts

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

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

Maximum ratings, absolute values		CCS†		
D-c plate voltage		12,000 max	volts	
D-c grid voltage		-3000 max	volts	
D-c plate current		2.0 max	amperes	
D-c grid current		0.4 max	amperes	
Plate input		24 max	kilowatts	
Plate dissipation		12 max	kilowatts	
Typical operation				
		CCS†		
D-c plate voltage	10,000	10,000	12,000	volts
D-c grid voltage	-800	-800	-1000	volts
Peak r-f grid voltage	1200	1280	1500	volts
D-c plate current	1.5	2.0	2.0	amperes
D-c grid current, approximate	0.10	0.16	0.14	amperes
Driving power, approximate	120	210	210	watts
Power output, approximate	11	15	18	kilowatts

TECHNICAL INFORMATION (CONT'D)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation

Maximum ratings, absolute values		CCS†		
D-c plate voltage		20,000	max	volts
D-c grid voltage		—3000	max	volts
D-c plate current		4.0	max	amperes
D-c grid current		0.4	max	amperes
Plate input		70	max	kilowatts
Plate dissipation		20	max	kilowatts
Typical operation		CCS†		
D-c plate voltage	12,000	15,000	18,000	volts
D-c grid voltage	—800	—900	—1000	volts
Peak r-f grid voltage	1430	1520	1630	volts
D-c plate current	3.5	3.6	3.6	amperes
D-c grid current, approximate	0.26	0.25	0.21	amperes
Driving power, approximate	360	370	340	watts
Power output, approximate	30	40	50	kilowatts

*Air flow to be directed into stem through tubing in center of base. The flow stem-cooling air must continue for 5 minutes after removal of filament and plate power.

§See drawing Filament Connections and Excitation Circuits, K-8639686.

†CCS = Continuous Commercial Service.

‡Averaged over any audio-frequency cycle of sine-wave form.

πAt crest of audio-frequency cycle with modulation factor of 1.0.

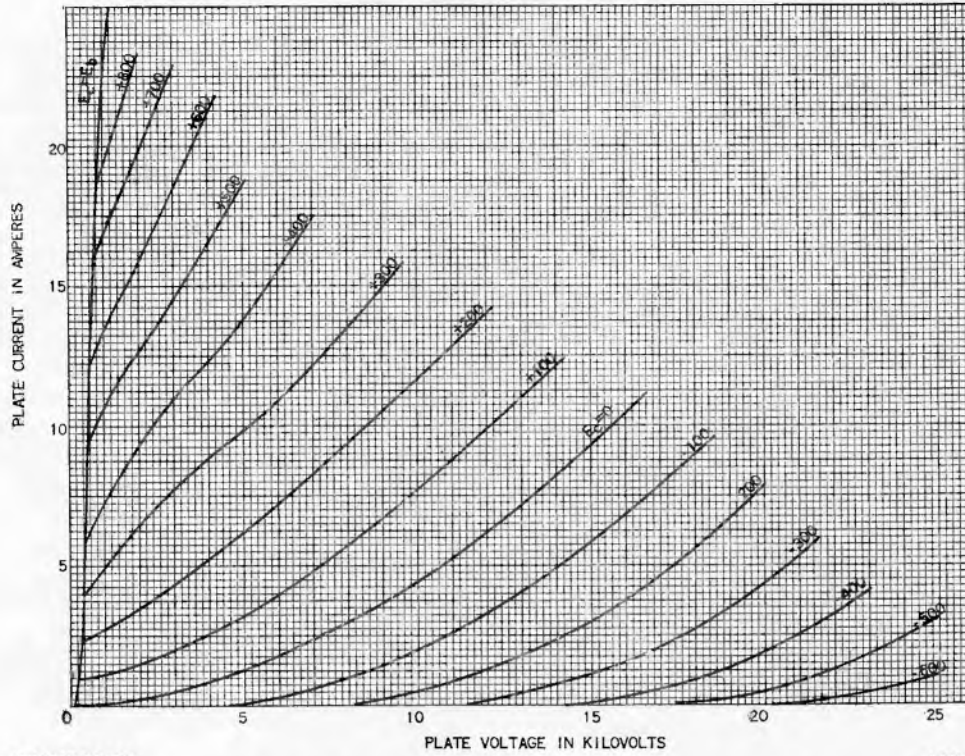
¶Modulation essentially negative may be used if the positive peak of the envelope does not exceed 145 percent of the carrier conditions.

Maximum ratings apply up to 5 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the

tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	5	12	25 megacycles
Percentage of maximum rated plate voltage and plate input			
Class B r-f	100	86	74 percent
Class C plate modulated	100	81	65 percent
Class C unmodulated			
Percentage of maximum rated plate voltage	100	81	65 percent
Percentage of maximum rated plate input	100	75	50 percent

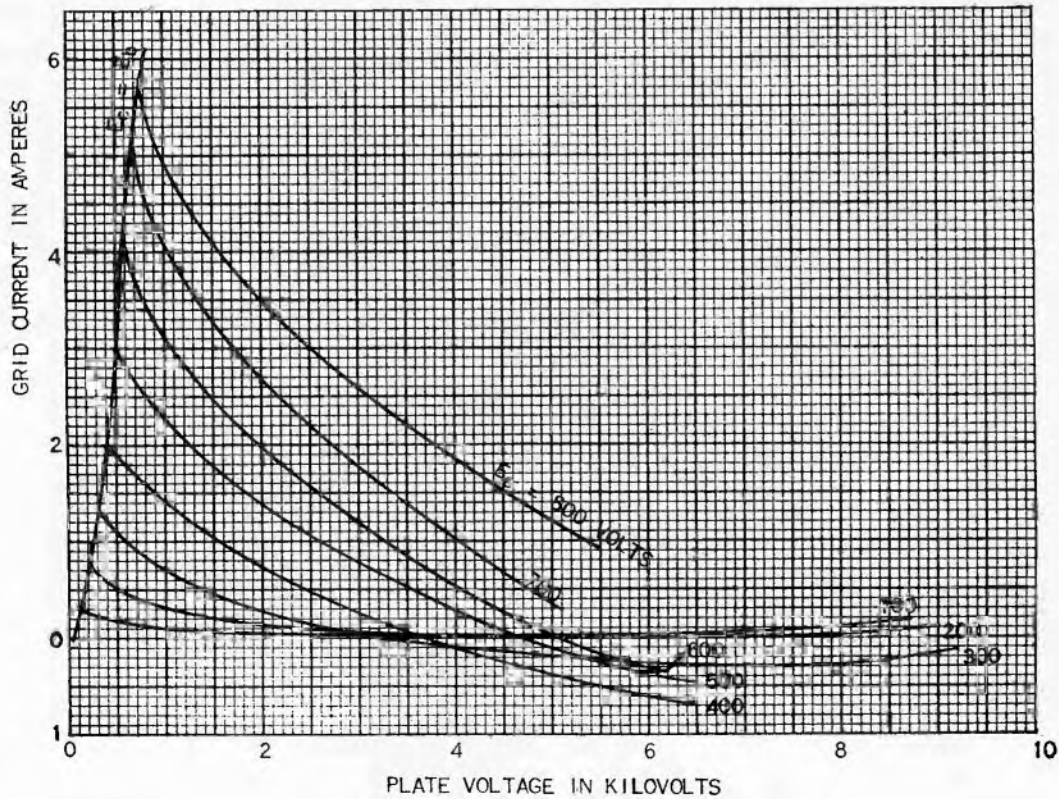
■ GL-893A-R AVERAGE PLATE CHARACTERISTIC
 $E_f = 20$ VOLTS A-C



K-69087-72A99
■ Drawing revised

4-27-49

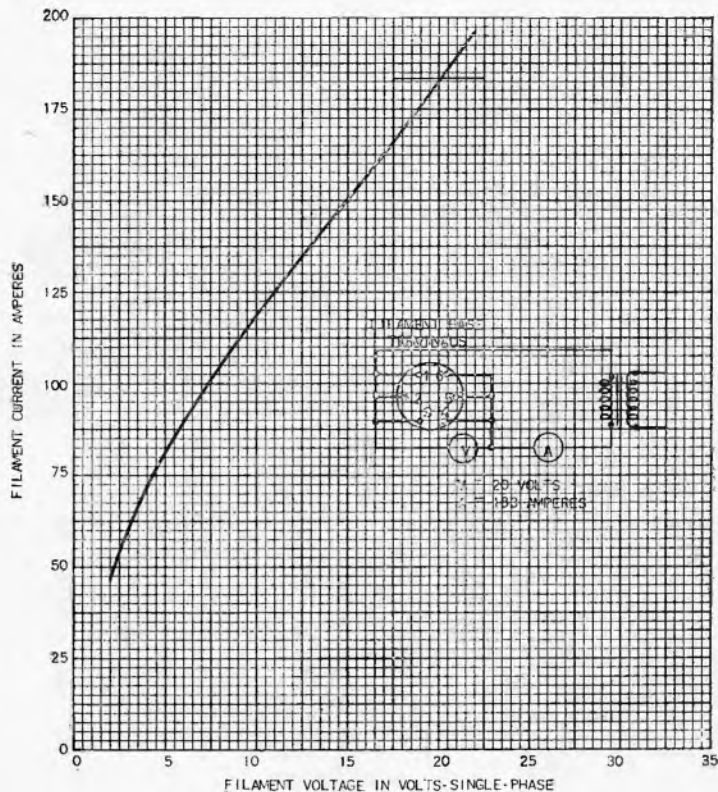
■ GL-893A-R GRID-PLATE TRANSFER CHARACTERISTIC
 $E_f = 20$ VOLTS A-C



K-69087-72A288
■ Drawing revised

4-25-49

■ GL-893A-R AVERAGE FILAMENT CHARACTERISTIC
SINGLE-PHASE CONNECTION
COLD RESISTANCE = 0.0093 OHM

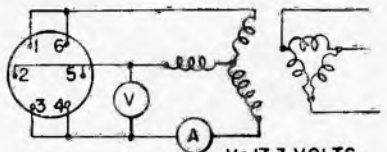


K-69087-72A267
■ Drawing revised

4-25-49

GL-893A-R FILAMENT CONNECTIONS

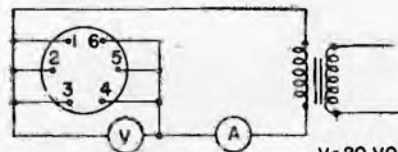
FILAMENT BASE TERMINALS



V = 17.3 VOLTS
A = 122 AMPERES

THREE-PHASE A-C FILAMENT EXCITATION

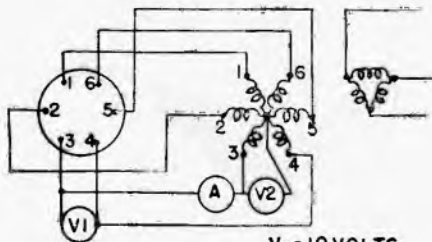
FILAMENT BASE TERMINALS



V = 20 VOLTS
A = 183 AMPERES

SINGLE-PHASE A-C FILAMENT EXCITATION

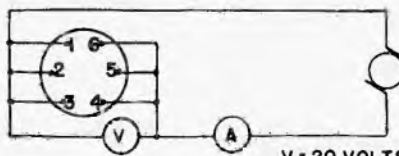
FILAMENT BASE TERMINALS



V₁ = 10 VOLTS
V₂ = 10 VOLTS
A = 61 AMPERES

SIX-PHASE A-C FILAMENT EXCITATION

FILAMENT BASE TERMINALS



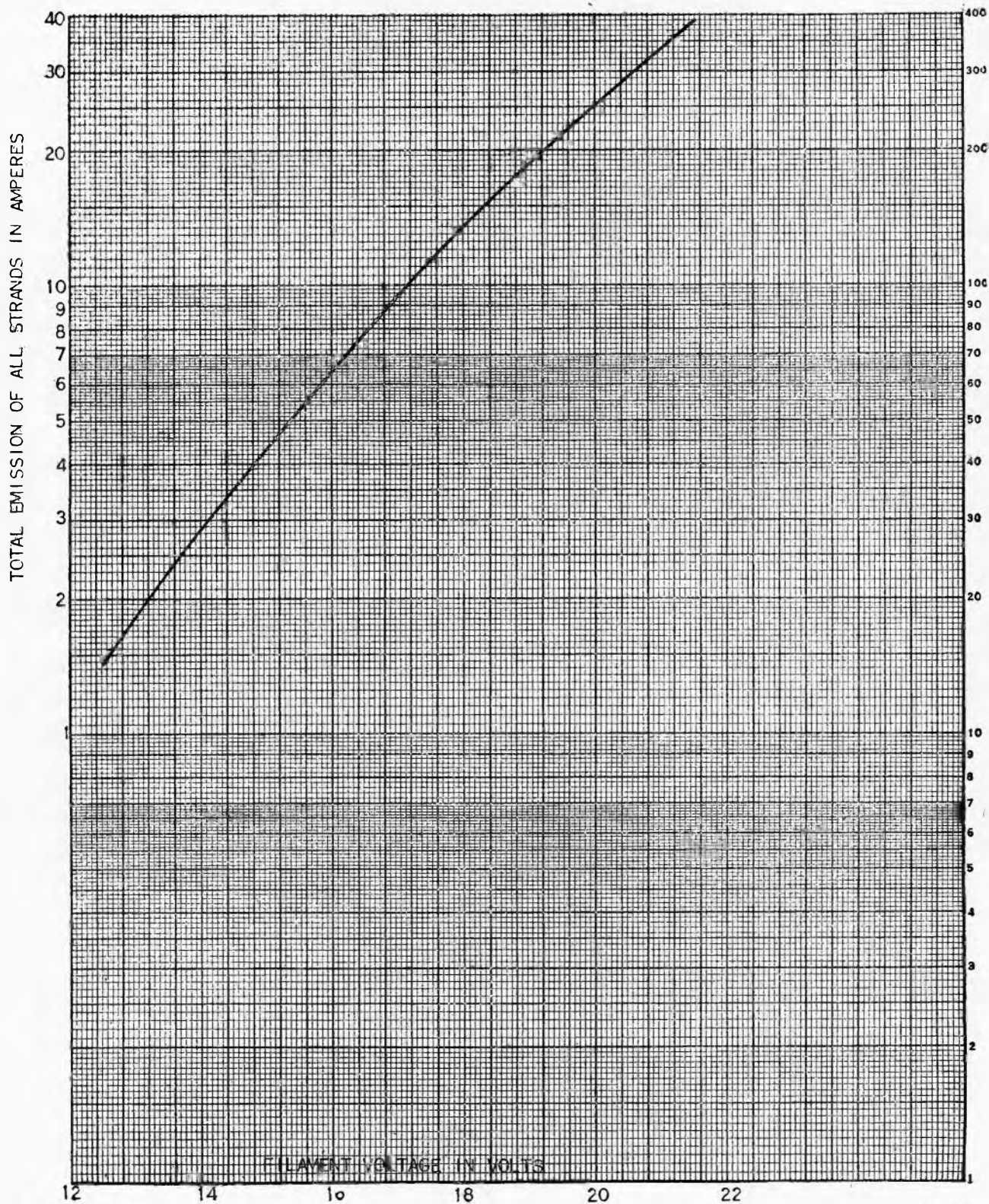
V = 20 VOLTS
A = 183 AMPERES

D-C FILAMENT EXCITATION

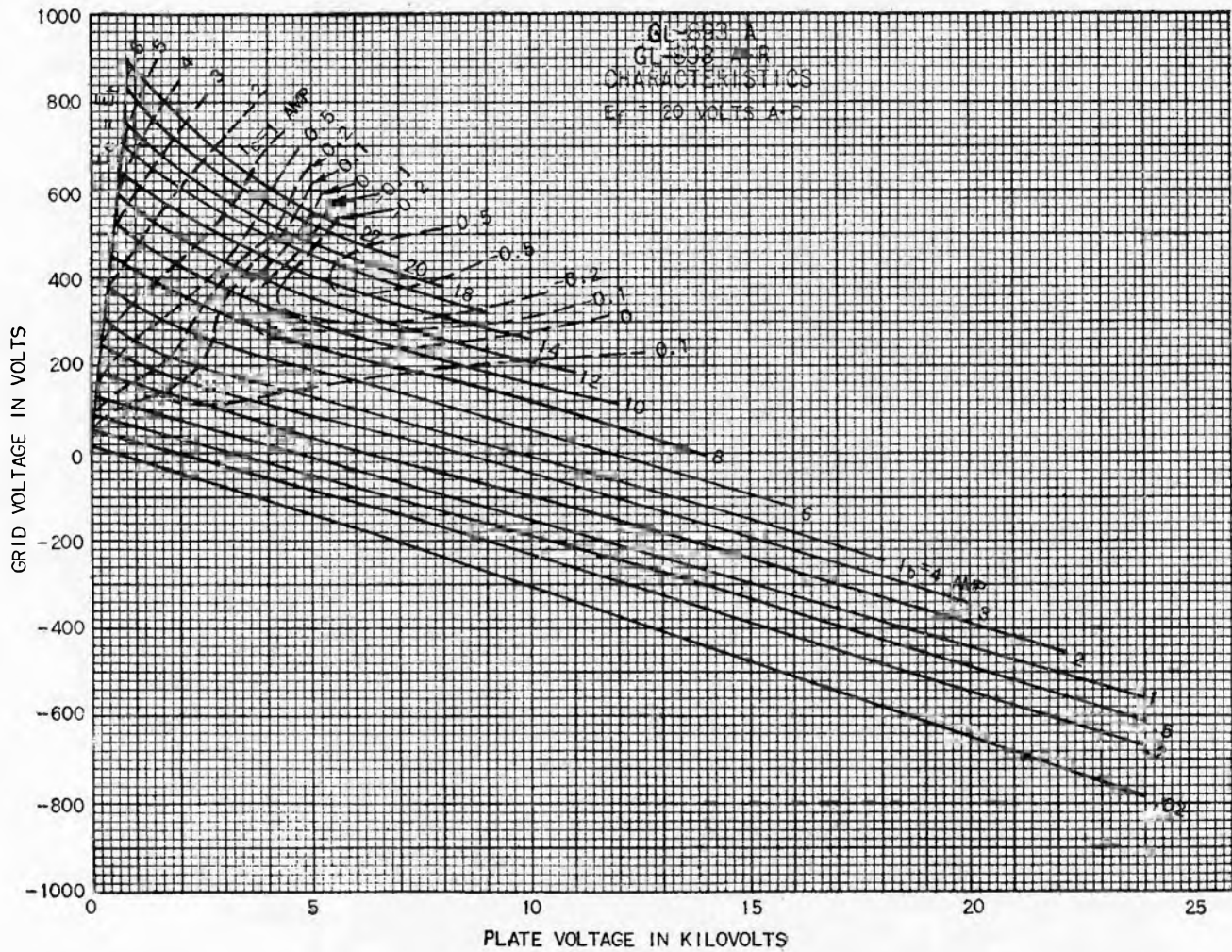
NOTE: TERMINALS MUST BE CONNECTED IN CORRECT PHASE RELATION AS SHOWN

■ GL-893A-R

AVERAGE FILAMENT EMISSION CHARACTERISTIC
SINGLE-PHASE FILAMENT CONNECTION



■ GL-893A-R
CHARACTERISTICS
 $E_1 = 20$ VOLTS A-C



K-69087-72A286
■ Drawing revised

4-25-49



PLIOTRON

DESCRIPTION

The GL-889R-A is a three-electrode power tube designed for use as a radio-frequency amplifier, oscillator, or Class B modulator. The plate is fitted with a special radiator and cooling is obtained by forced air. The design of the mount and terminal

connections minimizes lead inductance and makes the tube particularly suitable for high-frequency applications. The GL-889R-A can be operated at maximum ratings at frequencies as high as 40 megacycles and up to 100 megacycles at reduced ratings.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum
Filament voltage	—	11.0	11.5 volts
Filament current at bogey voltage	110	120	128 amperes
Filament starting current	—	—	180 amperes
Filament cold resistance	—	0.008	— ohm
Amplification factor, at $E_b = 1.0$ amp.			
$E_c = -100$ volts	17	21	25
Interelectrode capacitance			
Grid-plate	15.8	18.5	21.2 micromicrofarads
Grid-filament	19.2	23.3	27.4 micromicrofarads
Plate-filament	2.0	3.0	4.0 micromicrofarads

◆ Completely revised.


Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position				vertical, anode down
Type of cooling				forced air
Maximum incoming air temperature			45	centigrade
Required air flow on anode				
Plate dissipation—kilowatts	5.0	4.0	3.0	
Air flow—cubic feet per minute	500	390	300	
Static pressure—inches water	0.7	0.5	0.35	
Required air flow to bulb*			15	cubic feet per minute
Maximum glass temperature			150	centigrade
Net weight, approximate			35	pounds

*Air to be directed at the top of tube from a 3-inch-diameter nozzle. Cooling air may be obtained by directing the required air flow at the top of the glass envelope through a 3-inch-diameter nozzle, or by deflecting air at the top of the bulb from the radiator-cooling-air stream.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values				CCS**
D-c plate voltage			8500	maximum volts
Maximum signal d-c plate current†			2	maximum amperes
Maximum signal plate input†			12	maximum kilowatts
Plate dissipation†			5	maximum kilowatts
Typical operation				CCS*
Unless otherwise specified, values are for two tubes				
D-c plate voltage	5000	6000	7500	volts
D-c grid voltage	-180	-230	-300	volts
Peak a-f grid-to-grid voltage	1460	1680	1700	volts
Zero signal d-c plate current	0.4	0.4	0.4	amperes
Maximum signal d-c plate current	3.2	3.6	3.2	amperes
Effective load resistance, plate-to-plate	2520	3680	5000	ohms
Maximum signal driving power, approximate	170	180	150	watts
Maximum signal power output, approximate	8.8	12	15	kilowatts

†Averaged over any audio-frequency cycle of sine-wave form.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum ratings, absolute values				CCS**
D-c plate voltage			8500	maximum volts
D-c plate current			1.0	maximum ampere
Plate input			7.5	maximum kilowatts
Plate dissipation			5	maximum kilowatts
Typical operation				CCS**
D-c plate voltage	6000	7500		volts
D-c grid voltage	-250	-300		volts
Peak r-f grid voltage	460	500		volts
D-c plate current	0.9	0.9		ampere
D-c grid current, approximate	0.003	0.005		ampere
Driving power, approximate||	95	80		watts
Power output, approximate	1.5	2		kilowatts

||At crest of audio-frequency cycle with modulation factor of 1.0.

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

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

Maximum ratings, absolute values				CCS**
D-c plate voltage	6000			maximum volts
D-c grid voltage	-1000			maximum volts
D-c plate current	1.0			maximum ampere
D-c grid current	0.25			maximum ampere
Plate input	6			maximum kilowatts
Plate dissipation	3			maximum kilowatts

TECHNICAL INFORMATION (CONT'D)

Typical operation	CCS**		
D-c plate voltage	5000	6000	volts
D-c grid voltage	-800	-900	volts
Peak r-f grid voltage	1300	1420	volts
D-c plate current	0.9	1.0	ampere
D-c grid current, approximate	0.12	0.1	ampere
Driving power, approximate	155	140	watts
Power output, approximate	2.75	4	kilowatts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation

Maximum ratings, absolute values	CCS**		
D-c plate voltage	8500		maximum volts
D-c grid voltage	-1000		maximum volts
D-c plate current	2		maximum amperes
D-c grid current	0.25		maximum ampere
Plate input	16		maximum kilowatts
Plate dissipation	5		maximum kilowatts

Typical operation	CCS**			
D-c plate voltage	5000	6000	7500	volts
D-c grid voltage	-500	-600	-800	volts
Peak r-f grid voltage	1200	1460	1830	volts
D-c plate current	1.5	1.8	2	amperes
D-c grid current, approximate	0.19	1.21	0.24	amperes
Driving power, approximate	220	290	400	watts
Power output, approximate	5	7	10	kilowatts

Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

**CCS—Continuous Commercial Service.

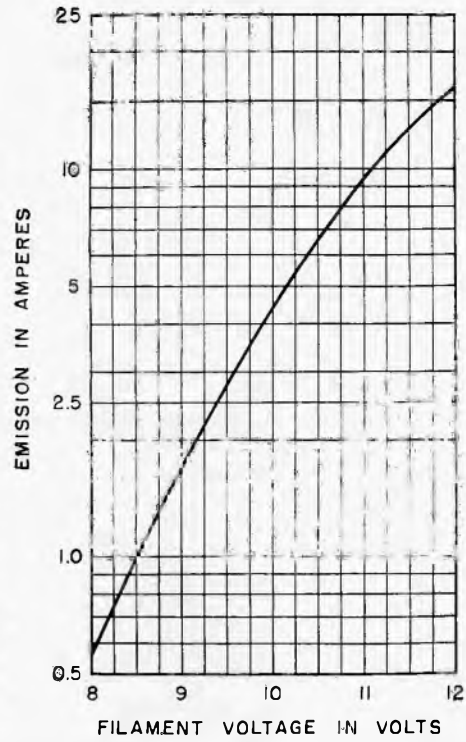
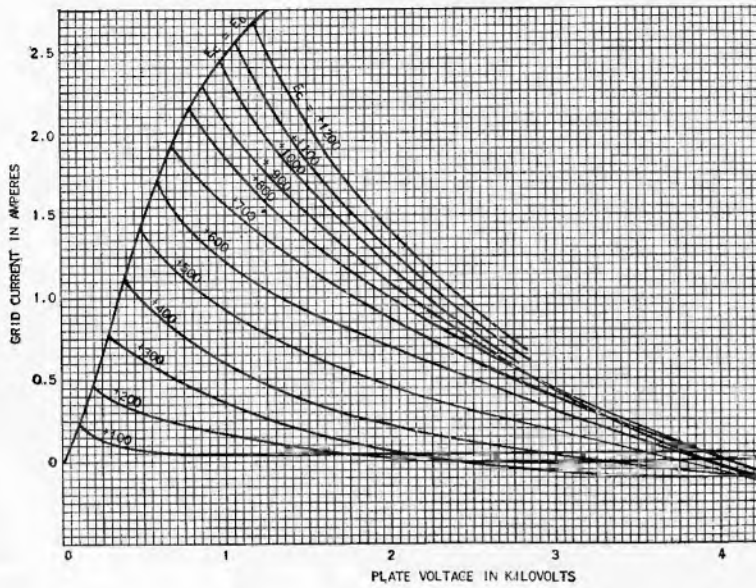
APPLICATION NOTES

*The GL-889R-A can be operated at maximum ratings in all classes of service at frequencies as high as 40 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced as the frequency is raised. (Other maximum ratings are the same as shown under TECHNICAL

INFORMATION.) The tabulation below shows the highest percentage of maximum plate voltage and power input that can be used up to 100 megacycles for the various classes of service. Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	40	65	100 megacycles
Percentage of maximum rated plate voltage and plate input			
Class B	100	85	72 per cent
Class C plate modulated	100	78	60 per cent
Class C unmodulated—maximum plate voltage	100	87	65 per cent
Class C unmodulated—maximum plate input	100	73	50 per cent

GL-889R-A
TYPICAL GRID-PLATE TRANSFER CHARACTERISTIC
E=11_f VOLTS A-C

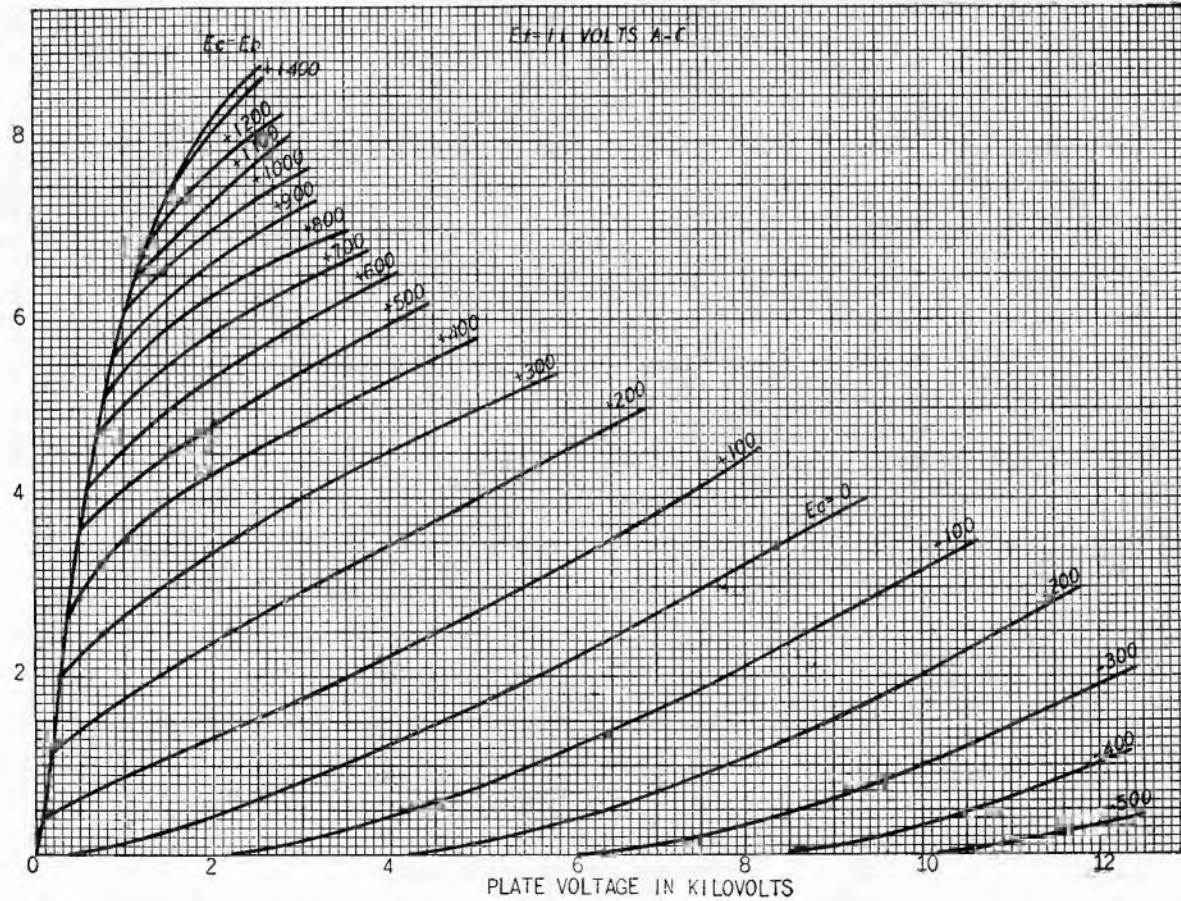


K-8074636
Revised

3-5-48 K-8074633

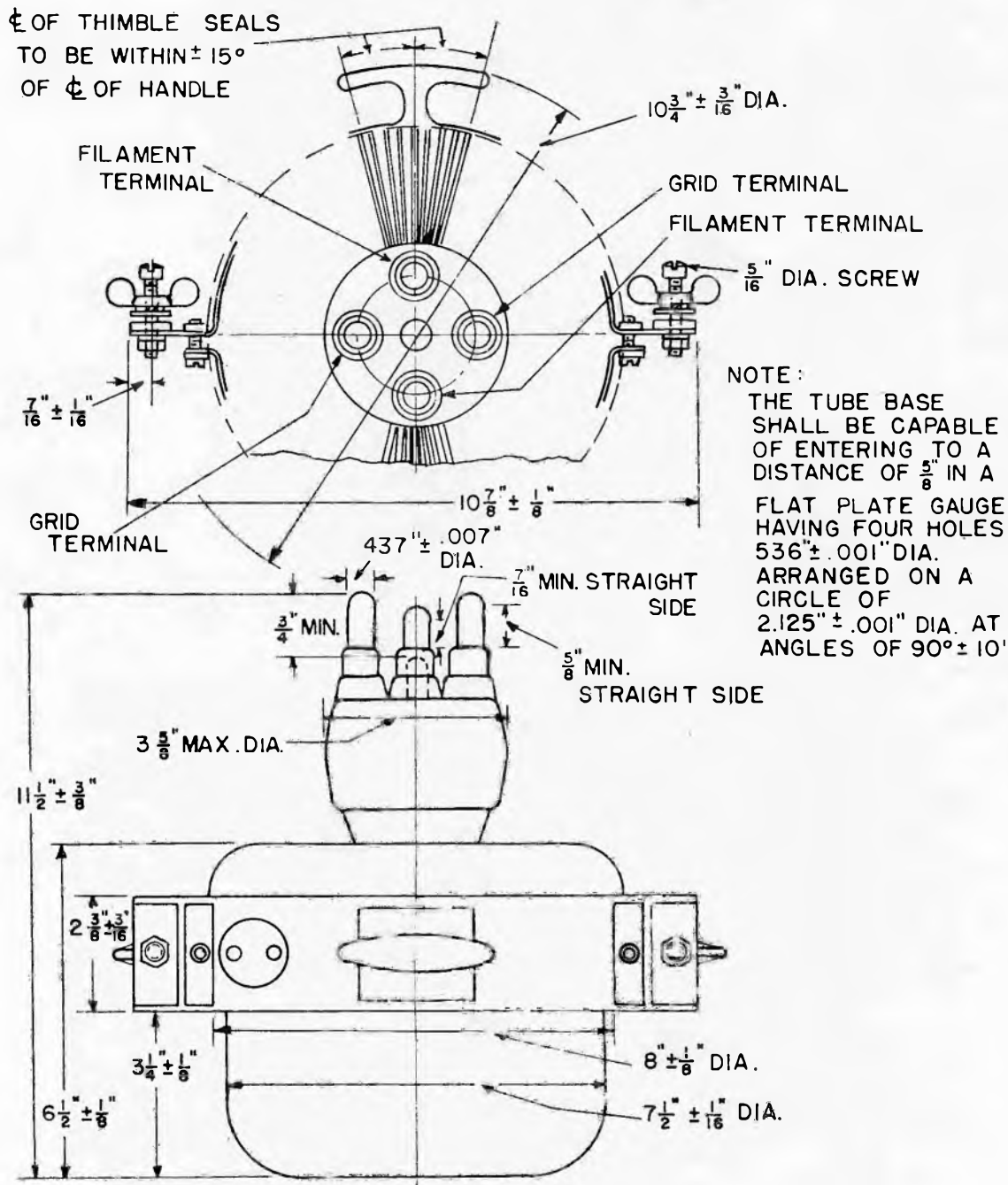
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GL-889R-A
AVERAGE PLATE CHARACTERISTIC



K-8074635
Revised

3-5-48

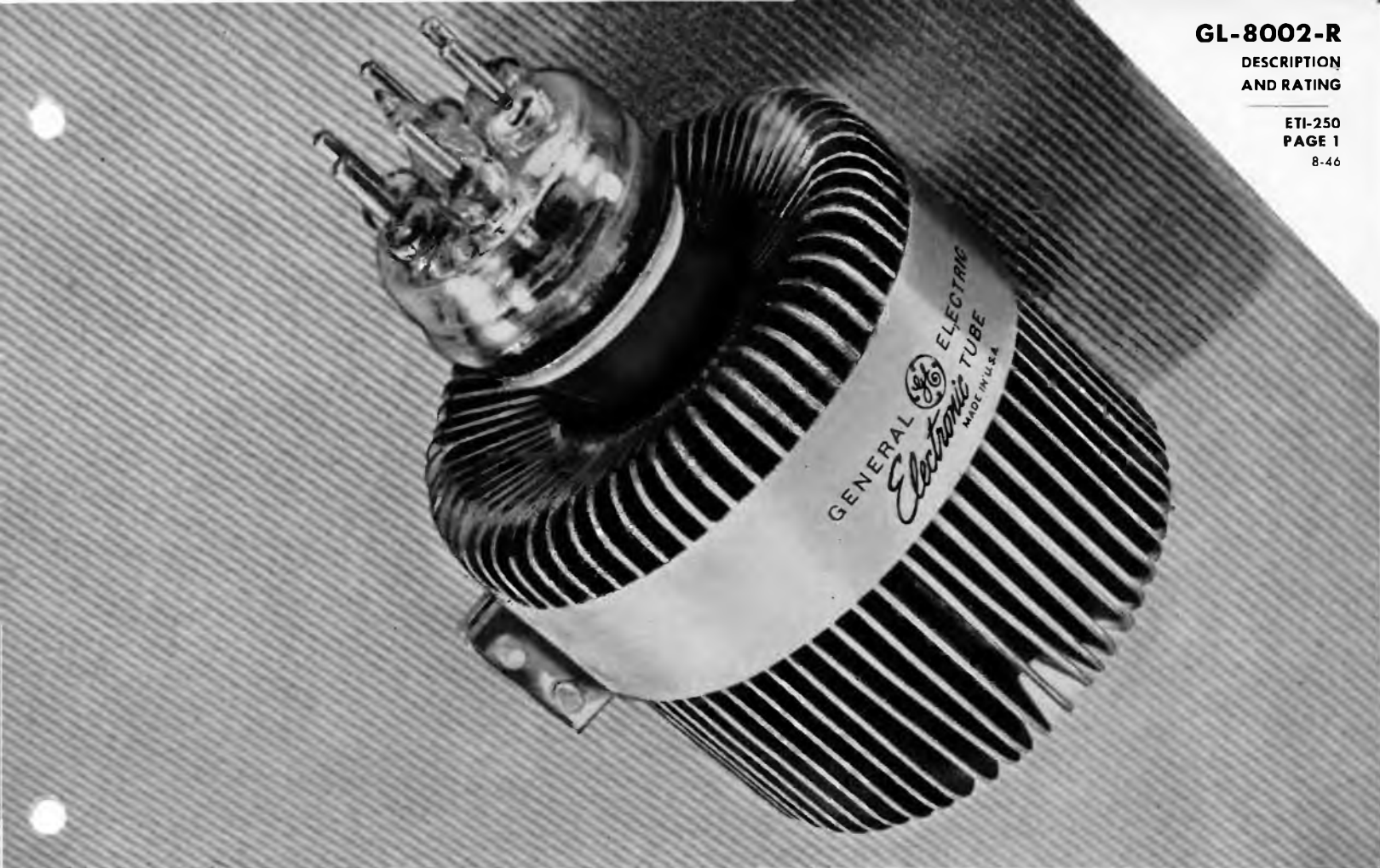


OUTLINE
 GL-889R-A PLIOTRON

K-6966908

3-16-45

Electronics Department
GENERAL ELECTRIC
 Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-8002-R is a three-electrode tube designed for use as a radio-frequency power amplifier at high frequencies. Multiple leads for both the filament and grid connectors minimize the inductance to these electrodes. The anode is

fitted with a special hub and cooling is obtained by forced air. Maximum ratings may be used up to a frequency of 120 megacycles and reduced ratings up to 200 megacycles. The GL-8002-R plate is capable of dissipating 750 to 1200 watts.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of Electrodes 3

Electrical

Cathode—Filamentary, tungsten

Filament voltage..... 16 volts

Filament current..... 38 amperes

Average characteristics, $E_b = 2.4$ kilovolts, $I_b = 0.5$ ampere
 $E_r = 16$ volts

Grid voltage..... 50 volts

Amplification factor..... 21.5

Direct interelectrode capacitances, approximate

Plate to grid..... 8.9 micromicrofarads

Grid to filament..... 10.2 micromicrofarads

Plate to filament..... 1.0 micromicrofarads

Frequency for maximum ratings..... 120 megacycles



GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

Mechanical

Type of cooling	forced air
Maximum incoming air temperature*	45 centigrade
Maximum glass temperature	150 centigrade
Air flow to radiator	100 cu ft per min
Net weight, approximate	pounds
Shipping weight, approximate	pounds
Mounting position	vertical, anode down

* Ordinarily, deflecting vanes diverting the outgoing air toward the terminal seals provide sufficient cooling

MAXIMUM RATINGS

CLASS B RADIO-FREQUENCY POWER AMPLIFIER

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

Plate voltage, d-c	3500 volts
Plate current, d-c	0.6 ampere
Plate input	1800 watts
Plate dissipation	1200 watts

CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR, PLATE MODULATED

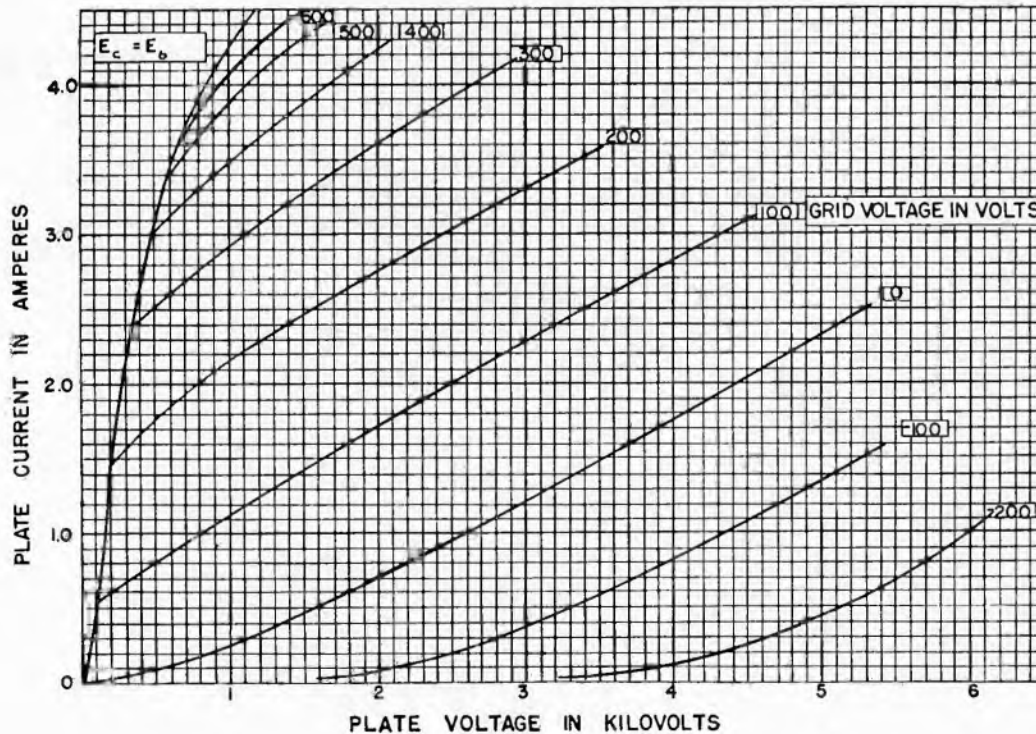
Carrier conditions per tube for use with a maximum modulation factor of 1.0

Plate voltage, d-c	2500 volts
Grid voltage, d-c	-500 volts
Plate current, d-c	0.5 ampere
Grid current, d-c	0.1 ampere
Plate input	1250 watts
Plate dissipation	750 watts

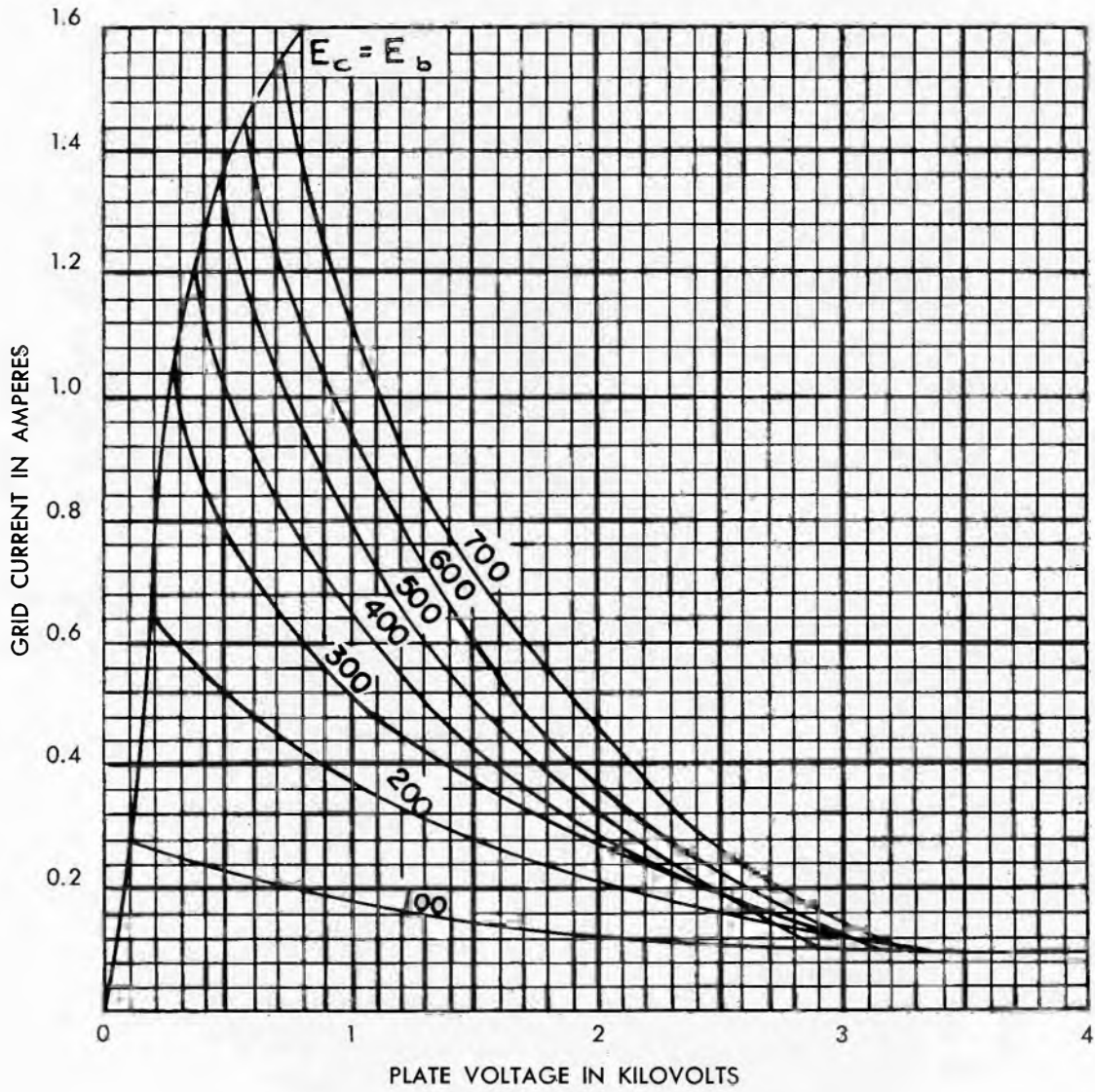
CLASS C RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR, TELEGRAPHY

Key-down conditions per tube without modulation. Essentially negative modulation may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

Plate voltage, d-c	3500 volts
Grid voltage, d-c	-500 volts
Plate current, d-c	1.0 ampere
Grid current, d-c	0.1 ampere
Plate input	3000 watts
Plate dissipation	1200 watts



GL-8002-R AVERAGE PLATE CHARACTERISTICS
($E_f = 16.0$ VOLTS A-C)



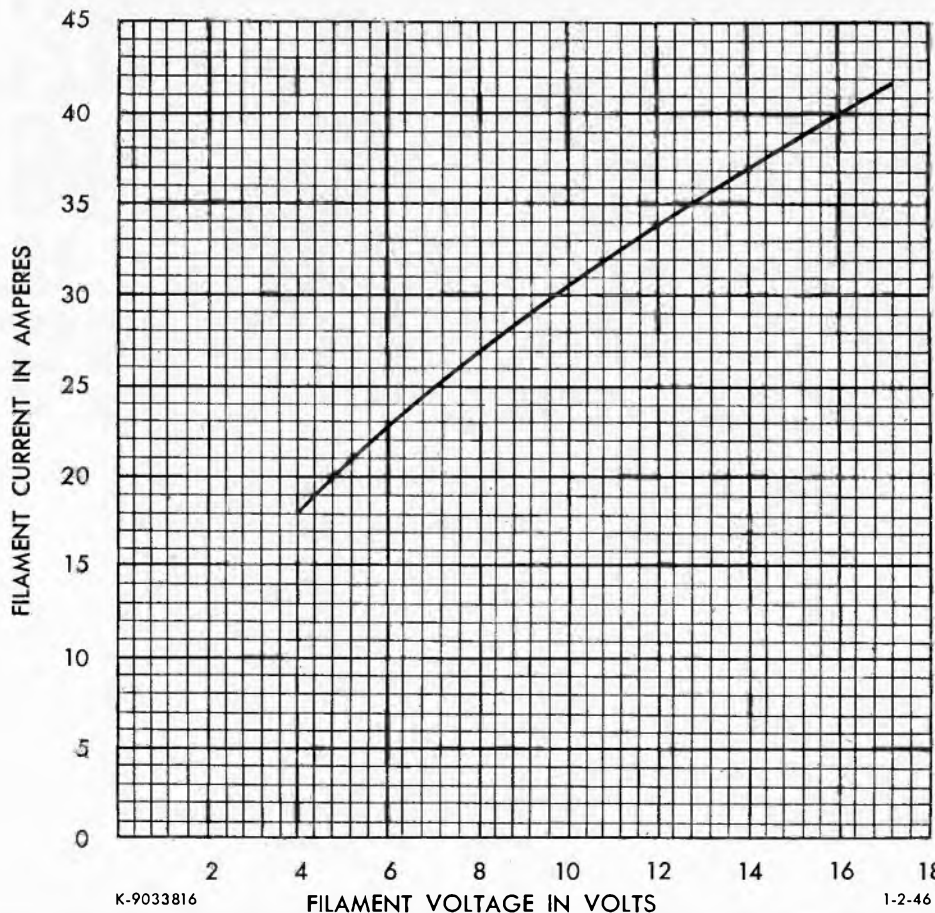
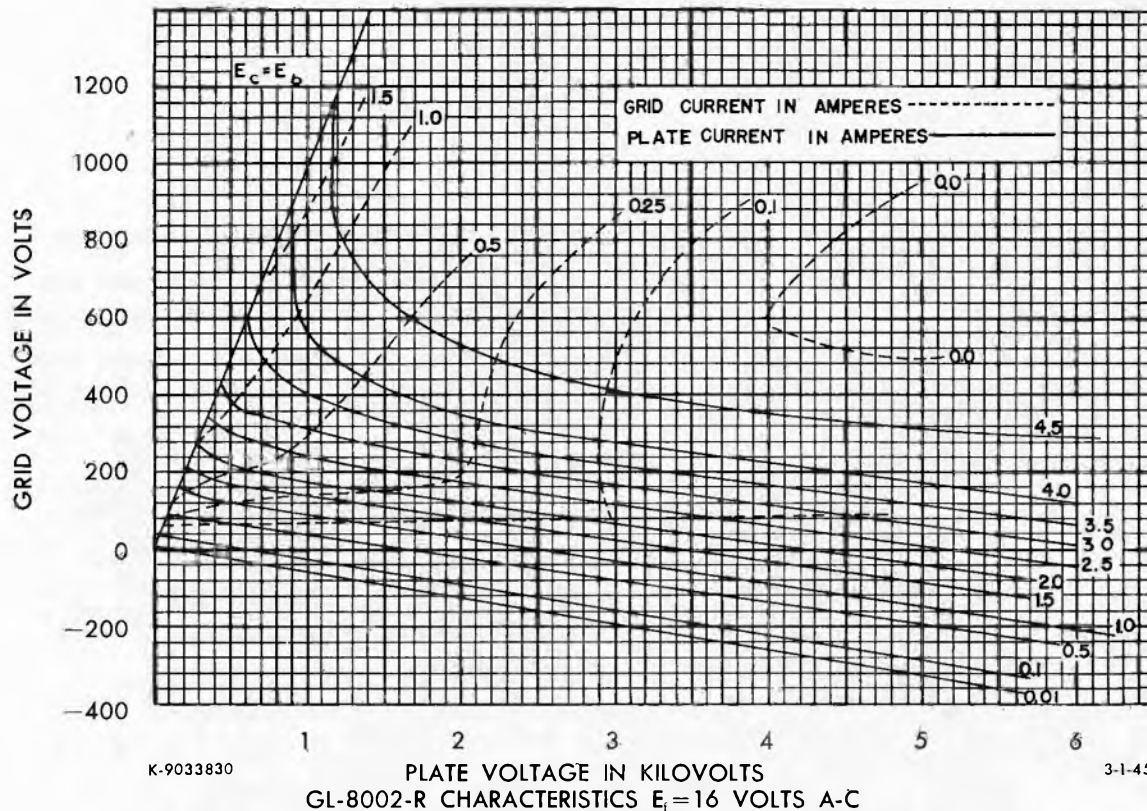
GL-8002-R TYPICAL GRID-PLATE TRANSFER CHARACTERISTICS
($E_f = 16.0$ VOLTS A-C)

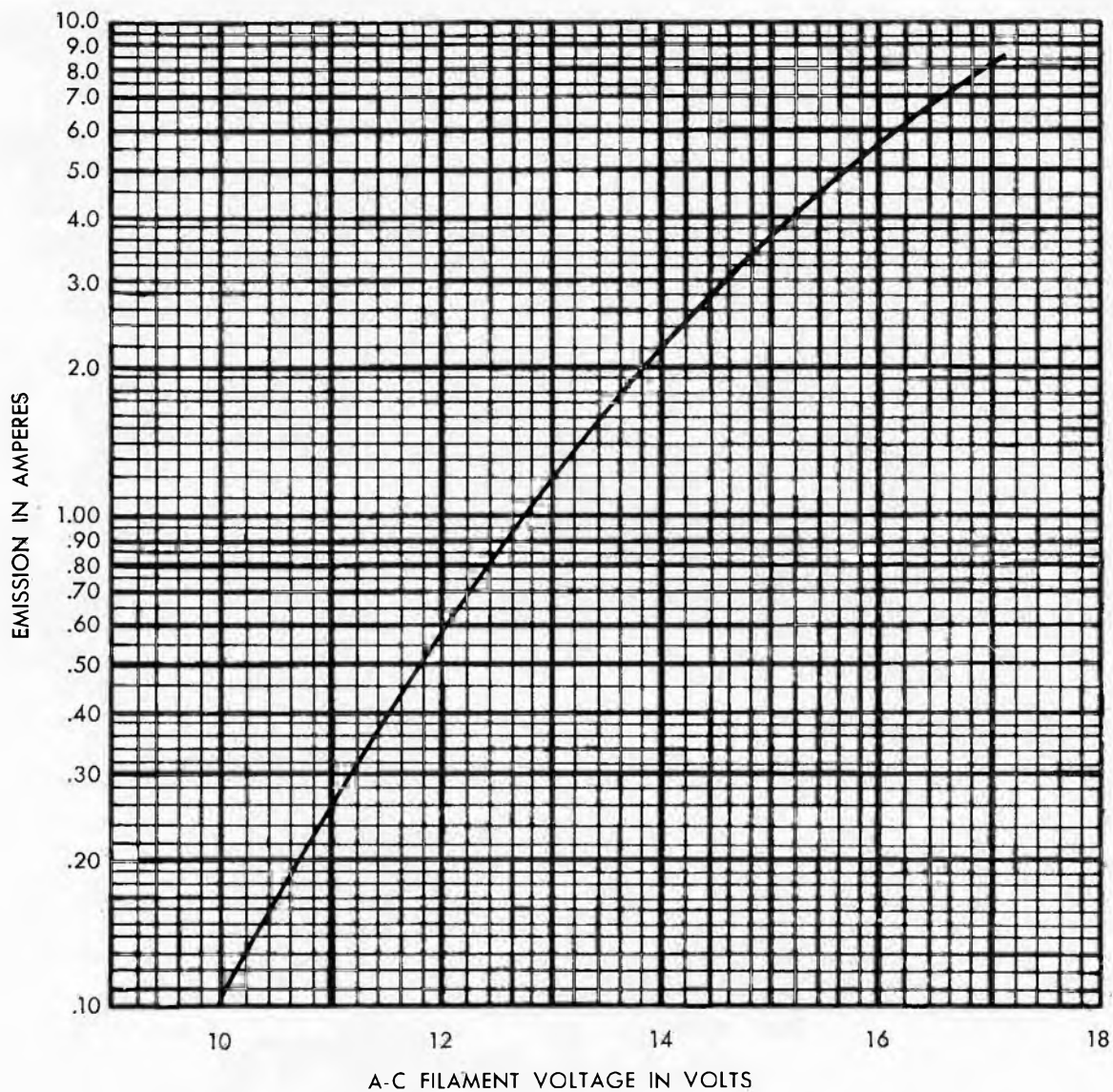
GL-8002-R

ETI-250

PAGE 4

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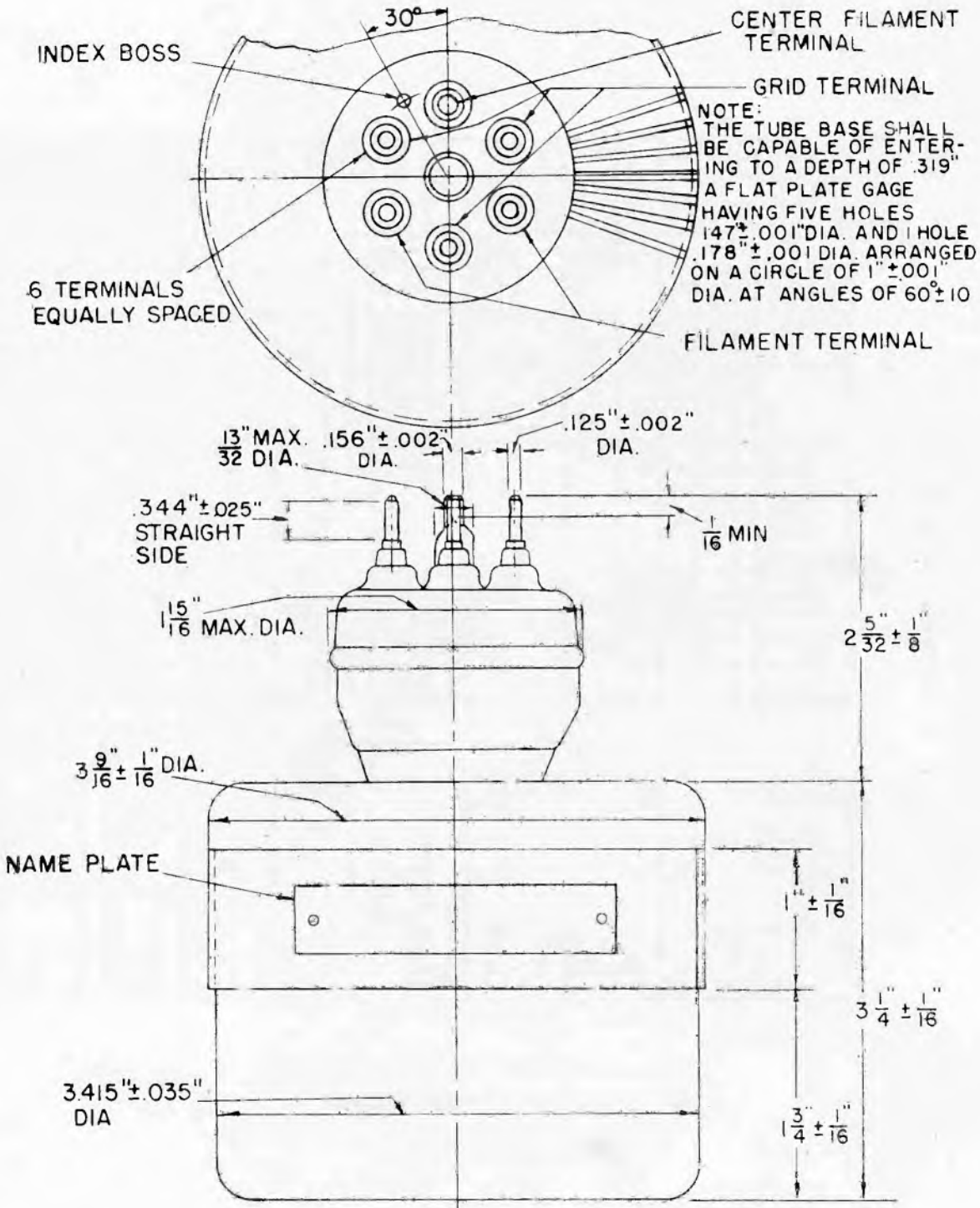
GL-8002-R AVERAGE EMISSION CHARACTERISTIC

K-9033817

2-22-45

GL-8002-R

ETI-250
PAGE 6
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OUTLINE GL-8002-R PIOTRON

K-6912385

10-9-45

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



TRIODE

DESCRIPTION

The GL-895 is a water-cooled transmitting tube for use as a Class B modulator, radio-frequency power amplifier, or oscillator. The plate is capable of dissipating up to 40 kilowatts.

TECHNICAL INFORMATION

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Filament voltage, to neutral*		19	20	volts
Filament current, per phase	128	138	146	amperes
Filament starting current**			210	amperes
Filament cold resistance (per phase to Y center)		0.013		ohm
Amplification factor, $E_c = -100$ volts,				
$I_b = 1$ amp.	30	37	43	
Interelectrode capacitances				
Grid-plate	32	40	48	uuf
Grid-filament	64	80	96	uuf
Plate-filament	5	8	11	uuf

*When the load conditions are lower than maximum, the tube may usually be operated with reduced filament voltage.

**Starting current must never exceed, even momentarily, a value of 210 amperes.



GENERAL  ELECTRIC

Supersedes ETI-251B dated 4-48

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position	vertical, glass-end up
Type of cooling	water and forced air***
Water flow on anode	20-25 GPM
Maximum outgoing water temperature	70 C
Air flow to filament and grid thimbles	5 CFM
Maximum glass temperature	150 C
Net weight, approximate	25 pounds

***Water flow of 20 to 25 gallons per minute must start before application of any voltage and continue for at least 5 minutes after removal of voltage. Water temperature must not exceed 70 C under any conditions of operation. Air flow of 5 cubic feet per minute directed on filament and grid thimbles is required before application of any voltage, and for 5 minutes after all voltage is switched off, to limit temperature of grid and filament seals to a maximum of 150 C.

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values

D-c plate voltage	17,000 max	volts
Maximum signal d-c plate current†	9 max	amperes
Maximum signal plate input†	100,000 max	watts
Plate dissipation†	40,000 max	watts

Typical operation

Unless otherwise specified, values are for two tubes

D-c plate voltage	12,500	10,000	10,000	volts
Zero signal d-c plate current	1.50	2.00	2.00	amperes
Maximum signal d-c plate current	10.80	10.80	5.10	amperes
D-c grid voltage	-250	-200	-200	volts
Peak a-f grid-to-grid voltage	1300	1200	800	volts
Effective load resistance, plate to plate	2700	2100	3600	ohms
Maximum signal driving power, approximate	700	600	75	watts
Maximum signal power output, approximate	90,000	70,000	30,000	watts

† Averaged over any audio-frequency cycle of sine-wave form.

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

CARRIER CONDITIONS PER TUBE FOR USE WITH A MAXIMUM MODULATION FACTOR OF 1.0

Maximum ratings, absolute values

D-c plate voltage	12,500 max	volts
D-c plate current	5 max	amperes
Plate input	62,500 max	watts
Plate dissipation	27,000 max	watts
D-c grid voltage	-3000 max	volts
D-c grid current	1.5 max	amperes

Typical operation

D-c plate voltage	12,500	12,500	10,000	volts
D-c plate current	2.5	4.40	3.35	amperes
D-c grid voltage	-1400	-1500	-1500	volts
Peak r-f grid voltage	1810	2080	2000	volts
Driving power, approximate	780	1700	1300	watts
Power output, approximate	25,000	45,000	25,000	watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

KEY-DOWN CONDITIONS PER TUBE WITHOUT MODULATION****

Maximum ratings, absolute values

D-c plate voltage	17,000 max	volts
D-c plate current	9 max	amperes
Plate input	140,000 max	watts
Plate dissipation	40,000 max	watts
D-c grid voltage	-3000 max	volts
D-c grid current	1.5 max	amperes

****Modulation, essentially negative, may be used if the positive peak of the audio envelope does not exceed 115 per cent of carrier conditions.

TECHNICAL INFORMATION (CONT'D)

Typical operation

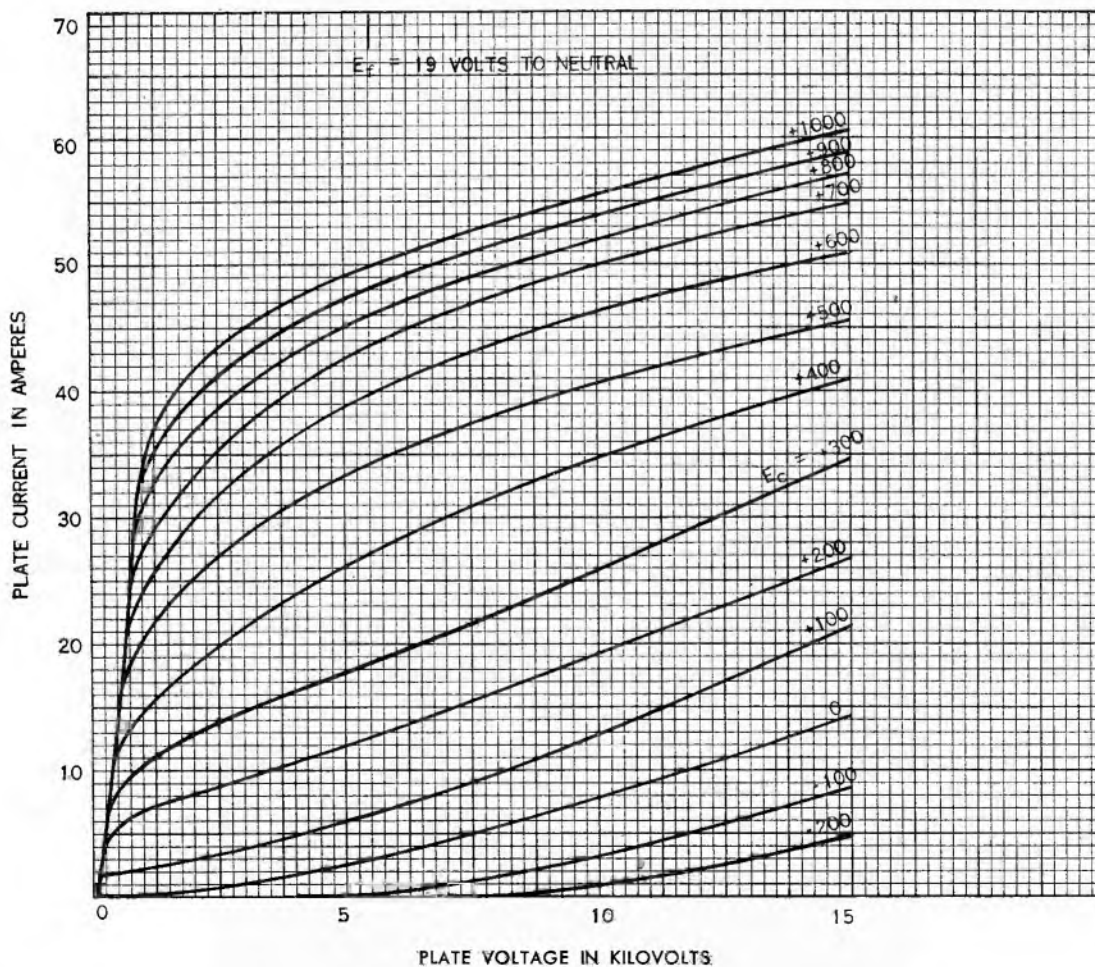
D-c plate voltage	17,000	15,000	12,000	10,000	volts
D-c plate current	7.50	8.60	7.20	7.15	amperes
D-c grid voltage	-1000	-700	-1000	-1000	volts
Peak r-f grid voltage	1700	1400	1700	1700	volts
D-c grid current, approximate	1.00	1.15	1.15	1.15	amperes
Driving power, approximate	1700	1500	1900	1900	watts
Power output, approximate	100,000	95,000	60,000	50,000	watts

APPLICATION NOTES

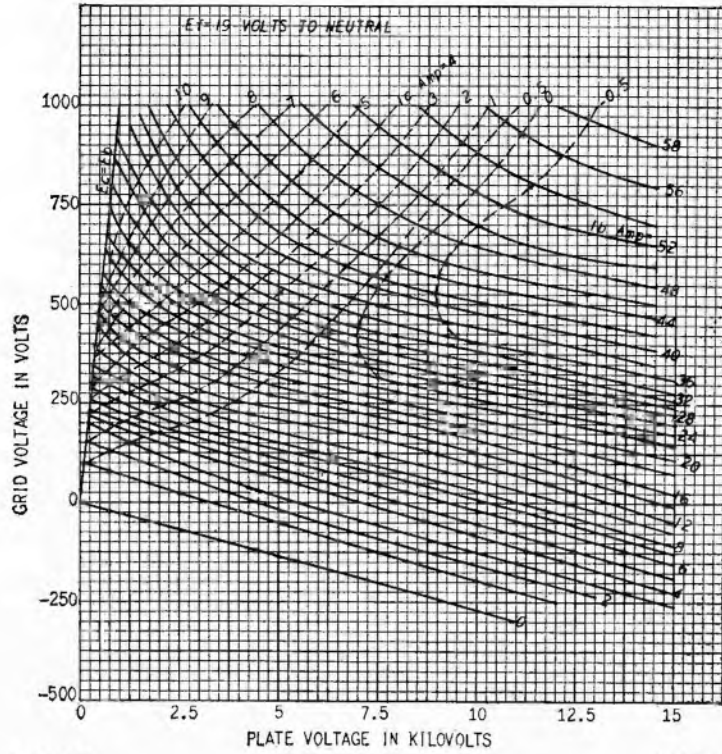
Maximum ratings apply up to 6 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	6	12	25	megacycles
Percentage of maximum rated plate voltage and plate input				
Class C plate modulated	100	90	81	per cent
Class C unmodulated	100	85	70	per cent

GL-895 AVERAGE PLATE CHARACTERISTICS



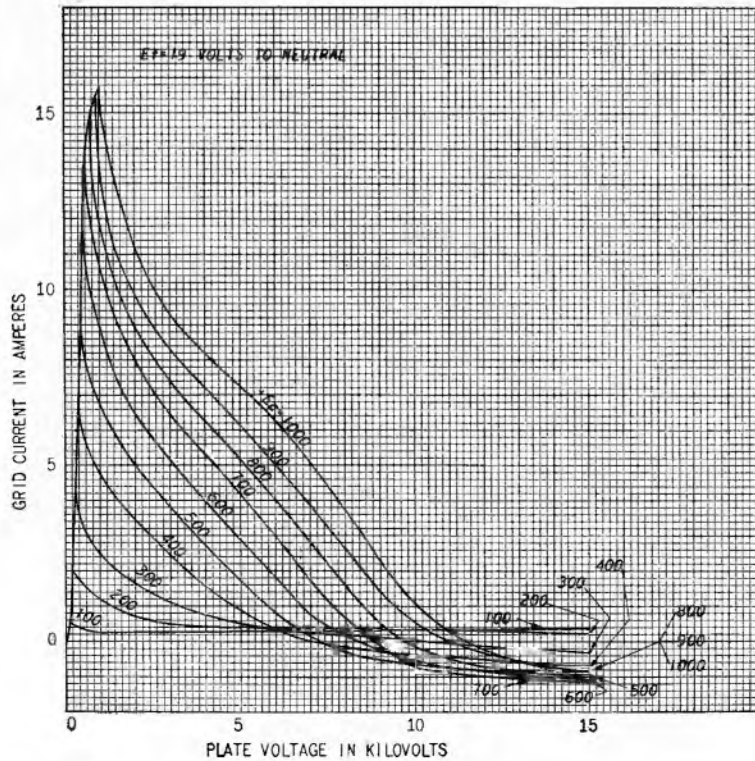
GL-895 CHARACTERISTICS



K-9186074

12-10-45

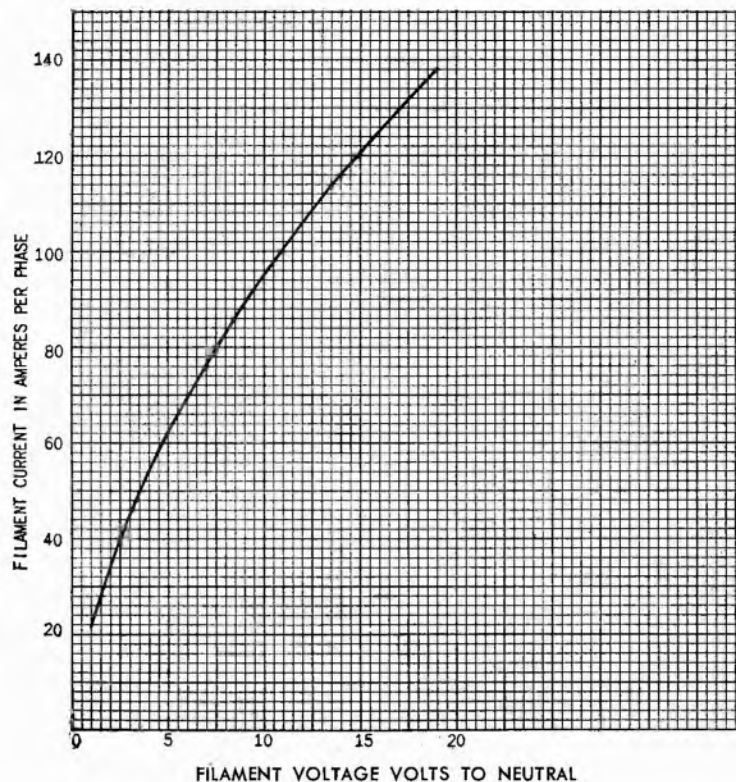
GL-895
TYPICAL GRID-PLATE TRANSFER CHARACTERISTICS



K-9186088

12-10-45

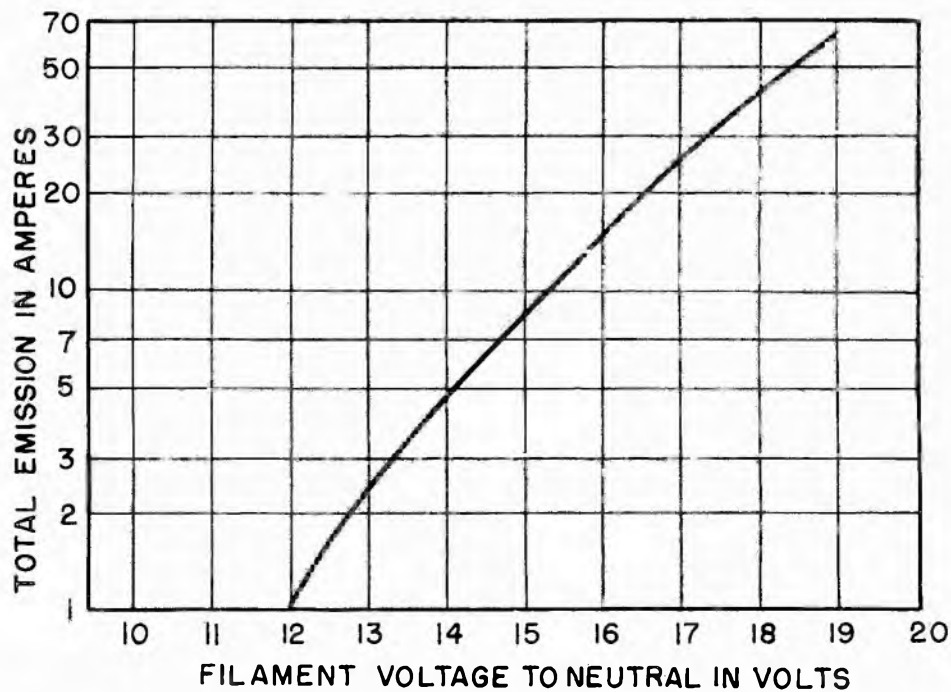
GL-895 FILAMENT CHARACTERISTICS



K-9186073

12-10-45

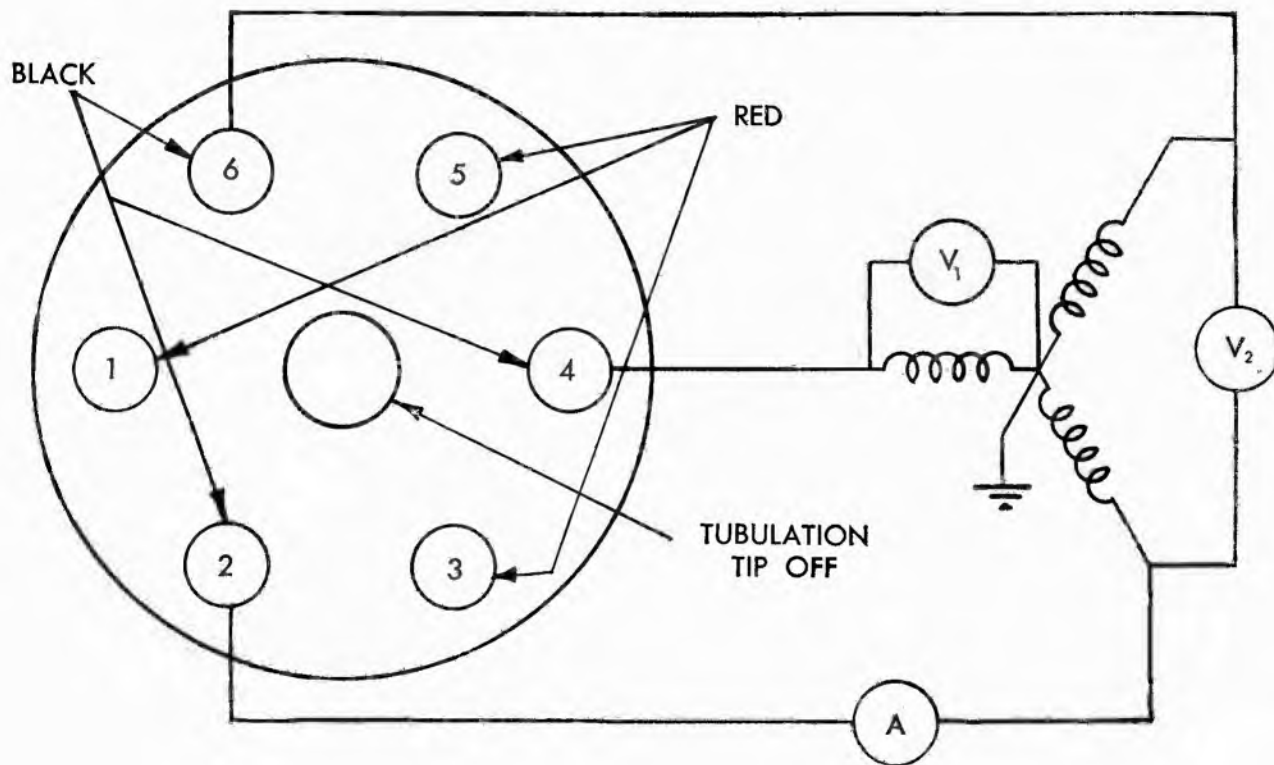
GL-895 AVERAGE FILAMENT EMISSION



K-9186072

1-9-46

GL-895 FILAMENT CONNECTIONS



$V_1 = 19$ VOLTS

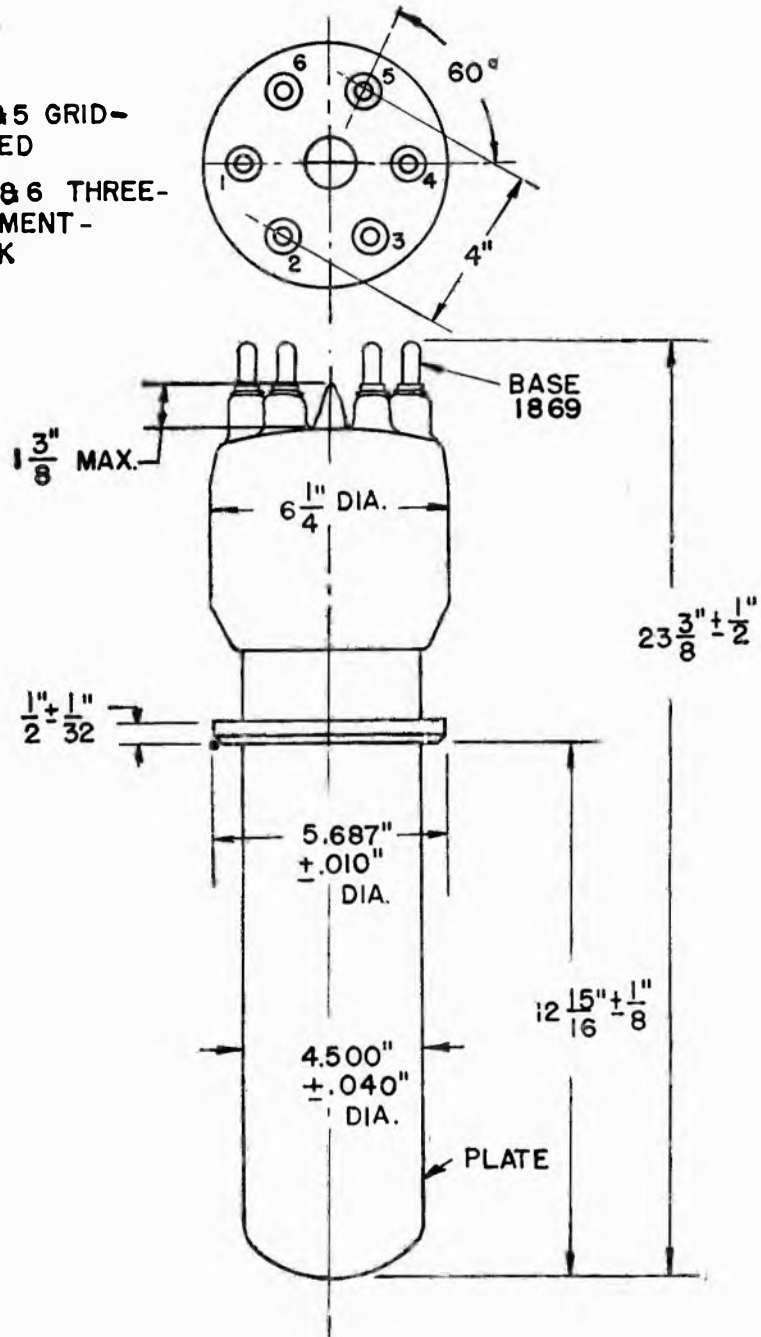
$V_2 = 33$ VOLTS

$A = 139$ AMPERES

BLACK 2, 4, 6—FILAMENT TERMINALS

RED 1, 3, 5—GRID TERMINALS

TERMINALS 1,3 & 5 GRID-MARKED RED
TERMINALS 2,4 & 6 THREE-PHASE Y FILAMENT-MARKED BLACK



OUTLINE
GL-895 PIOTRON

Tube Department, Electronics Division

GENERAL  **ELECTRIC**

Schenectady, N. Y.



TRIODE

DESCRIPTION

The GL-895-R is a forced-air cooled transmitting tube for use as a Class B modulator, radio-frequency power amplifier, or oscillator. The plate is capable of dissipating up to 20 kilowatts.

TECHNICAL INFORMATION

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Filament voltage, to neutral*	...	19	20	volts
Filament current, per phase	128	138	146	amperes
Filament starting current	...	...	210	amperes
Filament cold resistance (per phase to Y center)	...	0.013	...	ohm
Amplification factor, $E_c = -100$ volts,				
$I_b = 1$ amp	30	37	43	
Interelectrode capacitances				
Grid-plate	32	40	48	uuf
Grid-filament	64	80	96	uuf
Plate-filament	5	8	11	uuf



GENERAL  ELECTRIC

Supersedes ETI-252B dated 9-48

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position				vertical, radiator down
Type of cooling				forced air
Maximum incoming air temperature			45	C
Required air flow on anode†				
Plate dissipation—kilowatts	20	16	12	
Air flow—cubic feet per minute	1800	1550	1300	
Pressure—inches water	1.5	1.1	0.8	
Required air flow on filament and grid thimbles			5	CFM
Maximum temperature of filament seals			150	C
Net weight, approximate			225	pounds

*When the load conditions are lower than maximum, the tube may usually be operated with reduced filament voltage.
 †Temperature of anode seal must not exceed 180 C.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values

D-c plate voltage		17,000	max	volts
Maximum signal d-c plate current †		9	max	amperes
Maximum signal plate input †		50,000	max	watts
Plate dissipation †		20,000	max	watts
Temperature of air cooler**		180	max	C

Typical operation

Unless otherwise specified, values are for 2 tubes

D-c plate voltage	10,000	10,000	volts
Zero signal d-c plate current	2.00	2.00	amperes
Maximum signal d-c plate current	10.80	5.10	amperes
D-c grid voltage	-200	-200	volts
Peak a-f grid-to-grid voltage	1200	800	volts
Effective load resistance, plate to plate	2100	3600	ohms
Maximum signal driving power, approximate	600	75	watts
Maximum signal power output, approximate	70,000	30,000	watts

†Averaged over any audio-frequency cycle of sine-wave form.

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

CARRIER CONDITIONS PER TUBE FOR USE WITH A MAXIMUM MODULATION FACTOR OF 1.0

Maximum ratings, absolute values

D-c plate voltage		12,500	max	volts
D-c plate current		5	max	amperes
Plate input		62,500	max	watts
Plate dissipation		13,500	max	watts
D-c grid voltage		-3000	max	volts
D-c grid current		1.5	max	amperes
Temperature of air cooler**		180	max	C

Typical operation

D-c plate voltage	12,500	12,500	10,000	volts
D-c plate current	2.50	4.40	3.35	amperes
D-c grid voltage	-1400	-1500	-1500	volts
Peak r-f grid voltage	1810	2080	2000	volts
Driving power, approximate	780	1700	1300	watts
Power output, approximate	25,000	45,000	25,000	watts

TECHNICAL INFORMATION (CONT'D)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

KEY-DOWN CONDITIONS PER TUBE WITHOUT MODULATION***

Maximum ratings, absolute values

D-c plate voltage	17,000 max	volts
D-c plate current	9 max	amperes
Plate input	110,000 max	watts
Plate dissipation	20,000 max	watts
D-c grid voltage	-3000 max	volts
Grid current	1.5 max	amperes
Temperature of air cooler**	180 max	C

Typical operation

D-c plate voltage	17,000	15,000	12,000	10,000	volts
D-c plate current	6.0	6.4	7.20	7.15	amperes
D-c grid voltage	-1800	-1500	-1000	-1000	volts
D-c grid current, approximate	0.9	1.0	1.15	1.15	amperes
Driving power, approximate	2200	2100	1900	1900	watts
Power output, approximate	84,000	75,000	60,000	50,000	watts
Peak r-f grid voltage	2500	2200	1700	1700	volts

**Temperature is measured in thermometer well. The normal forced air of 1800 cubic feet per minute requires a static pressure of 1.5 inches of water and must be started before application of any voltage and continue for at least 5 minutes after removal of voltages. Temperature or anode seal must not exceed 180 C. An air flow of at least 5 cubic feet per minute through a nozzle directed at filament bases is required before and during application of any voltages to limit temperature of filament seals to 150 C.

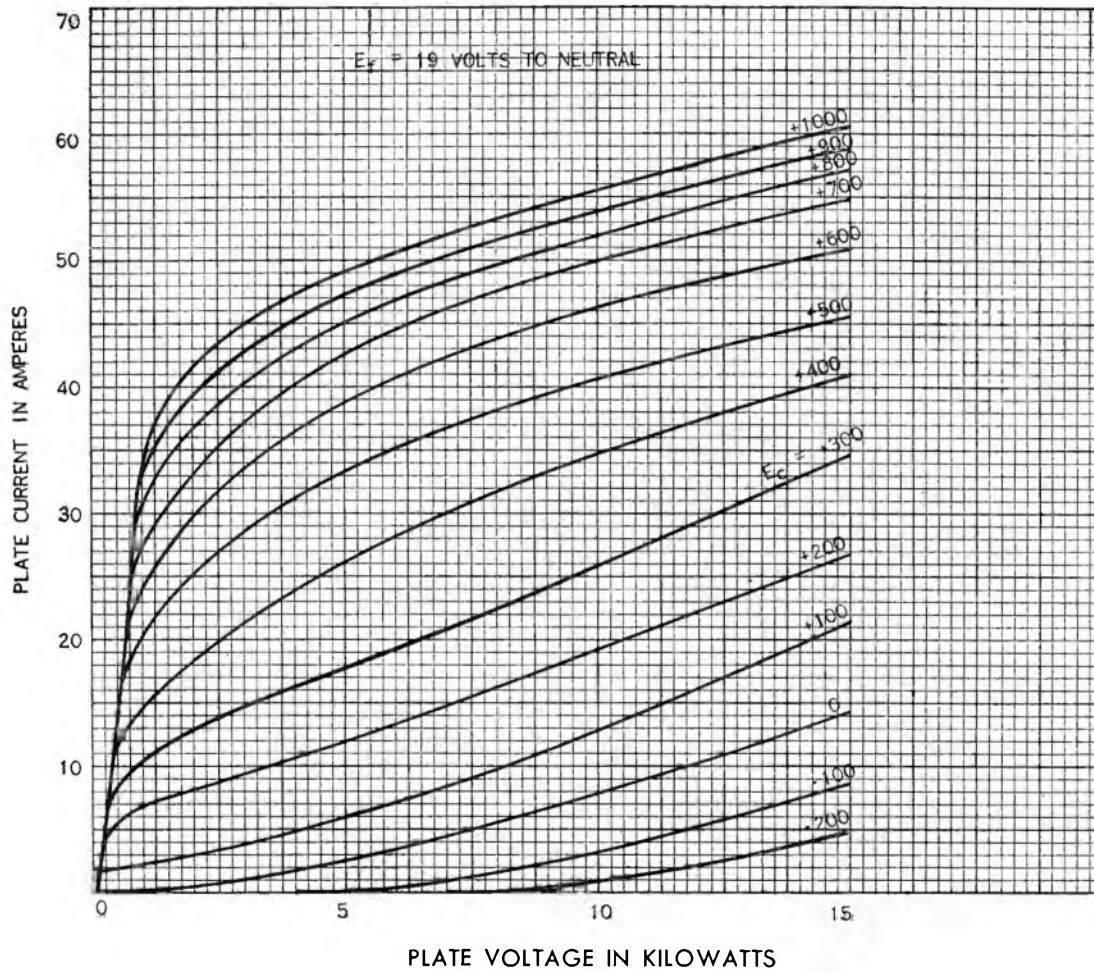
***Modulation, essentially negative, may be used if the positive peak of the audio frequency envelope does not exceed 115 per cent of the carrier conditions.

APPLICATION NOTES

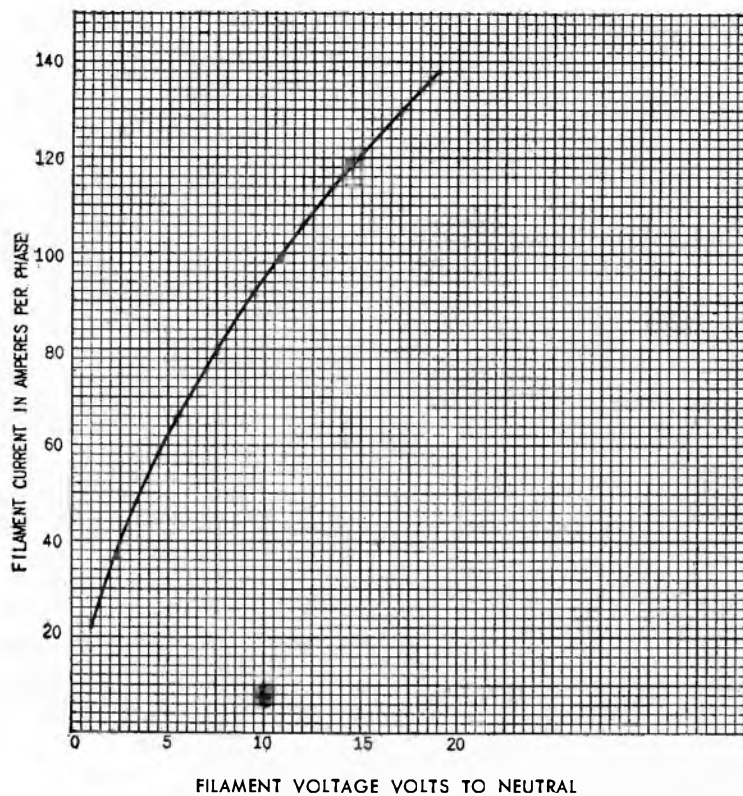
Maximum ratings apply up to 6 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	6	12	25 megacycles
Percentage of maximum rated plate voltage and plate input			
Class C plate modulated	100	90	81 per cent
Class C unmodulated	100	85	70 per cent

GL-895-R AVERAGE PLATE CHARACTERISTICS



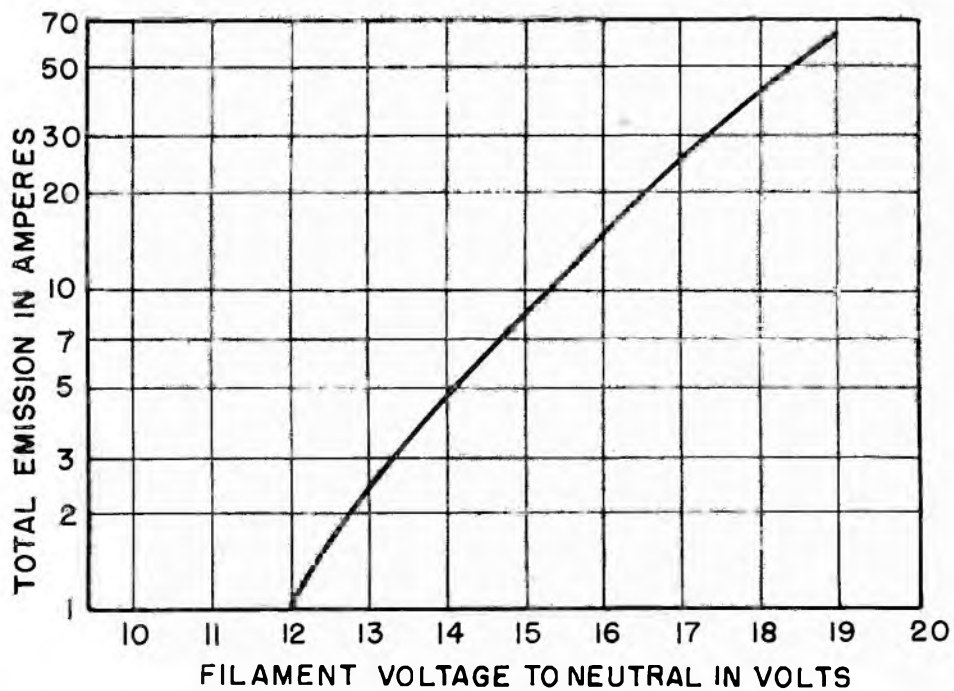
GL-895-R FILAMENT CHARACTERISTICS



K-9186073

12-10-45

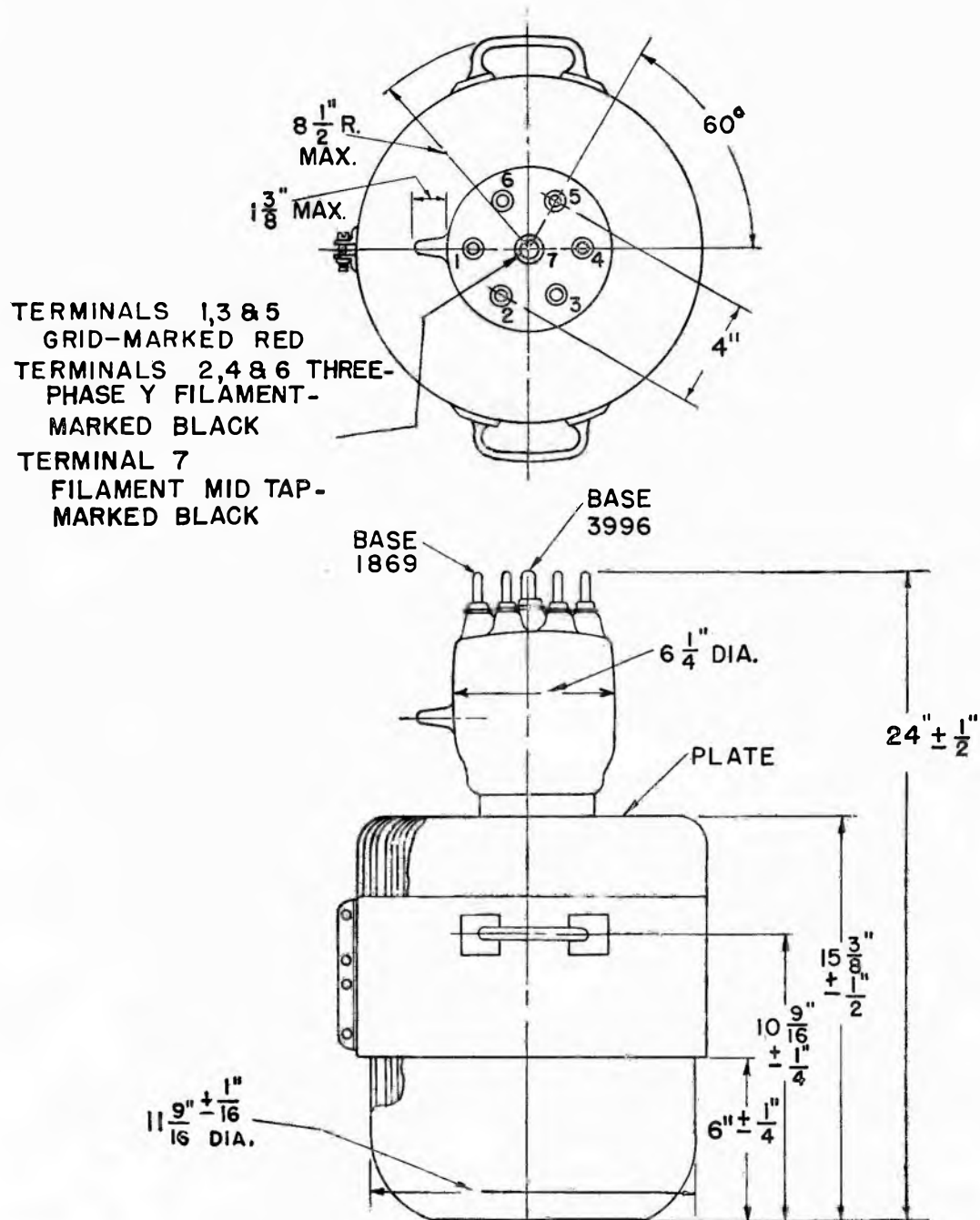
GL-895-R AVERAGE FILAMENT EMISSION



K-9186072

1-9-46

OUTLINE
GL-895-R PILOTRON



Tube Department, Electronics Division

GENERAL  **ELECTRIC**

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-473 is a three-electrode tube designed for use as a Class B power amplifier and modulator or Class C power amplifier or oscillator. The anode

is forced-air cooled and is capable of dissipating 2.5 kilowatts. The cathode is a thoriated-tungsten filament. Maximum ratings apply up to 60 megacycles.

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 3

Electrical

Cathode—Filamentary

Voltage 6 volts

Current 60 amperes

Average characteristics

Amplification factor 22

Direct interelectrode capacitances

Grid-plate 15 micromicrofarads

Grid-filament 17 micromicrofarads

Plate-filament 0.6 micromicrofarad



TECHNICAL INFORMATION (CONT'D)

Mechanical

Mounting position	vertical
Type of cooling	forced air*
Maximum incoming air temperature	45 centigrade
Net weight, approximate	3 $\frac{1}{4}$ pounds

* The required forced air flow (see curve) must be started with the application of filament voltage and may be shut off at the same time as removal of all voltage.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum Ratings, Absolute Values

D-c plate voltage	3000 max volts
Maximum signal d-c plate current†	1.4 max ampere
Maximum signal plate input†	4200 max watts
Plate dissipation†	2500 max watts

Typical Operation

Unless otherwise specified, values are for two tubes

D-c plate voltage	3000	volts
D-c grid voltage†	-160	volts
Peak a-f grid-to-grid voltage	820	volts
Zero signal d-c plate current	0.66	ampere
Maximum signal d-c plate current	2.80	amperes
Load resistance, per tube	765	ohms
Effective load resistance, plate to plate	3060	ohms
Maximum signal driving power, approximate	140	watts
Maximum signal power output, approximate	4350	watts

† Averaged over any audio-frequency cycle of sine-wave form.

† Grid voltages are given with respect to midpoint of filament operated on a-c. If d-c is used each stated value of grid voltage should be decreased by 4.25 volts and the circuit returns connected to the negative end of the filament.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

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

Maximum Ratings, Absolute Values

D-c plate voltage	3000 max volts
D-c plate current	-1.4 max ampere
Plate input	3300 max watts
Plate dissipation	2500 max watts

Typical Operation

D-c plate voltage	3000	volts
D-c grid voltage	-160	volts
Peak r-f grid voltage	280	volts
D-c plate current	1.1	ampere
D-c grid current, approximate	50	milliamperes
Driving power, approximate	15	watts
Power output, approximate	800	watts

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

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

Maximum Ratings, Absolute Values

D-c plate voltage	3500 max volts
D-c grid voltage	-1000 max volts
D-c plate current	1.4 max ampere
D-c grid current	500 max milliamperes
Plate input	4000 max watts
Plate dissipation	2500 max watts

TECHNICAL INFORMATION (CONT'D)

Typical Operation

D-c plate voltage.....	3500	volts
D-c grid voltage.....	—600	volts
Grid resistor.....	2150	ohms
Peak r-f grid voltage.....	950	volts
D-c plate current.....	1.14	ampere
D-c grid current, approximate.....	280	milliamperes
Driving power, approximate.....	270	watts
Power output, approximate.....	3200	watts

RADIO-FREQUENCY POWER AMPLIFIER—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation¶

Maximum Ratings, Absolute Values

D-c plate voltage.....	5000 max	volts
D-c grid voltage.....	—1000 max	volts
D-c plate current.....	1.4 max	ampere
D-c grid current.....	500 max	milliamperes
Plate input.....	5000 max	watts
Plate dissipation.....	2500 max	watts

Typical Operation.....	@60	@110	@110	megacycles
D-c plate voltage.....	5000	3500	3500	volts
D-c grid voltage.....	—850	—600	—300	volts
Grid resistor.....	4000	2400	1950	ohms
Peak r-f grid voltage.....	1200	940	555	volts
D-c plate current.....	1.0	1.0	1.0	ampere
D-c grid current, approximate.....	210	250	155	milliamperes
Driving power, approximate.....	250	235	85	watts
Power output, approximate.....	4100	2800	2550	watts

¶ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 per cent of the carrier conditions.

RADIO-FREQUENCY POWER OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without modulation

Maximum Ratings, Absolute Values

D-c plate voltage.....	5000	volts
D-c grid voltage.....	—1000	volts
D-c plate current.....	1.4	ampere
D-c grid current.....	500	milliamperes
Plate input.....	5000	watts
Plate dissipation.....	2500	watts

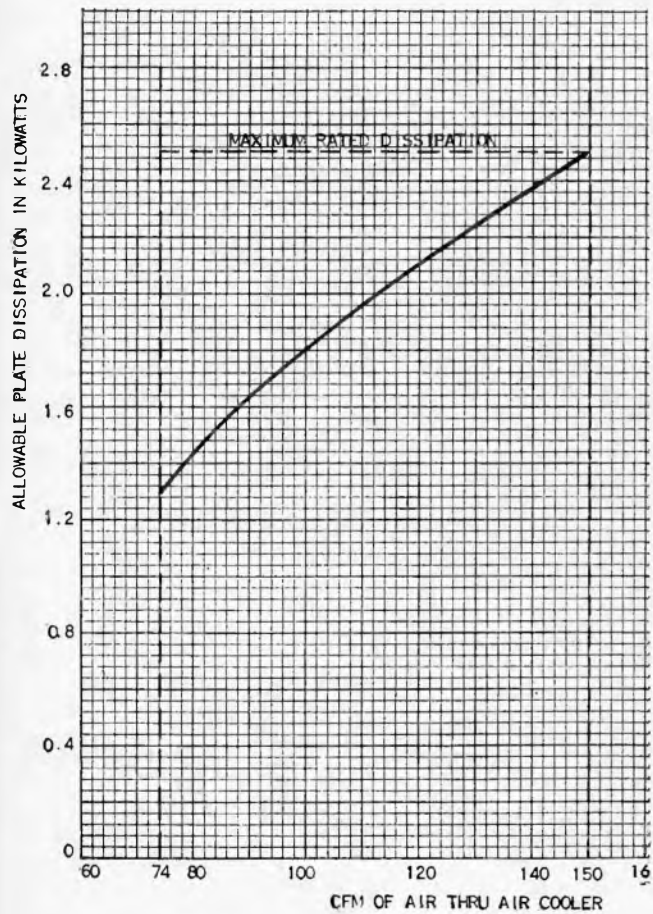
Typical Operation

D-c plate voltage.....	5000	volts
D-c grid voltage.....	—850	volts
Grid resistor.....	4000	ohms
Peak r-f grid voltage.....	1200	volts
D-c plate current.....	1.0	ampere
D-c grid current, approximate.....	210	milliamperes
Power output, approximate.....	3900	watts

Maximum ratings apply up to 60 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency.....	60	110	megacycles
Percentage of maximum rated plate voltage and plate input			
Class B.....	100	—	per cent
Class C plate modulated.....	100	—	per cent
Class C power amplifier unmodulated.....	100	70	per cent
Class C oscillator unmodulated.....	100	—	per cent

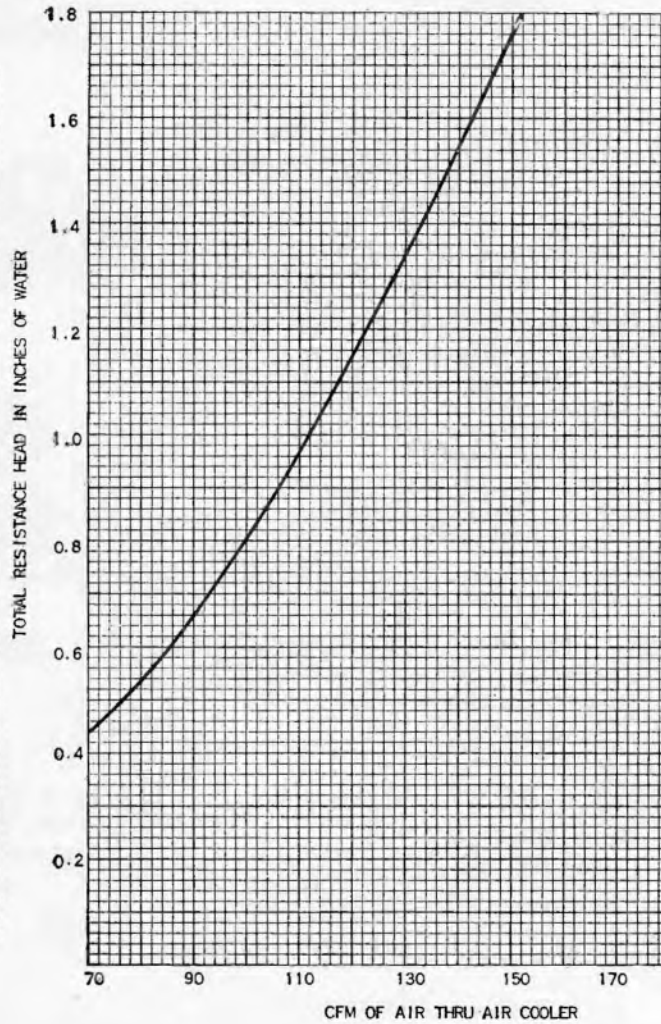
GL-473
QUANTITY OF AIR REQUIRED
VS
ALLOWABLE PLATE DISSIPATION



K-69087-72A163

8-4-47

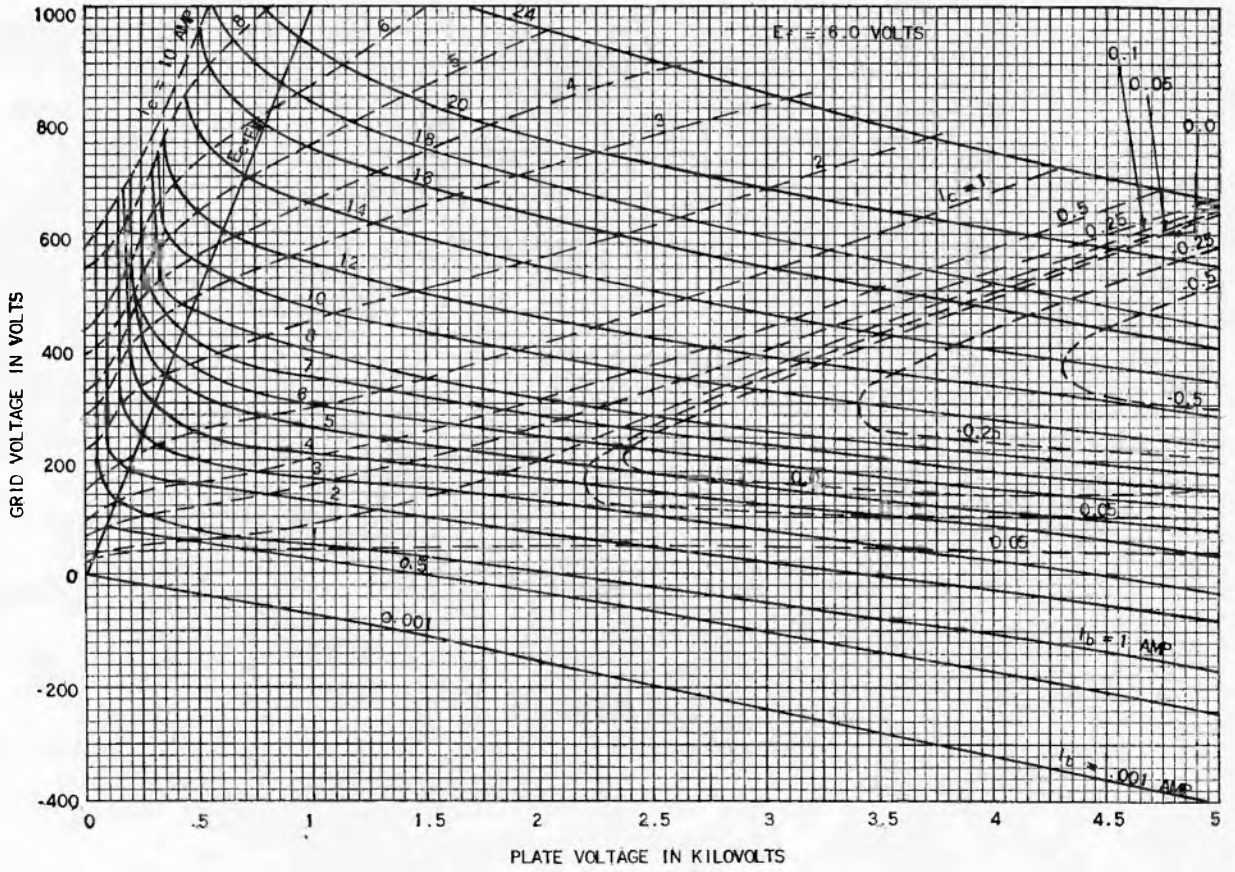
GL-473
TOTAL RESISTANCE PRESSURE OF AIR COOLER
FOR VARIOUS QUANTITIES OF AIR



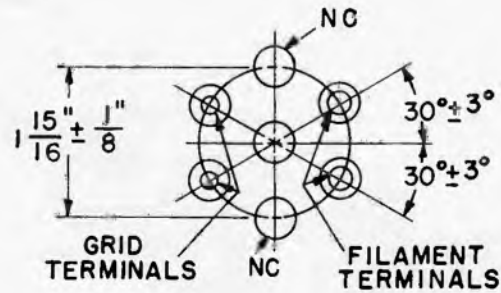
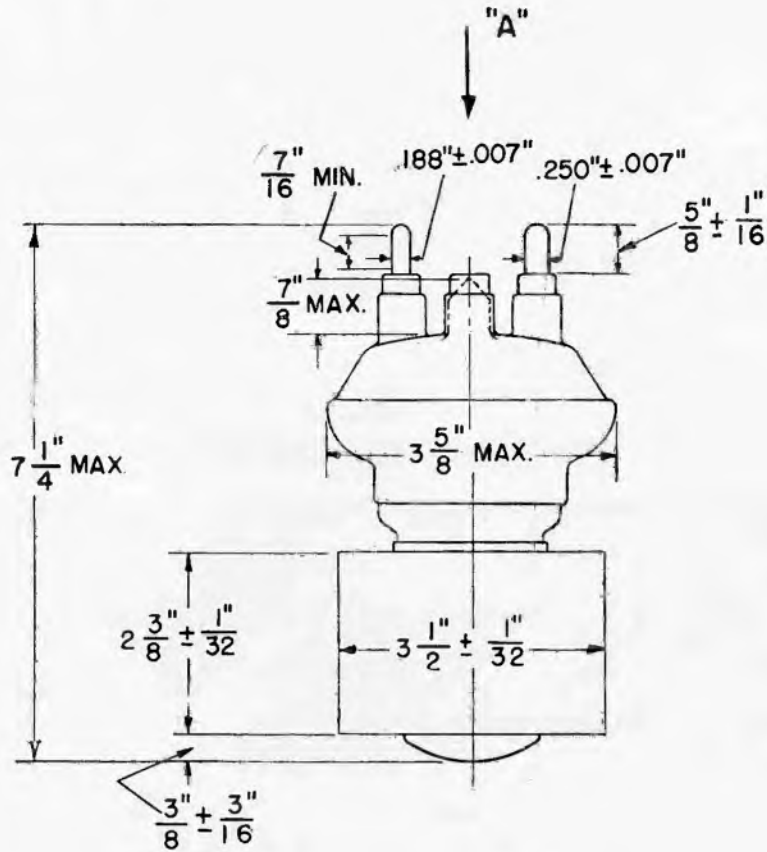
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GL-473
CONSTANT CURRENT CHARACTERISTICS



OUTLINE
GL-473



VIEW AT "A"

N15102A2

8-3-47

Electronics Department
GENERAL ELECTRIC
 Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-5610 is a 7-pin miniature triode amplifier for industrial application where small size is a factor.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 4

Electrical

Cathode—coated unipotential

Heater voltage 6.3 volts

Heater current 0.15 ampere

Mechanical

Mounting position—any

Envelope—T-5½ glass

Base—Miniature glass button 7-pin

Maximum diameter ¼ inch

Maximum over-all length 2 ⅛ inches

Maximum seated height 1 ⅞ inches



TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

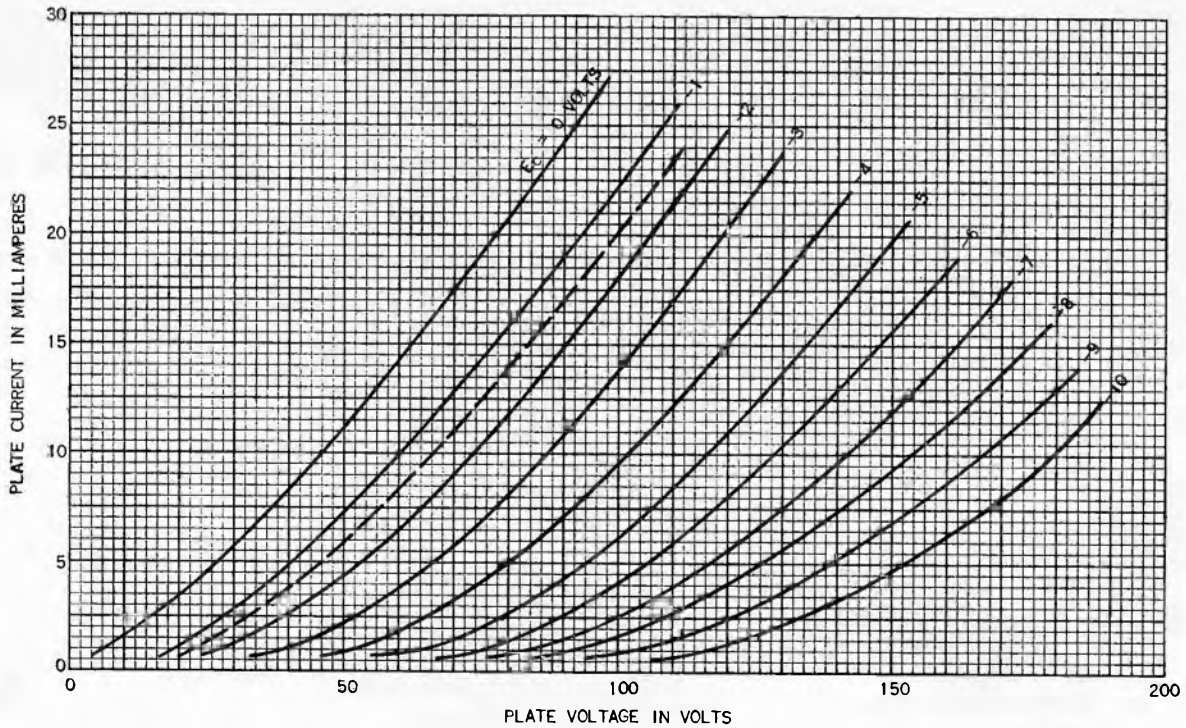
Maximum ratings, design center

Plate voltage	300 volts
A-c heater-cathode voltage	117 volts
Plate dissipation	3.0 watts

Typical operation

Class A amplifier

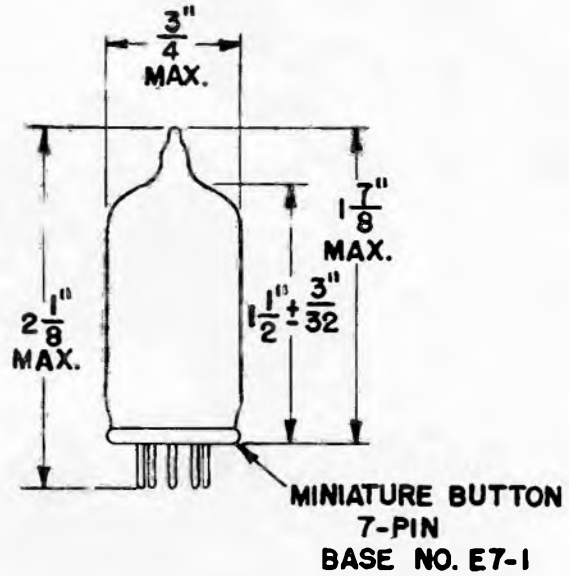
Heater voltage	6.3 volts
Plate voltage	90 volts
Grid bias voltage	-1.5 volts
Grid voltage for plate current = 10 microamperes, approximate	-15 volts
Plate current	17 milliamperes
Transconductance	4000 micromhos
Plate resistance	3500 ohms
Amplification factor	14



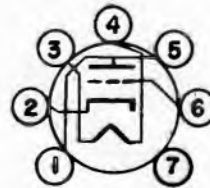
GL-5610
PLATE CHARACTERISTICS

TERMINAL CONNECTIONS

- PIN 1—PLATE
- PIN 2—CATHODE
- PIN 3—HEATER
- PIN 4—HEATER
- PIN 5—PLATE
- PIN 6—GRID
- PIN 7—NO CONNECTION



BASING DIAGRAM



6CG

OUTLINE
 PIOTRON GL-5610

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-5691 is a high-mu twin triode, high-vacuum tube for industrial use. It is designed particularly for use as a voltage amplifier in industrial applications where uniformity and stability of characteristic and resistance to shock and vibra-

tion are required. In addition to these features the 5691 has its heaters for the two triode units connected in series with the result that failure of either heater in bridge circuits makes both units inoperative.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Cathode—Indirectly heated

Heater voltage (A-C or D-C) $6.3 \pm 5\%^*$ volts

Heater current 0.6 ampere

Direct interelectrode capacitances with no external shield

Triode Unit No. 1—	Minimum	Average	Maximum
Grid to plate	3.1	3.6	4.1 uuf
Grid to cathode	1.9	2.4	2.9 uuf
Plate to cathode	1.8	2.3	2.8 uuf
Triode Unit No. 2—			
Grid to plate	3.1	3.6	4.1 uuf
Grid to cathode	2.2	2.7	3.2 uuf
Plate to cathode	2.1	2.6	3.1 uuf
Plate of Triode Unit No. 1 to			
Plate of Triode Unit No. 2—	2.7	3.2	3.7 uuf



TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position—any

Net weight, approximate 3 ounces

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Values are for each Unit

Maximum ratings, absolute values

D-c plate voltage	275 max	volts
D-c plate supply voltage	330 max	volts
Grid voltage		
Negative bias range	—1** min to	—100 max volts
Negative peak value		—200 max volts
D-c grid current	2 max	milliamperes
D-c cathode current	10 max	milliamperes
Plate dissipation	1 max	watt
Peak heater—Cathode voltage		
Heater negative with respect to cathode	100 max	volts
Heater positive with respect to cathode	100 max	volts
Ambient temperature range	55— to	+90 C

Maximum circuit value (for any operating condition)

Grid-circuit resistance 2 max megohms

Characteristics and range values

Heater voltage	6.3	volts
Plate voltage	250	volts
Grid voltage	—2	volts

	Minimum	Average	Maximum	
Heater current	0.55	0.6	0.65	amperes
Heater-cathode current with heater-cathode voltage of \approx 100 volts			5	microamperes
Plate current	1.7	2.3	2.9	milliamperes
Plate current for grid voltage of —5.5 volts			15	microamperes
Difference in plate current between triode units			0.9	milliampere
Reverse grid current			0.2	microampere
Amplification factor	60	70	80	
Plate resistance		44000		ohms
Transconductance	1300	1600	1900	micromhos

Typical operation—resistance-coupled amplifier (each triode unit)

	90			180			300			volts
Plate-supply voltage										
Plate load resistor	0.1	0.22	0.47	0.1	0.22	0.47	0.1	0.22	0.47	megohms
Grid resistor (of following stage)	0.22	0.47	1.0	0.22	0.47	1.0	0.22	0.47	1.0	megohms
Cathode resistor	4700	7400	14400	2600	4600	9000	2180	3970	7550	ohms
Cathode bypass capacitor***	2.1	1.3	0.7	2.8	1.6	0.9	3.1	1.8	1	uf
Blocking capacitor***	0.014	0.0065	0.0035	0.014	0.0065	0.0035	0.014	0.0065	0.0035	uf
Peak output voltage****	9	13	17	30	37	44	59	76	88	volts
Voltage gain	27†	35‡	40‡	33¶	42¶	46¶	36¶	45¶	50¶	

*May deviate \pm 10 per cent from rated value provided such deviation occurs for less than 2 per cent of the operating time.

**For resistance-coupled amplifier applications, the negative bias may be as low as —0.5 volt.

***The cathode by-pass capacitors and blocking capacitors have been chosen to give output voltages at 100 cycles per second (f_1) which are equal to 0.8 of the mid-frequency value. For any other value of (f_1), multiply the values of cathode by-pass and blocking capacitors by $100/f_1$.

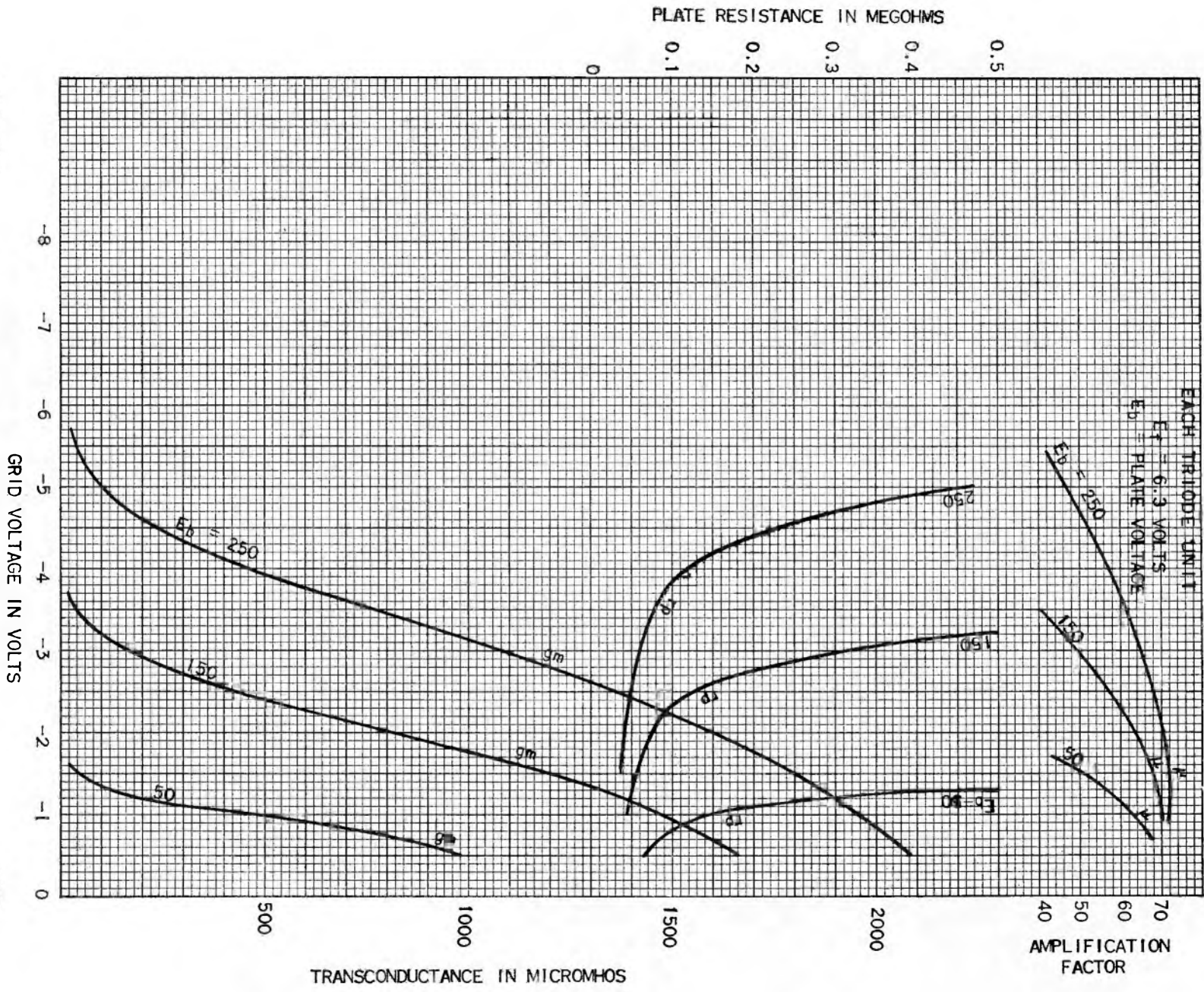
****This peak output voltage is obtained across the grid resistor of the following stage at any frequency within the flat region of the output vs frequency curve, and is for the condition where the signal level is adequate to swing the grid of the resistance-coupled amplifier tube to the point where its grid starts to draw current.

†At an output voltage of 3 volts rms.

‡At an output voltage of 4 volts rms.

¶At an output voltage of 5 volts rms.

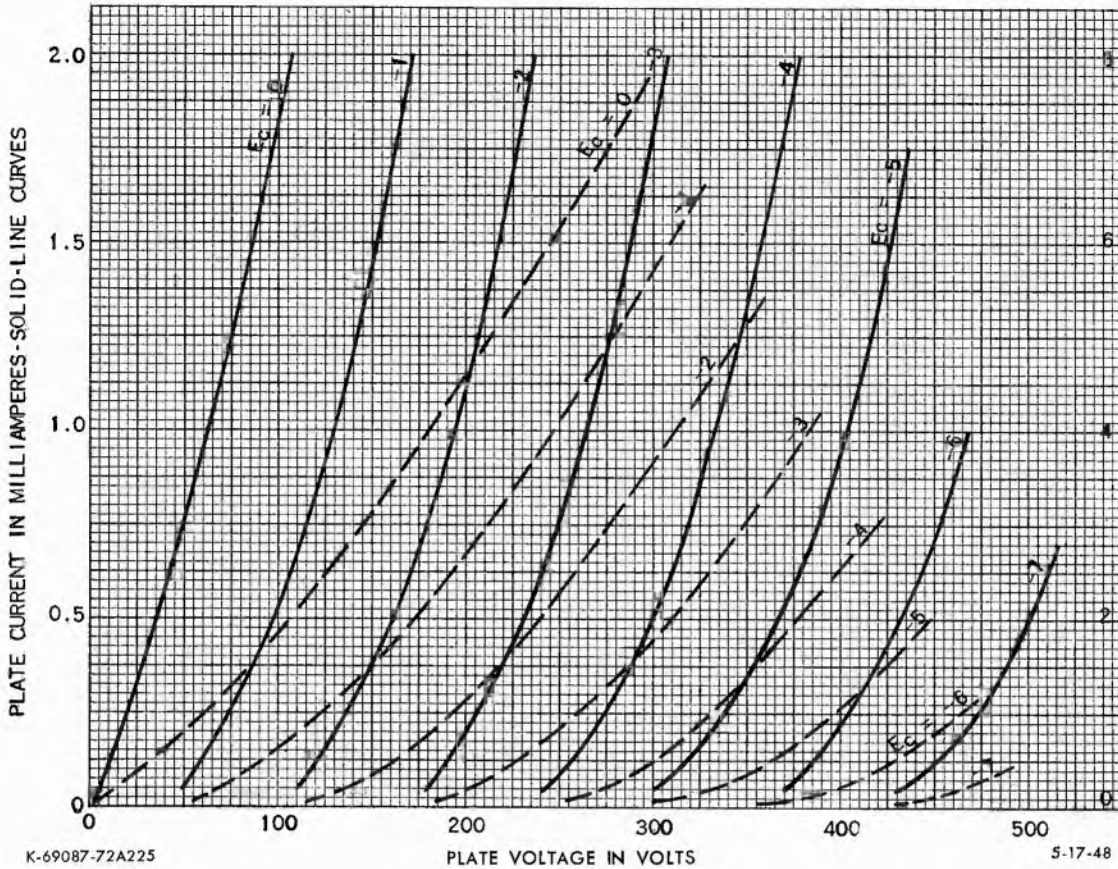
GL-5691
AVERAGE CHARACTERISTICS



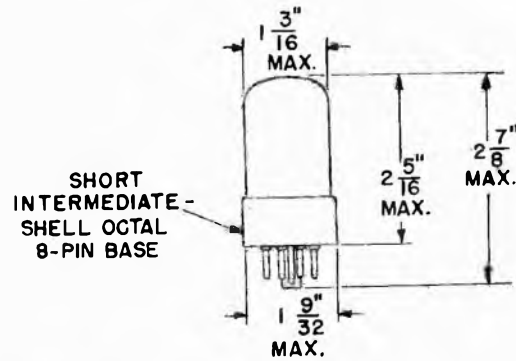
K-69087-72A226

5-17-48

GL-5691 AVERAGE PLATE CHARACTERISTICS
EACH TRIODE UNIT $E_f = 6.3$ VOLTS



OUTLINE GL-5691 PIOTRON



BASING DIAGRAM



- PIN 1: GRID OF TRIODE UNIT NO. 2
- PIN 2: PLATE OF TRIODE UNIT NO. 2
- PIN 3: CATHODE OF TRIODE UNIT NO. 2
- PIN 4: GRID OF TRIODE UNIT NO. 1
- PIN 5: PLATE OF TRIODE UNIT NO. 1
- PIN 6: CATHODE OF TRIODE UNIT NO. 1
- PIN 7: HEATER
- PIN 8: HEATER

N-15120AZ

8BD

5-17-48

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-5692 is a medium-mu twin triode, high-vacuum tube designed particularly for use in industrial applications as a balanced d-c amplifier, multivibrator, blocking oscillator, and resistance-coupled amplifier.

The heaters for the two triode units of the 5692

are connected in series so that failure of either heater in bridge circuits makes both units inoperative. Other features of this tube are stability and uniformity of characteristics, resistance to shock and vibration, and long life.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Cathode—Indirectly heated

Heater voltage (a-c or d-c) 6.3 ± 5%* volts

Heater current 0.6 ampere

Direct interelectrode capacitances, with no external shield

Triode Unit No. 1—

Minimum Average Maximum

Grid to plate 3.0 3.5 4.0 uuf

Grid to cathode 1.8 2.3 2.8 uuf

Plate to cathode 2.0 2.5 3.0 uuf

Triode Unit No. 2—

Grid to plate 2.8 3.3 3.8 uuf

Grid to cathode 2.1 2.6 3.1 uuf

Plate to cathode 2.2 2.7 3.2 uuf

Plate of Triode Unit No. 1 to

Plate of Triode Unit No. 2 2.7 3.2 3.7 uuf



TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Mounting position—any

Net weight, approximate..... 3 ounces

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Values are for each Unit

Maximum ratings, absolute values

D-c plate voltage.....	275 max	volts
D-c plate supply voltage.....	330 max	volts
Grid voltage		
Negative bias value.....	-1** min to	-100 max volts
Negative peak value.....		-200 max volts
D-c grid current.....	2 max	milliamperes
D-c cathode current.....	15 max	milliamperes
Plate dissipation.....	1.75 max	watts
Peak heater-cathode voltage		
Heater negative with respect to cathode.....	100 max	volts
Heater positive with respect to cathode.....	100 max	volts
Ambient temperature range.....	-55 to	+90 C

Maximum circuit value (for any operating condition)

Grid-circuit resistance..... 2 max megohms

Characteristics and range values

Heater voltage.....	6.3	volts
Plate voltage.....	250	volts
Grid voltage.....	-9	volts

Minimum Average Maximum

Heater current.....	0.55	0.6	0.65	amperes
Heater-cathode current with heater-cathode voltage of ± 100 volts.....				5 microamperes
Plate current.....	4.8	6.5	8.2	milliamperes
Plate current for grid voltage of -24 volts.....				15 microamperes
Difference in plate current between triode units.....				2.0 milliamperes
Reverse grid current.....				0.2 microampere
Amplification factor.....	18	20	22	
Plate resistance.....		9100		ohms
Transconductance.....	1825	2200	2575	micromhos

Typical operation—resistance-coupled amplifier (each triode unit)

	90			180			300			volts
	0.05	0.1	0.25	0.05	0.1	0.25	0.05	0.1	0.25	
Plate-supply voltage										
Plate load resistor.....	0.05	0.1	0.25	0.05	0.1	0.25	0.05	0.1	0.25	megohms
Grid resistor (of following stage).....	0.1	0.25	0.5	0.1	0.25	0.5	0.1	0.25	0.5	megohms
Cathode resistor.....	2070	3940	9760	1490	2830	7000	1270	2440	5770	ohms
Cathode by-pass capacitor †.....	2.66	1.29	0.55	2.86	1.35	0.62	2.96	1.42	0.64	uf
Blocking capacitor †.....	0.029	0.012	0.007	0.032	0.012	0.007	0.034	0.0125	0.0075	uf
Peak output voltage †.....	14	17	18	30	34	36	51	56	57	volts
Voltage gain Δ	12	13	13	13	14	14	14	14	14	

*May deviate ± 10 per cent from rated value provided such deviation occurs for less than 2 per cent of the operating time.

**For resistance-coupled amplifier applications, the negative bias may be as low as -0.5 volt.

†The cathode by-pass capacitors and blocking capacitors have been chosen to give output voltages at 100 cycles per second (f_1) which are equal to 0.8 of the mid-frequency value. For any other value of (f_1), multiply the values of cathode by-pass and blocking capacitors by $100/f_1$.

‡This peak output voltage is obtained across the grid resistor of the following stage at any frequency within the flat region the output vs frequency curve, and is for the condition where the signal level is adequate to swing the grid of the resistance-coupled amplifier tube to the point where its grid starts to draw current.

 Δ At an output voltage of 5 volts rms.

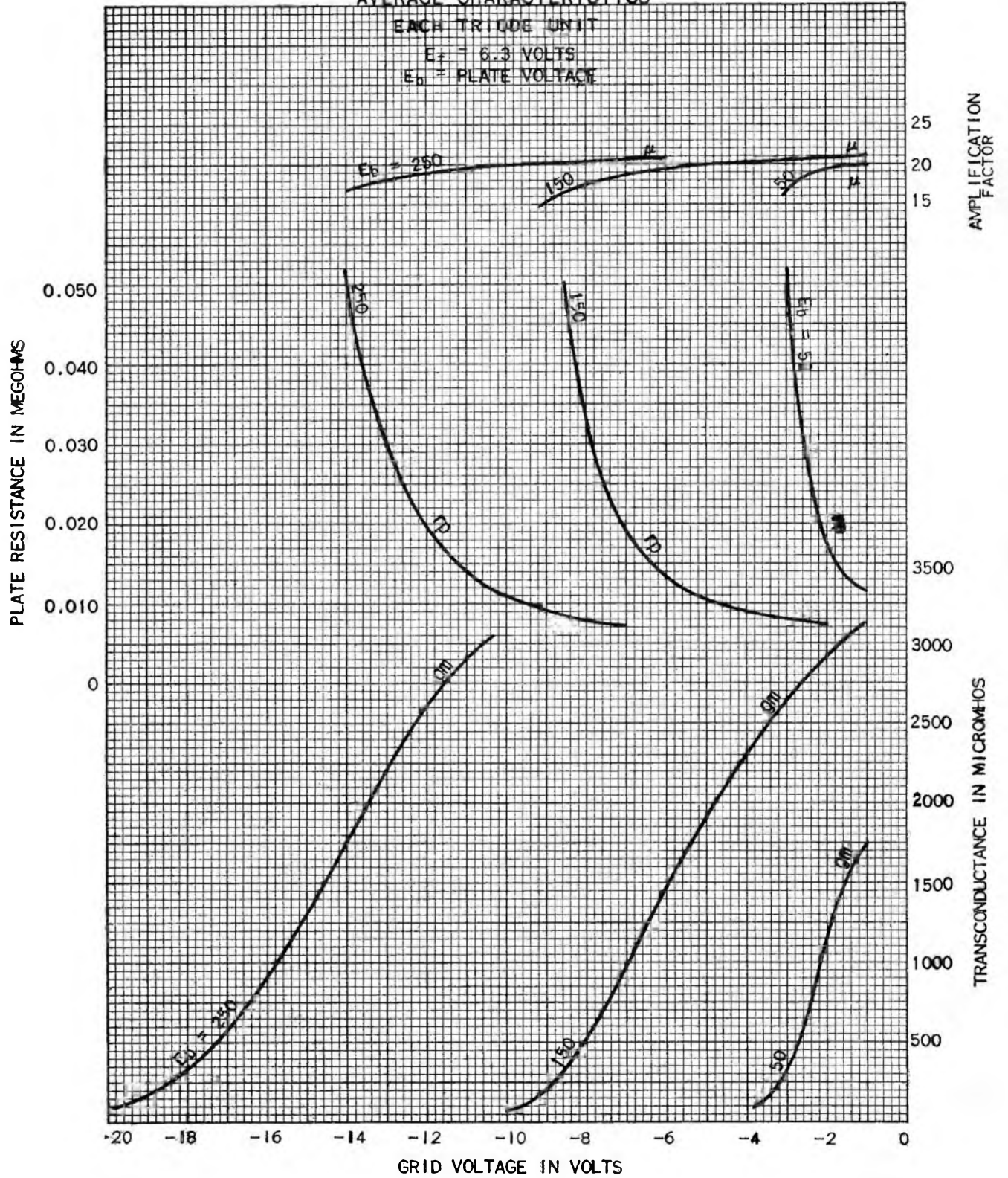
GL-5692

AVERAGE CHARACTERISTICS

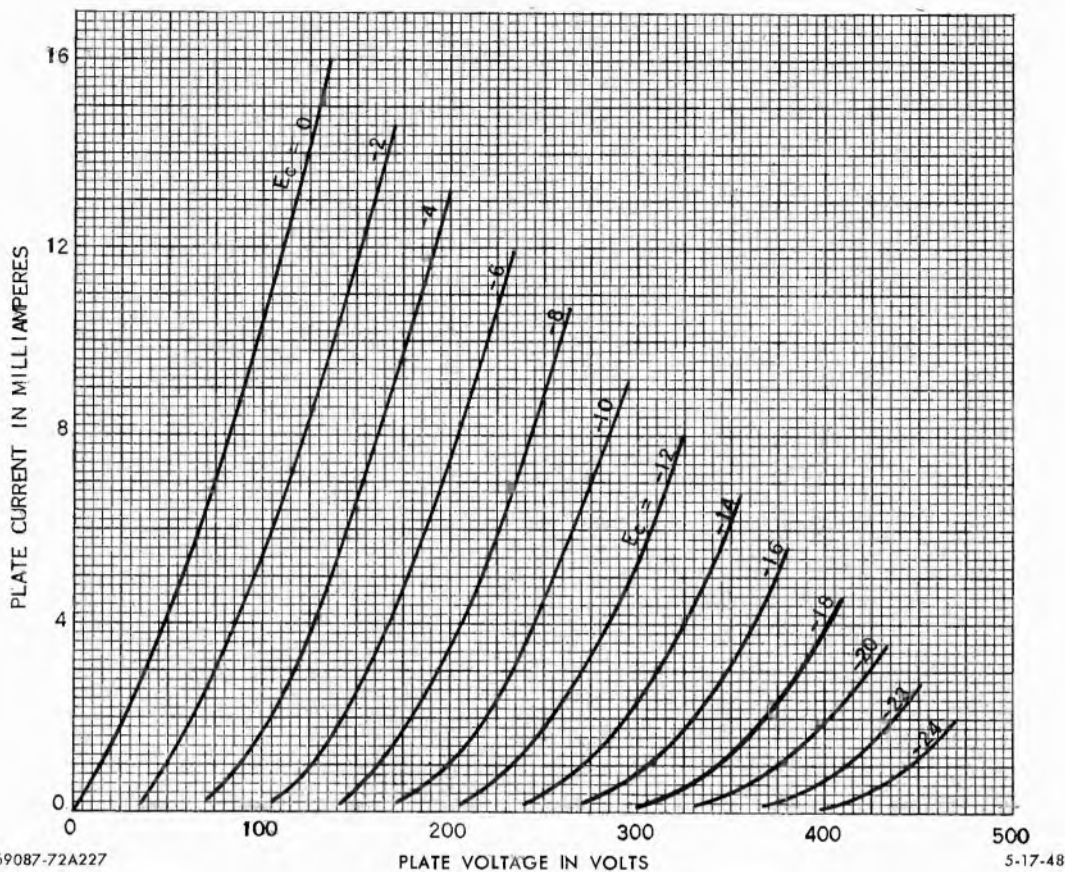
EACH TRIODE UNIT

$E_f = 6.3$ VOLTS

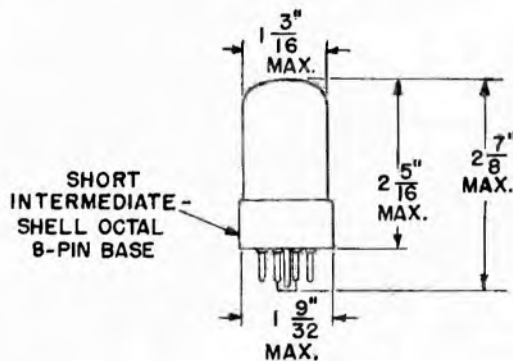
$E_b =$ PLATE VOLTAGE



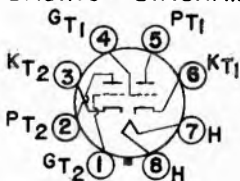
GL-5692
AVERAGE PLATE CHARACTERISTICS
EACH TRIODE UNIT $E_i = 6.3$ VOLTS



OUTLINE GL-5692 PIOTRON



BASING DIAGRAM



- PIN 1: GRID OF TRIODE UNIT NO. 2
- PIN 2: PLATE OF TRIODE UNIT NO. 2
- PIN 3: CATHODE OF TRIODE UNIT NO. 2
- PIN 4: GRID OF TRIODE UNIT NO. 1
- PIN 5: PLATE OF TRIODE UNIT NO. 1
- PIN 6: CATHODE OF TRIODE UNIT NO. 1
- PIN 7: HEATER
- PIN 8: HEATER

N-15120AZ

8BD

5-17-48

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-5693 is a sharp cut-off five-electrode, high vacuum tube for use as a high-gain, resistance-coupled amplifier in industrial applications.

A grid No. 1 resistor with a value as high as 40 megohms can be used with this tube depending upon the operating conditions as given on the curve

“Operational Characteristics.” In addition, the 5693 is characterized by uniformity and stability of characteristic, resistance to shock and vibration, and long life features especially desirable in industrial service.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

Electrical Data

Cathode—Indirectly heated

Heater voltage (a-c or d-c) 6.3 \pm 5%* volts

Heater current 0.3 ampere

Direct interelectrode capacitances, with shell connected to cathode

Minimum Average Maximum

Grid to plate 0.005 uuf

Input 4.8 5.3 5.8 uuf

Output 5.6 6.2 6.8 uuf

Mechanical Data

Mounting position—Any

Net weight, approximate 3 ounces

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum ratings, absolute values

D-c plate voltage	300 max volts
D-c plate supply voltage	330 max volts
D-c grid No. 3 (suppressor) voltage	
Negative bias value	0 min -100 max volts
D-c grid No. 2 (screen) voltage	125** max volts
D-c grid No. 2 supply voltage	330 max volts
Grid No. 1 (control-grid) voltage	
Negative bias range	1*** min to -50 max volts
Negative peak value	-50 max volts
D-c cathode current	10 max milliamperes
Plate dissipation	2 max watts
Grid No. 2 dissipation	0.3 max watt
Peak heater-cathode voltage	
Heater negative with respect to cathode	100 max volts
Heater positive with respect to cathode	100 max volts
Ambient temperature range	-55 to +90 C

*May deviate ±10 per cent from rated value provided such deviation occurs for less than 2 per cent of the operating time.

**The 5693 may be operated at a grid No. 2 voltage as high as the maximum rated grid No. 2 supply voltage (330 volts) when the grid No. 2 dissipation is not exceeded for any signal conditions and when a resistor is used in series with the grid No. 2 and its supply voltage.

***For resistance-coupled amplifier applications, the negative grid No. 1 bias may be as low as -0.5 volt.

Maximum circuit value (see curve K-69087-72A224)

Characteristics and range values

Heater voltage, 6.3; plate voltage, 250; grid No. 3 voltage, 0; grid No. 2 voltage, 100; grid No. 1 voltage, -3

	Minimum	Average	Maximum
Heater current	0.275	0.3	0.325 amperes
Heater-cathode current with heater-cathode voltage of ±100 volts			5 microamperes
Plate current	2.3	3.0	3.7 milliamperes
Plate current for grid No. 1 voltage of -7.5 volts	2	30	80 microamperes
Plate current for grid No. 3 voltage of -70 volts	150	450	750 microamperes
Grid No. 2 current	0.60	0.85	1.10 milliamperes
Reverse grid No. 1 current			0.1 microamperes
Plate resistance	1.0		megohms
Transconductance	1400	1650	1900 micromhos

Typical operation—resistance-coupled amplifier

Plate and grid No. 2 supply voltage	90			180			300			volts
Plate load resistor	0.1	0.25	0.5	0.1	0.25	0.5	0.1	0.25	0.5	megohms
Grid No. 1 resistor	0.25	0.5	1	0.25	0.5	1	0.25	0.5	1	megohms
Grid No. 2 resistor	0.29	0.92	1.7	0.31	0.94	2.2	0.37	1.10	2.2	megohms
Cathode resistor	880	1700	3800	800	1060	2180	530	860	1410	ohms
Grid No. 2 bypass capacitor †	0.085	0.045	0.03	0.09	0.06	0.04	0.09	0.06	0.05	uf
Cathode bypass capacitor †	7.4	4.5	2.4	8	6.6	3.8	10.9	7.4	5.8	uf
Blocking capacitor †	0.016	0.005	0.002	0.015	0.004	0.002	0.016	0.004	0.002	uf
Peak output voltage ‡	23	18	22	60	47	44	96	88	79	volts
Voltage gain △	68	93	119	82	131	192	98	167	238	

†The cathode and grid No. 2 bypass capacitors and blocking capacitors have been chosen to give output voltages at 100 cycles per second (f_i) which are equal to 0.7 of the mid-frequency value. For any other value of (f_i), multiply the values of cathode bypass, grid No. 2 bypass, and blocking capacitors by $100/f_i$.

‡This peak output voltage is obtained across the grid resistor of the following stage at any frequency within the flat region of the output vs frequency curve, and is for the condition where the signal level is adequate to swing the grid of the resistance-coupled amplifier tube to the point where its grid starts to draw current.

△At an output voltage of 5 volts rms.



PLIOTRON

DESCRIPTION

The GL-5693 is a sharp cut-off five-electrode, high vacuum tube for use as a high-gain, resistance-coupled amplifier in industrial applications.

A grid No. 1 resistor with a value as high as 40 megohms can be used with this tube depending upon the operating conditions as given on the curve

“Operational Characteristics.” In addition, the 5693 is characterized by uniformity and stability of characteristic, resistance to shock and vibration, and long life features especially desirable in industrial service.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

Electrical Data

Cathode—Indirectly heated

Heater voltage (a-c or d-c) 6.3 \pm 5%* volts

Heater current 0.3 ampere

Direct interelectrode capacitances, with shell connected to cathode

Minimum Average Maximum

Grid to plate 0.005 uuf

Input 4.8 5.3 5.8 uuf

Output 5.6 6.2 6.8 uuf

Mechanical Data

Mounting position—Any

Net weight, approximate 3 ounces

GE
Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum ratings, absolute values

D-c plate voltage	300 max volts
D-c plate supply voltage	330 max volts
D-c grid No. 3 (suppressor) voltage	
Negative bias value	0 min -100 max volts
D-c grid No. 2 (screen) voltage	125** max volts
D-c grid No. 2 supply voltage	330 max volts
Grid No. 1 (control-grid) voltage	
Negative bias range	1*** min to -50 max volts
Negative peak value	-50 max volts
D-c cathode current	10 max milliamperes
Plate dissipation	2 max watts
Grid No. 2 dissipation	0.3 max watt
Peak heater-cathode voltage	
Heater negative with respect to cathode	100 max volts
Heater positive with respect to cathode	100 max volts
Ambient temperature range	-55 to +90 C

*May deviate ±10 per cent from rated value provided such deviation occurs for less than 2 per cent of the operating time.

**The 5693 may be operated at a grid No. 2 voltage as high as the maximum rated grid No. 2 supply voltage (330 volts) when the grid No. 2 dissipation is not exceeded for any signal conditions and when a resistor is used in series with the grid No. 2 and its supply voltage.

***For resistance-coupled amplifier applications, the negative grid No. 1 bias may be as low as -0.5 volt.

Maximum circuit value (see curve K-69087-72A224)

Characteristics and range values

Heater voltage, 6.3; plate voltage, 250; grid No. 3 voltage, 0; grid No. 2 voltage, 100; grid No. 1 voltage, -3

	Minimum	Average	Maximum
Heater current	0.275	0.3	0.325 amperes
Heater-cathode current with heater-cathode voltage of ±100 volts			5 microamperes
Plate current	2.3	3.0	3.7 milliamperes
Plate current for grid No. 1 voltage of -7.5 volts	2	30	80 microamperes
Plate current for grid No. 3 voltage of -70 volts	150	450	750 microamperes
Grid No. 2 current	0.60	0.85	1.10 milliamperes
Reverse grid No. 1 current			0.1 microamperes
Plate resistance	1.0		megohms
Transconductance	1400	1650	1900 micromhos

Typical operation—resistance-coupled amplifier

Plate and grid No. 2 supply voltage	90			180			300			volts
Plate load resistor	0.1	0.25	0.5	0.1	0.25	0.5	0.1	0.25	0.5	megohms
Grid No. 1 resistor	0.25	0.5	1	0.25	0.5	1	0.25	0.5	1	megohms
Grid No. 2 resistor	0.29	0.92	1.7	0.31	0.94	2.2	0.37	1.10	2.2	megohms
Cathode resistor	880	1700	3800	800	1060	2180	530	860	1410	ohms
Grid No. 2 bypass capacitor †	0.085	0.045	0.03	0.09	0.06	0.04	0.09	0.06	0.05	uf
Cathode bypass capacitor †	7.4	4.5	2.4	8	6.6	3.8	10.9	7.4	5.8	uf
Blocking capacitor †	0.016	0.005	0.002	0.015	0.004	0.002	0.016	0.004	0.002	uf
Peak output voltage †	23	18	22	60	47	44	96	88	79	volts
Voltage gain △	68	93	119	82	131	192	98	167	238	

†The cathode and grid No. 2 bypass capacitors and blocking capacitors have been chosen to give output voltages at 100 cycles per second (f_1) which are equal to 0.7 of the mid-frequency value. For any other value of (f_1), multiply the values of cathode bypass, grid No. 2 bypass, and blocking capacitors by $100/f_1$.

‡This peak output voltage is obtained across the grid resistor of the following stage at any frequency within the flat region of the output vs frequency curve, and is for the condition where the signal level is adequate to swing the grid of the resistance-coupled amplifier tube to the point where its grid starts to draw current.

△At an output voltage of 5 volts rms.

GL-5693 OPERATIONAL CHARACTERISTICS

 $E_i = 6.3$ VOLTS PLATE VOLTAGE = 300

GRID NO. 3 VOLTAGE = 0

CURVE	GRID-NO. 2 RESISTOR	GRID-NO. 2 SUPPLY VOLTAGE
1	0 MEG.	100
2	0.25 MEG.	300
3	0.5 MEG.	300
4	0.75 MEG.	300

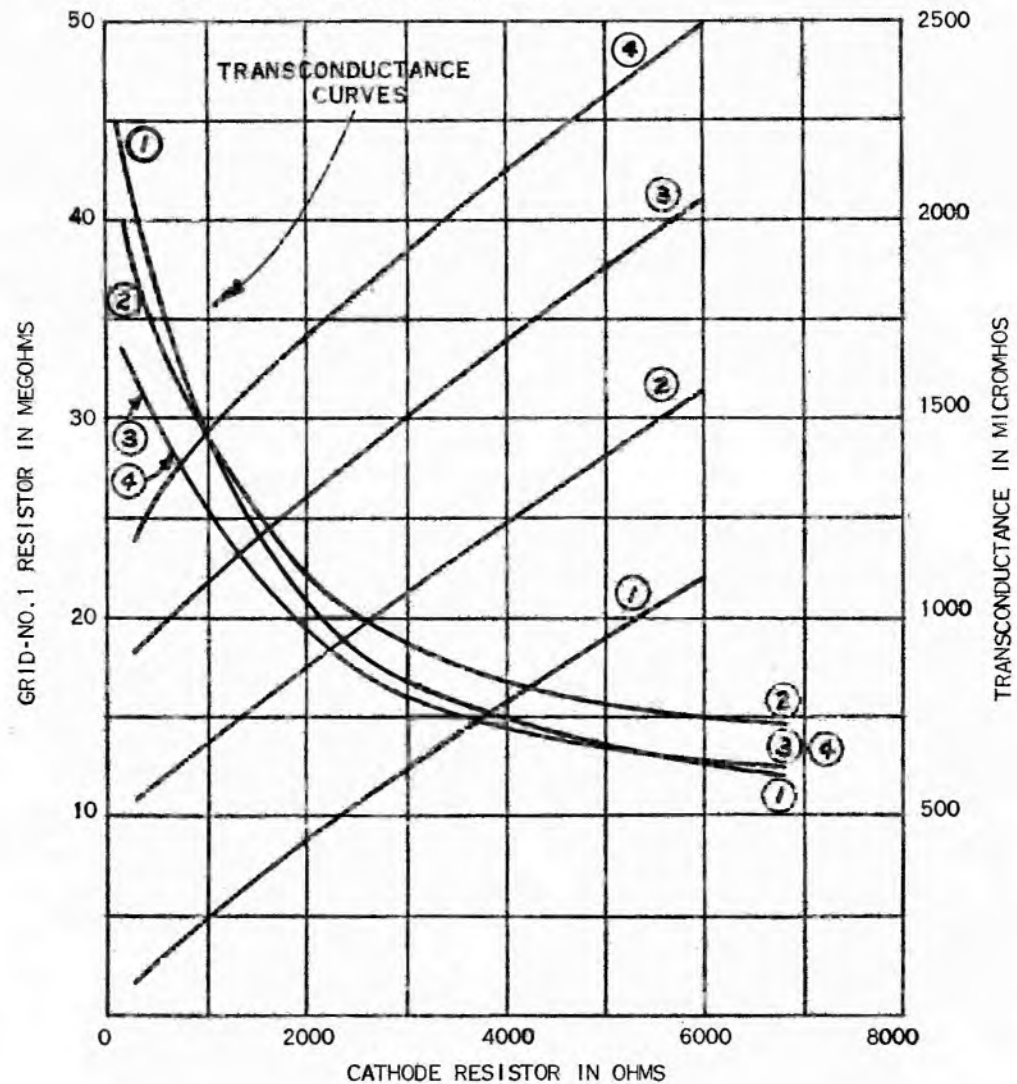
CURVES BASED ON FOLLOWING VALUES:
 $\Delta I_k = 300 \mu\text{AMP}$, $\Delta I_{g_1} = 0.1 \mu\text{AMP}$

EXPRESSING THESE VALUES AS A RATIO:

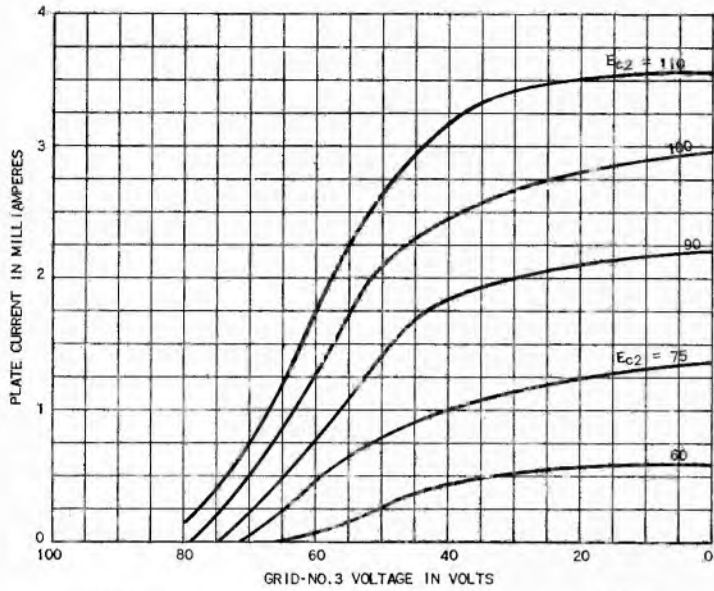
$$\frac{\Delta I_k}{\Delta I_{g_1}} = \frac{300}{0.1} \text{ OR } 3000$$

FOR APPLICATIONS PERMITTING OTHER VALUES OF ΔI_k , A NEW RATIO OF $\Delta I_k / \Delta I_{g_1}$ CAN BE CALCULATED. THE VALUES OF R_{g_1} AS READ FROM THE CURVE MUST BE MULTIPLIED BY A FACTOR WHICH IS THE QUOTIENT OF THE NEW RATIO DIVIDED BY THE OLD RATIO. FOR EXAMPLE, IF THE NEW RATIO IS 6000 THE MULTIPLYING FACTOR IS 6000/3000, OR 2, AND VALUES OF R_{g_1} AS READ FROM THE CURVE ARE THEREFORE MULTIPLIED BY 2.

NOTE: TRANSCONDUCTANCE CURVES WERE OBTAINED WITH GRID-NO. 2 RESISTOR AND CATHODE RESISTOR SUITABLY BYPASSED.



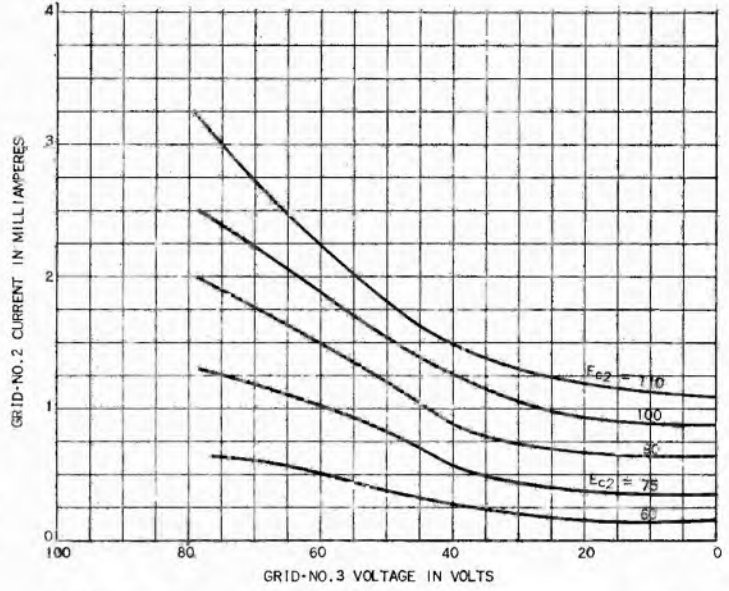
GL-5693
 AVERAGE SUPPRESSOR CHARACTERISTICS
 $E_i = 6.3$ VOLTS
 PLATE VOLTAGE = 250
 GRID NO. 1 VOLTAGE = -3



K-69087-72A229

8-26-48

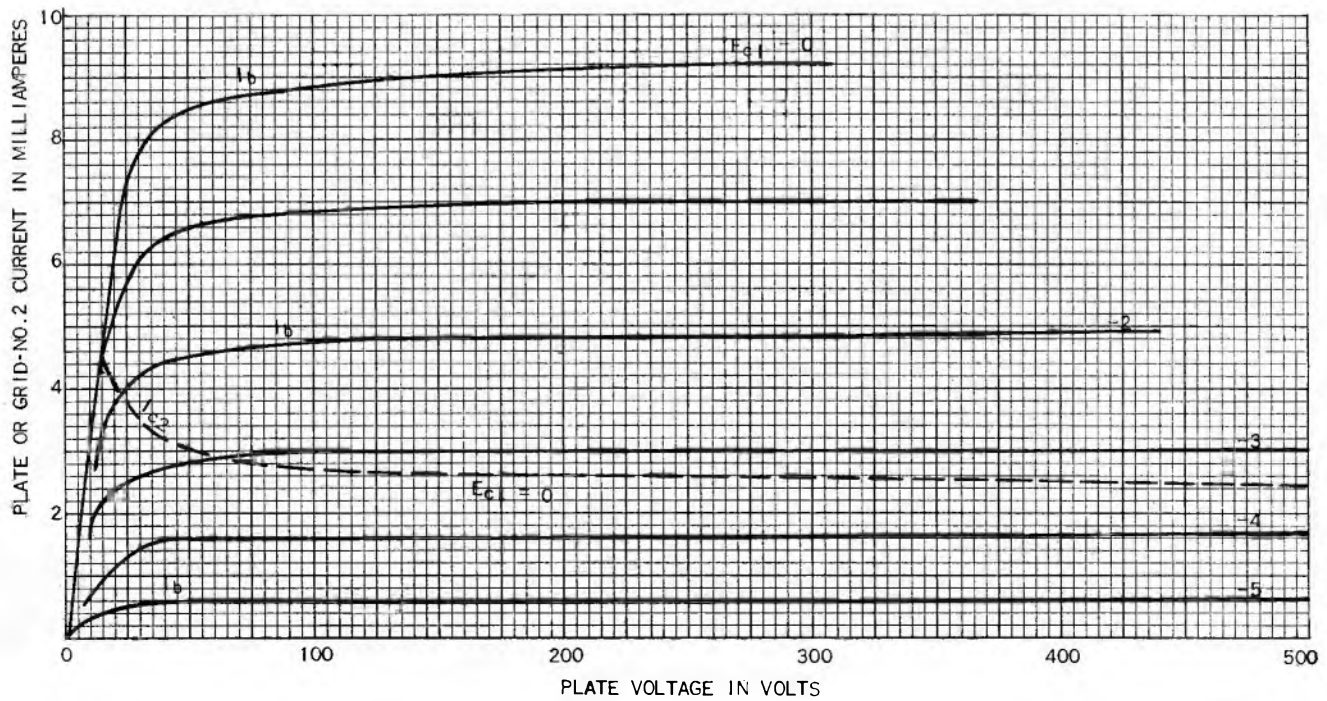
GL-5693
 AVERAGE SUPPRESSOR CHARACTERISTICS
 $E_i = 6.3$ VOLTS
 PLATE VOLTAGE = 250
 GRID NO. 1 VOLTAGE = -3



K-69087-72A230

8-26-48

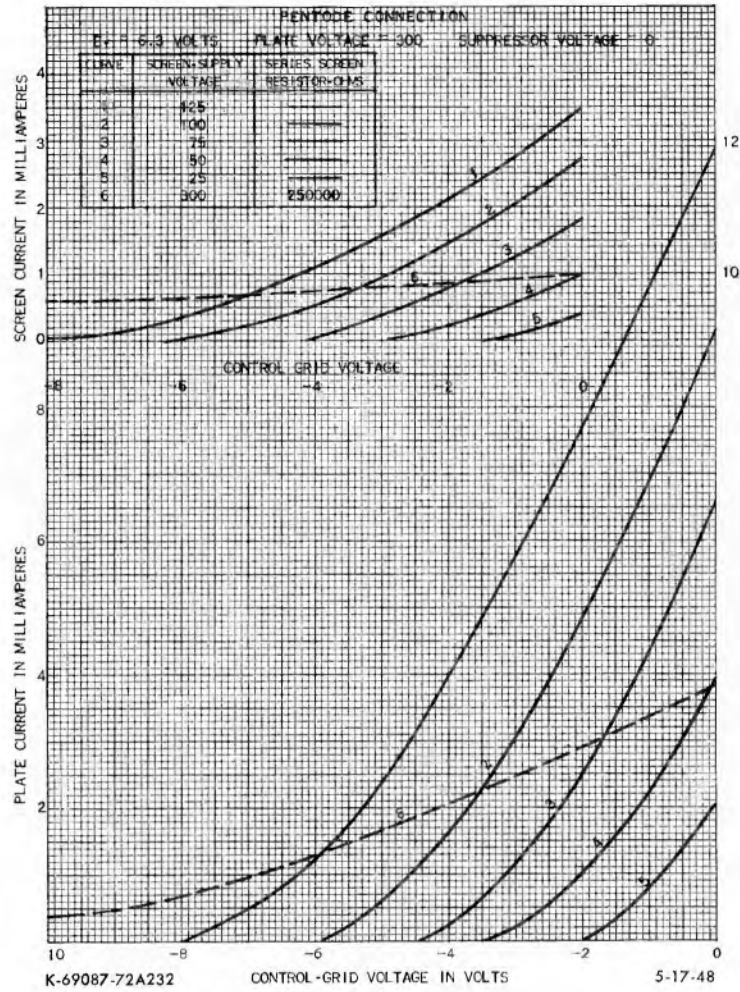
GL-5693
 AVERAGE PLATE CHARACTERISTICS
 PENTODE CONNECTION
 $E_i = 6.3$ VOLTS
 GRID NO. 2 VOLTAGE = 100
 GRID NO. 3 VOLTAGE = 0



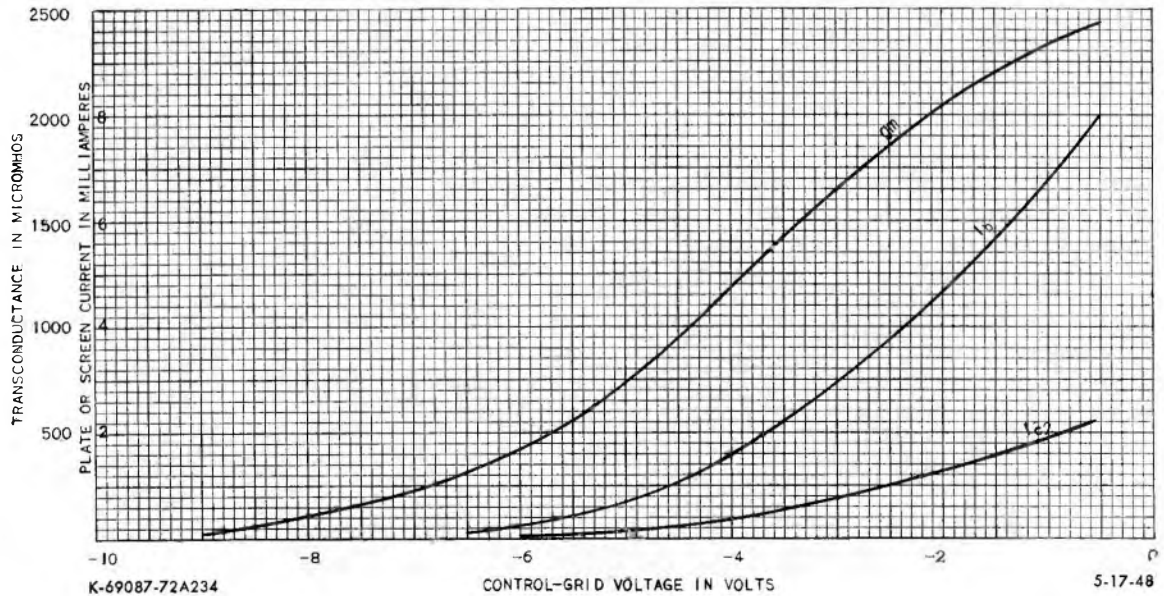
K-69087-72A231

5-17-48

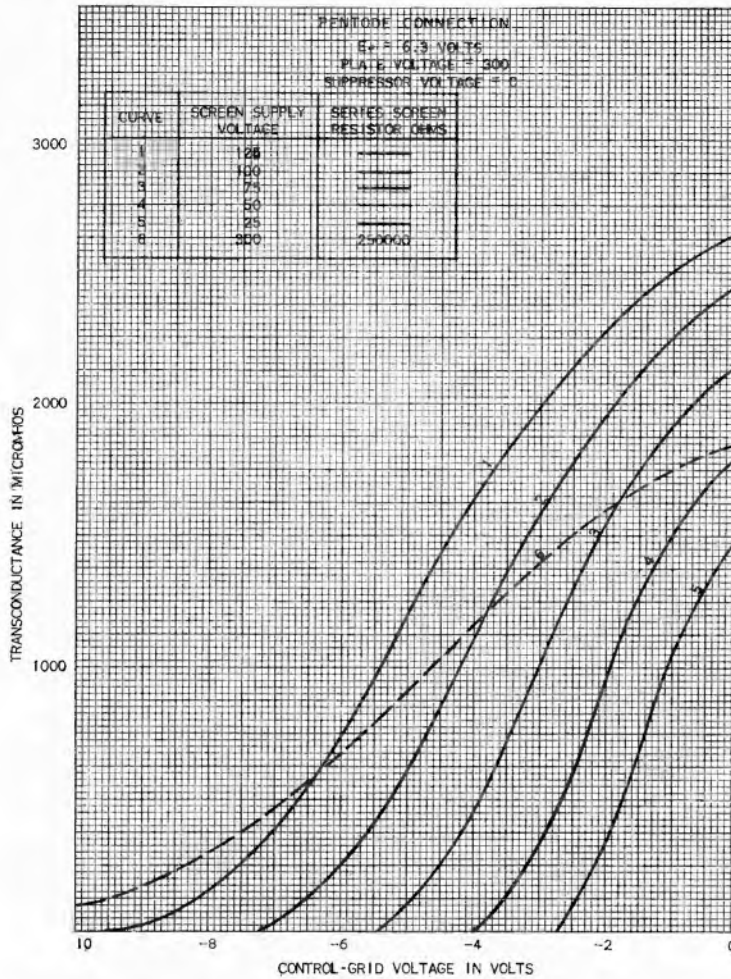
GL-5693 AVERAGE CHARACTERISTICS



GL-5693 AVERAGE CHARACTERISTICS
 PENTODE CONNECTION $E_f = 6.3$ VOLTS PLATE VOLTAGE = 250
 SUPPRESSOR VOLTAGE = 0 SCREEN VOLTAGE = 100



GL-5693 AVERAGE CHARACTERISTICS

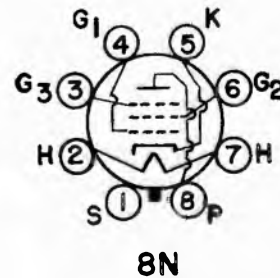
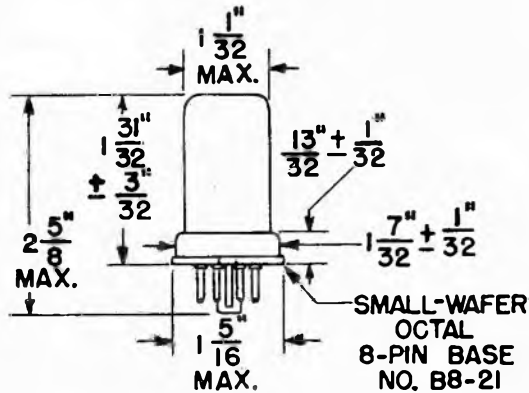


K-69087-72A233

5-17-48

**OUTLINE
GL-5693 PIOTRON**

BASING DIAGRAM



- PIN 1: SHELL
- PIN 2: HEATER
- PIN 3: GRID NO. 3
- PIN 4: GRID NO. 1
- PIN 5: CATHODE
- PIN 6: GRID NO. 2
- PIN 7: HEATER
- PIN 8: PLATE

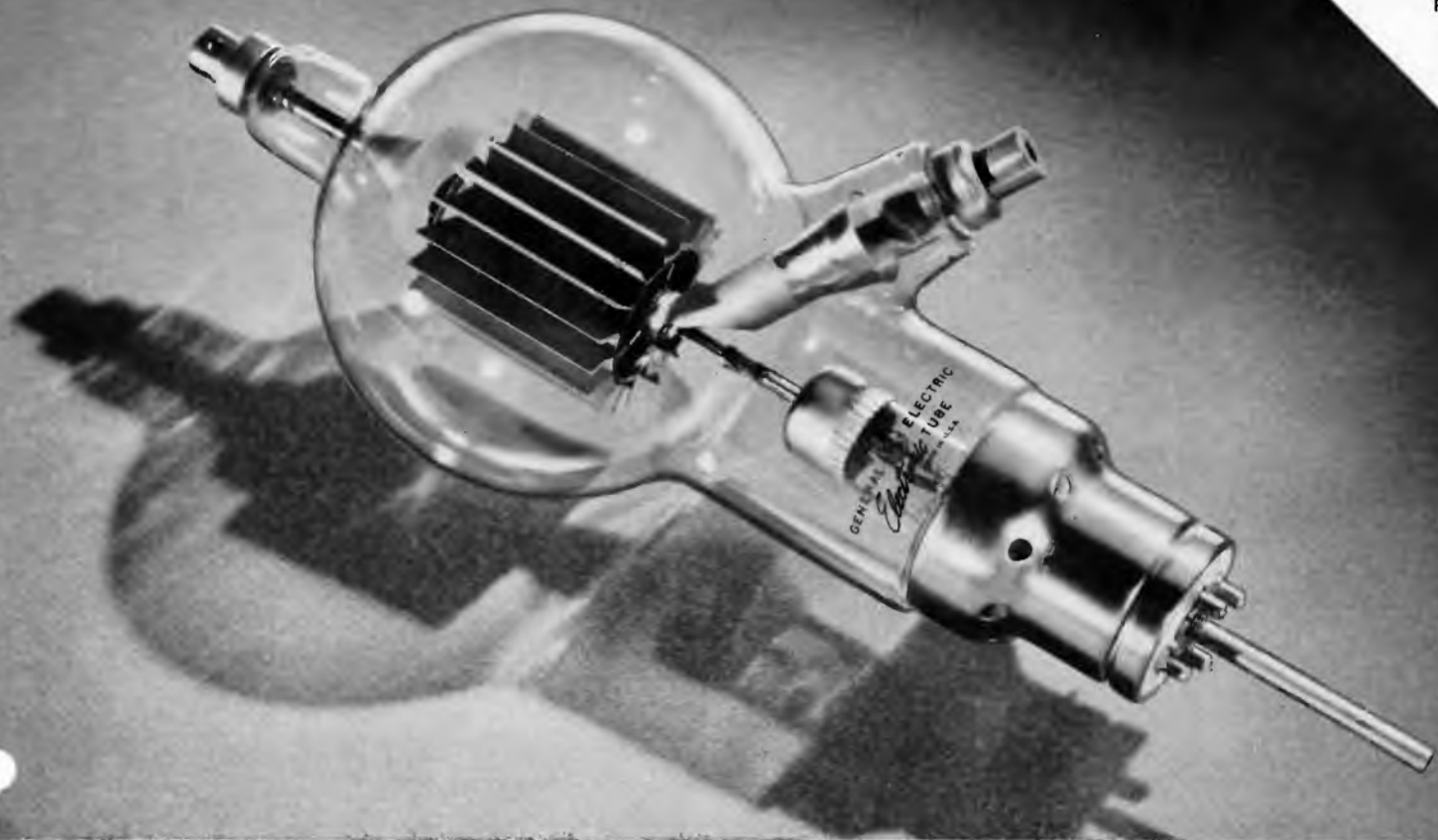
N-15119AZ

5-17-48

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PLIOTRON

DESCRIPTION

The GL-1000T is a three-electrode tube designed for use as a Class B audio-frequency power amplifier and modulator or as a Class C radio-frequency power amplifier and oscillator. The anode is capable of dissipating 1000 watts. Forced-air cooling of the envelope is required under all conditions of

operation and forced-air cooling of the seals, through the tube in the base, is necessary when the GL-1000T is operated at maximum conditions. The cathode is a thoriated-tungsten filament. Maximum ratings apply up to a frequency of 50 megacycles.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Filament voltage	7.5	volts
Filament current	17.0	amperes
Amplification factor	35	
Direct interelectrode capacitances		
Grid-plate	5.1	uuf
Grid-filament	9.3	uuf
Plate-filament	0.5	uuf
Transconductance, $I_b = 750$ ma, $E_b = 6000$, $E_c = -62$	9050	micromhos

Mechanical Data

Mounting position	vertical, base down
Type of cooling	forced air
Forced-air cooling of the seals is necessary under maximum conditions of operation. Each seal requires approximately 2 cubic feet per minute. The bulb must be cooled with air equivalent to that supplied by an 8-inch electric fan 12 inches from the bulb.	
Net weight, approximate	1.25 pounds



TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS AND TYPICAL OPERATION CONDITIONS
AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum ratings, absolute values			
D-c plate voltage			7500 max volts
Maximum signal d-c plate current			750 max milliamperes
Plate dissipation*			1000 max watts
Typical Operation			
Unless otherwise specified, values are for two tubes			
D-c plate voltage	4000	5000	6000 volts
D-c grid voltage, approximate	-70	-105	-135 volts
Peak a-f grid input voltage	490	530	600 volts
Zero Signal d-c plate current	.300	.240	.200 amperes
Maximum signal d-c plate current	1.25	1.14	1.11 amperes
Maximum signal driving power, approximate	28	31	35 watts
Effective load resistance, plate to plate	6350	9250	12200 ohms
Maximum signal power output, approximate	3000	3700	4600 watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

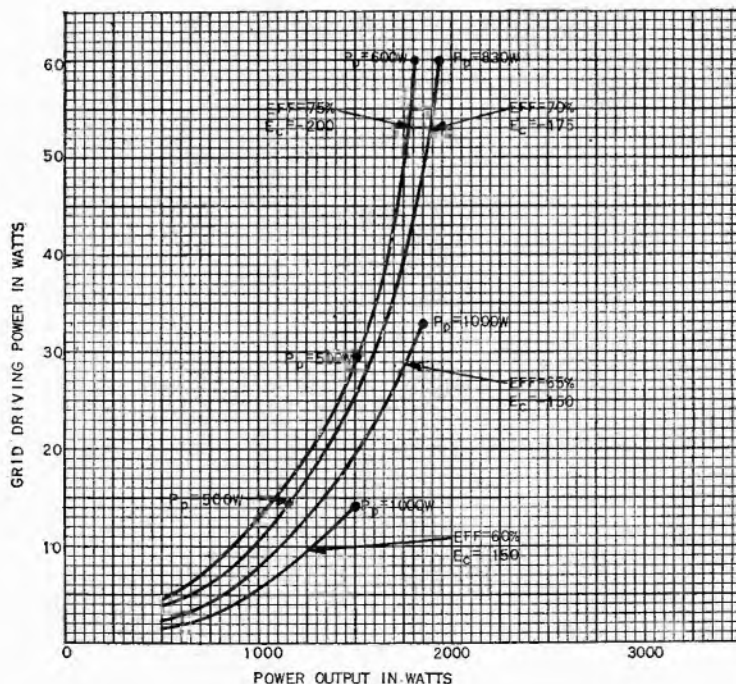
Key-down conditions per tube without modulation**

Maximum ratings, absolute values				
D-c plate voltage			7500 max volts	
D-c plate current			750 max milliamperes	
D-c grid current			.125 max milliamperes	
Plate dissipation			1000 max watts	
Typical operation				
D-c plate voltage	3000	4000	5000	6000 volts
D-c grid voltage	-150	-150	-225	-350 volts
Peak r-f grid input voltage, approximate	350	365	420	610 volts
D-c plate current	750	713	667	667 milliamperes
D-c grid current	90	100	87	110 milliamperes
Plate dissipation	900	1000	1000	1000 watts
Driving power, approximate	30	33	33	60 watts
Plate input	2250	2850	3333	4000 watts
Power output, approximate	1350	1850	2333	3000 watts

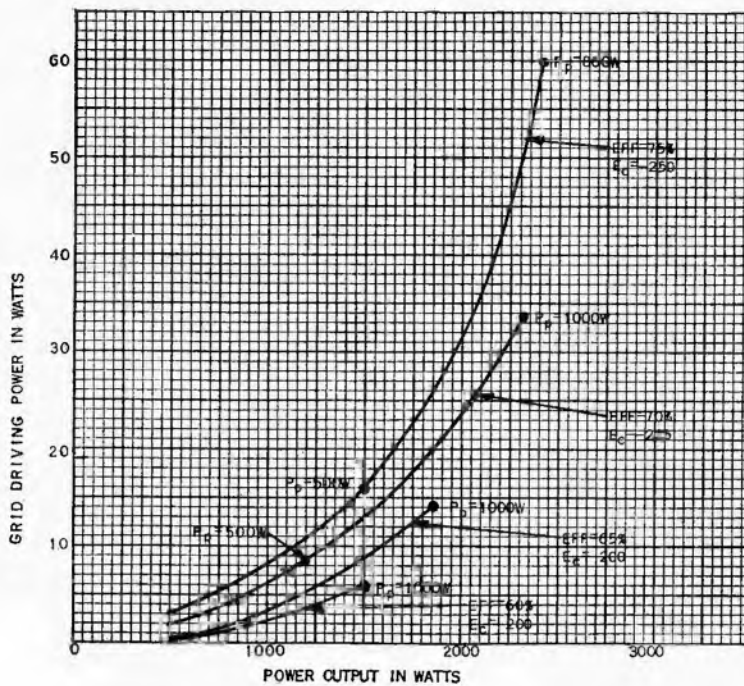
*Averaged over any audio-frequency cycle of sine-wave form.

**Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 per cent of the carrier conditions.

GL-1000T
DRIVING POWER VS POWER OUTPUT
PLATE VOLTAGE = 4000



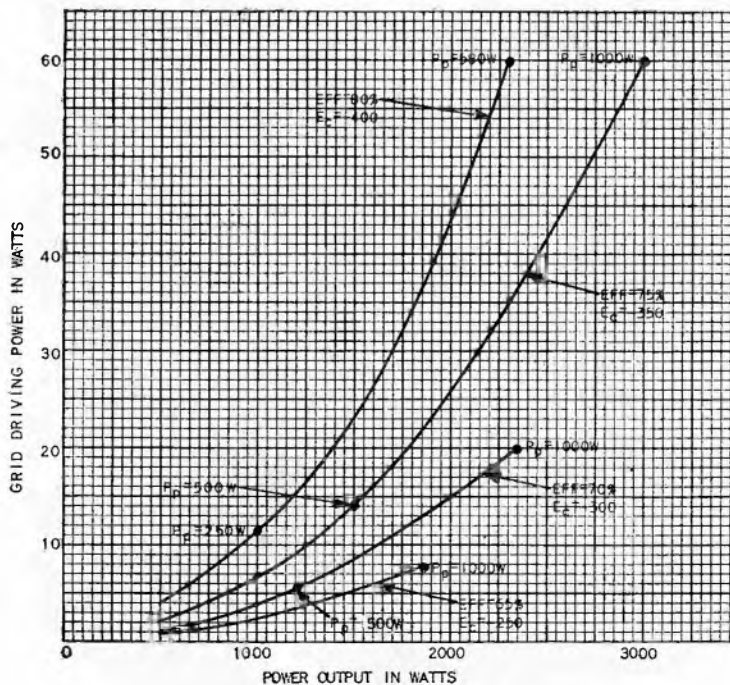
GL-1000T
DRIVING POWER VS POWER OUTPUT
PLATE VOLTAGE = 5000



K-69087-72A337

1-5-50

GL-1000T
DRIVING POWER VS POWER OUTPUT
PLATE VOLTAGE = 6000



K-69087-72A338

1-5-50

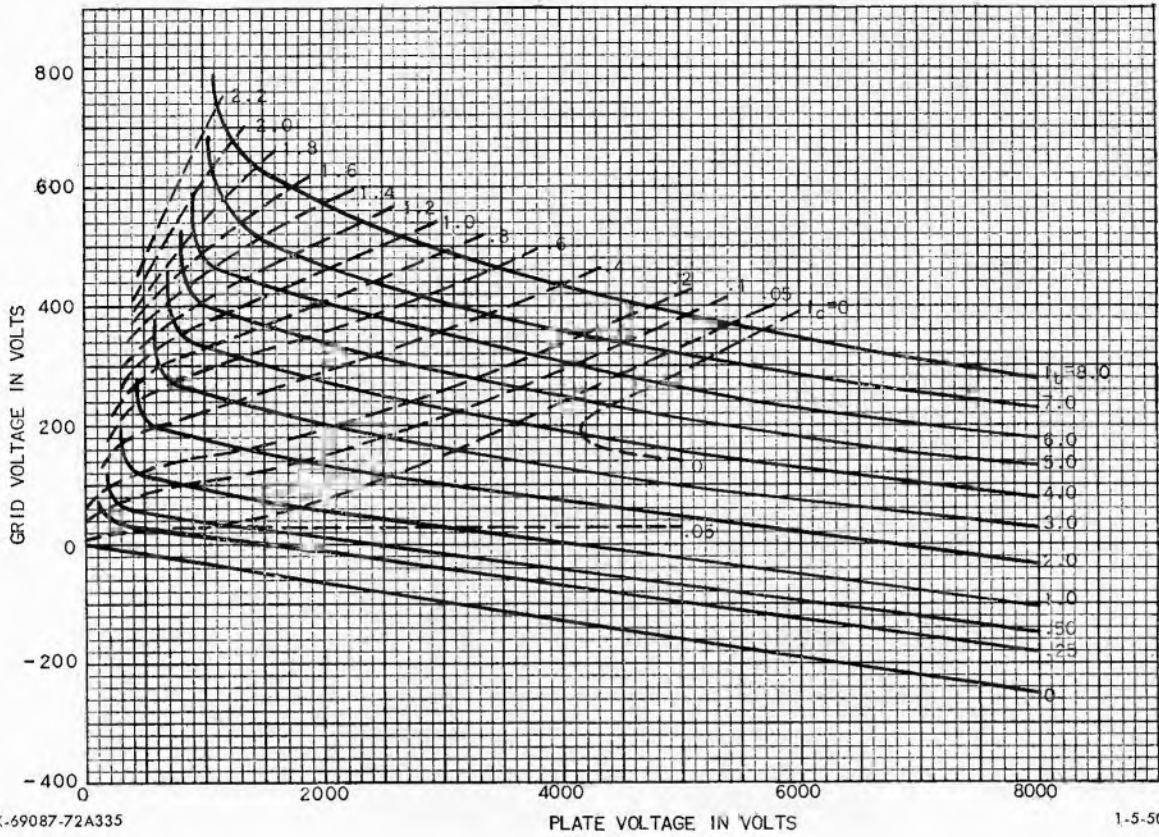
GL-1000T

ETI-314

PAGE 4

8-50

GL-1000T CHARACTERISTIC

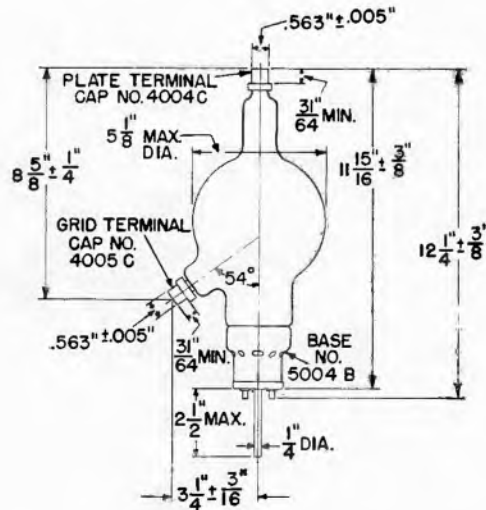


K-69087-72A335

PLATE VOLTAGE IN VOLTS

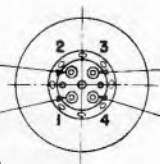
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OUTLINE GL-1000T



FILAMENT
TERMINAL

FILAMENT
(CONNECTED
INTERNALLY
TO PIN NO. 4)



FILAMENT
(CONNECTED
INTERNALLY
TO PIN NO. 2)

FILAMENT
TERMINAL

N15163AZ

1-5-50

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.

Electronics Department

GENERAL ELECTRIC

Pliotron 5659--Preliminary Technical Information

The 5659 is a beam power amplifier pentode similar to the 12A6 designed for reliable performance under conditions of severe vibration and intermittent operation.

TECHNICAL INFORMATION

GENERAL

Electrical Data

Cathode - Indirectly Heated

Heater Voltage (A-C or D-C)	12.6	Volts
Heater Current	0.150	Ampere

Mechanical Data

Envelope - MT-8

Base - Small Wafer Octal 7-Pin

Maximum Diameter	1 5/16	Inches
Maximum Overall Length	3 1/4	Inches
Maximum Seated Height	2 1/16	Inches

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Design Center

Plate Voltage	250	Volts
Screen Voltage	250	Volts
Plate Dissipation	7.5	Watts
Screen Dissipation	1.5	Watts

Typical Operation

Class A₁ Amplifier

Heater Voltage	12.6	Volts
Plate Voltage	250	Volts
Screen Voltage	250	Volts
Grid Voltage**	-12.5	Volts
Peak A-F Signal Voltage	12.5	Volts
Transconductance	3000	Micromhos
Plate Resistance, approximate	70000	Ohms
Zero Signal Plate Current	30	Milliamperes
Zero Signal Screen Current, Nominal	3.5	Milliamperes
Maximum-Signal Plate Current	32	Milliamperes
Maximum-Signal Screen Current, Nominal	5.5	Milliamperes
Load Resistance	7500	Ohms
Total Harmonic Distortion	7	Per Cent
Power Output	3.4	Watts
Vibration Output, maximum***	25	Millivolts

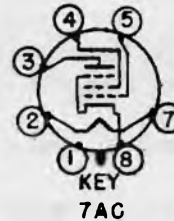
** The D-C resistance in the grid circuit, under rated maximum conditions, should not exceed 0.5 megohm for self-bias operation and 0.1 megohm for fixed bias operation.

*** RMS voltage measured across a load resistor of 2,000 ohms when tube is vibrated with a total sinusoidal motion of .08 inches at 25 cycles per second. Grid voltage = -22 volts. Average output is less than value shown.

TERMINAL CONNECTIONS

- Pin 1 - Shell
- Pin 2 - Heater
- Pin 3 - Plate
- Pin 4 - Grid #2
- Pin 5 - Grid #1
- Pin 7 - Heater
- Pin 8 - Cathode and beam plates

BASING DIAGRAM



Electronics Department

GENERAL ELECTRIC

Pliotron 5660--Preliminary Technical Information

The 5660 is a duplex-diode pentode similar to the 12C8 designed for reliable performance under conditions of severe vibration and intermittent operation.

TECHNICAL INFORMATION

GENERAL

Electrical Data

Cathode - Indirectly Heated

Heater Voltage (A-C or D-C)	12.6	Volts
Heater Current	0.150	Ampere

Mechanical Data

Envelope - MT-8

Cap - Miniature

Base - Small Wafer Octal 8-Pin

Mounting Position - Any

Direct Interelectrode Capacitances*

Grid to Plate	0.005	Maximum uuf
Input	6	uuf
Output	9	uuf

* Shell connected to cathode.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Design Center

Plate Voltage	300	Volts
Screen Supply Voltage	300	Volts
Screen Voltage	125	Volts
Plate Dissipation	2.25	Watts
Screen Dissipation	0.3	Watts
Minimum External Grid Bias Voltage	0	Volts
Maximum Diode Current per Plate for Continuous Operation	1.0	Milliamperes

Typical Operation

Pentode Section: Class A₁ Amplifier

Heater Voltage	12.6	Volts
Plate Voltage	250	Volts
Screen Voltage	125	Volts
Grid Voltage	-3	Volts
Plate Resistance, approximate	0.6	Megohm
Transconductance	1325	Micromhos

Typical Operation

Pentode Section: Class A₁ Amplifier

Plate Current	10 Milliamperes
Screen Current	2.3 Milliamperes
Grid Bias For Cathode Current Cut-Off, approximate	-21 Volts
Vibration Output, maximum**	25 Millivolts

Diode Sections:

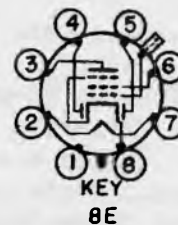
Minimum Diode Current per Plate With 10 Volts D-C Applied 0.8 Milliamperes

** RMS voltage measured across a load resistor of 10,000 ohms when tube is vibrated with a total sinusoidal motion of .08 inches at 25 cycles per second. Average output is less than value shown.

TERMINAL CONNECTIONS

Pin 1 - Shell
Pin 2 - Heater
Pin 3 - Pentode Plate
Pin 4 - Diode Plate #2
Pin 5 - Diode Plate #1
Pin 6 - Grid #2
Pin 7 - Heater
Pin 8 - Cathode and Grid #3
Cap - Grid #1

BASING DIAGRAM



Electronics Department

G E N E R A L E L E C T R I C

Pliotron 5661--Preliminary Technical Information

The 5661 is a voltage amplifier pentode similar to the 12SK7 designed for reliable performance under conditions of severe vibration and intermittent operation.

TECHNICAL INFORMATION

GENERAL

Electrical Data

Cathode - Indirectly Heated

Heater Voltage (A-C or D-C)	12.6	Volts
Heater Current	0.150	Ampere

Mechanical Data

Envelope - MP-8

Base - Small Wafer Octal 8-Pin

Mounting Position - Any

Direct Interelectrode Capacitances*

Grid to Plate	.003	Maximum uuf
Input	6.0	uuf
Output	7.0	uuf

* Shell connected to cathode.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum Ratings, Design Center

Plate Voltage	300	Volts
Screen Supply Voltage	300	Volts
Screen Voltage	125	Volts
Plate Dissipation	4.0	Watts
Screen Dissipation	0.4	Watts
Minimum External Control Grid Bias Voltage	0	Volts

Typical Operation

Class A₁ Amplifier

Heater Voltage	12.6	12.6	Volts
Plate Voltage	100	250	Volts
Screen Voltage	100	100	Volts
Control Grid Voltage	-1	-3	Volts
Suppressor - Connected to Cathode at Socket			
Plate Resistance, approximate	0.12	0.8	Megohm
Transconductance	2350	2000	Micromhos
Control Grid Voltage for Transcon-			
ductance = 10, approximate	-35	-35	Volts

Typical Operation

Class A₁ Amplifier (Cont'd)

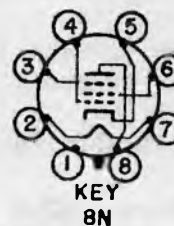
Plate Current	13	9.2	Milliamperes
Screen Current	4	2.6	Milliamperes
Vibration Output, maximum**	---	15	Millivolts

** RMS voltage measured across a load resistor of 2,000 ohms when tube is vibrated with a total sinusoidal motion of .08 inches at 25 cycles per second. Average output is less than value shown.

TERMINAL CONNECTIONS

- Pin 1 - Shell and internal shield
- Pin 2 - Heater
- Pin 3 - Grid #3
- Pin 4 - Grid #1
- Pin 5 - Cathode
- Pin 6 - Grid #2
- Pin 7 - Heater
- Pin 8 - Plate

BASING DIAGRAM



GLOW TUBES

GENERAL  ELECTRIC

Supersedes ETI-176 dated 4-45

GLOW TUBES



DESCRIPTION

A glow tube is a cold-cathode, gas-discharge tube in which no means is provided for controlling the unidirectional current flow. (NEMA definition). This type of tube is also known as a voltage-regulator tube, a name which describes its principal application.

Fundamentally, a glow tube consists of two electrodes, an anode and a cold cathode, in a partial

atmosphere of inert gas or vapor. The emission is obtained from the cold cathode by virtue of a potential gradient at the cathode surface. This gradient literally pulls electrons out of the cathode. For this reason cathodes are sometimes coated with some material which has a low work function so that electrons are given off with comparative ease.

GENERAL OPERATION

Two types of discharge are possible in a glow tube. A glow discharge, which is a uniform glow covering all or part of the cathode surface, will occur when the current carried by the tube is low. Under these conditions the tube drop is essentially independent of the current. This is the condition under which glow tubes normally operate. The exact voltage drop across the tube depends upon the electrode spacing and the type and amount of gas used.

If the current through the tube is increased be-

yond a certain point the tube will go into a so-called arc discharge. Under these conditions a cathode spot rather than a uniform cathode glow appears on the cathode and the tube drop decreases to a rather low value (10-20 volts). Although some glow tubes are designed to operate as arc-discharge tubes, the majority of glow tubes must not be operated so that an arc discharge takes place, as the life of the tube will be materially shortened.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Tube Type Number	GL-OA3, GL-OB3 GL-OC3, GL-OD3	GL-874
Type of voltage-regulator tube	Glow discharge	Glow discharge
Cathode	Cold type	Cold type
Maximum over-all length	4 $\frac{1}{8}$ inches	5 $\frac{3}{8}$ inches
Maximum seated height	3 $\frac{3}{16}$ inches	4 $\frac{3}{4}$ inches
Maximum diameter	1 $\frac{9}{16}$ inches	2 $\frac{1}{16}$ inches
Base	Small shell octal 6-pin	Medium 4-pin bayonet
Net weight, approx.	2 ounces	2 ounces
Shipping weight, approx.	3 pounds	3 pounds

MAXIMUM RATINGS

TUBE TYPE NUMBER	GL-OA3			GL-OB3			GL-OC3			GL-OD3			GL-874			
	Min	Bogey	Max	Min	Bogey	Max	Min	Bogey	Max	Min	Bogey	Max	Min	Bogey	Max	
Electrical Data																
D-c anode-supply voltage*	105	—	—	130	—	—	133	—	—	185	—	—	130	—	—	volts
D-c operating voltage	—	—	—	—	—	—	—	—	—	—	—	—	—	90	—	volts
Anode voltage drop	68	75	85	77	90	104	103	108	116	142	153	165	—	—	—	volts
Anode breakdown voltage	—	100	105	—	105	130	—	115	133	—	160	185	—	115	130	volts
Regulation	—	5	6.5	—	5	9	—	2	4	—	4	5.5	—	7	—	volts
Mechanical Data																
Mounting position																any
Net weight, maximum	1.3			1.3			1.3			1.3			1.3			ounces
Maximum Ratings, Absolute Values																
Maximum average starting current	100			100			100			100			—			milliamperes
Maximum averaging time	10			10			10			10			—			seconds
D-c Cathode Current																
Maximum	40			30			40			40			50			milliamperes
Minimum	5			5			5			5			10			milliamperes
Maximum frequency	0†			0			0			0			—			
Ambient temperature limits	-55 to +90			-55 to +90			-55 to +90			-55 to +90			-55 to +90			C

* To assure starting throughout tube life not less than the specified supply voltage should be provided.

† C operation only.

DEFINITIONS OF RATINGS

D-c Anode Supply Voltage, Minimum

This is the minimum value of voltage that the voltage supply must be capable of applying to the glow tube.

D-c Operating Current

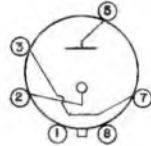
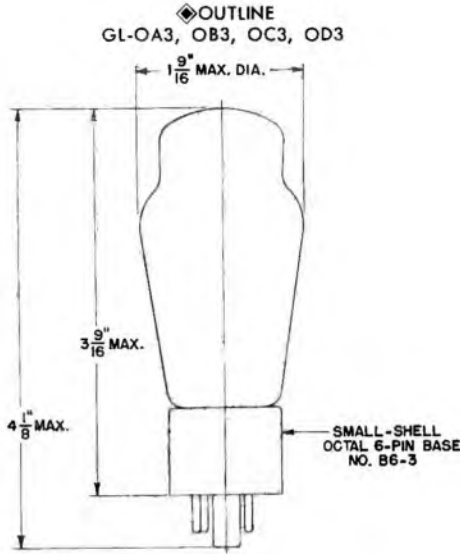
These values of maximum and minimum current indicate the range over which the glow tube will operate satisfactorily. Operation below the minimum current will cause erratic regulation and operation above maximum current will result in short life and erratic regulation.

Regulation

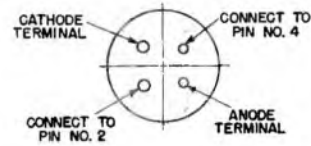
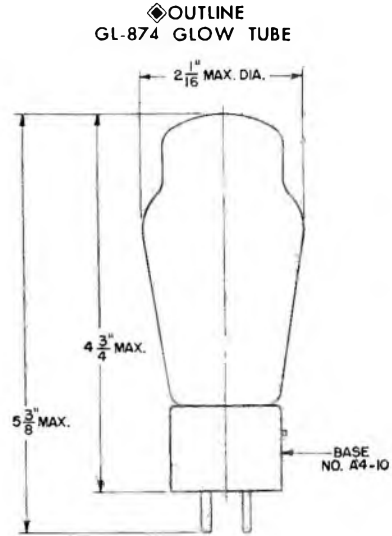
The regulation voltage is the maximum variation in voltage drop across the glow tube. It is calculated as the difference between the voltage drop obtained at the maximum current and the voltage drop obtained at the minimum current.

Ambient Temperature Range

This temperature range indicates the maximum and minimum temperatures at which satisfactory operation may be obtained.



K-8065597
 ◆Revised



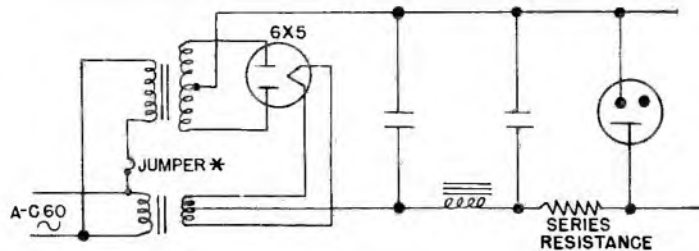
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 ◆Revised

11-22-50



APPLICATION CIRCUITS

The most common use of the glow tube is as a voltage regulating device.



K-8639684 Fig. 1—Voltage-Regulated Power Supply Circuit 9-25-44

*Most glow tubes are provided with a jumper wire connected internally. This is usually employed as a switch, and is wired in series with the primary of the transformer supplying power to the glow tube. When the tube is removed from the socket the power supply circuit is automatically shut off.

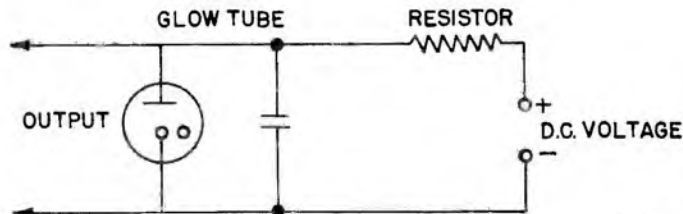
Fig. 1 above illustrates a voltage-regulated power supply circuit incorporating a glow tube as a voltage stabilizer.

Such a circuit is an inexpensive means of providing a regulated voltage within the capabilities of a tube for such applications. The series resistance must be of a value that will limit the current through the glow tube to the maximum rated current. It is also desirable to furnish a high enough voltage from the d-c supply so that the current through the glow tube does not drop below the

minimum rating.

Glow tubes may be used in series to provide higher regulated voltages than are available from one tube. These tubes need not be the same type, the only requirement being that the current must be limited so that it falls within the operating range of the combination. For example, if a GL-OA3 and a GL-OB3 are used in series, the current must be limited to 30 milliamperes maximum. Operation of glow tubes in parallel is not recommended.

A second application of the glow tube is the relaxation oscillator illustrated in Fig. 2.



K-8639685 Fig. 2—Relaxation Oscillator Circuit 9-25-44

In this type of circuit, a current charges a capacitor. In parallel with the capacitor is a glow tube, which will break down when the voltage on the capacitor reaches the voltage breakdown point of the glow tube. The frequency of this action may

be varied by changing the capacitance or type of glow tube.

#Circuits shown in ETI-176 are examples of possible tube applications and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company.

INSTALLATION AND OPERATION

Sufficient resistance must always be used in series with each of these tubes to limit the current through the tube to the maximum rated value under continuous (steady state) operating conditions. During the interval of 5 to 10 seconds which may be required for the regulated tubes in associated equipment to warm up and draw plate current, a maximum current of 100 milliamperes is permissible provided each such starting period is followed by a steady-state operating period of at least several minutes. Unless this pre-

caution is observed, tube performance will be impaired.

In voltage-regulator tubes of the glow-discharge type, regulation is somewhat dependent on past operating conditions. For example, the regulation value of a tube operated for a protracted period at 5 milliamperes and then changed to 35 milliamperes may be somewhat different from the value that will be obtained after a long period of operation at 35 milliamperes. Likewise, the regulation value may change somewhat after a long idle period.

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



GLOW TUBE

DESCRIPTION

The GL-OA2 is a miniature two-electrode inert-gas-filled cold-cathode tube for use as a voltage regulator.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
D-c Anode-supply Voltage*	185			volts
Anode voltage drop	140	151	168	volts
Anode breakdown voltage		156	185	volts
Shunt capacitor			0.1	microfarad
Regulation		2	6	volts

Mechanical Data

Mounting position—any				
Net weight, maximum			0.3	Ounce

*To assure starting throughout tube life not less than the specified supply voltage should be provided.



TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS, Absolute Values

Maximum average starting current	75 milliamperes
Maximum averaging time	10 seconds
D-c cathode current	
Maximum	30 milliamperes
Minimum	5 milliamperes
Maximum frequency	0 cycles per second
Ambient temperature limits	-55 to +90 C

APPLICATION NOTES

▣ The base of the GL-OA2 fits the miniature 7-pin socket which may be mounted to hold the tube in any position. No connection should be made to pins 3 and 6 which extend into the interior of the tube since any potentials applied to these pins may cause erratic tube performance. The three pin terminals for the cathode and the two for the anode offer the designer several different possibilities for connection so as to provide protection for the associated components in case the regulator tube is removed from its socket.

Sufficient resistance must always be used in series with the GL-OA2 to limit the current through the tube. The value for the series resistor is dependent on the maximum anode-supply voltage and the ratio of the current through the load to the operating current of the GL-OA2, and should be chosen to limit the operating current through the tube to 30 milliamperes at all times after the starting period.

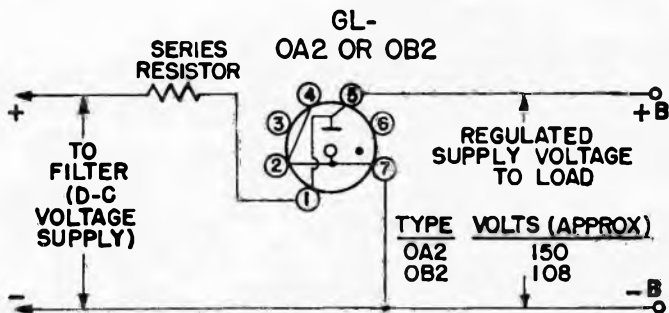
The maximum load current that can be regulated is determined by the minimum and maximum values of the supply voltage. The value of series resistor for the maximum supply voltage should be calculated as indicated above. The user should then determine whether this value will permit adequate starting voltage when the supply voltage falls to its minimum value. If adequate starting voltage is not obtained, a new load current of lower value must be used and the calculations repeated. It will be apparent from such calculations that the higher the minimum supply voltage and the smaller the difference between its minimum and maximum values, the higher will be the load current that can be regulated.

In order to handle more load current, two or more GL-OA2's may be operated in parallel, but such parallel operation requires that a resistor be used in series with each regulator tube in order to equalize division of the current between the paralleled tubes. Approximately a 100-ohm resistor for each tube should be used. The disadvantage of this method is that the use of resistors impairs the regulation which can be obtained.

When equipment utilizing the GL-OA2 is turned on, a starting current in excess of the average operating current is permissible as indicated under Maximum Ratings. When the tube is subjected to such high starting currents, the regulated voltage may require up to 20 minutes to drop to its normal operating value. This performance is characteristic of voltage-regulator tubes of the glow-discharge type. Similarly, the regulation voltage is affected by changes in current within the operating current range. For example, the regulation value of a tube operated for a protracted period at 5 milliamperes and then changed to 25 milliamperes, may be somewhat different from the value that will be obtained after a long period of operation at 25 milliamperes. Likewise, the regulation value may change somewhat after a long idle period.

If the associated circuit has a capacitor in shunt with the GL-OA2, the capacitor should be limited in value to 0.1 microfarad. A larger value may cause the regulator tube to oscillate and thus give unstable regulation performance.

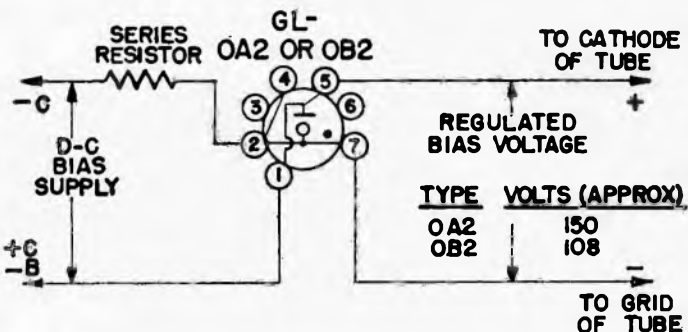
TYPICAL CIRCUITS
FOR
GLOW TUBE GL-OA2



CIRCUIT TO PROVIDE REGULATED SUPPLY VOLTAGE OF APPROXIMATELY 150 OR 108 VOLTS TO LOAD. REMOVAL OF TUBE FROM SOCKET REMOVES VOLTAGE FROM LOAD.

K-69087-72A280

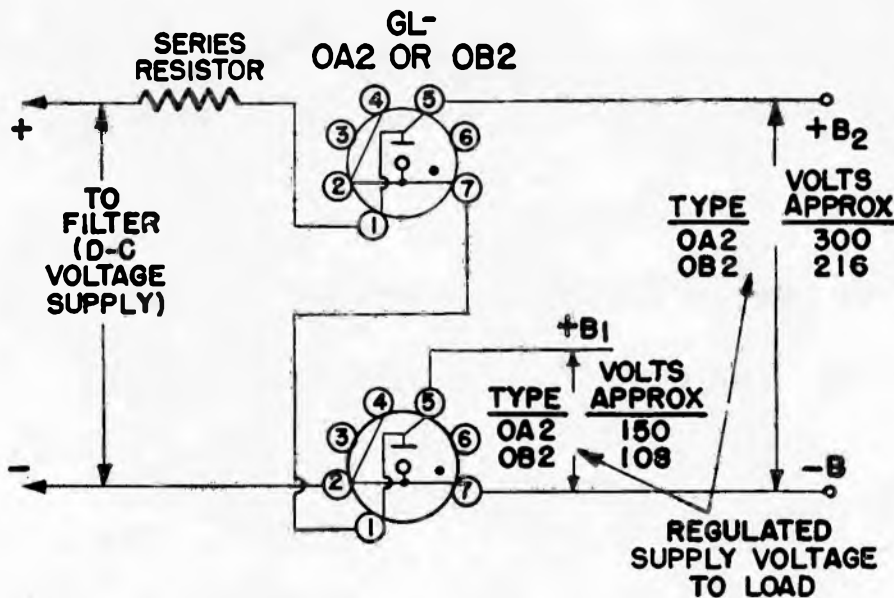
4-6-49



CIRCUIT FOR BIAS-SUPPLY REGULATION. REMOVAL OF TUBE FROM SOCKET OPENS B-SUPPLY CIRCUIT OF REGULATED TUBES.

K-69087-72A282

4-6-49

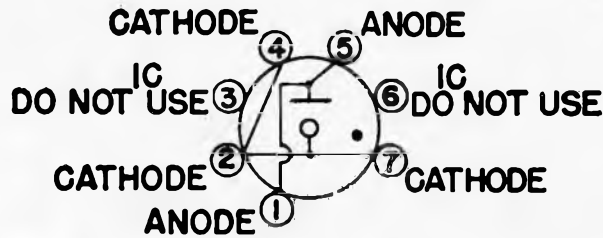
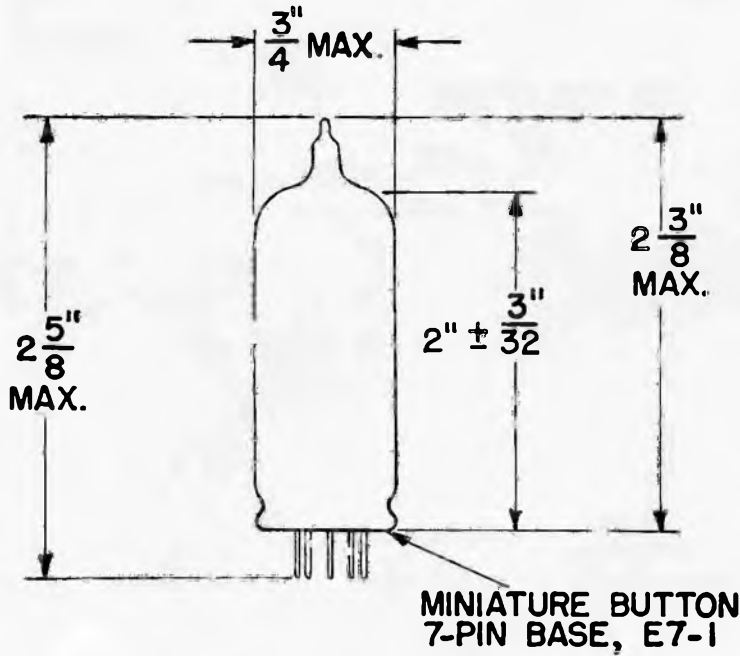


CIRCUIT USING TWO OA2'S OR TWO OB2'S TO PROVIDE REGULATED SUPPLY VOLTAGES OF APPROXIMATELY 300 OR 216 VOLTS AND 150 OR 108 VOLTS TO LOAD. SOCKET CONNECTIONS ARE SO MADE THAT VOLTAGE ON LOAD IS REMOVED WHEN EITHER TUBE IS TAKEN FROM ITS SOCKET.

K-69087-72A281

4-6-49

OUTLINE
GLOW TUBE GL-OA2



BASING DIAGRAM

N15146AZ

4-6-49

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



GLOW TUBE

DESCRIPTION

The GL-OB2 is a miniature two-electrode inert-gas-filled cold-cathode tube for use as a voltage regulator.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
D-c anode-supply voltage*	133	.....	.....	volts
Anode voltage drop	101	108	114	volts
Anode breakdown voltage	.....	115	133	volts
Shunt capacitor	.....	.....	0.1	microfarad
Regulation	.....	1	4	volts

Mechanical Data

Mounting position—any				
Net weight, maximum			0.3	ounce

*To assure starting throughout tube life not less than the specified supply voltage should be provided.



Electronic
 TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)**MAXIMUM RATINGS, ABSOLUTE VALUES**

Maximum average starting current.....	75 milliamperes
Maximum averaging time.....	10 seconds
D-c cathode current	
Maximum.....	30 milliamperes
Minimum.....	5 milliamperes
Maximum frequency.....	0 cycles per second
Ambient temperature limits.....	-55 to +90 °C

APPLICATION NOTES

The base of the GL-OB2 fits the miniature 7-pin socket which may be mounted to hold the tube in any position. No connection should be made to pins 3 and 6 which extend into the interior of the tube since any potentials applied to these pins may cause erratic tube performance. The three pin terminals for the cathode and the two for the anode offer the designer several different possibilities for connection so as to provide protection for the associated components in case the regulator tube is removed from its socket.

Sufficient resistance must always be used in series with the GL-OB2 to limit the current through the tube. The value for the series resistor is dependent on the maximum anode-supply voltage and the ratio of the current through the load to the operating current of the GL-OB2, and should be chosen to limit the operating current through the tube to 30 milliamperes at all times after the starting period.

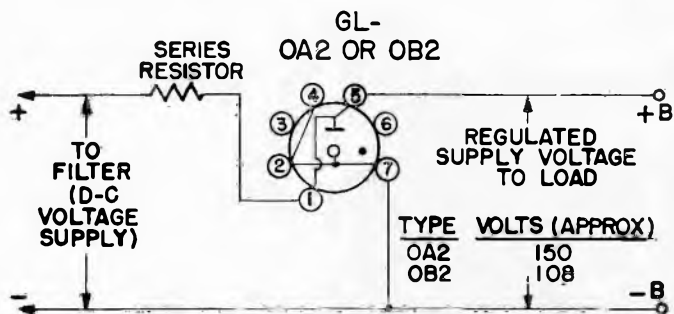
The maximum load current that can be regulated is determined by the minimum and maximum values of the supply voltage. The value of series resistor for the maximum supply voltage should be calculated as indicated above. The user should then determine whether this value will permit adequate starting voltage when the supply voltage falls to its minimum value. If adequate starting voltage is not obtained, a new load current of lower value must be used and the calculations repeated. It will be apparent from such calculations that the higher the minimum supply voltage and the smaller the difference between its minimum and maximum values, the higher will be the load current that can be regulated.

In order to handle more load current, two or more GL-OB2's may be operated in parallel, but such parallel operation requires that a resistor be used in series with each regulator tube in order to equalize division of the current between the paralleled tubes. Approximately a 100-ohm resistor for each tube should be used. The disadvantage of this method is that the use of resistors impairs the regulation which can be obtained.

When equipment utilizing the GL-OB2 is turned on, a starting current in excess of the average operating current is permissible as indicated under Maximum Ratings. When the tube is subjected to such high starting currents, the regulated voltage may require up to 20 minutes to drop to its normal operating value. This performance is characteristic of voltage-regulator tubes of the glow-discharge type. Similarly, the regulation voltage is affected by changes in current within the operating current range. For example, the regulation value of a tube operated for a protracted period at 5 milliamperes and then changes to 25 milliamperes, may be somewhat different from the value that will be obtained after a long period of operation at 25 milliamperes. Likewise, the regulation value may change somewhat after a long idle period.

If the associated circuit has a capacitor in shunt with the GL-OB2, the capacitor should be limited in value to 0.1 microfarad. A larger value may cause the regulator tube to oscillate and thus give unstable regulation performance.

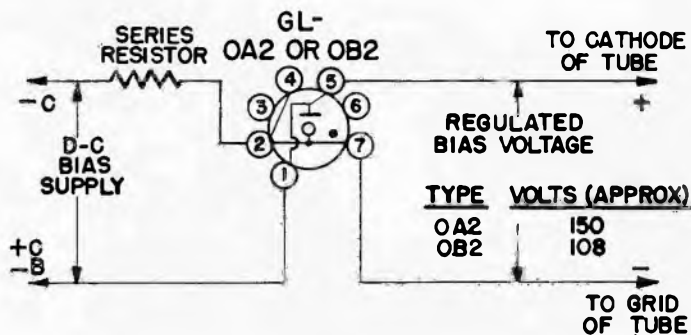
TYPICAL CIRCUITS
FOR
GLOW TUBE GL-OB2



CIRCUIT TO PROVIDE REGULATED SUPPLY VOLTAGE OF APPROXIMATELY 150 OR 108 VOLTS TO LOAD. REMOVAL OF TUBE FROM SOCKET REMOVES VOLTAGE FROM LOAD.

K-69087-72A280

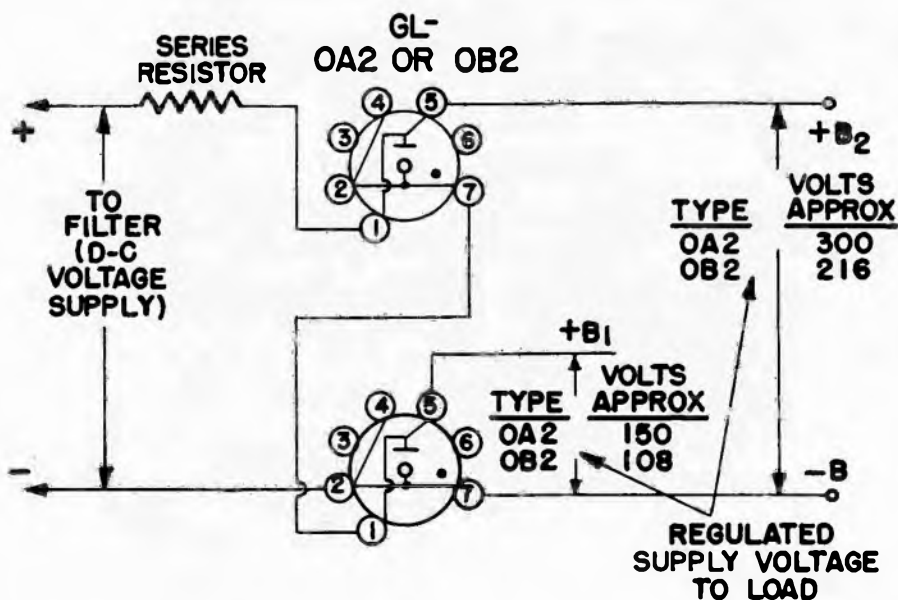
4-5-49



CIRCUIT FOR BIAS-SUPPLY REGULATION. REMOVAL OF TUBE FROM SOCKET OPENS B-SUPPLY CIRCUIT OF REGULATED TUBES.

K-69087-72A282

4-6-49



CIRCUIT USING TWO OA2'S OR TWO OB2'S TO PROVIDE REGULATED SUPPLY VOLTAGES OF APPROXIMATELY 300 OR 216 VOLTS AND 150 OR 108 VOLTS TO LOAD. SOCKET CONNECTIONS ARE SO MADE THAT VOLTAGE ON LOAD IS REMOVED WHEN EITHER TUBE IS TAKEN FROM ITS SOCKET.

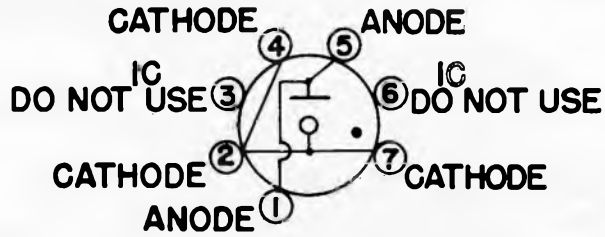
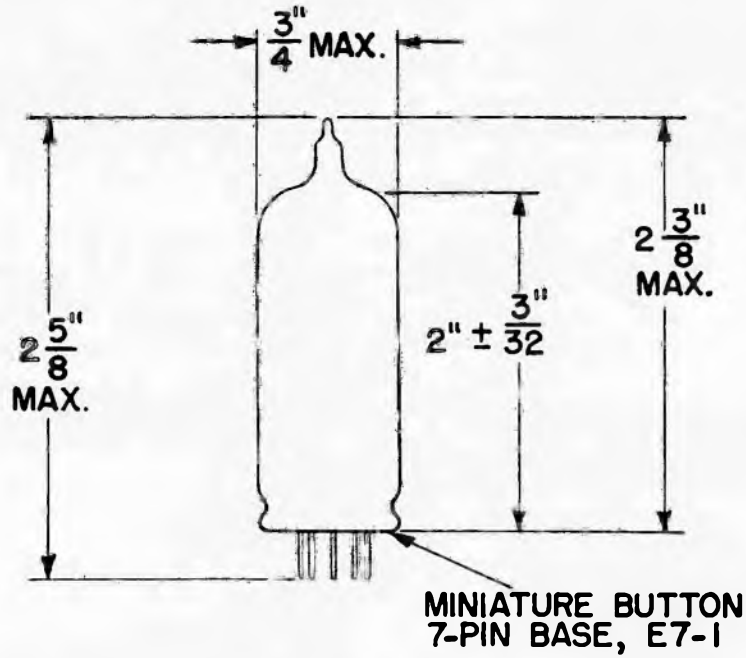
K-69087-72A281

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GL-OB2

ETI-306
PAGE 4
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OUTLINE
GLOW TUBE GL-OB2



BASING DIAGRAM

N-15146AZ

4-6-49

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.

PHOTOUBES



GENERAL  ELECTRIC

PHOTOTUBES



DESCRIPTION

The phototube is an electronic device that controls a flow of electrons by means of changes in light. Technically, a "phototube is a vacuum tube in which one of the electrodes is irradiated for the purpose of causing electron emission." (IRE Definition).

When a voltage in series with a resistance is

applied to the anode and cathode of a phototube and the cathode is illuminated by some light source, a current will flow in this circuit proportional to the amount of light striking the cathode.

A phototube may be used in any application where a current change due to a light intensity change can be utilized for control purposes.

FUNDAMENTALS

Phototubes consist essentially of two electrodes in an evacuated container in which there may be either a vacuum or an inert gas at low pressure.

There are three general types of phototubes, vacuum, gas, and electron multiplier. The last mentioned tube consists of the two usual electrodes, cathode and anode, as well as a series of electrodes called dynodes which amplify the electron current from the cathode by means of secondary emission.

The cathode has the property of emitting electrons under the action of light. A potential of from 15 to 25 volts applied to the anode is sufficient to attract all the electrons emitted from the cathode by the action of the light.

An increase of anode voltage above this value will cause little or no increase in current in the vacuum-type tube. However, when a low pressure of an inert gas is present, the original current is increased by the ionization of the gas.

The amount of ionization increases rapidly as the anode voltage is increased, until a point is reached at which the discharge breaks into a glow. Since this glow discharge will destroy the tube, it is

always necessary to limit the anode voltage to a point well below this value.

In the multiplier-type tube, increases in anode and dynode voltages cause greater electron flow due to secondary emission than in either of the other types.

In general, the vacuum types are the more stable in their characteristics and give an output directly proportional to the light flux incident on the cathode. The gas-filled tubes have the advantage of greater output per unit of light flux because of the ionization of the gas.

The color sensitivity of phototubes, which varies depending upon the type of light-sensitive material and glass envelope used, is quite different from that of the human eye. General Electric manufactures phototubes covering the following color ranges: Red-infrared, violet-green, blue, ultraviolet-blue, ultraviolet, violet-red.

Whenever it is desirable to have a device with a special color sensitivity, a standard phototube should be used in conjunction with a light filter with the proper transmission characteristics.

RATINGS

Phototubes are rated in terms of the following:

Spectral Response—expressed as a symbol composed of the letter "S" followed by a number, as S-1, S-2, etc. These symbols represent various curves of output versus light wavelength, and are standardized in accordance with RMA standards.

Luminous Sensitivity—usually expressed as the current in microamperes per lumen of light flux. Measurements are usually made at 0.1 lumen, the light source being a tungsten lamp operating at 2870° K. The ultraviolet-sensitive tubes are tested by means of ultraviolet lamps rather than the tungsten lamp.

Static Sensitivity—the ratio of anode direct current to a constant luminous flux.

Dynamic Sensitivity—the ratio of the variation in anode current to the variation of a varying luminous flux.

Leakage Resistance or Dark Current—a measure of the output impedance of the phototube. It is given either as a resistance in megohms or a current in microamperes through a given resistance. In the latter case, the cathode is in complete darkness.

Gas Ratio—the ratio of the current when ionization exists, to the current due to primary electrons alone. This ratio is obtained by comparing the luminous sensitivities at two voltages, usually 90 and 25 volts.

Maximum Anode Voltage—the maximum instantaneous value of voltage that should be impressed on the tube.

Maximum Anode Current—the maximum instantaneous value of current that should be allowed to pass through the tube.

Maximum Ambient Temperature—the maximum temperature to which the tube should be subjected.

CLASSES OF PHOTOTUBES

Although phototubes are made in a variety of styles and sizes, there are two general methods of classification—by size and by style. There are two general sizes:

- large—PJ-22
- small—GL-929

There are several special sizes, of which the

FJ-405 is one example. The size classes may be divided into three styles, vacuum, gas, and multiplier, the second method of classification. All styles do not exist in each size, as the multiplier type comes in only one size. In the large size tubes, GL-868/PJ-23 is the gas tube and the PJ-22 the vacuum tube.

APPLICATIONS

Phototubes can be divided into three general classes of use: control and safety, amusement and sound reproduction, inspection and measurement.

Under control and safety come such applications as:

1. Opening doors automatically
2. Burglar alarm systems
3. Automatic switching of street-lighting systems

Amusement and sound reproduction includes:

1. Pin-ball games
2. Theater sound systems
3. Horse race timers

Inspection and measurement uses include:

1. Color temperature pyrometers
2. Pinhole detection in sheet metal
3. Daytime measurements of cloud heights

These are but a few of the many applications in each of these categories and are given merely as an indication of some of the better known uses to which phototubes have been applied.

For most control applications ample illumination is provided by a lamp used as a source of light. In these cases, it is desirable to use a gas phototube of high sensitivity. This obviates the necessity of high-gain amplifier stages following the phototube.

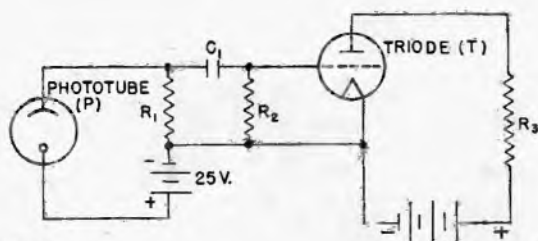
For measurement applications, where a very small amount of light is available, a fairly high output impedance is desirable. Leakage currents become important in this case. Phototubes with low leakage are the GL-917 and GL-919.

In applications requiring a stable phototube, the vacuum phototube is recommended. For best operation the anode voltage should be kept below 25 volts. It is also desirable to illuminate as much of the cathode area as possible, to avoid minor differences in sensitivity of various sections of the cathode.

Where extreme amplification is required the multiplier tube should be used. In comparison to a vacuum phototube, the multiplier phototube has an amplification factor approaching 1,000,000.

APPLICATION CIRCUITS

Fig. 1 shows an elementary circuit diagram of a phototube and amplifier. P is any phototube and T any triode. Changes in light on the phototube will cause a change in the current through the load resistance R_3 .



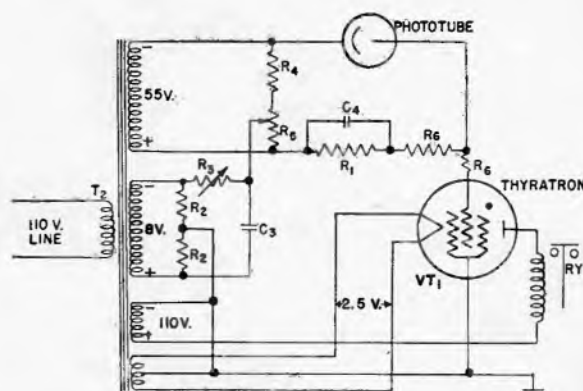
K-8639699

Fig. 1—Elementary Circuit Diagram of a Phototube and Amplifier

10-14-44

A variation of the elementary diagram is shown in Fig. 2. Here the phototube controls a double-grid thyatron, the thyatron conducting when the light level on the phototube decreases. The GL-868/PJ-23 phototube and the FG-97 thyatron are used in this circuit. This type of circuit pro-

vides an on-off arrangement, actuated by a phototube and is particularly suitable for applications requiring a high speed of response, where the values of current required are within the rating of the thyatron tube.



K-8639691

Fig. 2—Phototube Double-Grid Thyatron Relay Control Circuit

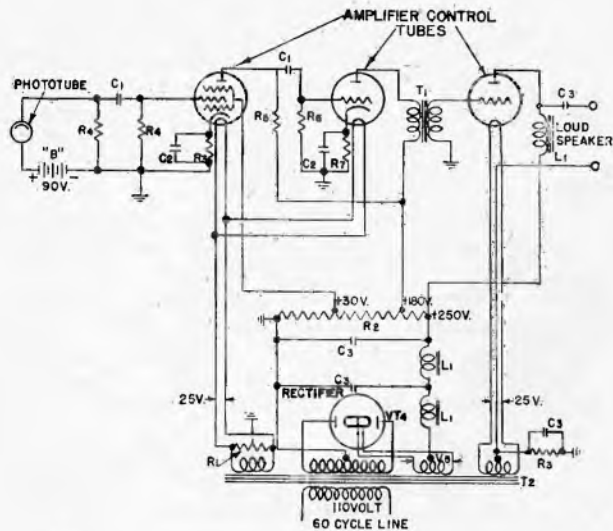
9-28-44

#Circuits shown in ETI-177 are examples of possible tube applications and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company.

The circuit in Fig. 3 demonstrates the use of the GL-868/PJ-23 phototube as an audio-frequency pickup tube. Any audio-fluctuation of a light

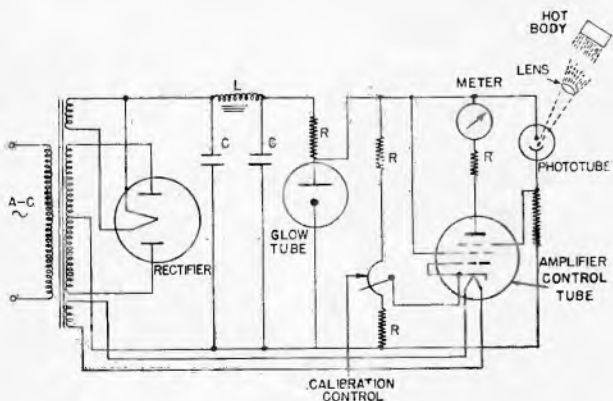
APPLICATION CIRCUITS (CONT'D)

source will be picked up on the phototube and amplified. This type of circuit is used commercially in talking motion pictures, to change the variations along the sound track on the film, back into actual sound and music as heard in our modern theatres. Such a circuit is also suitable for use in "Narrow-casting" with a beam of light where it is desirable to focus the direction of signals to make sure they are not read from other sources.



K-8639687 Fig. 3—High-Gain Phototube Amplifier Circuit 1-26-45

Figs. 4 through 10 illustrate some of the many circuits for specific applications where phototubes are particularly advantageous for measurement and control work. The circuit shown in Fig. 4 may be used for measuring and recording

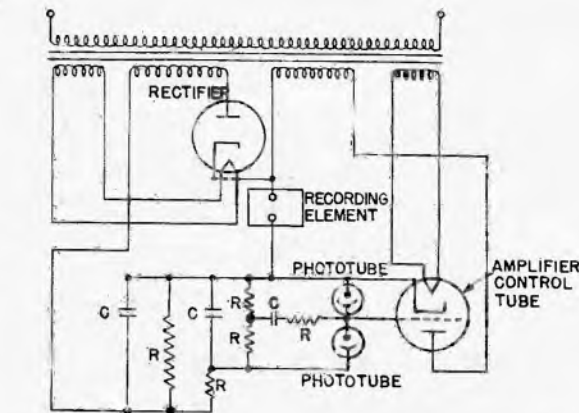


K-9033554 *Fig. 4—Phototube Pyrometer Circuit 12-11-44

*Fig. 4—King, W. R., *General Electric Review*, Vol. 39
†Fig. 5—Henney, *Electron Tubes in Industry*, P-418 McGraw-Hill Book Co. Inc., 1937
‡Fig. 7—Reich, H. J., *Theory and Application of Electron Tubes*, P-508 McGraw-Hill Book Co., 1939

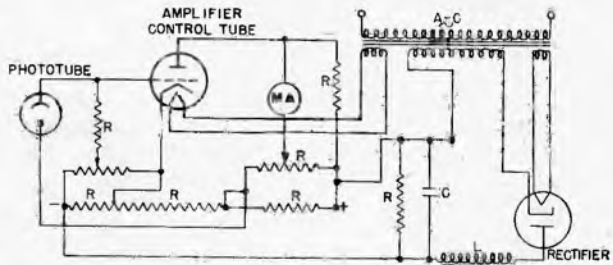
high temperatures where the heat is at a visible temperature.

The circuit shown in Fig. 5 has a high impedance input and is adapted for use where the continuous recording of small currents is desired.



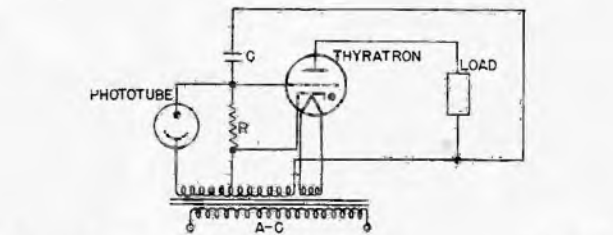
K-9033504 †Fig. 5—Recorder Circuit Using Phototubes, Rectifier and High-Vacuum Amplifier 10-14-44

Fig. 6 is a circuit used for the measurement of illumination. This circuit may be employed in applications which require the measurement of the output of different light levels.



K-9033501 Fig. 6—Phototube Circuit for the Measurement of Illumination 10-14-44

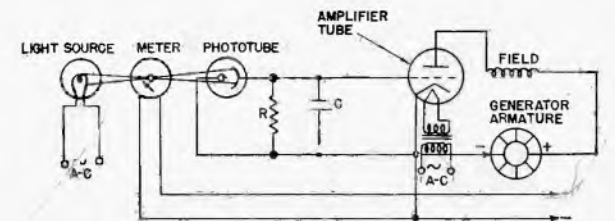
The circuit shown in Fig. 7 is suitable for counting, for on-off operation and similar uses. The voltage source in this circuit is a-c rather than d-c.



K-9033500 ‡Fig. 7—Thyatron Phase-Control Circuit Employing a Phototube 10-14-44

APPLICATION CIRCUITS (CONT'D)

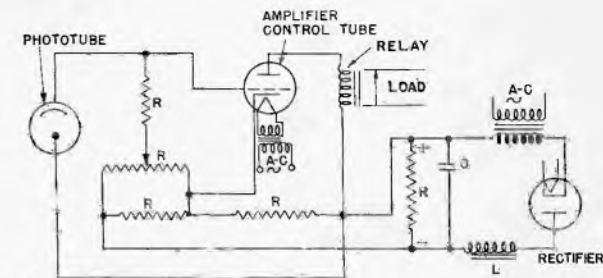
A circuit for regulating the voltage output from a generator by changing the field supply voltage is shown in Fig. 8.



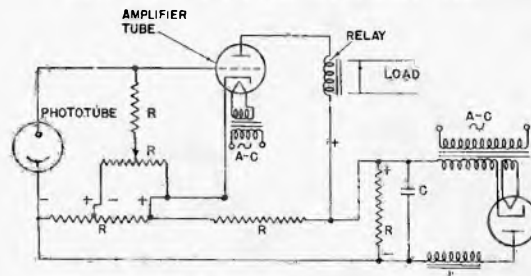
K-9033507 10-14-44
Fig. 8—Voltage Regulation Circuit Using Hole in Meter

The circuits illustrated in Figs. 9 and 10 are used for operating relays, for counters, or for on-off and limit-control applications. The circuit shown in Fig. 9 is applicable in cases where relay operation is desired with an increase in light level.

The circuit in Fig. 10 may be used in applications where it is desired to operate the relay with a decrease in light level.



K-8639696 10-14-44
Fig. 9—Forward D-c Photoelectric Relay Circuit



K-9033505 10-14-44
Fig. 10—Reverse D-c Photoelectric Relay Circuit

INSTALLATION AND OPERATION

Phototubes may be mounted in any position, but a shock-absorbing mounting must be used if the tubes are to be subjected to vibration or shock.

Tubes should never be used in an ambient temperature higher than that given under the Technical Information for the specific tube.

Care should be exercised in wiring to insure high insulation resistance and low capacitance in all parts of the circuit.

It is desirable to operate phototubes at as low a voltage and illumination as possible, as the life will be increased and better stability of operation will result. A high light level is harmful when the tube is disconnected as well as when it is in operation.

For high-frequency operation it is important that leads be kept short to reduce output capacitance.

The average amplifier circuit employing a phototube makes use of standard radio receiver tubes. These radio tubes are rated for approximately 10 megohms maximum d-c resistance between grid and cathode. Therefore 10 megohms is recommended as the maximum phototube load resistance.

If it is necessary to use a higher output impedance for the phototube, it is requisite to operate the radio tube at greatly reduced voltages. By using low plate and screen voltages, and a reduced filament voltage, gas ionization is decreased, and the radio tube will be comparatively stable.

PHOTOMETRIC TERMS AND FORMULAS

Some photometric terms often used in phototube work are given below for reference.

Luminous Flux—The rate of passage of radiant energy evaluated by reference to the luminous sensation produced by it is luminous flux.

Lumen—The unit of luminous flux is the lumen. It is equal to the flux emitted in a unit solid angle by a uniform point source of one international candle.

Luminous Intensity—The luminous intensity of a point source in any direction is the luminous flux

per unit solid angle emitted by that source in that direction.

Point Source of Light—The flux emanating from a light source whose dimensions are negligible in comparison with the distance from which it is observed may be considered as coming from a point.

International Candle—The unit of luminous intensity is the international candle.

Illumination—The illumination at a point of a surface is the density of the luminous flux incident

PHOTOMETRIC TERMS AND FORMULAS (CONT'D)

at that point or the quotient of the incident flux by the area of the surface when the latter is uniformly illuminated.

Foot-Candle—Taking the foot as the unit of length, the unit of illumination is the lumen per square foot; it is known as the foot-candle.

Brightness—The brightness in a given direction of a surface emitting light is the quotient of the luminous intensity measured in that direction by the area of this surface projected on a plane perpendicular to the direction considered.

Unit of Brightness—The practice recognized internationally is to express brightness in international candles per unit area of surface.

$$\begin{aligned} 1 \text{ Candle Power} &= 4\pi \text{ Lumens} \\ 1 \text{ Foot Candle} &= 1 \text{ Lumen per square foot} \\ 1 \text{ Lumen} &= \frac{\text{Candle Power (Area)}}{(\text{Distance})^2} \\ 1 \text{ Lumen} &= \text{Foot Candle (Area)} \\ \text{Foot Candle} &= \frac{\text{Candle Power}}{(\text{Distance})^2} \end{aligned}$$

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

This gas-filled, two-electrode phototube is useful in photoelectric control apparatus where a high degree of output per unit of light flux is required. The GL-1P29/FJ-401 has a high sensitivity in the visible range of the spectrum and reaches its maximum output in the blue portion.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Spectral response				S-3
Luminous sensitivity at 100 volts, 0 cycles	20	40	70	microamperes per lumen
Relative luminous sensitivity at 100 volts				
5000 cycles		87		per cent
10,000 cycles		78		per cent
Wavelength of maximum response			4200	angstroms
Sensitivity at maximum response			0.010	microampere per microwatt
Dark current at 90 volts			0.1	microampere
Gas amplification			9.0	
Interelectrode capacitance			3.0	micromicrofarads



GENERAL ELECTRIC

Supersedes ETX-178 dated 4-45

TECHNICAL INFORMATION (CONT'D)

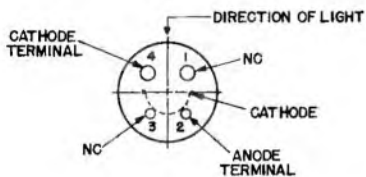
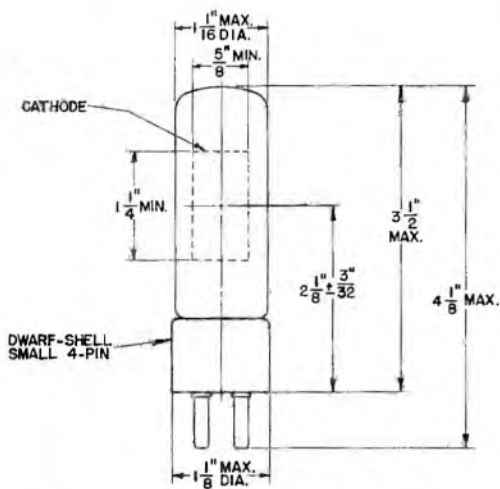
Mechanical Data

Window Dimensions	5/8 by 1 1/4 inches
Seated height to center of useful cathode area	2 1/8 ± 3/32 inches
Mounting position—any	

MAXIMUM RATINGS

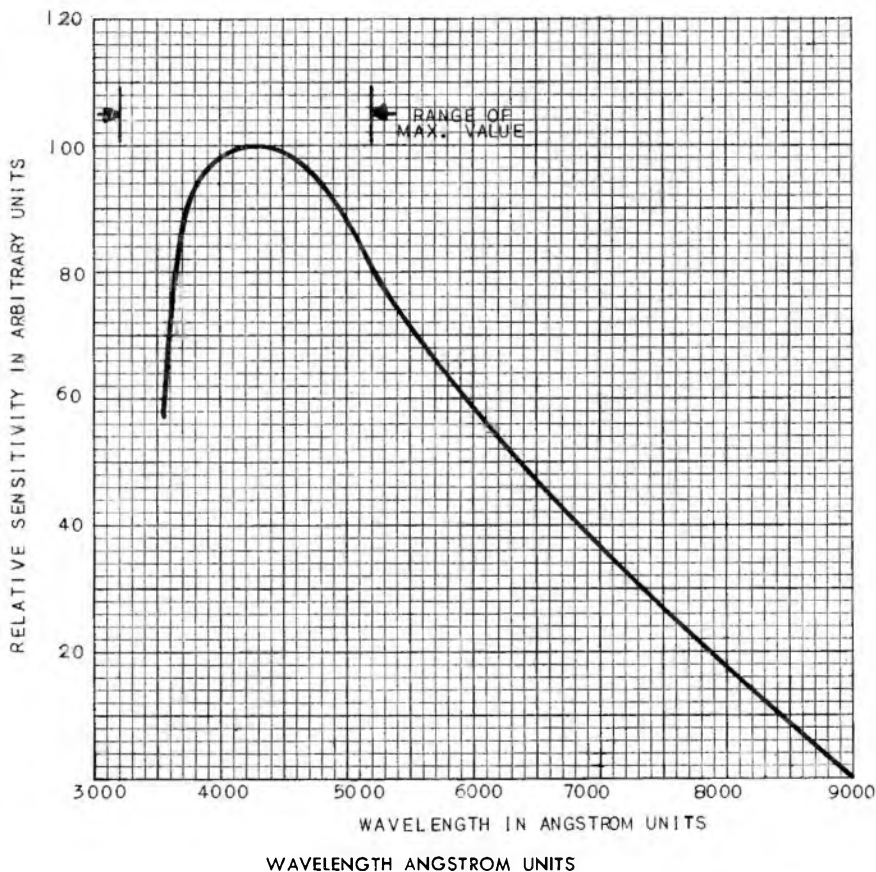
Anode voltage, d-c or peak a-c	100 max volts
Averaging time	30 max seconds
Cathode-current density	152 max microamperes per square inch
Peak cathode current	20 max microamperes
Ambient temperature	100 max C

◆ OUTLINE
 GL-1P29/FJ401 PHOTOTUBE



N15125AZ
 Drawing revised

8-4-48



K69087-72A05

9-19-50



PHOTOTUBE

DESCRIPTION

This two-electrode vacuum phototube is designed for use in photoelectric apparatus requiring reliable and accurate control. Although it will pass some current in the visible region, the PJ-22 is designed primarily for use in the red and infrared region

of the spectrum. The tube is especially useful where a high degree of stability of characteristic is required and where it is desirable to have the output directly proportional to the light flux incident on the cathode.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 2

Electrical

Spectral response	S-1	
Luminous sensitivity at 90 volts, 0 cycles	20	microamperes per lumen
Maximum gas amplification	1.1	
Interelectrode capacitance	3.0	micromicrofarads
Maximum dark current at 90 volts	0.1	microampere
Wavelength of maximum response	7500	angstroms
Sensitivity at maximum response	0.0020	microampere per microwatt


Electronic
TUBE

GENERAL  ELECTRIC

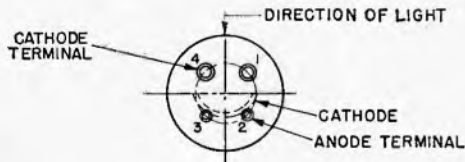
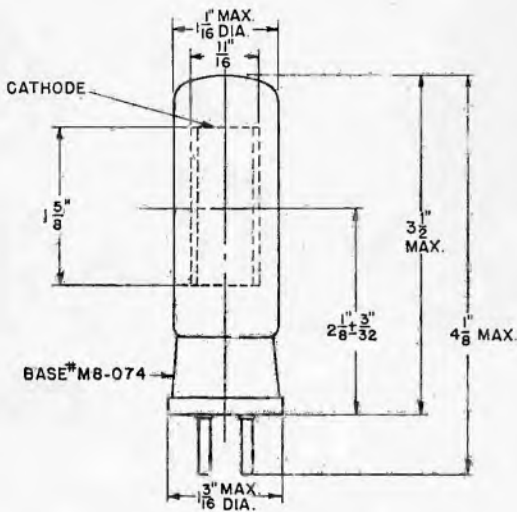
TECHNICAL INFORMATION (CONT'D)

Mechanical

Window dimensions	$\frac{11}{16} \times 1 \frac{5}{8}$ inches
Seated height to center of useful cathode area	$2 \frac{1}{8} \pm \frac{3}{32}$ inches
Maximum over-all height	$4 \frac{1}{8}$ inches
Maximum seated height	$3 \frac{1}{2}$ inches
Maximum diameter	$1 \frac{1}{16}$ inches
Base	M8-074
Mounting position	Any
Net weight, approx	$\frac{1}{2}$ ounce
Shipping weight, approx .....	.3 pounds

MAXIMUM RATINGS

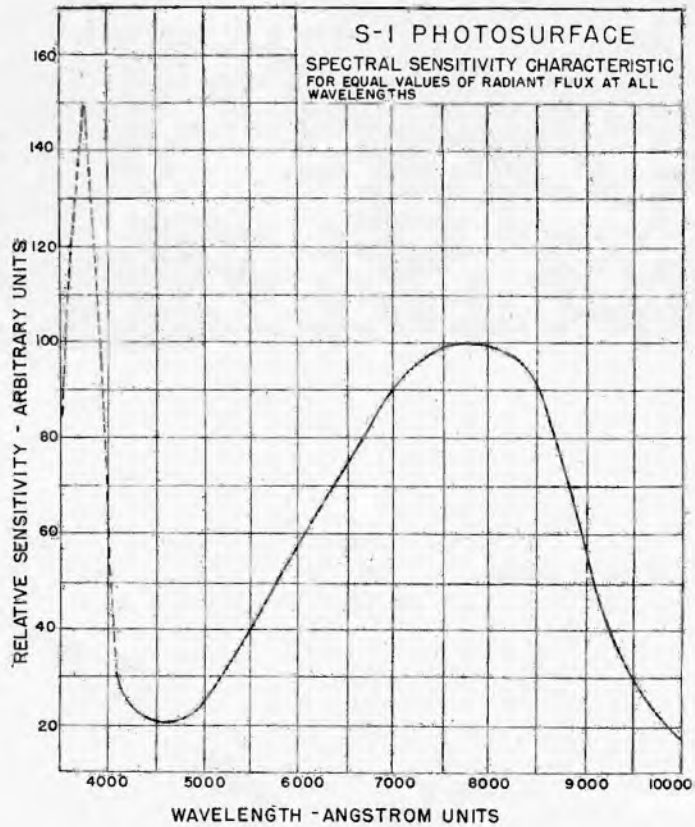
Anode voltage, d-c. or peak a-c.	500 volts
Cathode current density	152 microamperes per square inch
Ambient temperature	100 centigrade



OUTLINE
PJ-22 PHOTOTUBE

K-8639391

8-10-44



K-8638626

4-17-44

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-441 is a high-vacuum, two-electrode phototube which has high sensitivity to light sources predominating in blue radiation. Because of its excellent stability, and high sensitivity, it is particularly suitable for measurement and relay applications.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes	2
Electrical	
Spectral response	S-4
Luminous sensitivity at 250 volts, 0 cycles	0.45 microamperes per lumen
Maximum gas amplification	1.2
Interelectrode capacitance	3.0 micromicrofarads
Maximum dark current at 250 volts	0.1 microampere
Wavelength of maximum response	4000 angstroms
Sensitivity at maximum response	0.040 microampere per microwatt


Electronic
TUBE

GENERAL  ELECTRIC

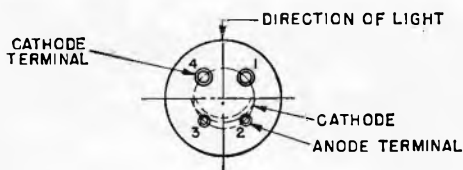
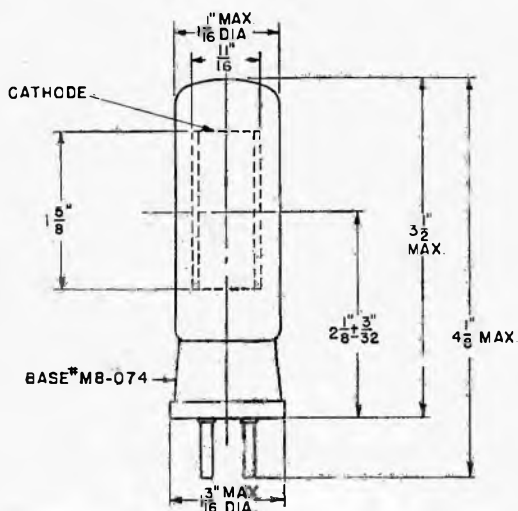
TECHNICAL INFORMATION (CONT'D)

Mechanical

Window dimensions	$1\frac{1}{16} \times 1\frac{5}{8}$ inches
Seated height to center of useful area	$2\frac{1}{8} \pm \frac{3}{32}$ inches
Maximum over-all height	$4\frac{1}{8}$ inches
Maximum seated height	$3\frac{1}{2}$ inches
Maximum diameter	$1\frac{1}{16}$ inches
Base	M8-074
Mounting position	Any
Net weight, approx.	$\frac{1}{2}$ ounce
Shipping weight, approx.	3 pounds

MAXIMUM RATINGS

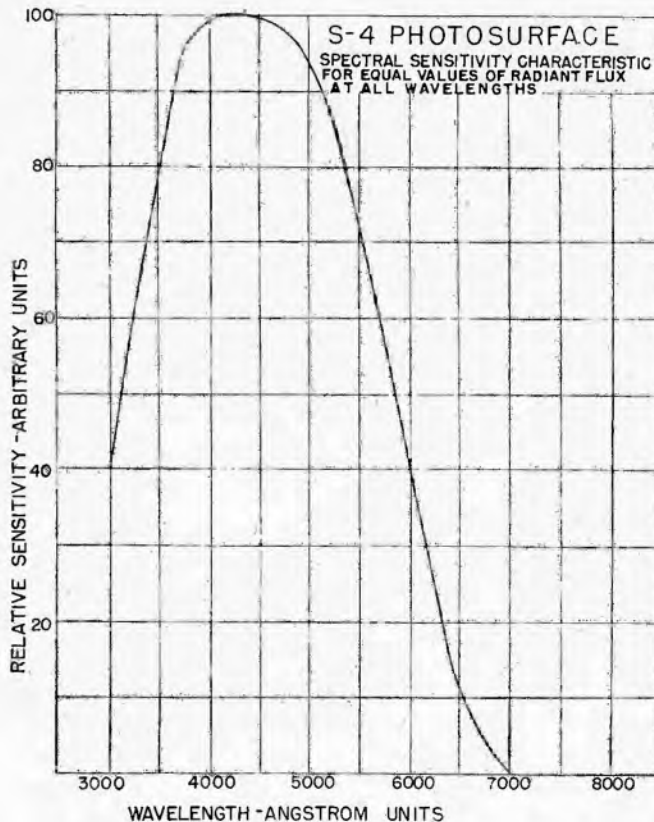
Anode voltage, d-c or peak a-c	250 volts
Cathode current density	102 microamperes per square inch
Ambient temperature	50 centigrade



OUTLINE
PHOTOTUBE GL-441

K-8639391

8-10-44



K-8639625

4-27-44

Electronics Department
GENERAL ELECTRIC
 Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

This gas-filled two-electrode phototube is designed for photoelectric control apparatus where a high degree of output per unit of light flux is re-

quired. While the GL-868/PJ-23 will pass some current in the visible region, it is designed primarily for use in the red and infrared region of the spectrum.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Spectral response.....	S-1
Wavelength of maximum response.....	8000 angstroms
Sensitivity at maximum response.....	0.009 microampere per microwatt
Dark current at 90 volts.....	0.1 microampere
Gas amplification.....	8
Interelectrode capacitance.....	3 micromicrofarads



GENERAL  ELECTRIC

Supersedes ETI-182 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

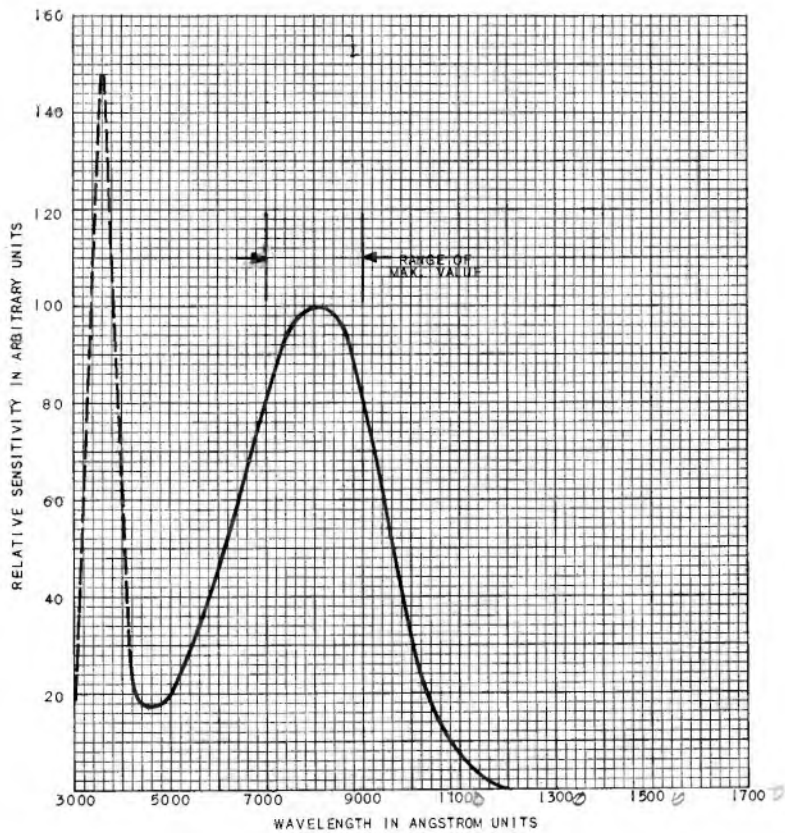
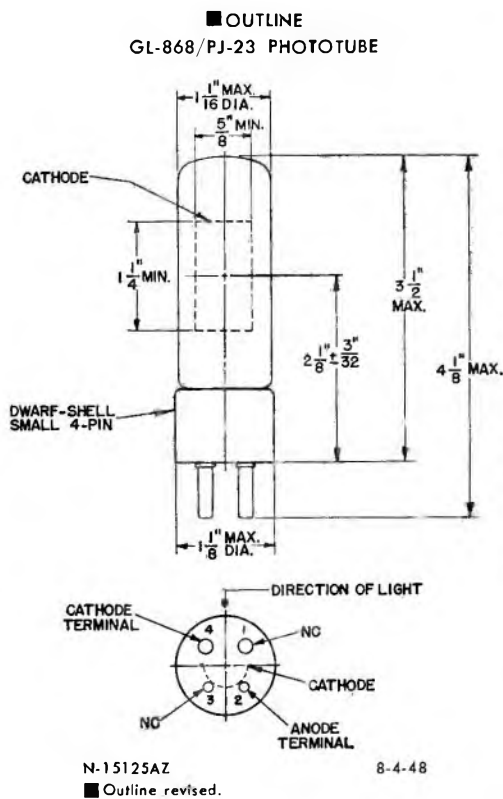
Window dimensions, minimum $\frac{5}{8}$ by $1\frac{1}{4}$ inches
 Seated height to center of window $2\frac{1}{8} \pm \frac{3}{32}$ inches
 Mounting position—any

MAXIMUM RATINGS

Anode voltage, d-c or peak a-c 100 max volts
 Average cathode current 5 ua 100 max volts
 Average cathode current 10 ua 80 max volts
 Averaging Time 30 max seconds
 Peak cathode-current density 100 max microamperes per square inch
 Peak cathode current 20 max microamperes
 Ambient temperature 100 max C

CHARACTERISTICS

Sensitivity	Minimum	Bogey	Maximum	
Luminous				
At 0 cycles	50	90	145	microamperes per lumen
At 5000 cycles		77		microamperes per lumen
At 10,000 cycles		67		microamperes per lumen
Gas amplification Factor			8	



K-69087-72A406

9-19-50

Tube Divisions, Electronics Department

GENERAL ELECTRIC
 Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-917 is a two-electrode high-vacuum phototube for measurement and relay applications. It has high sensitivity in the red and infrared regions of the spectrum. Construction affords high resistance to leakage current between electrodes, with resultant stability of operation and permanence

of calibration. The anode of the GL-917 is connected to the top cap, while in the GL-919 the cathode is connected to the top cap. As a result of this reversal of connections, the GL-917 may be used in series with the GL-919 with resultant very small leakage current and high overall sensitivity.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes.....	2
Electrical	
Spectral response.....	S-1
Luminous sensitivity at 250 volts, 0 cycles.....	20 microamperes per lumen
Interelectrode capacitance.....	2.0 micromicrofarads
Wavelength of maximum response.....	8000 angstroms
Sensitivity at maximum response.....	0.0020 microampere per microwatt



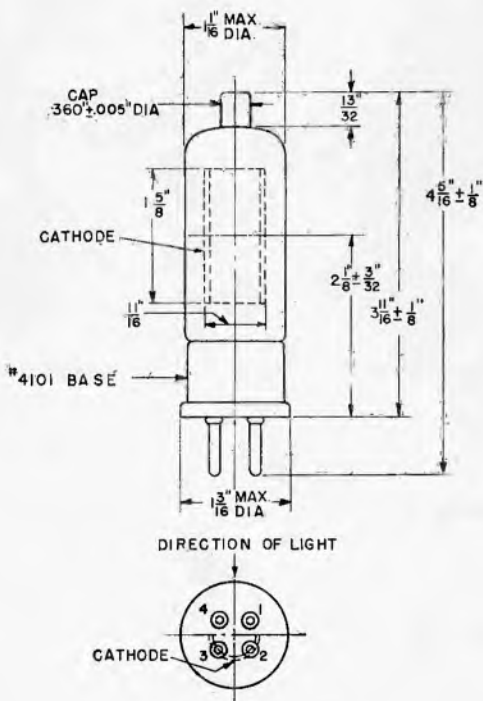
TECHNICAL INFORMATION (CONT'D)

Mechanical

Window dimensions	$\frac{11}{16} \times 1 \frac{5}{8}$ inches
Seated height to center of useful cathode area	$2 \frac{1}{8} \pm \frac{3}{32}$ inches
Maximum over-all height	$4 \frac{7}{16}$ inches
Maximum seated height	$3 \frac{11}{16}$ inches
Maximum diameter	$1 \frac{3}{16}$ inches
Cap	M8-125
Base	M8-074
Mounting position	Any
Net weight, approx.	$\frac{3}{4}$ ounce
Shipping weight, approx.	3 pounds

MAXIMUM RATINGS

Anode voltage, d-c or peak a-c	500 volts
Cathode current density	152 microamperes per square inch
Ambient temperature	100 centigrade

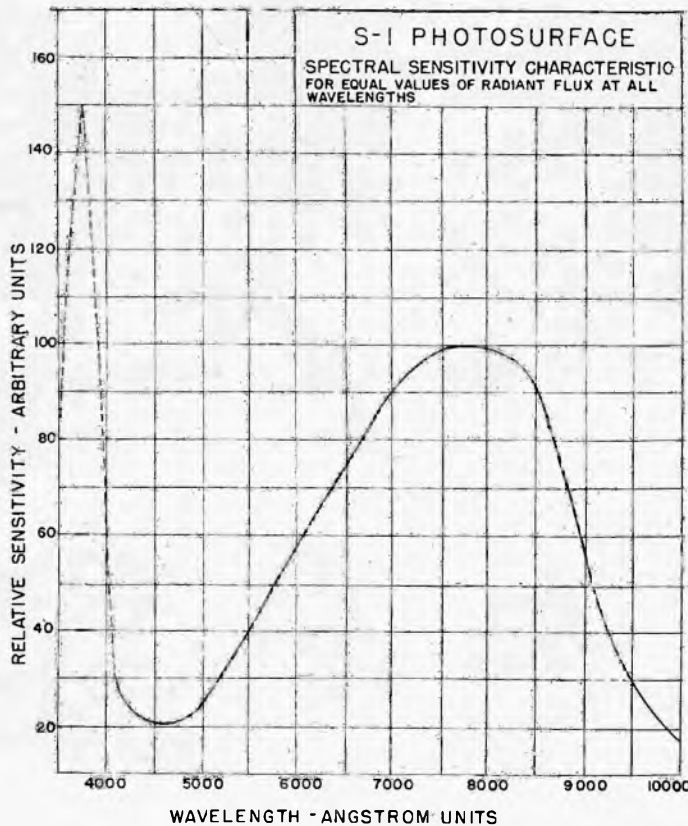


PIN	GL-917	GL-919
1		ANODE
2		
3		
4	CATHODE	
TOP CAP	ANODE	CATHODE

OUTLINE
PHOTOTUBE GL-917

K-8277038

6-30-44



K-8639626

4-17-44

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-918 is a two-electrode, gas-filled phototube and is designed for use in measurement and relay applications. The S-1 photosurface

used in this tube has a high sensitivity to red radiation and is designed particularly for use where the illumination on the phototube is low.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Spectral response				S-1
Relative luminous sensitivity				
0 cycles	120	150	220	microamperes per lumen
5,000 cycles		120		microamperes per lumen
10,000 cycles		105		microamperes per lumen
Wavelength of maximum response	8000 ± 1000			Angstroms
Sensitivity at maximum response		0.015		microamperes per microwatt
Dark current at 90 volts			0.1	microamperes
Gas amplification factor			10.5	
Direct interelectrode capacitance		3		micromicrofarads

◆ Completely revised.



Electronic
TUBE

GENERAL ELECTRIC

Supersedes ETI-184 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

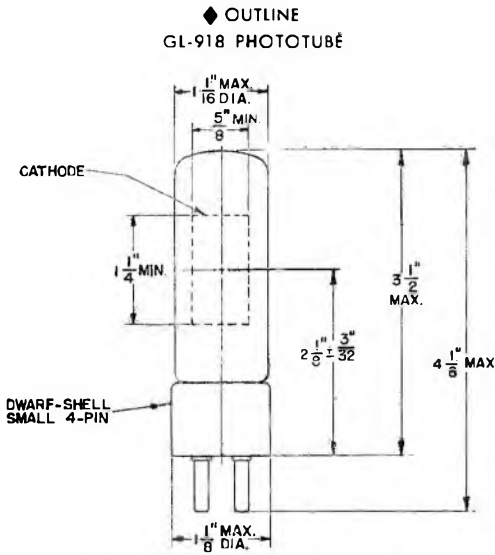
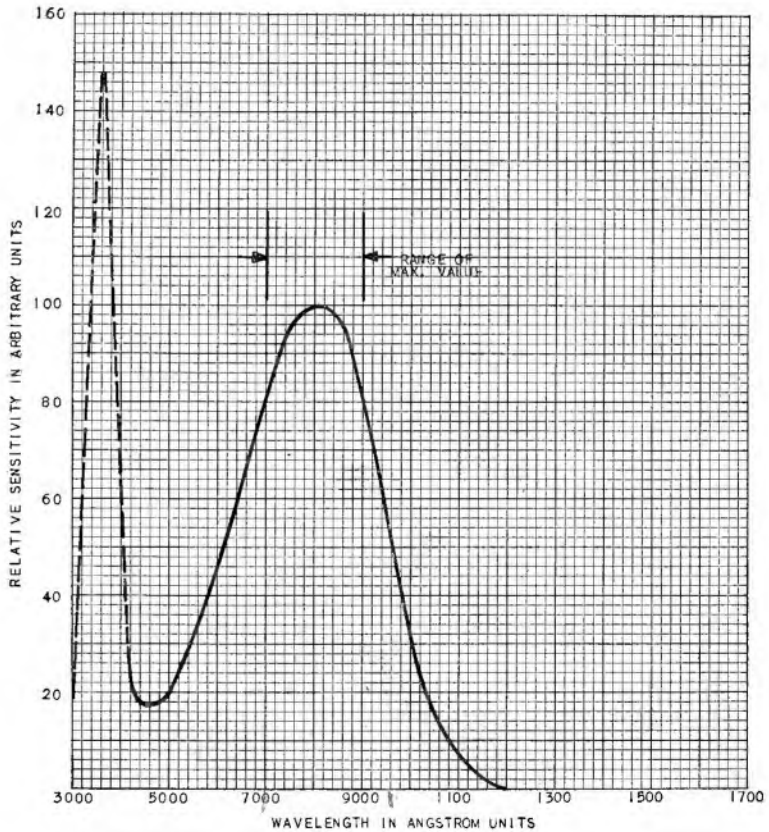
Window dimensions, minimum
 Seated height to center of window
 Mounting position—any

$\frac{5}{8}$ by $1\frac{1}{4}$ inches
 $2\frac{1}{8} \pm \frac{3}{32}$ inches

MAXIMUM RATINGS

Anode voltage (d-c or peak a-c)	90 max volts
Average cathode current 5 ua	70 max volts
Average cathode current 10 ua	30 max seconds
Averaging time	100 max microamperes per square inch
Peak cathode current density	20 max microamperes
Peak cathode current	100 max C
Ambient temperature	

S-1 PHOTOSURFACE
 SPECTRAL SENSITIVITY CHARACTERISTIC
 FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



N-15125A2
 Revised.

8-4-48

K-69087-72A406 (Revised)

9-19-50

Tube Divisions, Electronics Department



Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-919 is a two-electrode vacuum phototube for measurement and relay applications. It has high sensitivity in the red and infrared regions of the spectrum. Construction affords high resistance to leakage current between electrodes, with resultant stability of operation and permanence of

calibration. The cathode of the GL-919 is connected to the top cap, while in the GL-917 the anode is connected to the top cap. As a result of this reversal of connections, the GL-919 may be used in series with the GL-917 with resultant very small leakage current and high over-all sensitivity.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes	2
Electrical	
Spectral response	S-1
Luminous sensitivity at 250 volts, 0 cycles	20 microamperes per lumen
Interelectrode capacitance	2.0 micromicrofarads
Maximum dark current at 250 volts	0.1 microamperes
Wavelength of maximum response	8000 angstroms
Sensitivity at maximum response	0.0020 microamperes per microwatt



GENERAL  ELECTRIC

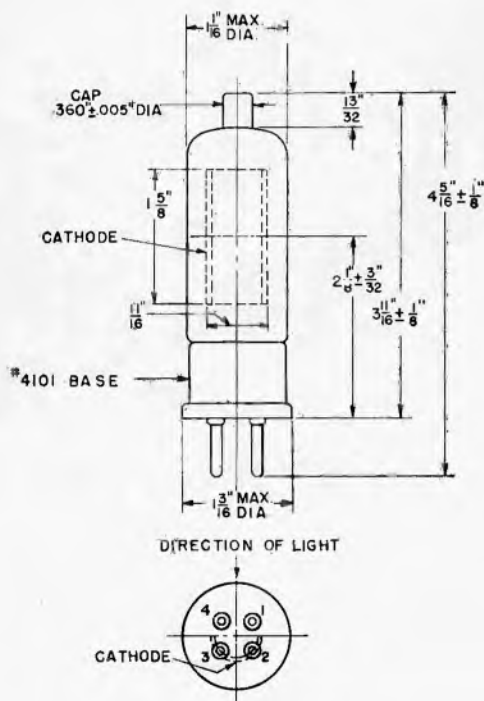
TECHNICAL INFORMATION (CONT'D)

Mechanical

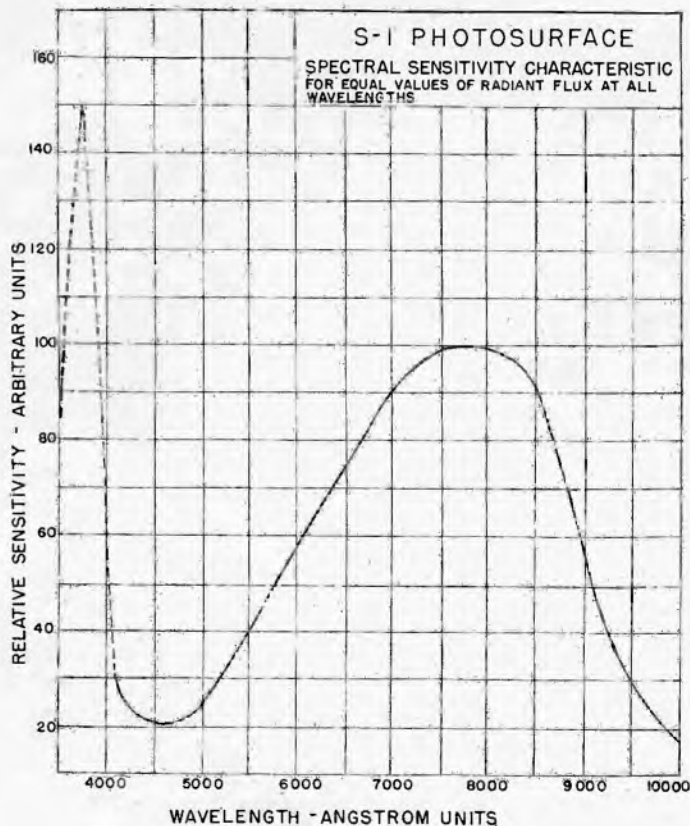
Window dimensions	$\frac{11}{16} \times 1\frac{5}{8}$ inches
Seated height to center of useful cathode area	$2\frac{1}{8} \pm \frac{3}{32}$ inches
Maximum over-all height	$4\frac{1}{16}$ inches
Maximum seated height	$3\frac{13}{16}$ inches
Maximum diameter	$1\frac{3}{16}$ inches
Cap	M8-125
Base	M8-074
Mounting position	Any
Net weight, approx.	$\frac{3}{4}$ ounce
Shipping weight, approx.	3 pounds

MAXIMUM RATINGS

Anode voltage, d-c or peak a-c	500 volts
Cathode current density	152 microamperes per square inch
Ambient temperature	100 centigrade



PIN	GL-917	GL-919
1		
2		ANODE
3		
4	CATHODE	
TOP CAP	ANODE	CATHODE



K-8639626

4-17-44

OUTLINE
PHOTOTUBE GL-919
K-8277038 6-30-44

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-920 is designed for sound reproduction applications. The S-1 photosurface used in this tube has high sensitivity in the red and infrared region.

Two separate phototube units are mounted in the envelope with the cathode and anode of each unit brought out to separate base connections.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes.....4

Electrical

Spectral response.....S-1
Luminous sensitivity at 90 volts, 0 cycles.....75 microamperes per lumen
Maximum gas amplification.....9.0
Interelectrode capacitances,
between cathode and anode of each unit.....1.5 micromicrofarads


Electronic
TUBE

GENERAL  ELECTRIC

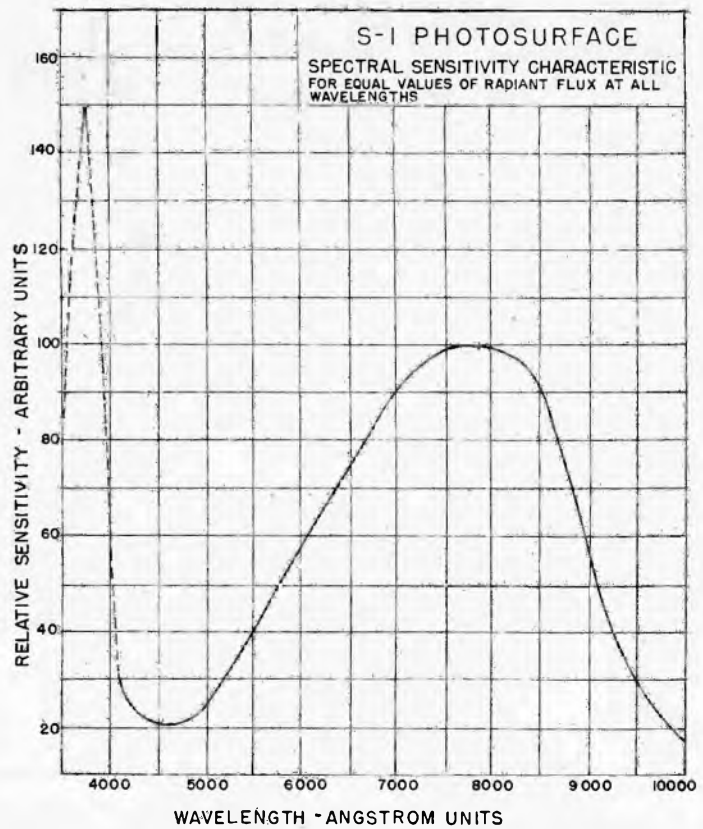
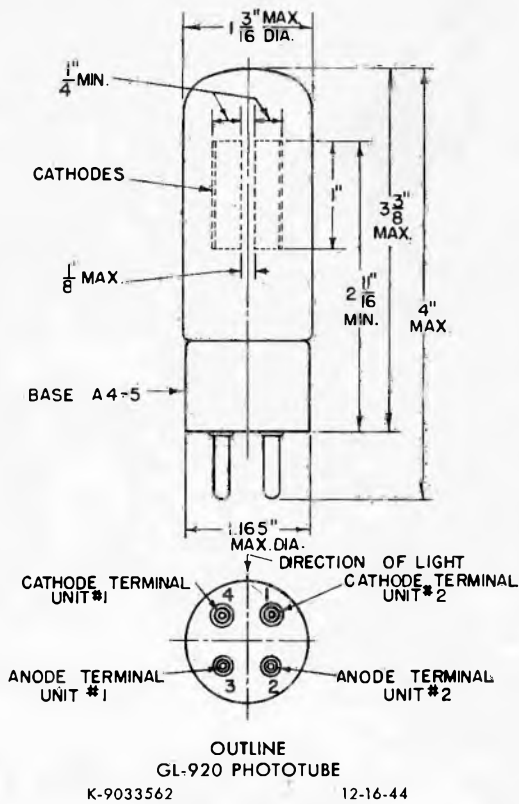
TECHNICAL INFORMATION (CONT'D)

Mechanical

Window dimensions.....	$\frac{1}{4}$ inch by 1 inch
Seated height to center of useful cathode area.....	$2\frac{1}{4} \pm \frac{3}{32}$ inches
Maximum over-all height.....	4 inches
Maximum seated height.....	$3\frac{3}{8}$ inches
Maximum diameter.....	$1\frac{3}{16}$ inches
Base.....	A4-5
Mounting position.....	Any
Net weight, approximate.....	1 ounce
Shipping weight.....	3 pounds

MAXIMUM RATINGS

Anode voltage, d-c or peak a-c.....	90 volts
Cathode current density.....	20 microamperes per square inch
Ambient temperature.....	100 centigrade



Electronics Department
GENERAL ELECTRIC
 Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-921 is a cartridge-type, two-electrode gas-filled phototube for relay- and light-measurement applications. It is highly sensitive to red and infrared radiation. The double-edged design, with a terminal at each end, provides a compact phototube useful in applications where space is restricted.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes.....2

Electrical

Spectral response.....	S-1	
Luminous sensitivity at 90 volts, 0 cycles.....	135	microamperes per lumen
Maximum gas amplification.....	10	
Interelectrode capacitance.....	1.0	micromicrofarad
Maximum dark current at 90 volts.....	0.1	microampere
Wavelength of maximum response.....	8000	angstroms
Sensitivity at maximum response.....	0.013	microampere per microwatt


Electronic
TUBE

GENERAL  ELECTRIC

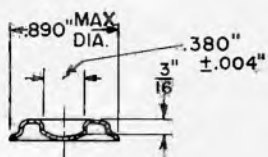
TECHNICAL INFORMATION (CONT'D)

Mechanical

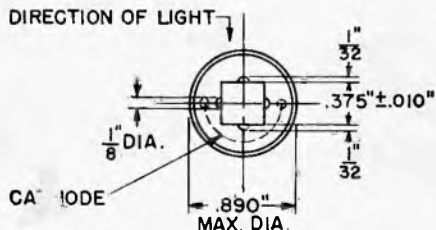
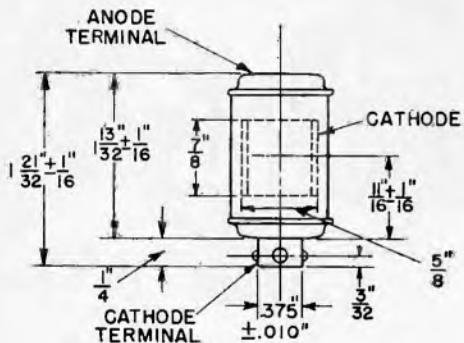
Window dimensions	$\frac{5}{8} \times \frac{7}{8}$ inches
Seated height to center of useful cathode area	$\frac{11}{16} \pm \frac{1}{16}$ inches
Maximum over-all height	$1\frac{23}{32}$ inches
Maximum seated height	$1\frac{15}{32}$ inches
Maximum diameter	0.890 inch
Mounting position	Any
Net weight, approx.	$\frac{1}{4}$ ounce
Shipping weight, approx.	.3 pounds

MAXIMUM RATINGS

Anode voltage, d-c or peak a-c	90 volts
Cathode current density	152 microamperes per square inch
Ambient temperature	100 centigrade



SECTIONAL VIEW OF ANODE TERMINAL

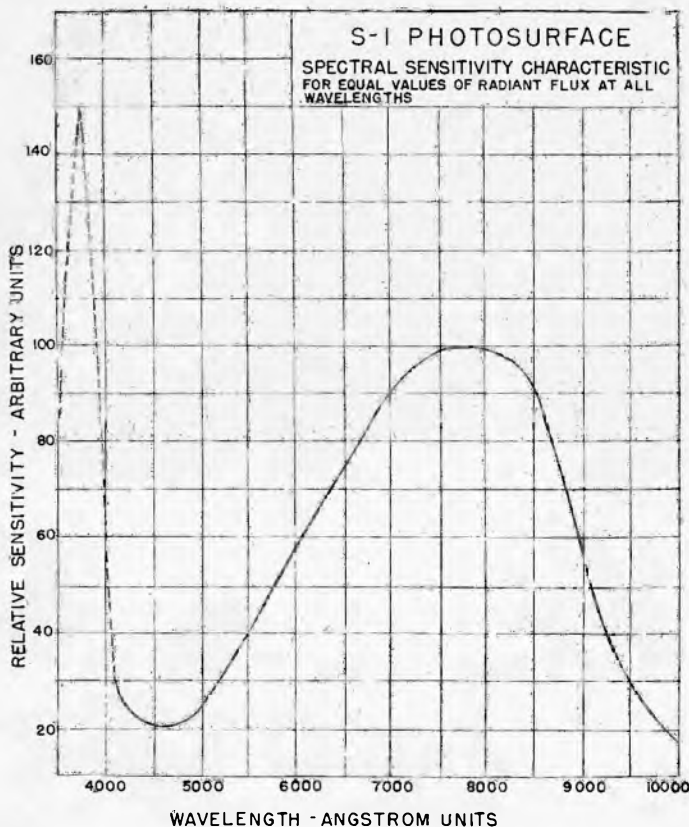


CATHODE-END VIEW

OUTLINE PHOTOTUBE GL-921

K-8277039

7-1-44



K-8639626

4-17-44

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-922 is a cartridge-type, two-electrode phototube for relay- and light-measurement applications. It is highly sensitive to red light and infra-red radiation. The double-edged design, with a terminal at each end, provides a compact phototube useful in many applications where space is restricted.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 2

Electrical

Spectral response	S-1	
Luminous sensitivity at 250 volts, 0 cycles	20	microamperes per lumen
Interelectrode capacitance	0.5	micromicrofarad
Wavelength of maximum response	8000	angstroms
Sensitivity at maximum response	0.0020	microampere per microwatt



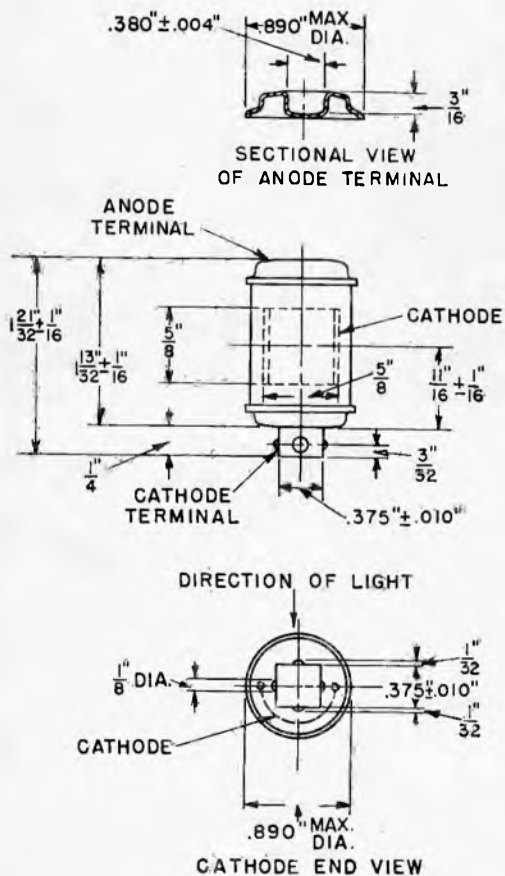
TECHNICAL INFORMATION (CONT'D)

Mechanical

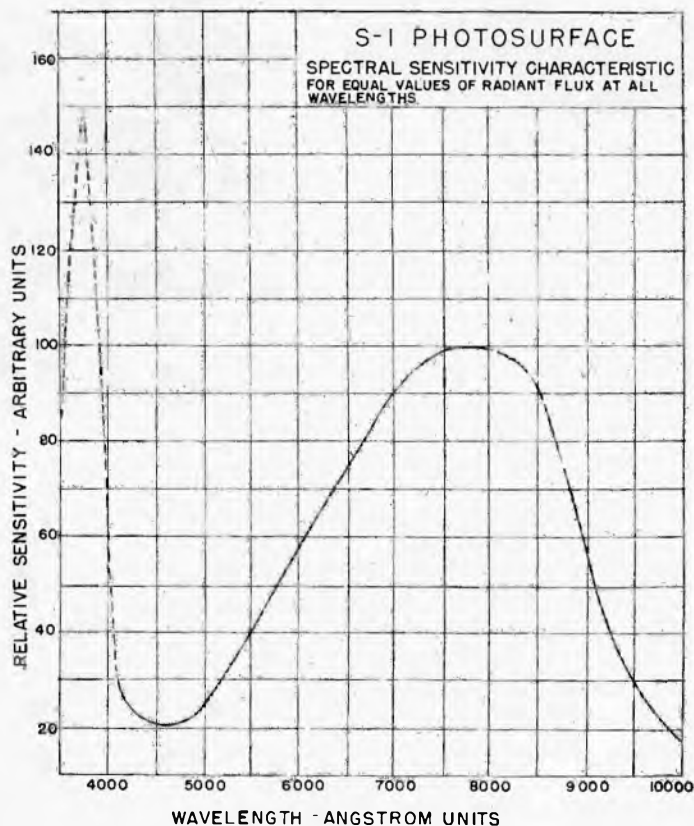
Window dimensions	$\frac{5}{8} \times \frac{5}{8}$ inches
Seated height to center of useful cathode area	$\frac{11}{16} \pm \frac{1}{16}$ inches
Maximum over-all height	$1\frac{13}{32}$ inches
Maximum seated height	$1\frac{15}{32}$ inches
Maximum diameter	0.890 inch
Mounting position	Any
Net weight, approx.	$\frac{1}{4}$ ounce
Shipping weight, approx.	3 pounds

MAXIMUM RATINGS

Anode voltage, d-c or peak a-c	500 volts
Cathode current density	152 microamperes per square inch
Ambient temperature	100 centigrade



OUTLINE
GL-922 PHOTOTUBE
K-8639380 6-30-44



K-8639626 4-17-44

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



*1P37 RCA equivalent
except blue light sensitive*

PHOTOTUBE

DESCRIPTION

The GL-923 is a two-electrode, gas-filled phototube used in measurement and relay applications. The S-1 photosurface used in this tube has a high sensitivity to red radiation and is designed particularly for use where the illumination on the phototube is low.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes.....	2
Electrical	
Spectral response.....	S-1
Luminous sensitivity at 90 volts, 0 cycles.....	135 microamperes per lumen
Maximum gas amplification.....	10.0
Interelectrode capacitance.....	2.6 micromicrofarads
Maximum dark current at 90 volts.....	0.1 microampere
Wavelength of maximum response.....	8000 angstroms
Sensitivity at maximum response.....	0.0130 microampere per microwatt



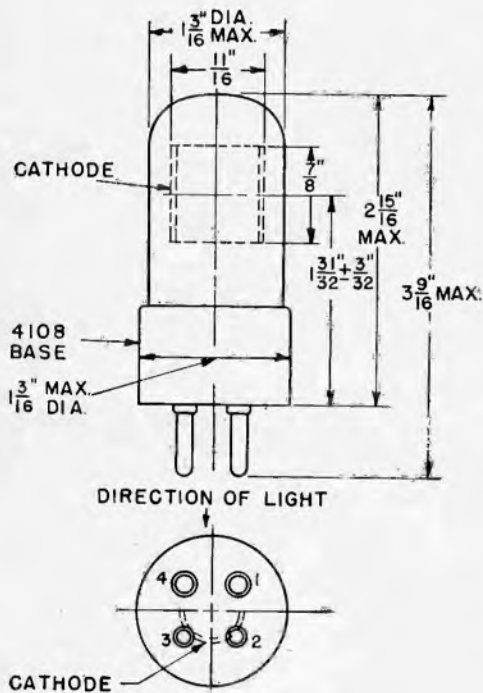
TECHNICAL INFORMATION (CONT'D)

Mechanical

Window dimensions.....	$\frac{11}{16} \times \frac{7}{8}$ inches
Seated height to center of useful cathode area.....	$1\frac{31}{32} \pm \frac{3}{32}$ inches
Maximum over-all height.....	$3\frac{9}{16}$ inches
Maximum seated height.....	$2\frac{15}{16}$ inches
Maximum diameter.....	$1\frac{3}{16}$ inches
Base.....	M8-071
Mounting position.....	Any
Net weight, approx.....	$\frac{3}{4}$ ounce
Shipping weight, approx.....	3 pounds

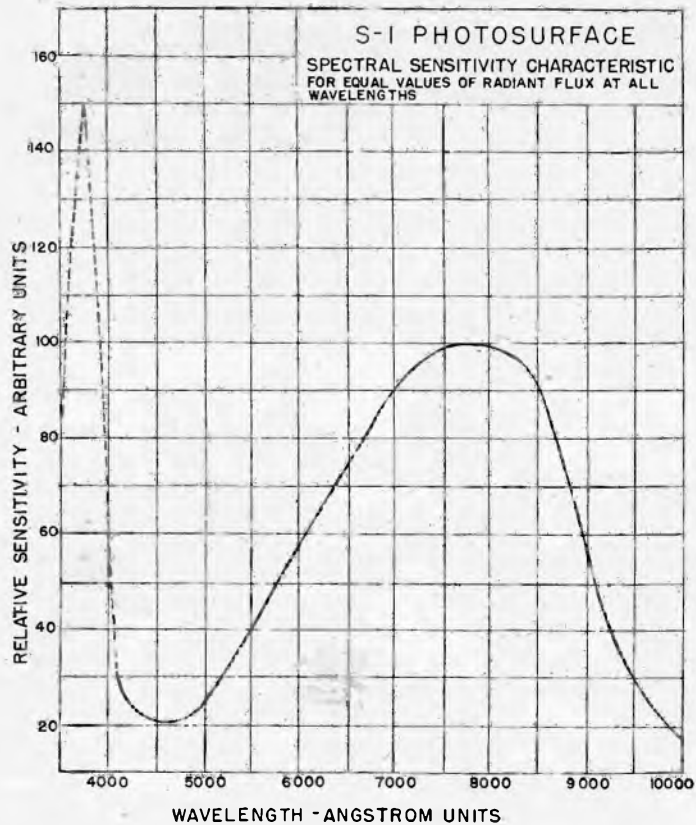
MAXIMUM RATINGS

Anode voltage, d-c or peak a-c.....	90 volts
Cathode current density.....	102 microamperes per square inch
Ambient temperature.....	100 centigrade



PIN	CONNECTION
1	NO CONNECTION
2	ANODE
3	NO CONNECTION
4	CATHODE

OUTLINE
GL-923 PHOTOTUBE
K-8065599 6-30-44



K-8639626

4-17-44



PHOTOTUBE

DESCRIPTION

The GL-927 is a two-electrode, gas-filled phototube which is used in measurement and relay applications. The S-1 photosurface used in this tube has a high sensitivity to red radiation and is designed particularly for use where the illumination on the phototube is low.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Number of electrodes	2
Spectral response	S-1
Luminous sensitivity at 90 volts, 0 cycles	125 microamperes per lumen
Interelectrode capacitance	2.0 micromicrofarads
Wavelength of maximum response	7500 angstroms
Sensitivity at maximum response	0.0150 microampere per microwatt


Electronic
TUBE

GENERAL  ELECTRIC

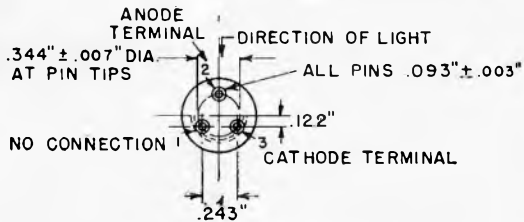
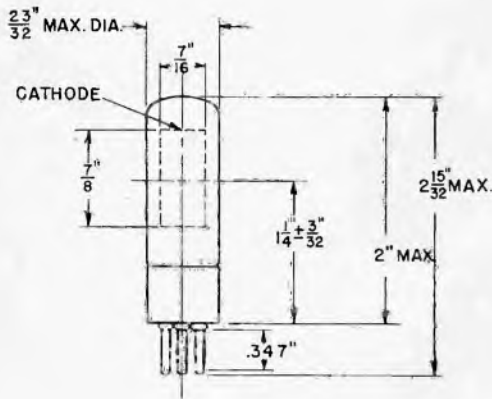
TECHNICAL INFORMATION (CONT'D)

Mechanical

Window dimensions.....	$\frac{7}{16} \times \frac{7}{8}$ inch
Seated height to center of useful cathode area.....	$1\frac{1}{4} \pm \frac{3}{32}$ inches
Maximum over-all height.....	$2\frac{15}{32}$ inches
Maximum seated height.....	2 inches
Maximum diameter.....	$\frac{23}{32}$ inch
Base.....	3313
Mounting position.....	Any
Net weight, approx.....	$\frac{1}{2}$ ounce
Shipping weight, approx.....	3 pounds

MAXIMUM RATINGS

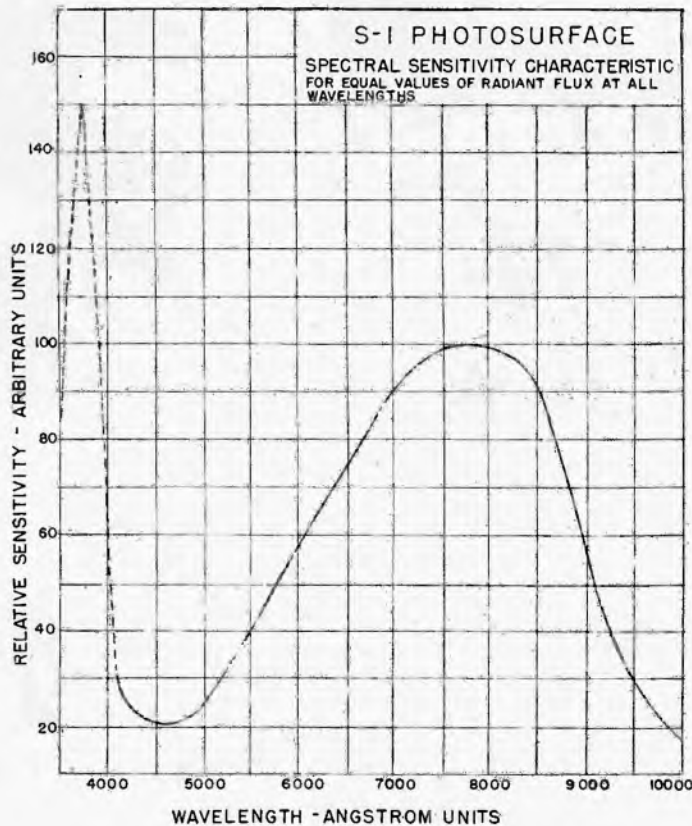
Anode voltage, d-c or peak a-c.....	90 volts
Cathode current density.....	101 microamperes per square inch
Ambient temperature.....	100 centigrade



OUTLINE
GL-927 GAS PHOTOTUBE

K-8277040

8-18-44



K-8639626

4-17-44

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-929 is a high-vacuum, two-electrode phototube which has extraordinarily high sensitivity to light sources predominating in blue radi-

ation. Because of its excellent stability, and high sensitivity, the GL-929 is particularly suited for measurement and relay applications.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Soegy	Maximum	
Spectral response				S-4
Luminous sensitivity at 250 volts, 0 cycles	25	45	70	microamperes per lumen
Relative luminous sensitivity at 250 volts				
10,000 cycles		100		per cent
Wavelength of maximum response	3500	4000	4500	Angstroms
Sensitivity at maximum response		0.037		microamperes per microwatt
Leakage resistance	20000			megohms
Gas amplification factor			1.25	
Interelectrode capacitance		2.6		micromicrofarads

◆ Completely revised.

Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-191 dated 4-45

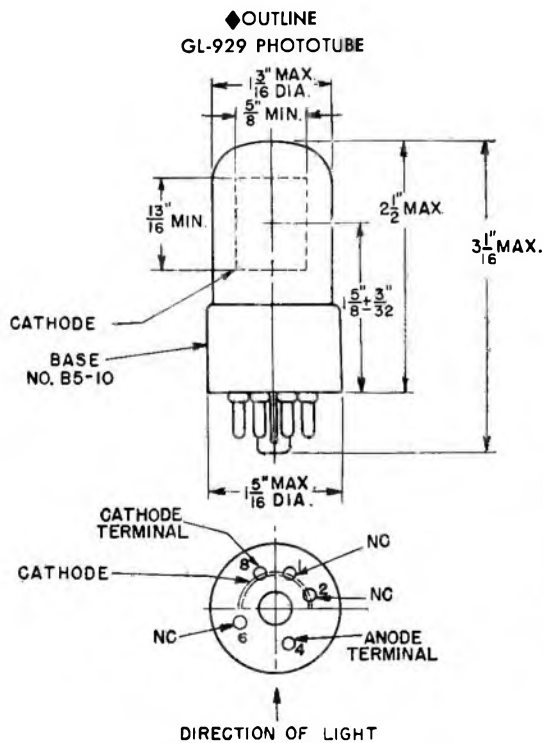
TECHNICAL INFORMATION (CONT'D)

Mechanical Data

Window dimensions $\frac{5}{8}$ by $\frac{13}{16}$ inches
 Seated height to center of window $1\frac{5}{8} \pm \frac{3}{32}$ inches
 Mounting position—any

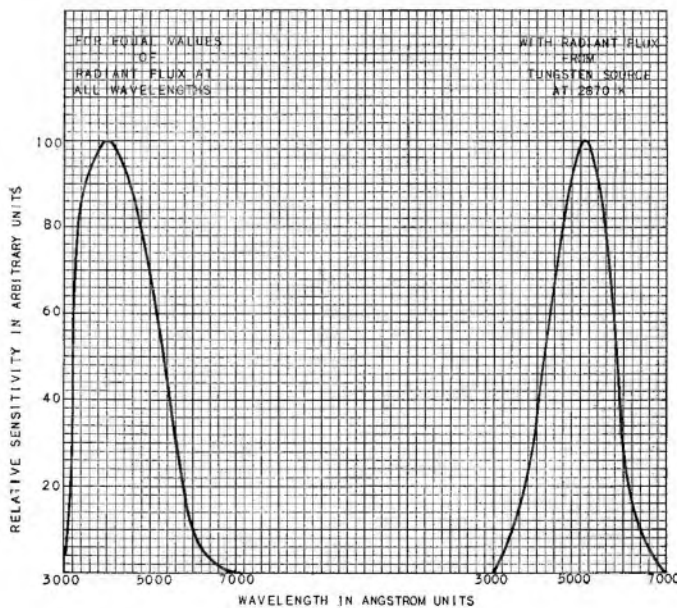
MAXIMUM RATINGS

Anode voltage (d-c or peak a-c) 250 max volts
 Averaging time 30 max seconds
 Peak cathode—current density 100 max microamperes per square inch
 Average cathode current 5 max microamperes
 Averaging time 30 seconds, maximum
 Peak cathode current 20 max microamperes
 Ambient temperature 75 max C



K-8070703
 Revised drawing. 8-4-48

**S-4 PHOTOSURFACE
 SPECTRAL SENSITIVITY CHARACTERISTIC**



K-69087-72A373 (Revised) 4-27-50

Tube Divisions, Electronics Department



Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-930 is a two-electrode, gas-filled phototube which is used in measurement and relay applications. The S-1 photosurface used in this

tube has a high sensitivity to red radiation. The GL-930 is designed particularly for use where the illumination on the phototube is low.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Spectral response				S-1
Luminous sensitivity at 90 volts, 0 cycles	90	135	205	microamperes per lumen
Relative luminous sensitivity at 90 volts				
10,000 cycles		75		per cent
Wavelength of maximum response	7000	8000	9000	Angstroms
Sensitivity at maximum response		0.0135		microamperes per microwatt
Leakage resistance	900			megohms
Gas amplification factor				10
Interelectrode capacitance		2.4		micromicrofarads

◆ Completely revised.


Electronic
TUBE

GENERAL  ELECTRIC

Supersedes ETI-192 dated 4-45

TECHNICAL INFORMATION (CONT'D)

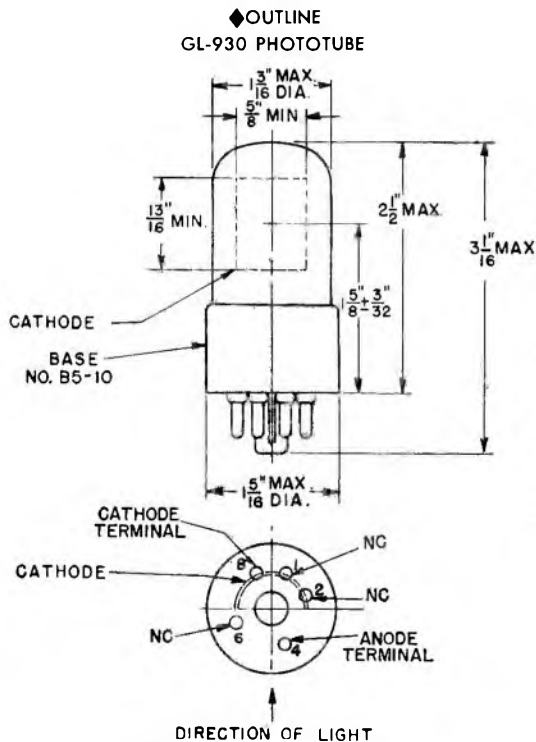
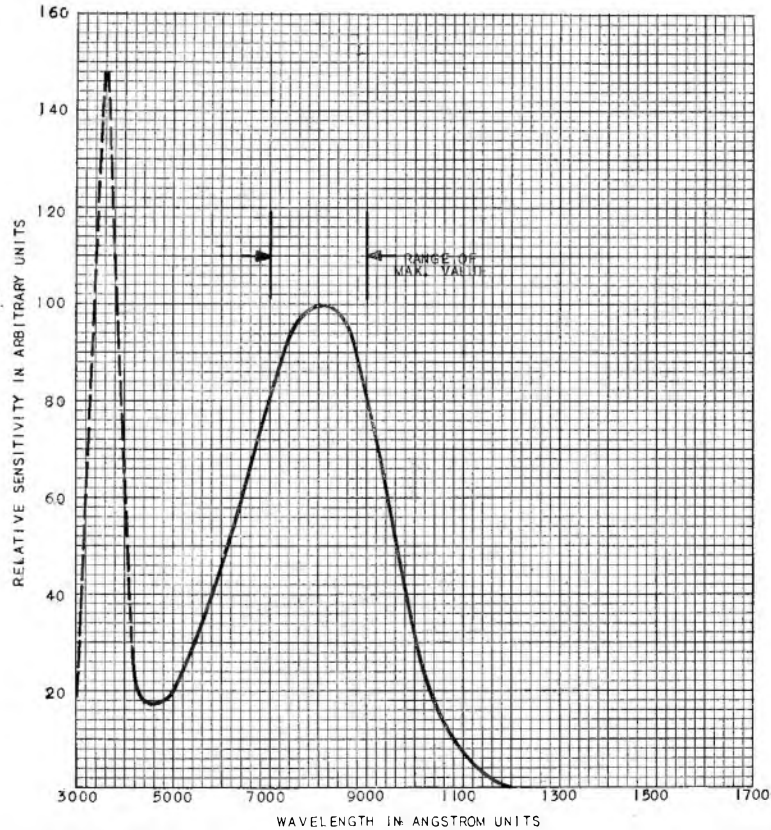
Mechanical Data

Window dimensions	$\frac{5}{8}$ by $\frac{13}{16}$ inches
Seated height to center of window	$\frac{3}{2} \pm 1\frac{5}{8}$ inches
Mounting position	any

MAXIMUM RATINGS

Anode voltage (d-c or peak a-c)	
Average cathode current 3 ua	90 max volts
Average cathode current 6 ua	70 max volts
Averaging time	30 max seconds
Average cathode—current density	
Below 70 volts	10.0 max microamperes per square inch
Above 70 volts	5 max microamperes per square inch
Peak cathode current	20 max microamperes
Ambient temperature	100 max C

**S-1 PHOTO SURFACE
SPECTRAL SENSITIVITY CHARACTERISTIC
FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS**



K-8070703
◆ Revised.

8-4-48

K-69087-72A406 (Revised)

9-19-50

Tube Divisions, Electronics Department



Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-931-A is a multiplier phototube predominately sensitive to blue radiation. The photocurrent produced at the cathode is, in tubes of the multiplier type, multiplied many times by secondary emission occurring at successive dynodes within

the tube. This tube can multiply feeble currents produced by weak illuminations as much as 200,000 times. To this feature is added high sensitivity, low noise level, low dark current, and freedom from distortion.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes				11
Electrical	Minimum	Bogey	Maximum	
Spectral response—S-4				
Luminous sensitivity				
At 1000 volts, 0 cycles	4.5	10	300	amperes per lumen
At 750 volts, 0 cycles		1.5		amperes per lumen
Relative luminous sensitivity at 1000 volts, 10,000 cycles		100		per cent

◆ Technical information completely revised.



GENERAL  ELECTRIC

Supersedes ETI-193 dated 4-45

TECHNICAL INFORMATION (CONT'D)

Electrical (Cont'd)

Wavelength of maximum response	3500	4000	4500	angstroms
Sensitivity at maximum response		9300		microamperes per microwatt
Dark current at 1000 volts			0.25	microampere
Current Amplification				
At 1000 volts		1,000,000		
At 750 volts		150,000		
Interelectrode Capacitances				
Anode to Dynode No. 9		4		micromicrofarads
Anode to all other electrodes		6.5		micromicrofarads

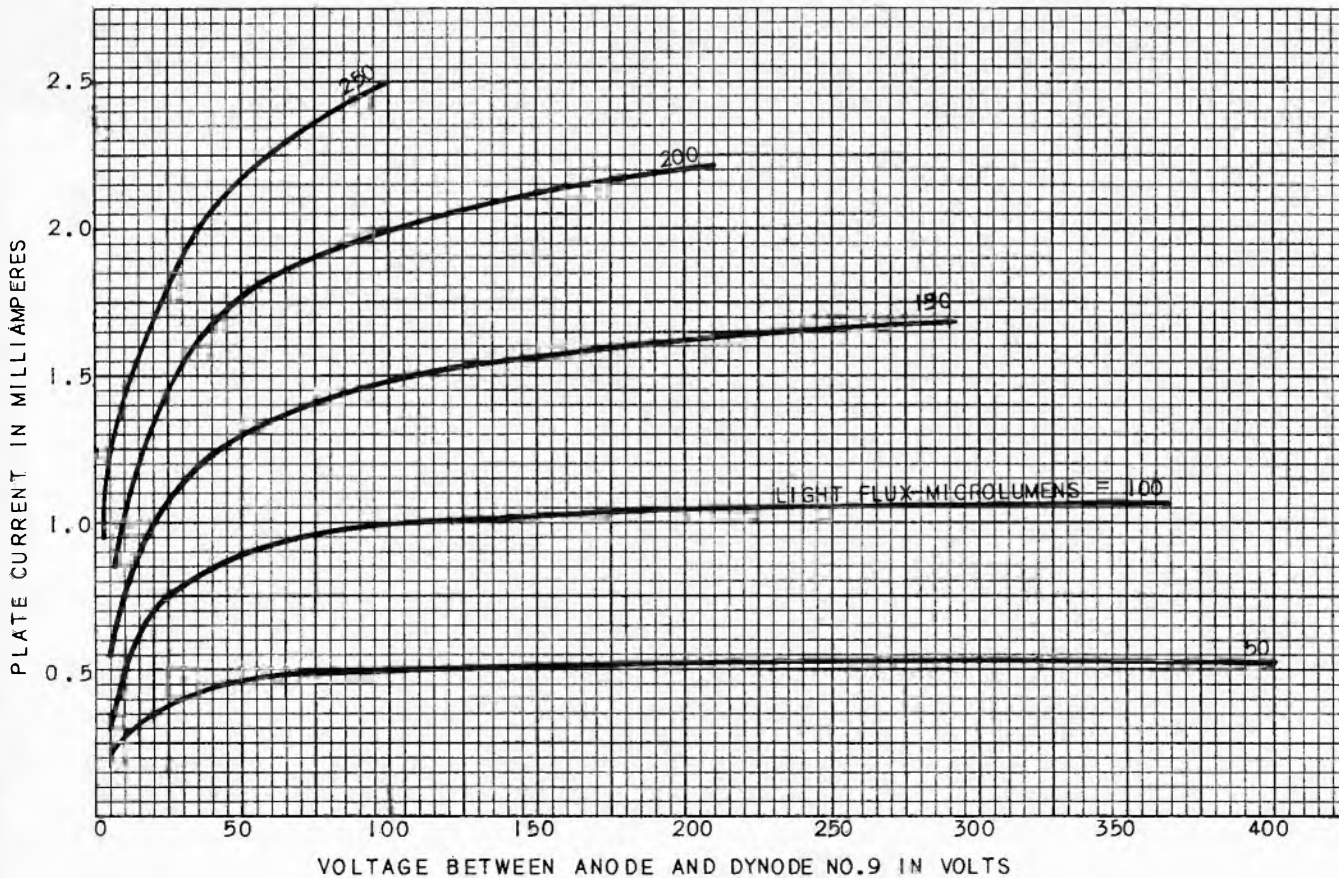
Mechanical

Window dimensions, minimum	$1\frac{5}{16}$ by $1\frac{5}{16}$	inches
Seated height to center of window	$1\frac{1}{16} \pm \frac{3}{32}$	inches
Mounting position		any

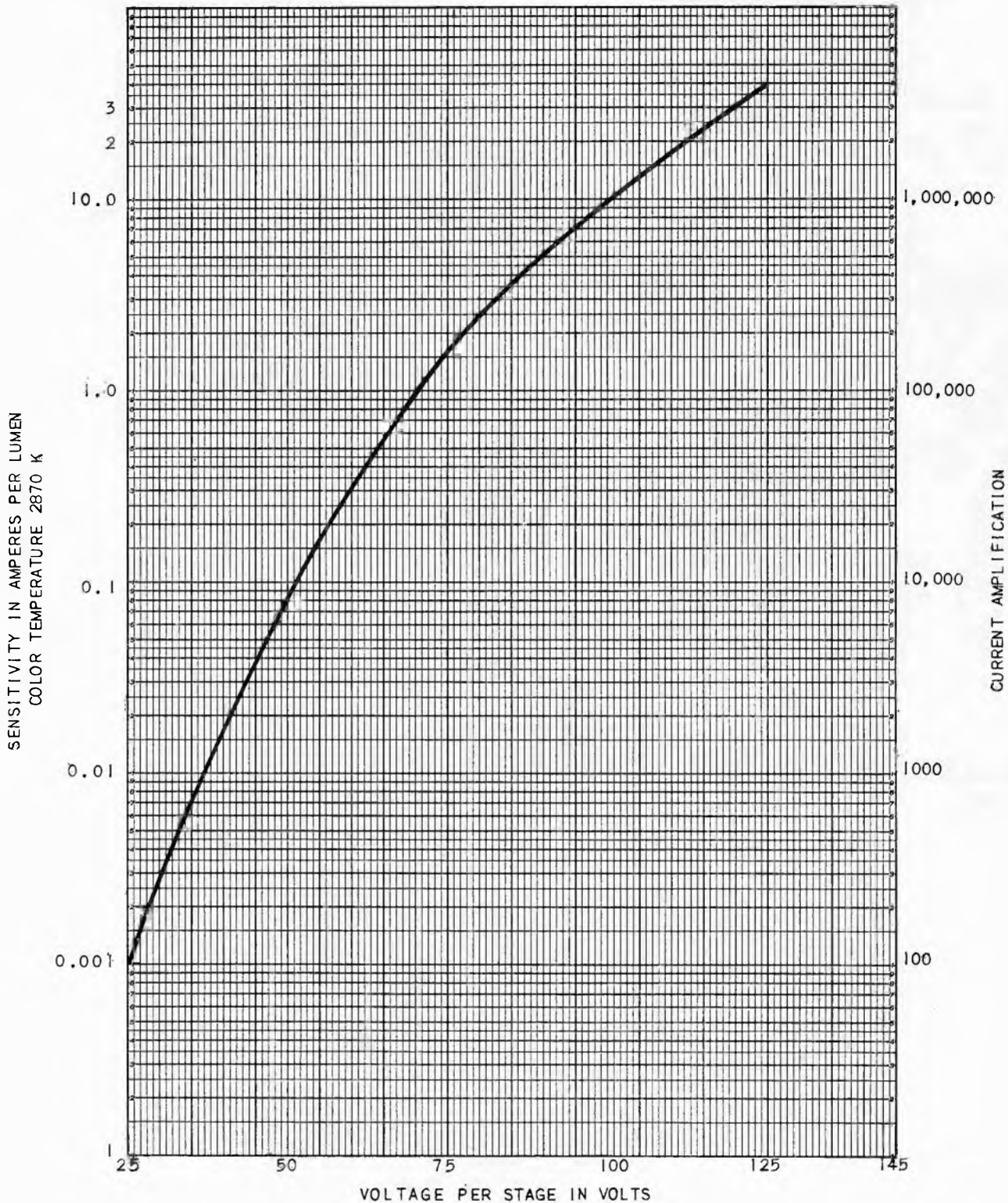
MAXIMUM RATINGS

Anode voltage, d-c or peak a-c	1250	volts
Averaging time	30	seconds
Peak anode current	.10	milliamperes
Average anode current	.1	milliampere
Ambient temperature	75	C

GL-931-A
AVERAGE ANODE CHARACTERISTICS
VOLTAGE PER STAGE = 100

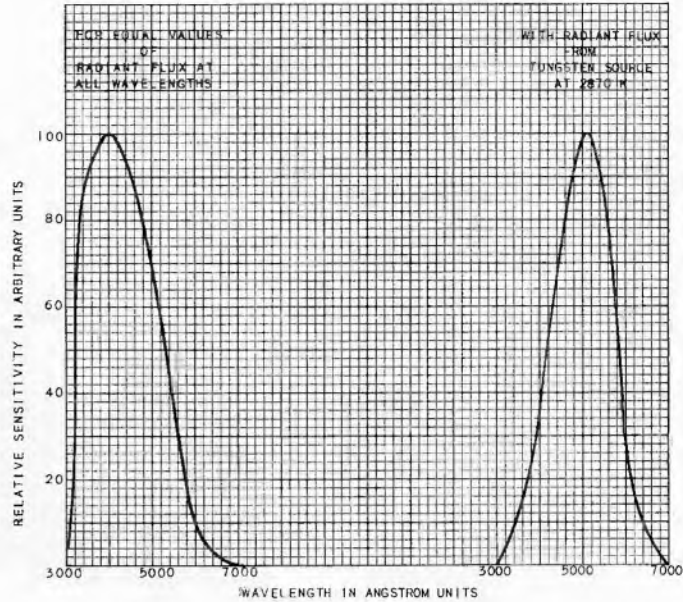
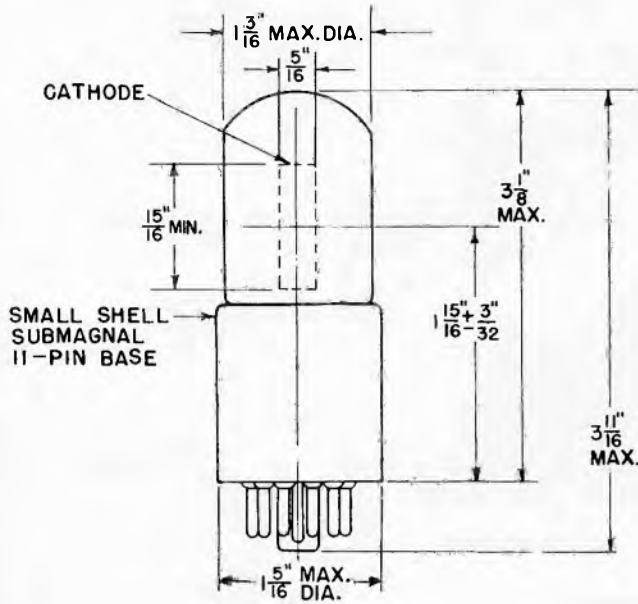


◆ GL-931-A
AVERAGE CHARACTERISTICS
D-C OPERATION



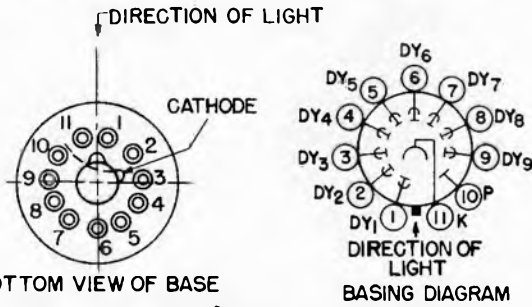
◆ S-4 PHOTOSURFACE
SPECTRAL SENSITIVITY CHARACTERISTIC

◆ OUTLINE
GL-931-A MULTIPLIER PHOTOTUBE



K-69087-72A373
◆ Revised drawing

4-27-50



Q OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERRECTED AT CENTER OF BOTTOM OF BASE.

K-8277037
◆ Revised drawing

4 28-50

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-935 is a high-vacuum phototube which has extraordinarily high sensitivity to light sources predominating in blue and ultraviolet radiation. This tube will respond in the region down to about

2000 angstroms. Because of its excellent stability, consistency of spectral response and extremely high sensitivity, the 935 is suited for use in measuring ultraviolet absorption of gases and liquids.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information see the Specifications.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Spectral response—S ⁵				
Luminous sensitivity*	18	35	70	microamperes per lumen
Wavelength of maximum response		3400 ± 50		angstroms
Sensitivity at maximum response		0.032		microamperes per microwatt
Dark current at 250 volts			0.0005	microamperes
Direct interelectrode capacitance		0.6		micromicrofarads

◆ Completely revised.



GENERAL  ELECTRIC

Supersedes ETI-270 dated 11-46

TECHNICAL INFORMATION (CONT'D)

Mechanical Data

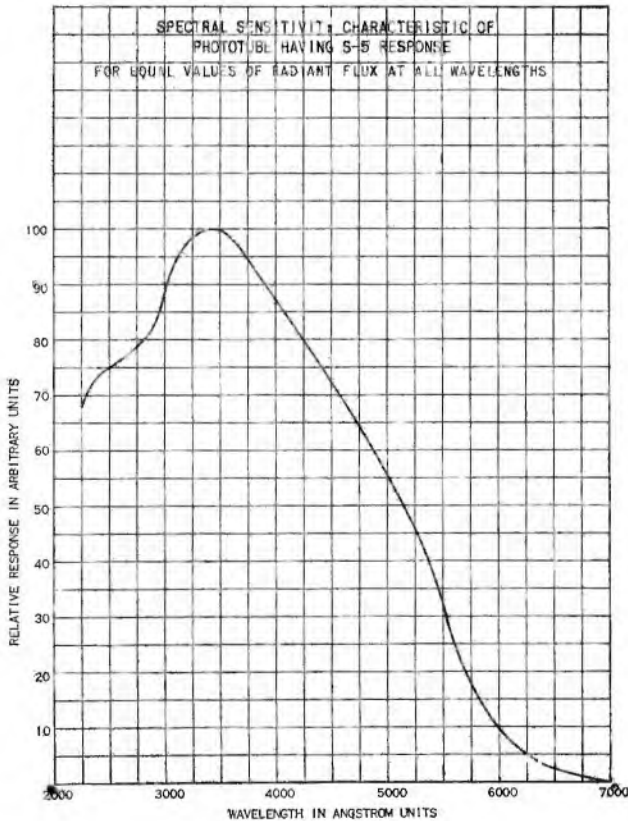
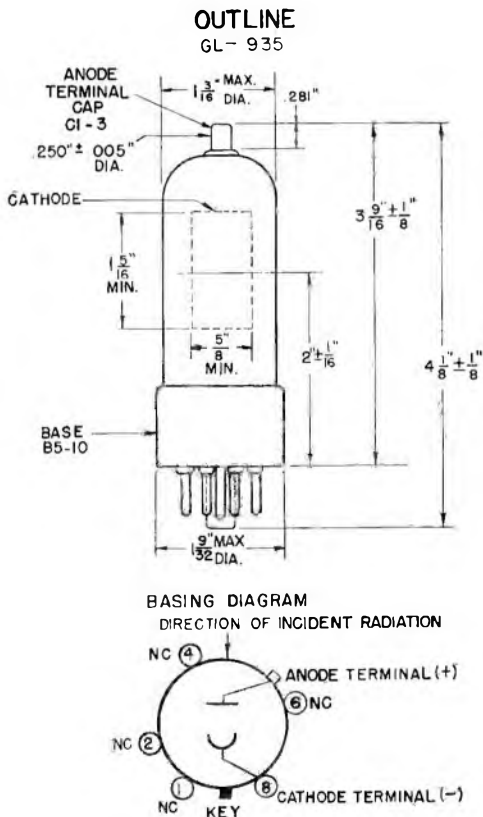
Window dimensions, minimum $\frac{5}{8}$ by $1\frac{3}{16}$ inches
 Seated height to center of window $2 \pm \frac{1}{16}$ inches
 Mounting position—any

MAXIMUM RATINGS

Anode voltage (d-c or peak a-c) 250 max volts
 Peak cathode-current density 100 max microamperes per square inch
 Average cathode current *10 max microamperes
 Maximum averaging time 30 seconds
 Peak cathode current 30 max microamperes
 Ambient temperature 75 max C

* Light source consists of Mazda projection lamp operating at filament color temperature of 2870 K. A steady light input of 0.1 lumen is used together with a d-c anode-supply voltage of 250 volts and a 1-megohm load resistor.

◆ **OUTLINE**
GL-935 PHOTOTUBE



N15078AZ
 Revised.

1-3-51

K-69087-72A162 (New)

6-11-47

Tube Divisions, Electronics Department



Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-1P37 is a gas phototube with high sensitivity to light sources predominating in blue radiation and negligible sensitivity to infrared radiation. It is, therefore, particularly suitable for use in sound reproduction involving a dye-image sound track in conjunction with an incandescent light source. It may also be used in measurement and color-control applications.

Because the GL-1P37 has little response in the infrared region where dye-image sound tracks have marked transparency, masking of the dye-image

modulation by infrared transmitted through the film is avoided, and the dye-image modulation of either variable-area or variable-density sound tracks is reproduced essentially to its full degree.

The luminous sensitivity, anode characteristics, and structure of the GL-1P37 are comparable with the same properties of Types GL-868 and GL-918 to permit use of the GL-1P37 without circuit modification in motion picture equipment designed to use the two older types.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Number of electrodes 2


Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

Electrical

Spectral response.....	S-4	
Sensitivity at 4000 angstroms.....	0.125	microampere per microwatt
Luminous sensitivity		
At 0 cycles.....	135	microamperes per lumen
At 5000 cycles.....	124	microamperes per lumen
At 10,000 cycles.....	108	microamperes per lumen
Wavelength of maximum response.....	4000 ± 500	angstroms
Maximum gas amplification factor.....	5.5	
Direct interelectrode capacitance.....	3	uuf
Maximum dark current at 90 volts.....	0.05	microampere

Mechanical

Mounting position—any

MAXIMUM RATINGS, ABSOLUTE VALUES

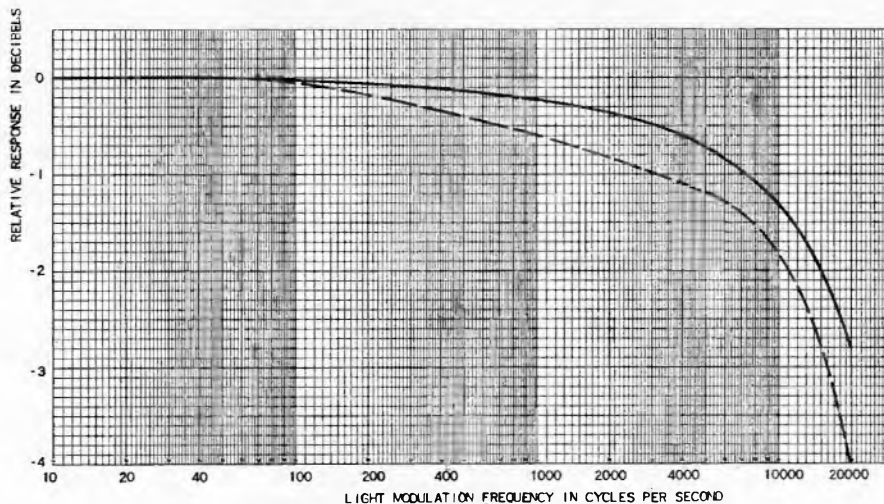
Anode voltage, d-c or peak a-c.....	100 max	volts
Average cathode current*.....	5 max	microamperes
Peak cathode current.....	20 max	microamperes
Peak cathode current density.....	100 max	microamperes per square inch
Ambient temperature.....	75 max	C

MINIMUM CIRCUIT VALUES

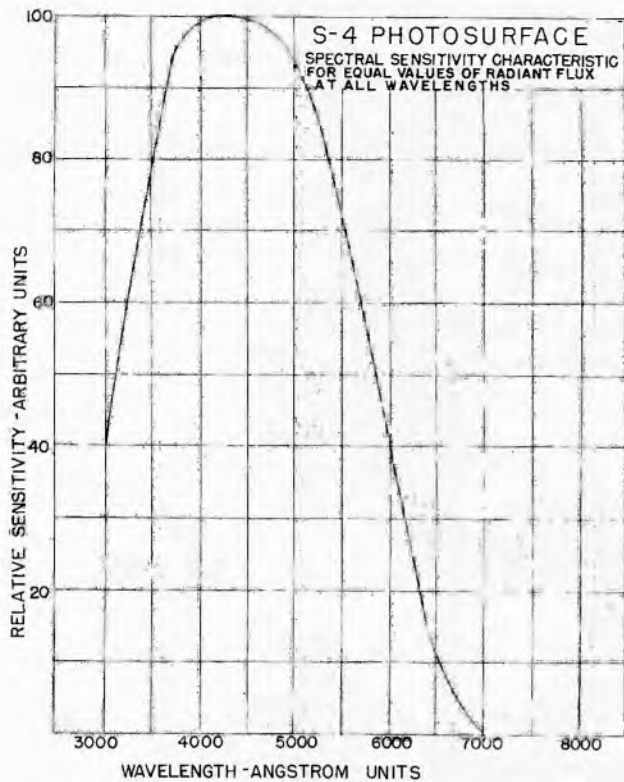
D-c load resistance	
With anode-supply voltage of 75 volts or less for d-c currents above 3 microamperes.....	0.1 megohm
D-c load resistance	
With anode-supply voltage of 75 volts or less for d-c currents below 3 microamperes.....	no minimum
With anode-supply voltage of 90 volts	
For d-c currents above 3 microamperes.....	2.5 megohms
For d-c currents below 3 microamperes.....	0.1 megohm

* Averaged over any interval of 30 seconds maximum. Average current may be doubled when anode-supply voltage is limited to 80 volts.

**GL-1P37
FREQUENCY-RESPONSE CHARACTERISTICS
ANODE VOLTAGE = 90 VOLTS
ANODE VOLTAGE = 110 VOLTS**

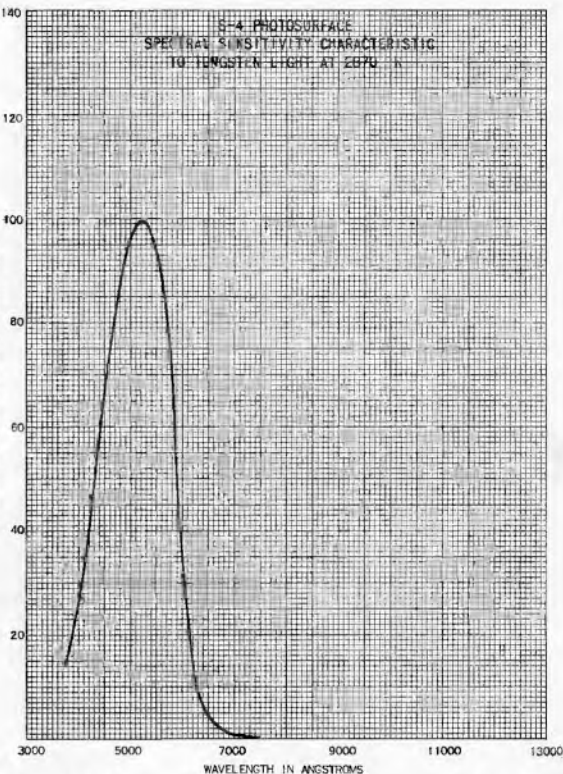


S-4 PHOTOSURFACE
SPECTRAL SENSITIVITY CHARACTERISTIC
TO TUNGSTEN LIGHT AT 2870 K



K-8639625

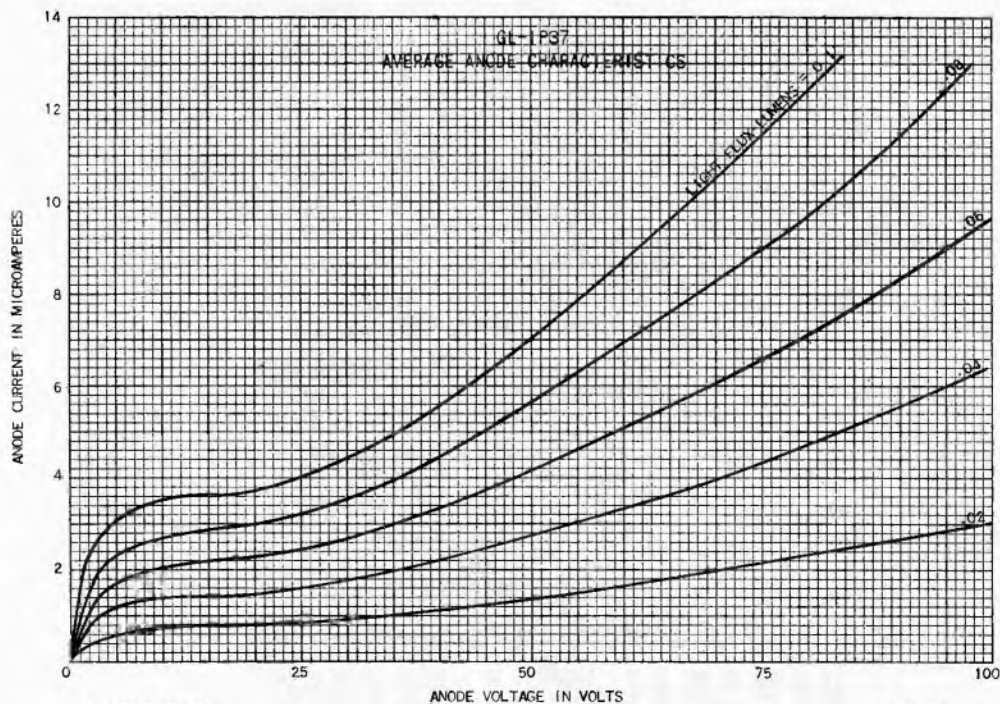
4-27-44



K-69087-72A249

8-18-48

GL-1P37
AVERAGE ANODE CHARACTERISTICS

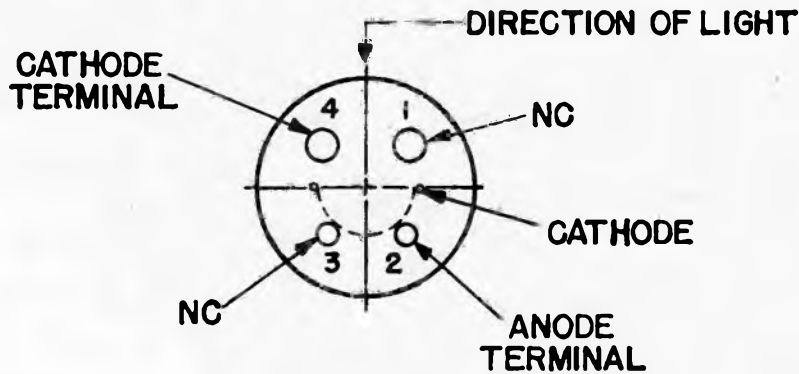
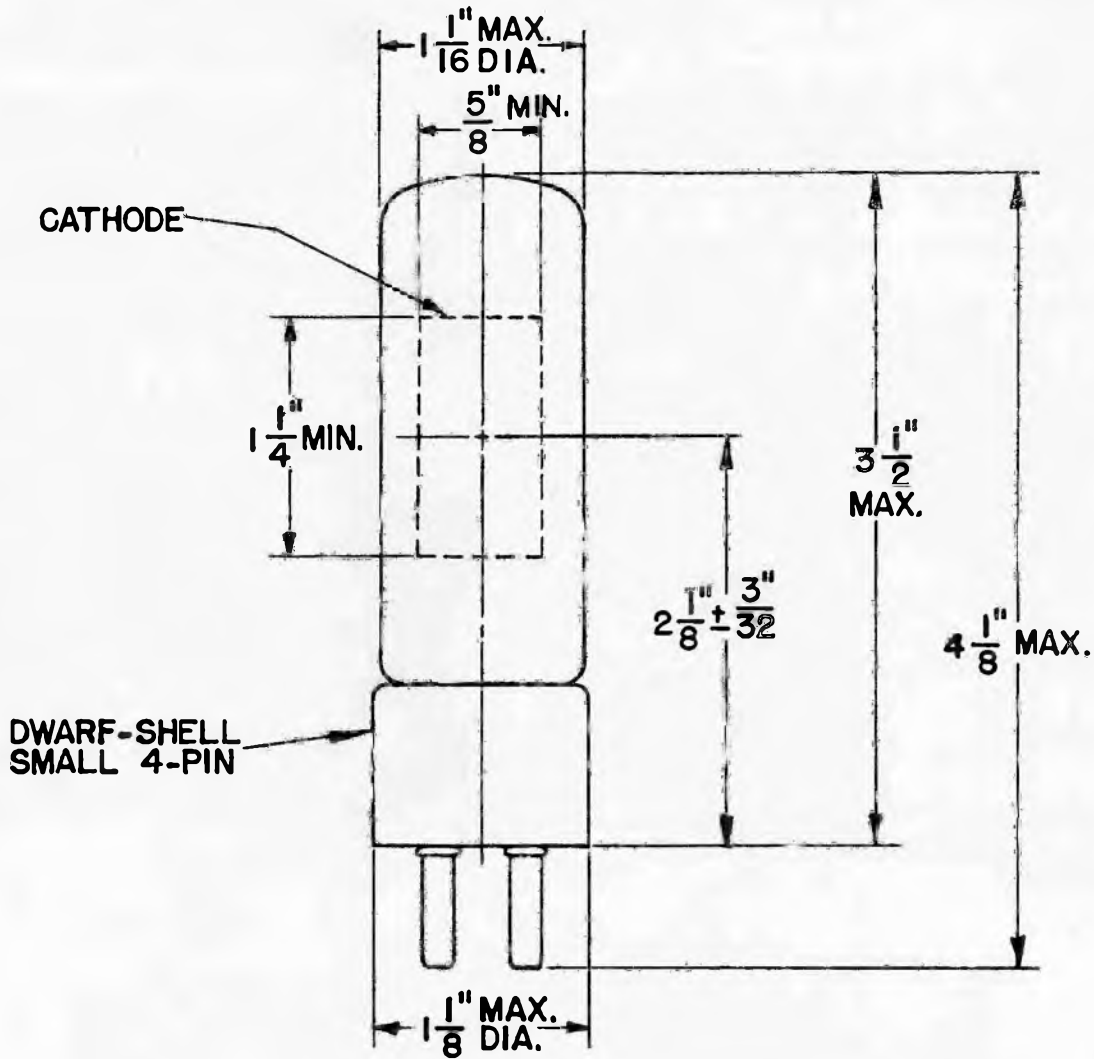


K-69087-72A250

8-18-48

GL-1P37

ETI-289
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N-15125AZ

OUTLINE
PHOTOTUBE GL-1P37

8-4-48

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-1P40 is a gas phototube with high response to red and near-infrared radiation. Because of its high sensitivity, it is recommended for use in sound reproduction, light-operated relays, and light-measurement applications utilizing an incandescent light source.

The GL-1P40 is similar to the GL-930 except

that it is provided with a non-hygroscopic base which insures a value of resistance between anode and cathode pins about 10 times higher than conventional bases under adverse operating conditions of high humidity. As a result, more output for a given light input is obtainable under high-humidity conditions.

◆ TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications

GENERAL CHARACTERISTICS

Number of electrodes..... 2

Electrical

Spectral response..... S-1

◆Completely revised.



GENERAL  ELECTRIC

Supersedes ETI-290 dated 12-48

TECHNICAL INFORMATION (CONT'D)

	Minimum	Bogey	Maximum	
Luminous sensitivity*				
0 cycles.....	90	135	205	microamperes per lumen
5000 cycles.....		111		microamperes per lumen
10000 cycles.....		101		microamperes per lumen
Wavelength of maximum response.....	7000	8000	9000	angstroms
Sensitivity at maximum response.....		0.0135		microamperes per microwatt
Dark current at 90 volts.....			0.1	microampere
Gas amplification.....			10	
Direct interelectrode capacitance.....		2.4		micromicrofarads

Mechanical Data

Window dimensions, minimum.....	$\frac{1}{16}$ by $\frac{5}{8}$	inch
Seated height to center of window.....	$1\frac{5}{8} \pm \frac{3}{32}$	inches
Mounting position—any		

MAXIMUM RATINGS, ABSOLUTE VALUES

Anode voltage, d-c or peak a-c.....	90 max	volts
Peak cathode-current density.....	100 max	microamperes per square inch
Peak cathode current.....	10 max	microamperes
Average cathode current**.....	3 max	microamperes
Ambient temperature.....	100 max	C

MINIMUM CIRCUIT VALUES

D-c load resistance

With anode-supply voltage of 75 volts or less

 For d-c currents above 3 microamperes..... 0.1 megohm

 For d-c currents below 3 microamperes..... no minimum

With anode—supply voltage of 90 volts

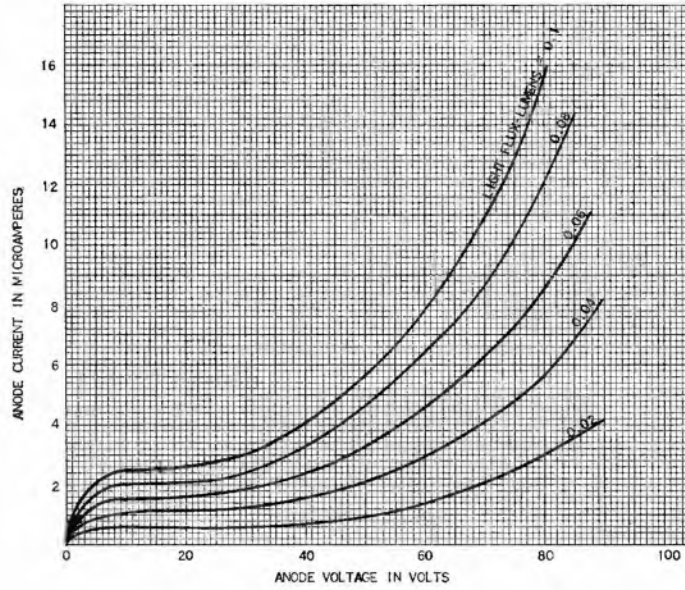
 For d-c currents above 2 microamperes..... 2.5 megohms

 For d-c currents below 2 microamperes..... 1 megohm

*Given for conditions where a Mazda projection lamp operated at a filament color temperature of 2870 K is used as a light source. The method for determining sensitivity employed a 90-volt supply and a 1.0-megohm resistor. For the 0-cycle measurements, a light input of 0.1 lumen was used. For the 5000- and 10,000-cycle measurements, the light input was varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean.

**Averaged over any interval of 30 seconds maximum. Average current may be doubled when anode-supply voltage is limited to 70 volts.

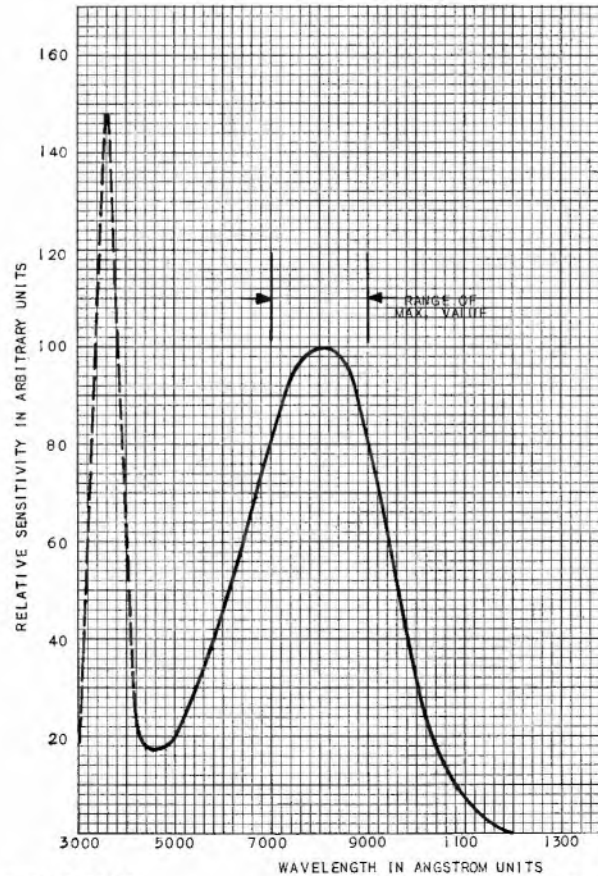
GL-1P40
AVERAGE ANODE CHARACTERISTICS



K-69087-72A253

8-18-48

◆ S-1 PHOTOSURFACE
SPECTRAL SENSITIVITY CHARACTERISTIC FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



K-69087-72A406
◆ Revised drawing.

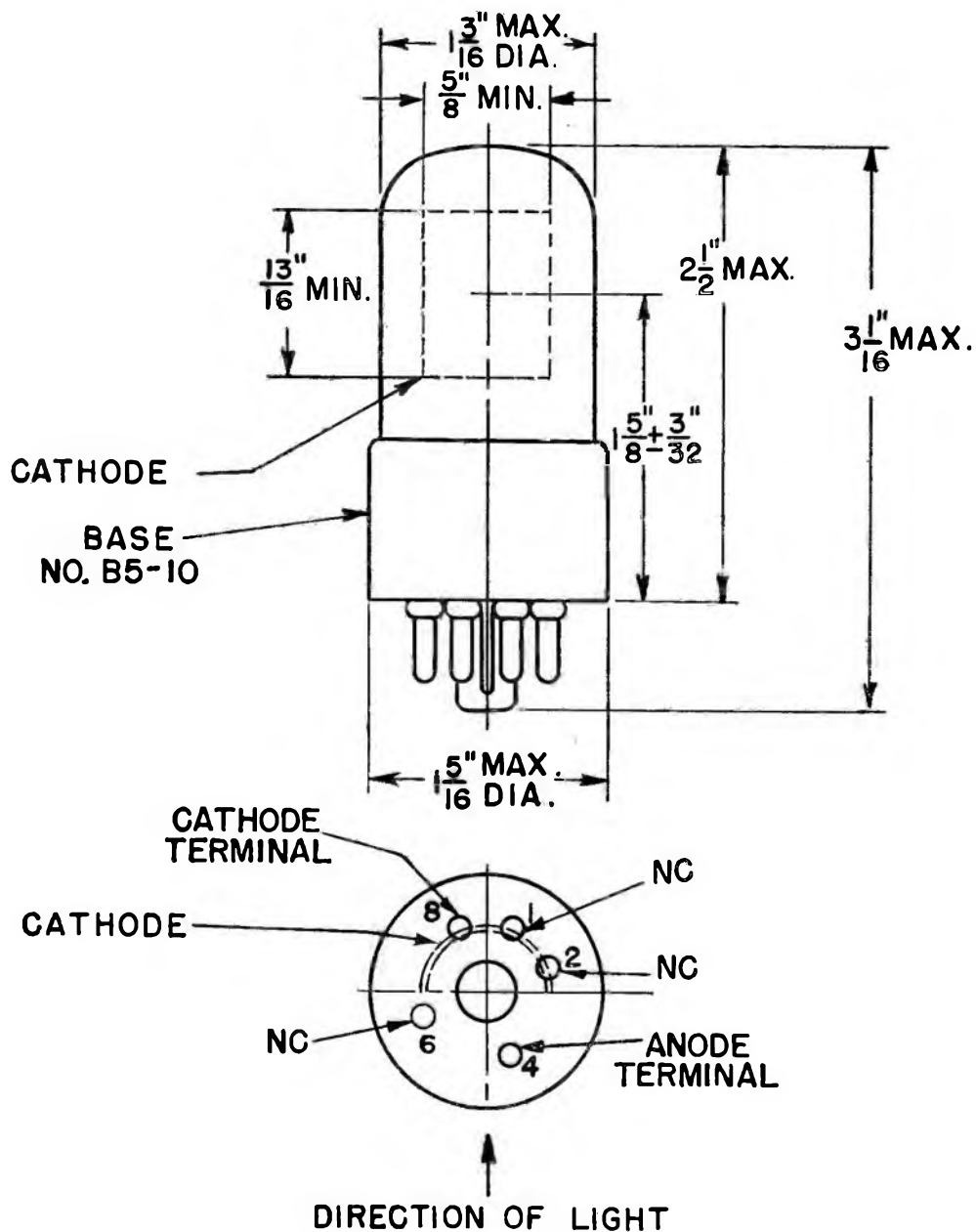
9-19-50

GL-1P40

ETI-290A

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Outline
Phototube GL-1P40

K-8070703

8-4-48

Tube Department, Electronics Division

GENERAL  ELECTRIC

Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-1P39 is a high-vacuum phototube with high sensitivity to light sources predominating in blue radiation, and negligible sensitivity to infrared radiation. It is useful in light-operated relay, measurement, and color-control applications.

The GL-1P39 is similar to the GL-929 except that it is provided with a non-hygroscopic base which

insures a value of resistance between anode and cathode pins about 10 times higher than conventional bases under adverse operating conditions of high humidity. As a result, more output for a given light input is obtainable under high-humidity conditions.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Spectral response—S-4

Sensitivity at 4000 angstroms 0.042 microamperes per microwatt

Luminous sensitivity* 45 microamperes per lumen

Wavelength of maximum response 4000 ± 500 angstroms

Direct interelectrode capacitance 2.6 uuf

Maximum dark current at 250 volts 0.005 microampere

Mechanical Data

Mounting position—any



TECHNICAL INFORMATION (CONT'D)

MAXIMUM RATINGS, Absolute Values

Anode voltage, d-c or peak a-c	250 max	volts
Average cathode current**	5 max	microamperes
Peak cathode current	20 max	microamperes
Peak cathode current density	100 max	microamperes per square inch
Ambient temperature	75 max	C

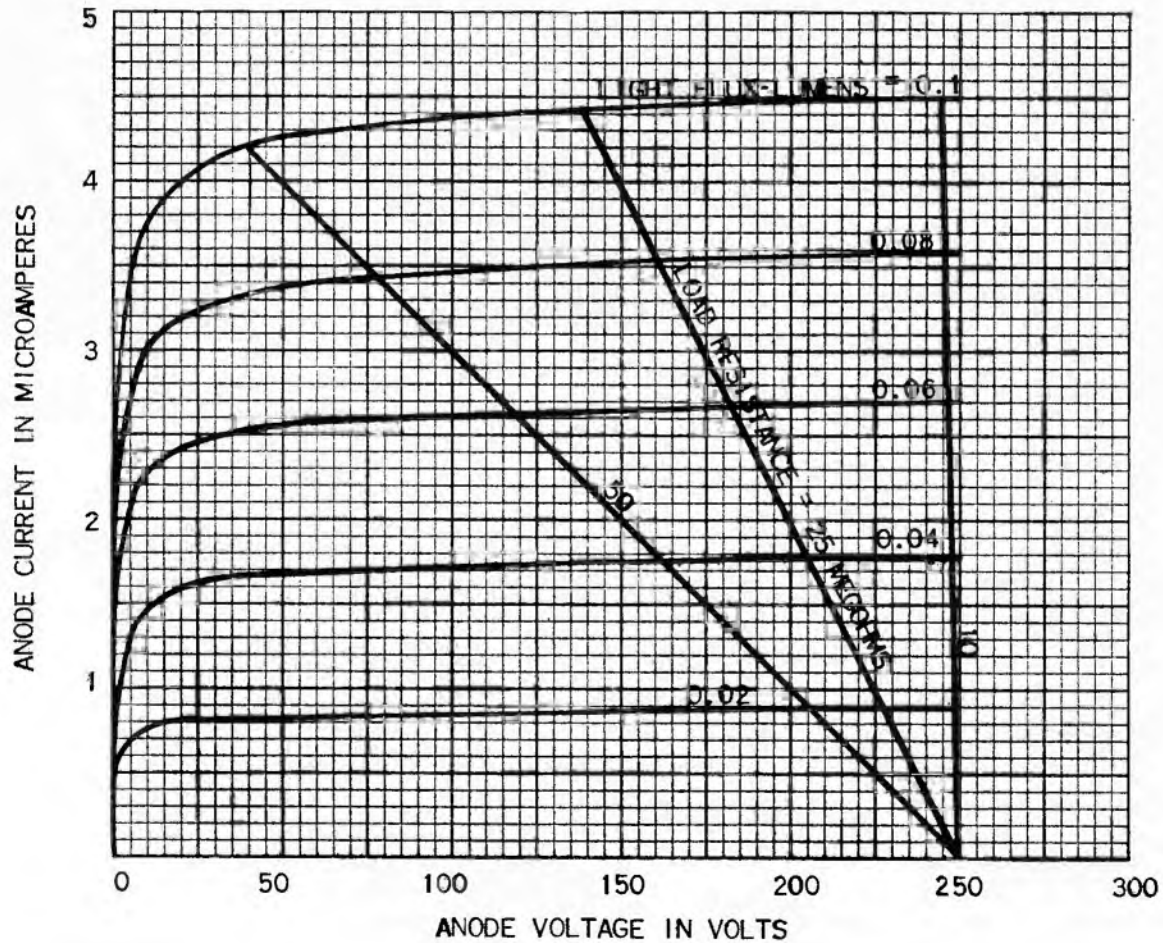
MINIMUM CIRCUIT VALUES

D-c load resistance..... 1 megohm

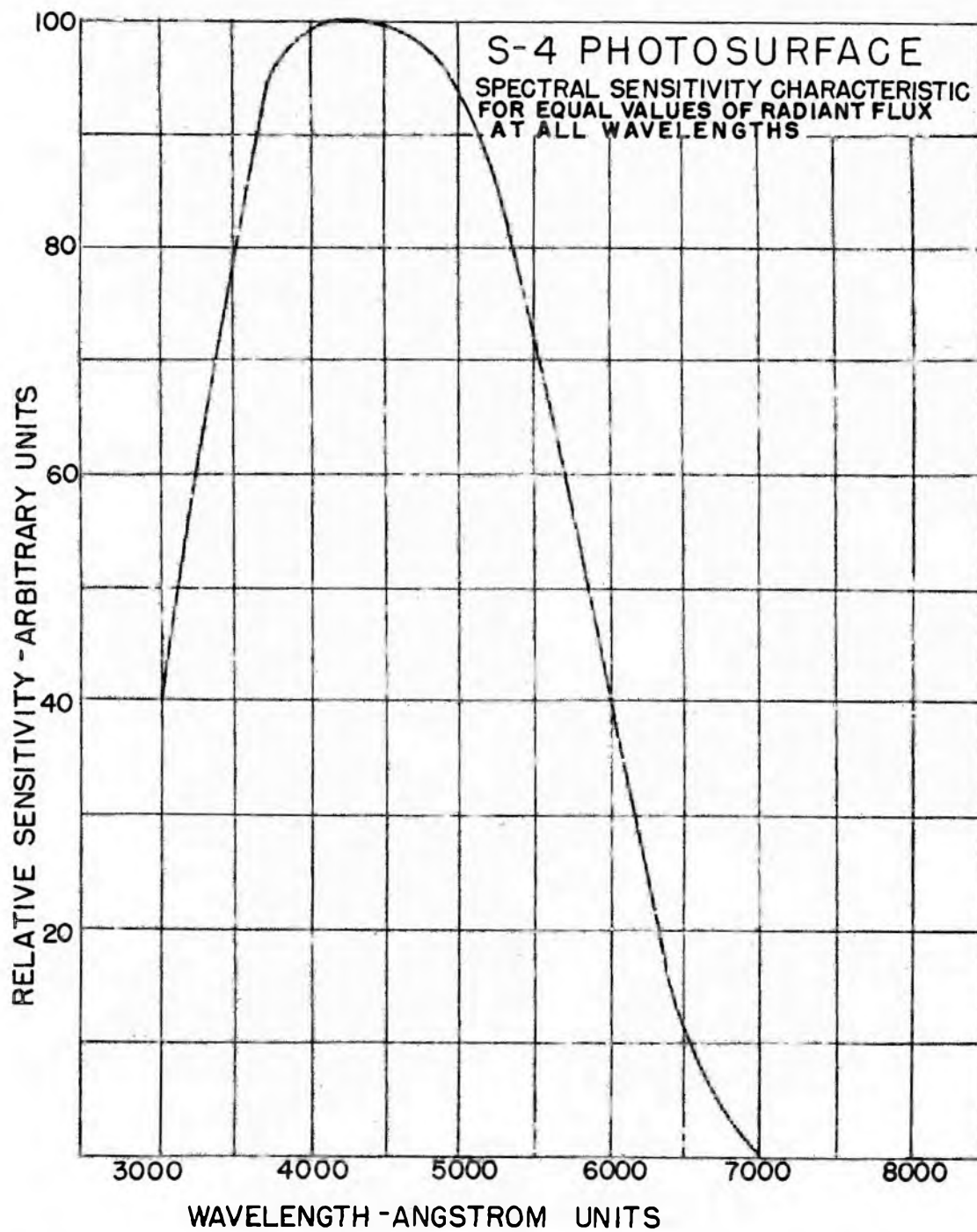
*Given for conditions where a Mazda projection lamp operated at a filament color temperature of 2870 K is used as a light source. The method for determining sensitivity employed a 250-volt supply, a 1.0-megohm load resistor and a light input of 0.1 lumen. With daylight, value is several times higher; to light from a high-pressure arc, many times higher.

**Average over any interval of 30 seconds maximum.

GL-1P39
AVERAGE ANODE CHARACTERISTICS



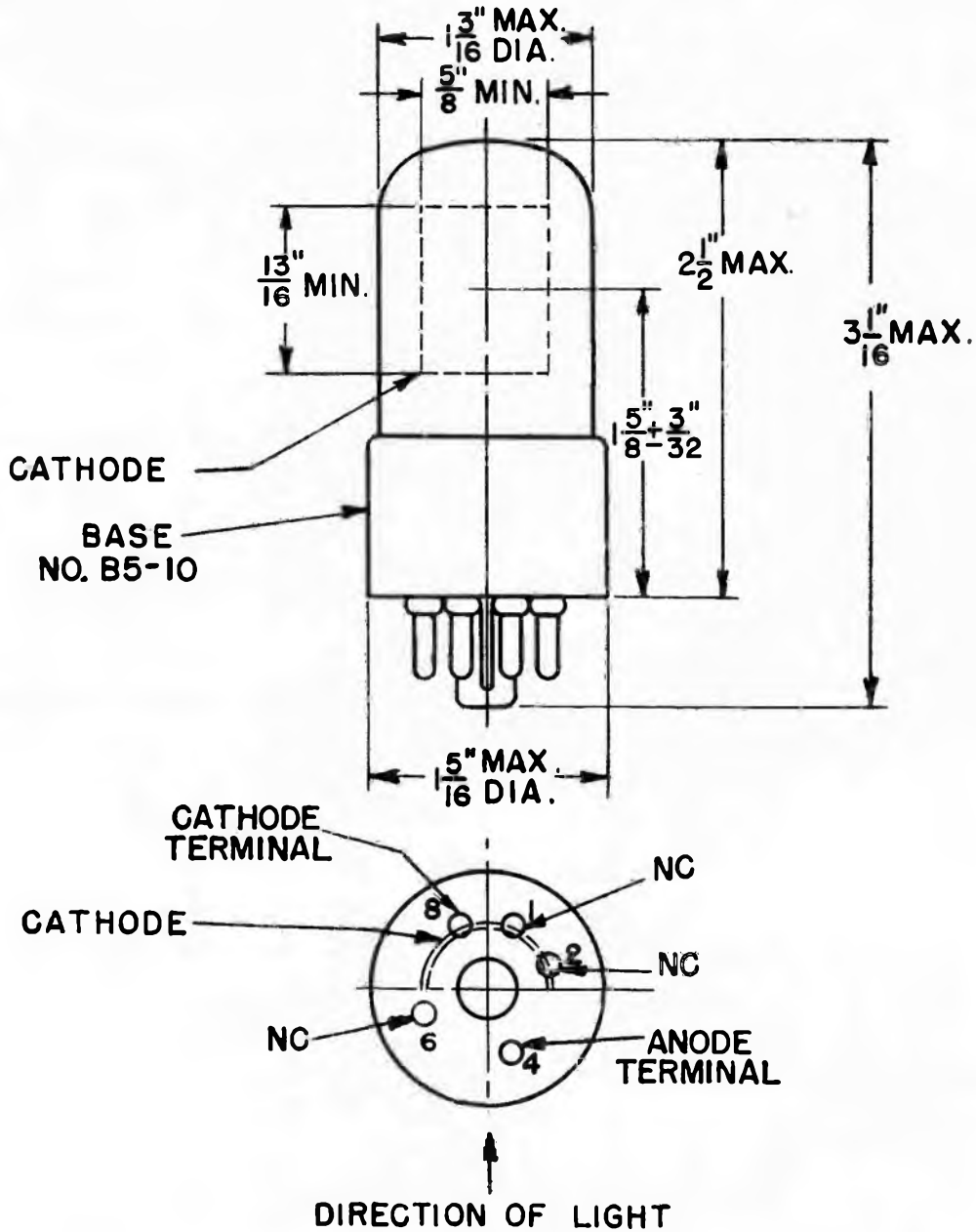
S-4 PHOTOSURFACE
SPECTRAL SENSITIVITY CHARACTERISTICS
FOR EQUAL VALUES OF RADIANT
FLUX AT ALL WAVELENGTHS



GL-1P39

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OUTLINE
GL-1P39 PHOTOTUBE



K-8070703

B-4-48

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-5581 is a gas phototube with high sensitivity to light sources predominating in blue radiation, and no response to infrared radiation. It is therefore, particularly suitable for use in sound reproduction involving a dye-image sound track in conjunction with an incandescent light source. The tube may also be used in measurement and color-control applications.

Because the GL-5581 has no response in the infrared region where dye-image sound tracks have marked transparency, masking of the dye-image

modulation by infrared transmitted through the film is avoided, and the dye-image modulation of either variable-area or variable-density sound tracks is reproduced essentially to its full degree.

The luminous sensitivity, anode characteristics, and structure of the GL-5581 are comparable with the same properties of Type GL-930 to permit use of the GL-5581 with minor circuit changes in motion picture and other equipment designed to use the older type.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Spectral Response—S-4	
Wavelength of maximum response	4000 \pm 500 angstroms
Direct interelectrode capacitance	2.6 uuf

GENERAL  **ELECTRIC**


Electronic
TUBE

TECHNICAL INFORMATION (CONT'D)

These data are for reference only. For design information refer to specifications.

GENERAL

	Min	Avg	Max	
Sensitivity at 4000 angstroms		0.125		microamperes per microwatt
Luminous sensitivity				
At 0 cycles	75	135	205	microamperes per lumen
At 5000 cycles		124		microamperes per lumen
At 10,000 cycles		108		microamperes per lumen
Gas amplification factor			5.5	
Dark current at 90 volts		0.050		microampere

Mechanical Data

Mounting position—any

MAXIMUM RATINGS, Absolute Values

Anode voltage, d-c or peak a-c	100	volts
Average cathode current*	3 max	microamperes
Peak cathode current	10 max	microamperes
Peak cathode current density	100 max	microamperes per square inch
Ambient temperature	75 max	C

*Average over any interval of 30 seconds maximum. Average current may be doubled when anode-supply voltage is limited to 80 volts.

MINIMUM CIRCUIT VALUES

D-c load resistance

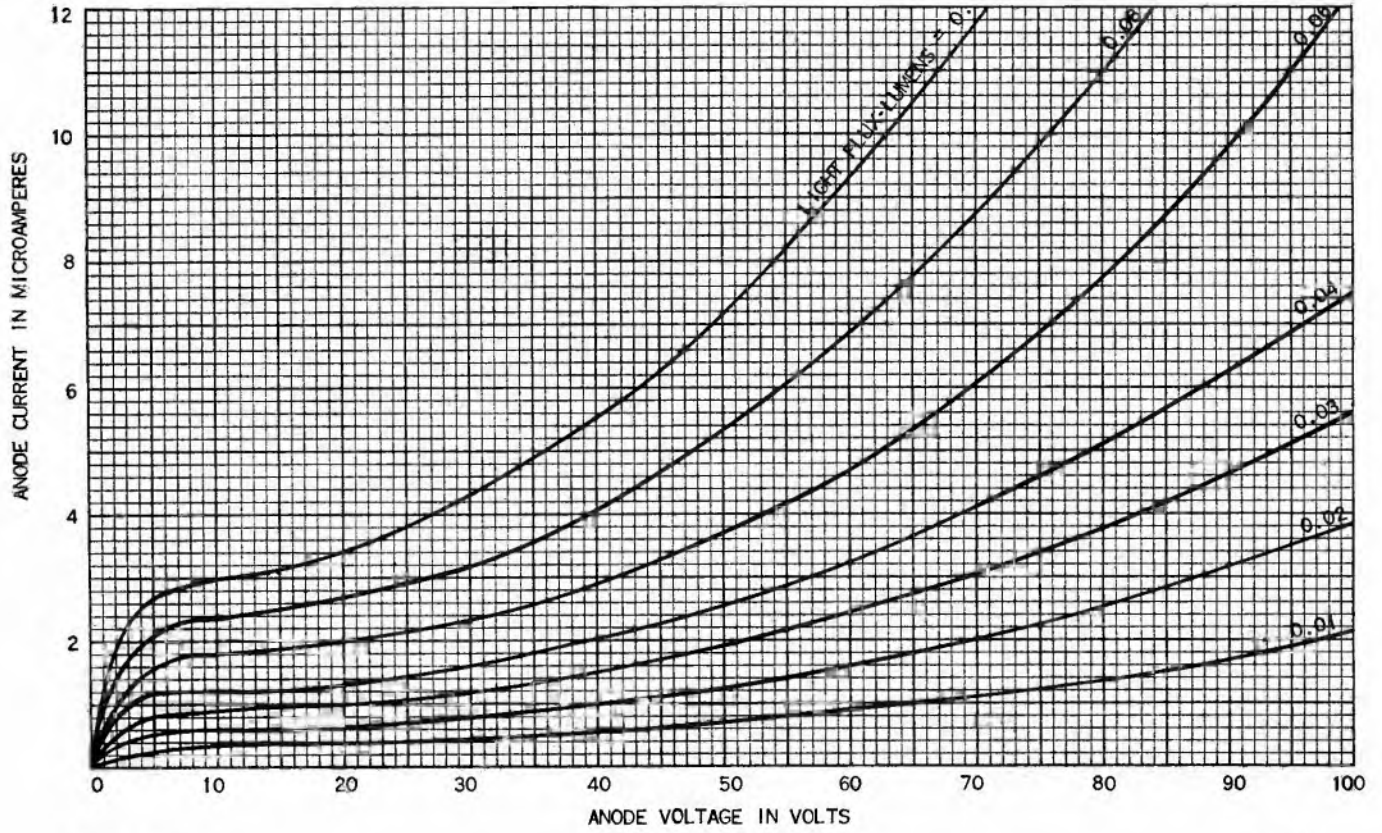
With anode-supply voltage of 80 volts or less

For d-c currents above 3 microamperes	0.1	megohm
For d-c currents below 3 microamperes		no minimum

With anode-supply voltage of 100 volts

For d-c currents above 1 microampere	2.5	megohms
For d-c currents below 1 microampere	0.1	megohm

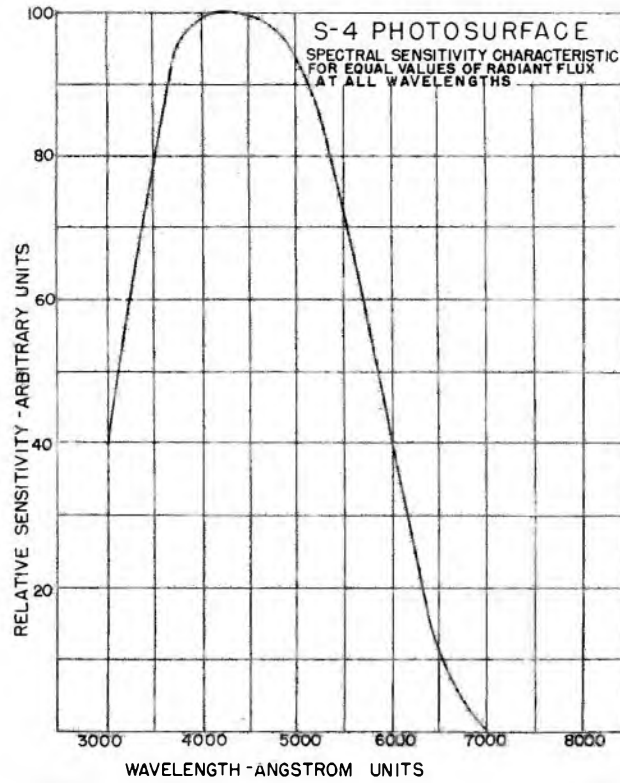
GL-5581 PHOTOTUBE
AVERAGE ANODE CHARACTERISTICS



K-69087-72A254

8-15-48

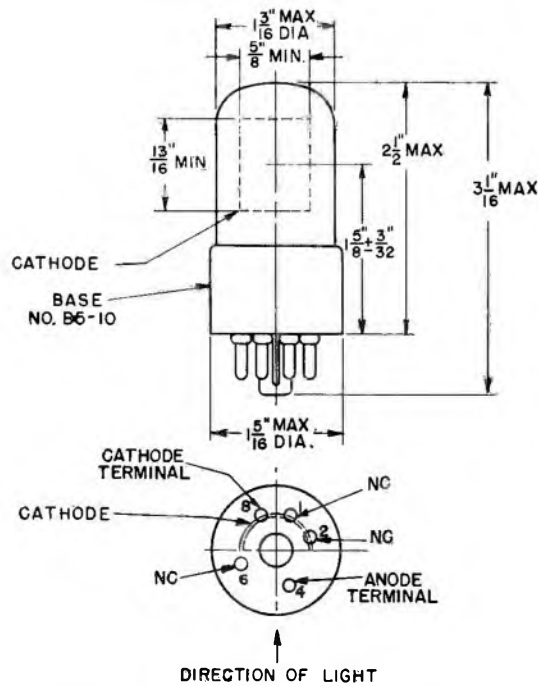
S-4 PHOTOSURFACE
SPECTRAL SENSITIVITY CHARACTERISTIC
FOR EQUAL VALUES OF RADIANT
FLUX AT ALL WAVELENGTHS



K-8639625

4-27-44

OUTLINE
GL-5581 PHOTOTUBE



K-8070703

8-4-48

Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.



PHOTOTUBE

DESCRIPTION

The GL-1P21 is a high-vacuum multiplier phototube characterized by extremely high sensitivity, very small d-c dark current, freedom from distortion, and an equivalent noise input of only 5×10^{-13} lumen at 25 C—features which adapt it particularly to applications employing a collimated light beam such as photoelectric spectrometers, astronomical telescopes, and scintillation counters with “light piping.”

In phototubes of the multiplier type the photocurrent produced at the cathode is multiplied many times by secondary emission occurring at successive dynodes. The GL-1P21 can multiply feeble currents produced under weak illumination by an average value of 2,000,000 times when operated at 100 volts per stage.

Since maximum spectral response occurs at approximately 4,000 angstroms, the tube has negli-

gible response to infrared radiation and high sensitivity to blue-rich light. The sensitivity to incandescent light depends on the color temperature of the source. Under normal operating conditions the output current of the GL-1P21 is a linear function of the exciting illumination. The frequency response, since secondary emission occurs almost instantaneously, is flat up to frequencies at which transit time and capacitance effects become the limiting factor.

In addition to those mentioned the GL-1P21 is recommended for all other specialized scientific applications where very low light levels are involved. The requirements of such service—extremely low equivalent noise input, high photosensitivity, very high secondary-emission amplification, and very small d-c dark current—are all features of this tube.

GENERAL  ELECTRIC


Electronic
TUBE

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Spectral response—S4	
Wavelength of maximum response	4000 ± 500 angstroms
Dark current at 1000 volts	0.1 microampere
Interelectrode capacitances	
Anode to dynode No. 9	4 uuf
Anode to all other electrodes	6.5 uuf

Mechanical Data

Cathode dimensions, minimum*	$\frac{5}{16}$ by $\frac{15}{16}$ inches
Seated height to center of useful cathode area	$1\frac{1}{8}$ ± $\frac{3}{32}$ inches
Mounting position—any	

MAXIMUM RATINGS

Anode-supply voltage, d-c or peak a-c**	1250 volts
Supply voltage between dynode No. 9 and anode, d-c or peak a-c	250 volts
Peak anode current	1.0 microamperes
Average anode current	0.1 microamperes
Averaging time, maximum	30 seconds
Ambient temperature	75 C

CHARACTERISTICS

100 volts per dynode stage and 100 volts between dynode No. 9 and anode

	Minimum	Average	Maximum
Anode dark current, d-c††			0.1 microamperes
Sensitivity			
At 4000 angstroms		74,000	microamperes per microwatt
Luminous#	40	80	amperes per lumen
Current amplification***		2,000,000	
Equivalent noise input****		5×10^{-13}	lumens
75 volts per dynode stage and 50 volts between dynode No. 9 and anode			
Sensitivity			
At 4000 angstroms		11,000	microamperes per microwatt
Luminous#		12	amperes per lumen
Current amplification***		300,000	

*On plane perpendicular to indicated direction of incident light.

**Referred to cathode.

†Dark current due to thermionic emission and ion feedback may be reduced by the use of refrigerants.

‡For maximum signal-to-noise ratio, operation below 1,000 volts is recommended.

#For conditions where a Mazda projection lamp operated at a filament color temperature of 2870 K is used as a light source. A light flux of 10 microlumens from a rectangular aperture approximately 0.8 inch long and 0.2 inch wide is projected normal to the center of the cathode. The load resistor has a value of 0.01 megohm. The applied voltages are as indi-

cated. The sensitivity is independent of frequency up to frequencies at which transit time becomes the limiting factor.

***Ratio of anode sensitivity to cathode sensitivity.

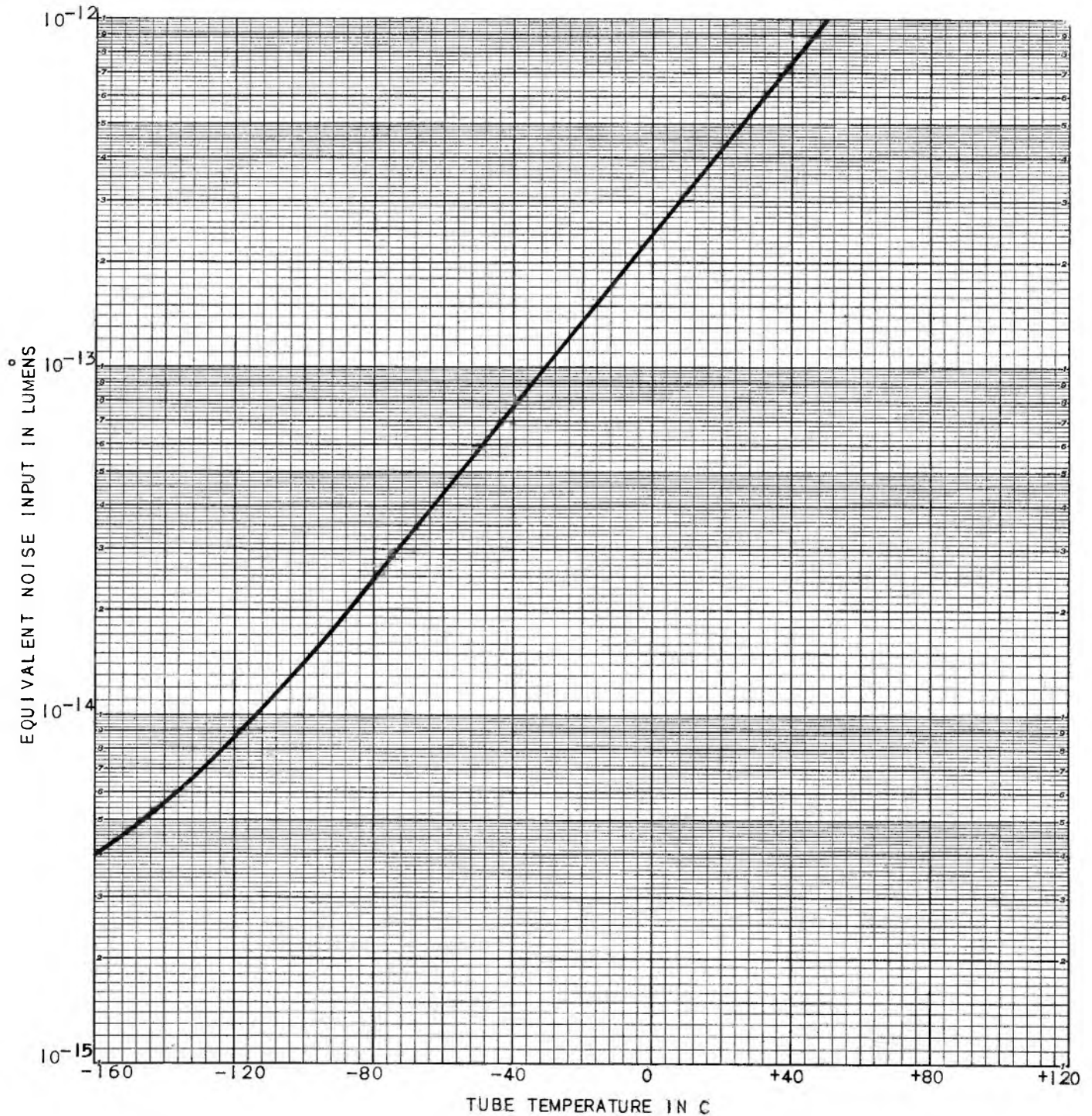
****Defined as the value where the rms output current is equal to the rms noise current determined under the following conditions: 100 volts per stage, 25 C tube temperature, a-c amplifier bandwidth of one cycle per second, tungsten light source 2870 K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period. The output current is measured through a filter which passes only the fundamental frequency of the pulses.

GL-1P21
EQUIVALENT-NOISE-INPUT CHARACTERISTIC

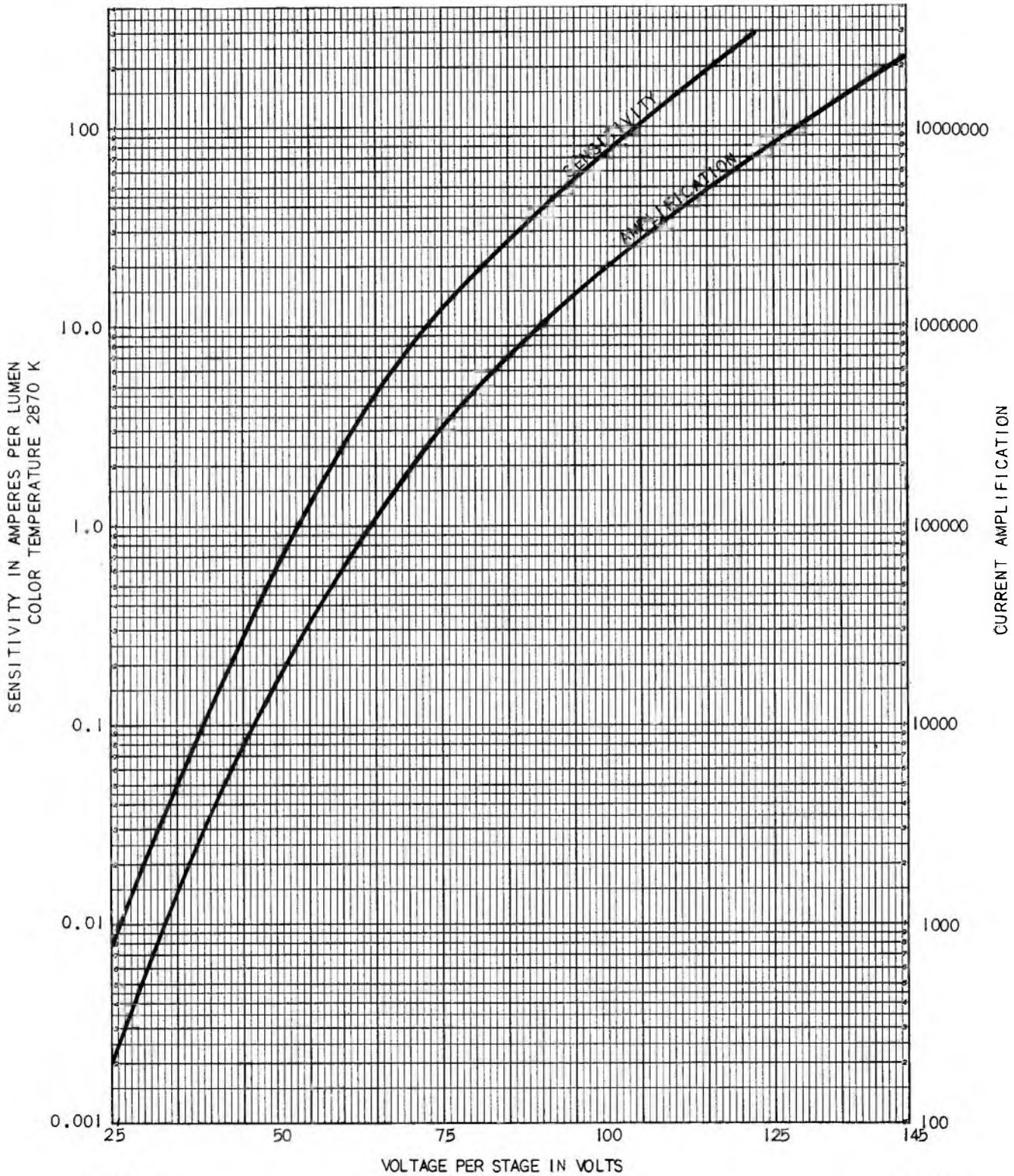
100 VOLTS PER STAGE

BANDWIDTH = 1 CPS

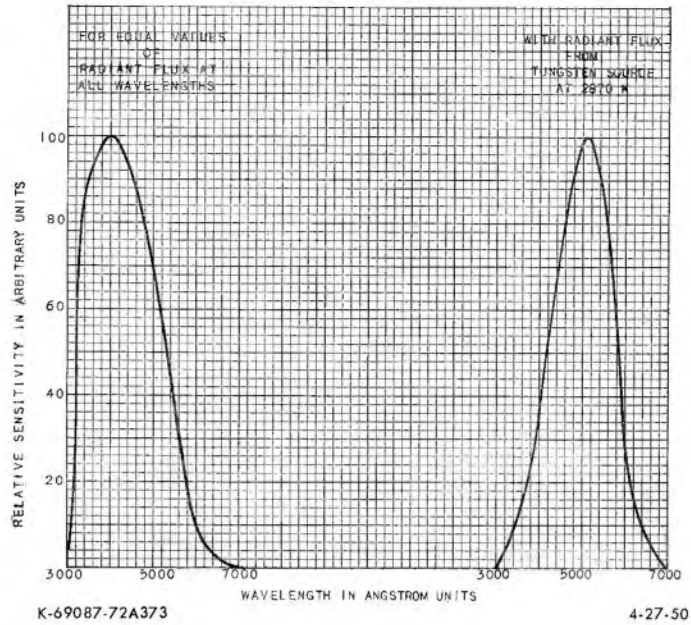
LIGHT SOURCE: TUNGSTEN, AT 2870 K:
INTERRUPTED AT 90 CPS TO PRODUCE PULSES
ALTERNATING BETWEEN ZERO AND FLUX VALUE
SHOWN FOR ANY GIVEN TUBE TEMPERATURE:
"ON" PERIOD OF PULSE EQUAL TO "OFF" PERIOD:
RMS SIGNAL CURRENT = RMS NOISE CURRENT.



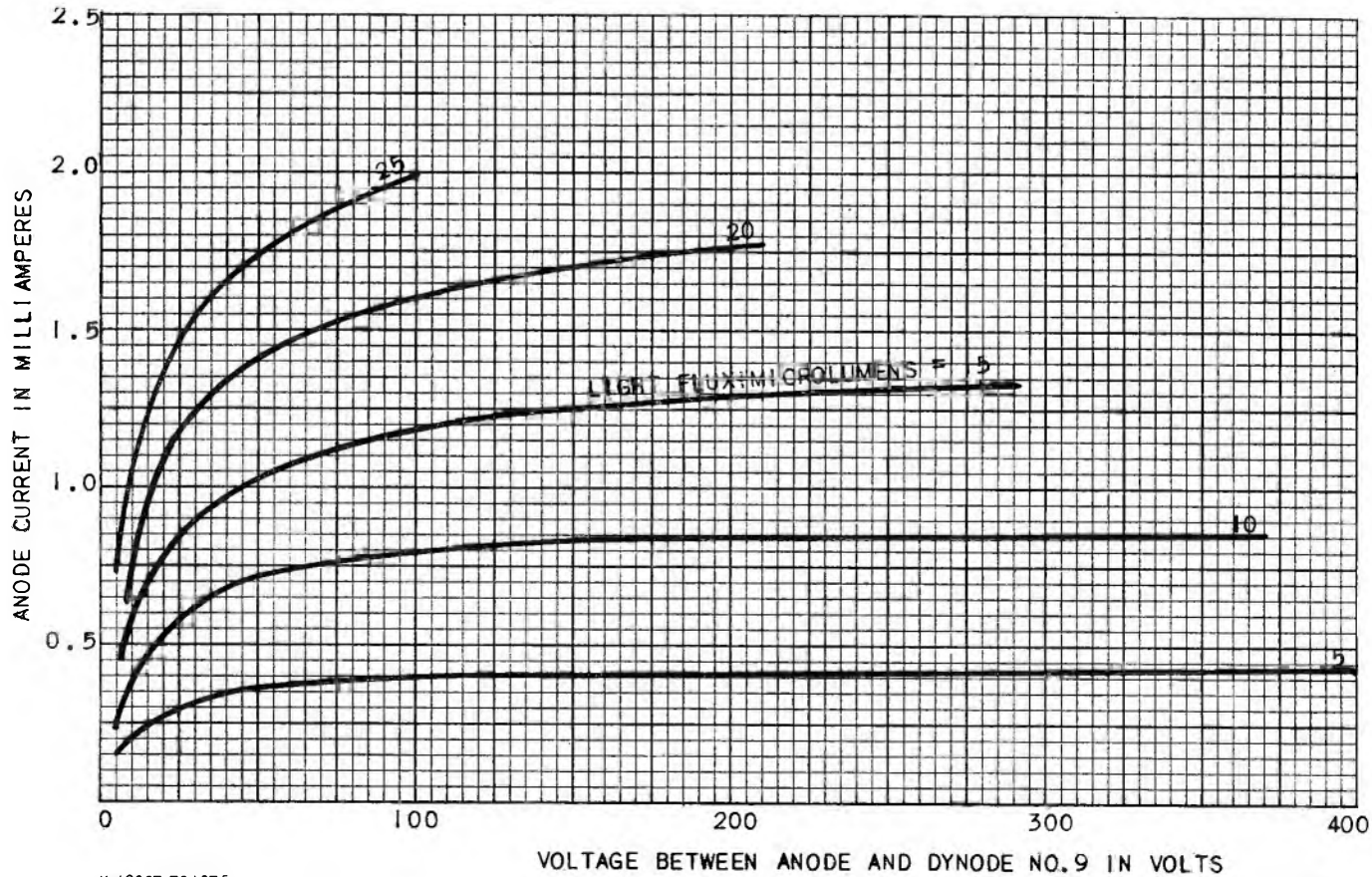
GL-1P21
AVERAGE CHARACTERISTICS



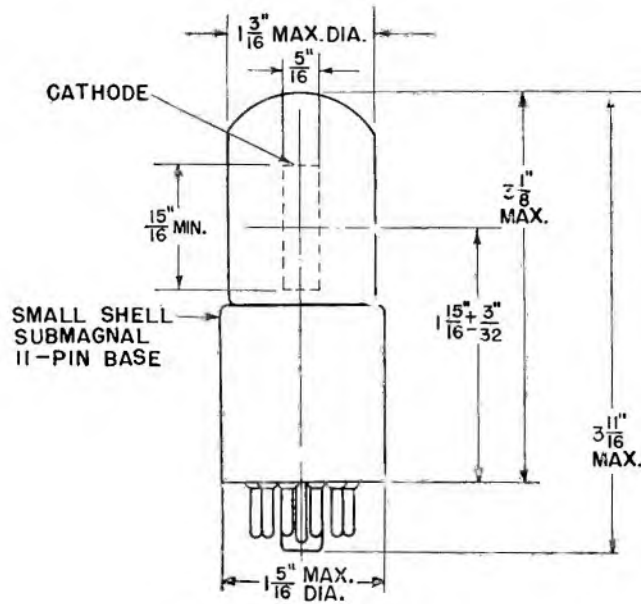
S-4 PHOTOSURFACE
SPECTRAL SENSITIVITY CHARACTERISTIC



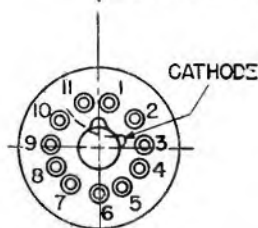
GL-1P21
AVERAGE ANODE CHARACTERISTICS
VOLTAGE PER STAGE = 100



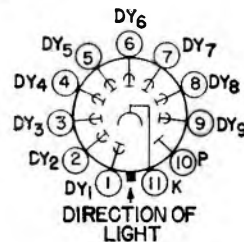
OUTLINE
GL-1P21 MULTIPLIER PHOTOTUBE



DIRECTION OF LIGHT



BOTTOM VIEW OF BASE



BASING DIAGRAM

Q OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERRECTED AT CENTER OF BOTTOM OF BASE.

K-8277037

4-28-50

Tube Divisions, Electronics Department

GENERAL ELECTRIC

Schenectady, N. Y.

BALLAST TUBES

GENERAL  ELECTRIC

BALLAST TUBES



DESCRIPTION

A ballast tube is essentially a constant-current device. It is a resistor whose resistance, at a certain critical temperature, varies with temperature so rapidly that, as the voltage across the tube varies, the current remains practically constant. The operation is the same on either alternating or direct current. Its function is to maintain a constant average current.

All ballast tubes now manufactured have been

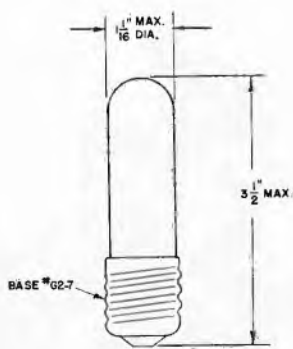
designed for a specific application and, as a result have non-uniform ratings. Because of the wide range of voltage and current ratings possible, no attempt has been made to manufacture a standard line. Ballast tubes may, however, be used in parallel or with shunting resistors across the load to increase or decrease the current rating, or with series resistors to increase the voltage rating. These methods are described under the section titled "Operation."

RATINGS AND DATA

In rating a ballast tube, the voltage range over which the current is nearly constant is given together with a maximum and minimum current. The upper limit of the voltage range is to be considered the maximum voltage at which the tube may be operated. Over the voltage range the current may vary two per cent above or below its average value. The average current of individual tubes

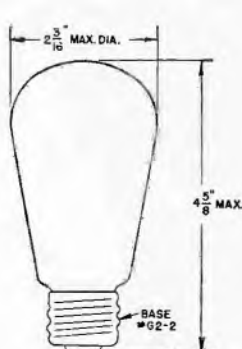
may be as much as two per cent above or below the average current of the entire production. Therefore, considering change of current with life and any other factors which may enter, the variation of current in a circuit using ballast tubes may be as much as five per cent above or below the average. The limits given in the tube ratings cover these factors.

TUBE TYPE NO.	VOLTAGE RANGE IN VOLTS		CURRENT IN AMPERES	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
GL-5621/B-6	15	21	0.95	1.01
GL-5622/B-25	7	16	1.07	1.16
GL-5624/B-46	8	18	2.70	3.25
GL-5623/B-47	8	18	2.05	2.35
GL-5620/FB-50	5	8	0.225	0.275



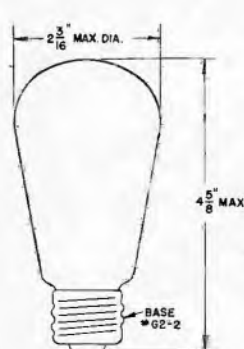
Outline
 GL-5621/B-6 Ballast Tube

N-2480CAZ 4-22-47



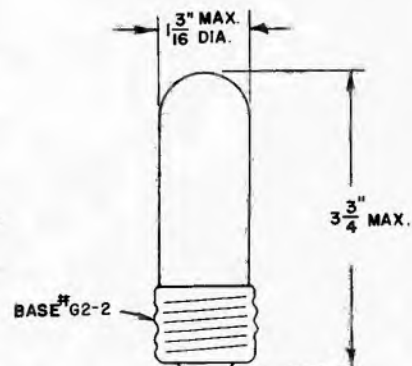
Outline
 GL-5622/B-25 Ballast Tube

N-2480IAZ 4-22-47



Outline
 GL-5624/B-46, GL-5623/B-47
 Ballast Tube

N-2480IAZ 4-22-47



Outline
 GL-5620/FB-50 Ballast Tube

N-2480IAZ 4-22-47

INSTALLATION

The ballast tube should be mounted, with the base down, in an enclosure rigid enough to stop flying glass since, should the tube develop an air leak, the mixture of oxygen with the hydrogen contained in the tube might become of the right proportion to explode. The envelope becomes quite hot during operation, and free circulation of air

must be allowed in order to keep the temperature of the air near the tube below 150 F. Marked changes in envelope temperature will cause a change in the current. Since the entire load current must pass through the ballast tube, the socket and connections to it must be clean and make good contact to prevent heating at these points.

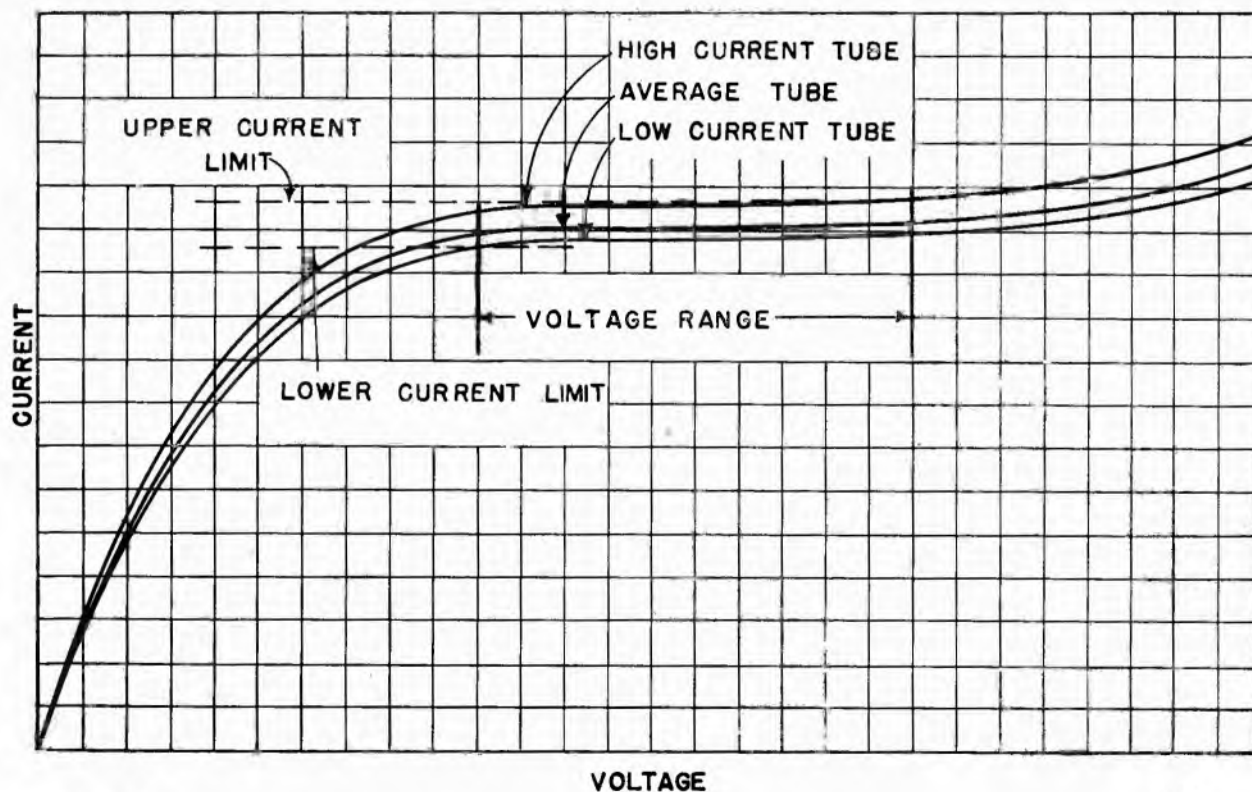
OPERATION

The operation of the tube is shown by the characteristic curves in Fig. 1. As the voltage across the filament rises from zero, the resistance of the tube increases slowly in the same manner as most metals. As the lower end of the operating range is reached, the resistance of the filament increases quite rapidly with temperature, so that further increase in voltage causes practically no further increase in current. As the upper end of the operating range is reached, the resistance again becomes nearly constant. A still further increase in voltage causes an almost proportional increase in current as illustrated in the curves of Fig. 1.

This operation of the tube can be seen by observing the filament. As the voltage across the tube is increased from zero and approaches the lower end of the operating range, a small section in the

middle of the filament will become red hot. As the voltage is increased further, the length of this red-hot section increases until the entire filament is visibly hot. This represents the end of the operating range and any increase in voltage will overheat and damage the tube. Operating the tube above the upper limit of voltage will result in excessive expansion and contraction of the filament as the voltage varies; this will cause the wire to stretch out the coils of the filament or to knot, which will increase the current and speed up the destructive process already started, resulting, shortly, in filament burn-out.

If a steady voltage of a value in the middle of the operating range is applied to the tube continuously, its life will be tens of thousands of hours. Opening and closing the circuit with the resulting lengthen-



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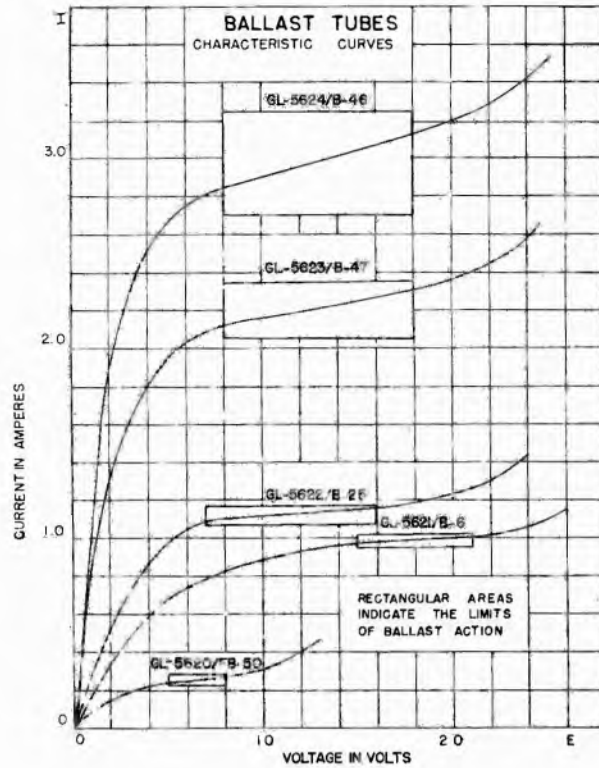
Fig. 1—Typical Ballast Tube Characteristics

ing and shortening of the filament greatly reduces the life of the tube. If full voltage is applied to the tube, the circuit may be opened and closed only a few hundred times before the current is outside the limits or the filament is burned out. Thus the life of the tube will be determined entirely by its duty cycle.

Because of the large thermal inertia of the tube, the temperature does not reach its final value immediately when the circuit is closed or when the voltage changes. Since the cold resistance of the filament is quite low, when the circuit is first closed the initial current may be several times the final value.

After a few seconds, however, the current will have fallen to within 25 per cent of the final value, and from 15 seconds to several minutes, depending upon the size of the tube, will be required for the current to reach a steady state. The real function of a ballast tube is to maintain a constant average current.

In Fig. 1 three curves are given to show the variation to be expected between tubes of a given rating. By choosing the proper coordinates, these curves are approximate for any ballast tube. Individual tubes may maintain the current to less than the range shown, but in any particular application variations up to plus or minus five per cent of the average may be expected. Typical characteristic curves indicating the limits of ballast action for the various types of ballast tubes are shown in Fig. 1A at the right.



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Fig. 1A

APPLICATION CIRCUITS#

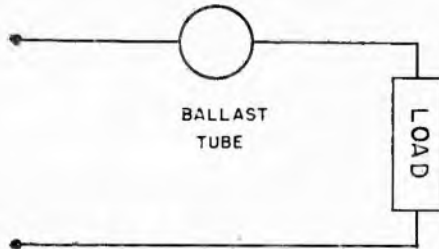
The commonest use of the ballast tube is to place it directly in series with the load as shown in Fig. 2 and Fig. 3.

The graphical representation of the current and voltages in the circuit is shown in Fig. 4.

When voltage is applied, the current which flows is determined by the intersection of the load characteristic and the tube characteristic. As the supply

voltage varies the current remains practically constant. The load voltage remains practically constant because the tube voltage varies by an amount proportional to the supply voltage variation. The tube used should have a voltage range equal to the variation in supply voltage.

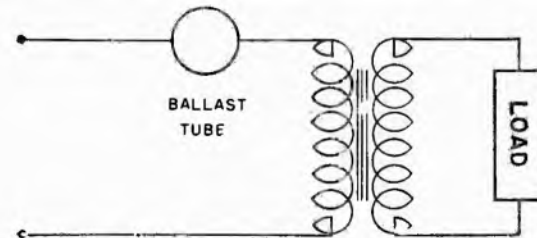
#Circuits shown in ETI-194A are examples of possible tube application and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company



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Fig. 2—Connection for A-c or D-c Circuit

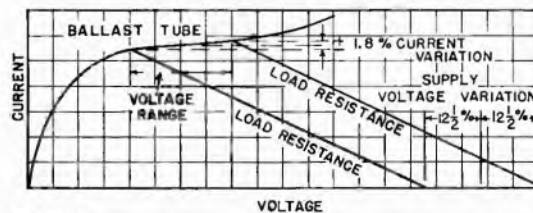
12-30-44



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Fig. 3—Connection Using a Transformer

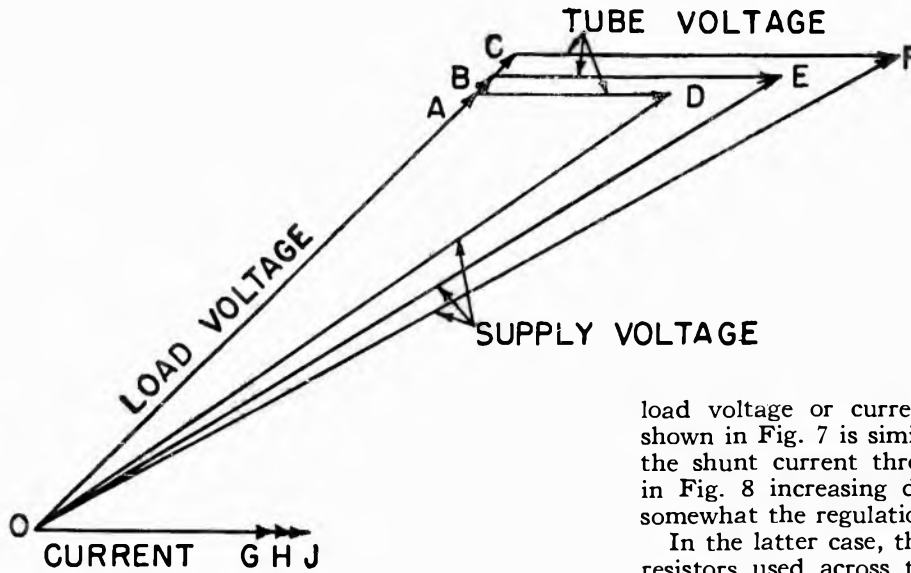
1-1-45



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Fig. 4—Ballast Tube in Series with Load

1-1-45



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1-1-45

Fig. 5—Vector Diagram for Inductive Load

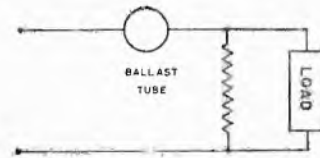
A ballast tube may be used with inductive loads as well as with pure-resistance loads. Fig. 5 shows the vector diagram for such a load. The vector OE represents the normal supply voltage, while the vectors OB and BE represent the normal load and ballast-tube voltages, respectively. OH is the normal current. As the supply voltage decreases to OD or increases to OF , the ballast-tube voltage decreases to AD or increases to CF . This maintains the load voltage between OA and OC and the current between OG and OJ .

If it is necessary to use a tube whose current rating is too high or too low, either the load or the tube, as the case may be, may be bridged with a resistor to carry the excess or additional current. Figs. 6 and 7 show these two connections.

The operation of the circuit shown in Fig. 6 is identical with that shown in Fig. 2, the resistor being considered part of the load. This circuit is also recommended where close adjustment of the

load voltage or current is required. The circuit shown in Fig. 7 is similar in operation except that the shunt current through the resistor, as shown in Fig. 8 increasing directly with voltage, spoils somewhat the regulation of the tube.

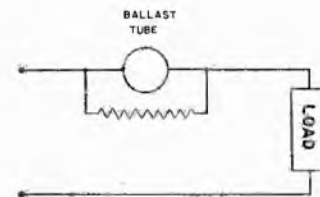
In the latter case, the higher the value of shunt resistors used across the ballast tube, the better the regulation. This connection is not recommended except in cases where close regulation is unnecessary.



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12-30-44

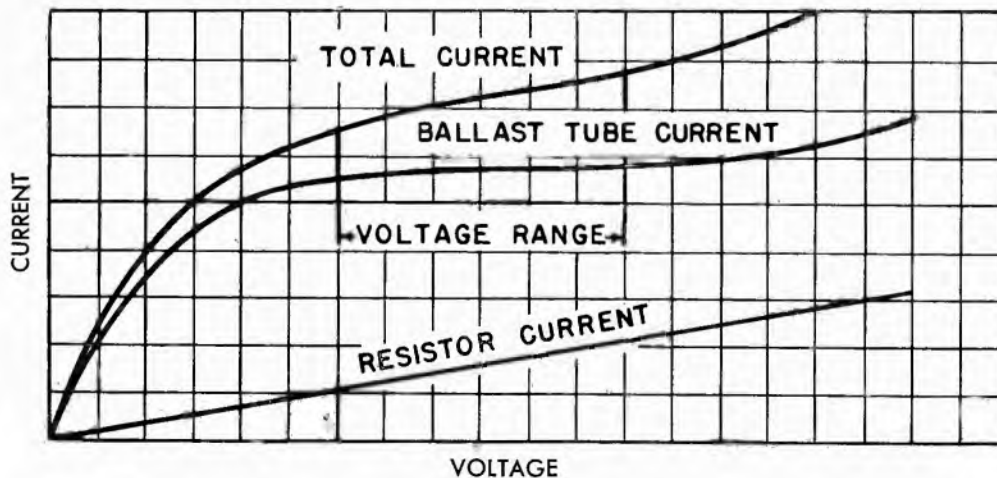
Fig. 6—Circuit Using Tube with Too Large a Current



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Fig. 7—Circuit Using Tube with Too Small a Current (Not recommended)



K-9033581

Fig. 8—Resistor Across Ballast Tube

1-1-45

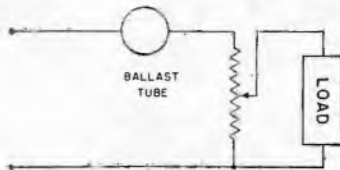
APPLICATION CIRCUITS (Contd.)

The ballast tube may be used to maintain constant current in a circuit requiring variation of the load. A suggested circuit is shown in Fig. 9.

Since the voltage across the ballast tube will vary with both the line voltage and load resistance (the potentiometer being considered part of the load) a greater voltage range will be required, and the ballast tube will use a greater percentage of power See Fig. 10 below.

The minimum voltage across the ballast tube will occur with minimum supply voltage and with the load adjusted to the minimum point on the potentiometer. The maximum voltage across the ballast tube will occur with the maximum supply voltage and with the load adjusted to the maximum point on the potentiometer. Since this circuit draws a constant current from the line, varying the potentiometer will not cause a variation in supply voltage to other apparatus on the line.

Ballast tubes may be used in parallel provided their voltage ranges are equal or nearly so. If their voltage ranges are unequal, good ballasting will occur only over that part of the voltage range which is included by both tubes. The current for any



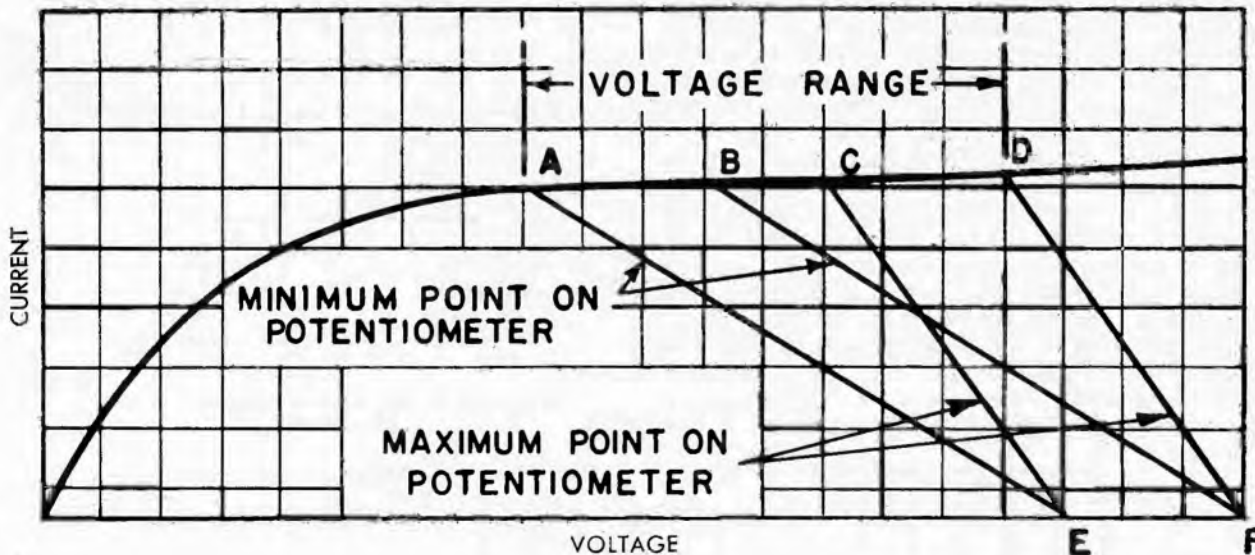
K-9033582

1-9-45

Fig. 9—Circuit for Varying Load Voltage

voltage will be the sum of the currents in both tubes at that voltage.

Ballast tubes cannot be used in series unless their current-voltage characteristics are identical. This can be shown by referring to Fig. 1. If two tubes, one having the maximum current and one the minimum for a particular rating, are used in series the current will be the same in both tubes at all times. At the value at which the higher-current tube starts to ballast, the lower-current tube is operating above its ballasting range and hence is over-loaded. Thus, the safe operating range of the combination is only that of the lower current tube.

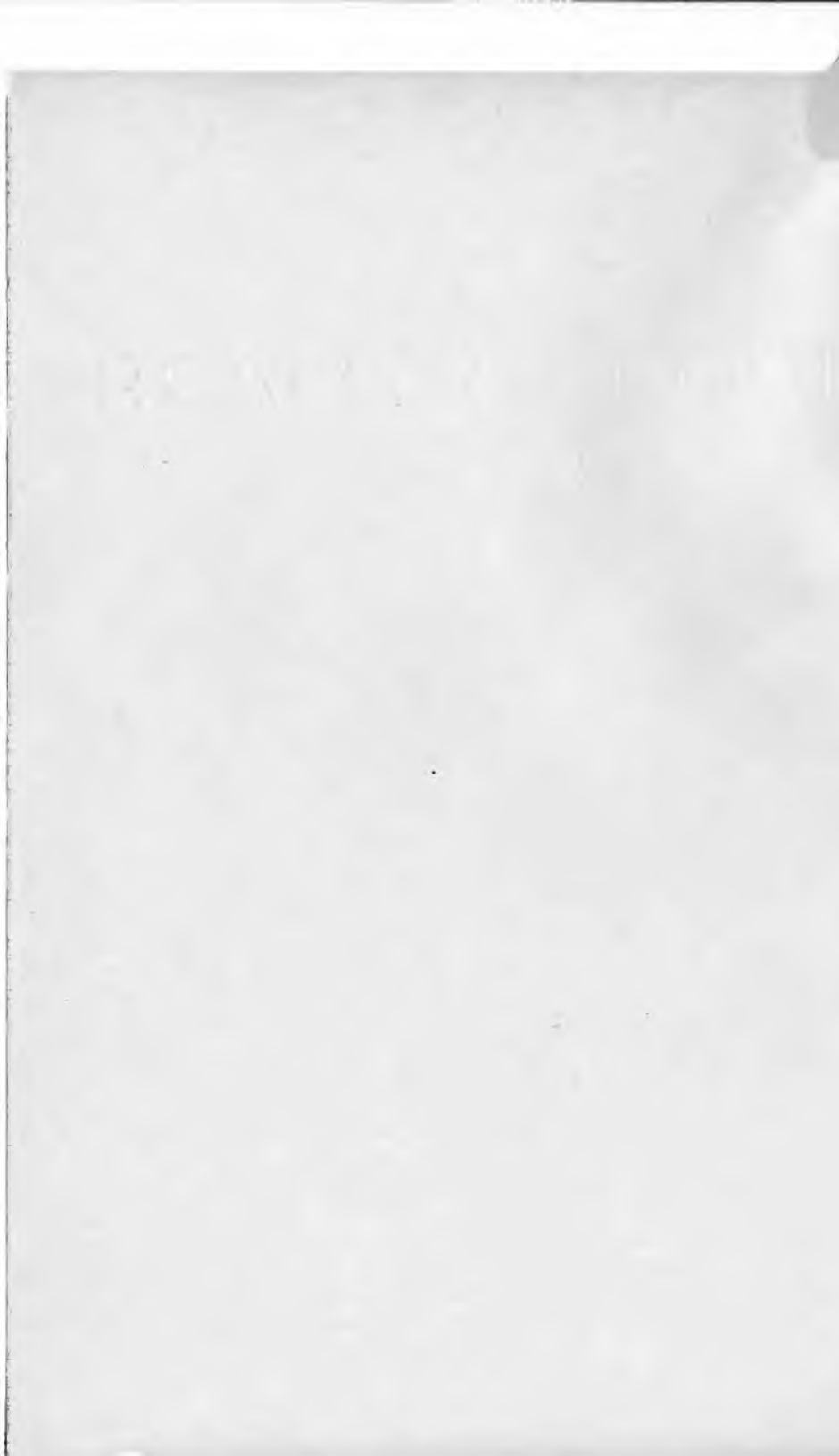


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Fig. 10—Ballast Tube in Series with Potentiometer, Load Across Potentiometer

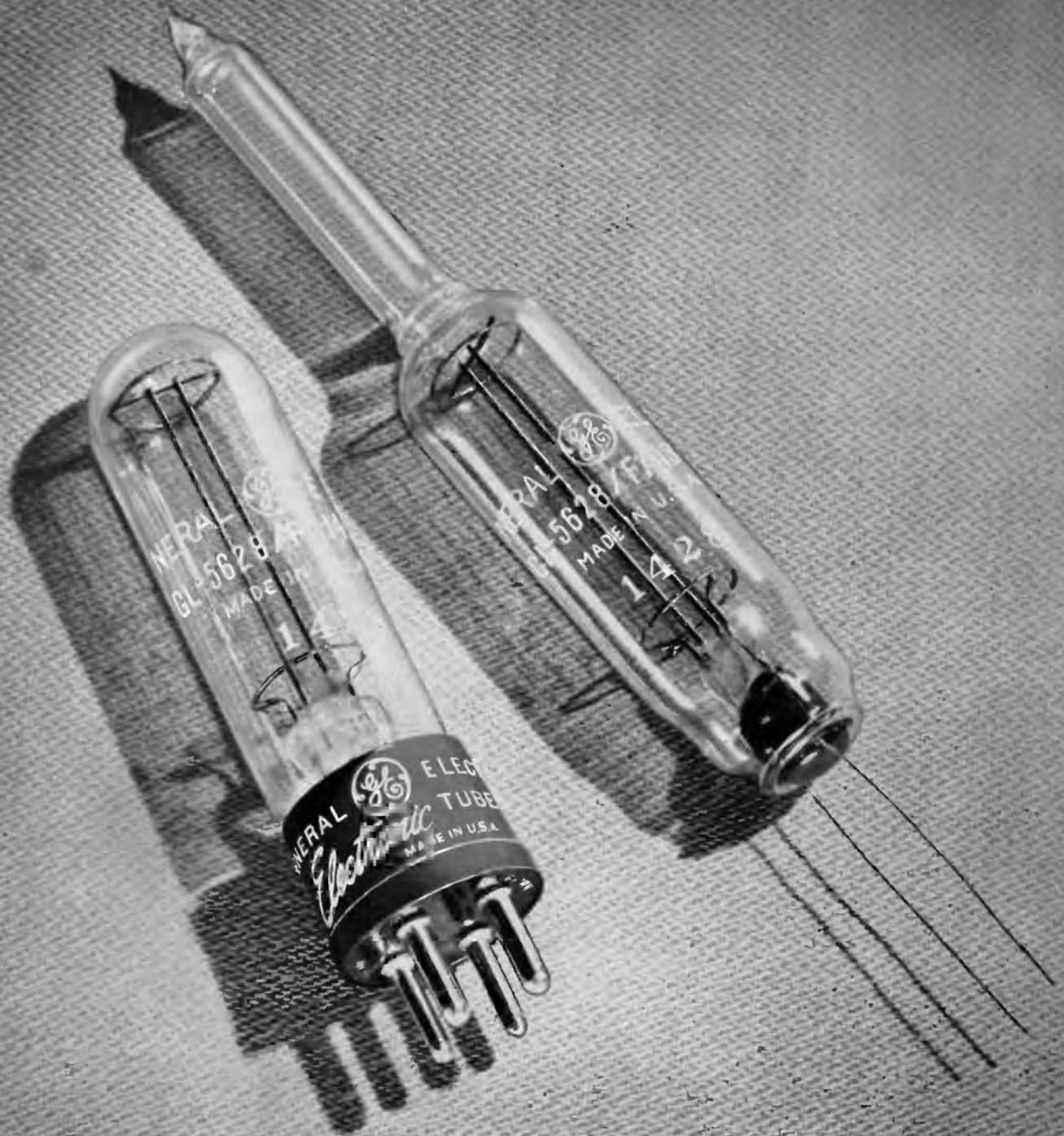
Electronics Department
GENERAL ELECTRIC
 Schenectady, N. Y.



VACUUM GAGES

GENERAL  ELECTRIC

RESISTANCE VACUUM GAGES



DESCRIPTION

The GL-5628/FA-13 and GL-5629/FA-14, used in a resistance vacuum gage possess features especially useful in providing a convenient method for measuring low gas pressures. With suitable associated apparatus, these tubes will provide a fast, continuous, direct reading. As the vacuum system is pumped down, a meter in the bridge circuit reads the unbalancing of the bridge, thus providing an uninterrupted and instantaneous reading and enabling the observer to determine at

all times the exact conditions in the system.

The resistance vacuum gage differs from the McLeod gage in that it gives an electrical, rather than mechanical, indication. Unlike the McLeod gage, it is also possible with this gage to take readings of condensable vapor, such as water vapor.

These tubes should be used in pairs since in combination they provide a much more stable and reliable reading than if the GL-5628/FA-13 is used alone.

TECHNICAL INFORMATION

GENERAL CHARACTERISTICS (Indicator Tube GL-5628/FA-13*)

Number of Electrodes 1

Electrical

Recommended range 0-600 microns
 Maximum d-c voltage 6 volts
 Resistance of average tube at 25 C. 7 ohms

Characteristics of an average tube at 3 volts—25 C, ambient temperature:

0 microns pressure, dry air	180 milliamperes
75 microns pressure, dry air	226 milliamperes
195 microns pressure, dry air	271 milliamperes
1000 microns pressure, dry air	327 milliamperes
Atmospheric pressure	353 milliamperes

Mechanical

Splice tubing $\frac{3}{8}$ inches diam. lime glass
 Net weight, approx. 1 ounce
 Shipping weight, approx. 3 pounds

**It is recommended that this tube be used in a bridge circuit in combinations with the GL-5629/FA-14 Compensator Tube.*

GENERAL CHARACTERISTICS (Compensator Tube GL-5629/FA-14)

Number of Electrodes 1

Electrical

Maximum d-c voltage 6 volts
 Resistance of average tube at 25 C. 7 ohms

Characteristics of an average tube at 25 C, ambient temperature:

1 Volt	90 milliamperes
2 Volts	140 milliamperes
3 Volts	180 milliamperes
4 Volts	218 milliamperes

Mechanical

Net weight, approx. 1 ounce
 Shipping weight, approx. 3 pounds

OPERATING NOTES

The GL-5628/FA-13 is used to measure the gas pressure. The GL-5629/FA-14, which has a filament identical with that of the GL-5628/FA-13, is sealed off under very high vacuum and is used to compensate for temperature and voltage changes.

The GL-5628/FA-13 and GL-5629/FA-14 are usually sold in matched pairs since there is some variation from time to time in manufacture. For this reason single tubes purchased separately and at different times may not match.

With the GL-5628/FA-13 the pressure indication

is obtained as a function of the change in resistance of a heated tungsten filament caused by the cooling, by convection current, of the gas being measured. Since different gases have different factors for convection cooling, the calibration of the gage will not be the same for all gases. For example, the gage is much more sensitive to hydrogen than to nitrogen. Since the response of the gage is a current change, it may be used for recording and for control—to start and stop a pump—as well as for indication.

INSTALLATION

The GL-5628/FA-13 and GL-5629/FA-14 may be mounted in any position, but should be protected from excessive shock or vibration. It is recommended that the connection to the base of the GL-5629/FA-14 be clamped solidly or soldered to avoid difficulty with contact resistance. The GL-5628/FA-13 is provided with connection leads

instead of a base and glass connection tubing for splicing to the exhaust system. This connection may be cemented on, or sealed to, another glass tube.

Greater stability will be obtained if tubes are protected from heat and direct light rays. If used in pairs it is advisable to place the tubes together so that their temperatures will vary simultaneously.

OPERATION

Although the GL-5628/FA-13 connected in series with a milliammeter, may be used for rough measurements, it is recommended that an ordinary bridge circuit be provided with the GL-5628/FA-13 in one arm, the GL-5629/FA-14 compensator tube in the opposite arm, and variable resistances in the two adjacent arms. The bridge arrangement gives greater sensitivity than the GL-5628/FA-13 alone and the use of a compensator tube results in substantial independence from ordinary voltage variation.

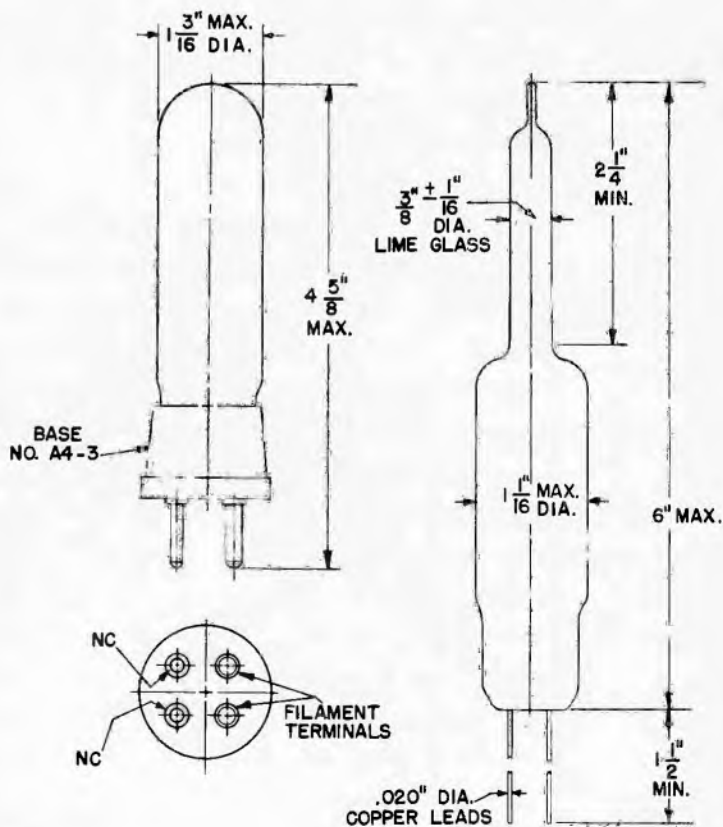
The characteristics shown by the curves are approximate. Where a high degree of accuracy is required, the individual gage must be calibrated against a standard. In Fig. 2, of page 4, the dotted curves are the compensator characteristics plotted in reverse. The distance between the origins represents the total voltage on the bridge; the intersections give the voltage division for various pressures.

With the bridge balanced at zero pressure, the horizontal distances between the zero intersection and the intersection for other pressures furnishes a rough calibration for corresponding measurement taken on the bridge with a high-resistance voltmeter.

These curves supply a convenient method for estimating the bridge sensitivity at various voltages. The calibration may change with wide variations in ambient temperature. Fig. 1 on page 4 illustrates the variation in current with pressure for two different voltages.

GL-5629/FA-14 COMPENSATOR TUBE

GL-5628/FA-13 INDICATOR TUBE

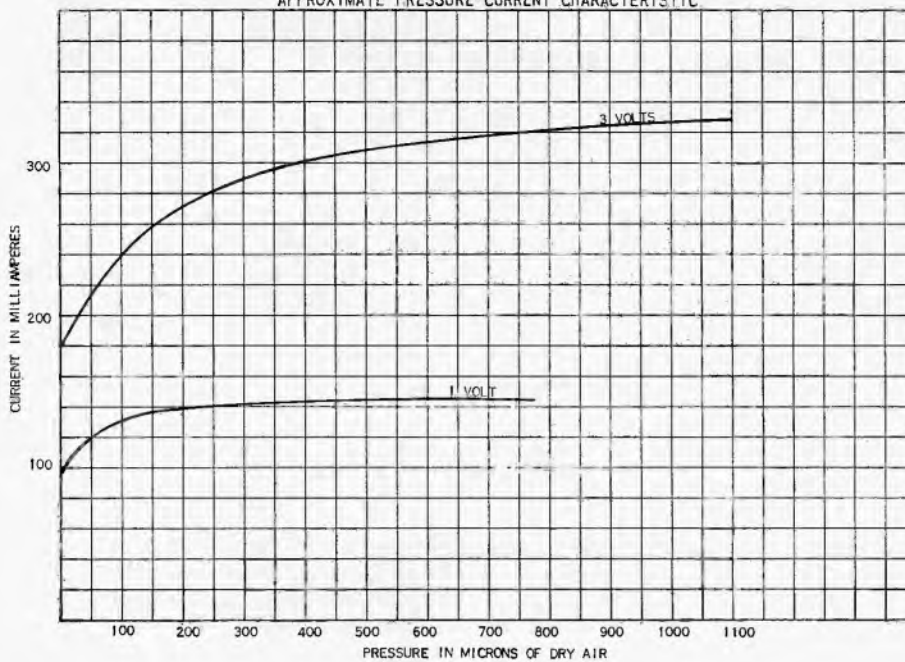


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5-20-48

OUTLINE RESISTANCE VACUUM GAGES

GL-5628/FA-13
 APPROXIMATE PRESSURE-CURRENT CHARACTERISTIC

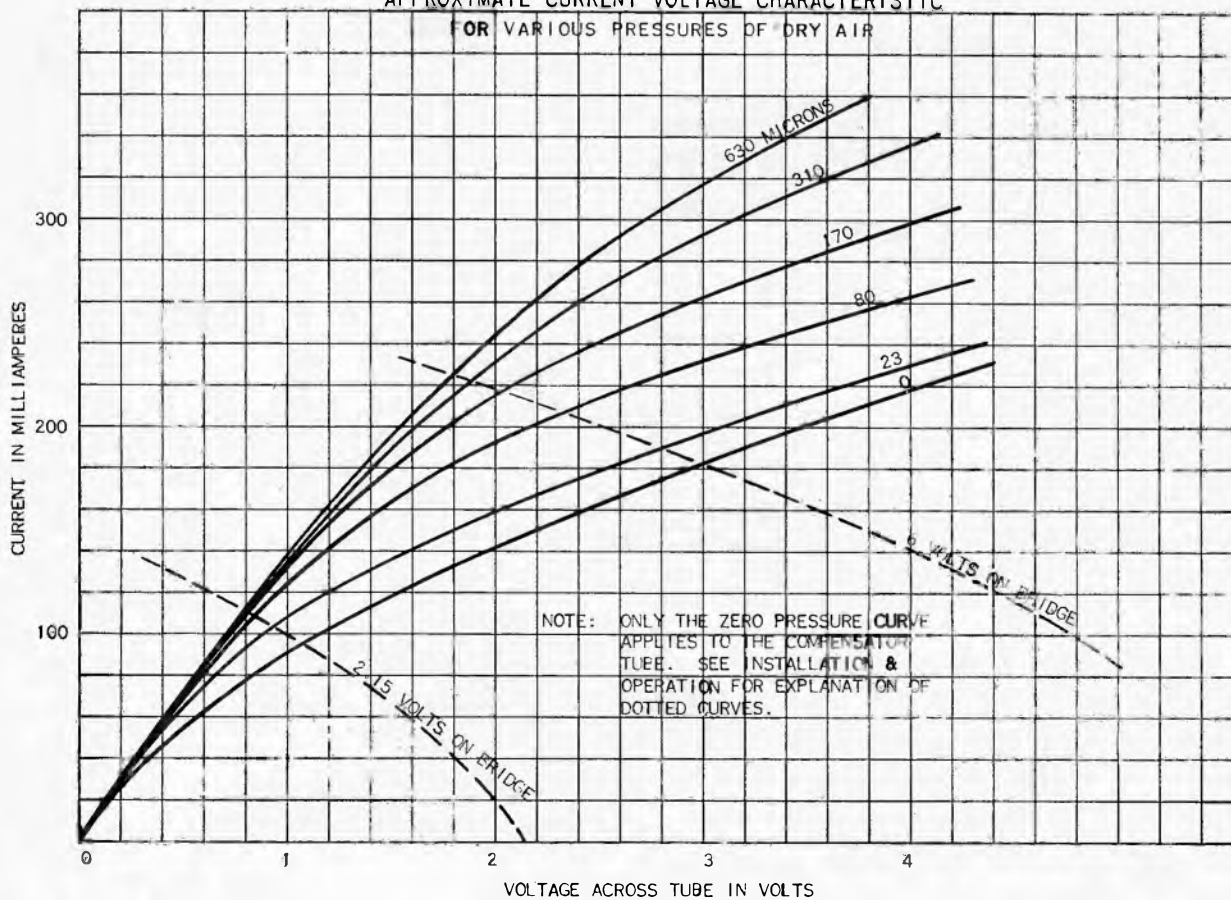


K-8639661

Fig. 1

5-20-48

GL-5628/FA-13, GL-5629/FA-14
 APPROXIMATE CURRENT-VOLTAGE CHARACTERISTIC
 FOR VARIOUS PRESSURES OF DRY AIR



K-8639660

Fig. 2

5-20-48

Electronics Department
GENERAL ELECTRIC
 Schenectady, N. Y.

GENERAL  ELECTRIC

VACUUM CAPACITORS



DESCRIPTION

The vacuum capacitor is a high-voltage, small-size vacuum-dielectric capacitor designed for use on d-c, a-c or radio-frequencies. G-E

vacuum capacitors are specially suited for high-voltage circuits where stability of operation and small size are important factors.

MECHANICAL ADVANTAGES

Vacuum-tightness and strong mechanical joints are assured by the use of glass to metal seals. (The fernico is imbedded in the glass which adheres permanently to both inside and outside of the fernico cup.) Mechanical sturdiness is realized by using metals of sufficient strength and thickness to withstand vibrations of 20 G. The compactness of design required for high mechanical strength results in a vacuum capacitor which best utilizes the inside space and

avoids long leads. Constructional features of a typical 7500-volt capacitor are shown in the cross-sectional view of Fig. 1. The bell-shaped construction of the 16,000-volt capacitor (see Fig. 2) minimizes circuit loss and also affords high-frequency operation.

All G-E vacuum capacitors are provided with terminals which fit a standard 30-ampere fuse clip, allowing rapid capacitor changes when desired.

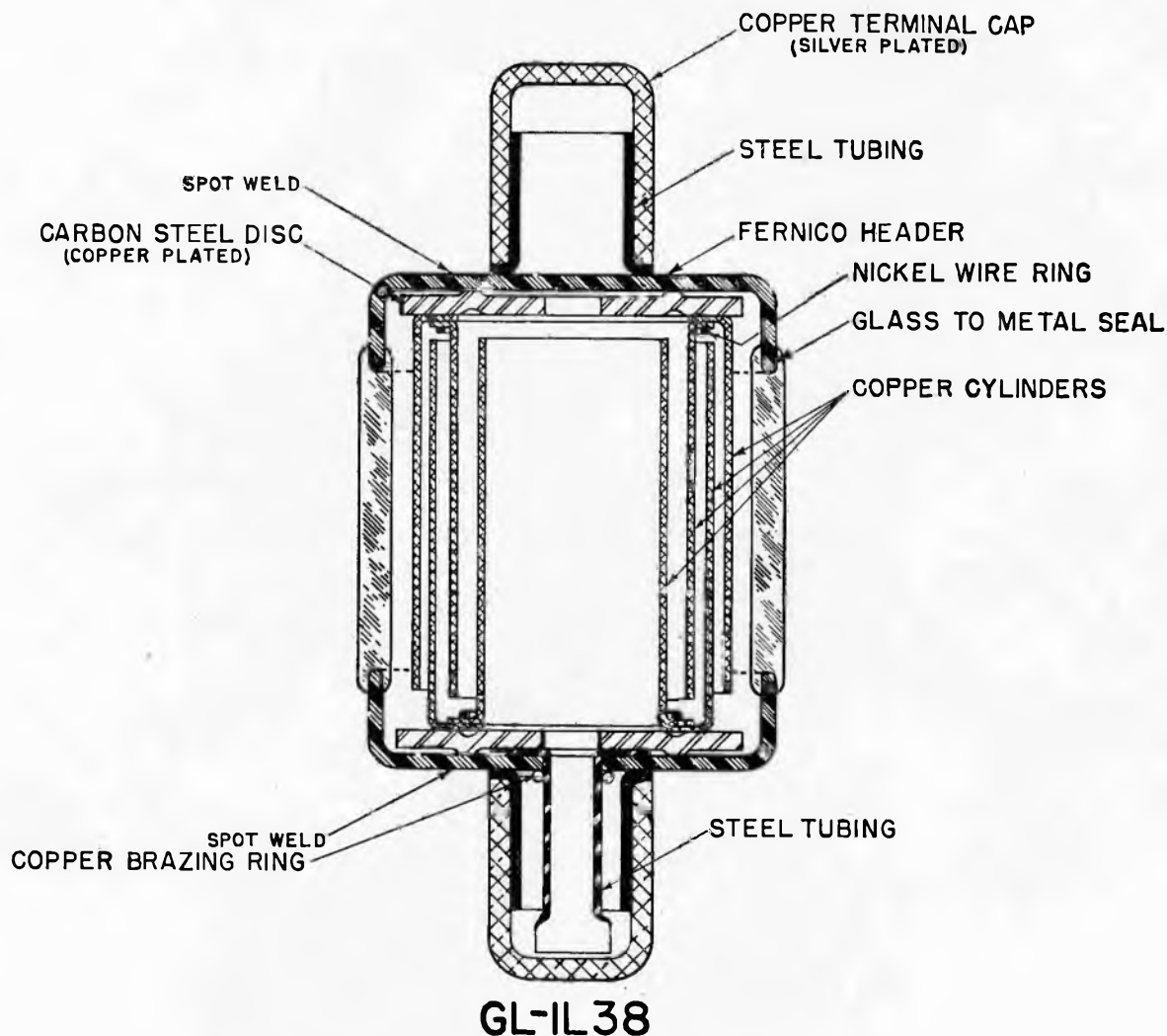
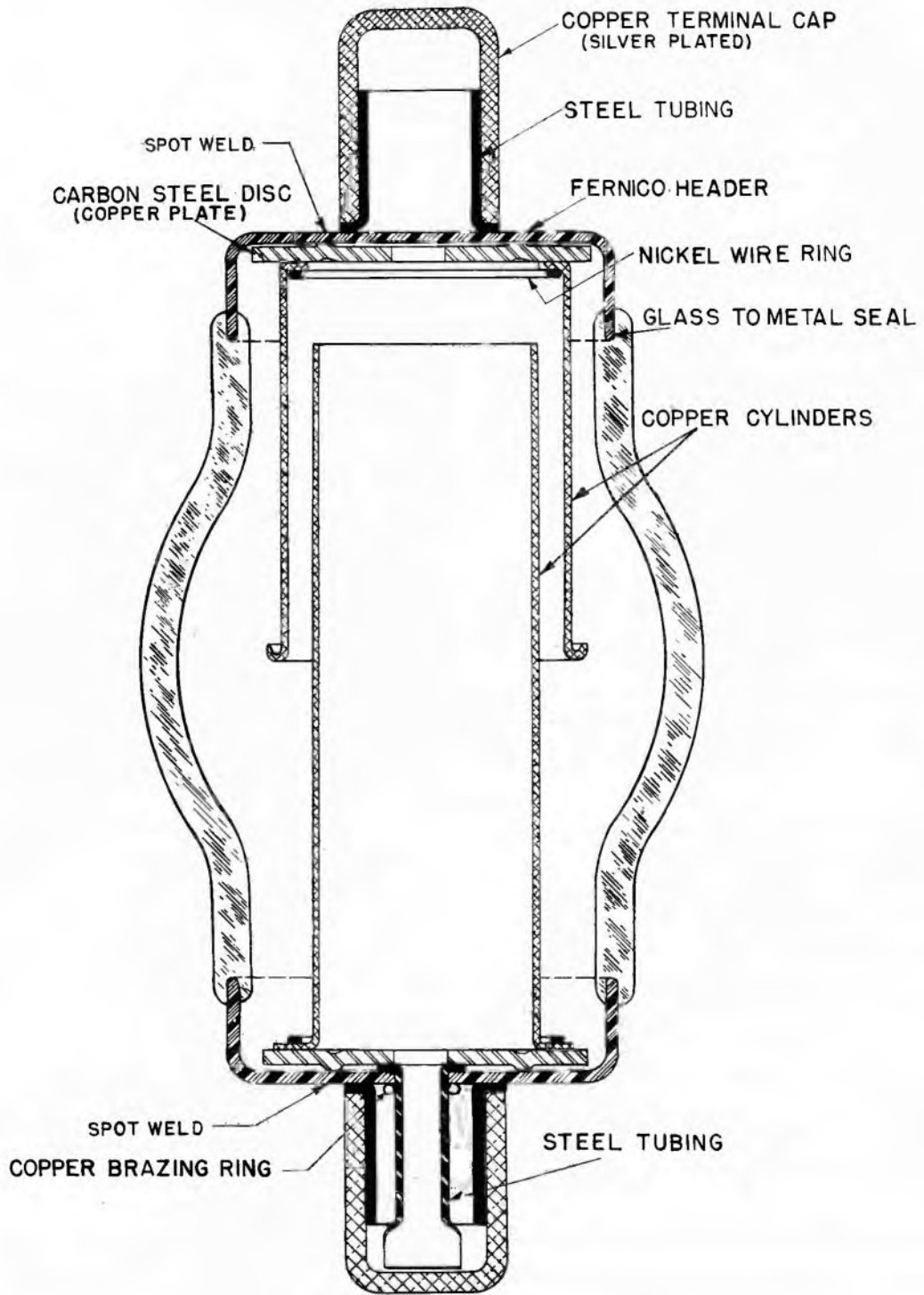


Fig. 1—Cross-sectional View of a 7500-volt Capacitor



GL-IL31

Fig. 2—Cross-sectional View of a 16,000-volt Capacitor

ELECTRICAL ADVANTAGES

G-E vacuum capacitors are designed with sufficiently great internal spacing that d-c voltages up to the maximum voltage rating may be applied. No de-rating is required for d-c applications with G-E vacuum capacitors. Similarly, capacitors may be placed in any series or parallel combination for use on d-c, a-c or radio frequencies.

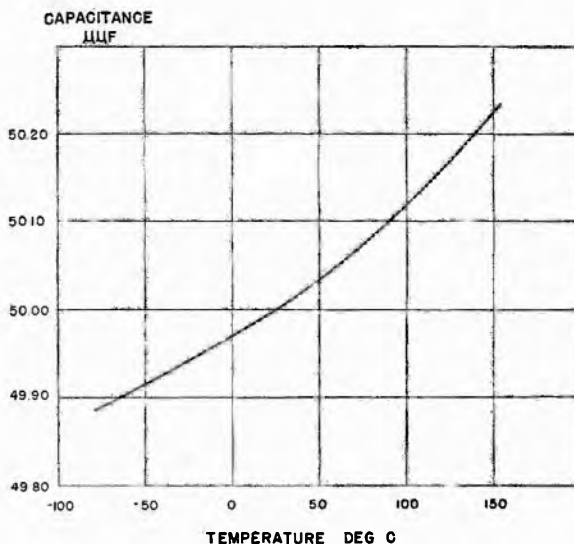
The coaxial cylinders which are brazed to the fernico headers introduce into an electrical circuit a minimum value of inductance, resulting in a high Q vacuum capacitor.

The vacuum construction allows operation at high altitudes and minimizes maintenance. Conditions of high humidity have no effect on the capacitance of G-E vacuum capacitors.

Moisture can cause a slight leakage current across the outside surfaces of the capacitor but this is usually only a momentary condition. With the capacitor operating the surface dries in a few seconds and external breakdown potential returns to normal.

G-E vacuum capacitors have a low temperature coefficient as is shown from the following curve. The temperature coefficient of the GL-1L38, as shown in the curve, from -50 C to $+100\text{ C}$ is $27 \times 10^{-6} \text{ mmf/mm}^2/\text{C}$.

The G-E vacuum capacitor does not depend upon a solid dielectric for its voltage insulation. For that reason, there is no dielectric to puncture if overvoltages are accidentally applied. On



K-9033913

8-8-45

Fig. 3—Temperature Coefficient Curve for a GL-1L38 Vacuum Capacitor

either direct current or radio-frequencies, overvoltages may cause a discharge to take place internally. In most cases, this discharge is not injurious to the G-E vacuum capacitor, and when the overvoltage is removed, the capacitor will function as usual. Overvoltages should be avoided if there is sufficient power in the source to cause melting of the electrodes.

RATINGS

Vacuum capacitors are rated in terms of the following characteristics:

Capacitance

All G-E vacuum capacitors are rated at a nominal capacitance $\pm 5\%$.

Voltage Rating

G-E vacuum capacitors are rated to operate at a given peak voltage which may not be exceeded for continuous operation. Transient voltages in excess of rated voltage are allowable up to the voltage breakdown limit given in the specifications.

The total voltage across the vacuum capacitor (excluding transient voltages) shall be considered to be the sum of the d-c and a-c peak voltages.

Voltage-frequency, Current-frequency Characteristics

The voltage-frequency curve on the particular description and rating sheet shows the maximum allowable peak radio-frequency voltage which

may be applied to the G-E vacuum capacitor at various frequencies. This radio-frequency voltage may be impressed upon a d-c voltage, if the sum of the two voltage does not exceed the voltage rating of the capacitor.

The current-frequency curve indicates the radio-frequency current which will flow through the capacitor when the maximum radio-frequency voltage is applied.

Operating Temperature

G-E vacuum capacitors may be operated from -40 C to $+65\text{ C}$. However, if the capacitor is carrying high radio-frequency currents, it is recommended that the ambient temperature be less than 50 C .

Type of Vacuum Capacitors

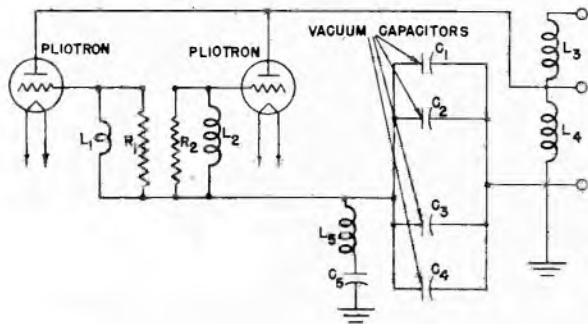
G-E vacuum capacitors are made in two voltage ranges, 7500 peak volts and 16,000 peak volts. They are available in capacitance values from 6 micromicrofarads to 100 micromicrofarads in both voltage ranges.

APPLICATIONS*

For the most part vacuum capacitors are used in applications where their particular characteristics result in the greatest benefit to the user. Because of their compact size they are

*Circuits shown on this page and those following are examples of possible tube applications and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company.

APPLICATIONS (CONT'D)



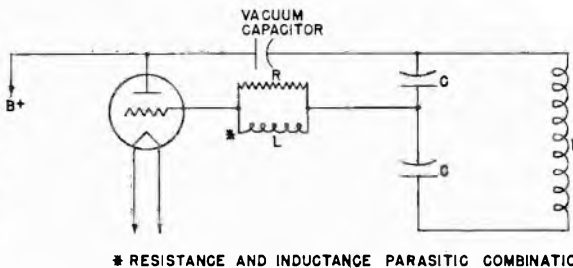
K-9033970

10-20-45

Fig. 4—Electronic-heater Circuit Using Vacuum Capacitors

specially suited for use as tank-circuit capacitors, and blocking and by-pass capacitors in diathermy and electronic heating equipment.

Fig. 4 illustrates the use of four GL-1L33 capacitors as grid-blocking capacitors in a 1200 watt Electronic Heater for dielectric heating. In this circuit the B+ voltage is grounded in order to minimize hazard to the operator.



* RESISTANCE AND INDUCTANCE PARASITIC COMBINATION

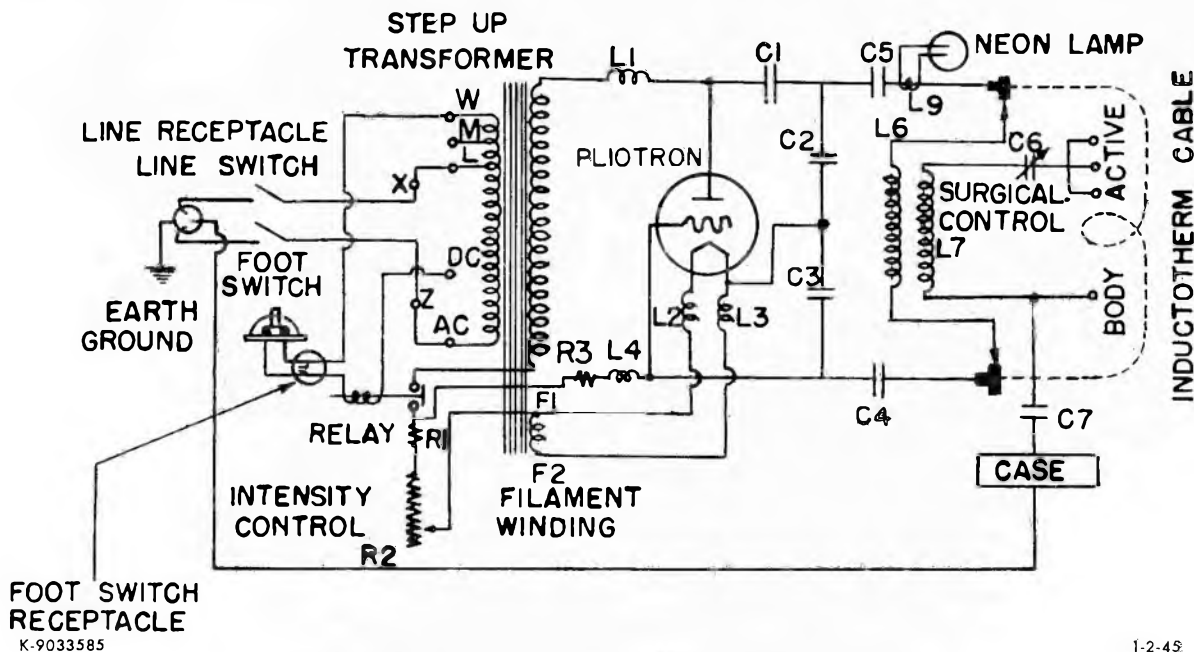
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Fig. 5—Oscillator Connection of Electronic-heater Circuit (Showing D-c Blocking Capacitor)

Another example of the use of vacuum capacitors in electronic heating equipment is shown in Fig. 5. Shunt feed is used to supply the plate voltage, and a vacuum capacitor is used as a d-c blocking capacitor to keep the plate voltage from the plate coil. The capacitor employed is a GL-1L23.

In diathermy applications, vacuum capacitors may be used as in Fig. 6. The capacitors C₁, C₂, C₃, C₄ and C₅ are employed as resonating and by-pass capacitors.



K-9033585

1-2-45

Fig. 6—Typical Circuit of Inductotherm Unit with Surgical Attachment

INSTALLATION AND OPERATION

In general, the exact method of mounting G-E vacuum capacitors will depend upon the circuit in which it is used. There are, however, several rules to be followed for maximum efficiency of operation.

Mechanical

The capacitor may be mounted in any position. Mounting terminals should exert sufficient

force to hold the capacitor firmly in applications where vibrations will be encountered.

G-E vacuum capacitors may be identified readily as to proper capacitance by examining the letter stamped in the header on one end. Symbols indicate capacitance as follows:

- A..... 6 micromicrofarads
- B..... 12 micromicrofarads
- C..... 25 micromicrofarads

INSTALLATION AND OPERATION (CONT'D)

D 50 micromicrofarads
E 100 micromicrofarads

The marked end of the capacitor is connected internally to the inner cylinder. For this reason it is advisable to connect the unmarked end to ground potential in those applications where a ground is permissible. This type of connection allows the outer cylinder of the capacitor to act as a shield to minimize the effects of nearby objects on the net capacitance of the unit.

Electrical

Vacuum capacitors should be mounted in such a way that the connections have ample current-carrying capacity. Fuse clips are not recommended for connectors if the current exceeds 10 amperes. A satisfactory connector may be made by drilling a hole approximately 0.550

inch in diameter in a block of copper or brass, splitting one side to allow the capacitor terminal to be inserted, and clamping the split sides together with a machine screw.

To prevent overheating, it is recommended that the vacuum capacitor be mounted so that it is as far as possible from any direct radio-frequency field.

Thermal

In cases where capacitors are connected to sources of heat, such as a hot radio-frequency coil, it is advisable to make the connectors of a large enough mass of material so that maximum heat radiation is obtained.

Applications using air-cooled tubes may provide for venting a portion of the air so that it flows over the vacuum capacitor in the circuit.

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



VACUUM CAPACITOR

DESCRIPTION

The GL-1L21 vacuum capacitor is designed for circuits where the peak voltages range up to 7500 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L21 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Capacitance \pm 5 per cent	12 micromicrofarads
Maximum peak voltage	7500 volts

GENERAL  ELECTRIC


Electronic
TUBE

TECHNICAL INFORMATION (CONT'D)

Ambient temperature
 Minimum -40 centigrade
 Maximum +65 centigrade

Mechanical

Maximum over-all length 3 ³/₈ inches
 Maximum diameter 1 ⁵/₈ inches
 Net weight, approx 4 ounces
 Shipping weight, approx 1 pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

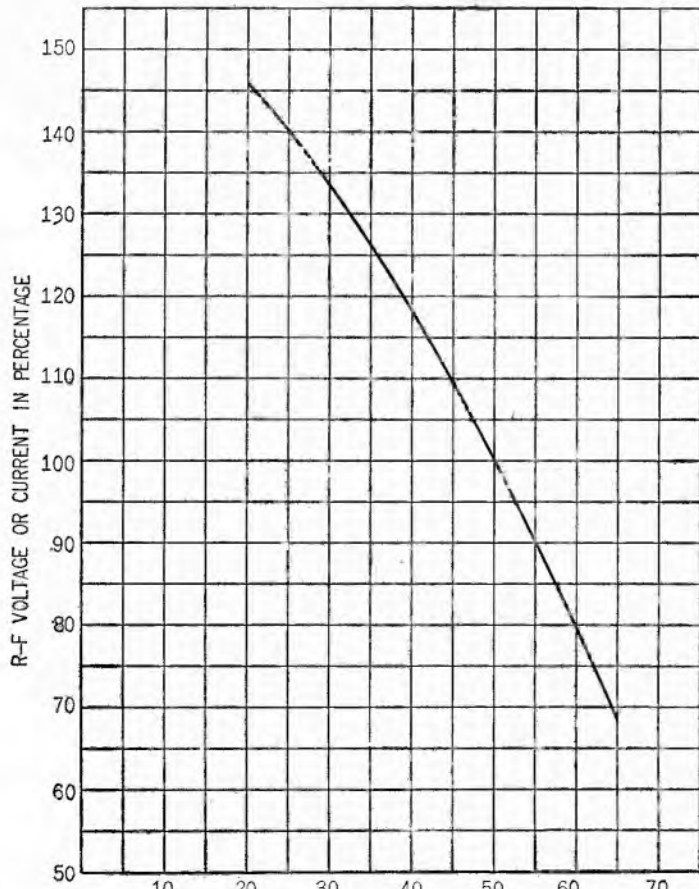
d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

Example—Assume a GL-1L21 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 4600 volts peak and a maximum current of 10 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 5428 volts and a maximum current of 11.8 amperes.

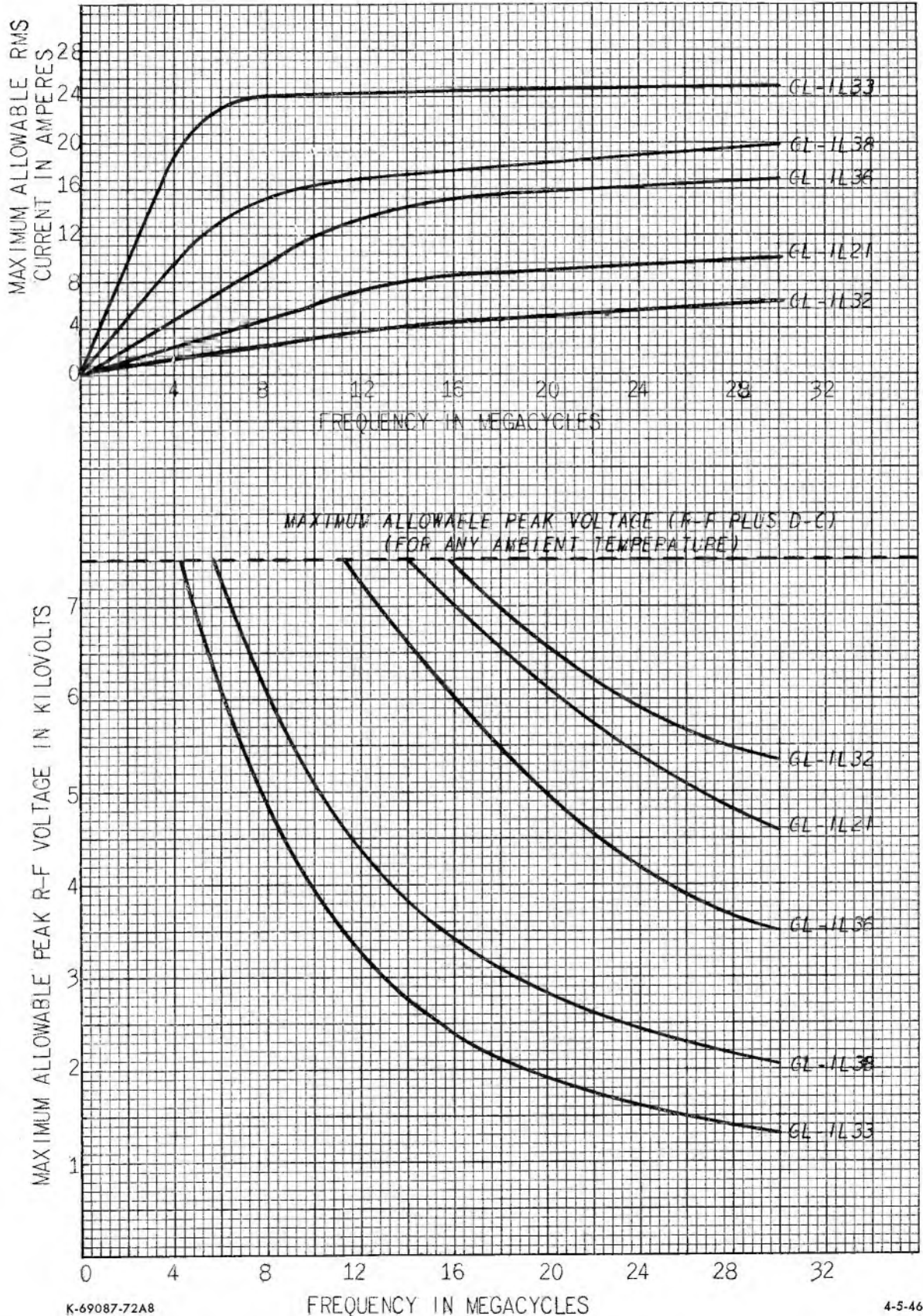
For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS

GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)



VOLTAGE AND CURRENT VS FREQUENCY
(FOR OPERATION AT 50 C AMBIENT TEMPERATURE)



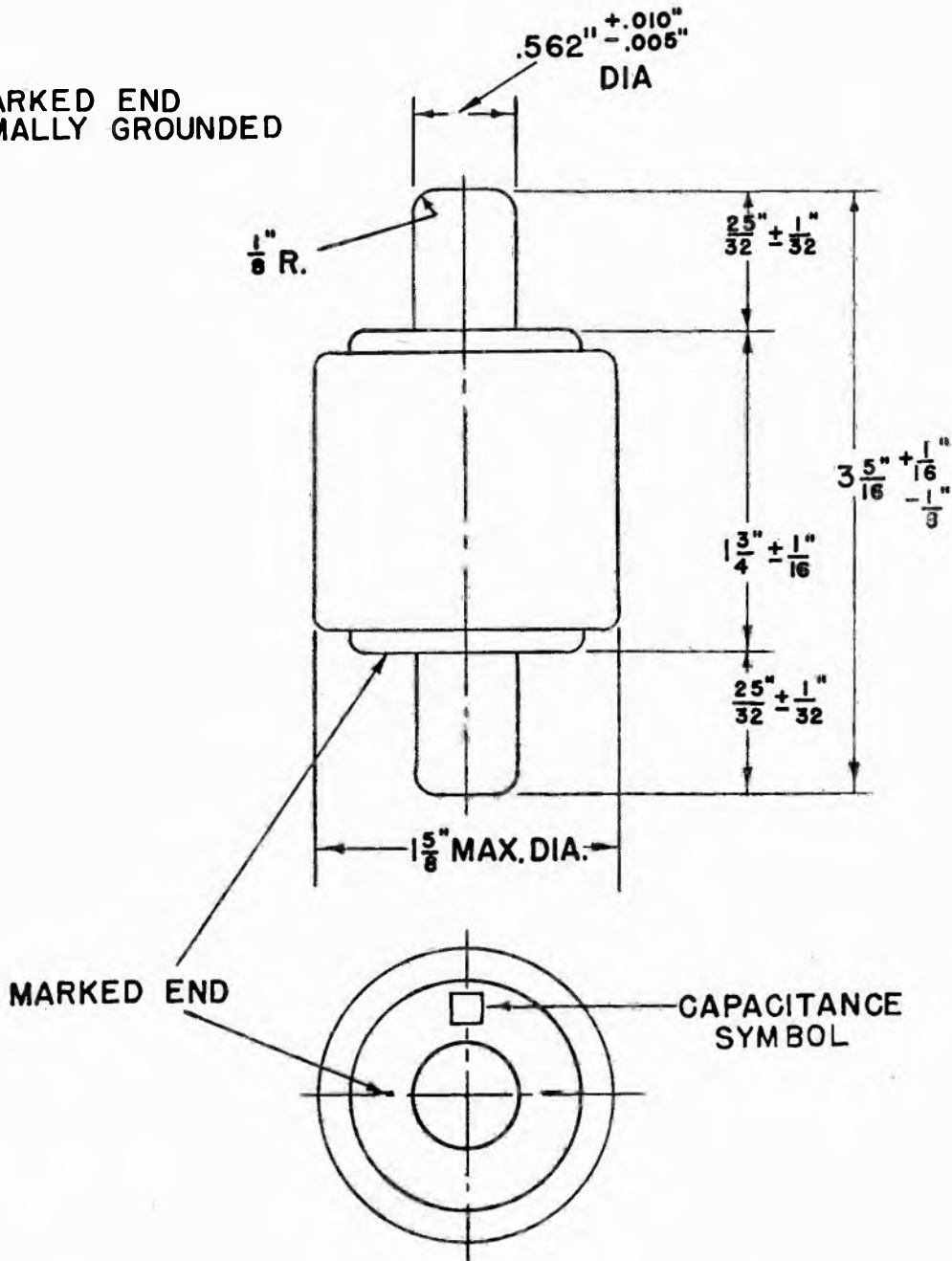
GL-1L21

ETI-262

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UNMARKED END
NORMALLY GROUNDED



GL-1L21 OUTLINE

K-5964469

10-29-45

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



VACUUM CAPACITOR

DESCRIPTION

The GL-1L22 vacuum capacitor is designed for circuits where the peak voltages range up to 16,000 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L22 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Capacitance ± 5 per cent.....	25 micromicrofarads
Maximum peak voltage.....	16,000 volts



GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

Ambient temperature

Minimum.....	-40	centigrade
Maximum.....	+65	centigrade

Mechanical

Maximum over-all length.....	$4\frac{9}{16} \pm \frac{1}{8}$	inches
Maximum diameter.....	.2	inches
Net weight, approx.....	6	ounces
Shipping weight, approx.....	1	pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

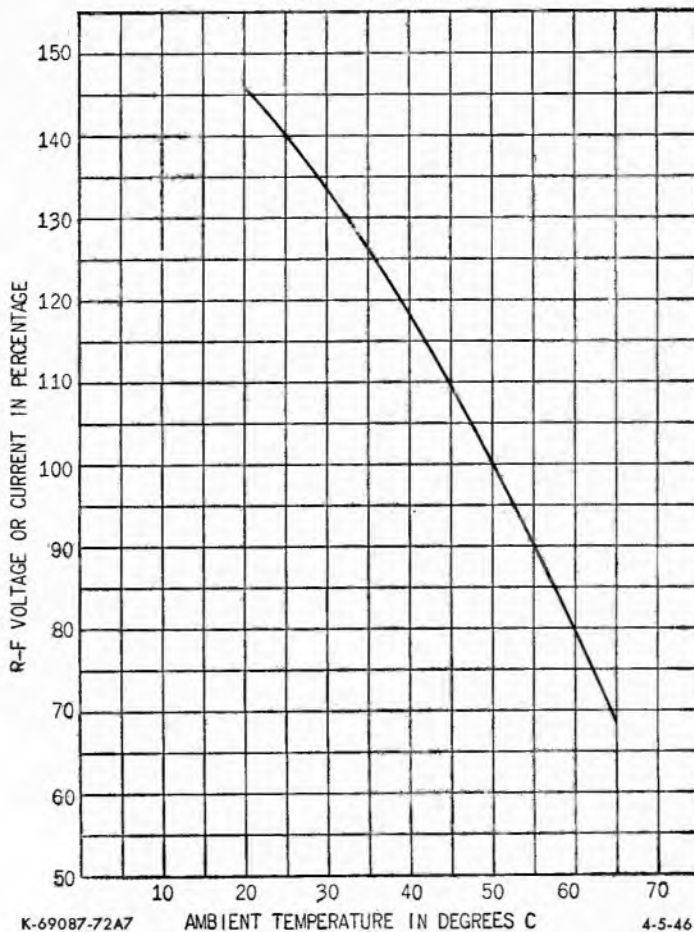
The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

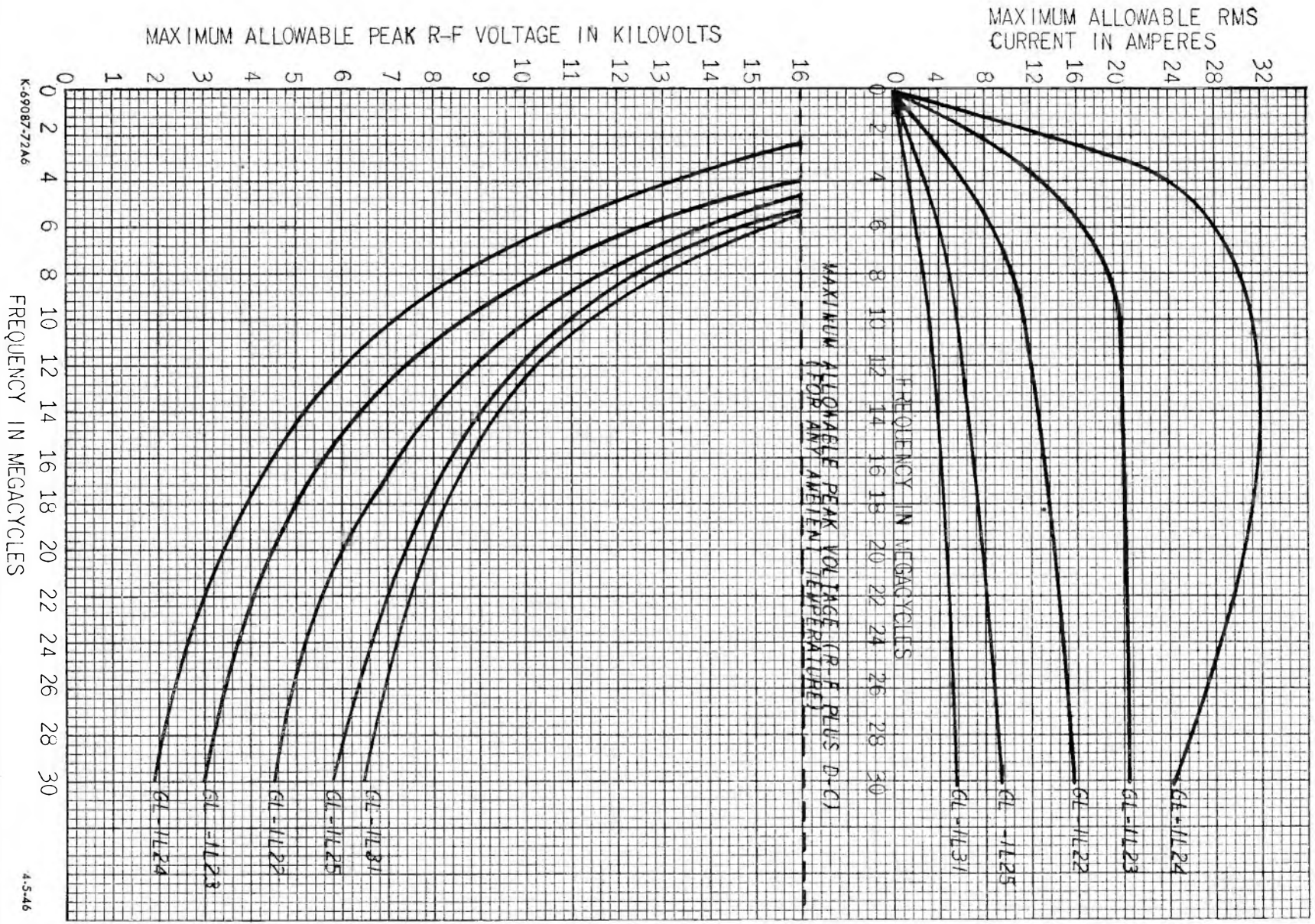
Example—Assume a GL-1L22 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 4500 volts peak and a maximum current of 15.5 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 5310 volts and a maximum current of 18.3 amperes.

For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS
GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)



VOLTAGE AND CURRENT VS FREQUENCY
(FOR OPERATION AT 50 C AMBIENT TEMPERATURE)



K-69087-72A6

FREQUENCY IN MEGACYCLES

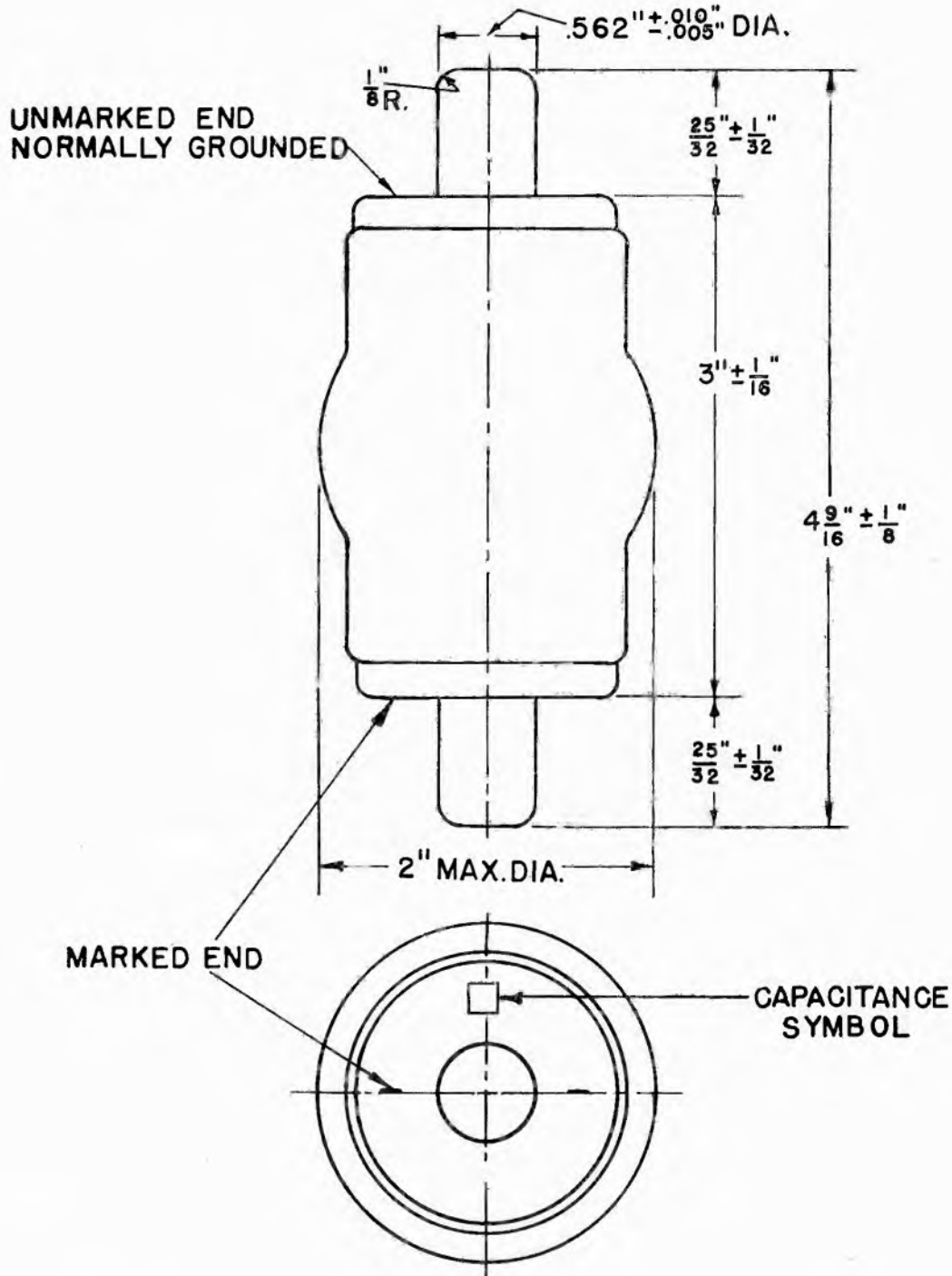
4-5-46

GL-1L22

ETI-263

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11-46



GL-1L22 OUTLINE

K-8639363

10-29-45

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



VACUUM CAPACITOR

DESCRIPTION

The GL-1L23 vacuum capacitor is designed for circuits where the peak voltages range up to 16,000 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L23 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Capacitance \pm 5 per cent	50 micromicrofarads
Maximum peak voltage	16,000 volts



Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

Ambient temperature

Minimum	-40	centigrade
Maximum	+65	centigrade

Mechanical

Maximum over-all length	$4\frac{9}{16} \pm \frac{1}{8}$	inches
Maximum diameter .....	.2	inches
Net weight, approx. ....	.6	ounces
Shipping weight, approx.	1	pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

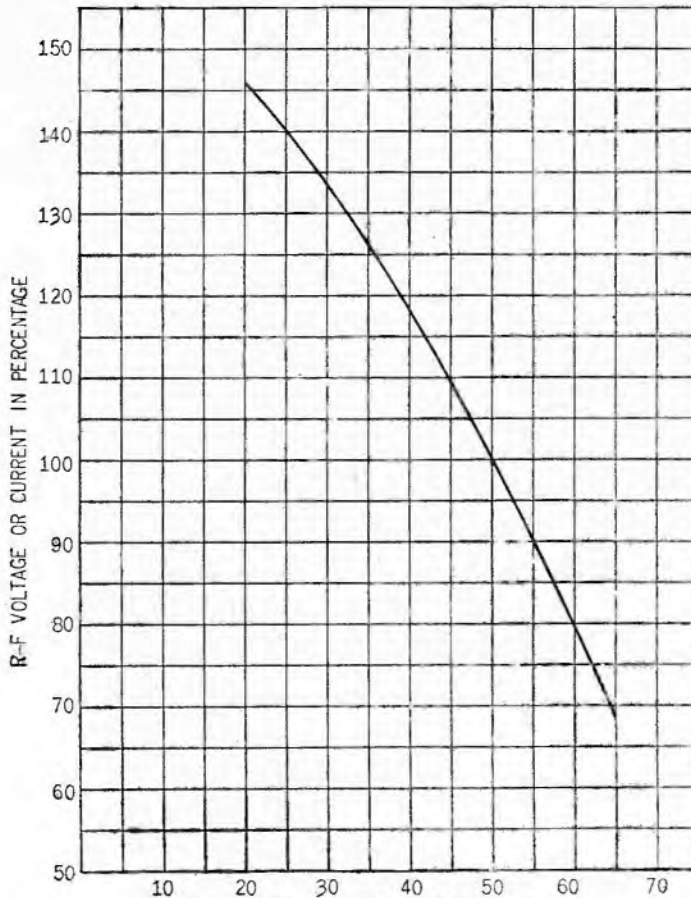
d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

Example—Assume a GL-1L23 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 3000 volts peak and a maximum current of 20.5 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 3540 volts and a maximum current of 24.2 amperes.

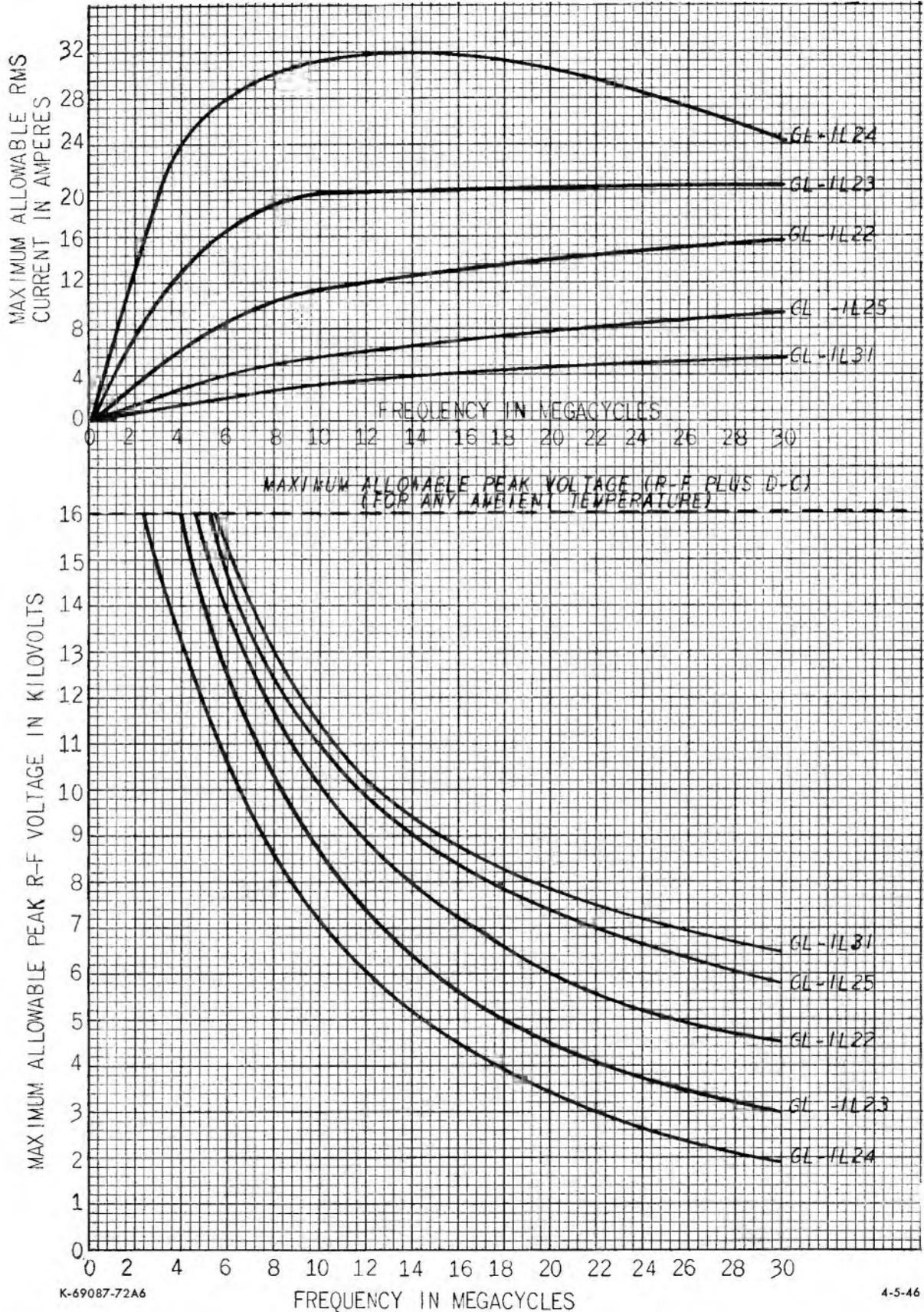
For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS

GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)



VOLTAGE AND CURRENT VS FREQUENCY
(FOR OPERATION AT 50 C AMBIENT TEMPERATURE)

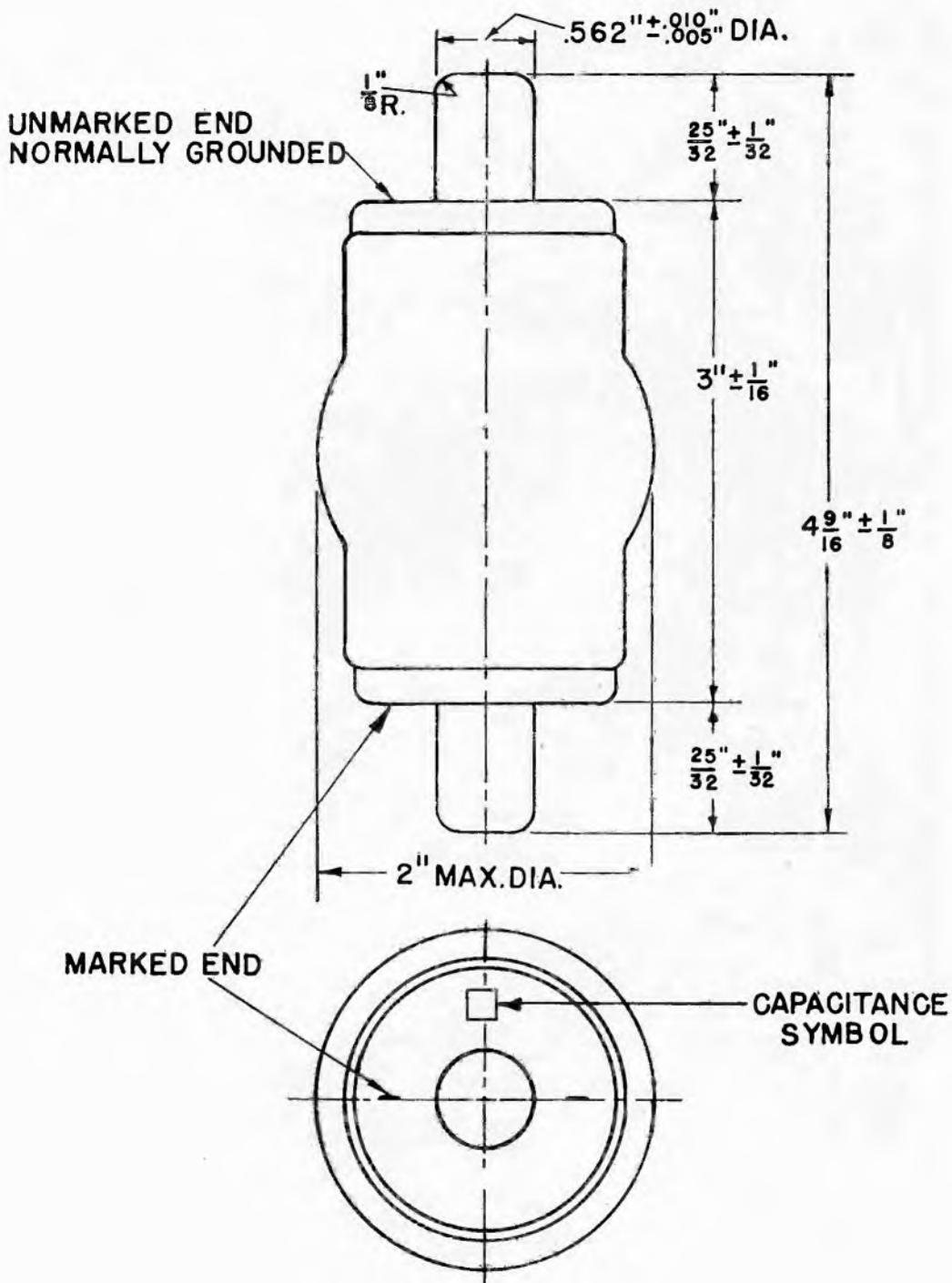


GL-1L23

ETI-264

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11-46



GL-1L23 OUTLINE

K-8639363

10-29-45

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



VACUUM CAPACITOR

DESCRIPTION

The GL-1L24 vacuum capacitor is designed for circuits where the peak voltages range up to 16,000 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L24 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Capacitance \pm 5 per cent.....	100 micromicrofarads
Maximum peak voltage.....	16,000 volts



GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

Maximum rms current.....	20 amperes
At 1.0 megacycle.....	7.0 amperes
At 50.0 megacycles.....	20 amperes
Ambient temperature	
Maximum.....	+65 centigrade
Minimum.....	-40 centigrade

Mechanical

Maximum over-all length.....	4 $\frac{11}{16}$ inches
Maximum diameter.....	2 $\frac{1}{4}$ inches
Net weight, approx.....	.8 ounces
Shipping weight, approx.....	1 pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

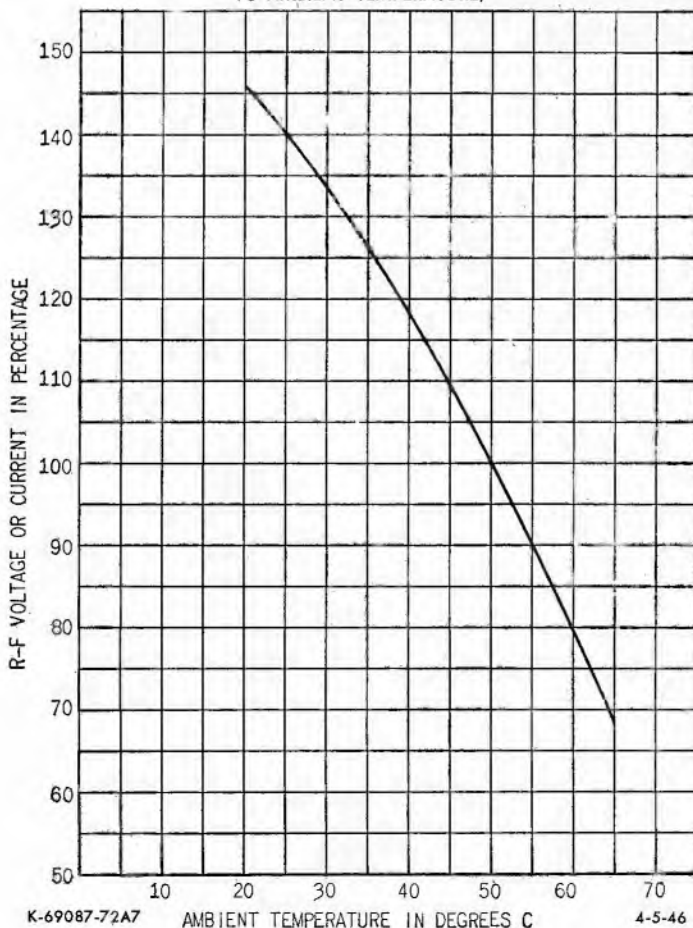
d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

Example—Assume a GL-1L24 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 1900 volts peak and a maximum current of 24.5 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 2240 volts and a maximum current of 28.9 amperes.

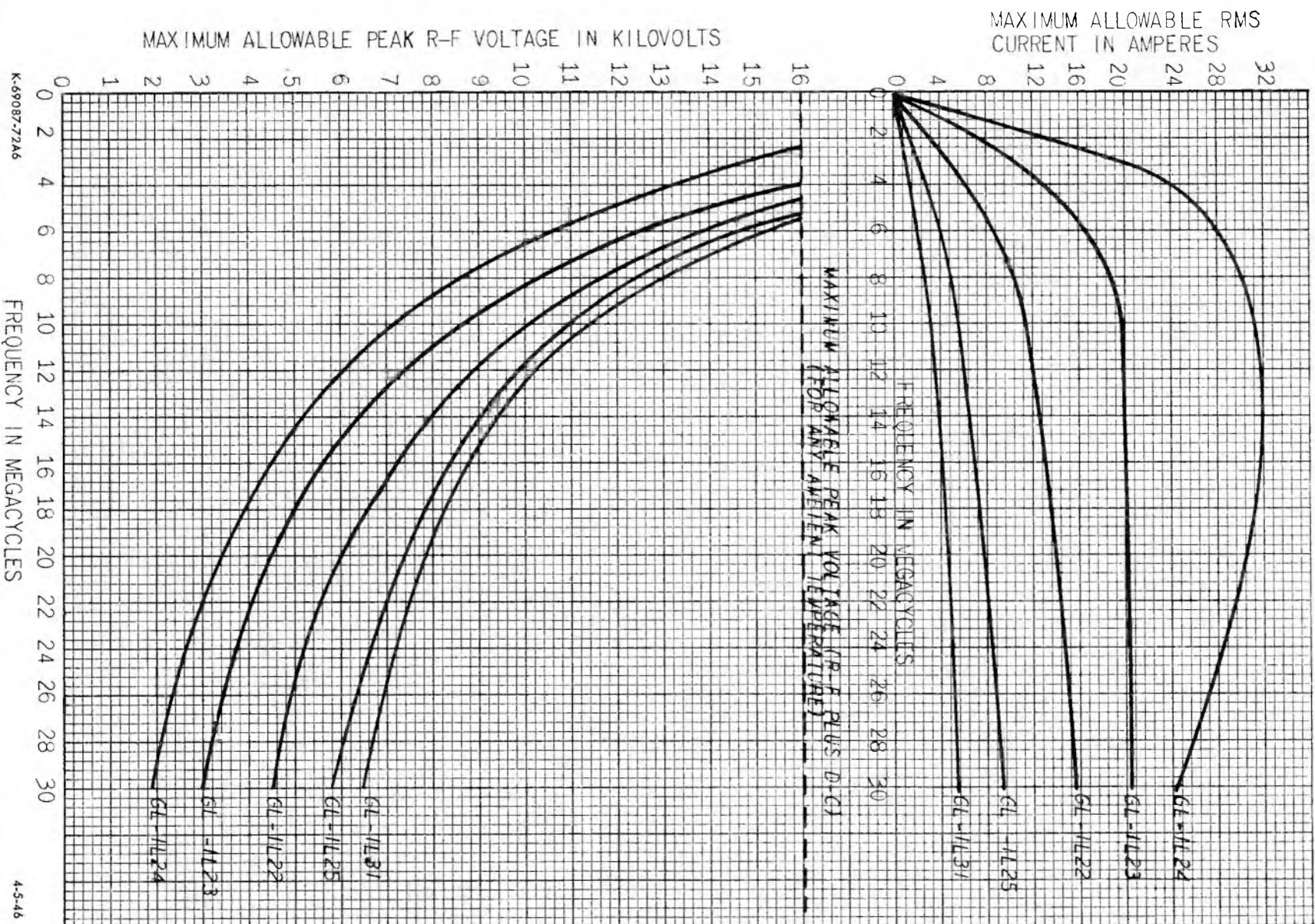
For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS

GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)



VOLTAGE AND CURRENT VS FREQUENCY
(FOR OPERATION AT 50 C AMBIENT TEMPERATURE)



K-69087-72A6

FREQUENCY IN MEGACYCLES

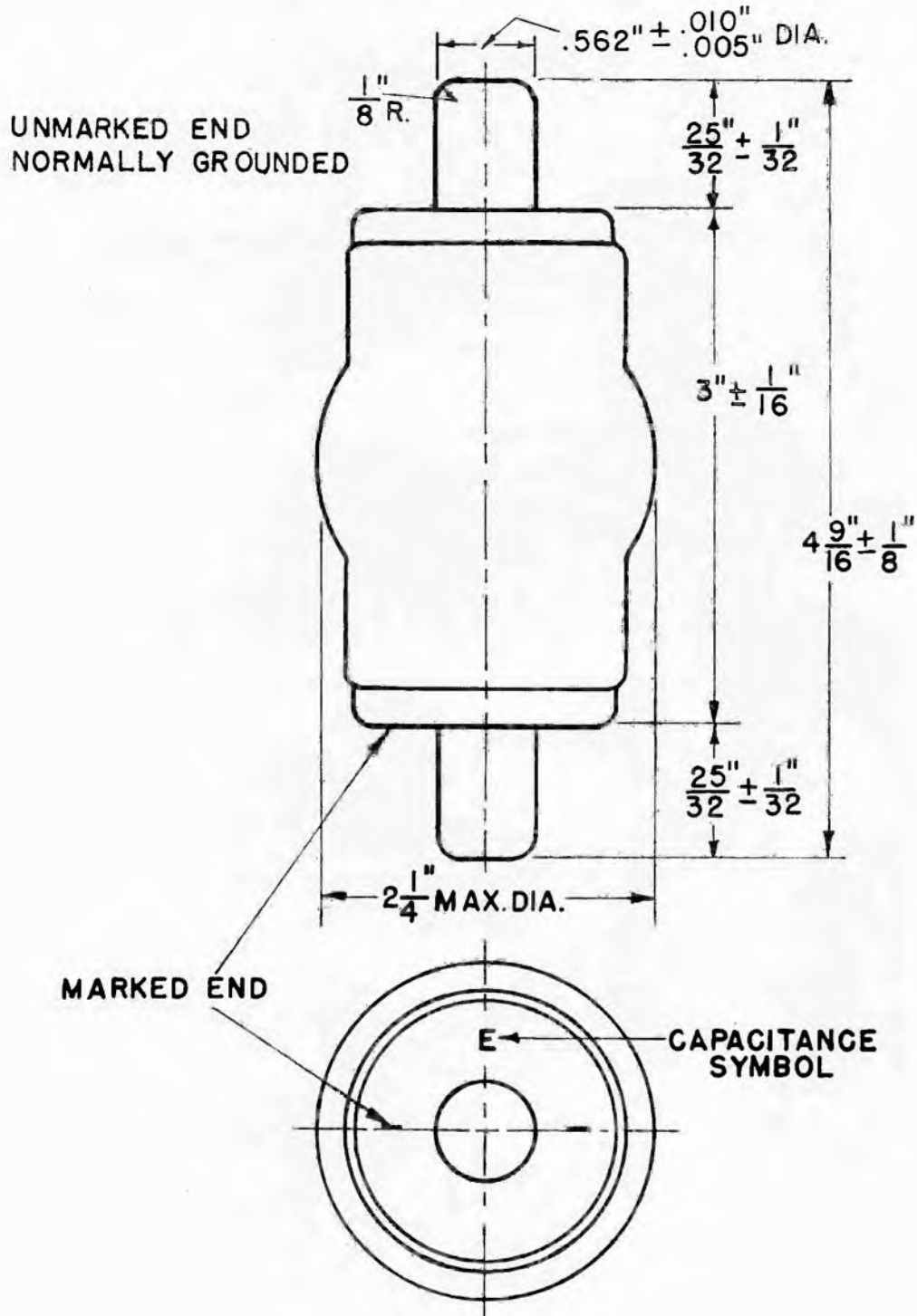
4-5-46

GL-1L24

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PAGE 4

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GL-1L24 OUTLINE

K-9033852

10-29-45

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



VACUUM CAPACITOR

DESCRIPTION

The GL-1L25 vacuum capacitor is designed for circuits where the peak voltages range up to 16,000 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L25 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Capacitance ± 5 per cent.	12 micromicrofarads
Maximum peak voltage	16,000 volts

GENERAL  ELECTRIC


Electronic
TUBE

TECHNICAL INFORMATION (CONT'D)

Ambient temperature

Minimum -40 centigrade

Maximum +65 centigrade

MechanicalMaximum over-all length $4\frac{9}{16} = 1\frac{1}{8}$ inches

Maximum diameter 2 inches

Net weight, approx. 6 ounces

Shipping weight, approx. 1 pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

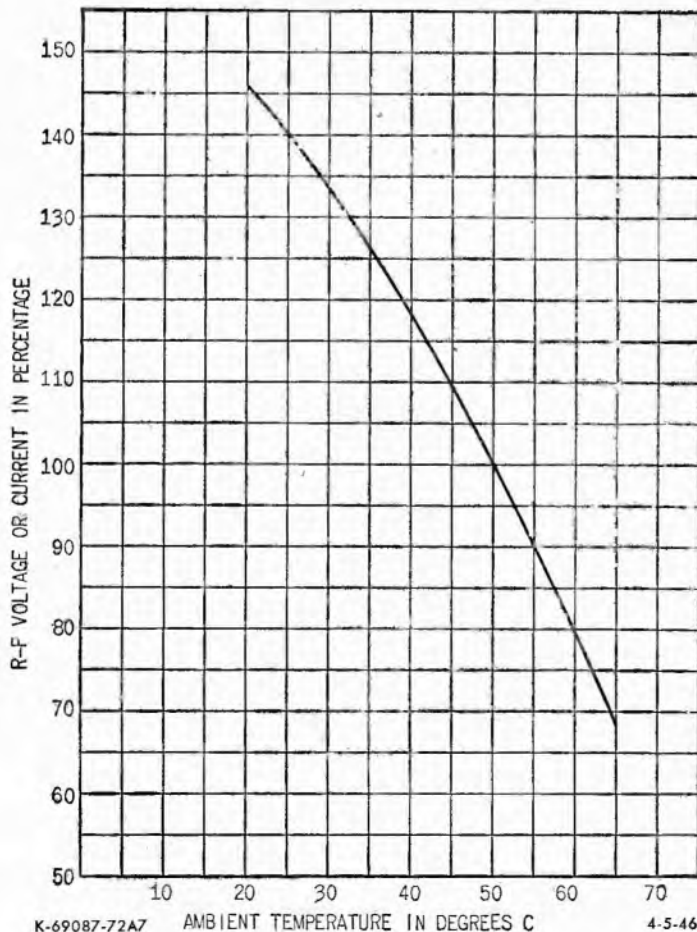
d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

Example—Assume a GL-1L25 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 5800 volts peak and a maximum current of 9.5 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 6845 volts and a maximum current of 11.2 amperes.

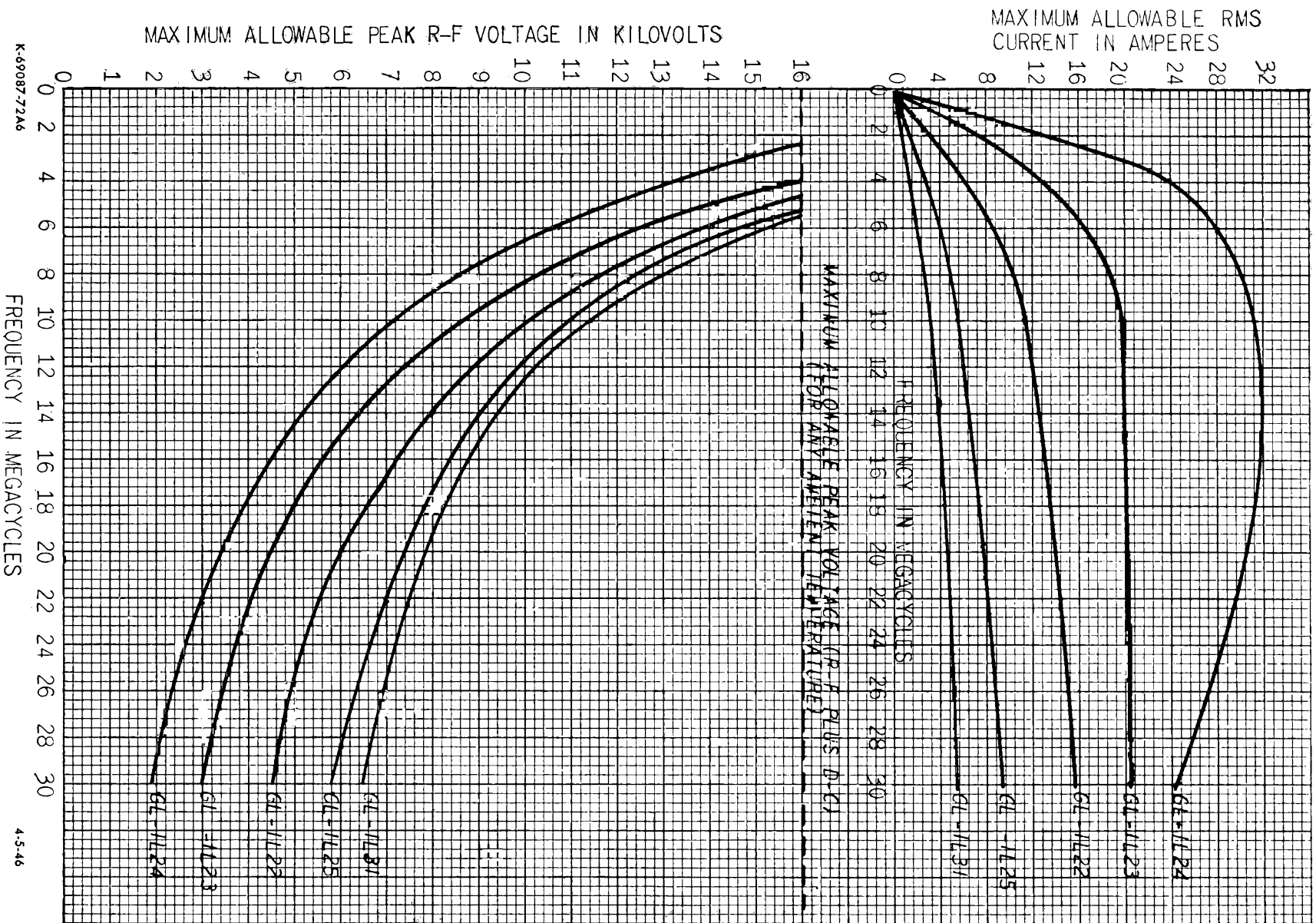
For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS

GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)



VOLTAGE AND CURRENT VS FREQUENCY
(FOR OPERATION AT 50 C AMBIENT TEMPERATURE)



K-69087-72A6

FREQUENCY IN MEGACYCLES

4-5-46

MAXIMUM ALLOWABLE PEAK R-F VOLTAGE IN KILOVOLTS

MAXIMUM ALLOWABLE RMS CURRENT IN AMPERES

MAXIMUM ALLOWABLE PEAK VOLTAGE (R-F PLUS D.C.)
(FOR ANY AMBIENT TEMPERATURE)

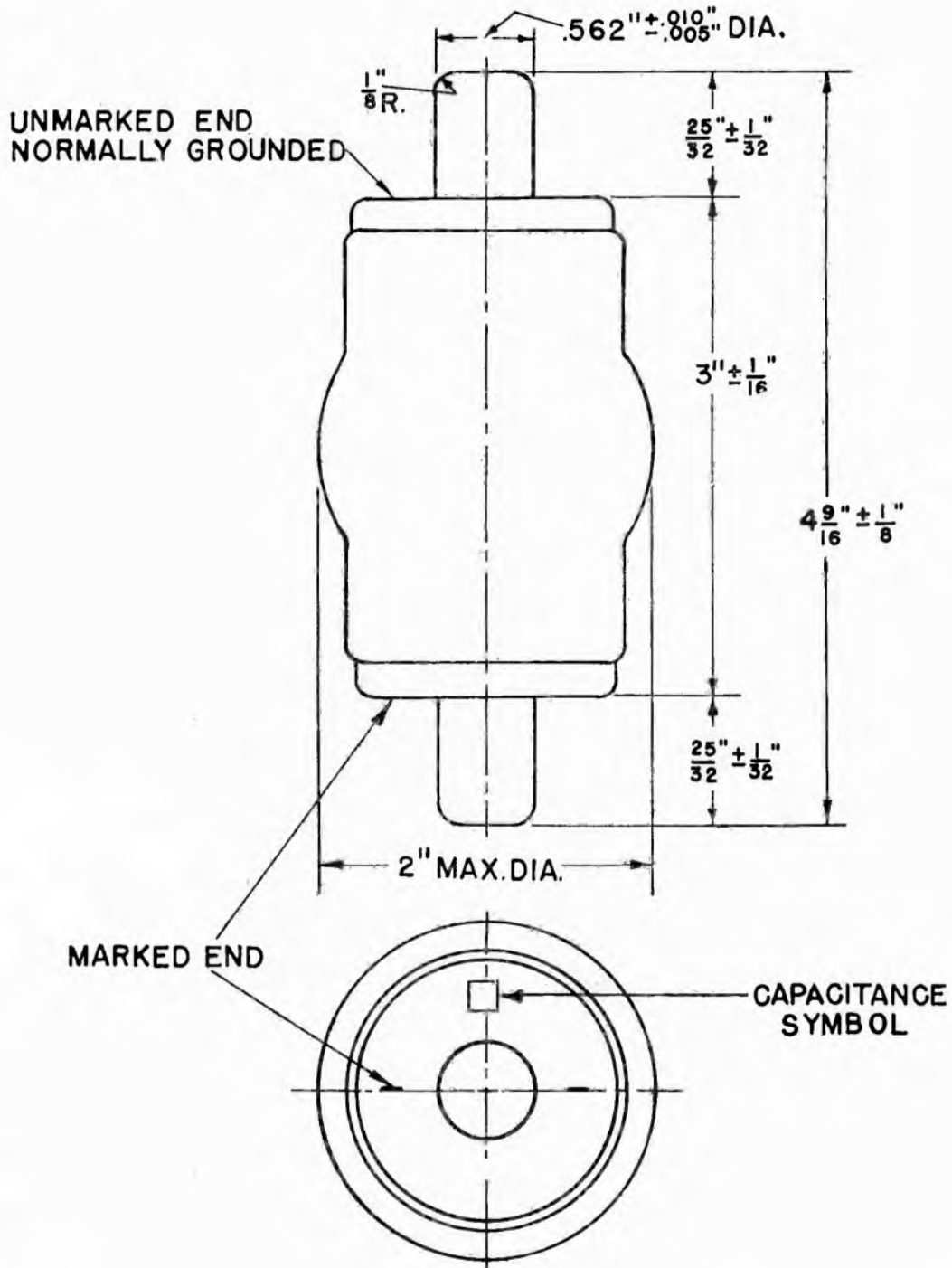
FREQUENCY IN MEGACYCLES

GL-1L25

ETI-266

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GL-1L25 OUTLINE

K-8639363

10-29-45

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



VACUUM CAPACITOR

DESCRIPTION

The GL-1L33 vacuum capacitor is designed for circuits where the peak voltages range up to 7500 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L33 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Capacitance \pm 5 per cent.	100 micromicrofarads
Maximum peak voltage.	7500 volts



TECHNICAL INFORMATION (CONT'D)

Ambient temperature	
Minimum	-40 centigrade
Maximum	+65 centigrade
Mechanical	
Maximum over-all length	$4\frac{9}{16} \pm \frac{1}{8}$ inches
Maximum diameter	$1\frac{5}{8}$ inches
Net weight, approx	6 ounces
Shipping weight, approx	1 pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

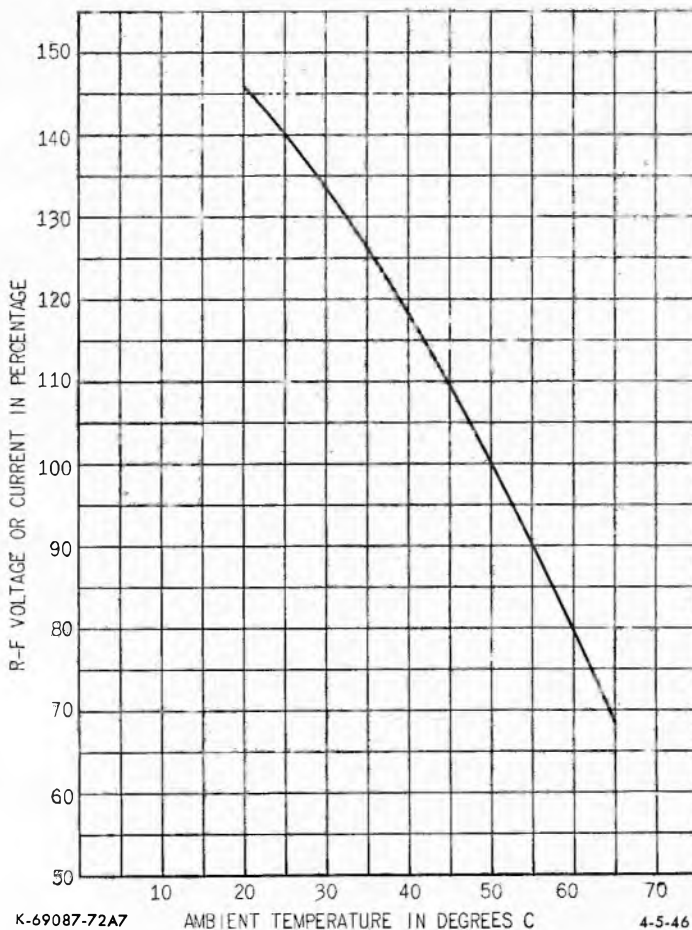
d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

Example—Assume a GL-1L33 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 1300 volts peak and a maximum current of 25 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 1534 volts and a maximum current of 29.5 amperes.

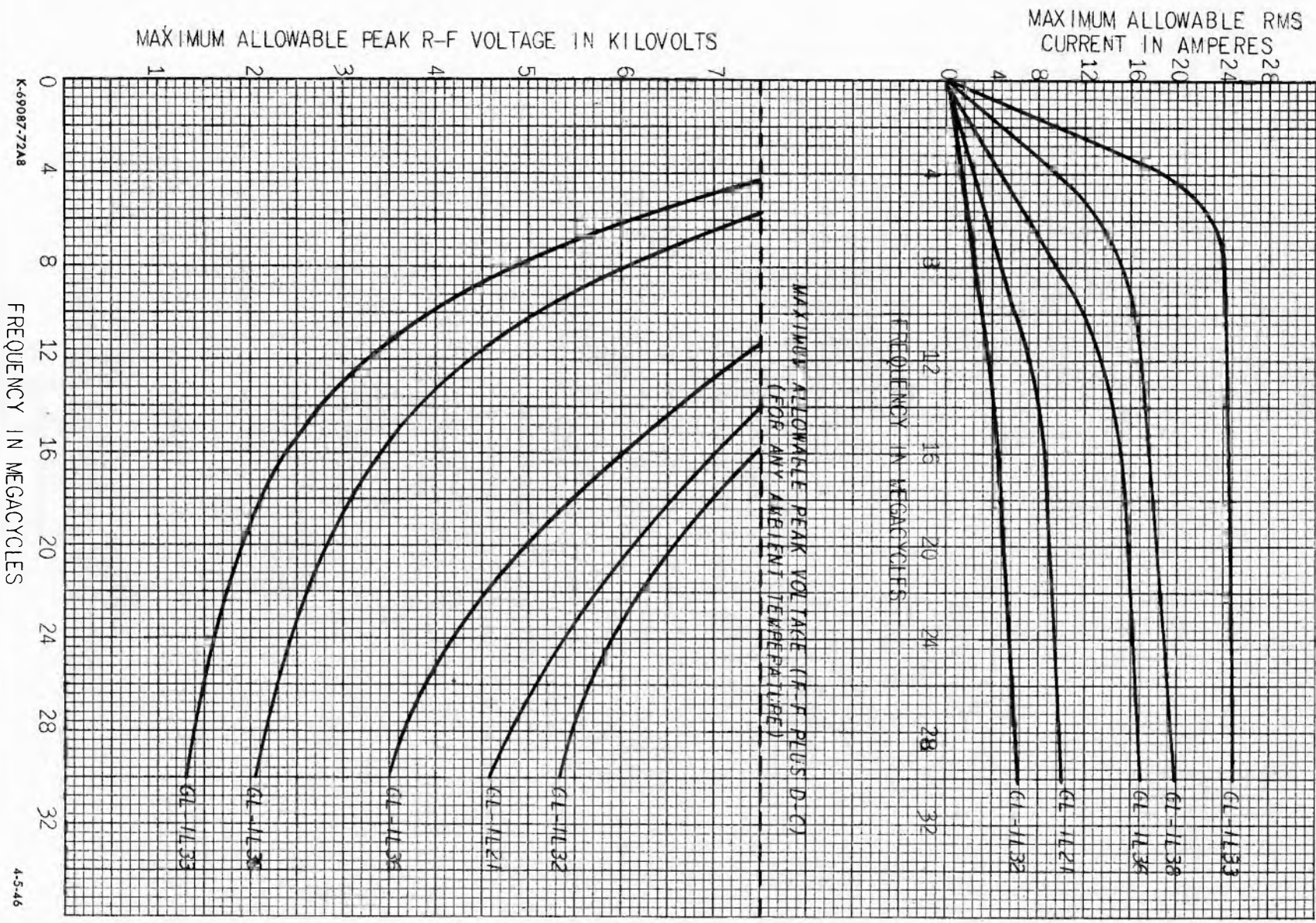
For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS

GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)



VOLTAGE AND CURRENT VS FREQUENCY
(FOR OPERATION AT 50 C AMBIENT TEMPERATURE)



K-99087-72A8

FREQUENCY IN MEGACYCLES

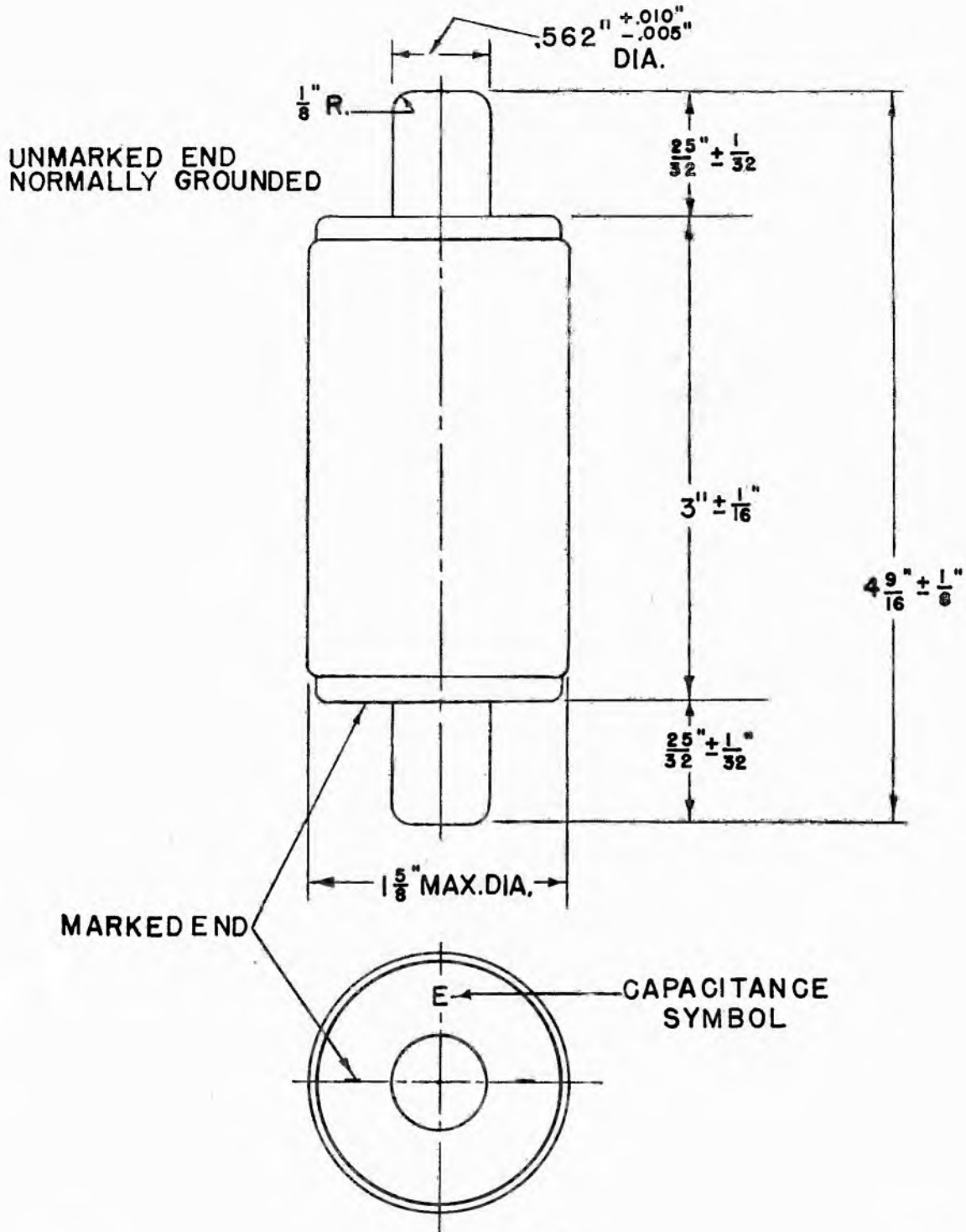
4-5-46

GL-1L33

ETI-267

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GL-1L33 OUTLINE

K-5964459

10-29-45

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



VACUUM CAPACITOR

DESCRIPTION

The GL-1L36 vacuum capacitor is designed for circuits where the peak voltages range up to 7500 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L36 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Capacitance \pm 5 per cent.....	25 micromicrofarads
Maximum peak voltage.....	7500 volts


Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

Ambient temperature	
Minimum.....	-40 centigrade
Maximum.....	+65 centigrade
Mechanical	
Maximum over-all length.....	3 ³ / ₈ inches
Maximum diameter.....	1 ⁵ / ₈ inches
Net weight, approx.....	.4 ounces
Shipping weight, approx.....	.1 pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

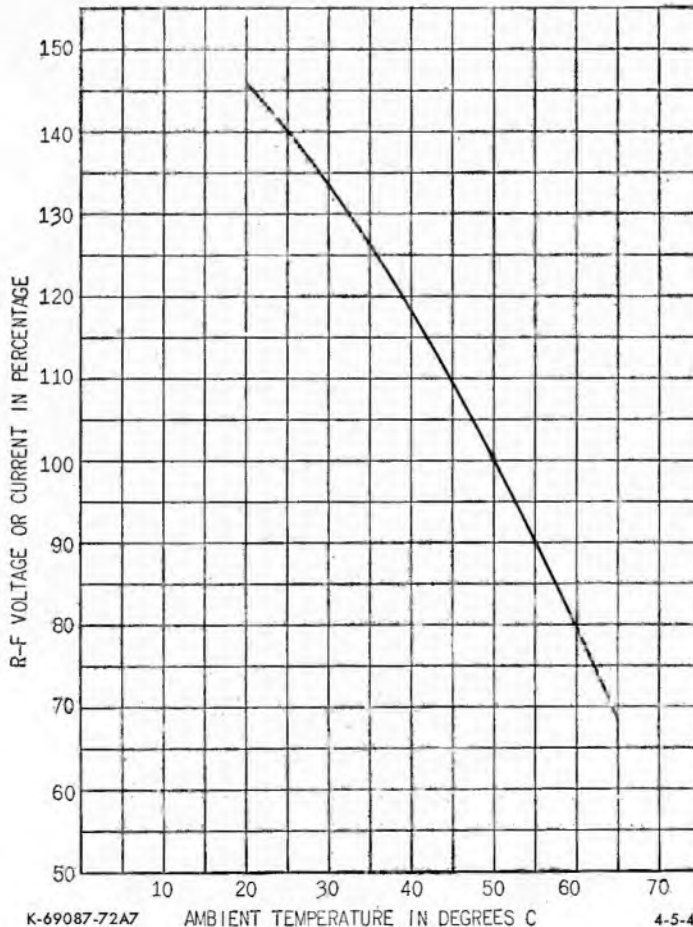
The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

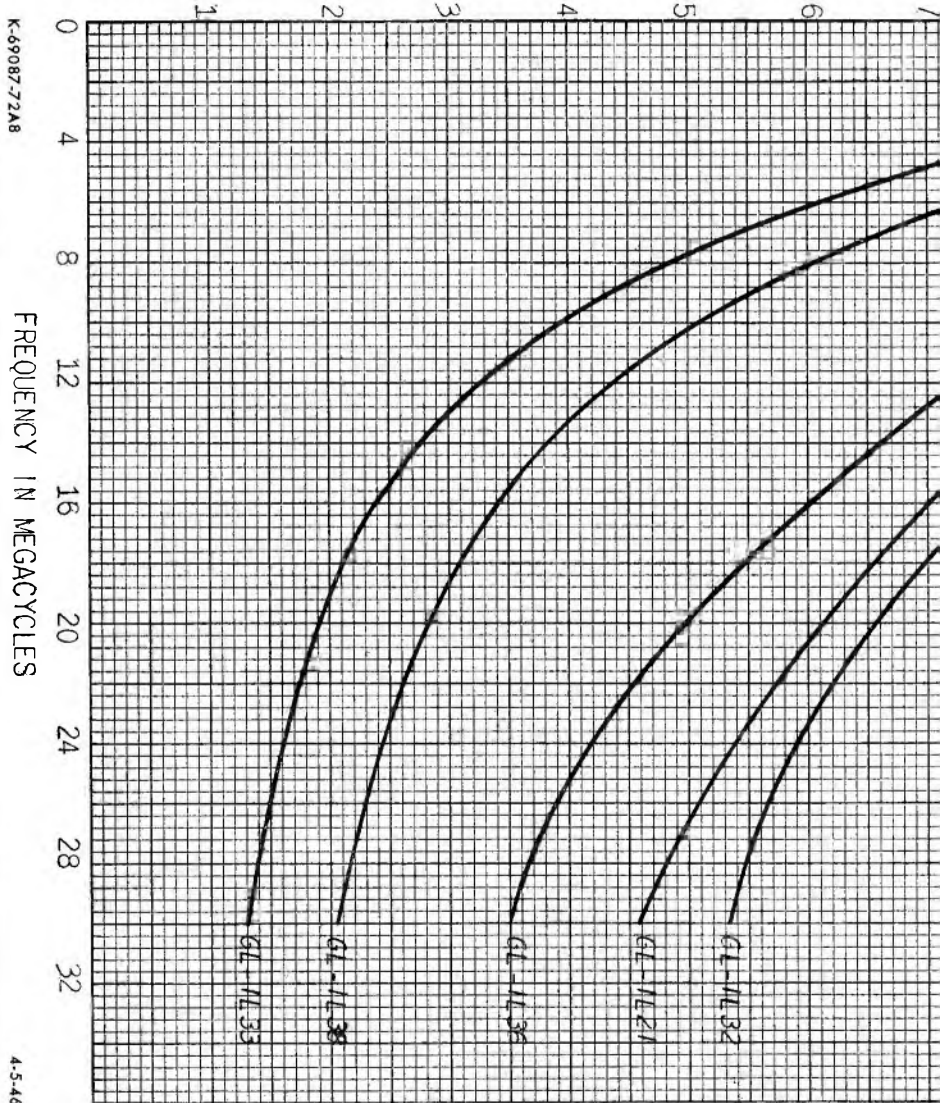
Example—Assume a GL-1L36 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 3500 volts peak and a maximum current of 16.8 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 4130 volts and a maximum current of 19.8 amperes.

For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS
GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)



MAXIMUM ALLOWABLE PEAK R-F VOLTAGE IN KILOVOLTS

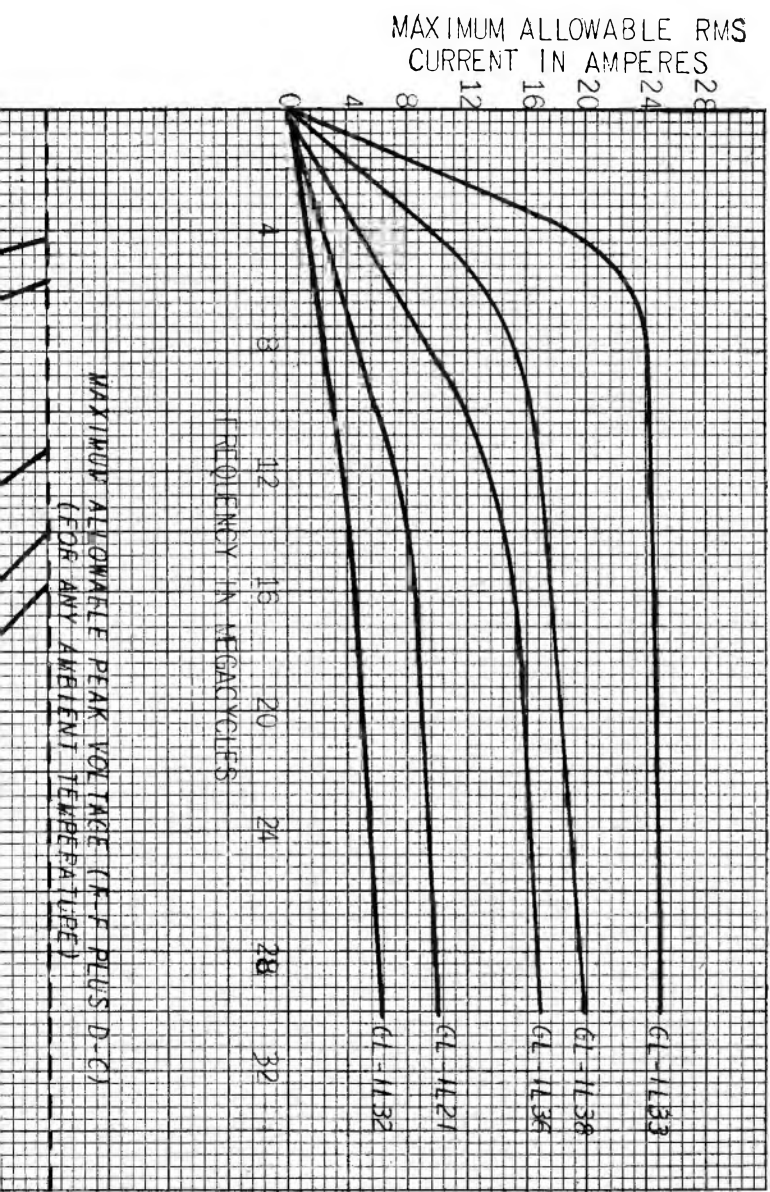


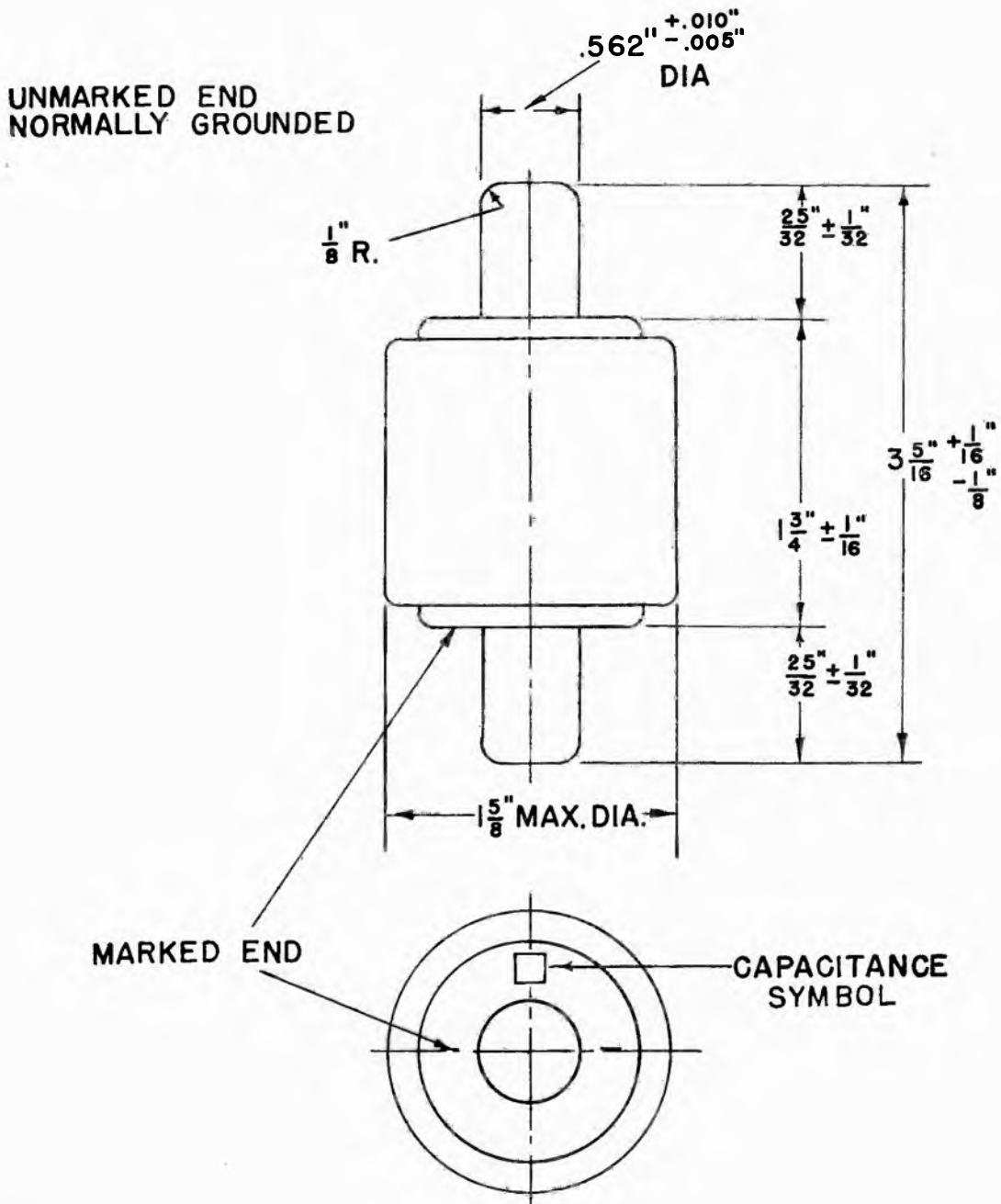
K-69087-72A8

FREQUENCY IN MEGACYCLES

4-5-46

VOLTAGE AND CURRENT VS FREQUENCY
 (FOR OPERATION AT 50 C AMBIENT TEMPERATURE)





GL-1L36 OUTLINE

K-5964469

10-29-45



VACUUM CAPACITOR

DESCRIPTION

The GL-1L38 vacuum capacitor is designed for circuits where the peak voltages range up to 7500 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L38 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications:

GENERAL CHARACTERISTICS

Electrical

Capacitance ± 5 per cent.	50 micromicrofarads
Maximum peak voltage	7500 volts

GENERAL  ELECTRIC


Electronic
TUBE

TECHNICAL INFORMATION (CONT'D)

Ambient temperature

Minimum..... -40 centigrade

Maximum..... +65 centigrade

Mechanical

Maximum over-all length..... 3 3/8 inches

Maximum diameter..... 1 5/8 inches

Net weight, approx..... 4 ounces

Shipping weight, approx..... 1 pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

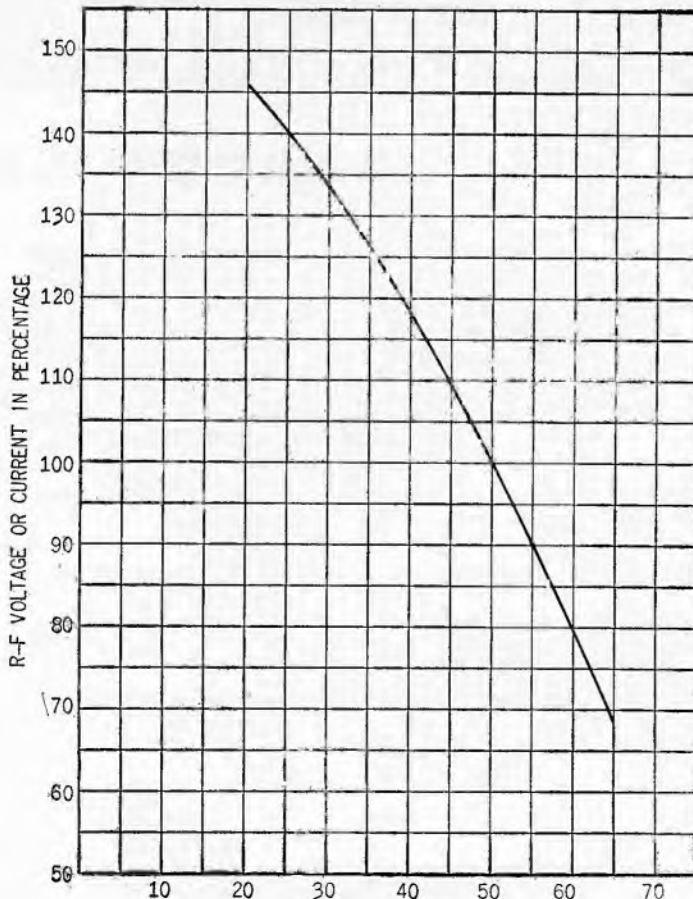
d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

Example—Assume a GL-1L38 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 2050 volts peak and a maximum current of 20 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 2419 volts and a maximum current of 23.6 amperes.

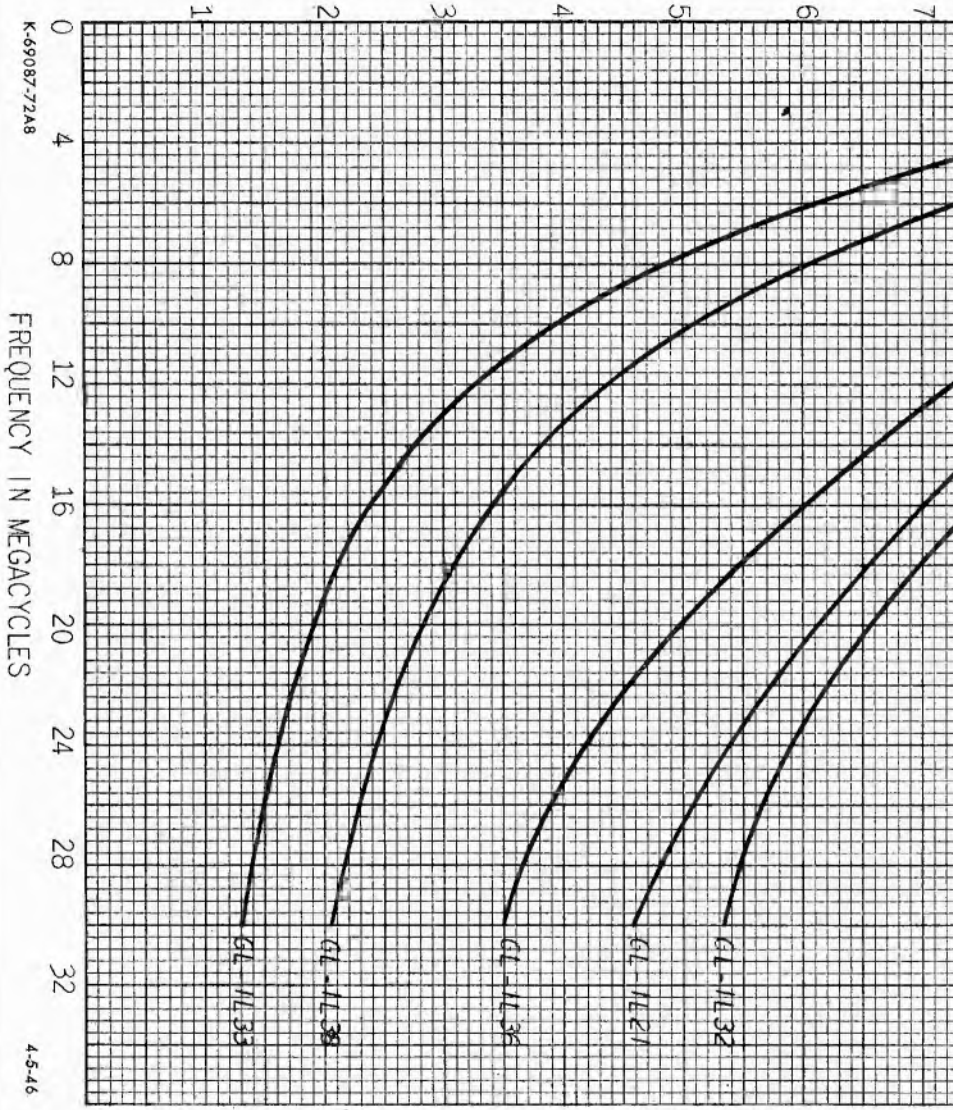
For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS

GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)



MAXIMUM ALLOWABLE PEAK R-F VOLTAGE IN KILOVOLTS

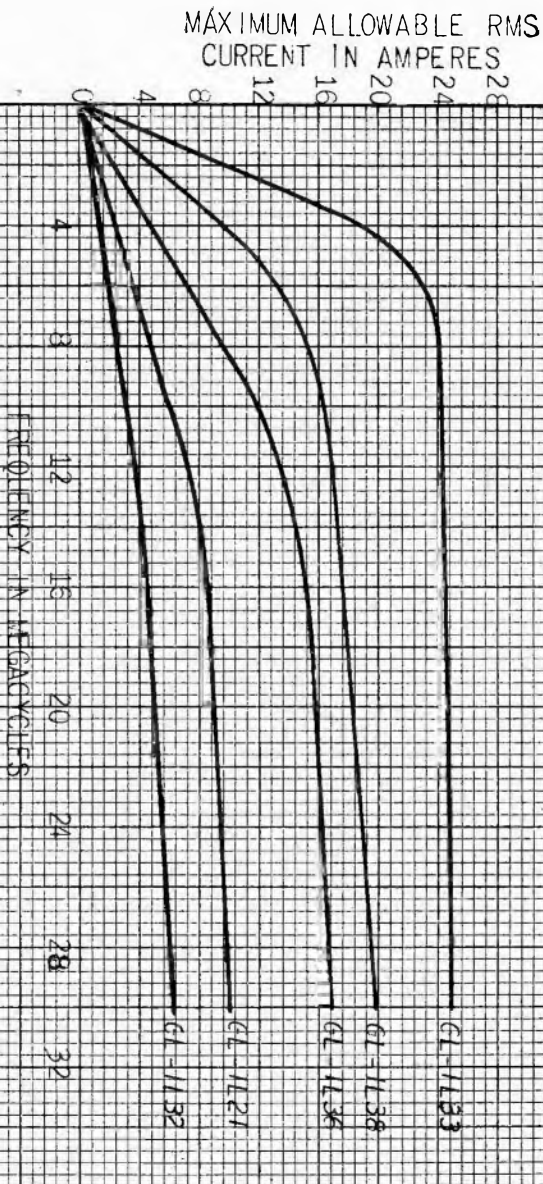


K-59087-72A8

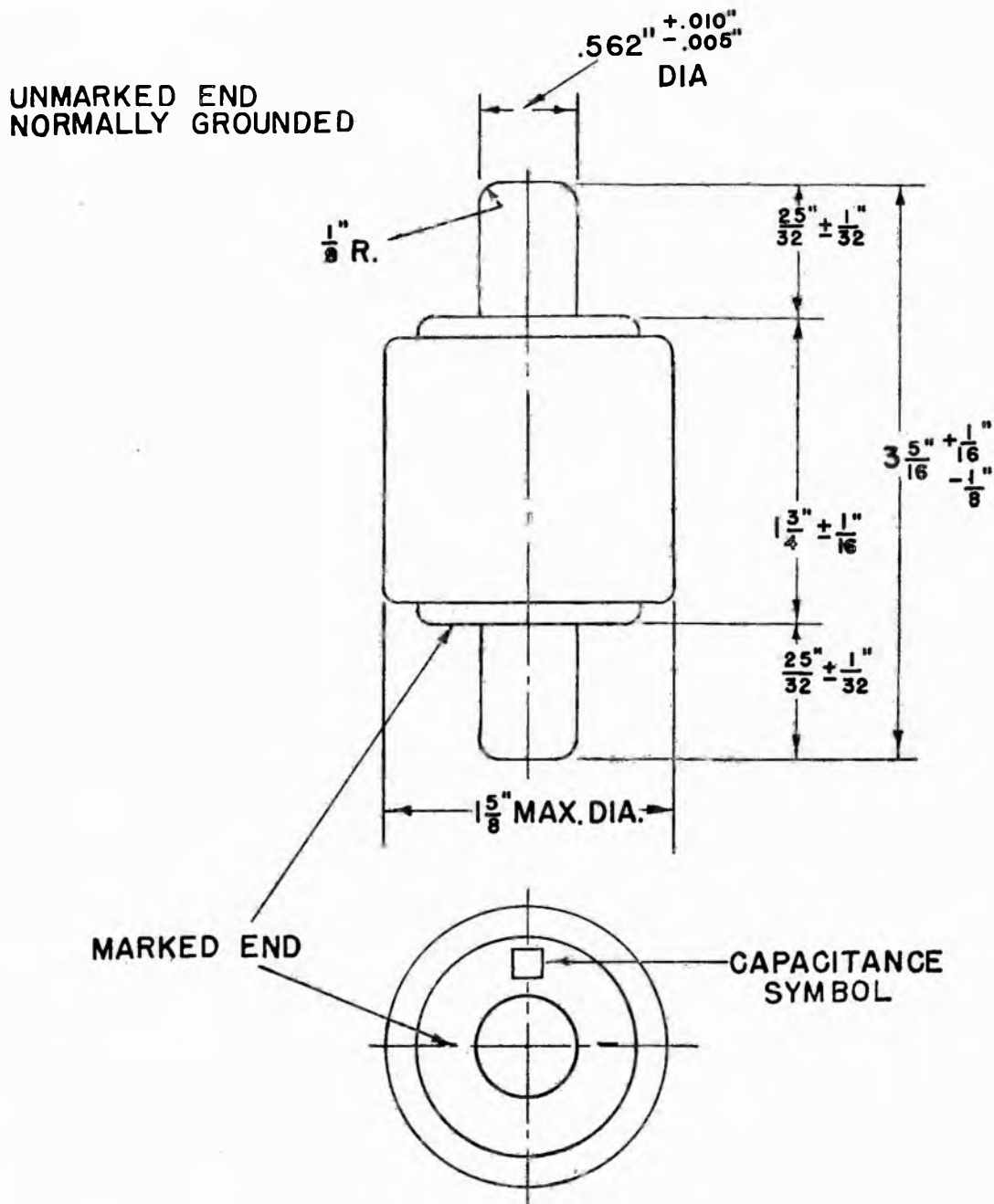
FREQUENCY IN MEGACYCLES

4-5-46

VOLTAGE AND CURRENT VS FREQUENCY
 (FOR OPERATION AT 50 C AMBIENT TEMPERATURE)



MAXIMUM ALLOWABLE PEAK VOLTAGE (K-F PLUS D-C)
 (FOR ANY AMBIENT TEMPERATURE)



GL-1L38 OUTLINE

K-5964469

10-29-45



VACUUM CAPACITOR

DESCRIPTION

The GL-1L31 vacuum capacitor is designed for circuits where the peak voltages range up to 16,000 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L31 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Capacitance \pm 5 per cent.	6 micromicrofarads
Maximum peak voltage	16,000 volts



TECHNICAL INFORMATION (CONT'D)

Ambient temperature

Minimum -40 centigrade

Maximum +65 centigrade

Mechanical

Maximum over-all length $4\frac{9}{16} \pm \frac{1}{8}$ inches

Maximum diameter 2 inches

Net weight, approx. 6 ounces

Shipping weight, approx. 1 pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

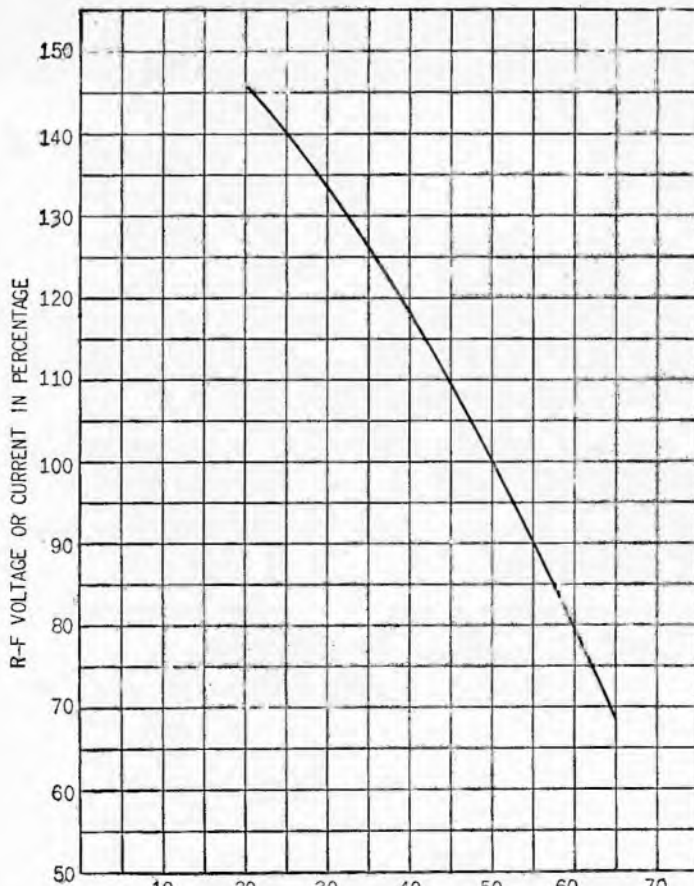
d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

Example—Assume a GL-1L31 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 6500 volts peak and a maximum current of 5.4 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 7670 volts and a maximum current of 6.4 amperes.

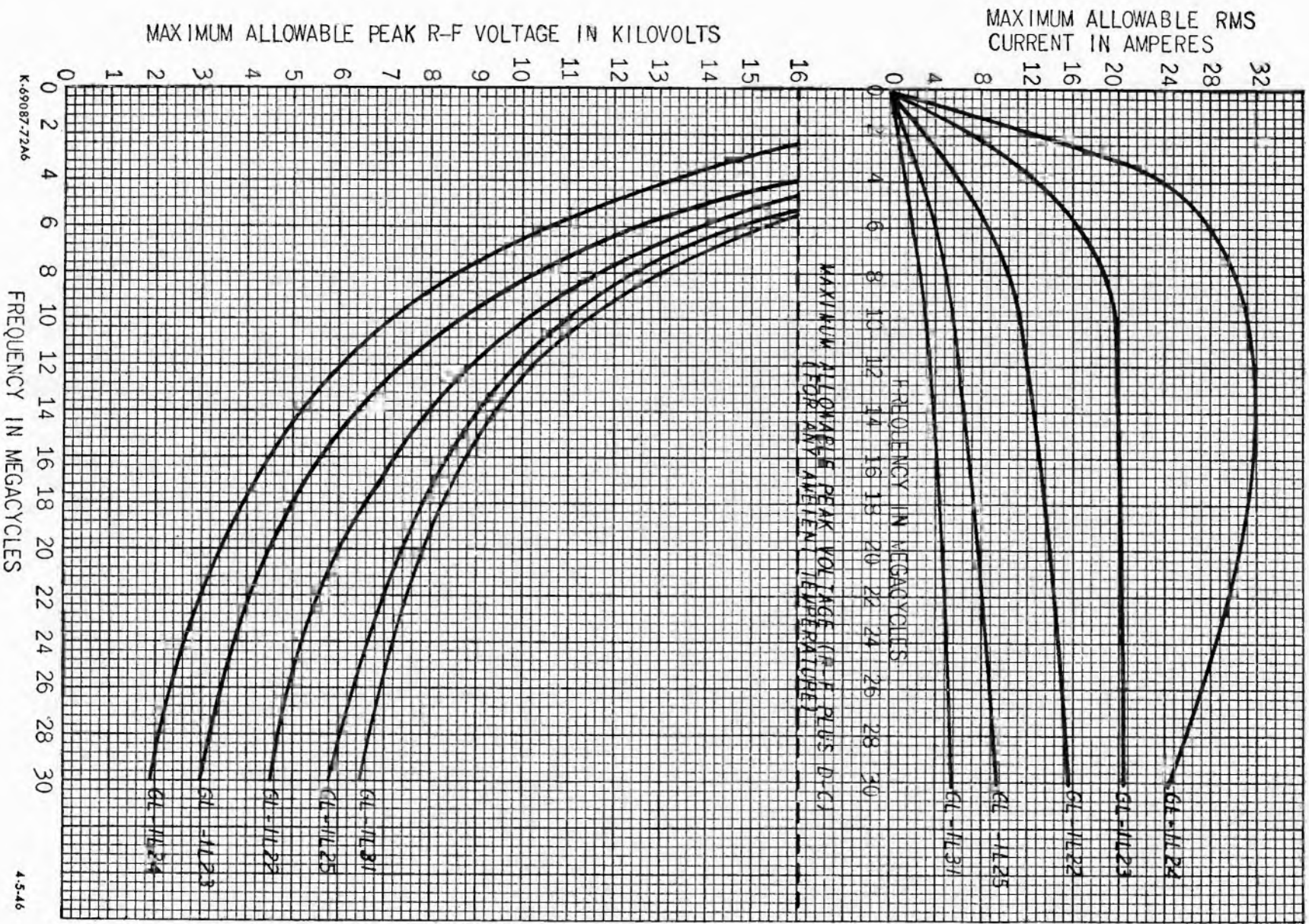
For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS

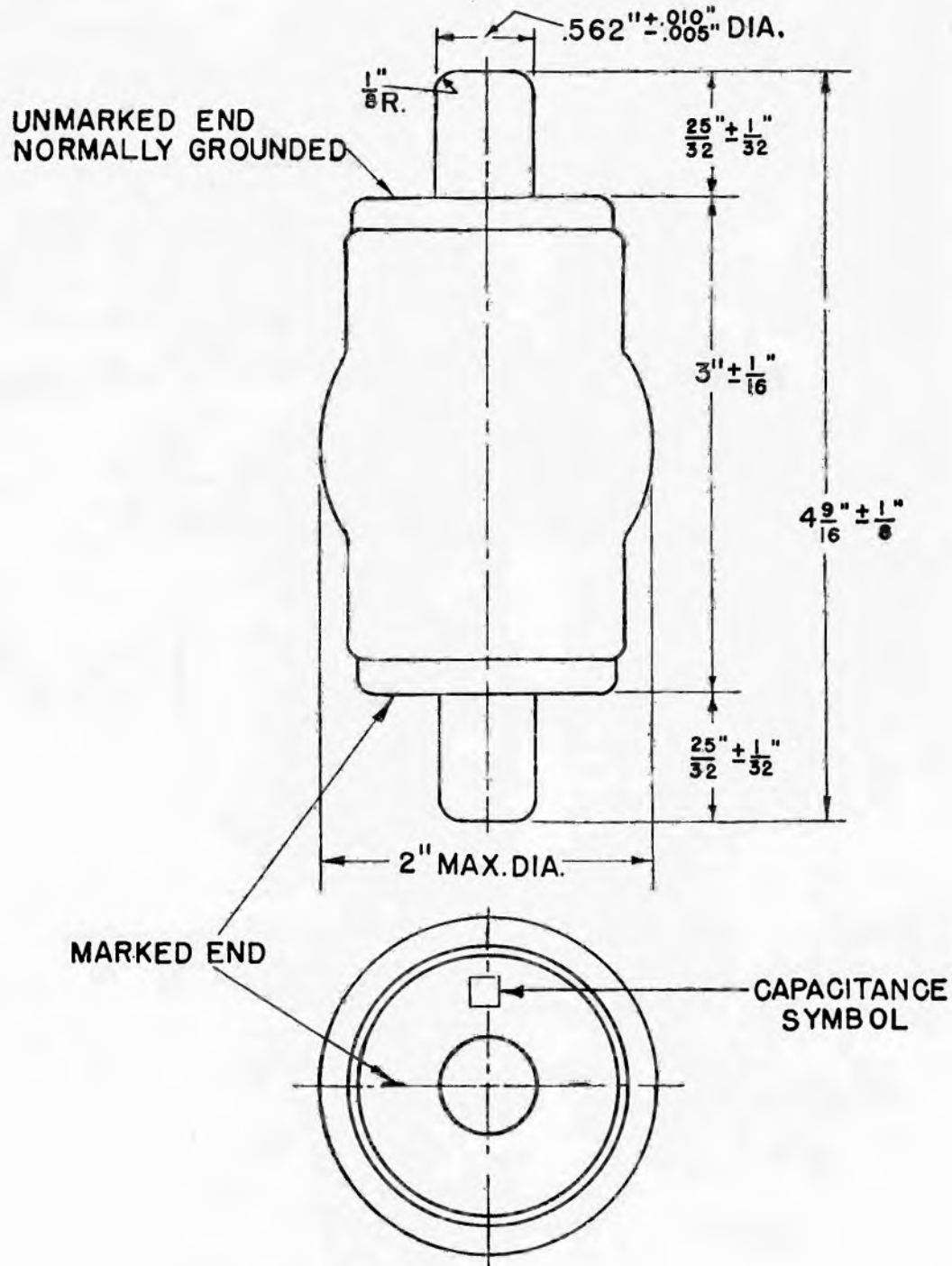
GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)



VOLTAGE AND CURRENT VS FREQUENCY
 (FOR OPERATION AT 50 C AMBIENT TEMPERATURE)



GL-1L31 OUTLINE



K-8639363

10-29-45



VACUUM CAPACITOR

DESCRIPTION

The GL-1L32 vacuum capacitor is designed for circuits where the peak voltages range up to 7500 volts. It is useful as a plate-tank and by-pass capacitor in radio-frequency oscillators or amplifiers. The GL-1L32 also serves as a neutralizing capacitor in radio-frequency amplifiers in conjunction with small, low-capacitance padding capacitors.

The small size and compact construction of the vacuum capacitor permits circuits to be designed more compactly, allowing shorter leads than with air capacitors. Some of the more important advantages, in the design of high-frequency circuits, are listed below:

1. Vacuum capacitors are comparatively loss-

free, since there are no losses in the vacuum dielectric and because the total capacitance is lumped into a size about 1 cubic inch.

2. Dust and other foreign matter have no effect on vacuum capacitors.
3. In communication applications, vacuum capacitors are extensively used as antenna-coupling capacitors—especially in aviation radio installations, where constant internal voltage breakdown is an essential requirement.
4. Internal voltage breakdown is constant and is independent of altitude, temperature, humidity and other factors because of the vacuum construction.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Capacitance ± 5 per cent 6 micromicrofarads
 Maximum peak voltage 7500 volts



Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

Ambient temperature	
Minimum.....	-40 centigrade
Maximum.....	+65 centigrade

Mechanical

Maximum over-all length.....	$3\frac{3}{8}$ inches
Maximum diameter.....	$1\frac{5}{8}$ inches
Net weight, approx.....	.4 ounces
Shipping weight, approx.....	.1 pound

VOLTAGE AND CURRENT VS. FREQUENCY

The curves of page 3 show the maximum allowable peak r-f voltage and maximum rms current for G-E vacuum capacitors when operated at various frequencies. An additional d-c voltage is permissible so long as the total voltage (d-c plus r-f) does not exceed the maximum allowable peak voltage as indicated by the dotted line shown on the curve.

These curves apply when the capacitors are operated at an ambient temperature of 50 C and for normal operating conditions with natural air cooling.

The correction curve below indicates the percentage increase or decrease in r-f voltage and current when G-E vacuum capacitors are operated at ambient temperatures above or below 50 C. (Note that the allowable peak voltage (r-f plus

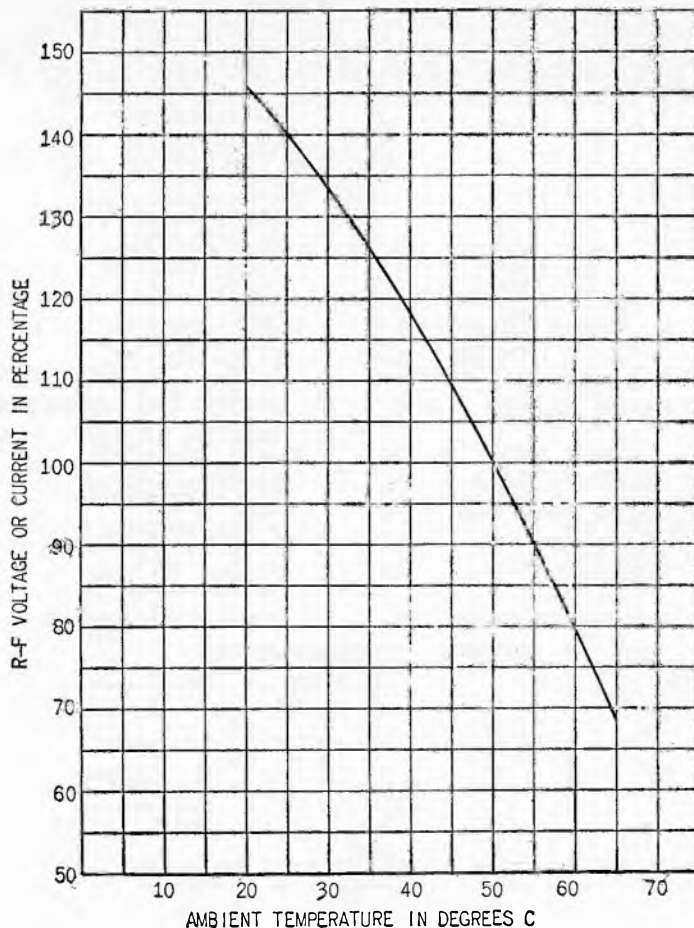
d-c) at any ambient temperature should not exceed the maximum as indicated by the dotted line of the curve shown on page 3.)

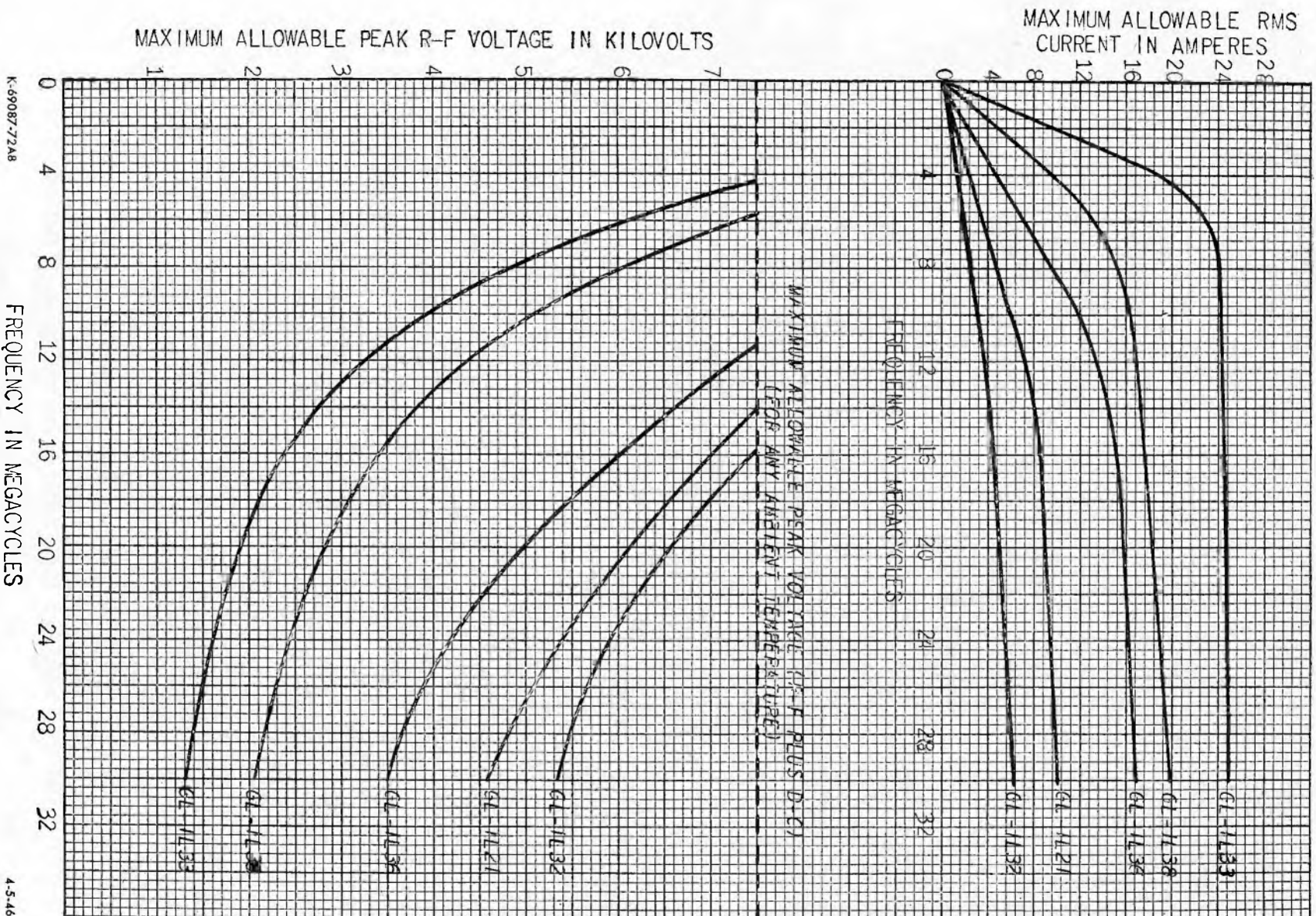
Example—Assume a GL-1L32 is to be used at a frequency of 30 megacycles and at an ambient temperature of 40 C. The correction curve indicates a correction of 118 per cent. The curves of page 3 indicate a maximum r-f voltage of 5320 volts peak and a maximum current of 6.4 amperes. Applying the correction factor of 118 per cent to these values indicates an allowable maximum peak r-f voltage of 6278 volts and a maximum current of 7.6 amperes.

For operation at frequencies higher than those indicated, consult the Electronics Department, General Electric Company, Schenectady 5, New York.

VACUUM CAPACITORS

GL-1L21, 32, 33, 36, 38, 22, 23, 24, 25 AND 1L31 CORRECTION CURVE (PERCENTAGE VOLTAGE OR CURRENT VS AMBIENT TEMPERATURE)





K-69087-72A8

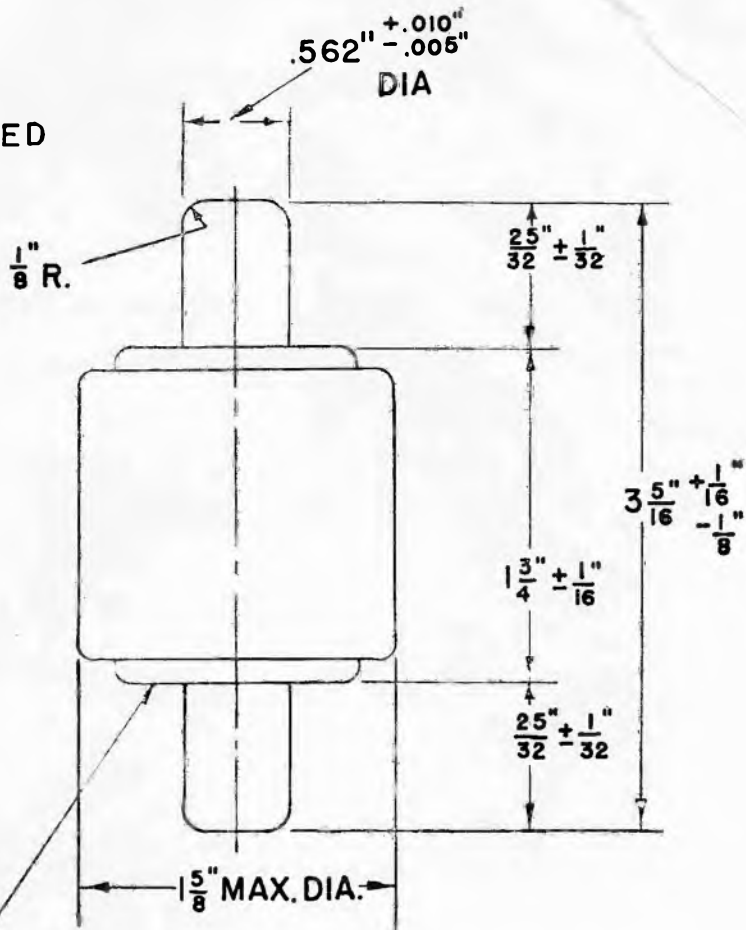
FREQUENCY IN MEGACYCLES

4-5-46

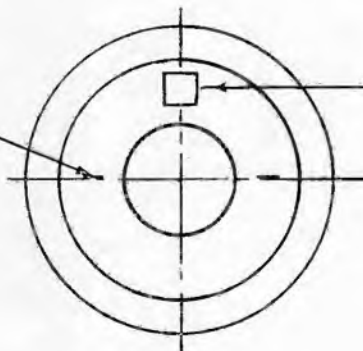
GL-1L32

ETI-308
PAGE 4
8-50

UNMARKED END
NORMALLY GROUNDED



MARKED END



CAPACITANCE
SYMBOL

GL-1L32 OUTLINE

K-5964469

10-29-45

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.

CATHODE RAY TUBES



CATHODE-RAY TUBE

DESCRIPTION

The GL-2BP1 is a small cathode-ray tube with a small, brilliant, focused spot and high deflection sensitivity. The two-inch, medium-persistence, green-fluorescence screen provides high contrast. The tube is designed for use as an indicator and is also recommended for use in general oscillographic applications where compactness is an essential consideration.

With separate base-pin connections provided for each of the four deflecting electrodes, the 2BP1 is intended primarily for use in balanced electrostatic-deflection circuits and gives best definition when so used. However, it is also well suited for use with unbalanced deflection because of design features

which minimize the spot and pattern distortion characteristic of such operation.

The spot in this tube can be focused sharply on the screen, both at the center and at the edges, and remains sharp when beam current is varied over a wide range. This feature results from the electron gun used in the 2BP1 in which the Grid No. 2 operates at voltage high enough to keep the beam current from being affected by changes in the anode-No. 1 voltage. Another feature, the very small current taken by Anode No. 1, permits the use of a low-current voltage-divider system and hence the use of a small filter capacitor.


Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Heater voltage (A-C or D-C)	6.3 \pm 10%	volts
Heater current	0.6	ampere
Focusing method—Electrostatic		
Deflecting method—Electrostatic		
Phosphor—P1		
Fluorescence—Green		
Persistence—Medium		
Direct interelectrode capacitances, approximate		
Grid No. 1 to all other electrodes	8	uuf
D1 to D2	.2	uuf
D3 to D4	.2	uuf
D1 to all other electrodes	11	uuf
D2 to all other electrodes	8	uuf
D3 to all other electrodes	.7	uuf
D4 to all other electrodes	.8	uuf

Mechanical Data

Mounting position—Any		
Over-all length	$7\frac{5}{8} \pm \frac{3}{16}$	inches
Greatest diameter of bulb	$2\frac{1}{16}$	inches
Minimum useful screen diameter	$1\frac{3}{4}$	inches
Base No. B12-43, small-shell duodecal 12-pin		

MAXIMUM RATINGS Design Center Values

Anode No. 2 voltage*	2500	max volts
Anode No. 1 voltage	1000	max volts
Grid No. 2 voltage	2500	max volts
Grid No. 1 voltage		
Negative-bias value	200	max volts
Positive-bias value	0	max volts
Positive-peak value	.2	max volts
Peak heater-cathode voltage		
Heater negative with respect to cathode	.125	max volts
Heater positive with respect to cathode	.125	max volts
Peak voltage between anode—No. 2 and any deflection electrode	.500	max volts

EQUIPMENT DESIGN RANGES

For any anode No. 2 voltage (E_{b2}) between 500** and 2500 volts

Anode No. 1 voltage	15% to 28%	of E_{b2}	volts
Grid No. 1 voltage for visual cutoff, maximum	6.75%	of E_{b2}	volts
Anode No. 1 current for any operating condition	-15 to +10	microamperes	
Deflection factors			
D1 and D2	115 to 155	volts D-C per inch per kilovolt of E_{b2}	
D3 and D4	74 to 100	volts D-C per inch per kilovolt of E_{b2}	

EXAMPLES OF USE OF DESIGN RANGES

For anode No. 2 voltage of	1000	2000	volts
Anode No. 1 voltage	150 to 280	300 to 560	volts
Grid No. 1 voltage for visual cutoff	-67.5	-135	volts
Deflection factors			
D1 and D2	115 to 155	230 to 310	volts D-C per inch
D3 and D4	74 to 100	148 to 200	volts D-C per inch

MAXIMUM CIRCUIT VALUES

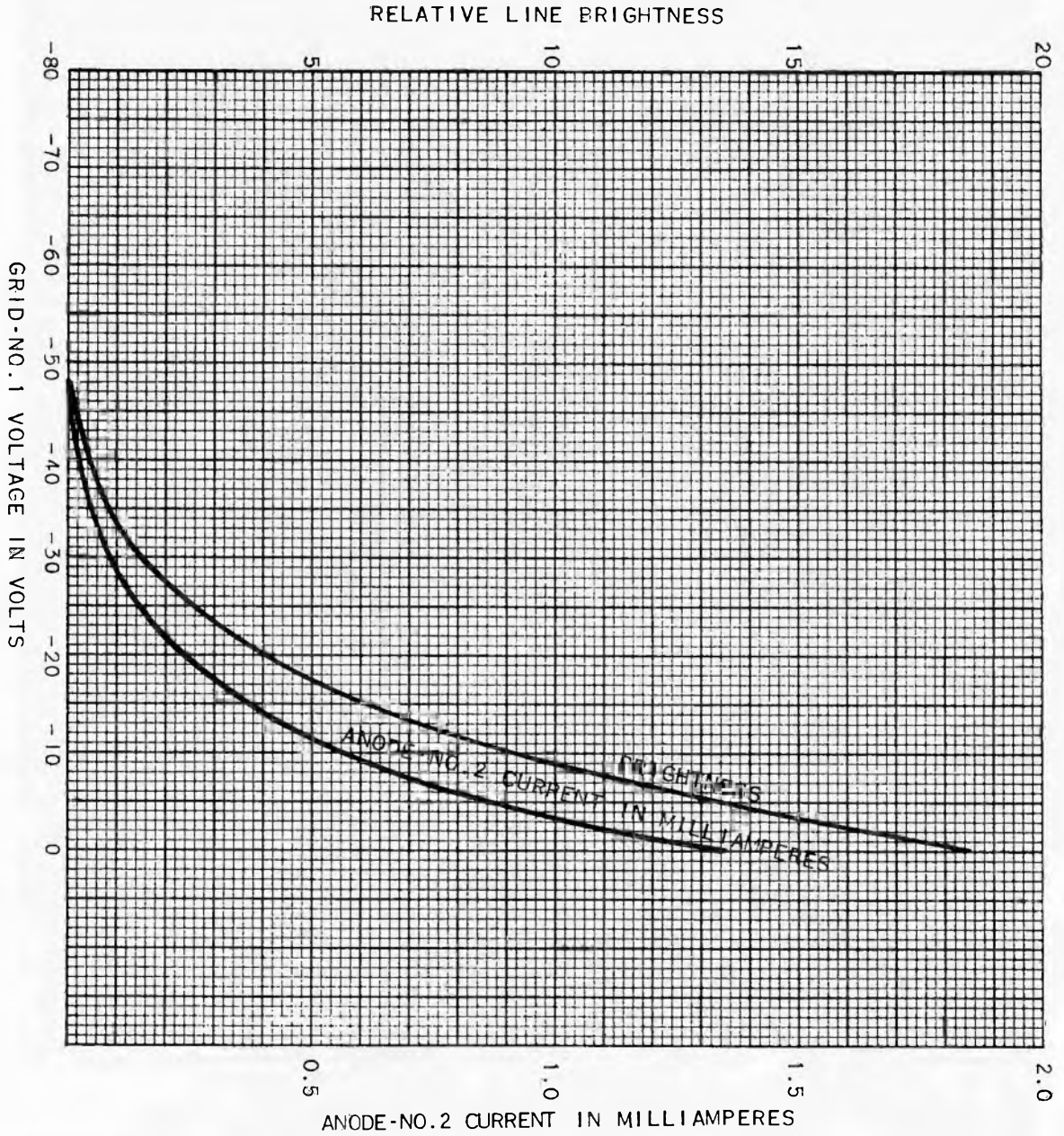
Grid No 1—Circuit resistance	1.5	max megohms
Resistance in any deflecting-electrode circuit†	5.0	max megohms

*Anode No. 2 and Grid No. 2 which are connected together within the tube are referred to herein as Anode No. 2.

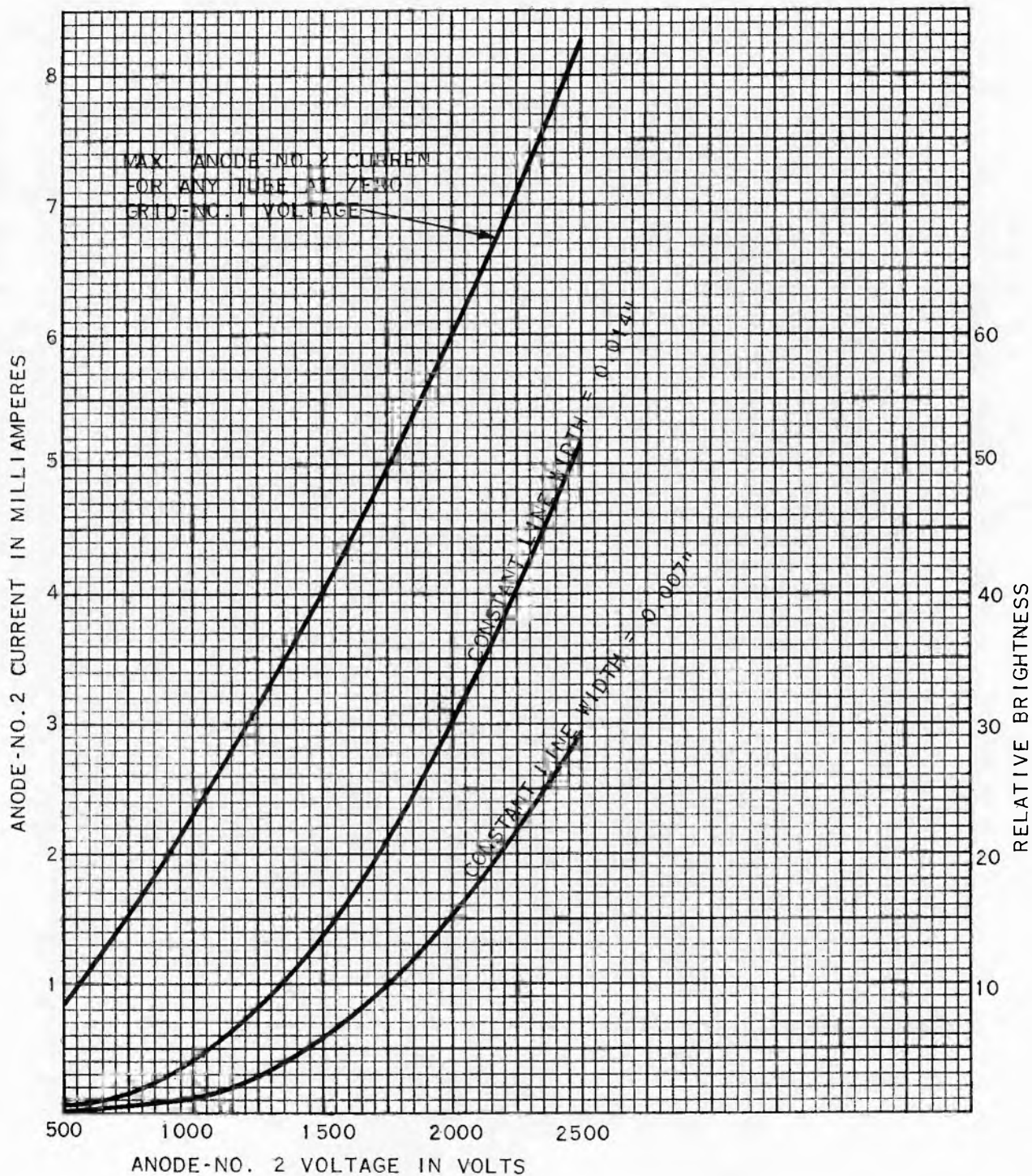
**Brilliance and definition decrease with decreasing Anode No. 2 voltage. A value as low as 500 volts is recommended only for low-velocity deflection and low room-light levels.

†It is recommended that the deflecting-electrode-circuit resistance be approximately equal.

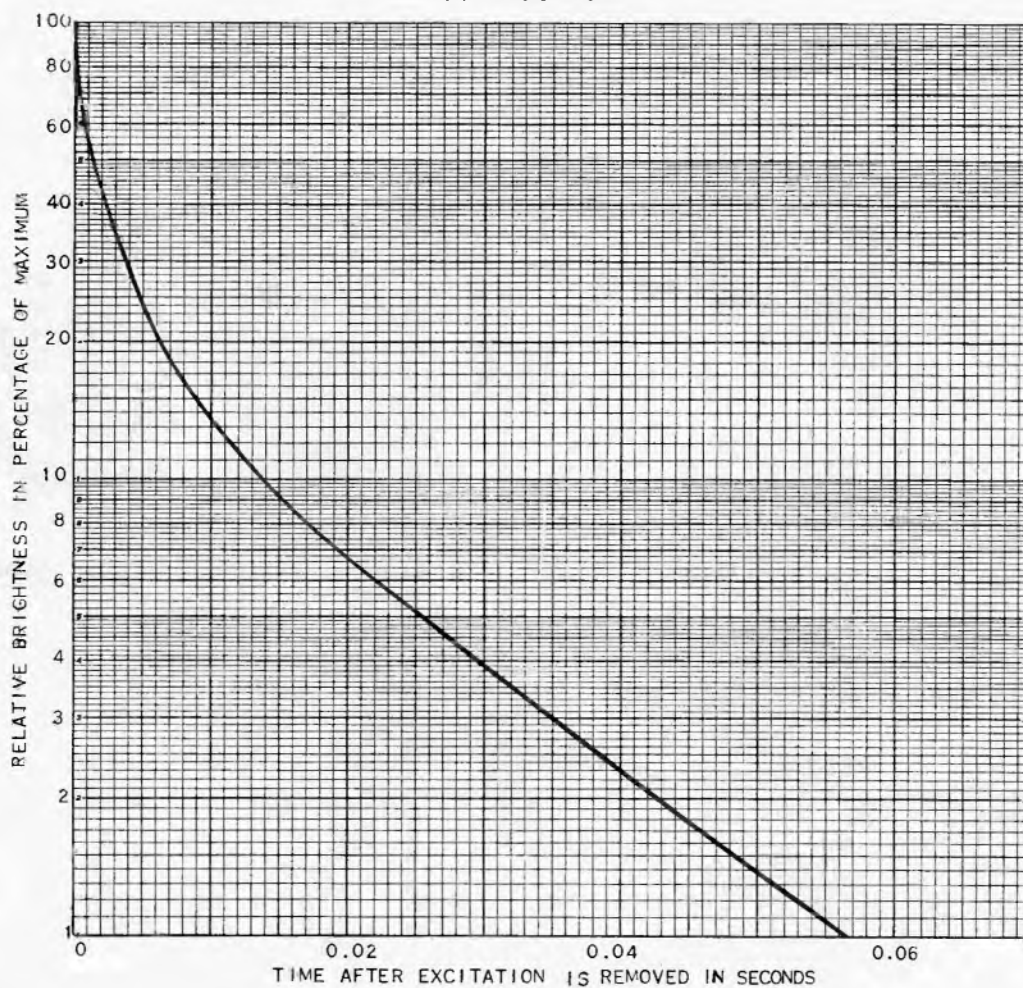
GL-2BP1
AVERAGE CHARACTERISTIC
ANODE NO. 1 VOLTAGE ADJUSTED FOR FOCUS
ANODE NO. 2 VOLTAGE = 1000
 $E_f = 6.3$ VOLTS



GL-2BP1
CHARACTERISTICS
ANODE NO. 1 VOLTAGE ADJUSTED FOR FOCUS
 $E_f = 6.3$ VOLTS



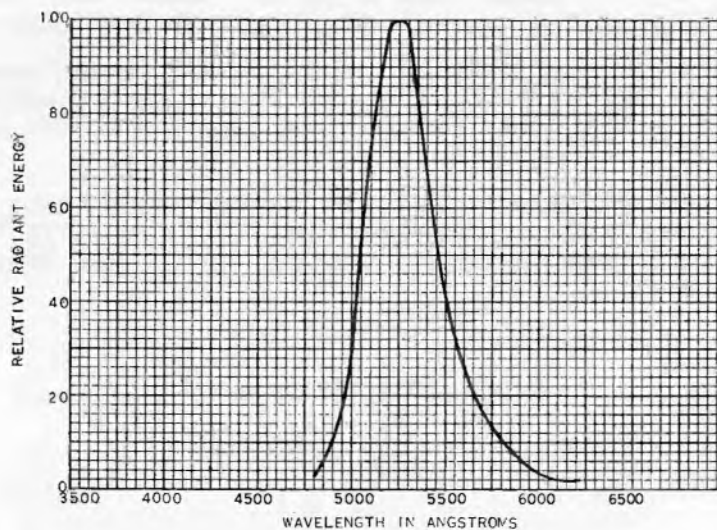
PERSISTENCE CHARACTERISTIC
P1 PHOSPHOR



K-69087-72A326

12-13-49

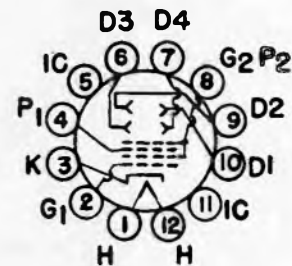
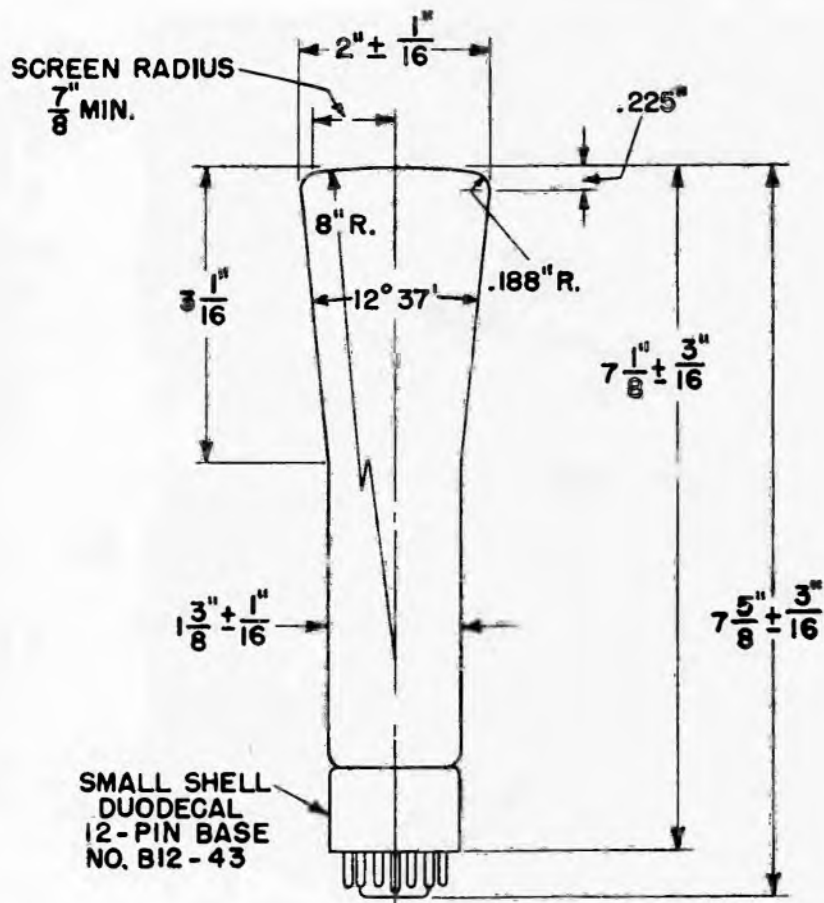
SPECTRAL-ENERGY EMISSION
CHARACTERISTIC
P1 PHOSPHOR



K-69087-72A327

12-13-49

OUTLINE
CATHODE-RAY TUBE GL-2BP1



BASING DIAGRAM

☉ OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF BOTTOM OF THE BASE.

THE PLANE THROUGH THE TUBE AXIS AND PIN NO. 4 MAY VARY FROM THE TRACE PRODUCED BY D1 AND D2 BY AN ANGULAR TOLERANCE (MEASURED ABOUT THE TUBE AXIS) OF 10° . ANGLE BETWEEN D1 - D2 TRACE AND D3 - D4 TRACE IS $90^\circ \pm 3^\circ$.

D1 AND D2 ARE NEARER THE SCREEN; D3 AND D4 ARE NEARER THE BASE. WITH D1 POSITIVE WITH RESPECT TO D2, THE SPOT WILL BE DEFLECTED TOWARD PIN NO. 4; LIKewise, WITH D3 POSITIVE WITH RESPECT TO D4, THE SPOT WILL BE DEFLECTED TOWARD PIN NO. 1.

N-15160AZ

12-9-49

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



CATHODE-RAY TUBE

DESCRIPTION

The GL-3KP1 is an electrostatic-focus-and-deflection cathode-ray tube for oscilloscope applications. A medium-persistence green-fluorescence screen provides high contrast. The tube has a small brilliant focused spot and high deflection sensitivity.

The anode No. 1 takes negligible current. Changes in the voltage of this anode will not affect the beam current because of the high voltage at which anode No. 2 operates. These features allow the spot to be focused sharply on the screen and to remain sharp even when the beam current

is varied over a wide range. The small anode No. 1 current permits the use of a low-current voltage-divider system and hence a small filter capacitor.

With separate base-pin connections for each of the four deflecting electrodes, the GL-3KP1 is intended primarily for use in balanced electrostatic-deflection circuits and gives best definition when so used. The tube, however, can be used with unbalanced deflection because the design features minimize spot and pattern distortion usually characteristic of such operation.


Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Heater voltage	6.3 volts
Heater current	0.6 ampere
Focusing method	electrostatic
Deflecting method	electrostatic
Phosphor—P1	
Fluorescence	green
Persistence	medium
Direct interelectrode capacitances, approximate	
Grid No. 1 to all other electrodes	8 uuf
D1 to D2	2.5 uuf
D3 to D4	2.5 uuf
D1 to all other electrodes	11 uuf
D2 to all other electrodes	8 uuf
D3 to all other electrodes	7.0 uuf
D4 to all other electrodes	8 uuf

Mechanical Data

Mounting position	any
Over-all length	$11\frac{1}{2} \pm \frac{1}{4}$ inches
Greatest diameter of bulb	$3 \pm \frac{1}{16}$ inches
Minimum useful screen diameter	$2\frac{3}{4}$ inches
Base	medium shell mag-nal 11-pin
Basing	11M

MAXIMUM RATINGS Design Center Values

Anode No. 2 voltage*	2500 max	volts d-c
Anode No. 1 voltage	1000 max	volts d-c
Grid No. 1 voltage		
Negative—bias value	200 max	volts d-c
Positive—bias value	0 max	volts d-c
Positive peak value	2 max	volts d-c
Peak heater—cathode voltage		
Heater negative with respect to cathode	125 max	volts d-c
Heater positive with respect to cathode	125 max	volts d-c
Peak voltage between anode No. 2 and any deflecting electrode	500 max	volts

EQUIPMENT DESIGN RANGES

For any anode No. 2 voltage between recommended minimum** and 2500 volts		
Anode No. 1 voltage	16 to 30%	of E_{b2} volts
Grid No. 1 voltage for visual cutoff, maximum	4.5%	of E_{b2} volts
Anode No. 1 current	-15 to +10	microamperes
Deflection factors		
D1 and D2	50 to 68	volts d-c per inch per kv of E_{b2}
D3 and D4	38 to 52	volts d-c per inch per kv of E_{b2}
Spot position***		

Examples of Use for Design Ranges

For anode No. 2 voltage of	1000	2000
Anode No. 1 voltage	160-300	320-600
Grid No. 1 voltage for visual cutoff	-45	-90 volts
Deflection factors		
D1 and D2	50 to 68	100 to 136 volts d-c per inch
D3 and D4	38 to 52	76 to 104 volts d-c per inch

MAXIMUM CIRCUIT VALUES

Grid No. 1 circuit resistance	1.5 max	megohms
Resistance in any deflecting—electrode circuit†	5.0 max	megohms

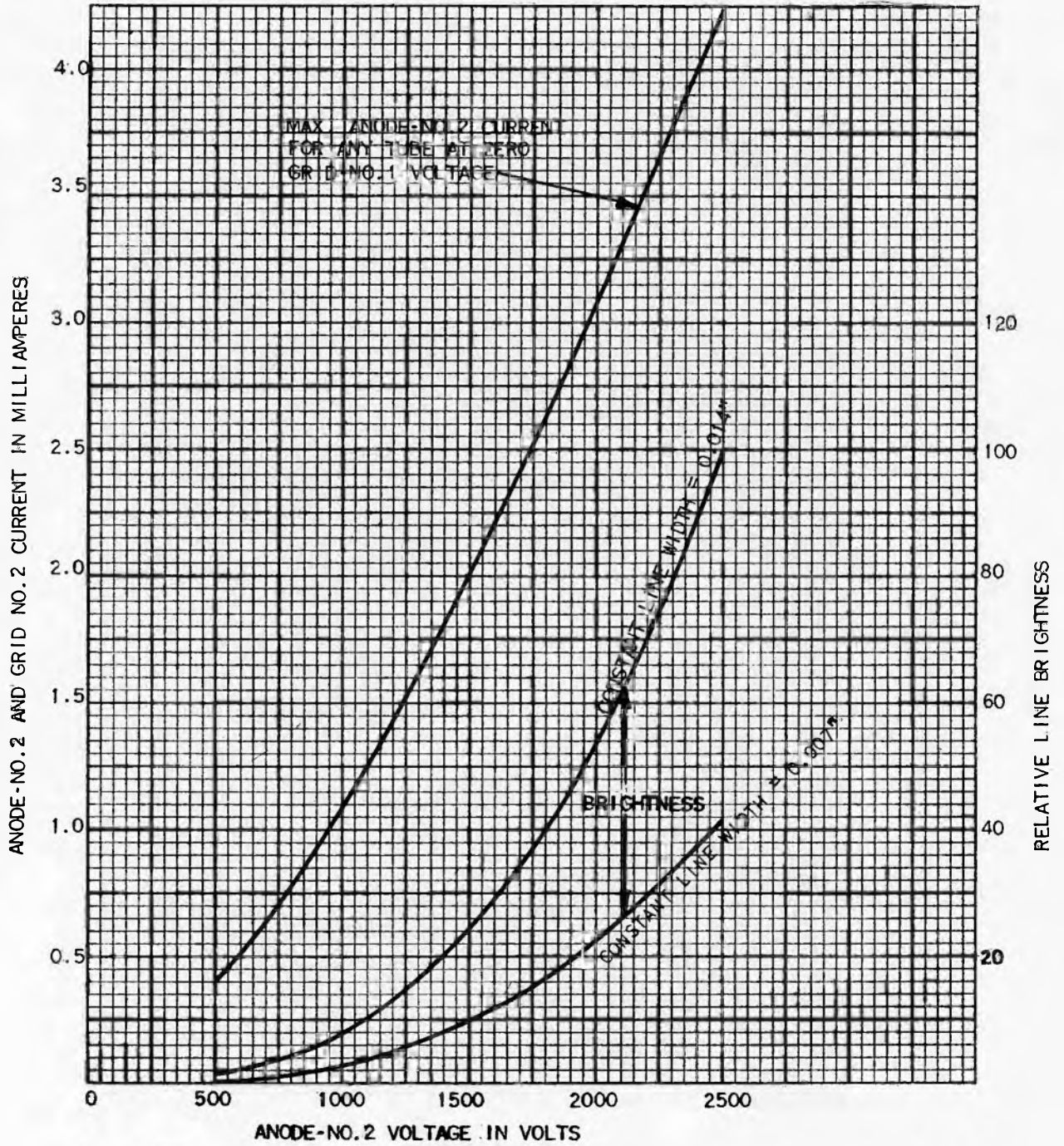
*Anode No. 2 and grid No. 2 which are connected together within the tube are referred to herein as anode No. 2. The product of anode No. 2 voltage and average anode No. 2 current should be limited to 6 watts.

**Brilliance and definition decrease with decreasing anode No. 2 voltage. Recommended minimum is 1000 volts in general service, but a value as low as 500 volts may be used under conditions of low-velocity deflection and low ambient-light conditions.

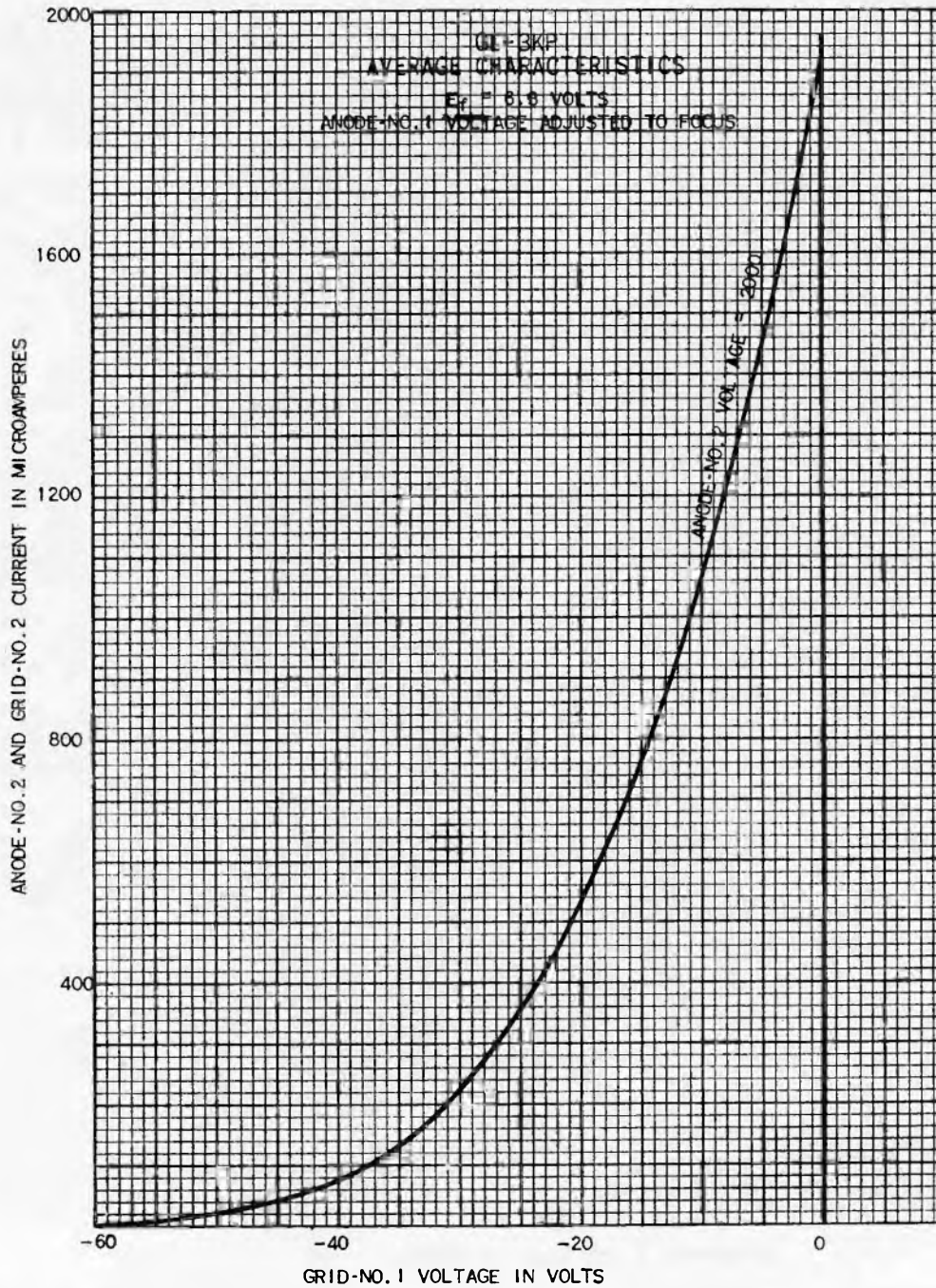
***The center of the undeflected, focused spot will fall within a circle having 7.5-mm radius concentric with the center of the tube face.

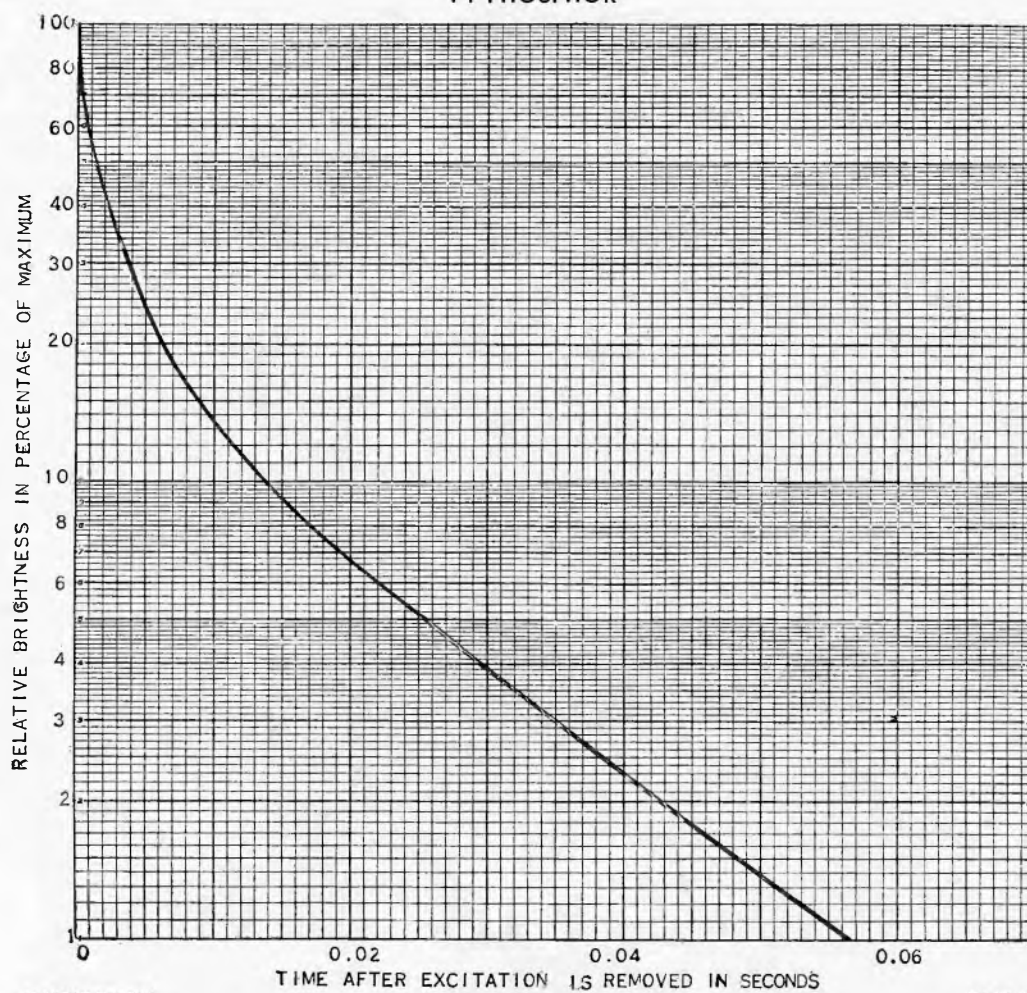
†It is recommended that the deflecting-electrode-circuit resistances be approximately equal.

GL-3KP1
CHARACTERISTICS
 $E_f = 6.3$ VOLTS
ANODE NO. 1 VOLTAGE ADJUSTED FOR FOCUS



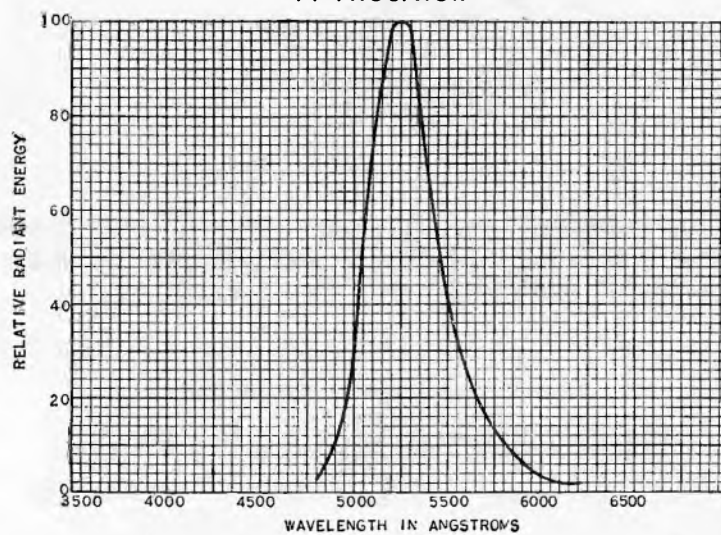
GL-3KP1
AVERAGE CHARACTERISTICS
 $E_f = 6.3$ VOLTS
ANODE-NO. 1 VOLTAGE ADJUSTED TO FOCUS



PERSISTENCE CHARACTERISTIC
P1 PHOSPHOR

K-69087-72A326

12-13-49

SPECTRAL-ENERGY EMISSION
CHARACTERISTIC
P1 PHOSPHOR

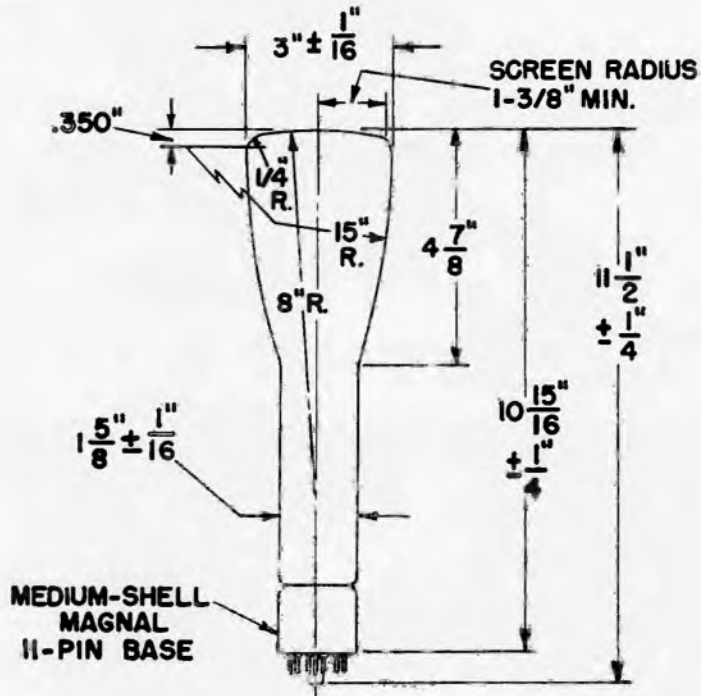
K-69087-72A327

12-13-49

GL-3KP1

ETI-311
PAGE 6
3-50

OUTLINE
CATHODE-RAY TUBE GL-3KP1



BASING DIAGRAM

CENTER LINE OF BULB WILL NOT DEVIATE MORE THAN 2 DEGREES IN ANY DIRECTION FROM PERPENDICULAR ERECTED AT CENTER OF BOTTOM OF BASE.

N-15145AZ

3-17-49

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.



CATHODE-RAY TUBE

DESCRIPTION

The GL-5UP1 is a cathode-ray tube with a small brilliant focused spot and high deflection sensitivity. The green-fluorescence medium-persistence screen has exceptionally good brightness contrast between the scanned line and the background, and high visual efficiency even at an anode No. 2 voltage as low as 1000 volts. The tube is designed particularly for general oscillographic applications where recurrent wave phenomena are to be observed visually.

Design features of this tube include a bulb face with a minimum curvature consistent with bulb strength, a large useful screen surface in relation to bulb diameter, and separate base-pin connections for each of the four deflecting electrodes. Balanced deflecting-electrode input capacitances minimize cross-talk and eliminate the necessity for neutralizing circuits.

The 5UP1 is intended primarily for use in balanced electrostatic-deflection circuits and gives best definition when so used. However, it is also well suited for use with unbalanced deflection because of design features which minimize the spot and pattern distortion characteristic of such operation.

The spot in the 5UP1 can be focused sharply on the screen and will remain sharp when the beam current is varied over a wide range. This feature results from the electron gun used in which the grid No. 2 operates at voltage high enough to keep the beam current from being affected by changes in the anode No. 1 voltage. Another feature, the very small current taken by anode No. 1, permits the use of a low-current voltage-divider system and hence the use of a small filter capacitor.

GENERAL  ELECTRIC


Electronic
TUBE

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Heater voltage (a-c or d-c)	6.3 ± 10%	volts
Heater current	0.6	ampere
Focusing method		electrostatic
Deflecting method		electrostatic
Phosphor—P1		
Fluorescence		green
Persistence		medium
Direct interelectrode capacitances, approximate		
Grid No. 1 to all other electrodes	8.0	uuf
D1 to D2	2.5	uuf
D3 to D4	2.5	uuf
D1 to all other electrodes	11.0	uuf
D2 to all other electrodes	8.0	uuf
D3 to all other electrodes	7.0	uuf
D4 to all other electrodes	8.0	uuf

Mechanical Data

Mounting position		any
Over-all length	14 $\frac{3}{4}$ ± $\frac{3}{8}$	inches
Greatest diameter of bulb	5 $\frac{1}{4}$ ± $\frac{3}{32}$	inches
Minimum useful screen diameter	4 $\frac{1}{2}$	inches
Base No. B12-43, small-shell duodecal 12-pin		
Anode No. 2 voltage*	2500 max	volts
Anode No. 1 voltage	1000 max	volts
Grid No. 1 voltage		
Negative-bias value	200 max	volts
Positive-bias value	0 max	volts
Positive-peak value	2 max	volts
Peak heater-cathode voltage		
Heater negative with respect to cathode	125 max	volts
Heater positive with respect to cathode	125 max	volts
Peak voltage between anode No. 2 and any deflection electrode	500 max	volts

EQUIPMENT DESIGN RANGES

For any anode No. 2 voltage (E_{b2}) between 1000 and 2500 volts

Anode No. 1 voltage	17% to 32%	of E_{b2}	volts
Grid No. 1 voltage for visual cutoff	4.5%	of E_{b2}	volts
Anode No. 1 current for any operating condition	-15 to +10		microamperes†
Deflection factors			
D1 and D2	28 to 38.5	volts d-c per inch	per kv of E_{b2}
D3 and D4	23 to 31	volts d-c per inch	per kv of E_{b2}

EXAMPLE OF USE OF DESIGN RANGES

For anode No. 2 voltage of	1000	2000	volts
Anode No. 1 voltage	170 to 320	340 to 640	volts
Grid No. 1 voltage for visual cutoff, maximum	-45	-90	volts
Deflection factors			
D1 and D2	28 to 38.5	56 to 77	volts d-c per inch
D3 and D4	23 to 31	46 to 62	volts d-c per inch

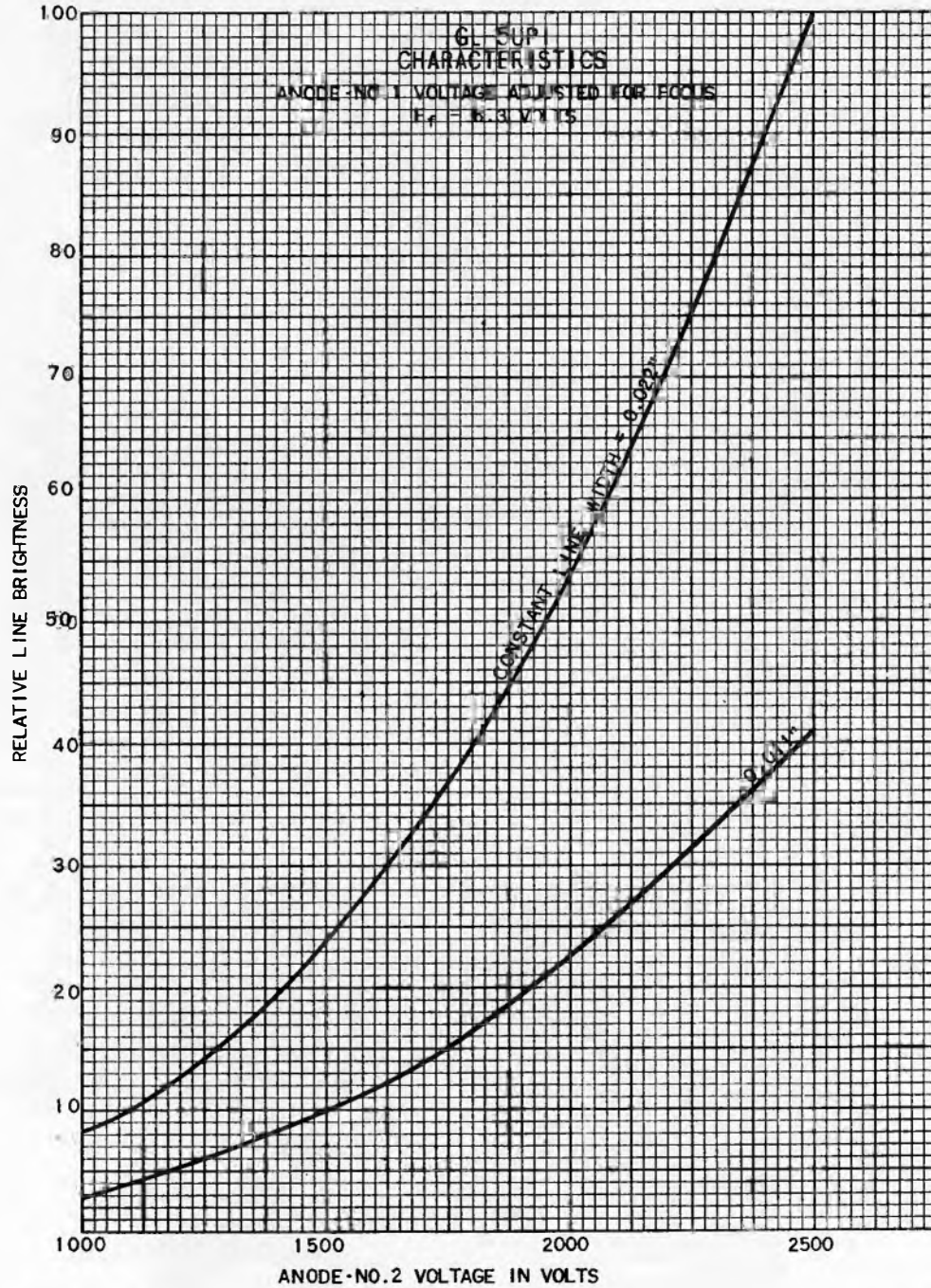
MAXIMUM CIRCUIT VALUES

Grid No. 1 circuit resistance	1.5 max	megohms
Resistance in any deflecting-electrode circuit†	5.0 max	megohms

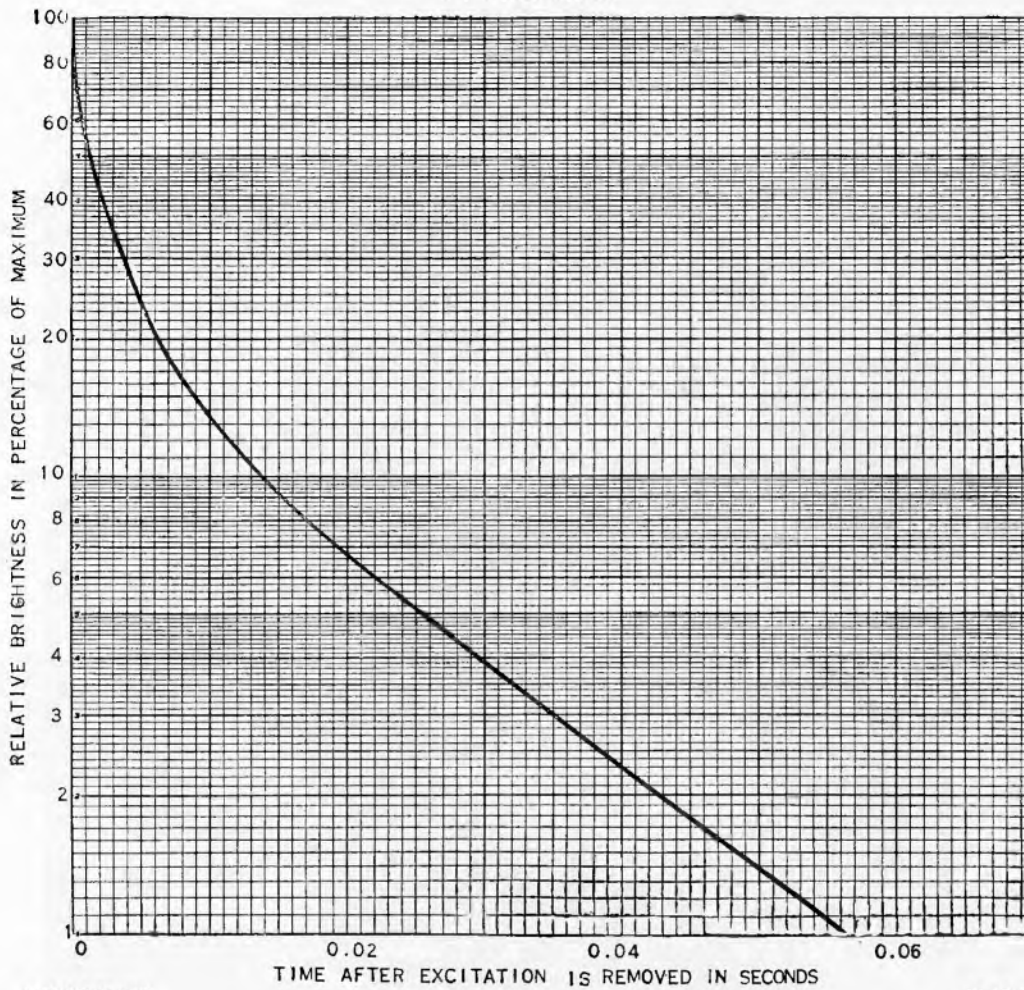
*Anode No. 2 and grid No. 2, which are connected together within the tube, are referred to herein as anode No. 2.

†It is recommended that the deflecting-electrode-circuit resistances be approximately equal.

GL-5UP1
 CHARACTERISTICS
 ANODE NO. 1 VOLTAGE ADJUSTED FOR FOCUS
 $E_f = 6.3$ VOLTS



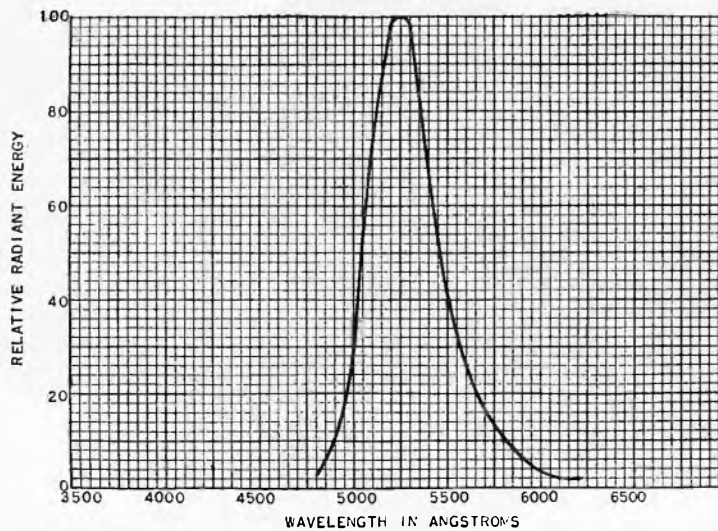
PERSISTENCE CHARACTERISTIC
P1 PHOSPHOR



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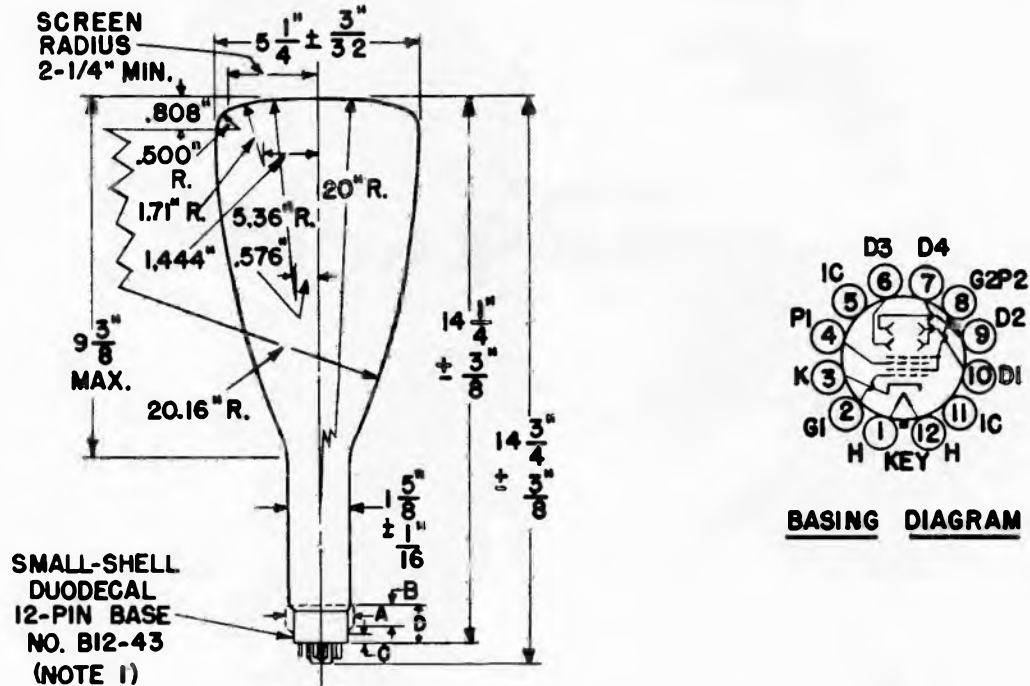
SPECTRAL-ENERGY EMISSION CHARACTERISTIC
P1 PHOSPHOR



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OUTLINE
CATHODE-RAY TUBE GL-5UP1



6 OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF BOTTOM OF THE BASE.

THE PLANE THROUGH THE TUBE AXIS AND PIN 4 MAY VARY FROM THE TRACE PRODUCED BY D1 AND D2 BY AN ANGULAR TOLERANCE (MEASURED ABOUT THE TUBE AXIS) OF 10°. ANGLE BETWEEN D1 - D2 TRACE AND D3 - D4 TRACE IS 90° ± 3°.

D1 AND D2 ARE NEARER THE SCREEN; D3 AND D4 ARE NEARER THE BASE. WITH D1 POSITIVE WITH RESPECT TO D2, THE SPOT WILL BE DEFLECTED TOWARD PIN NO. 4; LIKEWISE, WITH D3 POSITIVE WITH RESPECT TO D4, THE SPOT WILL BE DEFLECTED TOWARD PIN NO. 1.

NOTE 1: THIS BASE MAY BE SUPERSEDED BY AN ALTERNATE BASE WHICH WILL FIT THE SAME SOCKET BUT WHICH WILL HAVE A FLARED SHELL INDICATED BY THE DASHED LINES AND DIMENSIONED APPROXIMATELY AS FOLLOWS: A = 1.85" MAX., B = 0.500", C = 0.200" MIN., D = 0.925".

Tube Divisions, Electronics Department

GENERAL  ELECTRIC
Schenectady, N. Y.



CATHODE-RAY TUBE

DESCRIPTION

The GL-3MP1 is an electrostatic focus and deflection type of cathode-ray tube intended for oscillograph use. The short length of this three-inch diameter tube adapts it for use in small portable equipment.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL

Electrical Data

Heater voltage	6.3 volts
Heater current	0.6 \pm 10% amperes
Focusing method—Electrostatic	
Deflecting method—Electrostatic	
Phosphor—P1	
Fluorescence—Green	
Persistence—Medium	
Direct interelectrode capacitances, approximate	
Cathode to all other electrodes	2.2 uuf
Grid No. 1 to all other electrodes	10.3 uuf
D1 to D2	1.3 uuf
D3 to D4	1.2 uuf
D1 to all other electrodes except D2	4.4 uuf



Electronic
TUBE

GENERAL  ELECTRIC

TECHNICAL INFORMATION (CONT'D)

D2 to all other electrodes except D1	5.6 uuf
D3 to all other electrodes except D4	5.0 uuf
D4 to all other electrodes except D3	4.5 uuf

Mechanical Data

Over-all length	$8 \pm \frac{1}{4}$ inches
Greatest diameter of bulb	$3 \pm \frac{1}{16}$ inches
Minimum useful screen diameter	$2 \frac{3}{4}$ inches
Base, small-shell duodecal—12 pin	
Basing, 12F	
Base alignment	
D1-D2 trace aligns with pin No. 4 and tube axis	± 10 degrees
Positive voltage on D1 deflects beam approx toward pin No. 4	
Positive voltage on D3 deflects beam approx toward pin No. 1	

MAXIMUM RATINGS Design Center Values

Anode No. 1 voltage	1000 max volts d-c
Anode No. 2 voltage	2500 max volts d-c
Grid No. 1 voltage	
Negative-bias value	200 max volts d-c
Positive-bias value	2 max volts d-c
Peak heater cathode voltage*	
Heater negative with respect to cathode	
During equipment warm-up period not exceeding 15 seconds	410 max volts d-c
After equipment warm-up period not exceeding 15 seconds	140 max volts d-c
Heater positive with respect to cathode	140 max volts d-c
Peak voltage between anode No. 2 and any deflection electrode	500 max volts

EQUIPMENT DESIGN RANGES

Anode No. 1 voltage	20% to 35% of E_{b2} volts
Grid No. 1 voltage for visual cut-off of spot	0% to 6.3% of E_{b2} volts
Anode No. 1 current for any operating condition	-15 to +10 microamperes
Deflection factors	
D1 and D2	115 to 145 volts d-c per inch per kv of E_{b2}
D3 and D4	110 to 140 volts d-c per inch per kv of E_{b2}

EXAMPLES OF USE OF DESIGN RANGES

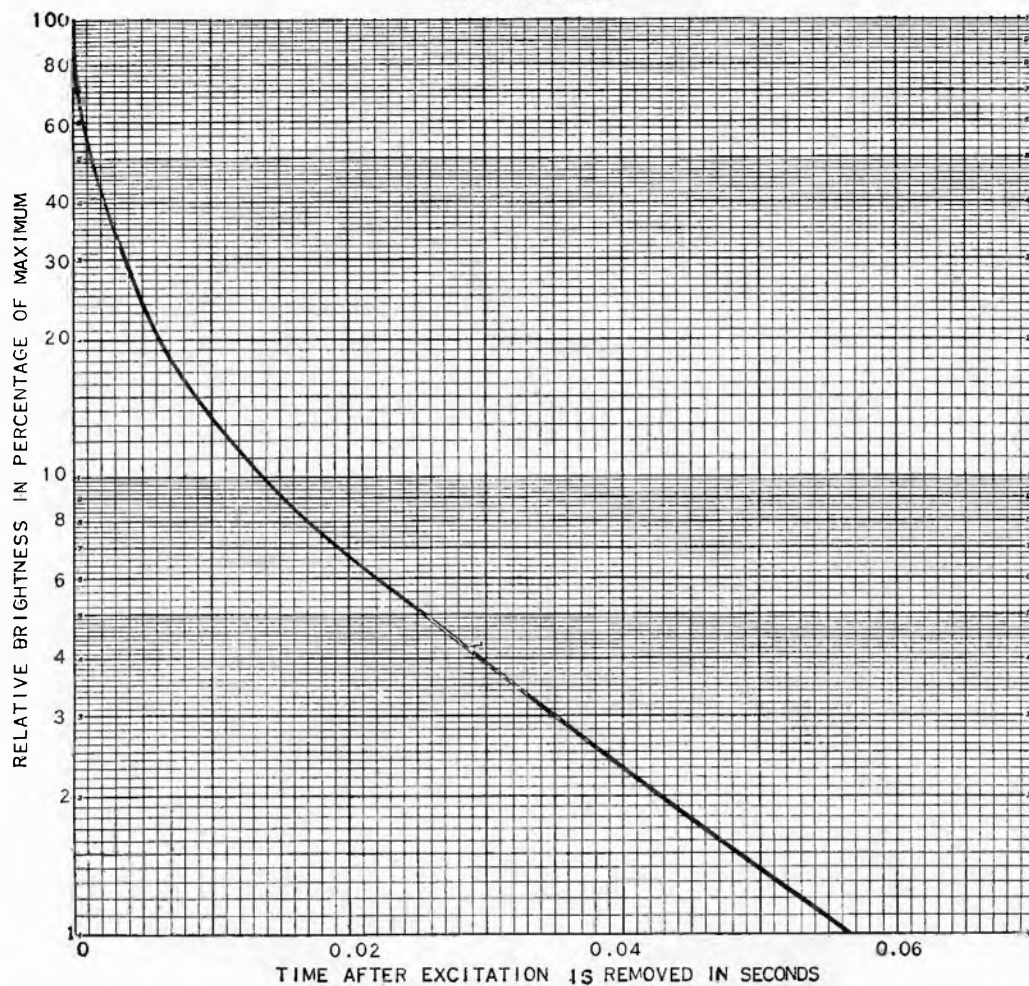
For anode No. 2 voltage of	1000	2000	volts
Anode No. 1 voltage	200 to 350	400 to 700	volts
Grid No. 1 voltage for visual cut-off	0 to 63	0 to 126	volts
Deflection factors			
D1 and D2	115 to 145	230 to 290	volts d-c per inch
D3 and D4	110 to 140	220 to 280	volts d-c per inch

MAXIMUM CIRCUIT VALUES

Grid No. 1 circuit resistance	†1.5 max megohms
Resistance in any deflecting—electrode circuit	5.0 max megohms

*Cathode should be returned to one side or to the mid-tap of the heater transformer winding.
†It is recommended that the deflecting-electrode-circuit resistance be approximately equal.

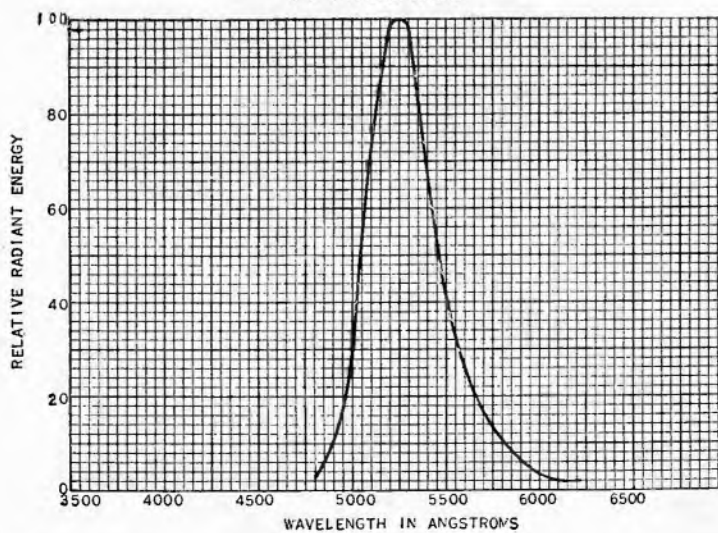
PERSISTENCE CHARACTERISTIC
P1 PHOSPHOR



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SPECTRAL-ENERGY EMISSION CHARACTERISTIC
P1 PHOSPHOR



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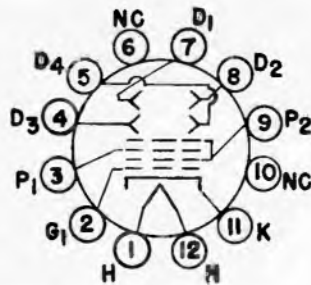
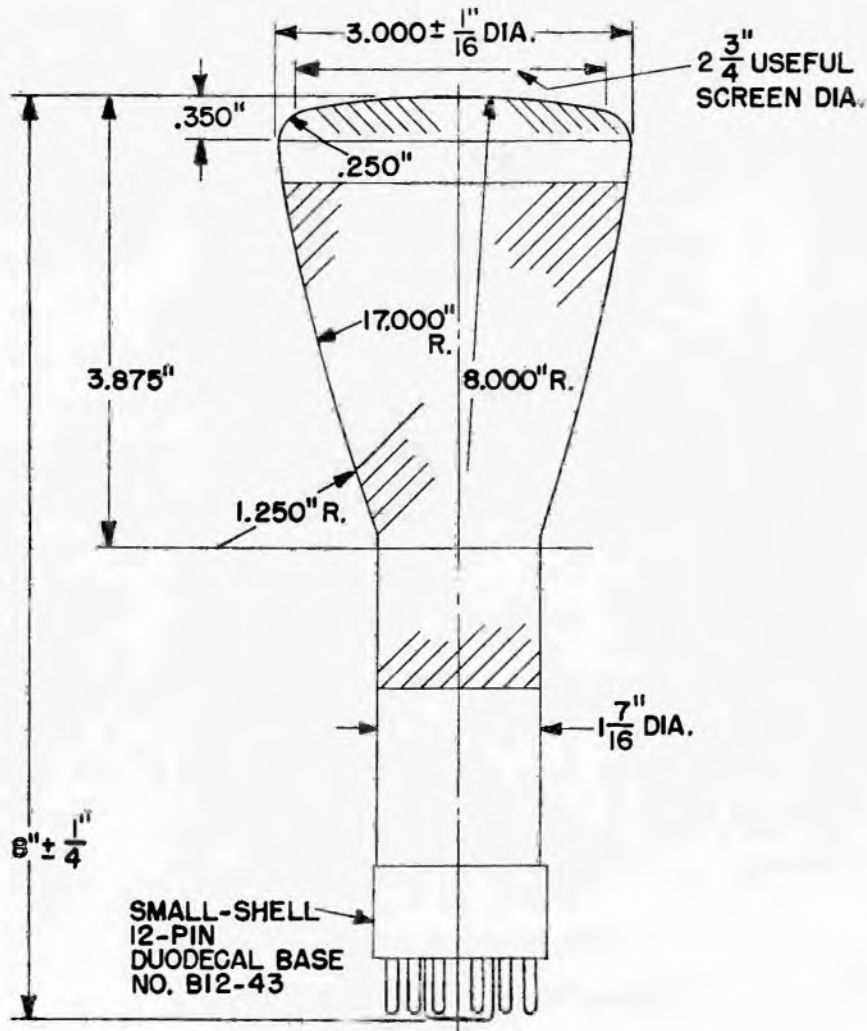
GL-3MP1

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OUTLINE
CATHODE-RAY TUBE GL-3MP1



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Tube Divisions, Electronics Department

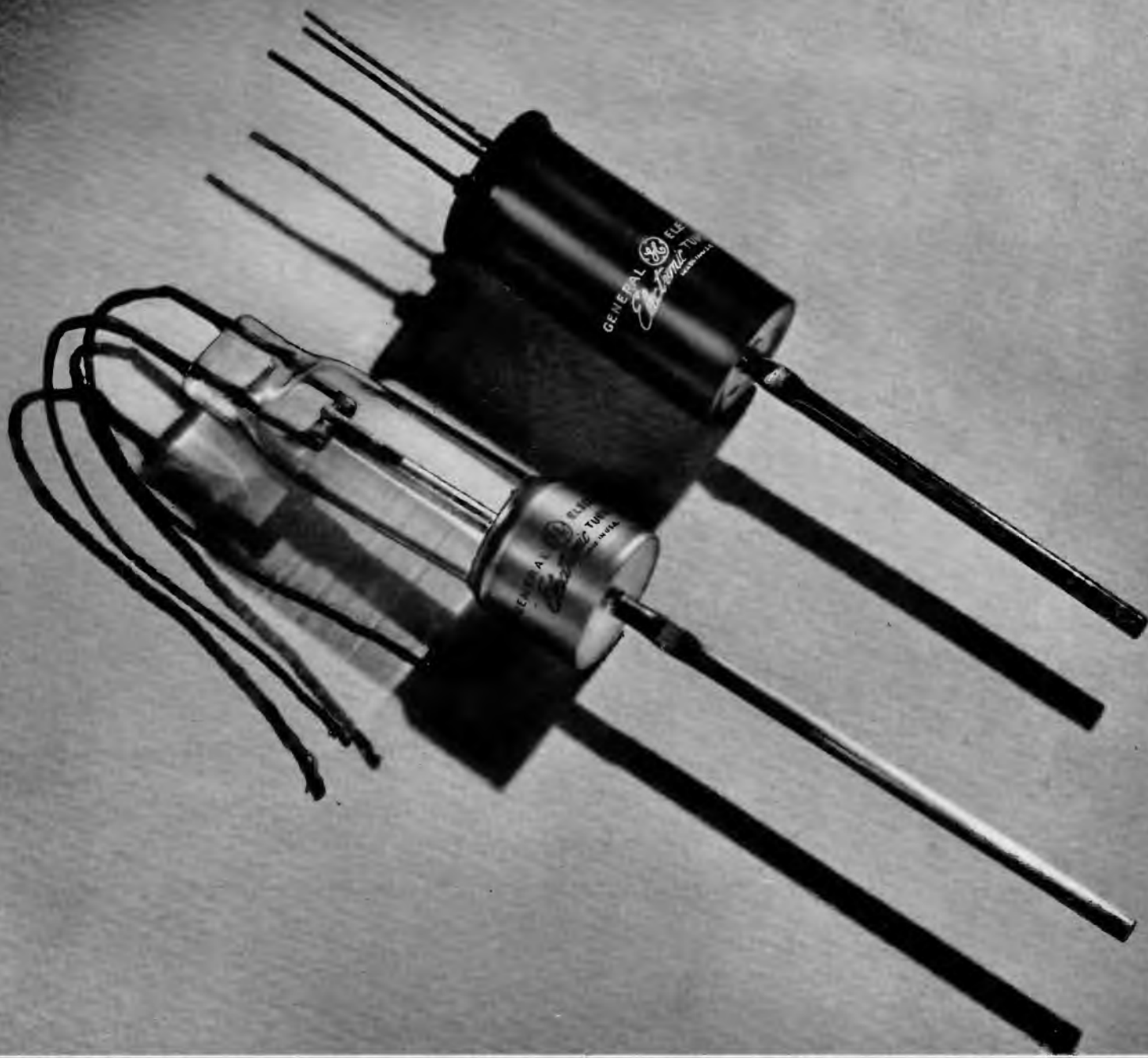
GENERAL  ELECTRIC

Schenectady, N. Y.



GENERAL  ELECTRIC

VACUUM SWITCHES



DESCRIPTION

The vacuum switch is a vacuum device incorporating movable and fixed contacts, arranged so that a mechanical motion of the movable contact makes or breaks the switch circuit. The motion of the movable contact is obtained by means of a flexible diaphragm mounted on a metal cup to which the glass or metal body of the switch is attached. The fixed contact leads are mounted on the body

of the switch.

Vacuum switches are useful in any application requiring the control of high voltages or high currents where space requirements are stringent. Since the contacts are mounted in a vacuum, they are relatively free from the effects of corrosion and arcing, are unaffected by dust or oxidation, and will give longer wear than exposed contacts.

MECHANICAL ADVANTAGES

Because General Electric vacuum switches operate mechanically, a variety of actuating means may be used. The flexible diaphragm used eliminates the necessity for an external fulcrum. This transmits movement to the contacts and acts as a natural fulcrum for the operating arm. Movement is obtained from the mechanism to be controlled, or from other apparatus to suit the application.

This movement is often provided by a slow-moving cam or by the movement of a thermostat. Air or liquid bellows, a rod-linkage system, an electrically operated relay, or almost any other means

can be used to operate the vacuum switch. This is possible because a very small force is required to achieve the switching motion. There are several advantages which result from this feature.

The vacuum switch is capable of being operated over a wide range of speed. Operation from several cycles an hour to several thousand cycles per minute are permissible.

The contacts of the switches close without vibration, enabling them to be mounted on or near delicate instruments.

ELECTRICAL ADVANTAGES

The vacuum construction of the switch allows the use of close spacings between fixed and movable contacts, with the result that it is possible to interrupt high voltages although the movable contact travels only a few thousandths of an inch. This small movement brings about an economy of space that is possible only with vacuum switches.

In air-break switches, the breaking of the switch contact is accompanied by an ionization of the air present around the contacts. This ionization causes an arc to occur, with subsequent heat loss, and the switch is unable to break the circuit rapidly.

In vacuum switches, there being no gas present as a source of ions, a very rapid break is made. (See under "Installation and Operation.")

Under some conditions an arc or spark will occur, but this condition will exist only when the switch is handling high currents. If such currents were

broken by an equivalent air switch, welded contacts might easily result.

The fact that arcs rarely occur, or, if they occur, are not in air, brings up two important advantages of vacuum switches over air switches. Because of the enclosed construction, G-E switches are especially valuable for use in flour mills, magnesium finishing rooms, and similar dust-laden atmospheres.

In addition to operating under the adverse conditions described above, G-E vacuum switches are capable of operating under any liquid which provides sufficient insulation for the leads so that an external short is obviated. Some liquids, such as transformer oil, will actually increase the external voltage breakdown allowable, and thus reduce maintenance to a minimum.

RATINGS

Vacuum switches are rated in terms of the following characteristics:

Internal Hold-Off Voltage

This is the maximum voltage that the vacuum switch can hold off internally; that is, when the movable contact is held against one stationary contact and the voltage is applied across the two stationary contacts. This voltage is usually expressed as an rms value.

The criterion of proper operation is absence of gas discharge. With the test voltage applied, there should be no evidence of a gas discharge. Fluores-

cence is a phenomenon which will not affect the operation of the switch.

External Hold-Off Voltage

This is the maximum voltage that the vacuum switch should be called upon to hold off externally; that is, from stationary contact to stationary contact, or from stationary contact to movable contact. This rating must specify an ambient humidity and assumes that the external surface of the switch is moderately clean. It is also necessary to provide corona shields of some sort in order to achieve the hold-off voltage stated for this rating.

This test is normally made at some external pressure lower than that encountered at sea level. This pressure is stated in terms of altitude in feet above sea level.

Interrupting Rating

This is a measure of the life expectancy of the vacuum switch. The life of the switch will depend upon the application in which it is used. Low-current, high-voltage applications cause no perceptible contact wear, and the life depends upon the mechanical strength of the switch diaphragm. High-current, low-voltage applications cause vaporization of the contact material, with subsequent shortening of life. Interrupting ratings are usually given on the basis of a certain number of allowable operations for several conditions of voltage and current.

Initial Tension

Initial tension is the force required on the movable contact to open the circuit, if the movable contact is touching one of the stationary contacts. This force is usually measured on the operating arm $\frac{5}{8}$ " from the switch diaphragm.

Operating Force

Operating force is the energy required to move the movable contact from one stationary contact to the other, including initial tension. The measurement is usually made on the operating arm at a point $\frac{5}{8}$ " from the diaphragm.

Arm Travel

The travel of the operating arm is the motion required to move the movable contact from one stationary contact to the other. The measurement is usually made on the operating arm $\frac{5}{8}$ " from the diaphragm.

Maximum Continuous Current

This is the maximum current that may be carried safely by the switch for an indefinite period of time.

Maximum Allowable Force on Operating Arm

This is maximum force which may be applied to any point on the operating arm. This rating is important in that it dictates the design of the actuating mechanism. This rating must be observed carefully, as a value higher than that recommended will result in decreased life.

TYPES OF SWITCHES

Vacuum switches are made in two general types. The first type, exemplified by the FA-6 and FA-15, is an all-purpose switch for general switching applications. The second type, of which the GL-1S21* is an example, was designed with particular em-

phasis on external voltage breakdown. This results in a switch which is extremely useful at greatly reduced air pressures, such as are encountered in aircraft applications.

APPLICATIONS#

There are six properties peculiar to the vacuum switch which enable it to be used with extreme advantage in many applications.

1. Vacuum Construction

The fact that the switch contacts are enclosed in a vacuum contributes in general to all the various advantages found in the use of these switches.

Operation of other switches at extremely high altitudes is complicated by the fact that the distance between contacts having a given voltage impressed across them must be greatly increased due to the lowered air pressure. For example, if a given distance is able to hold off 30 kilovolts at sea level, it will arc over at approximately 7 kilovolts at an altitude of 50,000 feet.

Vacuum switches are unaffected internally by high-altitude operation. Externally, it is comparatively easy to provide a sufficiently long path so that the external voltage breakdown is adequate.

Applications made possible by the vacuum construction also take advantage of the fact that an arc cannot be sustained easily in a vacuum. When a circuit is broken by a vacuum switch, the arc produced by ionization of gas is minimized, inas-

much as there is practically no gas present. This means that by proper actuator design a very rapid break may be achieved, and a very high induced voltage may be obtained as a consequence of this rapid break.

2. Enclosed Construction

It is very often necessary to operate switches in the presence of gases, oil spray, heavy dust concentrations, or under conditions that adversely affect the operation of electrical equipment. The sealed construction of vacuum switches causes them to work most efficiently under such conditions.

The enclosed construction also minimizes the hazard of switching in an explosive atmosphere, as for example, in a flour mill.

3. Small Size and Weight

Inch-for-inch and ounce-for-ounce the vacuum switch will handle higher voltages at higher currents than any other type of switch. For example, a 20-ampere circuit-breaker for 600 volts alternating current may be approximately 2 cubic feet in volume.

The FA-15 vacuum switch will break 10 amperes at 600 volts alternating current and is only one

Circuits shown in ETI-196 are examples of possible tube applications and the description and illustration of them does not convey to the purchaser of tubes any license under patent rights of General Electric Company.

* Write to General Electric Company, Electronics Department, Tube Sales Section for bulletin.

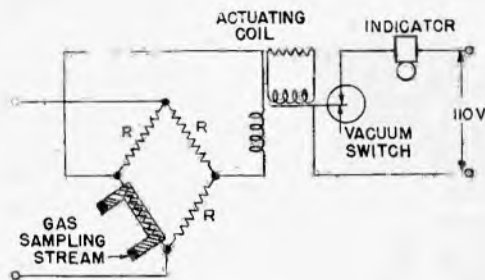
five-hundredth the volume.

The vacuum switch will not operate at the above current for too many operations, but in any application where size or weight is the prime consideration, the vacuum switch can be used to advantage.

4. Low Operating Force

There are many applications where the force available for actuating a switch is very small. Among these are thermostats used in air-conditioning control. With the use of a vacuum switch, it is possible to handle the full load current without the use of auxiliary devices between the actuating force and the circuit to be controlled.

The circuit shown in Fig. 1 illustrates the vacuum



K-9033508

10-14-44

Fig. 1—Wheatstone Bridge Circuit for Sampling Gases Dissolved in Liquid

Electronics Engineering Manual, Vol. III, P-73, McGraw-Hill Book Co., Inc.

switch used in a Wheatstone Bridge method of sampling gases dissolved in liquid. The vacuum switch is used as one arm of the bridge. In such an application the amount of power that can be used is very small. This circuit acts as a sensitive switching relay. It is useful in applications where there is a minimum of power available and where the indicating force is small in magnitude.

5. High-Speed Operation

Vacuum switches are constructed with the moving parts so light in weight that the speed at which they are capable of operating is limited more by the actuating equipment used than by the switch itself.

Vacuum switches are capable of being operated at several thousand cycles per minute and will accommodate a motion produced by an actuator when the rate of operation is changed rapidly over a period of a second or two.

6. Low-Speed Operation

The vacuum switch is so designed that there is no definite resting point or on-off position. For this reason the switch may be used in any application where the motion available for switching is extremely slow.

An application such as this is the operation of the switch by means of a cam, where the cam might be operated by some searching or hunting mechanism.

INSTALLATION AND OPERATION

Mechanical

Installation of G-E vacuum switches is simplified by their compact construction and by the fact that they can be mounted in any position.

Mounting may be accomplished by clamping to any portion of the body of the metal switch, FA-6, but glass-body switches must be mounted by clamping to the cylindrical metal cup. Suggested mounting arrangements will be found at the end of this article.

The clamping should be uniform, not unduly tight, and care should be used not to damage glass parts and seals. It is important that the clamp does not come closer than $\frac{1}{16}$ " to the glass seal on the cup.

The actuator design must allow for overtravel of the operating mechanism so that sufficient contact pressure is applied to the switch. If this provision is not made, the maximum force allowable on the operating arm will be exceeded and serious damage to the diaphragm may result.

The pressure required to make good contact is much less than the rated safe pressure. Pressure in excess of the rated safe pressure imposes undue strains on the insulating glass as well as on the diaphragm.

Any connections made to the fixed contact leads should be flexible enough so that no part of the mounting strain is carried on the leads themselves.

When a vacuum switch is mounted in a holder

it will be noticed that there is a great deal of freedom of movement of the operating arm. It is therefore necessary to design the actuator so that it holds the operating arm in position between the two stationary contacts.

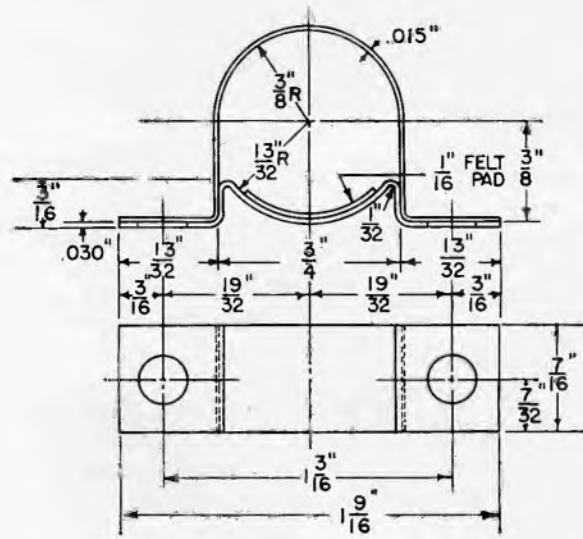
Electrical

Electrical connection must be made either to the lead wire which is welded to the body in the case of the metal switch, or to the cap in the case of the glass switches.

As explained previously, the quick break given by a vacuum switch causes high induced voltages.

It is desirable to use a small capacitor (about 0.01 to 0.05 microfarad) across the contacts or across the load on non-inductive circuits when the current is more than 5 amperes. With inductive circuits the sum of the normal and transient voltages must be limited by a capacitor to a value not greater than the maximum voltage rating of the switch.

It is also advisable, in highly inductive circuits, to limit the value of capacitance required by use of a shunt resistance across the load. This resistance, while increasing the total current in the circuit will reduce greatly the amount of capacitance required. Too large a capacitance will cause unnecessary wear and welding at the contacts. When it is necessary to use a capacitance greater than 0.5 microfarad



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†2-12-44

Fig. 6

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.



VACUUM SWITCH

DESCRIPTION

The GL-5627/FA-6 single-pole double-throw metal-clad vacuum switch is designed to perform switching operations at high speed with low operating pressure and long contact life.

The totally enclosed, vacuum-sealed construction offers many advantages; protection from dust, weather, and other corrosive influences which may affect adversely the life of switch elements; the

contacts retain a low contact resistance suitable for low-voltage use with very little heating, and require very little power to operate.

Although the spacing between contacts is only 0.070 inch (approx) there is no arc-over inside the switch. Changes in air pressure and humidity have no effect on the breakdown because the contacts are in vacuum.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Hold-off voltage

Internal.....	550 volts rms
External*, at sea level.....	550 volts rms

Interrupting rating, resistive load

For total life of 1000 operations at 550 volts a-c rms.....	10 amperes a-c rms
For total life of 1,000,000 operations at 550 volts a-c rms.....	2 amperes a-c rms
For total life of 500,000,000 operations at 550 volts a-c rms.....	0.1 ampere a-c



GENERAL  ELECTRIC

Supersedes ETI-197 dated 4-45

TECHNICAL INFORMATION (CONT'D)

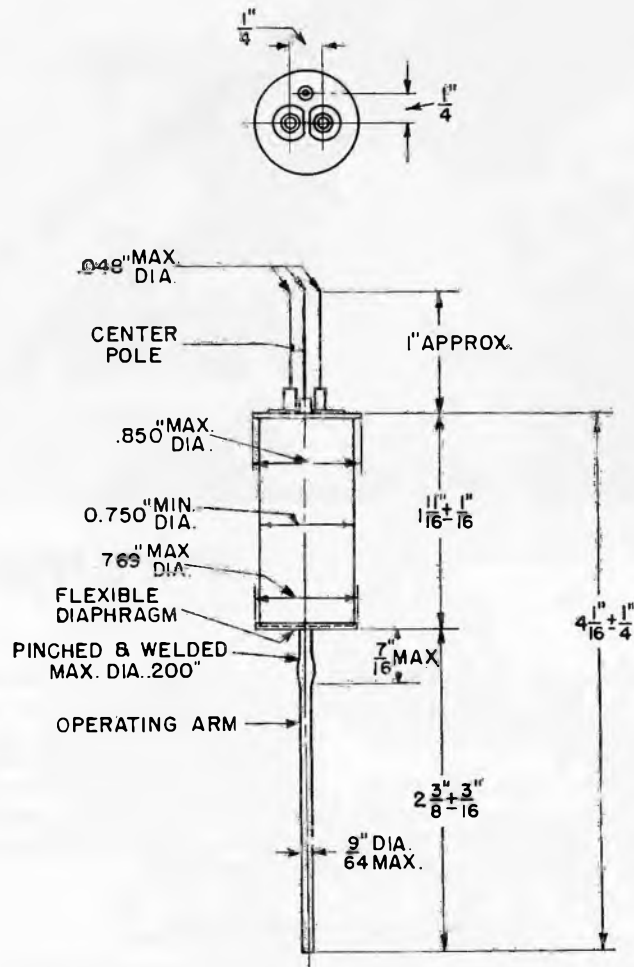
Mechanical

Net weight, approximate..... 1½ ounces
 Shipping weight, approximate..... 3 pounds

MAXIMUM RATINGS

Internal hold-off voltage..... 550 volts rms
 Maximum continuous current..... 10 amperes rms
 Ambient temperature range..... -40 to +100 C
 Maximum allowable force on operating arm..... 500 grams

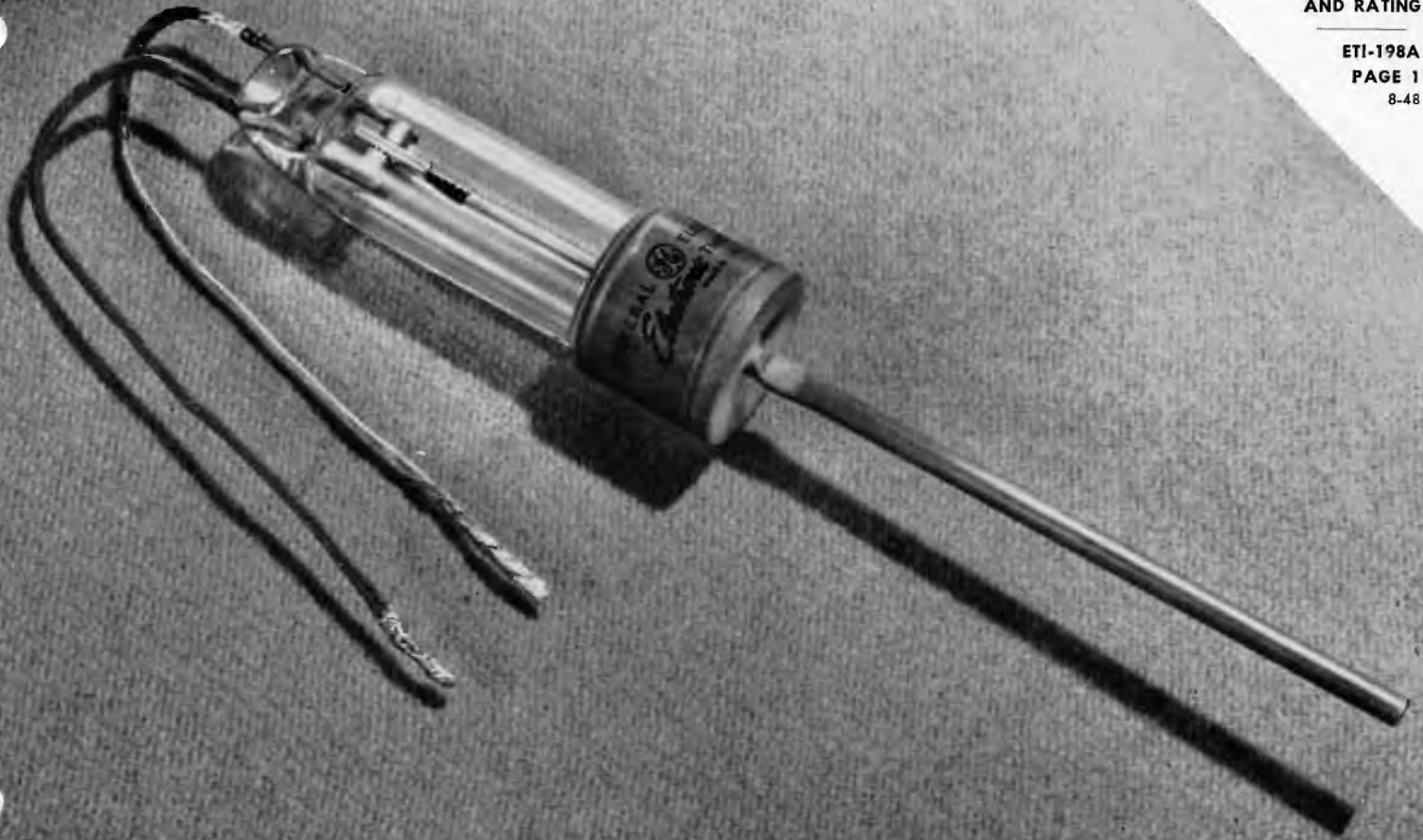
* At 50 per cent humidity.



OUTLINE
 GL-5627 /FA-6 VACUUM SWITCH

K-5188108

6-4-48



VACUUM SWITCH

DESCRIPTION

The GL-5626/FA-15 single-pole double-throw vacuum switch is designed for operation in high-speed relay construction, in d-c circuits involving high inductance, and in installations that require the circuit to be opened by a slow movement.

Since the switch is enclosed in a vacuum, its operation is unaffected by atmospheric conditions, con-

tacts are free from contamination, and resistance remains low. The construction minimizes arcing at the contacts. Only a few thousandths of an inch movement is required to interrupt rated current. This feature coupled with low operating pressure and light weight of the moving parts enables the GL-5626/FA-15 to be operated by a small amount of power.

TECHNICAL INFORMATION

These data are for reference only. For design information refer to specifications.

GENERAL CHARACTERISTICS

Electrical

Hold-off voltage

Internal	3000 volts rms
External*, at sea-level	3000 volts rms

Interrupting rating, resistive load

For total life of 1000 operations at 3000 volts a-c rms	10 amperes a-c rms
For total life of 100,000 operations at 3000 volts a-c rms	3 amperes a-c rms
For total life of 1,000,000 operations at 3000 volts a-c rms	1 ampere a-c rms
For total life of 500,000,000 operations at 3000 volts a-c rms	0.1 ampere a-c rms



GENERAL  ELECTRIC

Supersedes ETI-198 dated 4-45

TECHNICAL INFORMATION (CONT'D)

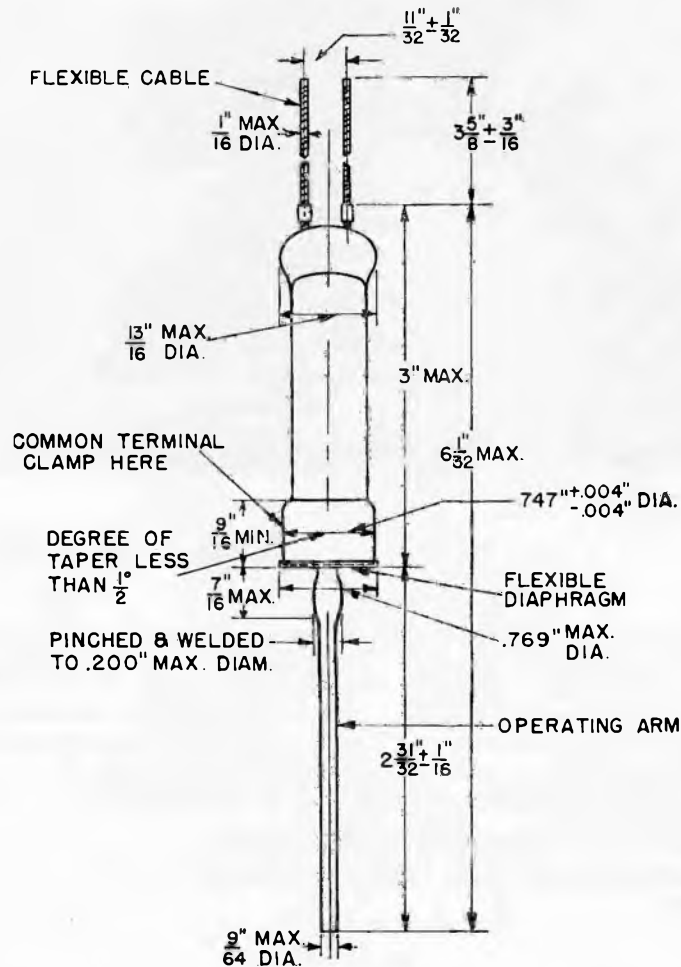
Mechanical

Net weight, approximate.....1 ounce
Shipping weight, approximate.....4 ounces

MAXIMUM RATINGS

Internal hold-off voltage.....3000 volts rms
Maximum continuous current.....15 amperes rms
Ambient temperature range.....-40 C to +100 C
Maximum allowable force on operating arm.....500 grams

* At 50 per cent humidity.



K-5340821

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OUTLINE
GL-5626/FA-15 VACUUM SWITCH

Electronics Department
GENERAL ELECTRIC
Schenectady, N. Y.



Electronic
TUBES

INTERCHANGEABILITY CHART

INDUSTRIAL TYPES

The tubes listed below under "other types" are arranged in numerical order and the G-E equivalent types, which are completely interchangeable, are shown in the adjacent column. Where types of other manufacturers are omitted, there are, to our knowl-

edge, no G-E types completely interchangeable.

For information on types not included in this listing, consult your nearest G-E dealer, distributor, or write to the Electronics Department, General Electric Company, Schenectady 5, N. Y.

Other Types	G-E Equivalent Type No.	Other Types	G-E Equivalent Type No.	Other Types	G-E Equivalent Type No.
CE-1**	PJ-22	250-TL	GL-806	800	GL-800
CE-1†	GL-868/PJ-23	261-A	GL-835	801	GL-801-A
CE-11V	GL-917	266-B	GL-266-B	802	GL-802
CE-20	GL-827	276-A	GL-276-A	803	GL-803
CE-21	GL-920	295-A	GL-203-A	805	GL-805
CE-31V	GL-919	303-A	GL-203-A	806	GL-806
CE-306	GL-5545	304-A	GL-204-A	807	GL-807
EL-C3J	GL-5632	F-307-A	GL-207	809	GL-809
EL-C6J	GL-5545	KU-627	GL-627	810	GL-810
EL-5685	GL-5545	311	GL-211	811-A	GL-811-A
NL-710	GL-5632	311CT	GL-835	812-A	GL-812-A
NL-715/5557	GL-5557/FG-17	311CT	FP-285	813	GL-813
RK-25	GL-802	311T	GL-211	814	GL-814
RK-25B	GL-802			815	GL-815
RK-28A	GL-803	VR-105	GL-0C3	816	GL-816
RK-30	GL-800	VR-150	GL-0D3	826	GL-826
RK-31	GL-830-B	WE-319-A	GL-872-A	828	GL-828
RK-36	GL-806	WE-322-A	GL-803	829-B	GL-829-B
RK-39	GL-807	331-A	GL-805	833-A	GL-833-A
RK-44	GL-837	342-B	GL-242-C	835	GL-835
		342-C	GL-242-C		
RK-47	GL-814			836	GL-836
RK-57	GL-805	F-353-A	GL-872-A	837	GL-837
RK-58	GL-838	F-357-A	GL-857-B	838	GL-838
RK-60	GL-1641	358-A	GL-858	842	GL-842
HF-60	GL-8005	361-A	GL-835	843	GL-843
T-155	GL-806	376-A	GL-276-A	845	GL-845
HF-130	GL-835	WL-33	GL-5720/FG-33		
HF-130	FP-285	WL-41	GL-5830/FG-41	849	GL-849
203-A	GL-203-A	WL-414	GL-414	851	GL-851
204-A	GL-204-A	WL-469	FP-285	857-B	GL-857-B
		WL-473	GL-473	858	GL-858
207	GL-207				
211	GL-211	WL-469	FP-285	862	GL-862-A
211C	GL-835	WL-473	GL-473	866	GL-866-A
211C	FP-285	WL-502-A	GL-502-A	866-A	GL-866-A
211D	FP-285	WL-616	GL-5625/KC-4	866-A/866	GL-866-A
217C	GL-217-C	WL-672-A	GL-672-A	868	GL-868/PJ-23
242A	GL-242-C	WL-678	GL-678	869-B	GL-869-B
242B	GL-242-C	575-A	GL-575-A	870-A	GL-870-A
242C	GL-242-C	WT-606	GL-2D21	872	GL-872-A
242C	GL-242-C	WL-734	PJ-22	872-A	GL-872-A
250T	GL-806	WL-735	GL-868/PJ-23	872-A/872	GL-872-A

**Vacuum-type phototube

†Gas-type phototube

Other Types	G-E Equivalent Type No.	Other Types	G-E Equivalent Type No.	Other Types	G-E Equivalent Type No.
880	GL-880	945	GL-845	WL-5553/655	GL-5553/FG-258-A
889	GL-889-A	949	GL-849	WL-5554/679	GL-5554/FG-259-B
889-A	GL-889-A	951	GL-851	WL-5555/653-B	GL-5555/FG-238-B
889-R	GL-889-R-A	966	GL-866-A	5556	GL-5556/PJ-8
889-R-A	GL-889-R-A	966-A	GL-866-A	WL-5557/17	GL-5557/FG-17
891	GL-891	967	GL-5557/FG-17	WL-5558/32	GL-5558/FG-32
891-R	GL-891-R	972	GL-872-A	WL-5559/57	GL-5559/FG-57
892	GL-892	972-A	GL-872-A	WL-5561/104	GL-5561/FG-104
892-R	GL-892-R	975-A	GL-575-A		
893	GL-893-A			WL-5685	GL-5545
		1613	GL-1613	5691	GL-5691
893-A	GL-893-A	1614	GL-1614	5692	GL-5692
893-A-R	GL-893-A-R	1616	GL-1616	5693	GL-5693
895	GL-895	1619	GL-1619	8002	GL-8002
895-R	GL-895-R	1623	GL-1623	8002-R	GL-8002-R
WL-896	GL-5620/FB-50	1624	GL-1624	8005	GL-8005
898	GL-898-A	1625	GL-1625	8008	GL-8008
898-A	GL-898-A	1701	GL-5557/FG-17	8009	GL-8009
905	GL-805	2050	GL-502-A*	8012-A	GL-8012-A
930-B	GL-830-B	WL-5550/681	GL-5550/GL-415		
938	GL-838	WL-5551/652	GL-5551/FG-271	8013-A	GL-8013-A
942	GL-842	WL-5552/651	GL-5552/FG-235-A	8020	GL-8020

* Metal tube—shell connected to cathode.

NOTE: In general, tubes of the same class (i.e., gas-filled control tubes, high-vacuum rectifiers, phototubes, etc.) that have the same type numbers but different letter prefixes are completely interchangeable; e.g., RX-884, GL-884, etc.

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.

BASING AND SOCKET CHART

The outline drawings and dimensions of electronic tube bases included in this section of the manual are for your convenience in determining the size or style of tube sockets or connectors required for your particular application. The proper choice of socket or connector usually depends upon the

requirements of the particular equipment design.

The sockets and connectors listed here are some of those commonly used for industrial tubes. In addition to those included in this chart, there are other variations of tube sockets and connectors available for special requirements.

Notes for Sockets

- Note 1. Angle-type sockets listed below for medium and super jumbo 4-pin bases can be furnished with or without bayonet-locking device.
- Note 2. Angle-type sockets for super-jumbo, 4-pin bases, can be supplied to accommodate either front or back panel wiring.
- Note 3. Angle-type sockets for jumbo 4-pin bases are not included in the tables below but can be supplied upon request.

Note 4. The wafer or ceramic type of socket listed has the metal mounting plate soldered to the ceramic part of the socket to avoid cracking of the ceramic base in mounting.

Note 5. Sockets listed as "Industrial types" are furnished with screw-driver connections for ease of installation and maintenance.

Consult your local G-E office, distributor or dealer for your socket requirements, or write to:

**COMPONENT & UNIVERSAL PARTS SECTION
SPECIALTY DIVISION
ELECTRONICS DEPARTMENT
GENERAL ELECTRIC COMPANY
SYRACUSE, NEW YORK**

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
IGNITRONS				
FG-235-A	Anode, Cathode & Ignitor Terminal Leads	ETI-109 Tube Outline		
FG-238-B	Anode, Cathode & Ignitor Terminal Leads	ETI-110 Tube Outline		
FG-258-A	Anode, Cathode & Ignitor Terminal Leads	ETI-111 Tube Outline		
FG-259-B	Anode, Cathode & Ignitor Terminal Leads	ETI-112 Tube Outline		
FG-271	Anode, Cathode & Ignitor Terminal Leads	ETI-113 Tube Outline		
GL-415	Anode & Ignitor Terminal Leads	ETI-114 Tube Outline	Cooling Clamp (Hex Hd. Rt.) or Cooling Clamp (Hex Hd. Left)	See sheet CR7503 P-543 dated 8/7/44
GL-427	Anode, Cathode & Ignitor Terminal Leads	ETI-115 Tube Outline		

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
THYRATRONS (cont.)				
GL-3C23	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
GL-3C23	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-17	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-17	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-27-A	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-27-A	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-33	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-33	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-41	Special 4-Pin	{ ETI-201, Fig. 33 }	Special 4-Pin Socket	103J522
FG-41	Anode Cap, Skirted Large	{ ETI-201, Fig. 11 }	Large Cap Connector	102J299
FG-57	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-57	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-67	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-67	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-81-A	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-81-A	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
THYRATRONS (cont.)				
FG-95	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-95	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-95	Grid Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-97	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-97	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-97	Grid Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-98-A	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-98-A	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-98-A	Grid Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-105	Super-Jumbo, 4-Pin	{ ETI-201, Fig. 20 }	Shell Type <i>or</i> Angle Type <i>or</i> Angle Type (Back Wired)	104J52 103J173 <i>or</i> 103J174
FG-105	Anode Cap, Large	{ ETI-201, Fig. 7 }	Large Cap Connector	102J299
FG-105	Control Grid Cap, Large	{ ETI-201, Fig. 7 }	Large Cap Connector	102J299
FG-154	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-154	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-154	Grid Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-172	{ Anode, Filament, Shield Grid, Terminal Leads }	{ ETI-130 Tube Outline }	} Special Mount, 2 Required	102J304
FG-172	{ Control Grid & Cathode Terminal Leads }	{ ETI-130 Tube Outline }		

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
THYRATRONS				
FG-178-A	Small 4-Pin	{ ETI-201, Fig. 15 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
FG-178-A	Anode Cap, Small	{ ETI-201, Fig. 1 }	Small Cap Connector	102J302
GL-393-A	Medium-Shell Octal 5-Pin	{ ETI-201, Fig. 26 }	Wafer Type, Octal <i>or</i> Industrial Octal	103J164 <i>or</i> 103J58
GL-393-A	Anode Cap, Small	{ ETI-201, Fig. 2 }	Small Cap Connector	102J302
GL-414	Anode, Filament, Control-Grid, and Cathode Terminal Leads	{ ETI-133 Tube Outline }	Special Mount, 2 Required	102J304
GL-502-A	Small-Wafer Octal 8-Pin	{ ETI-201, Fig. 27 }	Wafer Type, Octal <i>or</i> Industrial Octal	103J164 <i>or</i> 103J58
GL-546	Miniature Button, 7-Pin	{ ETI-201, Fig. 28 }	Industrial 7-Pin Miniature	103J172
GL-627	Small Shell Super-Jumbo 4-Pin	{ ETI-201, Fig. 21 }	Shell Type <i>or</i> Angle Type	104J52 <i>or</i> 103J173
GL-627	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
GL-672	Large Shell Super-Jumbo 4-Pin	{ ETI-201, Fig. 22 }	Shell Type <i>or</i> Angle Type	104J52 <i>or</i> 103J173
GL-672	Anode Cap, Skirted Medium	{ ETI-201, Fig. 5 }	Medium Cap Connector	102J300
GL-678	Special 4-Pin	{ ETI-201, Fig. 36 }		
GL-678	Anode Cap, Skirted Medium	{ ETI-201 Fig. 6 }	Medium Cap Connector	102J300
GL-884	Small-Shell Octal 6-Pin	{ ETI-201, Fig. 24 }	Wafer Type, Octal <i>or</i> Industrial Octal	103J64 <i>or</i> 103J58
GL-885	Small 5-Pin	{ ETI-201, Fig. 16 }	Wafer Type	103J166
GL-2050	Small-Shell Octal 8-Pin	{ ETI-201, Fig. 23 }	Wafer Type, Octal <i>or</i> Industrial Octal	103J164 <i>or</i> 103J58
GL-2051	Small-Shell Octal 8-Pin	{ ETI-201, Fig. 23 }	Wafer Type, Octal <i>or</i> Industrial Octal	103J164 <i>or</i> 103J58
KENOTRONS				
KC-4	Special 2-Pin	{ ETI-201, Fig. 34 }	Special 2-Pin Socket, Shell Type	103J523
KC-4	Anode Cap, Skirted Large	{ ETI-201, Fig. 12 }	Large Cap Connector	102J299
FP-85-A	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FP-85-A	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
KENOTRONS (cont.)				
FP-400	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
GL-411	Special 2-Pin	{ ETI-201, Fig. 34 }	Special 2-Pin Socket, Shell Type	103J523
GL-411	Anode Cap, Skirted Large	{ ETI-201 Fig. 12 }	Large Cap Connector	102J299
GL-8020	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
GL-8020	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
PHANOTRONS				
FG-32	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FG-32	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
FG-104	Super-Jumbo 4-Pin	{ ETI-201, Fig. 20 }	Shell Type <i>or</i> Angle Type <i>or</i> Angle Type (Back Wired)	104J52 <i>or</i> 103J173 <i>or</i> 103J174
FG-104	Anode Cap, Large	{ ETI-201, Fig. 7 }	Large Cap Connector	101J61
FG-166	Anode and Filament Terminal Leads	{ ETI-149 Tube Outline }	Special Mount, 2 Required	102J304
FG-190	Anode and Filament Terminal Leads	{ ETI-150 Tube Outline }	Special Mount, 2 Required	102J304
FG-280	Anode and Filament Terminal Leads	{ ETI-151 Tube Outline }	Special Mount, 2 Required	102J304
GL-575-A	Jumbo, 4-Large Pin, Bayonet	{ ETI-201, Fig. 19 }	Shell Type <i>or</i> Wafer Type	104J51 <i>or</i> 103J162
GL-575-A	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
GL-673	Super Jumbo 4-Pin, Bayonet	{ ETI-201, Fig. 20 }	Shell Type <i>or</i> Angle Type	104J52 <i>or</i> 103J173
GL-673	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
GL-857-B	2-Terminal Base	{ ETI-201, Fig. 37 }	Panel Type Mounting	P-7765662
GL-857-B	Anode Cap, Skirted Large	{ ETI-201, Fig. 9 }	Large Cap Connector	102J299

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
PHANOTRONS (cont.)				
GL-866-A/866	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer type <i>or</i> High-Voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
GL-866-A/866	{ Anode Cap, Medium (with Insulating Collar)	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
GL-869-B	Special 2-Terminal Base	{ ETI-201, Fig. 32 }	Cathode Mounting	7651887G3
GL-869-B	Anode Cap, Skirted Large	{ ETI-201, Fig. 8 }	Anode Mounting <i>or</i> Large Cap Connector	7651887G5 <i>or</i> 102J299
GL-872-A/872	Jumbo 4-Pin	{ ETI-201, Fig. 19 }	Shell Type <i>or</i> Wafer Type	104J51 <i>or</i> 103J162
GL-872-A/872	Anode Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
PLIOTRONS				
PJ-7	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage Type <i>or</i> Angle Type Medium Cap Connector	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50 102J300
PJ-8	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage Type <i>or</i> Angle Type Medium Cap Connector	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50 102J300
PJ-21	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage Type <i>or</i> Angle Type Medium Cap Connector	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50 102J300
FP-54	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
FP-54	Control Grid Cap, Small	{ ETI-201, Fig. 1 }	Small Cap Connector	102J302
FP-62	Flexible Leads	{ ETI-161 Tube Outline }		
GL-207	Water-Cooled Anode	{ ETI-162 Tube Outline }	Water Jacket	ML- 7474287G1
GL-207	Filament Terminal Leads	{ ETI-162 Tube Outline }		
GL-207	Grid Terminal	{ ETI-162 Tube Outline }		
FP-265	Super-Jumbo 4-Pin	{ ETI-201, Fig. 20 }	Shell Type <i>or</i> Angle Type	104J52 <i>or</i> 103J173
FP-265	Anode Cap, Large	{ ETI-201, Fig. 7 }	Large Cap Connector	102J299

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
PLIOTRONS (cont.)				
FP-285	Jumbo 4-Pin	{ ETI-201, Fig. 19 }	Shell Type <i>or</i> Wafer Type	104J51 <i>or</i> 101J162
GL-592	Anode Terminal (Special)	{ ETI-245 Tube Outline }	Cloverleaf Cap Connector	102J301
GL-592	Grid Terminals	{ ETI-245 Tube Outline }	Grid Cap Connectors (2)	102J307
GL-592	Filament Terminals	{ ETI-245 Tube Outline }	Wafer Type	102J306
GL-807	Medium 5-Pin	{ ETI-201, Fig. 18 }	Wafer Type	103J166
GL-807	Anode Cap, Small	{ ETI-201, Fig. 1 }	Small Cap Connector	102J302
GL-810	Jumbo 4-Pin	{ ETI-201, Fig. 19 }	Shell Type <i>or</i> Wafer Type	104J51 <i>or</i> 101J162
GL-810	Anode Cap, Skirted Medium	{ ETI-201, Fig. 4 }	Medium Cap Connector	102J300
GL-810	Grid Cap, Medium	{ ETI-201, Fig. 3 }	Medium Cap Connector	102J300
GL-833-A	Anode & Grid Terminals	{ ETI-167 Tube Outline }	Anode & Grid Connectors	.....
GL-833-A	Filament Terminals	{ ETI-167 Tube Outline }	Filament Connectors	.....
GL-851	Grid & Filament Terminals	{ ETI-201, Fig. 30 }	Cathode Mounting	7651887G3
GL-851	Anode Cap, Skirted Large	{ ETI-201, Fig. 10 }	Anode Mounting <i>or</i> Large Cap Connector	7651887G5 <i>or</i> 102J299
GL-862-A	Water-Cooled Anode	{ ETI-169 Tube Outline }	Water Jacket	ML- 7663852G1
GL-862-A	Grid Terminal	{ ETI-169 Tube Outline }	.....	.....
GL-862-A	Filament Terminal Leads	{ ETI-201, Fig. 35 }	.....	.....
GL-880	Water-Cooled Anode	{ ETI-170 Tube Outline }	Water Jacket	ML- 7767694G1
GL-880	Filament Terminals	{ ETI-170 Tube Outline }	Filament Connectors (2)	.....
GL-880	Grid Terminals	{ ETI-170 Tube Outline }	Grid Connectors (2)	.....
GL-889-A	Water-Cooled Anode	{ ETI-171 Tube Outline }	Water Jacket	ML- 7473962G1
GL-889-A	Filament Terminals	{ ETI-171 Tube Outline }	Filament Connectors (2)	.....
GL-889-A	Grid Terminals	{ ETI-171 Tube Outline }	Grid Connectors (2)	.....

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
PIOTRONS (cont.)				
GL-889R-A	Forced-Air-Cooled Anode	{ ETX-181 Tube Outline }		
GL-889R-A	Filament Terminals	{ ETX-209, Fig. 12 }	Filament Connectors	
GL-889R-A	Grid Terminals	{ ETX-209, Fig. 10 }	Grid Connectors	
GL-891	Water-Cooled Anode	{ ETI-172 Tube Outline }	Water Jacket	ML- 7474287G1
GL-891	Grid Terminal	{ ETI-172 Tube Outline }		
GL-891	Filament Terminals	{ ETI-201, Fig. 31 }		
GL-891-R	Forced-Air-Cooled Anode	{ ETX-183 Tube Outline }		
GL-891-R	Grid Terminal	{ ETX-209, Fig. 12 }		
GL-891-R	Filament Terminals	{ ETX-209, Fig. 30 }		
GL-892	Water-Cooled Anode	{ ETI-173 Tube Outline }	Water Jacket	ML- 7474287G1
GL-892	Grid Terminal	{ ETI-173 Tube Outline }		
GL-892	Filament Terminals	{ ETI-201, Fig. 31 }		
GL-892-R	Forced-Air-Cooled Anode	{ ETX-185 Tube Outline }		
GL-892-R	Grid Terminal	{ ETX-209, Fig. 12 }		
GL-892-R	Filament Terminals	{ ETX-209, Fig. 30 }		
GL-893-A	Water-Cooled Anode	{ ETI-174 Tube Outline }	Water Jacket	ML- 7651761
GL-893-A	Grid Terminal	{ ETI-174 Tube Outline }		
GL-893-A	Filament Terminals	{ ETI-201, Fig. 38 }		
GL-893A-R	Forced-Air-Cooled Anode	{ ETX-187 Tube Outline }		
GL-893A-R	Grid Terminal	{ ETX-187 Tube Outline }		
GL-893A-R	Filament Terminals	{ ETX-209, Fig. 34 }		

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
GL-895-R	Forced-Air-Cooled Anode	{ ETX-189 Tube Outline }		
GL-895-R	Grid Terminals	{ ETX-189 Tube Outline }		
GL-895-R	Filament Terminals	{ ETX-189 Tube Outline }		
GL-8002	Water-Cooled Anode	{ ETI-175 Tube Outline }	Water Jacket	ML-7473098G1
GL-8002	Filament Terminals	{ ETI-175 Tube Outline }		
GL-8002	Grid Terminals	{ ETI-175 Tube Outline }		
GL-8002-R	Force-Air-Cooled Anode	{ ETX-201 Tube Outline }		
GL-8002-R	Filament Terminals	{ ETX-201 Tube Outline }		
GL-8002-R	Grid Terminals	{ ETX-201 Tube Outline }		
GLOW TUBES				
GL-OA3/VR75	Small-Shell Octal 6-Pin	{ ETI-201, Fig. 24 }	Industrial Octal <i>or</i> Wafer Type, Octal	103J58 <i>or</i> 103J164
GL-OB3/VR90	Small-Shell Octal 6-Pin	{ ETI-201, Fig. 24 }	Industrial Octal <i>or</i> Wafer Type, Octal	103J58 <i>or</i> 103J164
GL-OC3/VR105	Small-Shell Octal 6-Pin	{ ETI-201, Fig. 24 }	Industrial Octal <i>or</i> Wafer Type, Octal	103J58 <i>or</i> 103J164
GL-OD3/VR150	Small-Shell Octal 6-Pin	{ ETI-201, Fig. 24 }	Industrial Octal <i>or</i> Wafer Type, Octal	103J58 <i>or</i> 103J164
GL-874	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
PHOTOTUBES				
PJ-22	Tapered Small 4-Pin	{ ETI-201, Fig. 14 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
FJ-405	Medium 4-Pin Bayonet	{ ETI-201, Fig. 17 }	Shell Type <i>or</i> Wafer Type <i>or</i> High-Voltage Type <i>or</i> Angle Type	103J516 <i>or</i> 103J165 <i>or</i> 102J305 <i>or</i> 104J50
GL-868/PJ-23	Tapered Small 4-Pin	{ ETI-201, Fig. 14 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
GL-1P29/FJ-401	Tapered Small 4-Pin	{ ETI-201, Fig. 14 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
GL-441	Tapered Small 4-Pin	{ ETI-201, Fig. 14 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
GL-917	Tapered Small 4-Pin	{ ETI-201, Fig. 14 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
GL-917	Anode Cap, Small	{ ETI-201, Fig. 1 }	Small Cap Connector	102J302

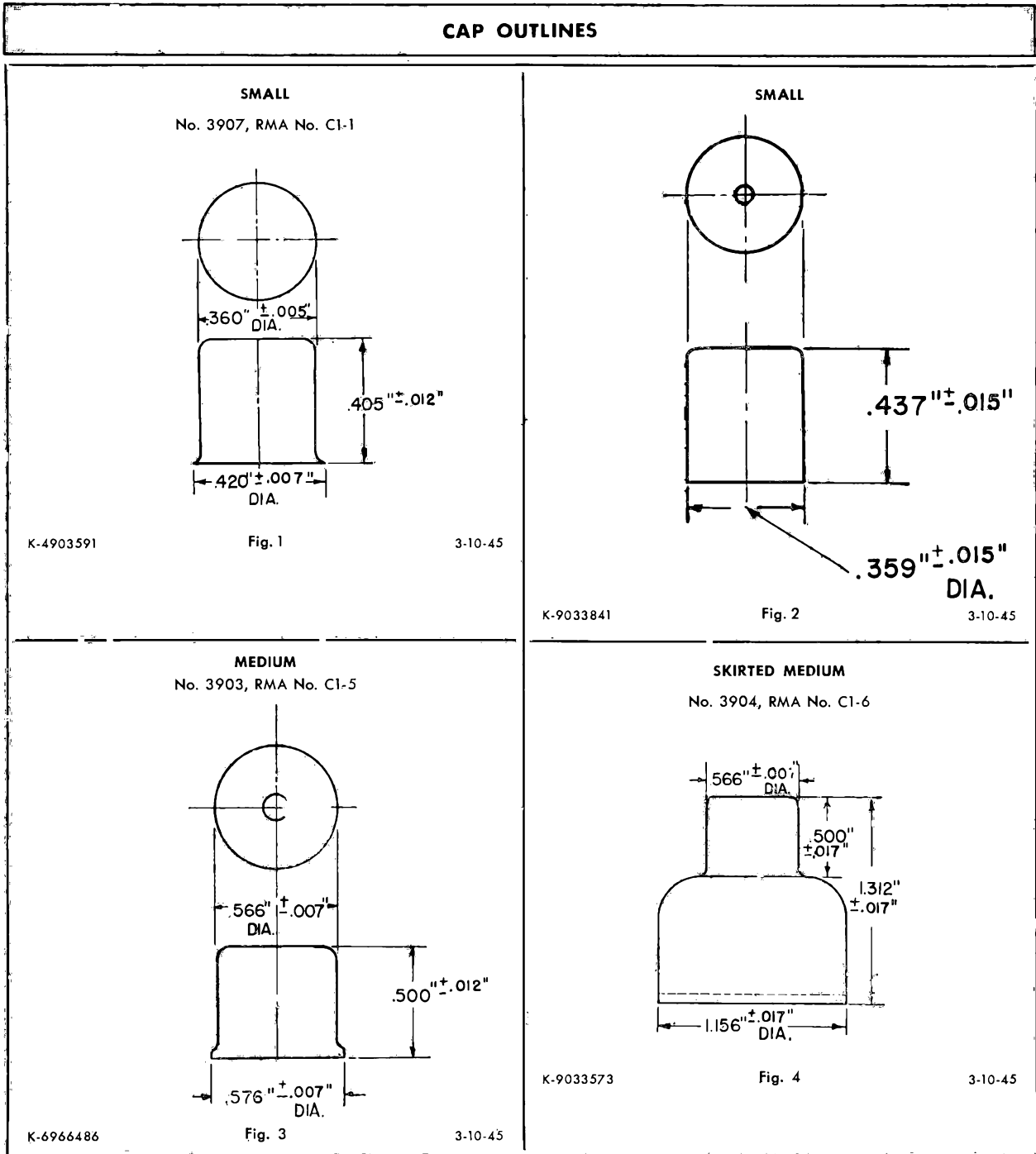
TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
PHOTOTUBES (cont.)				
GL-918	Tapered Small 4-Pin	{ ETI-201, Fig. 14 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
GL-919	Tapered Small 4-Pin	{ ETI-201, Fig. 14 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
GL-919	Cathode Cap, Small	{ ETI-201, Fig. 1 }	Small Cap Connector	102J302
GL-920	Small 4-Pin	{ ETI-201, Fig. 15 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
GL-921	Anode Terminal	{ ETI-187 Tube Outline }	Anode Connector	102J303
GL-921	Cathode Terminal	{ ETI-187 Tube Outline }	Cathode Socket	
GL-922	Anode Terminal	{ ETI-188 Tube Outline }	Anode Connector	102J303
GL-922	Cathode Terminal	{ ETI-188 Tube Outline }	Cathode Socket	
GL-923	Small 4-Pin	{ ETI-201, Fig. 15 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50
GL-927	Peewee 3-Pin	{ ETI-201, Fig. 13 }	Special Peewee 3-Pin	113J130
GL-929	Intermediate-Shell Octal 5-Pin	{ ETI-201, Fig. 25 }	Wafer Type, Octal <i>or</i> Industrial Octal	103J164 <i>or</i> 103J58
GL-930	Intermediate-Shell Octal 5-Pin	{ ETI-201, Fig. 25 }	Wafer Type, Octal <i>or</i> Industrial Octal	103J164 <i>or</i> 103J58
GL-931-A	Small-Shell Submagnal 11-Pin	{ ETI-201, Fig. 29 }		
GL-935	Intermediate-Shell Octal 5-Pin	{ ETI-201, Fig. 25 }	Wafer Type, Octal <i>or</i> Industrial Octal	103J164 <i>or</i> 103J58
GL-935	Anode Cap, Miniature	{ ETI-201 Tube Outline }		
BALLAST TUBES				
B-6	St'd Medium Lamp Base	{ ETI-201, Fig. 40 }	Screw Base Type	
B-25	St'd Medium Lamp Base	{ ETI-201, Fig. 39 }	Screw Base Type	
B-46	St'd Medium Lamp Base	{ ETI-201, Fig. 39 }	Screw Base Type	
B-47	St'd Medium Lamp Base	{ ETI-201, Fig. 39 }	Screw Base Type	
FB-50	St'd Medium Lamp Base	{ ETI-201, Fig. 39 }	Screw Base Type	
RESISTANCE VACUUM GAGES				
FA-13	Filament Leads	{ ETI-195 Tube Outline }		
FA-14	Tapered Small 4-Pin	{ ETI-201, Fig. 14 }	Wafer Type <i>or</i> Angle Type	103J165 <i>or</i> 104J50

TUBE TYPE	DESCRIPTION OF BASE, CAP OR TERMINAL	OUTLINE REFERENCE	DESCRIPTION OF SOCKET OR CAP CONNECTOR	G-E SOCKET NUMBER
VACUUM SWITCHES				
FA-6	Terminal Leads and Actuator	{ ETI-197 Tube Outline }	See Special Suggested Mountings on Application Data, ETI-196	....
FA-15	Terminal Leads and Actuator	{ ETI-198 Tube Outline }	See Special Suggested Mountings on Application Data, ETI-196	....
VACUUM CAPACITORS				
GL-1L21*	Cap Type Terminals (Two)	{ ETI- 262 Tube Outline }	Connector	ML- 7477177G2

* GL-1L22, -23, -24, -25, -33, -36 and -38 use same connector, ML-7477177G2.

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.

OUTLINES—CAPS AND BASES



CAP OUTLINES

SKIRTED MEDIUM

No. 3995

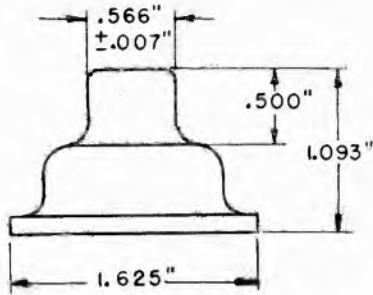


Fig. 5

SKIRTED MEDIUM

No. 3985

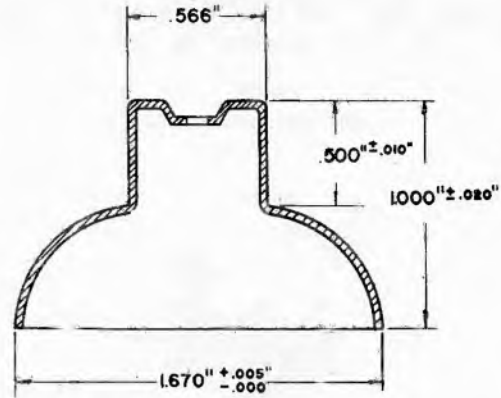


Fig. 6

N-15093AZ

10-31-46

LARGE

No. 3917, RMA No. C1-8

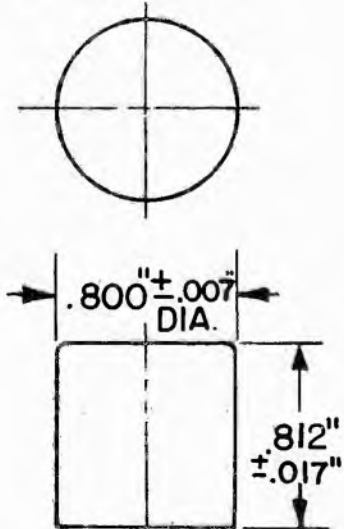


Fig. 7

K-4955973

3-10-45

SKIRTED LARGE

No. 3905-A, RMA No. C1-9

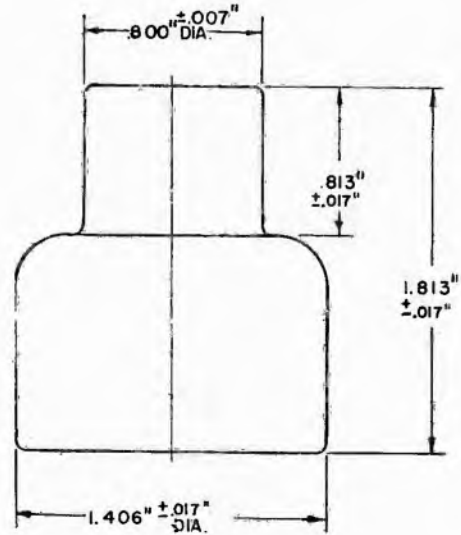


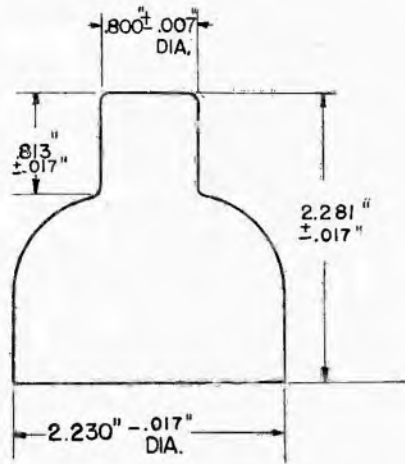
Fig. 8

K-6966485

3-10-45

CAP OUTLINES

SKIRTED LARGE
 No. 1904, RMA No. C1-10

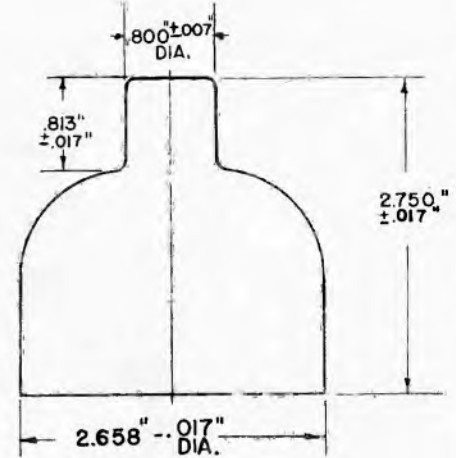


K-6966488

Fig. 9

3-10-45

SKIRTED LARGE
 No. 1902

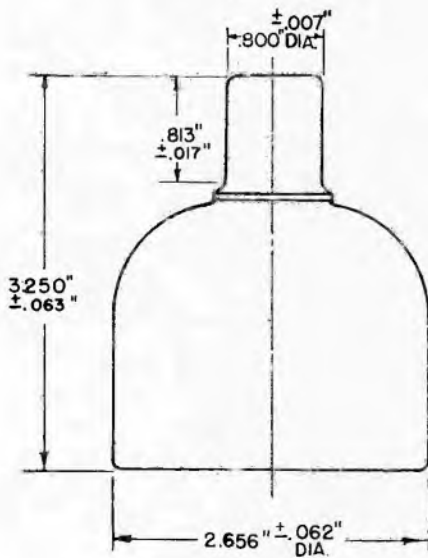


K-9033522

Fig. 10

3-19-45

SKIRTED LARGE
 No. 3909

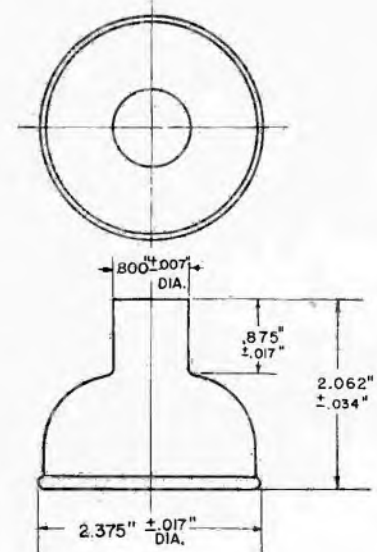


K-6966482

Fig. 11

3-19-45

SKIRTED LARGE
 No. 3912



K-4373344

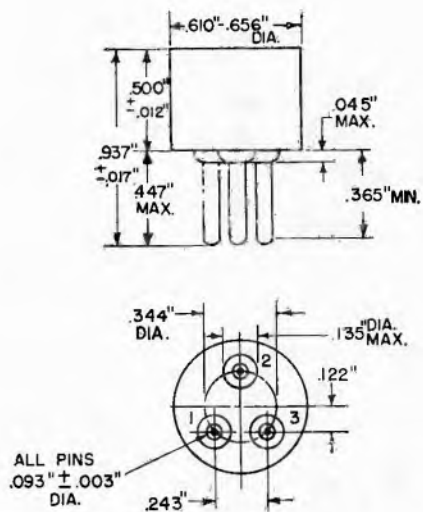
Fig. 12

3-21-45

BASE OUTLINES

PEEWEE 3-PIN

No. 3313, RMA No. A3-1



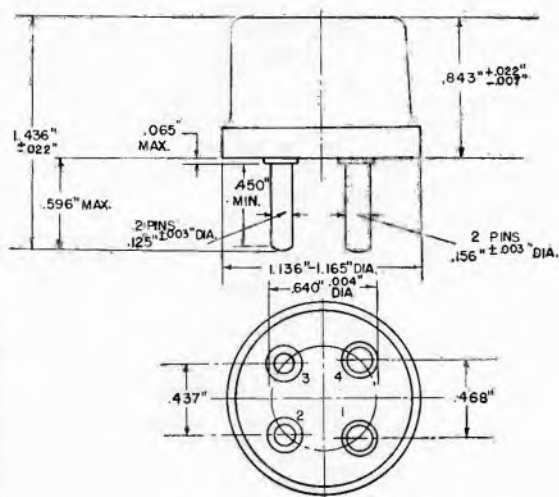
K-9033572

Fig. 13

3-19-45

TAPERED SMALL 4-PIN

No. 4101, RMA No. A4-3



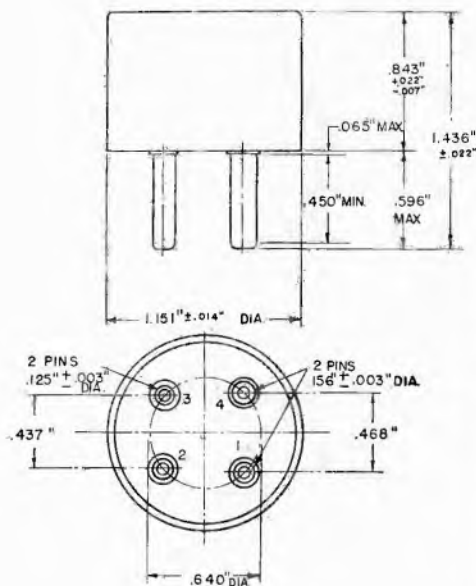
K-4903590

Fig. 14

3-25-45

SMALL 4-PIN

No. 4108, RMA No. A4-5



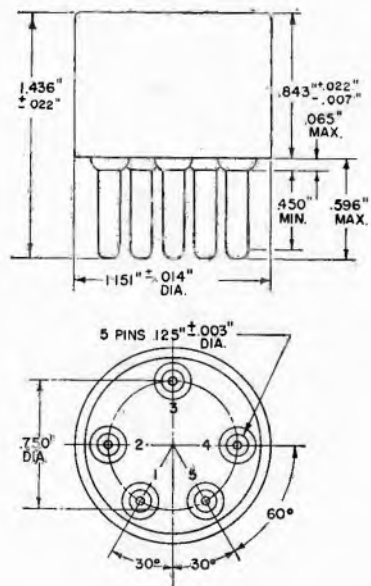
K-4909060

Fig. 15

3-21-45

SMALL 5-PIN

No. 5108, RMA No. A5-6



K-9033571

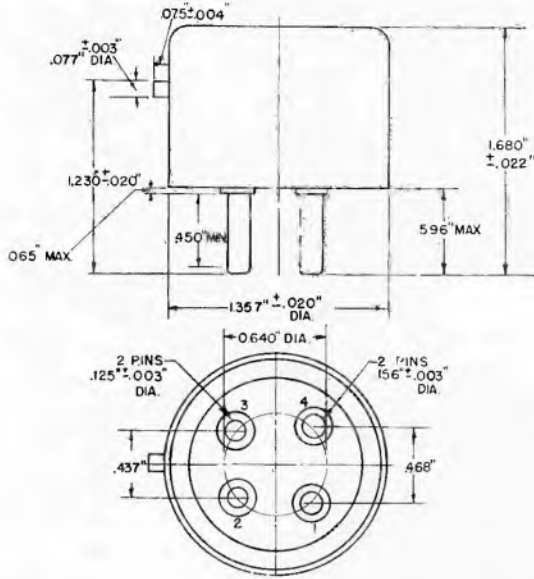
Fig. 16

3-19-45

BASE OUTLINES

MEDIUM 4-PIN WITH BAYONET

*No. 4102 and 4103, RMA No. A4-10



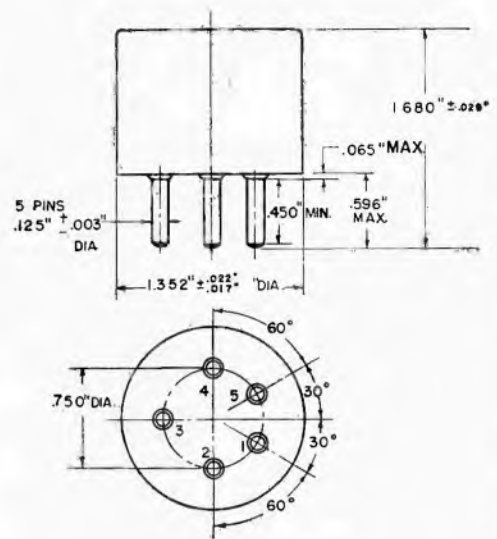
K-6966493

Fig. 17

3-19-45

MEDIUM 5-PIN

No. 5106, RMA No. A5-11



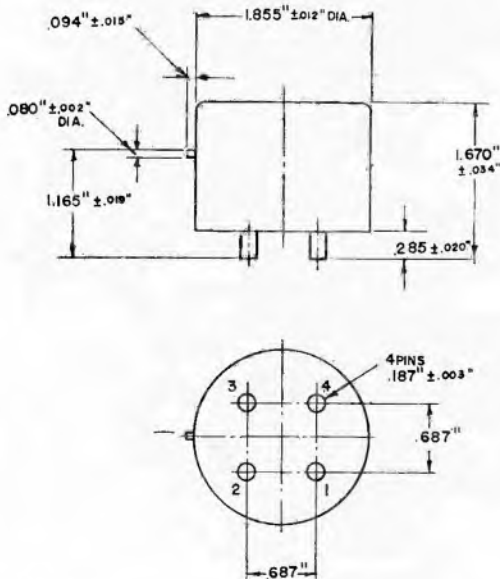
K-6966487

Fig. 18

3-21-45

JUMBO 4-PIN WITH BAYONET

No. 1839, RMA No. A4-29



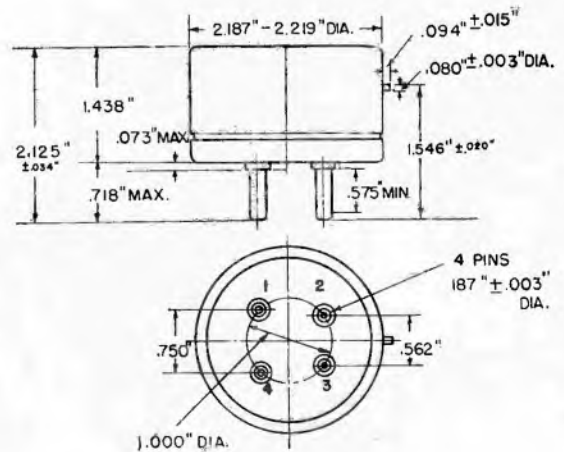
K-6966492

Fig. 19

3-21-45

SUPER-JUMBO 4-PIN WITH BAYONET

No. 4310, RMA No. A4-18



K-4955974

Fig. 20

3-28-45

*4102—Composition Shell
 4103—Metal Shell

BASE OUTLINES

SMALL-SHELL, SUPER-JUMBO 4-PIN

No. 411, RMA No. A4-15

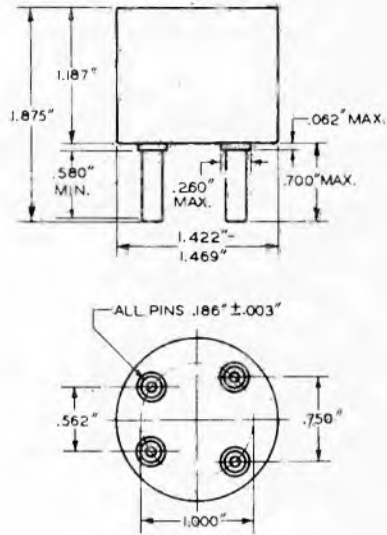


Fig. 21

SUPER-JUMBO 4-PIN

No. 3982

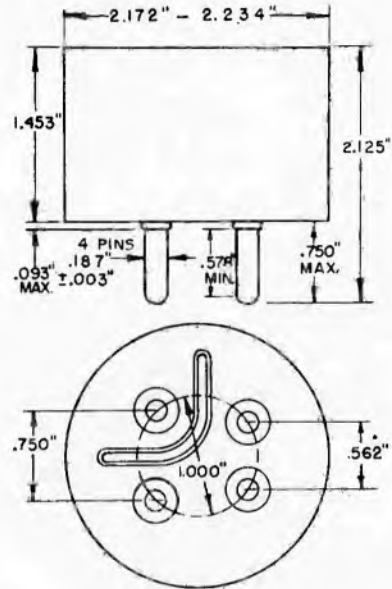


Fig. 22

SMALL-SHELL OCTAL 8-PIN

No. 8529, RMA No. B8-1

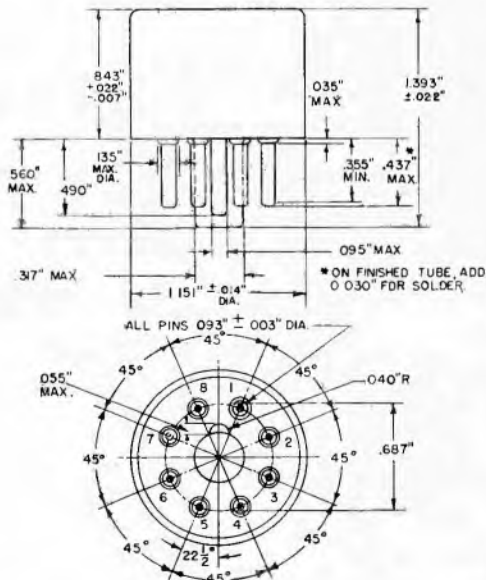


Fig. 23

K-9033851

3-24-45

SMALL-SHELL OCTAL 6-PIN

No. 6529, RMA No. B6-3

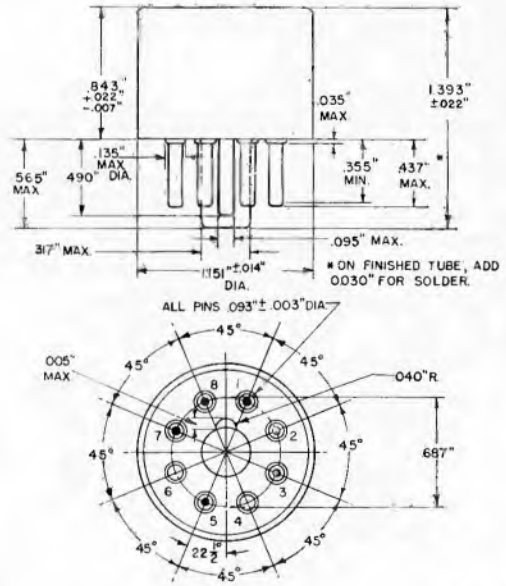


Fig. 24

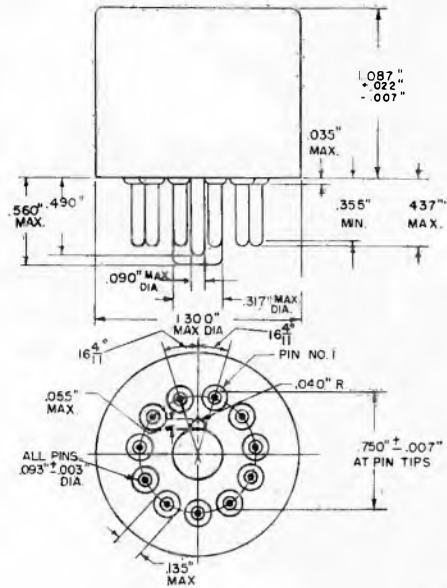
K-9033848

3-24-45

BASE OUTLINES

SMALL-SHELL SUBMAGNAL 11-PIN

No. 11343, RMA No. B11-33



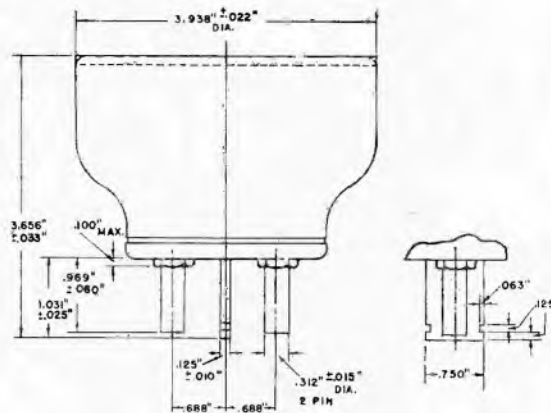
K-9033574

Fig. 29

3-27-45

BASE 3117

RMA No. A3-23

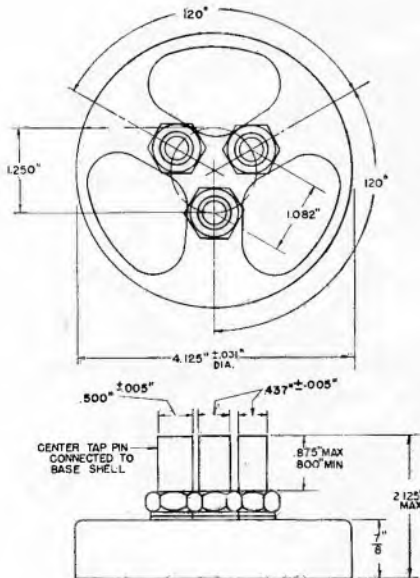


K-6966474

Fig. 30

3-21-45

BASE 3232-L1



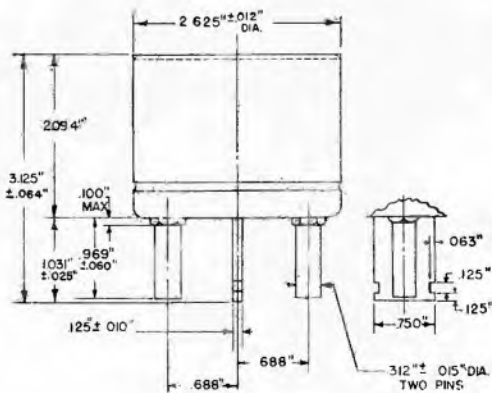
K-9033548

Fig. 31

3-26-45

BASE 3502

RMA No. A3-20



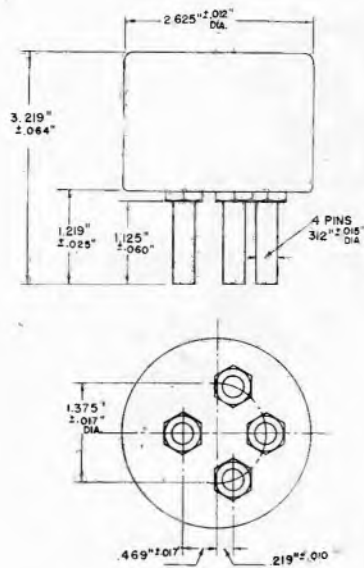
K-6966478

Fig. 32

3-27-45

BASE OUTLINES

BASE 3601

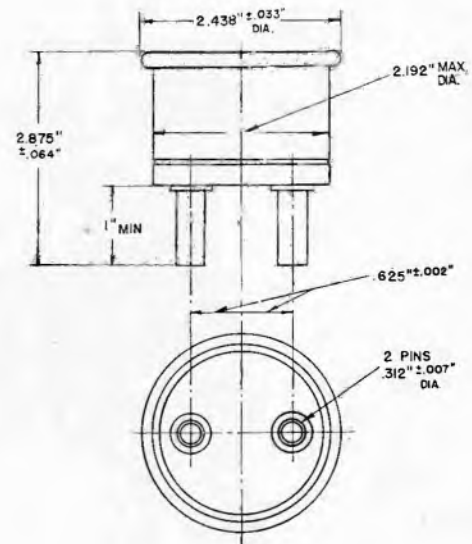


K-3846066

Fig. 33

3-27-45

BASE 3701

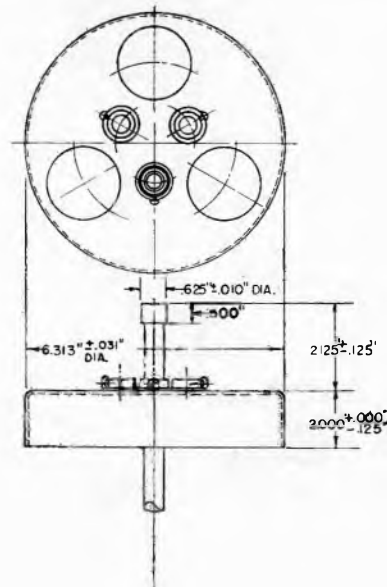


K-4373346

Fig. 34

3-27-45

BASE 3908



K-6966483

Fig. 35

3-26-45

BASE 3985

RMA No. A4-30

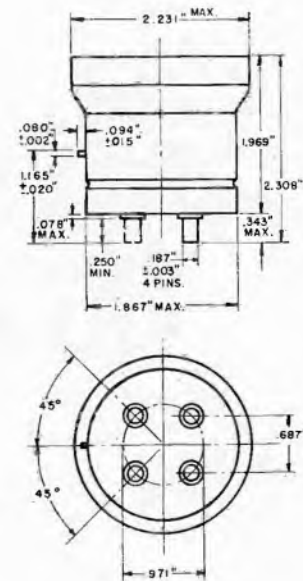
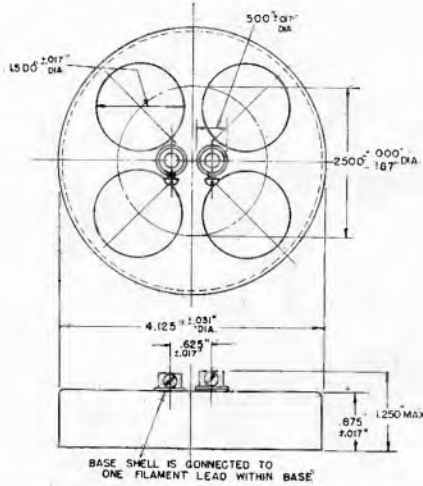


Fig. 36

BASE OUTLINES

BASE 3911

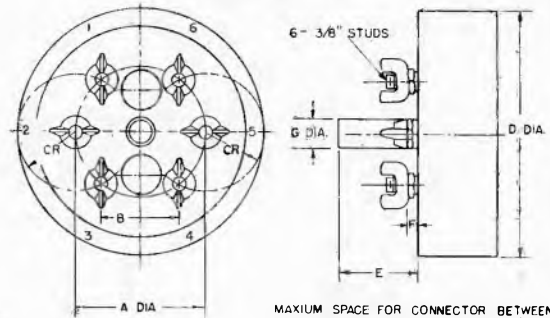


K-9033549

Fig. 37

3-26-45

BASE 6628



DIMENSIONS IN INCHES
MIN. MAX.

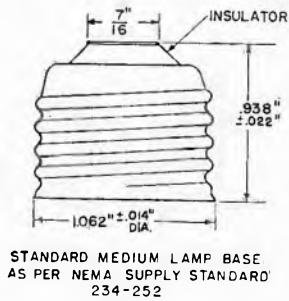
	MIN.	MAX.
A	3.310"	3.380"
B	1.965"	2.035"
C	1.465"	1.535"
D	6.250"	6.375"
E	1.875"	2.250"
F	0.215"	0.285"
G	0.590"	0.660"

K-5188125

Fig. 38

3-26-45

MEDIUM LAMP BASE
No. 102



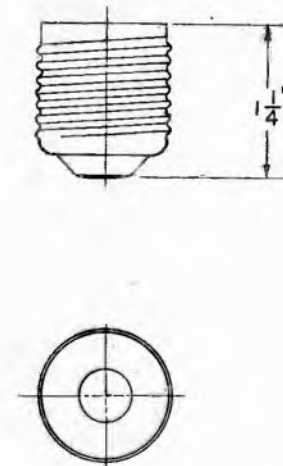
STANDARD MEDIUM LAMP BASE
AS PER NEMA SUPPLY STANDARD
234-252

K-5185217

Fig. 39

3-27-45

MEDIUM LAMP BASE
No. 118



STANDARD MEDIUM LAMP BASE
AS PER NEMA SUPPLY STANDARD
234-252

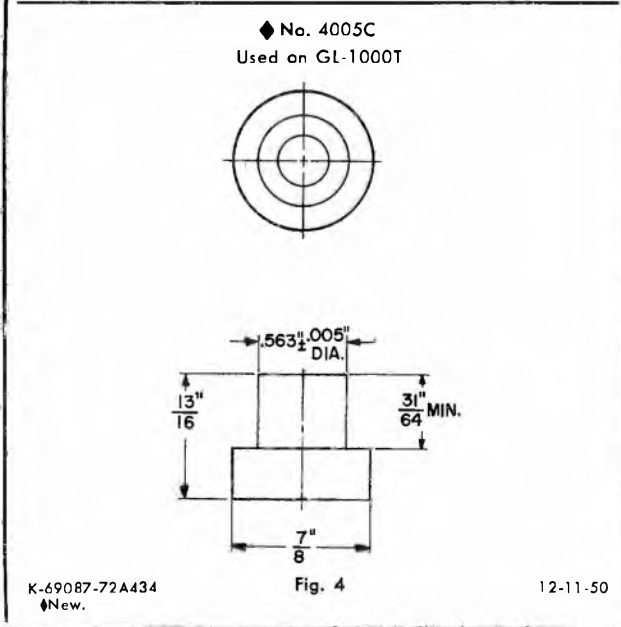
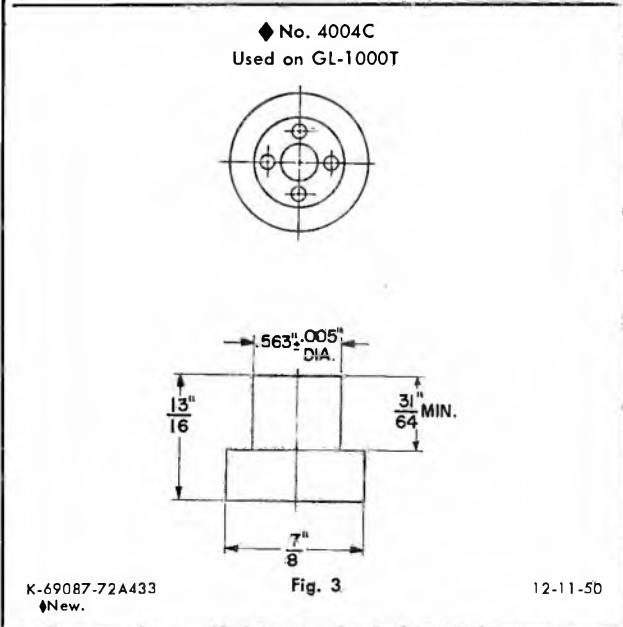
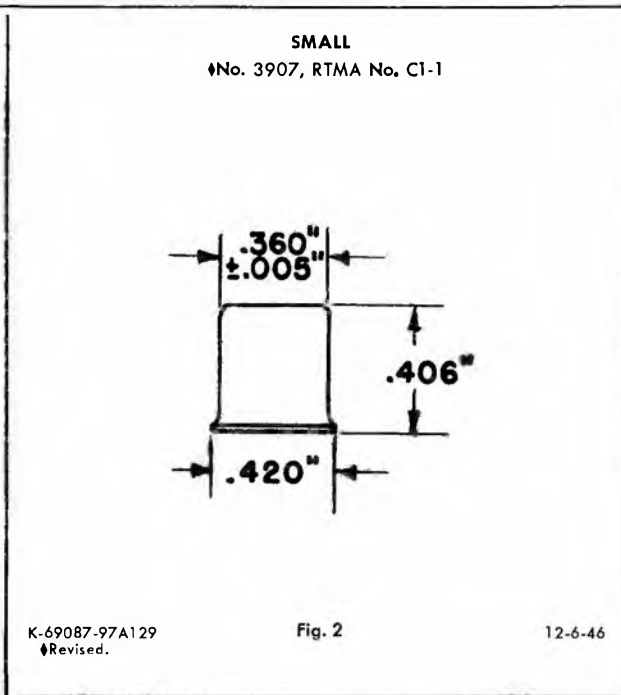
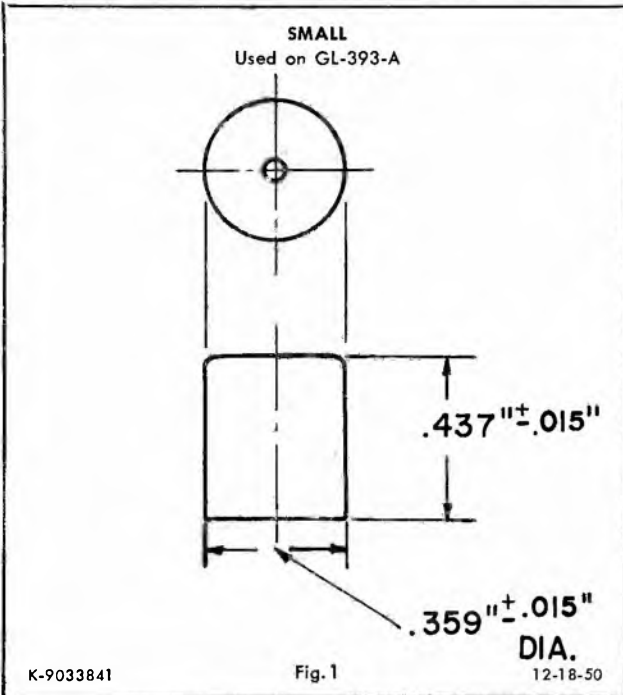
K-5182057

Fig. 40

3-27-45

OUTLINES—CAPS AND BASES

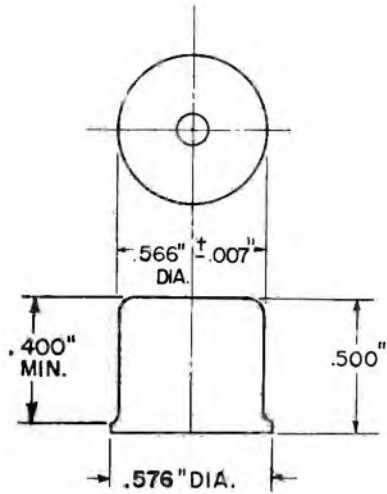
CAP OUTLINES



CAP OUTLINES

MEDIUM

◆ No. 3903, RTMA No. C1-5



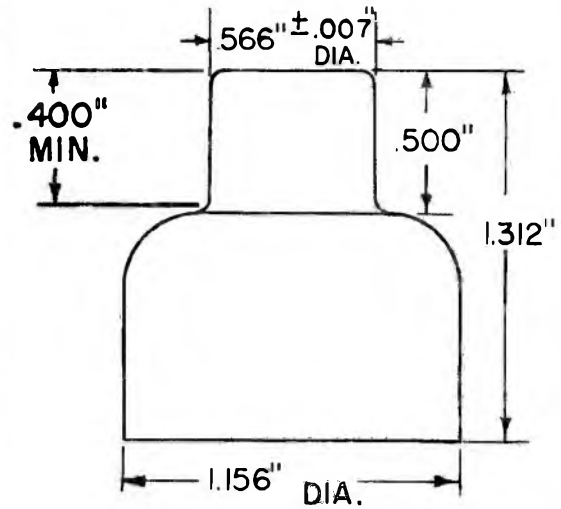
K-6966486
 ◆ Revised.

Fig. 5

12-18-50

SKIRTED MEDIUM

◆ No. 3904, RTMA No. C1-6

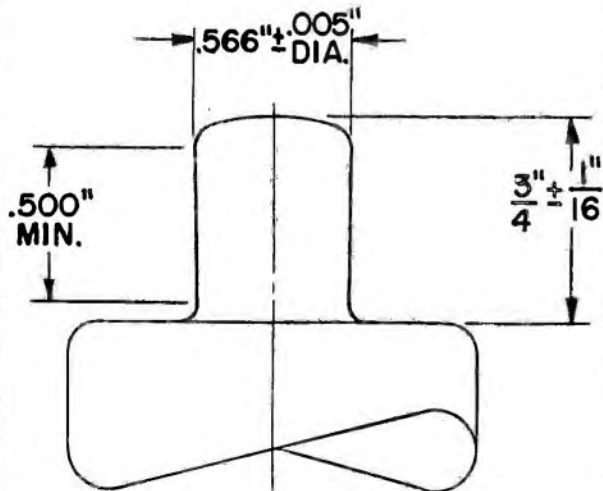


K-9033573
 ◆ Revised.

Fig. 6

12-18-50

◆ No. 3935



K-69087-72A428
 ◆ New.

Fig. 7

12-22-50

SKIRTED MEDIUM

No. 3995

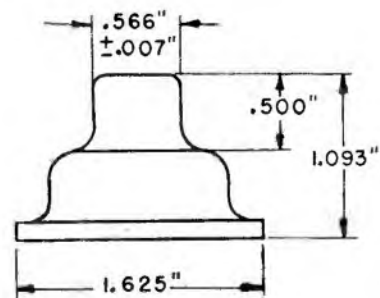
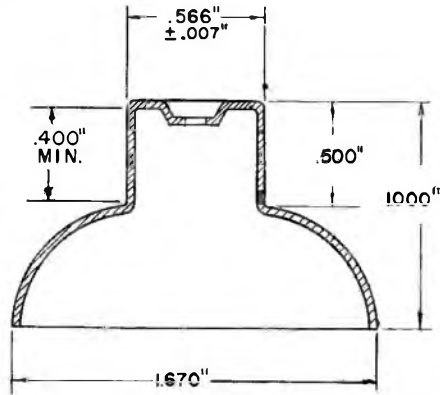


Fig. 8

CAP OUTLINES

SKIRTED MEDIUM

◆ No. C1-27



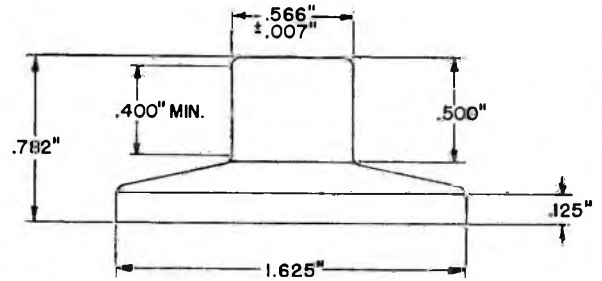
ON FINISHED TUBE ADD 0.040" FOR
SOLDER TO LENGTHS AFFECTED

N-15093AZ
↕ Revised.

Fig. 9

12-18-50

◆ No. C1-29



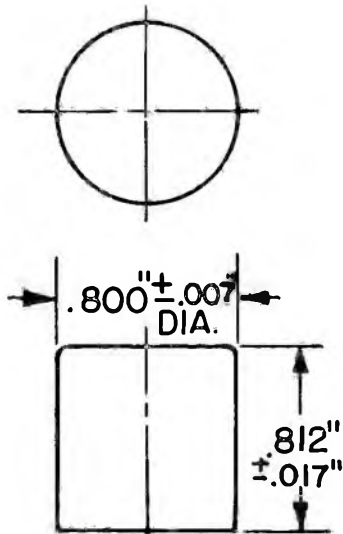
N-15001TC
↕ New.

Fig. 10

6-15-48

LARGE

No. 3917, RTMA No. C1-15



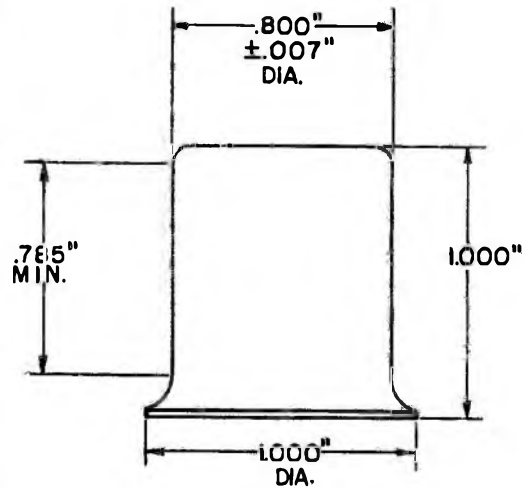
K-4955973

Fig. 11

9-15-50

LARGE

◆ No. C1-8



K-9186042
↕ New.

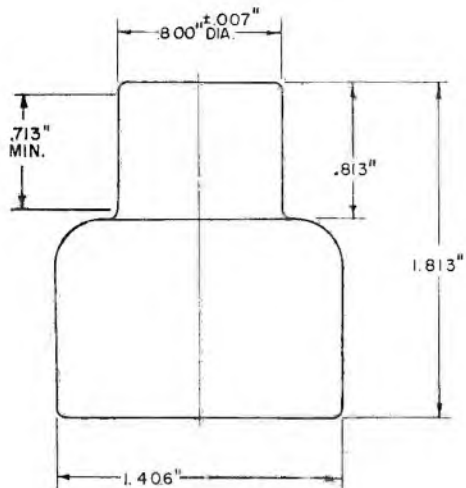
Fig. 12

12-18-50

CAP OUTLINES

SKIRTED LARGE

◆ No. 3905, RTMA No. C1-9



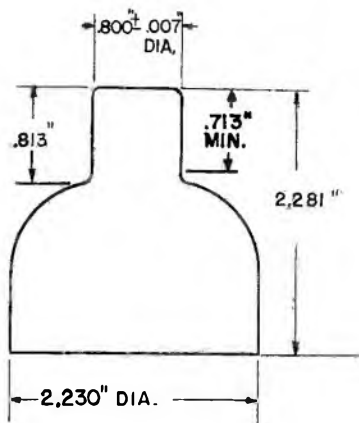
K-6966485
 ↓Revised.

Fig. 13

12-18-50

SKIRTED LARGE

◆ No. 1904, RTMA No. C1-10



ON FINISHED TUBE ADD
 0.060" FOR SOLDER TO
 LENGTHS AFFECTED

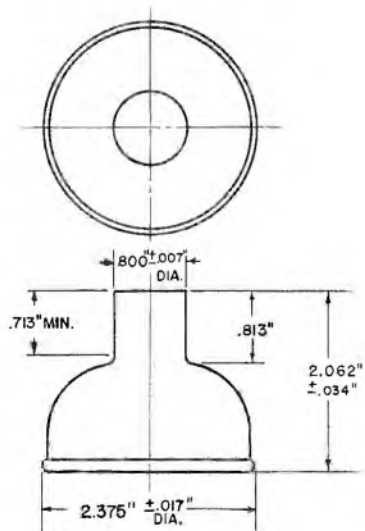
K-6966488
 ↓Revised.

Fig. 14

12-18-50

SKIRTED LARGE

◆ No. 3912



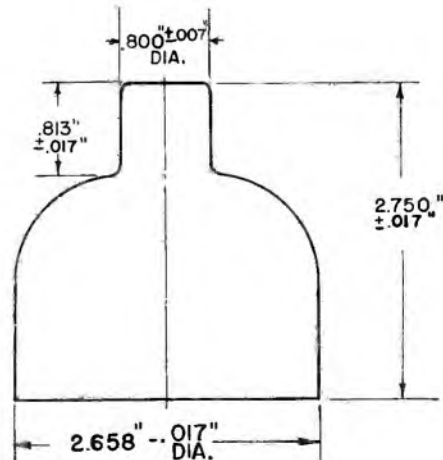
K-4373344
 ↓Revised.

Fig. 15

8-16-48

SKIRTED LARGE

No. 1902, RTMA No. C1-30



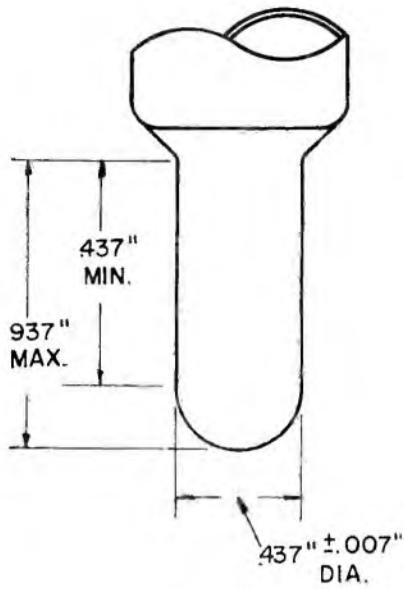
K-9033522

Fig. 16

12-18-50

TERMINAL OUTLINES

◆ No. J1-1

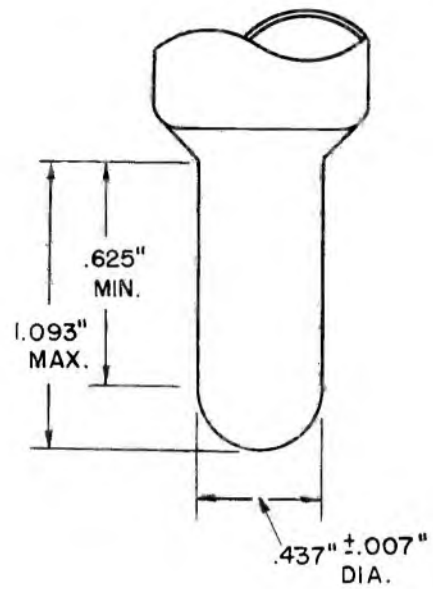


K-9186044
◆New.

Fig. 17

12-18-50

◆ No. J1-8

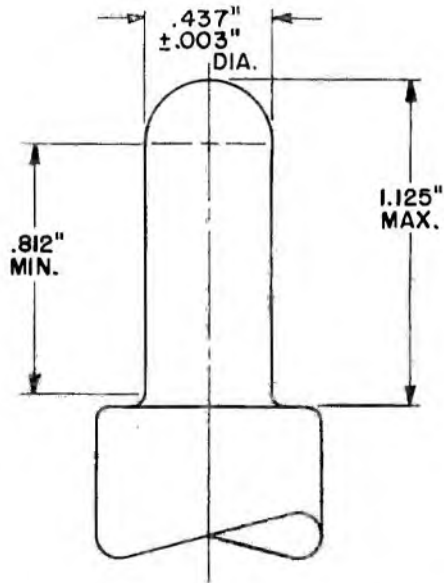


K-9186039
◆New.

Fig. 18

12-18-50

◆ No. J1-9

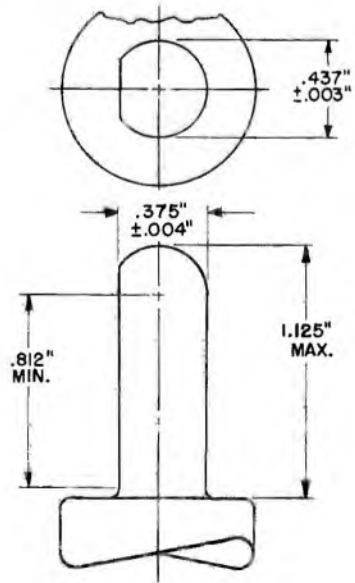


K-69087-72A430
◆New.

Fig. 19

12-18-50

◆ No. J1-10



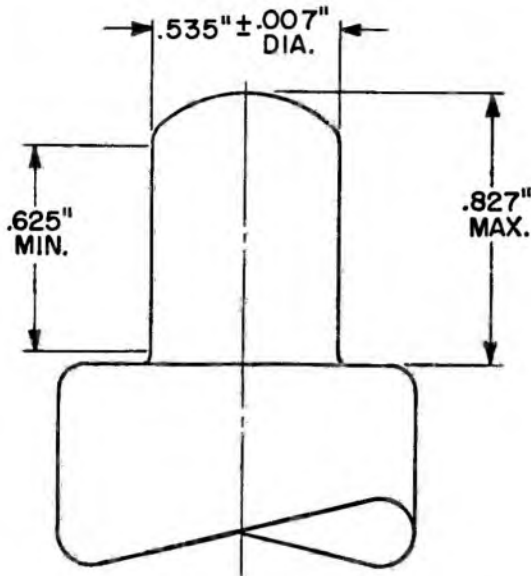
K-69087-72A431
◆New.

Fig. 20

12-18-50

TERMINAL AND BASE OUTLINES

◆ No. J1-13

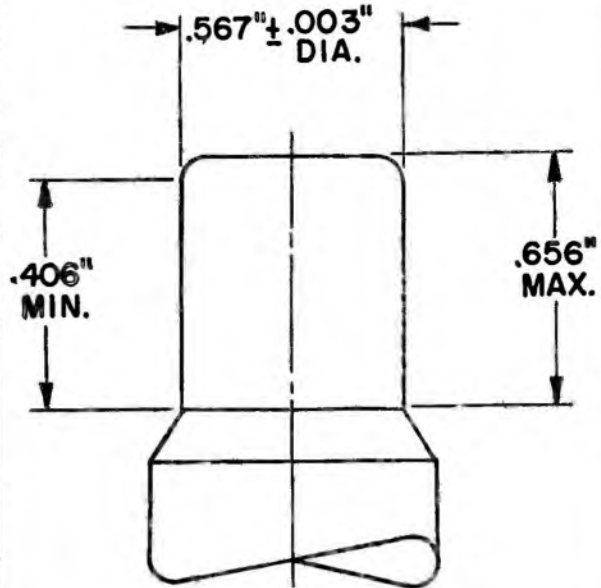


K-69087-72A432
 ◆New.

Fig. 21

12-18-50

◆ No. J1-7

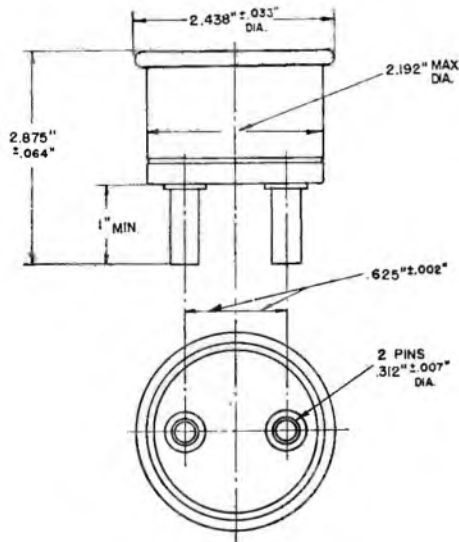


K-69087-72A429
 ◆New.

Fig. 22

12-18-50

BASE 3701



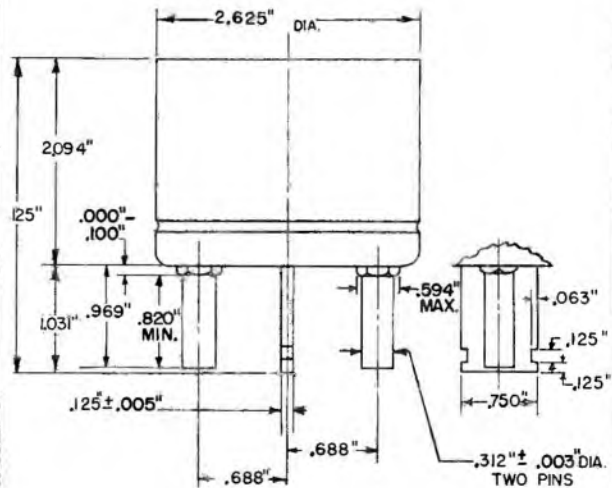
K-4373346

Fig. 23

3-27-45

BASE 3502

◆ RTMA No. A3-20



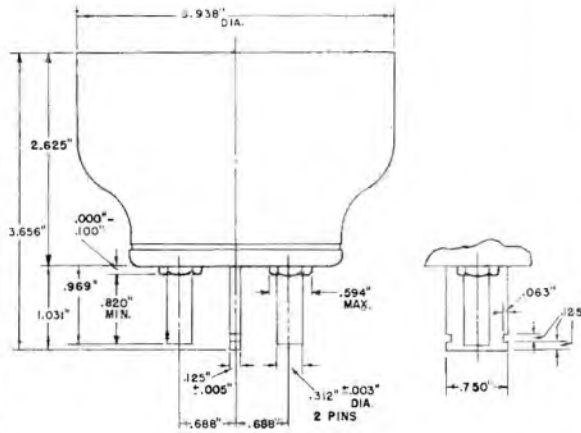
K-6966478
 ◆Revised.

Fig. 24

12-18-50

BASE OUTLINES

BASE 3117
◆ RTMA No. A3-23

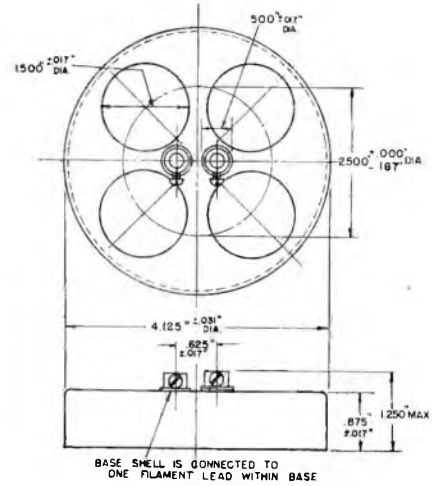


K-6966474
◆ Revised.

Fig. 25

12-18-50

BASE 3911
RTMA No. FO-2

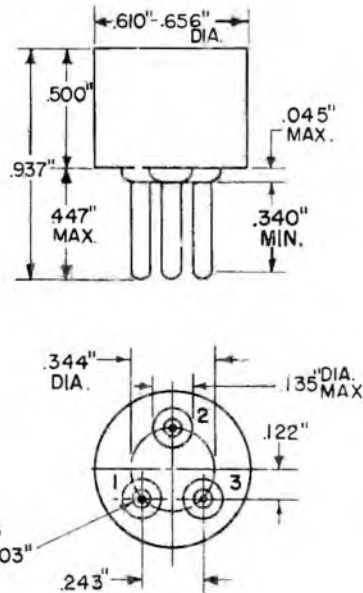


K-9033549

Fig. 26

9-26-50

PEEWEE 3-PIN
◆ No. 3313, RTMA No. A3-1

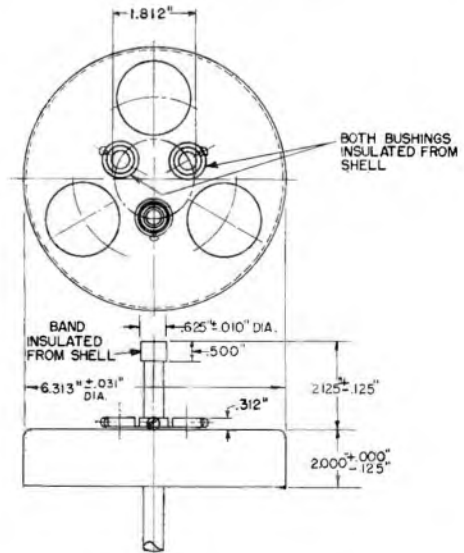


K-9033572
◆ Revised.

Fig. 27

12-18-50

BASE 3908
◆ RTMA No. FO-3



K-6966483
◆ Revised.

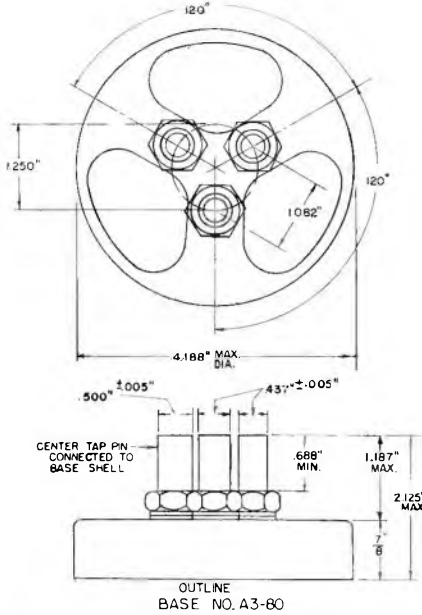
Fig. 28

12-18-50

BASE OUTLINES

BASE 3232-L1

◆ RTMA No. A3-80



OUTLINE
 BASE NO. A3-80

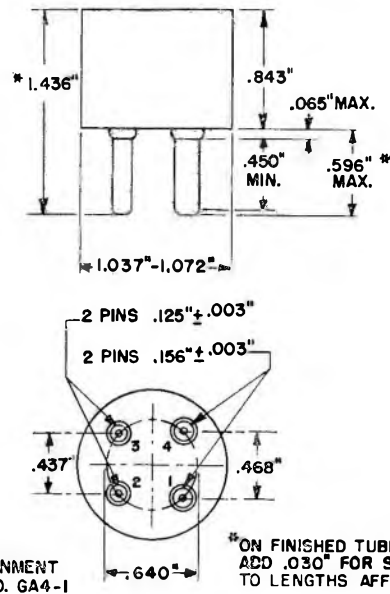
Fig. 29

K-9033548
 †Revised.

12-18-50

◆ DWARF-SHELL 4-PIN BASE

RTMA No. A4-26



FOR PIN ALIGNMENT
 USE GAGE NO. GA4-1

*ON FINISHED TUBE,
 ADD .030" FOR SOLDER
 TO LENGTHS AFFECTED

Fig. 30

K-69087-72A426
 †New.

12-18-50

SMALL 4-PIN

◆ No. 4108, RTMA No. A4-5

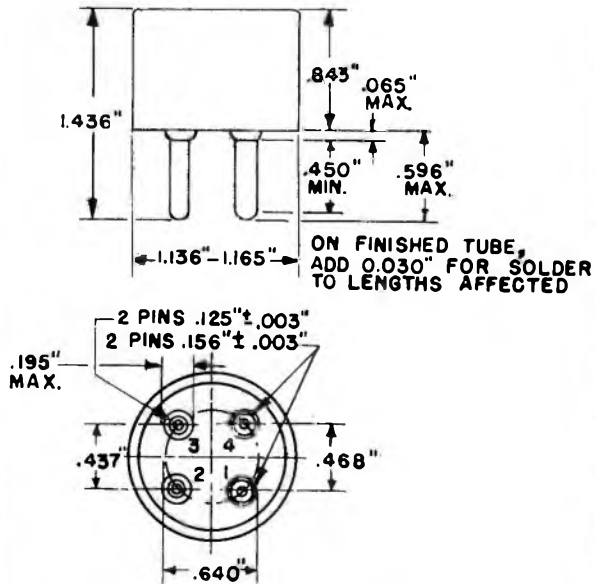


Fig. 31

K-69087-97A114
 †Revised.

12-30-46

MEDIUM 4-PIN WITH BAYONET

◆ No. 4102 and 4103, RTMA No. A4-10

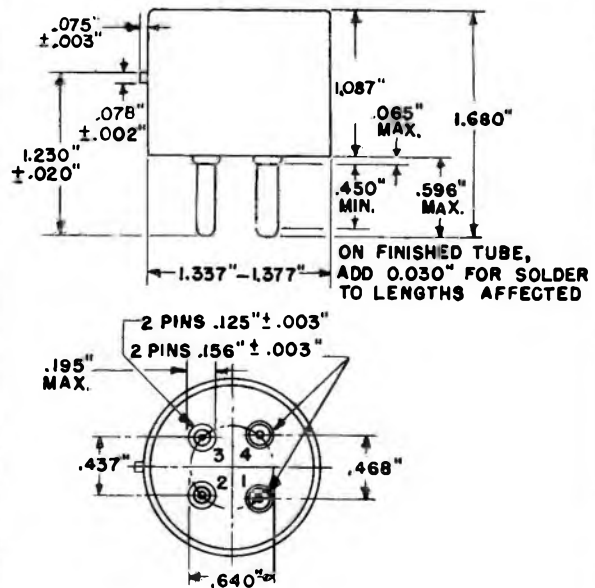


Fig. 32

K-69087-97A116
 †Revised.

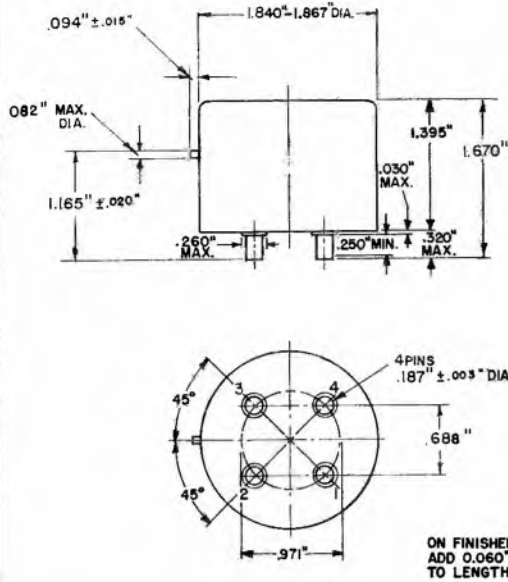
12-30-46

*4102—Composition Shell
 4103—Metal Shell

BASE OUTLINES

JUMBO 4-PIN WITH BAYONET

◆ No. 1839, RTMA No. A4-29



K-6966492
 Revised.

Fig. 33

12-18-50

ON FINISHED TUBE
 ADD $0.060''$ FOR SOLDER
 TO LENGTHS AFFECTED

SMALL-SHELL, SUPER-JUMBO 4-PIN

No. 411, RTMA No. A4-15

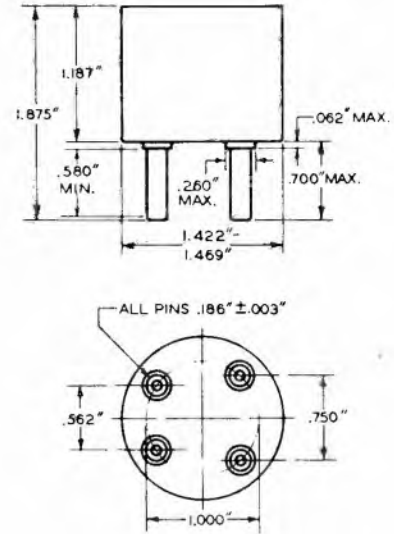
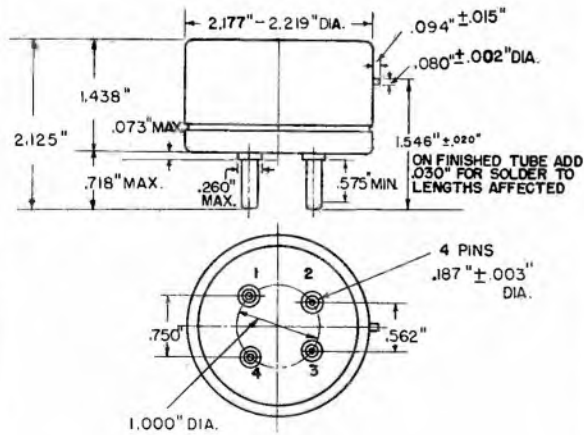


Fig. 34

SUPER-JUMBO 4-PIN WITH BAYONET

◆ No. 4310, RTMA No. A4-18



K-4955974
 Revised.

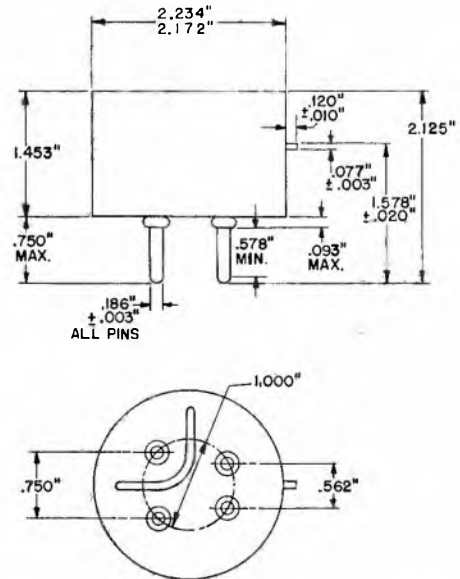
Fig. 35

9-15-50

ON FINISHED TUBE
 ADD $.030''$ FOR SOLDER
 TO LENGTHS AFFECTED

SUPER-JUMBO 4-PIN

◆ No. 3982



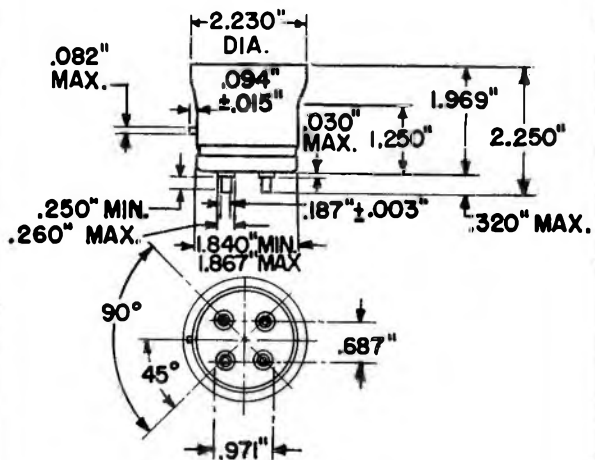
N-15000TC
 Revised.

Fig. 36

8-6-48

BASE OUTLINES

◆ No. 4260, RTMA No. A4-69

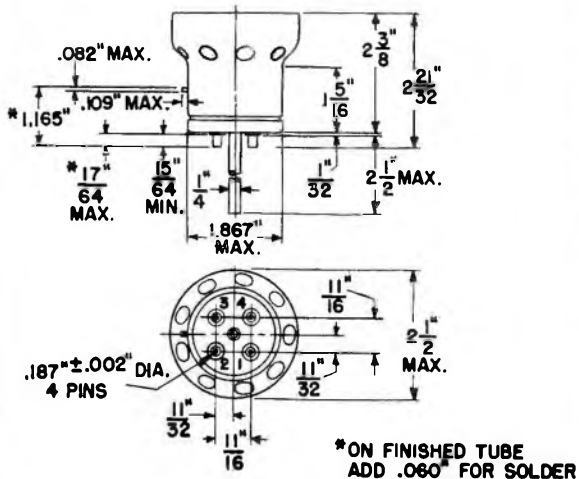


K-69087-72A427
 ◆New.

Fig. 37

12-18-50

◆ No. 5004B USED ON GL-1000T



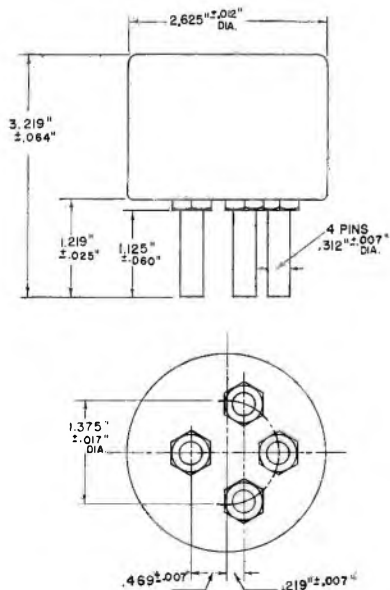
*ON FINISHED TUBE
 ADD .060" FOR SOLDER

K-69087-72A423
 ◆New.

Fig. 38

12-18-50

◆ BASE 3601



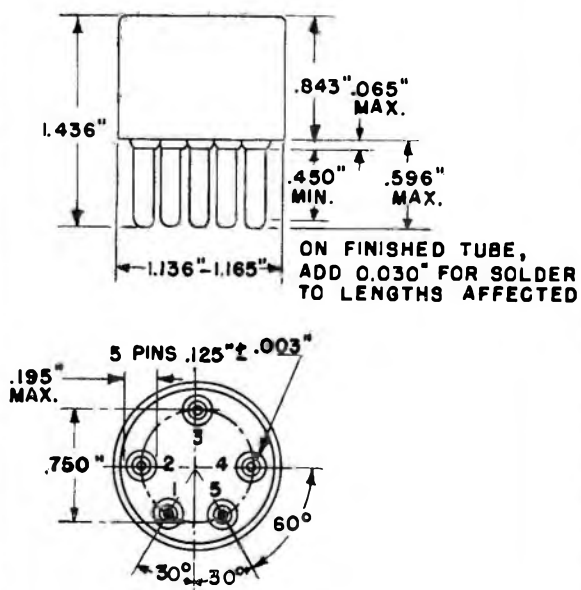
K-3846066
 ◆Revised.

Fig. 39

6-24-48

SMALL 5-PIN

◆ No. 5108, RTMA No. A5-6



ON FINISHED TUBE,
 ADD 0.030" FOR SOLDER
 TO LENGTHS AFFECTED

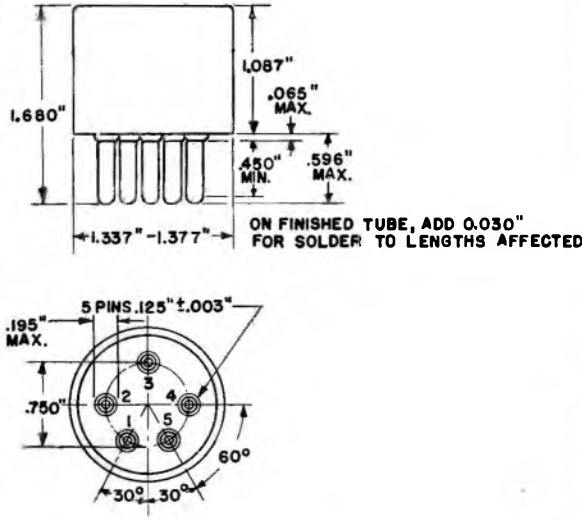
K-69087-97A117
 ◆Revised.

Fig. 40

12-30-46

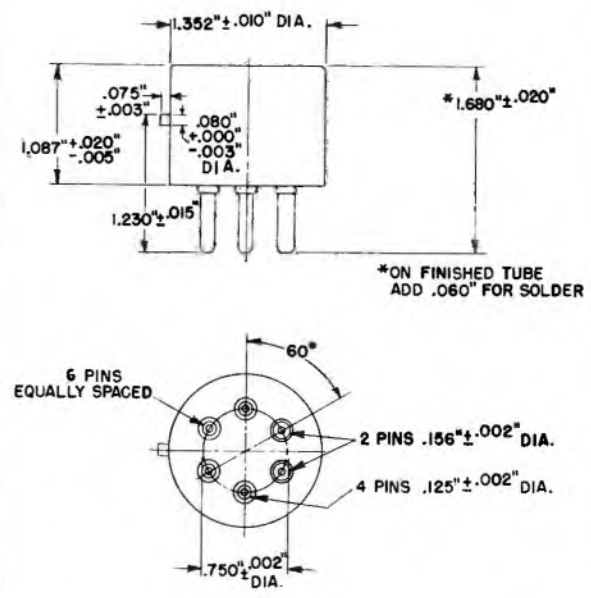
BASE OUTLINES

MEDIUM 5-PIN
◆ No. 5106, RTMA No. A5-11



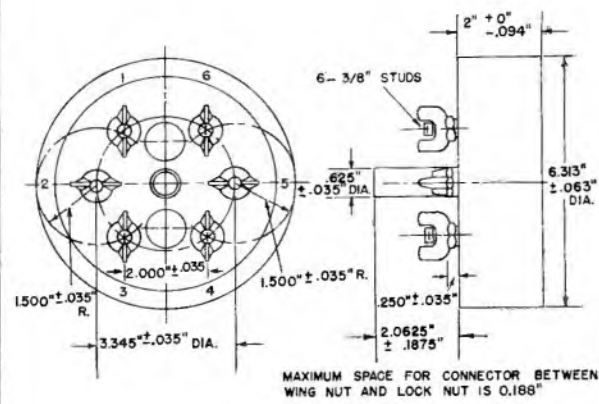
K-69087-97A118
◆ Revised. Fig. 41 12-30-46

◆ No. 6102



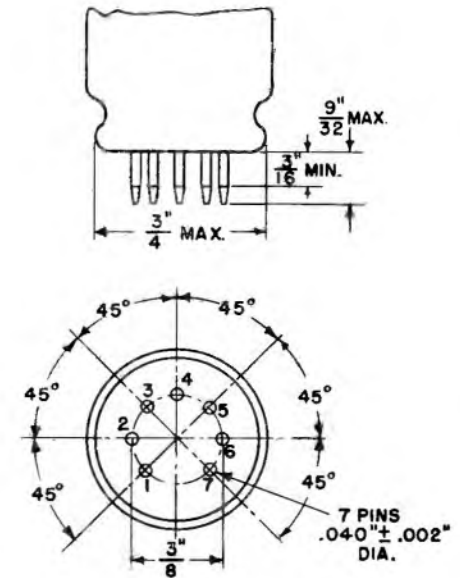
K-69087-72A425
◆ New. Fig. 42 12-18-50

◆ BASE 6628
RTMA No. FO-6



N-15047TA
◆ Revised. Fig. 43 12-18-50

MINIATURE BUTTON 7-PIN
◆ RTMA No. E7-1

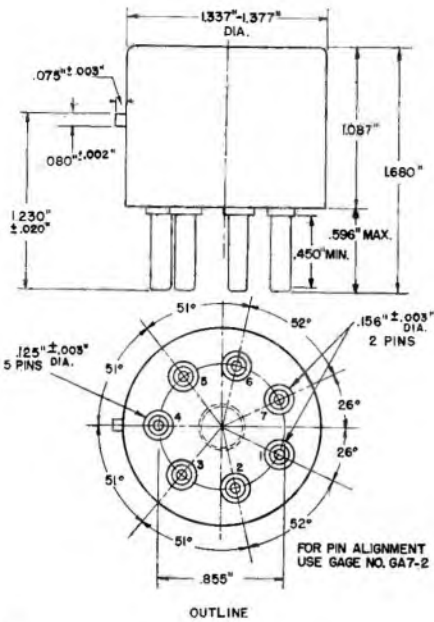


K-69087-97A134
◆ Revised. Fig. 44 12-30-46

BASE OUTLINES

MEDIUM 7-PIN WITH BAYONET

◆ RTMA No. A7-14



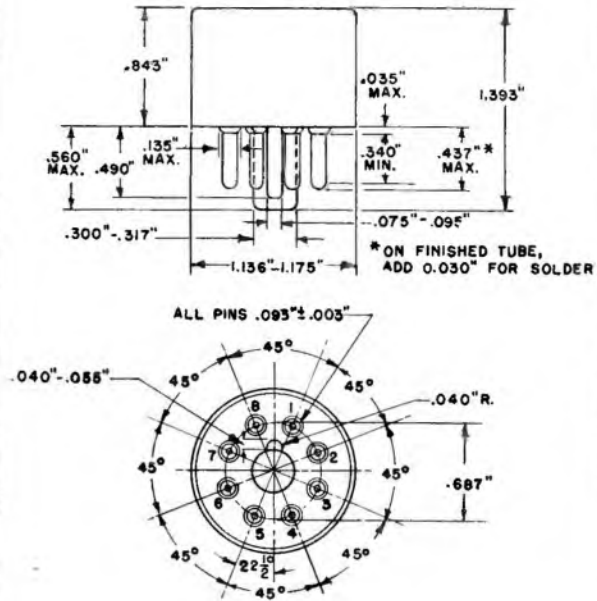
K-9186047
 ◆New.

Fig. 45

8-4-48

◆ SMALL-SHELL OCTAL 8-PIN

No. B8-1



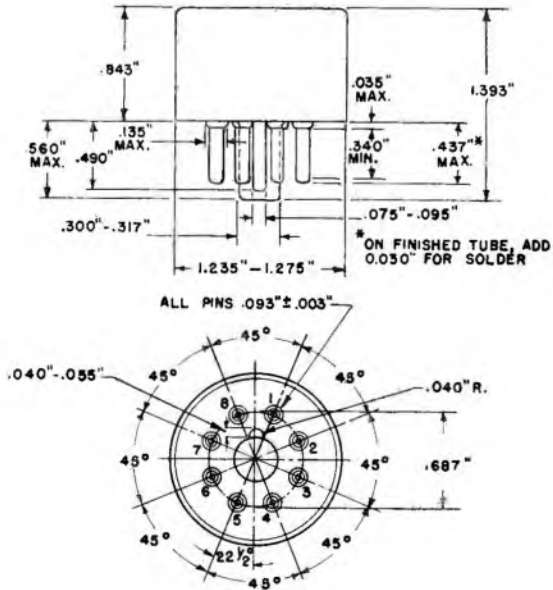
K-69087-97A124
 ◆Revised.

Fig. 46

12-30-46

◆ INTERMEDIATE-SHELL OCTAL

No. B8-6 8 Pins
 No. B7-7 7 Pins
 No. B6-8 6 Pins
 No. B5-10 5 Pins



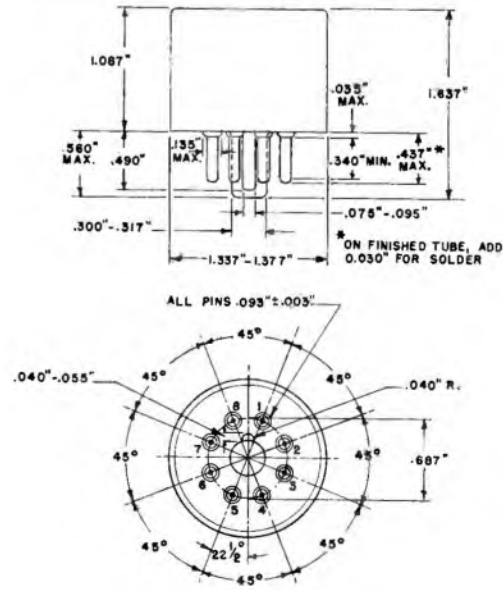
K-69087-97A125
 ◆Revised.

Fig. 47

12-30-46

◆ MEDIUM-SHELL OCTAL

No. B8-11 8 Pins
 No. B7-12 7 Pins
 No. B6-13 6 Pins
 No. B5-15 5 Pins



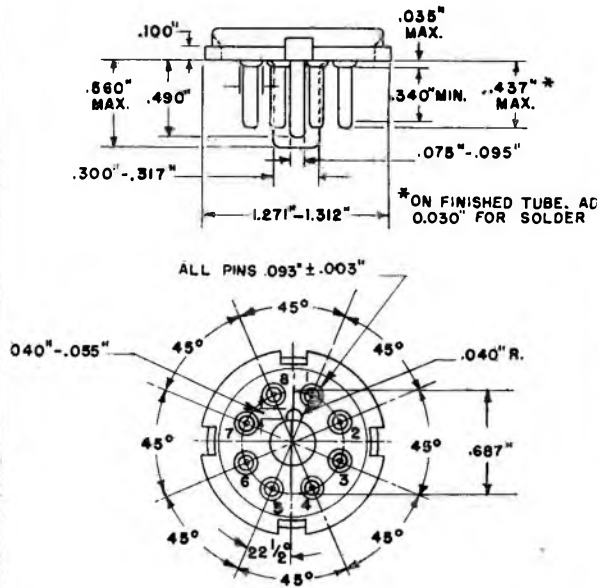
K-69087-97A126
 ◆Revised.

Fig. 48

12-30-46

BASE OUTLINES

◆ SMALL-WAFER OCTAL 8-PIN
No. B8-21

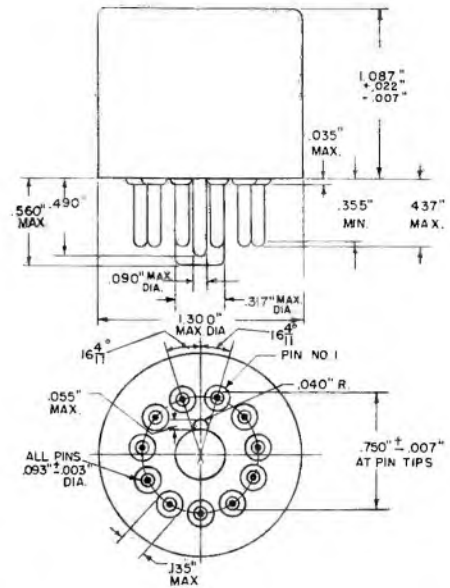


K-69087-97A127
◆ Revised.

Fig. 49

12-30-46

SMALL-SHELL SUBMAGNAL 11-PIN
No. 11343

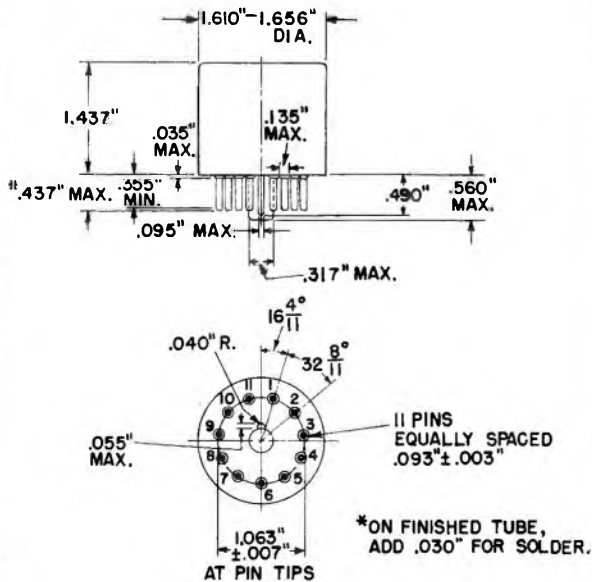


K-9033574

Fig. 50

12-18-50

MEDIUM-SHELL MAGNAL 11-PIN
◆ No. 11248

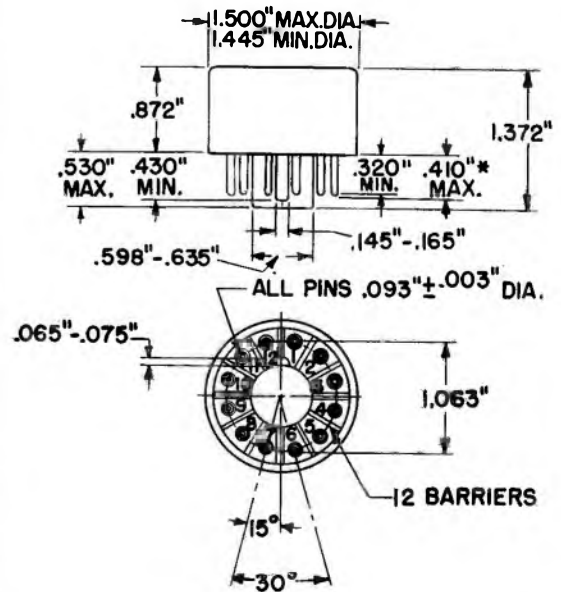


K-69087-72A424
◆ New.

Fig. 51

12-18-50

SMALL-SHELL DUODECAL 12-PIN
◆ RTMA No. B12-43



K-69087-72A422
◆ New.

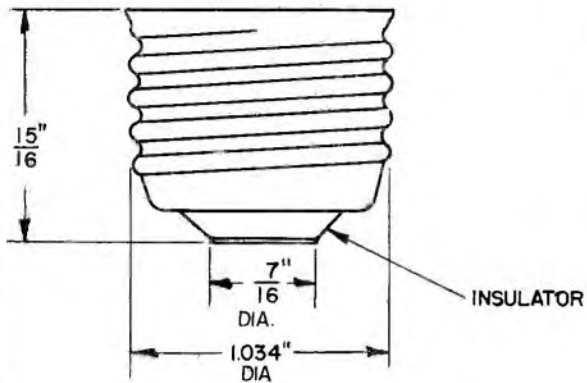
Fig. 52

12-18-50

BASE OUTLINES

MEDIUM LAMP BASE

◆ No. G2-2



SCREW THREADS CONFORM
TO ASA STANDARD C44-1931

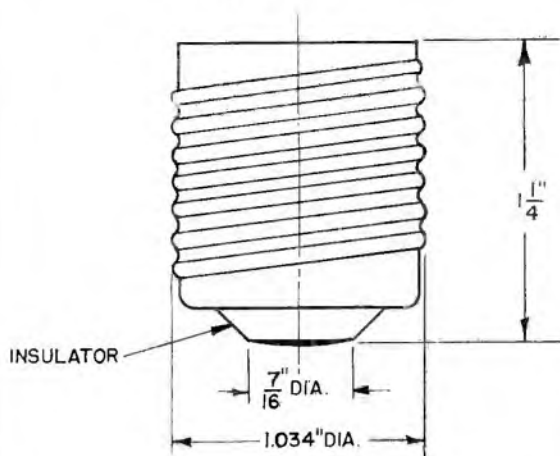
K-5185217
◆ Revised.

Fig. 53

5-13-47

MEDIUM LAMP BASE

◆ No. G2-7



SCREW THREADS CONFORM TO
ASA STANDARD C44-1931

K-5182057
◆ Revised.

Fig. 54

11-6-47

Tube Divisions, Electronics Department

GENERAL  ELECTRIC

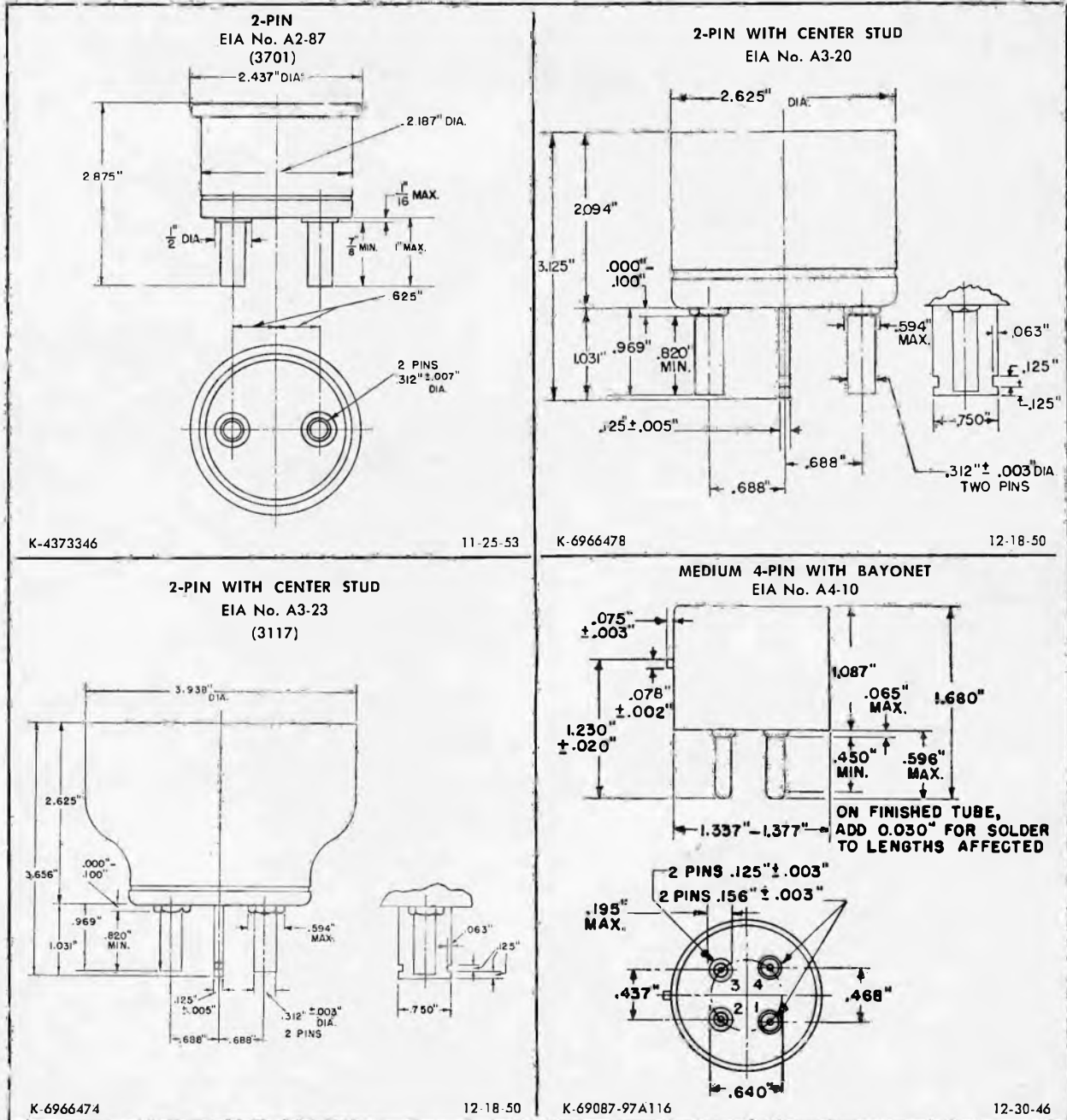
Schenectady, N. Y.

BASES, CAPS POWER TUBES

This listing includes the bases and caps used on all tubes included in the Industrial and Transmitting Tube Manuals. The bases are arranged in order by number of contacts. Following these, the caps are arranged by size.

The number references are the standard Electronic Industries Association numbers. These numbers are referenced on the tube outline drawings included with the technical data, enabling ready reference to the detailed drawings included here. In a few instances, the outline drawings on the data sheets have not been changed to show the EIA designation. In these cases the old General Electric identification is included in paranthesis with the EIA number.

BASES

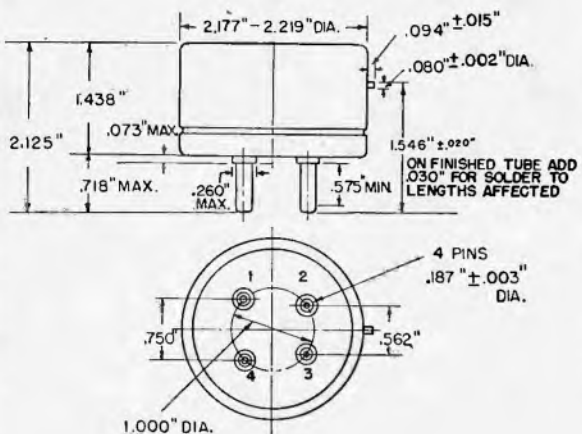


GENERAL ELECTRIC

Supersedes ETI-201B dated 12-50 and ETX-209A dated 3-51

BASES

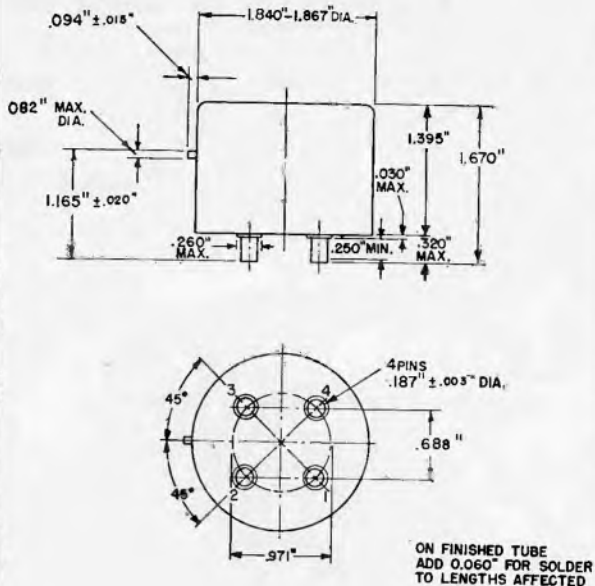
SUPER-JUMBO 4-PIN WITH BAYONET
 EIA No. A4-18
 (4310)



K-4955974

9-15-50

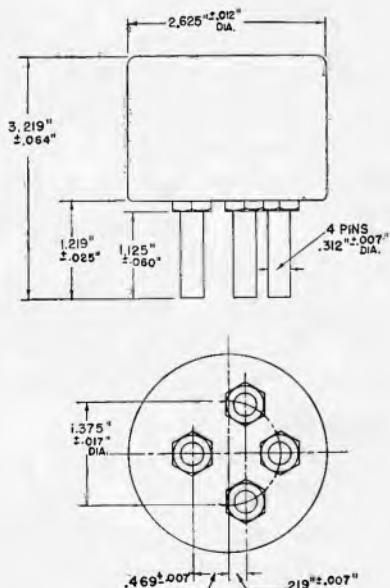
JUMBO 4-PIN WITH BAYONET
 EIA No. A4-29



K-6966492

12-18-50

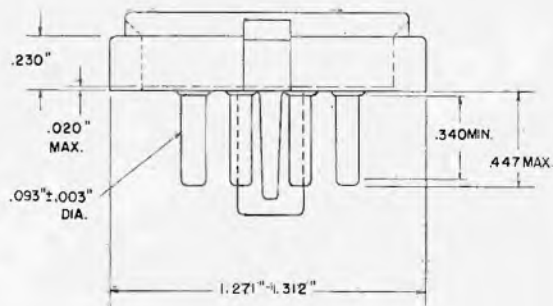
4-PIN
 EIA No. A4-75



K-3846066

6-24-48

SMALL H-WAFER OCTAL, 6-PIN
 EIA No. B6-108

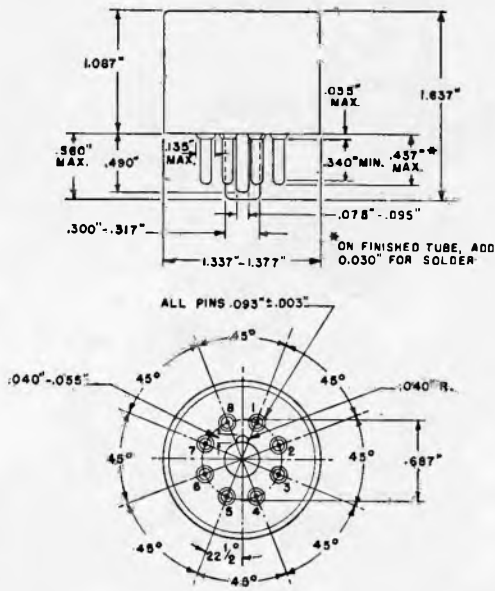


K-69087-97A189

10-9-58

BASES

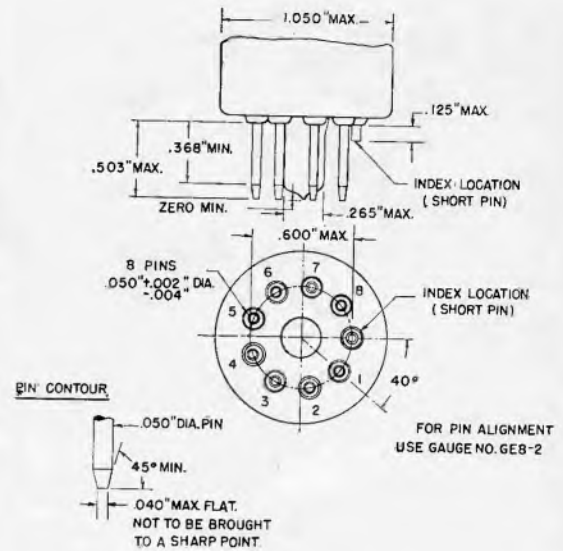
MEDIUM-SHELL OCTAL, 7-PIN
 EIA No. B7-12



K-69087-97A126

12-30-46

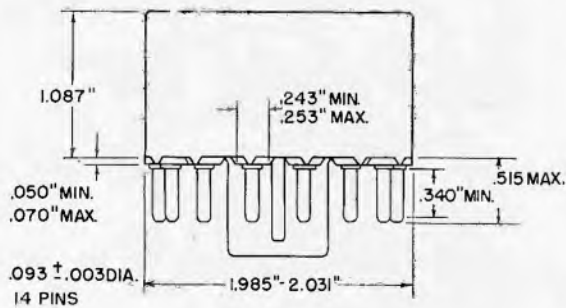
SMALL-BUTTON DITETRAR, 8-PIN
 EIA No. E8-11



K-69087-97A187

10-8-58

SMALL-SHELL DIHEPTAL, 14-PIN
 EIA No. B14-45

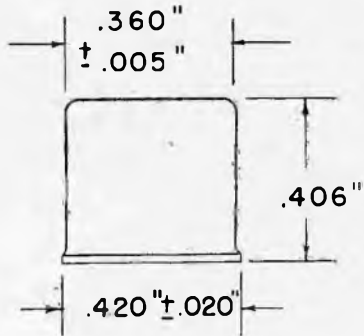


K-69087-97A188

10-8-58

CAPS

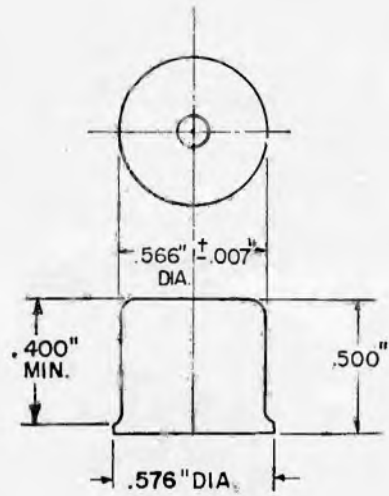
SMALL CAP
EIA No. C1-1



K-69087-97A129

10-9-58

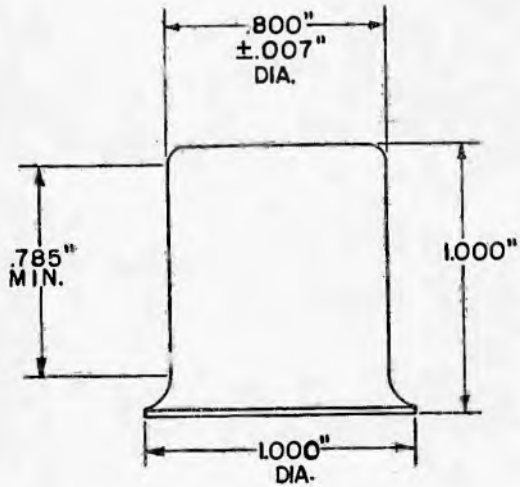
MEDIUM CAP
EIA No. C1-5



K-6966486

12-18-50

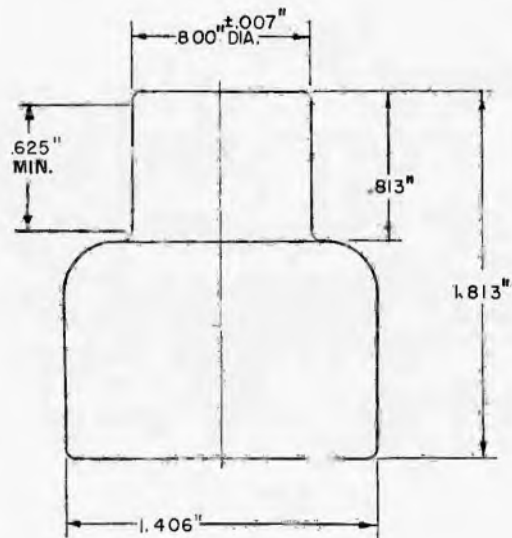
LARGE CAP
EIA No. C1-8



K-9186042

12-18-50

SKIRTED LARGE CAP
EIA No. C1-9



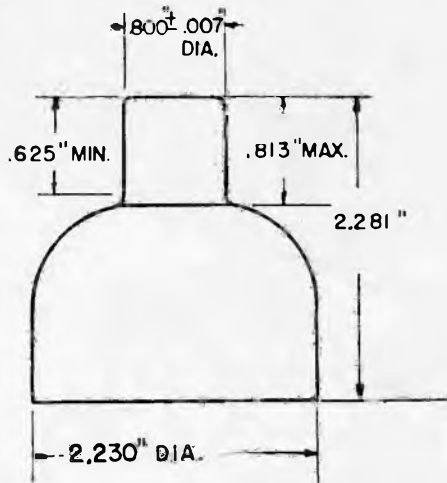
K-6966485

10-9-58

CAPS

SKIRTED LARGE CAP

EIA No. C1-10
 (1904)



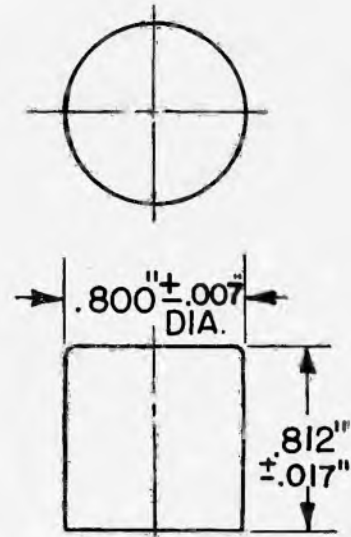
ON FINISHED TUBE ADD
 0.060" FOR SOLDER TO
 LENGTHS AFFECTED

K-6966488

10-9-58

LARGE CAP

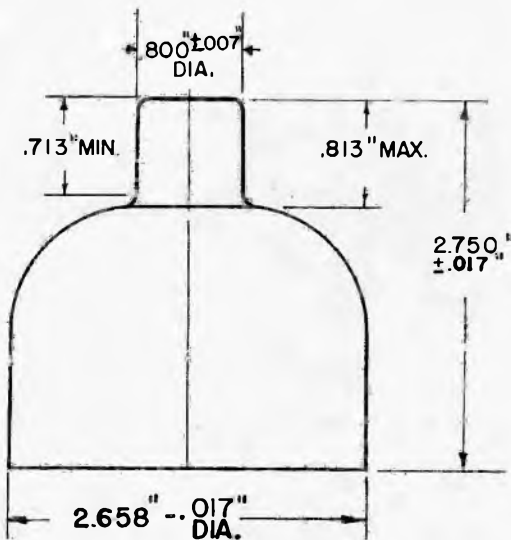
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9-15-50

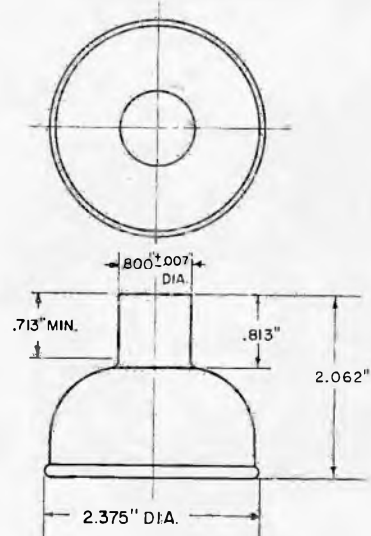
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10-9-58

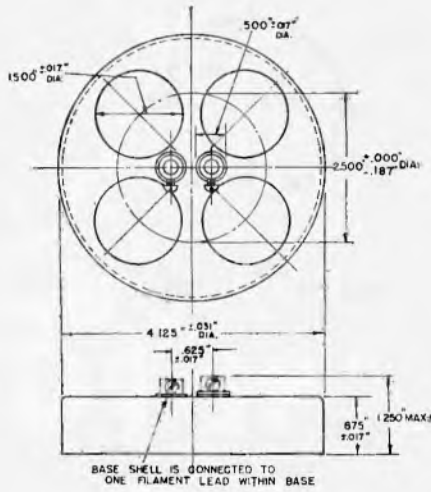
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10-9-58

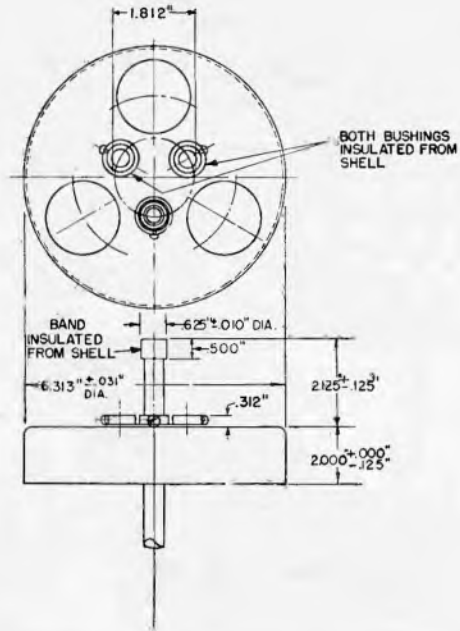
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9-26-50

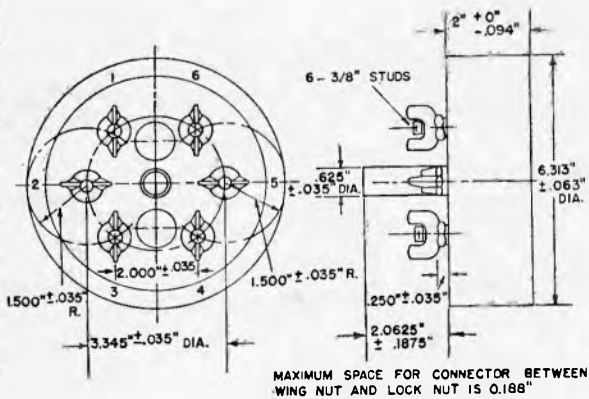
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 (3908)



K-6966483

12-18-50

TERMINAL-SUPPORT SHELL
 EIA No. FO-6
 (6628)



N-15047A

12-18-50

ELECTRONIC COMPONENTS DIVISION

GENERAL  ELECTRIC

Schenectady 5, N. Y.

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SPECIFICATIONS

ELECTRONIC TUBES FOR INDUSTRY

INTRODUCTION TO SPECIFICATIONS

Specifications in this section are a form of electronic tube data, the significance of which has not been fully appreciated by those who design tube equipment. They are equally as important as the Description and Rating Sheets when tube applications are being considered since their purpose is to serve as a guide to the interpretation of the ratings given on that sheet. If equipment in which an electronic tube is to be used is to be designed correctly, it is essential that the Specifications be used. The Specification is a detailed exposition of how the tube will operate under given sets of conditions.

There are two main sections, one covering Mechanical Requirements, the other Electrical Requirements. The former refers to the Outline Drawing where all essential dimensions, bases, caps, and basing connections are shown. The second section "Electrical Requirements" is the more detailed. This portion lists all electrical tests with their conditions and maximum and minimum limits. The electrical tests cover all relevant tube characteristics. A study of these conditions and the limits given will provide the tube application engineer with a clear understanding of what can be

expected in normal operation.

The Specifications are particularly important when one considers that the Description and Rating Sheet is designed to assist in preliminary selection of a tube whereas the Specifications are then to be used for determining proper design of the equipment in which the tube is to be used.

The Description and Rating Sheet will enable the designer to estimate quickly the power output capabilities and power supply requirements of a particular tube whereas the Specifications will serve to indicate what variation may be expected during the life of the tube or what deviation there may be between individual tubes.

Equipment should not be designed from the Description and Rating Sheet which gives only the maximum ratings and, in some cases, typical operating conditions. Use of the Specifications as a guide to equipment design assures the user that any tube of a given type will operate within its ratings, and thus is a prerequisite to satisfactory performance of the apparatus.

The following list of IRE letter symbols is included for your convenience. These symbols will appear throughout the specification data sheets.

IRE SYMBOLS

e_c	Instantaneous total grid voltage	E_g	Effective or maximum value of varying component of grid voltage
e_b	Instantaneous total plate voltage	E_p	Effective or maximum value of varying component of plate voltage
i_c	Instantaneous total grid current	I_g	Effective or maximum value of varying component of grid current
i_b	Instantaneous total plate current	I_p	Effective or maximum value of varying component of plate current
E_c	Average or quiescent value of grid voltage	E_t	Filament or heater terminal voltage
E_b	Average or quiescent value of plate voltage	I_t	Filament or heater current
I_c	Average or quiescent value of grid current	I_s	Total electron emission
I_b	Average or quiescent value of plate current	g_j	Conductance of electrode j
e_g	Instantaneous value of varying component of grid voltage	r_j	Resistance of electrode j
e_p	Instantaneous value of varying component of plate voltage	g_p	Plate conductance
i_g	Instantaneous value of varying component of grid current	r_p	Plate resistance
i_p	Instantaneous value of varying component of plate current	g_g	Grid conductance



Electronic
TUBE

IRE SYMBOLS (Continued)

r_g	Grid resistance	C_g	Grid capacitance
g_{jk}	Transconductance from electrode k to electrode j	C_p	Plate capacitance
g_m	($\equiv g_{pg}$) Grid-plate transconductance (mutual conductance)	C_k	Cathode capacitance
g_n	($\equiv g_{pg}$) Plate-grid transconductance (inverse mutual conductance)	E_{inv}	Peak (or crest) inverse voltage
μ_{jkl}	μ factor, electrodes j and k with respect to the current of electrode l	E_{fwd}	Peak (or crest) forward voltage
μ	Amplification factor	e'_{fwd}	Instantaneous tube voltage drop
C_{gp}	Grid-plate capacitance	$e_{c@eb}$	Critical grid voltage
C_{gk}	Grid-cathode capacitance	$i_{c@eb}$	Critical grid current
C_{pk}	Plate-cathode capacitance	t_h	Tube heating time
C_{gh}	Grid-heater capacitance	T_{Hg}	Temperature of mercury condensate
C_{ph}	Plate-heater capacitance	t_d	Deionization time
		t_k	Cathode heating time
		P_o	Power output
		P_i	Power input
		P_p	Anode dissipation

Electronics Department
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SPECIFICATIONS

12-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-111.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	Test Conditions								Test Limits		
	See Note	I_p Amp Min	RMS Demand Current Amp- Min	I_6 Amp Min	Conduc- tion Time per Spot Seconds Mini- mum	Averag- ing Time Seconds Max	Dura- tion of Test	E_p Volts	Min	Max	Units
Ignitor Resistance	1	—	—	—	—	—	—	—	5	110	Ohms
Peak Voltage Drop	2	100	—	—	—	—	—	—	—	16	Volts
A-c Welder Control Operation-Inter- mittent	3	—	2600	250	1	4.89	20 min. Minimum	—	—	—	20 Arc Backs 200 Ignitor Voltage for Ignition 30 Ignitor Current for Ignition 100 Ignitor Ignition time
High Potential	4	—	—	—	—	—	10 sec	12000	—	—	—

NOTES

1. With no other voltage applied, the ignitor-to-cathode resistance shall be measured with the tube mounted vertically and shall be within the limits specified.

For this test the tube temperature shall be between 15 and 35 C.

2. With the tube operating in a 60-cycle, half-wave rectifier adjusted to give the specified peak anode current and no greater than average anode current, the peak voltage drop exclusive of starting voltage measured from anode to cathode shall not exceed the limit specified. This voltage may be

observed by use of a cathode-ray oscilloscope connected directly, or through an amplifier to the tube under test.

For this test the water temperature shall be less than 15 C. Rated water flow shall be used.

3. The tube shall be connected "back to back" with a previously tested good tube to control alternating current to an inductive load with a power factor lower than 30 per cent. The tube under test shall be in the trailing position. The ignitor of each tube shall be connected to a suitable firing control circuit in such a manner that current will flow through the ignitor in the forward direction only.

The supply voltage shall be 575 plus or minus 25 volts rms, 60 cycles. With no phase retard the minimum rms demand current, conduction time per spot, and minimum average anode current shall be as specified.

After the initial spot and for the next four spots, the ignitor voltage for ignition shall not exceed 200 volts. During this and subsequent operation, the ignitor shall maintain control and the time required to initiate the arc shall not exceed 100

microseconds.

During the last three minutes of tube operation, the ignitor firing shall be retarded in phase so that the rms demand current is 75 plus or minus 5 per cent of the previous value. During this period, the number of arc backs shall not exceed the specified maximum. At the end of this period, the ignitor current for ignition shall not exceed 30 amperes when flowing for a time not exceeding 100 microseconds.

For this test rated water cooling shall be used at rated flow.

4. With the tube mounted in a vertical position, the specified voltage shall be applied for the specified time. During the last half of this test, there shall be no indication of current flow through the tube. Momentary flashes shall not be considered as an indication of current flow.

This test shall be given at least 15 hours after operation for those tubes which have been operated.

For this test the tube temperature shall be between 15 and 35 C.

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Schenectady, N. Y.

SPECIFICATIONS

12-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-113.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	Test Conditions								Test Limits		
	See Note	I_b Amp Min	RMS Demand Current Amp-Min	I_b Amp Min	Conduction Time per Spot Seconds Minimum	Averaging Time Seconds Max	Duration of Test	E_p Volts	Min	Max	Units
Ignitor Resistance	1	—	—	—	—	—	—	—	5	110	Ohms
Peak Voltage Drop	2	100	—	—	—	—	—	—	—	16	Volts
A-c Welder Control Operation—Intermittent	3	—	635	40	1	7.82	10 min Minimum	—	—	—	2 Arc Backs 200 Ignitor Voltage for Ignition 30 Ignitor Current for Ignition 100 Ignitor Ignition Time
High Potential	4	—	—	—	—	—	10 sec	12000	—	—	—

NOTES

1. With no other voltage applied, the ignitor-to-cathode resistance shall be measured with the tube mounted vertically and shall be within the limits specified.

For this test the tube temperature shall be between 15 and 35 C.

2. With the tube operating in a 60-cycle, half-

wave rectifier adjusted to give the specified peak anode current and no greater than average anode current, the peak voltage drop exclusive of starting voltage measured from anode to cathode shall not exceed the limit specified. This voltage may be observed by use of a cathode-ray oscilloscope connected directly, or through an amplifier to the tube under test.

For this test the water temperature shall be less than 15 C. Rated water flow shall be used.

3. The tube shall be connected "back to back" with a previously tested good tube to control alternating current to an inductive load with a power factor lower than 30 per cent. The tube under test shall be in the trailing position. The ignitor of each tube shall be connected to a suitable firing control circuit in such a manner that current will flow through the ignitor in the forward direction only.

The supply voltage shall be 575 plus or minus 25 volts rms, 60 cycles. With no phase retard the minimum rms demand current, conduction time per spot, and minimum average anode current shall be as specified.

After the initial spot and for the next four spots, the ignitor voltage for ignition shall not exceed 200 volts. During this and subsequent operation, the ignitor shall maintain control and the time required to initiate the arc shall not exceed 100 microseconds.

During the last three minutes of tube operation, the ignitor firing shall be retarded in phase so that the rms demand current is 75 plus or minus 5 per cent of the previous value. During this period, the number of arc backs shall not exceed the specified maximum. At the end of this period, the ignitor current for ignition shall not exceed 30 amperes when flowing for a time not exceeding 100 microseconds.

For this test rated water cooling shall be used at rated flow.

4. With the tube mounted in a vertical position, the specified voltage shall be applied for the specified time. During the last half of this test, there shall be no indication of current flow through the tube. Momentary flashes shall not be considered as an indication of current flow.

This test shall be given at least 15 hours after operation for those tubes which have been operated.

For this test the tube temperature shall be between 15 and 35 C.

Electronics Department
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SPECIFICATIONS

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-109.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	Test Conditions								Test Limits		
	See Note	I_p Amp Min	RMS Demand Current Amp- Min	I_b Amp Min	Conduc- tion Time per Spot Seconds Mini- mum	Averag- ing Time Seconds Max	Dura- tion of Test	E_p Volts	Min	Max	Units
Ignitor Resistance	1	—	—	—	—	—	—	—	5	110	Ohms
Peak Voltage Drop	2	100	—	—	—	—	—	—	—	16	Volts
A-c Welder Control Operation—Inter- mittent	3	—	1265	100	1	6.19	15 min Minimum	—	—	—	5 200 30 100 Arc Backs Ignitor Voltage for Ignition Ignitor Current for Ignition Ignitor Ignition time
High Potential	4	—	—	—	—	—	10 sec	12000	—	—	—

NOTES

1. With no other voltage applied, the ignitor-to-cathode resistance shall be measured with the tube mounted vertically and shall be within the limits specified.

For this test the tube temperature shall be between 15 and 35 C.

2. With the tube operating in a 60-cycle, half-

wave rectifier adjusted to give the specified peak anode current and no greater than average anode current, the peak voltage drop exclusive of starting voltage measured from anode to cathode shall not exceed the limit specified. This voltage may be observed by use of a cathode-ray oscilloscope connected directly, or through an amplifier to the tube under test.

Supersedes ETI-236A dated 12-45


Electronic
TUBE

For this test the water temperature shall be less than 15 C. Rated water flow shall be used.

3. The tube shall be connected "back to back" with a previously tested good tube to control alternating current to an inductive load with a power factor lower than 30 per cent. The tube under test shall be in the trailing position. The ignitor of each tube shall be connected to a suitable firing control circuit in such a manner that current will flow through the ignitor in the forward direction only.

The supply voltage shall be 575 plus or minus 25 volts rms, 60 cycles. With no phase retard the minimum rms demand current, conduction time per spot, and minimum average anode current shall be as specified.

After the initial spot and for the next four spots, the ignitor voltage for ignition shall not exceed 200 volts. During this and subsequent operation, the ignitor shall maintain control and the time required to initiate the arc shall not exceed 100 microseconds.

During the last three minutes of tube operation, the ignitor firing shall be retarded in phase so that the rms demand current is 75 plus or minus 5 per cent of the previous value. During this period, the number of arc backs shall not exceed the specified maximum. At the end of this period, the ignitor current for ignition shall not exceed 30 amperes when flowing for a time not exceeding 100 microseconds.

For this test rated water cooling shall be used at rated flow.

4. With the tube mounted in a vertical position, the specified voltage shall be applied for the specified time. During the last half of this test, there shall be no indication of current flow through the tube. Momentary flashes shall not be considered as an indication of current flow.

This test shall be given at least 15 hours after operation for those tubes which have been operated.

For this test the tube temperature shall be between 15 and 35 C.

Tube Divisions, Electronics Department

GENERAL  ELECTRIC
Schenectady, N. Y.

SPECIFICATIONS

12-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-114.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	Test Conditions								Test Limits		
	See Note	I_p Amp Min	RMS Demand Current Amp- Min	I_b Amp Min	Conduc- tion Time per Spot Seconds Mini- mum	Averag- ing Time Seconds Max	Dura- tion of Test	E_p Volts	Min	Max	Units
Ignitor Resistance	1	—	—	—	—	—	—	—	5	110	Ohms
Peak Voltage Drop	2	100	—	—	—	—	—	—	—	16	Volts
A-c Welder Control Operation—Inter- mittent	3	—	317	16	0.5	9.56	10 min Minimum	—	—	—	2 Arc Backs 200 Ignitor Voltage for Ignition 30 Ignitor Current for Ignition 100 Ignitor Ignition time
High Potential	4	—	—	—	—	—	10 sec	12000	—	—	—

NOTES

1. With no other voltage applied, the ignitor-to-cathode resistance shall be measured with the tube mounted vertically and shall be within the limits specified.

For this test the tube temperature shall be between 15 and 35 C.

2. With the tube operating in a 60-cycle, half-

wave rectifier adjusted to give the specified peak anode current and no greater than average anode current, the peak voltage drop exclusive of starting voltage measured from anode to cathode shall not exceed the limit specified. This voltage may be observed by use of a cathode-ray oscilloscope connected directly, or through an amplifier to the tube under test.

For this test the water temperature shall be less than 15 C. Rated water flow shall be used.

3. The tube shall be connected "back to back" with a previously tested good tube to control alternating current to an inductive load with a power factor lower than 30 per cent. The tube under test shall be in the trailing position. The ignitor of each tube shall be connected to a suitable firing control circuit in such a manner that current will flow through the ignitor in the forward direction only.

The supply voltage shall be 575 plus or minus 25 volts rms, 60 cycles. With no phase retard the minimum rms demand current, conduction time per spot, and minimum average anode current shall be as specified.

After the initial spot and for the next four spots, the ignitor voltage for ignition shall not exceed 200 volts. During this and subsequent operation, the ignitor shall maintain control and the time required to initiate the arc shall not exceed 100 microseconds.

During the last three minutes of tube operation, the ignitor firing shall be retarded in phase so that the rms demand current is 75 plus or minus 5 per cent of the previous value. During this period, the number of arc backs shall not exceed the specified maximum. At the end of this period, the ignitor current for ignition shall not exceed 30 amperes when flowing for a time not exceeding 100 microseconds.

For this test rated water cooling shall be used at rated flow.

4. With the tube mounted in a vertical position, the specified voltage shall be applied for the specified time. During the last half of this test, there shall be no indication of current flow through the tube. Momentary flashes shall not be considered as an indication of current flow.

This test shall be given at least 15 hours after operation for those tubes which have been operated.

For this test the tube temperature shall be between 15 and 35 C.

Electronics Department

GENERAL  ELECTRIC

Schenectady, N. Y.

SPECIFICATIONS

4-45

GENERAL

Equipment using any of these types should be so designed that any tube within the limits specified will operate satisfactorily. The tube shall be designed to have the average characteristics and maximum ratings given on the Description and

Rating sheets, ETI-141, 142, and 144.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

TEST	TYPE OF TUBE	TEST CONDITIONS IRE Symbols				TEST LIMITS		
		E _f Volts	E _b	I _b Ma	Time Minutes	Min.	Max.	Unit
Operation *	KC-4	20	150 kv peak inverse	150	5	—	—	—
	FP-85-A	10	20 kv peak inverse	25	5	—	—	—
	GL-411	10	100 kv peak inverse	80	5	—	—	—
Emission	KC-4	17	3000 volts d-c	Read	—	200	—	Ma
	FP-85-A	8	200 volts rms, a-c	Read	†	5	—	Ma
	GL-411	9	3000 volts d-c	Read	—	80	—	Ma
Filament Current	KC-4	20	—	—	—	23	26	Amp
	FP-85-A	10	—	—	—	4	5.3	Amp
	GL-411	10	—	—	—	13	16	Amp

*For the operation test the tubes are operated in pairs under the conditions given above in a single-phase, full-wave, 60-cycle circuit. Capacitance of approximately 0.0025 mfd connected across load, and each tube protected by sphere gap adjusted to 30 kv peak. If either electrode vibrates excessively reject tube.

†Operate until plate current stabilizes (about 30 sec).

SPECIFICATIONS

4-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-145.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols					Limits		
	See Note	E_f Volts	E_b Volts	I_b Amperes	Time Minutes	Min	Max	Units
Operation	1	5	40,000 Peak Inverse	0.100	5			
Emission		3	500 d-c	read	1/2	30	—	Ma
Plate current		5	200 d-c	read	—	75	—	Ma
Filament current		5	—	—	—	5.5	6.5	Amp
End of life	2	3	500 d-c	read	1/2	15	—	Ma

NOTES

1. Half-wave rectifier circuit without filter.
2. Life test conditions per Operation Test.

THYRATRON**GL-502-A****SPECIFICATIONS**

3-47

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tubes shall be designed to have the average characteristic and maximum ratings given on the

Description and Rating Sheet, ETI-134.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

For the electrical tests, the cathode must reach steady state operating temperature before any other potential is applied.

Except where otherwise specified; rated heater voltage will be applied, and the shield grid shall be connected to the cathode.

Test	TEST CONDITIONS					TEST LIMITS		
	See Note	E_{rwd}	E_{inv}	I_b	E_c	Min	Max	Units
Heater Current	1	—	—	—	—	0.54	0.66	Ampere
Tube Voltage Drop	2	125 d-c	—	0.3A d-c	—	—	14	Volts
Characteristic	3	A Read B 650 a-c	—	—	0 Read	—	60	Volts
Operation	4	650 a-c	1300	0.1A d-c	—	-5.0	-1.5	Volts

NOTES

1. With no other voltage applied to the tube, the heater current shall not exceed the limits specified.

2. An anode voltage of 125 volts d-c shall be applied, with sufficient series resistance to limit the average anode current to the specified value. The control grid shall be connected to the anode through a resistance of 1000 to 10,000 ohms.

The tube drop is measured from the anode to the cathode by calibrated cathode-ray oscilloscope or other suitable means, and shall not exceed the limit specified.

3. An anode resistor shall be used to limit the anode current to within rated average value. A

resistor not exceeding 0.1 megohm shall be in series with the control grid.

A. With the control grid voltage zero, the d-c anode voltage necessary to start a discharge shall not be greater than the limit specified.

B. With the specified anode voltage applied and a sufficiently negative d-c grid voltage applied to prevent conduction, the control-grid supply voltage shall gradually be made more positive until conduction occurs to the anode. The grid supply voltage at which conduction occurs shall be within the limits specified.

4. Two tubes shall be operated in a rectifier circuit with a resistance load without a filter.

Supersedes ETI-234 dated 12-45

3-47 (3M)
Filing No. 8850



Electronic
TUBE

GENERAL ELECTRIC

The control grid shall be supplied with an a-c voltage of not more than 120 volts, through a resistance of 0.1 megohm.

The tubes shall be operated for five minutes under the conditions specified without arc back.

At the end of the period, the current of each tube shall be reduced from the rated current to zero by varying only the phase of the applied grid voltage from zero to 180 electrical degrees lagging with respect to the anode voltage.

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PHANOTRONS**FG-32, FG-104****FG-280****SPECIFICATIONS**

4-45

GENERAL

Equipment using these types should be so designed that any tube within the limits specified will operate satisfactorily.

The tubes shall be designed to have the average characteristics and maximum ratings given in the

Description and Rating Sheets, ETI-147, 148 and 151.

MECHANICAL REQUIREMENTS

The tubes shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

For the electrical tests, the filament or cathode must reach steady state operating temperature before any other potential is applied. The anode and grid returns shall be made to the midtap of the filament transformer for filamentary tubes, or to the cathode connection for indirectly heated cathodes. The filament or heater voltage shall be in phase with the anode voltage and the cathode end of the heater shall be negative when the anode is positive.

Except where otherwise specified, rated filament or heater voltage shall be applied.

See Page 3 for detailed values and limits referred to in the following description of tests.

1. Filament or Heater Current Test

With no other voltage applied to the tube, the filament or heater current shall not exceed the limits specified.

2. Peak Voltage Drop Test (Emission)

An anode voltage of 110 volts a-c at 60 cycles shall be applied, with sufficient series resistance to limit the peak anode current to the rated value. A circuit shall be employed such that the tube

carries anode current for periods of not more than one-tenth second and preferably for only one-half cycle. These periods shall be spaced at a maximum rate of one pulse per second.

In testing mercury tubes, the condensed-mercury temperature shall be held at 40 ± 2 C.

The peak voltage drop, exclusive of the starting voltage, is measured from the anode to the anode return by a calibrated cathode-ray oscilloscope or other suitable means, and shall not exceed the limit specified.

3. Operation Test

Two tubes shall be operated in a bi-phase full-wave (4-anode) rectifier circuit with a resistance load and without a filter in the load circuit. The over-all regulation of the anode supply voltage shall be less than 10 per cent.

For this test, the ambient temperature shall be held between 20 and 40 C.

After the mercury (when mercury tubes are tested) has been properly distributed, the tubes shall be operated for five minutes with specified peak inverse voltage, and rated average current per tube without arcbreak or apparent sputtering of the cathode.

Type of Tube	TEST—Phanotrons			
	1. Filament Current I_f —Amperes		2. Peak Voltage Drop Max	3. Operation E_{inv}
	Min	Max		
FG-32	4.3	4.9	20	1000
FG-104	9.25	10.75	20	3000
FG-280§	9.25	10.75	20	2000

§Before any tests are made, the filament must be operated for 15 minutes in the case of the FG-280 to condense properly the mercury in the radiator.

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PHANOTRON

FG-190

SPECIFICATIONS

GENERAL

Equipment using this tube should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-150.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

For the electrical tests, the filament must reach steady state operating temperature before any

other potential is applied. The anode return shall be made to the midtap of the filament transformer.

Test	TEST CONDITIONS					TEST LIMITS		
	See Note	E_f	E_{inv}	I_p (Peak)	I_b (Average)	Min	Max	Units
Filament current	—	2.5	—	—	—	11.0	13.0	Amperes
Emission	1	2.5	—	5.0	—	—	12	Volts
Operation	2	2.5	190	—	1.25	—	—	—

1. Peak Voltage Drop Test (Emission)

An anode voltage of 110 volts a-c at 60 cycles shall be applied, with sufficient series resistance to limit the peak anode current per anode to the specified value. A circuit shall be employed such that one anode carries current for periods of not more than one-tenth second and preferably for only one-half cycle. These periods shall be spaced at a maximum rate of one pulse per second.

The peak voltage drop, exclusive of the starting voltage, is measured from each anode to the center tap of the filament transformer by a calibrated cathode-ray oscilloscope or other suitable means,

and shall not exceed the value specified.

2. Operation Test

The tube shall be operated in a rectifier circuit with a resistance load and without a filter in the load circuit. The over-all regulation of the anode supply voltage shall be less than 15 per cent.

The tube shall be operated for five minutes at the peak inverse voltage specified and with the average current specified per anode without arcbreak or apparent sputtering of the cathode.

For this test, the ambient temperature shall be between +20 and +40 C.

SPECIFICATIONS

4-45

GENERAL

Equipment using these types should be so designed that any tube within the limits specified will operate satisfactorily.

The tubes shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-152.

MECHANICAL REQUIREMENTS

The tubes shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

For the electrical tests, the cathode must reach steady state operating temperature before any other potential is applied. The anode return shall be made to the midtap of the filament transformer.

The filament voltage shall be in phase with the anode voltage and the filament shield shall be negative when the anode is positive.

TEST	TEST CONDITIONS							TEST LIMITS		
	See Note	E_f	Filament Heating Time (Min)	E_{inv}	i_p	I_b	Temp C	Min	Max	Units
Filament current	1	5.0	—	—	—	—	—	27	33	Amp
Peak voltage drop (emission)	2	5.0	1	—	40	—	30-40	—	20	Volts
Operation	3	5.0	30	22000	—	10	30-40	—	—	—

1. With filament voltage specified and no other voltage applied to the tube, the filament or heater current shall not exceed the limits indicated.

2. An anode voltage of 110 volts a-c at 60 cycles shall be applied, with sufficient series resistance to limit the peak anode current to the specified value. A circuit shall be employed such that the tube carries anode current for periods of not more than one-tenth second and preferably for only one-half cycle. These periods shall be spaced at a maximum rate of one pulse per second.

The peak voltage drop, exclusive of the starting voltage, is measured from the anode to the anode return by a calibrated cathode-ray oscilloscope or other suitable means, and shall not exceed the

limit specified. The condensed-mercury shall be within the limits specified.

3. The tubes shall be operated in a 60-cycle rectifier circuit with a resistance load and without a filter in the load circuit. The over-all regulation of the anode supply voltage shall be less than 10 per cent.

After the mercury has been properly distributed, half the peak inverse voltage specified shall be applied and increased within one minute to the full value. The tubes shall then be operated with the specified average current per tube for five minutes without arcbreak or apparent sputtering of the cathode. The ambient temperature shall be within the limit specified.

Artificial cooling may be used.

PHANOTRON

GL-869-B

SPECIFICATIONS

4 45

GENERAL

Equipment using these types should be so designed that any tube within the limits specified will operate satisfactorily.

The tubes shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-154.

MECHANICAL REQUIREMENTS

The tubes shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

For the electrical tests, the cathode must reach steady state operating temperature before any other potential is applied. The anode return shall be made to the midtap of the filament transformer.

The filament voltage shall be in phase with the anode voltage and the filament shield shall be negative when the anode is positive.

TEST	TEST CONDITIONS							TEST LIMITS		
	See Note	E_f	Filament Heating Time (Min)	E_{inv}	i_p	I_b	Temp C	Min	Max	Units
Filament current	1	5.0	—	—	—	—	—	17	21	Amp
Peak voltage drop (emission)	2	5.0	1	—	15	—	30-40	—	20	Volts
Operation	3	5.0	30	20000	—	2.5	30-40	—	—	—

1. With filament voltage specified and no other voltage applied to the tube, the filament or heater current shall not exceed the limits indicated.

2. An anode voltage of 110 volts a-c at 60 cycle shall be applied, with sufficient series resistance to limit the peak anode current to the specified value. A circuit shall be employed such that the tube carries anode current for periods of not more than one-tenth second and preferably for only one-half cycle. These periods shall be spaced at a maximum rate of one pulse per second.

The peak voltage drop, exclusive of the starting voltage, is measured from the anode to the anode return by a calibrated cathode-ray oscilloscope or other suitable means, and shall not exceed the

limit specified. The condensed-mercury temperature shall be within the limits specified.

3. The tubes shall be operated in a 60-cycle rectifier circuit with a resistance load and without a filter in the load circuit. The over-all regulation of the anode supply voltage shall be less than 10 per cent.

After the mercury has been properly distributed, half the peak inverse voltage specified shall be applied and increased within one minute to the full value. The tubes shall then be operated with the specified average current per tube for five minutes without arcbreak or apparent sputtering of the cathode. The ambient temperature shall be within the limits specified.

Artificial cooling may be used.

SPECIFICATIONS

4.45

GENERAL

Equipment using these types should be so designed that any tube within the limits specified will operate satisfactorily.

The tubes shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-155.

MECHANICAL REQUIREMENTS

The tubes shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

For the electrical tests, the cathode must reach steady state operating temperature before any other potential is applied. The anode return shall be made to the midtap of the filament transformer.

The filament voltage shall be in phase with the anode voltage and the filament shield shall be negative when the anode is positive.

TEST	TEST CONDITIONS							TEST LIMITS		
	See Note	E_f	Filament Heating Time (Min)	E_{inv}	i_p	I_b	Temp C.	Min	Max	Units
Filament current	1	5.0	—	—	—	—	—	6.25	8.0	Amp
Peak voltage drop (emission)	2	5.0	1	—	5.0	—	30-45	—	20	Volts
Operation	3	5.0	30	10000	—	1.25	20-60	—	—	—

1. With filament voltage specified and no other voltage applied to the tube, the filament or heater current shall not exceed the limits indicated.

2. An anode voltage of 110 volts a-c at 60 cycles shall be applied, with sufficient series resistance to limit the peak anode current to the specified value. A circuit shall be employed such that the tube carries anode current for periods of not more than one-tenth second and preferably for only one-half cycle. These periods shall be spaced at a maximum rate of one pulse per second.

The peak voltage drop, exclusive of the starting voltage, is measured from the anode to the anode return by a calibrated cathode-ray oscilloscope or

other suitable means, and shall not exceed the limit specified. The condensed-mercury temperature shall be within the limits specified.

3. The tubes shall be operated in a 60-cycle rectifier circuit with a resistance load and without a filter in the load circuit. The over-all regulation of the anode supply voltage shall be less than 10 per cent.

After the mercury has been properly distributed, the tubes shall be operated for five minutes with specified peak inverse voltage, and average current per tube without arcbreak or apparent sputtering of the cathode. The ambient temperature shall be within the limits specified.

Artificial cooling may be used.

PHANOTRON

GL-8008

SPECIFICATIONS

12-45

GENERAL

Equipment using these types should be so designed that any tube within the limits specified will operate satisfactorily.

The tubes shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-256.

MECHANICAL REQUIREMENTS

The tubes shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

For the electrical tests, the cathode must reach steady state operating temperature before any other potential is applied. The anode return shall be made to the midtap of the filament transformer. The filament voltage shall be in phase with the anode voltage and the filament shield shall be negative when the anode is positive.

TEST	TEST CONDITIONS							TEST LIMITS		
	See Note	E_r	Filament Heating Time (Min)	E_{inv}	i_p	I_b	Temp C	Min	Max	Units
Filament current	1	5.0	—	—	—	—	—	6.25	8.0	Amp
Peak voltage drop (emission)	2	5.0	1	—	5.0	—	30-45	—	20	Volts
Operation	3	5.0	30	10000	—	1.25	20-60	—	—	—

NOTES

1. With filament voltage specified and no other voltage applied to the tube, the filament or heater current shall not exceed the limits indicated.

2. An anode voltage of 110 volts a-c at 60 cycles shall be applied, with sufficient series resistance to limit the peak anode current to the specified value. A circuit shall be employed such that the tube carries anode current for periods of not more than one-tenth second and preferably for only one-half cycle. These periods shall be spaced at a maximum rate of one pulse per second.

The peak voltage drop, exclusive of the starting voltage, is measured from the anode to the anode return by a calibrated cathode-ray oscilloscope or

other suitable means, and shall not exceed the limit specified. The condensed-mercury temperature shall be within the limits specified.

3. The tubes shall be operated in a 60-cycle rectifier circuit with a resistance load and without a filter in the load circuit. The over-all regulation of the anode supply voltage shall be less than 10 per cent.

After the mercury has been properly distributed, the tubes shall be operated for five minutes with specified peak inverse voltage, and average current per tube without arcbreak or apparent sputtering of the cathode. The condensed-mercury temperature shall be within the limits specified. Artificial cooling may be used.



SPECIFICATIONS

12-45

GENERAL

Equipment using these types should be so designed that any tube within the limits specified will operate satisfactorily.

The tubes shall have the average characteristics and maximum ratings given on the Description

and Rating Sheet, ETI-243.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

For the electrical tests, the cathode must reach steady state operating temperature before any other potential is applied. The anode return shall be made to the midtap of the filament transformer. The filament voltage shall be in phase with the anode voltage and the filament shield shall be negative when the anode is positive.

Test	TEST CONDITIONS							TEST LIMITS		
	See Note	E_f	Filament Heating Time (Min)	E_{inv}	I_p	I_b	Temp C	Min	Max	Units
Filament Current	1	5.0	—	—	—	—	—	9.0	11.5	Amperes
Peak Voltage Drop (Emission)	2	5.0	0.5	—	6.0	—	30-45	—	20	Volts
Operation	3	5.0	30	15000	—	1.5	20-60	—	—	—

NOTES

1. With filament voltage specified and no other voltage applied to the tube, the filament or heater current shall not exceed the limits indicated.

2. An anode voltage of 110 volts a-c at 60 cycles shall be applied, with sufficient series resistance to limit the peak anode current to the specified value. A circuit shall be employed such that the tube carries anode current for periods of not more than one-tenth second and preferably for only one-half cycle. These periods shall be spaced at a maximum rate of one pulse per second.

The peak voltage drop, exclusive of the starting voltage, is measured from the anode to the anode return by a calibrated cathode-ray oscilloscope or other suitable means, and shall not exceed the

limit specified. The condensed-mercury temperature shall be within the limits specified.

3. The tubes shall be operated in a 60-cycle rectifier circuit with a resistance load and without a filter in the load circuit. The over-all regulation of the anode supply voltage shall be less than 10 per cent.

After the mercury has been properly distributed, half the peak inverse voltage specified shall be applied and increased within one minute to the full value. The tubes shall then be operated with the specified average current per tube for five minutes without arcback or apparent sputtering of the cathode. The condensed-mercury temperature shall be within the limits specified.

Artificial cooling may be used.

SPECIFICATIONS

11-46

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tubes shall have the average characteristics and maximum ratings given in the Description and

Rating sheet, ETI-244.

MECHANICAL REQUIREMENTS

The tubes shall have the dimensions and be within the tolerances shown on the outline drawing.

ELECTRICAL REQUIREMENTS

For the electrical tests, the cathode must reach steady state operating temperature before any other potential is applied. The anode return shall be made to the midtap of the filament transformer.

The filament voltage shall be in phase with the anode voltage and the filament shield shall be negative when the anode is positive.

Test	TEST CONDITIONS							TEST LIMITS		
	See Note	E_f	Fil. Heating Time (Min)	E_{inv}	i_p	I_b	Temp C	Min	Max	Units
Filament Current	1	5.0	—	—	—	—	—	9.0	11.5	Amperes
Peak Voltage Drop (Emission) Operation	2	5.0	0.5	—	6	—	38-42	—	20	Volts
	3	5.0	30	15,000	—	1.5	20-60	—	—	—

NOTES

1. With filament voltage specified and no other voltage applied to the tube, the filament current shall not exceed the limits indicated.

2. An anode voltage of 110 volts a-c at 60 cycles shall be applied, with sufficient series resistance to limit the peak anode current to the specified value. A circuit shall be employed such that the tube carries anode current for periods of not more than one-tenth second and preferably for only one-half cycle. These periods shall be spaced at a maximum rate of one pulse per second.

The peak voltage drop, exclusive of the starting voltage, is measured from the anode to the anode return by a calibrated cathode-ray oscilloscope or other suitable means, and shall not exceed the limit specified. The condensed mercury tempera-

ture shall be within the limits specified.

3. The tubes shall be operated in a 60-cycle rectifier circuit with a resistance load and without a filter in the load circuit. The over-all regulation of the anode supply voltage shall be less than 10 per cent.

After the mercury has been properly distributed, half the peak inverse voltage specified shall be applied and increased within one minute to the full value. The tubes shall then be operated with the specified average, current per tube for five minutes without arcbreak or apparent sputtering of the cathode. The condensed mercury temperature shall be within the limits specified.

Artificial cooling may be used.



SPECIFICATIONS

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-160A.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	(Test Conditions—IRE Symbols)						Limits		
	E_f	E_b	E_{c1}	E_{c2}	I_b	I_{c1}	Min	Max	Units
Plate Current	2.5	6.0	4.0	-4.0	Read	—	20	150	μ A
Grid-plate Transconductance	2.5	6.0	4.0	-4.0	—	—	15	—	μ mhos
Grid Current	2.5	6.0	4.0	-4.0	—	Calculate	—	5×10^{-15}	Amp
Filament Current	2.5	—	—	—	—	—	75	105	Ma

(Filament current test methods according to IRE Standards.)

The GL-5740/FP-54 is a low grid current tube requiring special technique and equipment for proper testing. Details of the testing equipment are shown on the circuit diagrams K-5344693 and K-8074613. All wiring, meters, controls, and batteries of this equipment should be mounted in a grounded, metallic test set to eliminate stray electromagnetic effects. The capacitance of the grid disconnecting switch must be negligible compared to the input capacitance of the GL-5740/FP-54.

The following outlines the procedure to be followed in conducting the specified tests. Thoroughly clean and dry the bulb before inserting the tube into the test set.

1. Plate Current

With the amplifier input switch in short-circuit position and the grid switch closed, adjust electrode voltages to specified values and read plate current.

2. Grid-plate Transconductance

With amplifier input switch in short-circuit

position and grid switch closed read plate current with grid voltage at -3.8 and -4.2 volts. Calculate the gridplate transconductance from the formula,

$$G_m = \frac{I_{p1} - I_{p2}}{0.4} \text{ micromhos.}$$

3. Grid Current

- Adjust GL-5740/FP-54 circuit as in test 1.
- Open amplifier input switch and turn on Vernier grid voltage supply SW_3 . Adjust amplifier bias and screen voltage to obtain 5.0 to 10 milliamperes amplifier plate current and an output current of approximately 70 to 80 microamperes.
- Adjust the GL-5740/FP-54 plate voltage to obtain the same plate current as on test 1.
- The stability of the amplifier, as determined by the rate of drift of the output current, is affected by the amplifier screen voltage. Therefore, the above settings must be varied to obtain a drift of less than 0.5 microamperes per minute.

The values of amplifier plate current and output current and the GL-5740/FP-54 plate current must be maintained as specified in B and C. This procedure may take several hours.

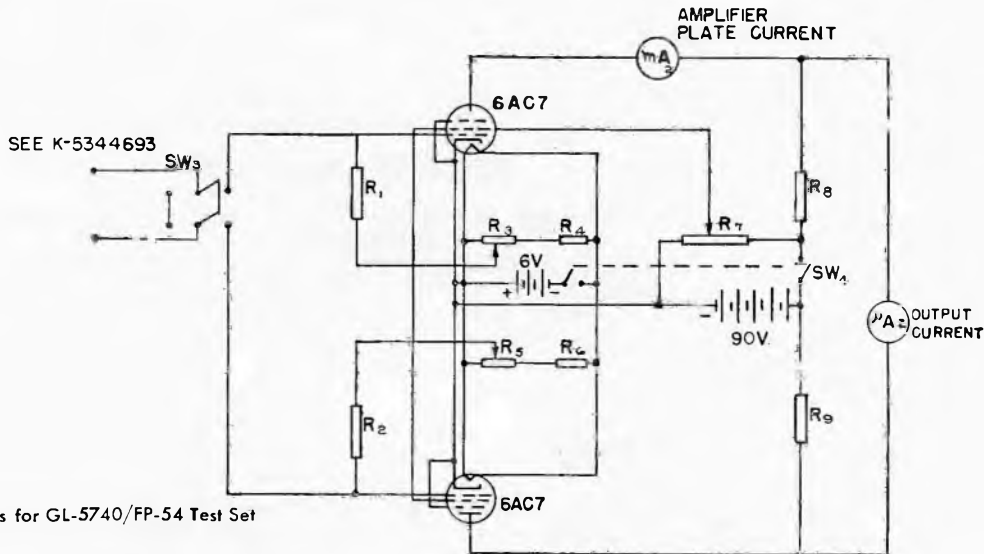
- E. Calibrate the amplifier by noting the output current before and after changing the GL-5740/FP-54 grid voltage 10 millivolts.
- F. Adjust the grid voltage to a value at which the output current is approximately 15 microamperes greater than the highest value noted in E.

- G. Open the grid disconnecting switch and time to the nearest second the interval required for the output current to drift between the two points noted in E (disregard initial transients).
- H. Repeat G until three successive readings agree within 5 per cent.
- I. The grid current is calculated from the following formula:

$$I_c = \frac{6 \times 10^{-14}}{t} \text{ amperes}$$

where t = time in seconds obtained from G.

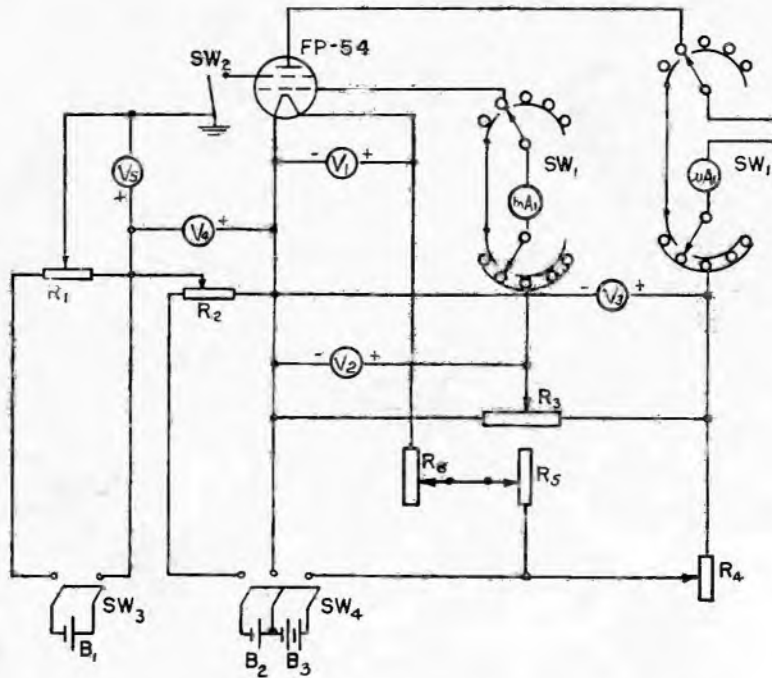
- R₁—10,000 Ohms, 5 w
- R₂—10,000 Ohms, 5 w
- R₃—200 Ohms
- R₄—200 Ohms, 5 w
- R₅—200 Ohms
- R₆—200 Ohms, 5 W
- R₇—20,000 Ohms
- R₈—2,000 Ohms, 5 w
- R₉—2,000 Ohms, 5 w
- SW₃—DPDT Shorting Switch (Input)
- μA₂—0-20-200 Microammeter D-c
- mA₂—0-15 Panel Milliammeter D-c
- SW₄—DPST Switch



Schematic Diagram of Connections for GL-5740/FP-54 Test Set
K-8074613
2-13-42

- R₁—400 Ohms
- R₂—400 Ohms
- R₃—400 Ohms
- R₄—400 Ohms
- R₅—100 Ohms
- R₆—7 Ohms
- B₁—2 V Storage Cell
- B₂—6 V Storage Battery
- B₃—8 V Storage Battery
- V₁—0-7.5 Panel Voltmeter D-c
- V₂—0-7.5 Panel Voltmeter D-c
- V₃—0-7.5 Panel Voltmeter D-c
- V₄—0-7.5 Panel Voltmeter D-c
- V₅—0-200 Millivoltmeter D-c
- SW₁—1400 L Switch, Yaxley 1 Stage, 5 Position Circuit Selector Switch
- SW₂—Low Capacity Switch (Grid Disconnecter)
- μA₁—0-100 Microammeter D-c
- MA₁—0-1 Panel Milliammeter D-c
- SW₃—DPST Mercury Contact Switch
- SW₄—TPST Mercury Contact Switch

NOTE: Five GL-5740/FP-54 positions with separate grid switches are selected by means of SW₁ for measuring space charge grid current and plate current.



Schematic Diagram of Connections for GL-5740/FP-54 Test Set
K-5344693
7-16-45

PLIOTRON

GL-207

SPECIFICATIONS

4-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-162.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_c Volts	E_b Kv	E_c Volts	I_b Amp	I_{ct} Amp	Time	Min	Max	Units
Capacitance (Cg-p)	—	—	—	—	—	—	—	24	30	$\mu\mu f$
Capacitance (Cg-f)	—	—	—	—	—	—	—	15	21	$\mu\mu f$
Capacitance (Cp-f)	—	—	—	—	—	—	—	1.5	2.5	$\mu\mu f$
Amplification factor	3	—	—	—	—	—	—	18	22	—
Operation	1	22	15	—	2.33	0.2	5 min.	22	—	kw
Emission	—	15	2	2000	read total	—	Inst.	0.35	0.65	amp
Grid voltage	2	22	10	read	0.02	—	Inst.	-450	-650	volt
Plate voltage	2	22	read	-300	0.75	—	Inst.	9	11	kv
Plate voltage	2	22	read	0	0.75	—	Inst.	3.5	4.5	kv
Reverse grid current	4	22	10	adjust	0.75	read	5 min	—	-100	μa
Filament current	—	22	—	—	—	—	—	49	53	amp

Notes

- Self-excited oscillator, grid leak approx 15,000 ohms
- Grid voltage measured from filament transformer centertap
- Calculate from plate voltage readings
- Read I_{ct} , at end of 5 minutes operation

SPECIFICATIONS

4-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-168.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Volts	E_{c1} Volts	I_b Ma	I_{c1} Ma	Time Minutes	Min	Max	Units
Capacitance	—	—	—	—	—	—	—	41	53	$\mu\mu\text{f}$
Cgp	—	—	—	—	—	—	—	21	30	$\mu\mu\text{f}$
Cgk	—	—	—	—	—	—	—	3.4	5.6	$\mu\mu\text{f}$
Cpk	—	—	—	—	—	—	—	18.5	22.5	—
Amplification factor	5	—	—	—	—	—	—	1600	—	watts
Operation	1	11	2500	—	1000	180	5	—	—	volts
Emission check	2	read	—	—	—	—	—	—	9.8	volts
Grid characteristic	—	11	2000	read	10	—	—	-90	-125	volts
Plate characteristic	—	11	read	-60	300	—	—	1700	2060	volts
Plate characteristic	—	11	read	0	300	—	—	550	750	volts
Reverse grid current	3	11	2000	adjust	400	read	5	—	-550	μa
Reverse grid current	4	0	—	—	—	—	—	—	-50	μa
Filament current	—	11	—	—	—	—	—	14.7	16.3	amp

Notes

- Self-excited oscillator, frequency below 3 mc, grid leak approximately 3000 ohms.
- After operation test, reduce filament voltage until power output reduces 10 per cent.
- Read $-I_{c1}$ at end of 5 minutes' operation.
- After preceding reverse grid current test, open filament circuit, allow electrodes to cool below visible color, reclose filament circuit, and read $-I_{c1}$ immediately.
- Calculate from plate characteristic tests.

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.

PLIOTRON

GL-862-A

SPECIFICATIONS

4-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-169.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawings.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Units
Capacitance	—	—	—	—	—	—	—	54	85	μf
Cgp	—	—	—	—	—	—	—	43	63	μf
Cgk	—	—	—	—	—	—	—	3	6	μf
Cpk	—	—	—	—	—	—	—	40	50	—
Amplification factor	1	—	—	—	—	—	—	115	—	kw
Operation	2	33	20	—	10	1.0	5	1.4	2.7	amp
Emission	—	22	3	3000	read total	—	Inst.	18	23	kv
Plate characteristic	3	33	read	-100	3.0	—	Inst.	14	18	kv
Plate characteristic	3	33	read	0	3.0	—	Inst.	-280	-370	volts
Grid characteristic	3	33	18	read	0.1	—	Inst.	—	-500	μa
Reverse grid current	4	33	20	adjust	2.5	read	5	199	215	amp
Filament current	—	33	—	—	—	—	—	—	—	—

NOTES

1. Calculate from plate characteristic readings.
2. Self-excited oscillator 1.5 Mc, grid leak approximately 1600 ohms.
3. Grid voltage measured from filament transformer centertap.
4. Read I_{c1} at end of 5 minutes' operation.

SPECIFICATIONS

4-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-170.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_s Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Units
Capacitance	—	—	—	—	—	—	—	21	27	$\mu\mu f$
Cgp	—	—	—	—	—	—	—	28.8	41.2	$\mu\mu f$
Cgk	—	—	—	—	—	—	—	1.0	3.0	$\mu\mu f$
Cpk	—	—	—	—	—	—	—	18	22	—
Amplification factor	1	—	—	—	—	—	—	18	22	—
Operation	2	12.6	10	—	4.5	0.80	5	28	—	kw
Emission	—	7	2	2000	read total	—	Inst.	0.2	0.5	amp
Plate characteristic	3	12.6	read	-200	2.0	—	Inst.	6.5	8.1	kv
Plate characteristic	3	12.6	read	0	2.0	—	Inst.	2.8	3.6	kv
Grid characteristic	3	12.6	10	read	0.02	—	Inst.	-460	-690	volts
Reverse grid current	4	12.6	10	adjust	2.0	read	5	—	-250	μa
Filament current	—	12.6	—	—	—	—	—	300	330	amp

NOTES

1. Calculate from plate characteristic readings.
2. Self-excited oscillator, grid resistor approx 1600 ohms.
3. Grid voltage measured from filament transformer centertap.
4. Read I_{c1} at end of 5 minutes' operation.

PLIOTRON

GL-889-A

SPECIFICATIONS

4-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-171.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Units
Capacitance										
Cgp	—	—	—	—	—	—	—	15.0	20.0	$\mu\mu\text{f}$
Cgk	—	—	—	—	—	—	—	19.2	27.4	$\mu\mu\text{f}$
Cpk	—	—	—	—	—	—	—	1.8	3.6	$\mu\mu\text{f}$
Amplification factor	1	—	—	—	—	—	—	18.9	23.1	—
Operation	2	11	10	—	2.0	0.30	5	12	—	kw
Emission	—	8	1	1000	read total	—	Inst.	0.3	0.8	amp
Plate characteristic	3	11	read	-200	1.0	—	Inst.	6.5	8.5	kv
Plate characteristic	3	11	read	0	1.0	—	Inst.	2.8	3.8	kv
Grid characteristic	3	11	7.5	read	0.02	—	Inst.	-325	-475	volts
Reverse grid current	4	11	7.5	adjust	1.0	read	5	—	-100	μa
Filament current	—	11	—	—	—	—	—	120	128	amp

NOTES

1. Calculate from plate characteristic readings.
2. Self-excited oscillator, grid leak approx 6000 ohms.
3. Grid voltage measured from filament transformer centertap.
4. Read I_{c1} at end of 5 minutes' operation.

SPECIFICATIONS

4-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-172.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Units
Capacitance	—	—	—	—	—	—	—	24	31	$\mu\mu\text{f}$
Cgp	—	—	—	—	—	—	—	15	23	$\mu\mu\text{f}$
Cgk	—	—	—	—	—	—	—	1.0	3.0	$\mu\mu\text{f}$
Cpk	—	—	—	—	—	—	—	7.6	9.4	—
Amplification factor	1	—	—	—	—	—	—	14	—	kw
Operation	2	22	17	—	2.2	0.16	5	14	—	kw
Emission	—	15	2	2000	read total	—	Inst.	0.35	0.85	amp
Plate characteristic	3	22	read	-1000	0.75	—	Inst.	9.5	11.5	kv
Plate characteristic	3	22	read	0	0.75	—	Inst.	1.6	2.2	kv
Grid characteristic	3	22	12	read	0.020	—	Inst.	-1500	-1950	volts
Reverse grid current	4	22	10	adjust	0.75	read	5	—	-100	μa
Filament current	—	22	—	—	—	—	—	57	62	amp

NOTES

1. Calculate from plate characteristic readings.
2. Self-excited oscillator, 1.5 mc. Grid leak approx 17,500 ohms.
3. Grid voltage measured from filament transformer centertap.
4. Read I_{c1} at end of 5 minutes' operation.

SPECIFICATIONS

4-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-173.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_g Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Units
Capacitance										
Cgp	—	—	—	—	—	—	—	27	33	$\mu\mu\text{f}$
Cgk	—	—	—	—	—	—	—	15	24	$\mu\mu\text{f}$
Cpk	—	—	—	—	—	—	—	0.5	2.5	$\mu\mu\text{f}$
Amplification factor	1	—	—	—	—	—	—	42.5	57.5	—
Operation	2	22	15	—	2.0	0.25	5	20	—	kw
Emission	—	15	2.0	2000	read total	—	Inst.	0.35	0.85	amp
Plate characteristic	3	22	read	-100	0.75	—	Inst.	12	16.5	kv
Plate characteristic	3	22	read	0	0.75	—	Inst.	7.5	11.0	kv
Grid characteristic	3	22	15	read	0.020	—	Inst.	-240	-400	volts
Reverse grid current	4	22	15	adjust	0.50	read	5	—	-100	μa
Filament current	—	22	—	—	—	—	—	57	62	amp

NOTES

1. Calculate from plate characteristic readings.
2. Self-excited oscillator, 1.5 mc. Grid leak approx 5000 ohms.
3. Grid voltage measured from filament transformer centertap.
4. Read I_{c1} at end of 5 minutes' operation.

PLIOTRON

GL-893-A

SPECIFICATIONS

4-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-174.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time	Min	Max	Units
Capacitance (Cg-p)	—	—	—	—	—	—	—	28.5	37.5	$\mu\mu f$
Capacitance (Cg-f)	—	—	—	—	—	—	—	39.5	56.5	$\mu\mu f$
Capacitance (Cp-f)	—	—	—	—	—	—	—	2.0	4.0	$\mu\mu f$
Amplification factor	3	—	—	—	—	—	—	32.4	39.6	—
Operation	1	20	20	—	4	0.6	5 min	50	—	kw
Emission	—	14	2	2000	read total	—	Inst.	1.5	4.0	amp
Grid voltage	2	20	20	read	0.02	—	Inst.	-530	-770	volts
Plate voltage	2	20	read	-200	1.0	—	Inst.	9.2	13.2	kv
Plate voltage	2	20	read	0	1.0	—	Inst.	3	5	kv
Reverse grid current	4	20	20	adjust	1.0	read	5 min	—	-250	μa
Filament current	—	20	—	—	—	—	—	175	190	amp

NOTES

- Self-excited oscillator, grid leak approx 6000 ohms.
- Grid voltage measured from filament transformer centertap.
- Calculate from plate voltage readings.
- Read I_{c1} at end of 5-minute operation.

SPECIFICATIONS**GENERAL**

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-175.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Units
Capacitance										
Cgp	—	—	—	—	—	—	—	7.6	9.8	$\mu\mu f$
Cgk	—	—	—	—	—	—	—	8.4	12.0	$\mu\mu f$
Cpk	—	—	—	—	—	—	—	0.6	1.2	$\mu\mu f$
Amplification Factor	1	—	—	—	—	—	—	17.2	25.8	
Operation	2	16	4.0	—	1.0	0.10	5	2.0	—	kw
Emission	—	11	1	1000	Read total	—	Inst.	0.25	0.75	amp
Plate Characteristic	3	16	Read	-50	0.5	—	Inst.	1.8	2.8	kv
Plate Characteristic	3	16	Read	0	0.5	—	Inst.	1.2	1.8	kv
Grid Characteristic	3	16	3.0	Read	0.02	—	Inst.	-160	-270	volts
Reverse Grid Current	4	16	3.0	Adjust	0.5	Read	—	—	-125	μa
Filament Current	—	16	—	—	—	—	—	35	40	amp

NOTES

1. Calculate from plate characteristic readings.
2. Self-excited oscillator, grid resistor approx 1600 ohms.
3. Grid voltage measured from filament transformer centertap.
4. Read I_{c1} at end of 5 minutes' operation.

SPECIFICATIONS

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-250.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Units
Capacitance	—	—	—	—	—	—	—	7.7	10.1	$\mu\mu f$
Cgp	—	—	—	—	—	—	—	8.4	12.0	$\mu\mu f$
Cgk	—	—	—	—	—	—	—	0.7	1.3	$\mu\mu f$
Cpk	—	—	—	—	—	—	—	17.2	25.8	
Amplification Factor	1	—	—	—	—	—	—	2.0	—	kw
Operation	2	16	4.0	—	1.0	0.10	5	0.25	0.75	amp
Emission	—	11	1	1000	Read total	—	Inst.	1.8	2.8	kv
Plate Characteristic	3	16	Read	-50	0.5	—	Inst.	1.2	1.8	kv
Plate Characteristic	3	16	Read	0	0.5	—	Inst.	—	-270	volts
Grid Characteristic	3	16	3.0	Read	0.02	—	Inst.	—	-125	μa
Reverse Grid Current	4	16	3.0	Adjust	0.5	Read	—	35	40	amp
Filament Current	—	16	—	—	—	—	—	—	—	—

NOTES

- Calculate from plate characteristic readings.
- Self-excited oscillator, grid leak approx 4000 ohms.
- Grid voltage measured from filament transformer centertap.
- Read I_{c1} at end of 5 minutes' operation.

SPECIFICATIONS

12-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-249.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Kv	E_{cl} Volts	I_b Amp	I_{cl} Amp	Time Minutes	Min	Max	Units
Capacitance	—	—	—	—	—	—	—	—	—	—
Cg-p	—	—	—	—	—	—	—	15.8	21.2	$\mu\mu f$
Cg-k	—	—	—	—	—	—	—	19.2	27.4	$\mu\mu f$
Cp-k	—	—	—	—	—	—	—	2	4	$\mu\mu f$
Amplification Factor	1	—	—	—	—	—	—	18.9	23.1	—
Operation	2	11	10	—	1.5	.30	5	10	—	kw
Emission	—	8	1.0	1000	read total	—	Inst.	0.5	1.4	amp
Plate Characteristic	3	11	read	-200	1.0	—	Inst.	6.5	8.5	kv
Plate Characteristic	3	11	read	0	1.0	—	Inst.	2.8	3.8	kv
Grid Characteristic	3	11	7.5	read	0.02	—	Inst.	-325	-475	volts
Reverse Grid Current	4	11	5.0	adjust	1.0	read	5	—	-100	μa
Filament Current	—	11	—	—	—	—	—	110	128	amp

Notes

1. Calculate from plate characteristic readings.
2. Self-excited oscillator, grid leak approximately 6000 ohms.
3. Grid voltage measured from filament transformer centertap.
4. Read I_{cl} at end of 5 minutes' operation.

PLIOTRON

GL-891-R

SPECIFICATIONS

12-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-246.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_r Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Units
Capacitance	—	—	—	—	—	—	—	—	—	—
C _{g-p}	—	—	—	—	—	—	—	27	33	$\mu\mu f$
C _{g-k}	—	—	—	—	—	—	—	15	21	$\mu\mu f$
C _{p-k}	—	—	—	—	—	—	—	1.5	2.5	$\mu\mu f$
Operation	1	22	13.5	—	1.0	0.075	5	8.5	—	kw
Emission	—	15	2.0	2000	read total	—	Inst.	0.35	0.65	amp
Plate Characteristic	2	22	read	0	0.75	—	Inst.	1.6	2.2	kv
Grid Characteristic	2	22	12	read	0.02	—	Inst.	-1450	-1950	volts
Reverse Grid Current	3	22	10	adjust	0.45	read	5	—	-100	μa
Filament Current	—	22	—	—	—	—	—	58	61	amp

Notes

1. Self-excited oscillator, 1.5 mc. Grid leak approx 25,000 ohms.
2. Grid voltage measured from filament transformer centertap.
3. Read I_{c1} at end of 5 minutes' operation.

SPECIFICATIONS

12-45

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-247.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Unit
Capacitance	—	—	—	—	—	—	—	—	—	—
Cg-p	—	—	—	—	—	—	—	28	34	$\mu\mu\text{f}$
Cg-k	—	—	—	—	—	—	—	15	24	$\mu\mu\text{f}$
Cp-k	—	—	—	—	—	—	—	1.0	3.0	$\mu\mu\text{f}$
Amplification Factor	4	—	—	—	—	—	—	42.5	57.5	—
Operation	1	22	12.5	—	2.0	0.25	5	15	—	kw
Emission	—	15	2.0	2000	read total	—	Inst.	0.35	.85	amp
Plate Characteristic	2	22	read	0	.42	—	—	5.0	7.4	kw
Plate Characteristic	2	22	read	-100	0.42	—	—	9.2	13.2	kv
Grid Characteristic	2	22	15	read	0.020	—	Inst.	-240	-400	volts
Reverse Grid Current	3	22	12.5	adjust	0.42	read	5	—	-100	mu a
Filament Current	—	22	—	—	—	—	—	57	62	amp

Notes

1. Self-excited oscillator, 1.5 mc. Grid leak approx 5000 ohms.
2. Grid voltage measured from filament transformer centertap.
3. Read I_{c1} at end of 5 minutes' operation.
4. Calculate from plate characteristics.

PLIOTRON

GL-893A-R

12-45

SPECIFICATIONS

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-248.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_r Volts	E_b Kv	E_{c1} Volts	I_b Amp	I_{c1} Amp	Time Minutes	Min	Max	Units
Capacitance (C_{g-p})	—	—	—	—	—	—	—	29.8	38.8	$\mu\mu f$
Capacitance (C_{g-f})	—	—	—	—	—	—	—	39.5	56.5	$\mu\mu f$
Capacitance (C_{p-f})	—	—	—	—	—	—	—	2.6	4.4	$\mu\mu f$
Amplification Factor	3	—	—	—	—	—	—	32.4	39.6	—
Oscillation	1	20	20	—	4.0	0.6	5 min	50	—	kw
Emission	—	14	2	2000	read total	—	Inst.	1.5	4.0	amp
Grid Voltage	2	20	20	read	0.02	—	Inst.	-530	-770	volt
Plate Voltage	2	20	read	-200	1.0	—	Inst.	9.2	13.2	kv
Plate Voltage	2	20	read	0	1.0	—	Inst.	3	5	kv
Reverse Grid Current	4	20	20	adjust	1.0	read	5 min	—	-250	μa
Filament Current	—	20	—	—	—	—	—	175	190	amp

Notes

1. Self-excited oscillator, grid leak approx 6000 ohms.
2. Grid voltage measured from filament transformer centertap.
3. Calculate from plate voltage readings.
4. Read I_{c1} at end of 5-min. operation.

SPECIFICATIONS

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-163.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	TEST CONDITIONS IRE Symbols							TEST LIMITS		
	See Note	E_f Volts	E_b Volts	E_{c1} Volts	I_b Ma	I_{c1} Ma	Time Minutes	Min	Max	Units
Capacitance	—	—	—	—	—	—	—	9.5	12.5	μf
Cgp	—	—	—	—	—	—	—	6.4	10.2	μf
Cgk	—	—	—	—	—	—	—	2.9	4.7	μf
Cpk	—	—	—	—	—	—	—	67.5	82.5	—
Amplification factor	1	10	read	vary	90	—	—	180	—	watts
Operation	2	10	1500	—	200	45	2	—	—	—
Emission check	3	read	—	—	—	—	—	—	8.5	volts
Plate current	—	10	1500	-5	read	—	—	20	60	ma
Reverse grid current (a)	4	10	1500	adjust	200	—	5	—	—	μa
Reverse grid current (b)	—	10	1500	-5	—	—	—	—	15	μa
Filament current	—	10	—	—	—	—	—	5.0	5.5	amp

Notes

1. Read E_b for $E_{c1} =$ zero and +10 volts.
2. Self-excited oscillator, frequency approximately 8 megacycles, grid leak approximately 5000 ohms.
3. After operation test, decrease E_f until power output reduces 10 per cent.
4. Grid current to be read within three seconds maximum after switching over from condition "a."

GLOW TUBES

GL-OD3/VR150

5-49

SPECIFICATIONS

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the Description and Rating Sheet, ETI-176.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	See Note	Limits		
		Min	Max	Units
Starting voltage	1		180	volts
Anode voltage at 5 milliamperes anode current	2	145		volts
Anode voltage at 40 milliamperes anode current	2		162	volts
Regulation (5-40 milliamperes)			5.5	volts

NOTES:

1. Sufficient resistance is placed in series with the anode-supply voltage to limit the anode current to 30 milliamperes. The d-c anode-supply voltage is increased until complete breakdown occurs. Starting voltage is read just before breakdown.
2. The anode current specified is obtained by adjusting the d-c anode-supply voltage, the resistor in series with the anode, or both the voltage and resistor.
3. The regulation (5-40 milliamperes) is equal to the difference between the anode voltage at 5 milliamperes and the anode voltage at 40 milliamperes.

GLOWTUBES
GL-OC3/VR105

5-49

SPECIFICATIONS

GENERAL

Equipment using this type should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-176.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test methods according to IRE Standards

Test	See Note	Limits		
		Min	Max	Units
Starting voltage	1		127	Volts
Anode voltage at 5 milliamperes anode current	2	105		Volts
Anode voltage at 40 milliamperes anode current	2		112	Volts
Regulation (5-40 milliamperes)	3		4	Volts

NOTES:

1. Sufficient resistance is placed in series with the anode-supply voltage to limit the anode current to 30 milliamperes. The d-c anode-supply voltage is increased until complete breakdown occurs. Starting voltage is read just before breakdown.
2. The anode current specified is obtained by adjusting the d-c anode-supply voltage, the resistor in series with the anode, or both the voltage and resistor.
3. The regulation (5-40 milliamperes) is equal to the difference between the anode voltage at 5 milliamperes and the anode voltage at 40 milliamperes.



PHOTOTUBES

GL-1P29/FJ-401

SPECIFICATIONS

5-49

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-178.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

For all tests the anode voltage shall be applied through a resistance of one megohm.

Test	Type of Tube	See Note	TEST CONDITIONS NEMA SYMBOLS		TEST LIMITS		
			E	λ , A	Min	Max	Unit
Monochromatic Sensitivity (S_v)	GL-1P29/FJ-401	—	90	4000	4.75	—	$\mu\text{a/watt}$
		—	90	4500	3.75	—	$\mu\text{a/watt}$
		—	90	5000	2.75	—	$\mu\text{a/watt}$
		—	90	7000	—	$\frac{1}{2} S_v$ at 4000	$\mu\text{a/watt}$



PHOTOTUBE

GL-917

SPECIFICATIONS

4-45

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-183.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E_{bb}	Light Flux Lumens	R_p Meg	Min	Max	Units
Emission	1, 5	25	0.1	1.0	1.0	—	μa
Sensitivity	1, 5	250	0.1	1.0	1.2	3.2	μa
Leakage	2	250	0	1.0	—	0.1	μa
A-K resistance	3	—	0	—	50,000	—	Meg
Gas ratio	4	—	—	—	—	1.3	—

NOTES

1. Light source: Mazda projection lamp operated at 2870 K. It shall be replaced or photometered every 100 hours. Use diaphragm opening $\frac{1}{2}$ in. in diameter. Center the light beam on the center of cathode. Pins 3 and 4 nearest light source.

2. This test is made in absolute darkness.

3. Use high resistance ohmmeter.

4. Gas ratio: Sensitivity/emission.

5. Preheat tubes for one hour with $E_{bb} = 250$ v, $R_p = 1.0$ meg. Light source: 125 v—25 w inside frosted Mazda lamp, operated at 117–127 v, rms. Phototube cathode located approx 6.5 in. from center of lamp filament. Center the light beam on center of cathode. Pins 3 and 4 nearest the light source. Adjust lamp voltage to give $I_{10} = 9 \mu a$.

SPECIFICATIONS

4-45

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-185.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E_{bh}	Light Flux Lumens	R_p Meg	Min	Max	Units
Emission	1, 4	25	0.1	1.0	1.0	—	μa
Sensitivity	1, 4	250	0.1	1.0	1.2	3.2	μa
Leakage	2	250	0	1.0	—	0.1	μa
A-K resistance	5	—	0	—	50,000	—	Meg
Gas ratio	3	—	—	—	—	1.3	—

NOTES

1. Light source: Mazda projection lamp operated 2870 K. It shall be replaced or photometered every 100 hours. Use diaphragm opening $\frac{1}{2}$ in. in diameter. Center the light beam on center of cathode. Pins 3 and 4 nearest light source.

2. Use high resistance ohmmeter. This test is made in absolute darkness.

3. Gas ratio: Sensitivity/emission.

4. Preheat tubes for 1 hour with $E_{bh} = 250$ v, $R_p = 1.0$ meg light source: 125 v—25 w inside frosted Mazda lamp, operated at 117–127 v rms. Phototube cathodes located approx 6.5 in. from center of lamp filament. Center the light beam on the center of cathode. Pins 3 and 4 nearest to the light source. Adjust lamp voltage to give $I_b = 9 \mu a$.

5. This test is made in absolute darkness.

PHOTOTUBE

GL-921

SPECIFICATIONS

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-187.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E_{bb}	Light Flux Lumens	R_p Meg	Min	Max	Units
Emission	1	25	0.1	1.0	1.0	—	μa
Sensitivity	1	90	0.1	1.0	7.5	20.5	μa
Gas amplification	2	—	—	—	—	10	—
Leakage	3	90	0	1.0	—	0.1	μa

NOTES

1. Light source: Mazda projection lamp operated at 2870 K. It shall be replaced or photometered every 100 hours. Use diaphragm opening $\frac{1}{2}$ in. in diameter. Center the light beam on the center of

cathode.

- Gas amplification: Sensitivity/emission.
- This test is made in absolute darkness.

SPECIFICATIONS

4-45

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-188.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E_{bb}	Light Flux Lumens	R_p Meg	Min	Max	Units
Emission	1, 5	25	0.1	1.0	1.0	—	μa
Sensitivity	1, 5	250	0.1	1.0	1.2	3.2	μa
Leakage	2	250	0	1.0	—	0.1	μa
A-K resistance	3	—	0	—	50,000	—	Meg
Gas ratio	4	—	—	—	—	1.5	—

NOTES

1. Light source: Mazda projection lamp operated at 2870 K. It shall be replaced or photometered every 100 hours. Use diaphragm opening $\frac{1}{2}$ in. in diameter. Center the light beam on the center of cathode.

2. This test is made in absolute darkness.

3. Use high resistance ohmmeter.

4. Gas ratio: Sensitivity/emission.

5. Preheat tubes for one hour with $E_{bb} = 250$ v, $R_p = 1.0$ meg. Light source: 125 v—25 w inside frosted Mazda lamp, operated at 117–127 v rms. Phototube cathode located approx 6.5 in. from center of lamp filament. Center of lamp filament is to be on same plane as center of cathode. Adjust lamp voltage to give $I_{11} = 4 \mu a$.

PHOTOTUBE

GL-923

SPECIFICATIONS

4-45

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-189.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TESTS LIMITS		
	See Note	E_{bb}	Light Flux Lumens	R_p Megohms	Min	Max	Units
Dark Current	1	90	0	1.0	—	0.1	μ a D-c
Emission	2	25	0.1	1.0	1.0	—	μ a D-c
Sensitivity	2	90	0.1	1.0	7.5	20.5	μ a D-c
Gas Amplification	3	—	—	—	—	10	
Interelectrode Capacitance	—	—	—	—	1.5	2.5	μ f

Note 1—This test is made in absolute darkness.

2—Test made in a light-tight compartment with a Mazda projection lamp operated at 2870 K as a source of light. A dia-

phragm with an opening $\frac{1}{2}$ -inch in diameter is located so that the light beam is centered on the cathode.

3—Gas amplification: Sensitivity/Emission.

PHOTOTUBE**GL-927****SPECIFICATIONS**

4-45

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-190.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E_{bb}	Light Flux Lumens	R_p Meg	Min	Max	Units
Emission	1	25	0.1	1.0	.9	—	μa
Sensitivity	1	90	0.1	1.0	6.0	18.5	μa
Gas amplification	2	—	—	—	—	10	—
Leakage	3	90	0	1.0	—	0.1	μa

NOTES

1. Light source: Mazda projection lamp operated at 2870 K. It shall be replaced or photometered every 100 hours. Use diaphragm opening of 17 mm by 7.5 mm rectangular aperture. Center the

light beam on center of cathode. Pin 2 nearest the light source.

2. Gas amplification: Sensitivity/emission: —
 3. This test is made in absolute darkness.


Electronic
 TUBE

SPECIFICATIONS

4-45

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-191.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E_{hb}	Light Flux Lumens	R_p Megohms	Min	Max	Units
Dark Current	1	250	0	1.0	—	0.0125	μa D-c
Emission	2	25	0.1	1.0	—	—	μa D-c
Sensitivity	2	250	0.1	1.0	2.5	7.0	μa D-c
Gas Amplification	3	—	—	—	—	1.25	—
Interelectrode Capacitance	—	—	—	—	1.9	3.3	μf

Note 1—This test is made in absolute darkness.

2—Test made in a light-tight compartment with a Mazda projection lamp operated at 2870 K as a source of light. A dia-

phragm with an opening $\frac{1}{2}$ -inch in diameter is located so that the light beam is centered on the cathode.

3—Gas amplification: Sensitivity/Emission.

PHOTOTUBE

GL-930

SPECIFICATIONS

4-45

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-192.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E_{bb}	Light Flux Lumens	R_p Megohms	Min	Max	Units
Dark Current	1	90	0	1.0	—	0.1	μa D-c
Emission	2	25	0.1	1.0	1.0	—	μa D-c
Sensitivity	2	90	0.1	1.0	7.5	20.5	μa D-c
Gas Amplification	3	—	—	—	—	10	
Interelectrode Capacitance	—	—	—	—	1.8	3.2	$\mu\mu f$

Note 1—This test is made in absolute darkness.

2—Test made in a light-tight compartment with a Mazda projection lamp operated at 2870 K as a source of light. A dia-

phragm with an opening $\frac{1}{2}$ -inch in diameter is located so that the light beam is centered on the cathode.

3—Gas amplification: Sensitivity/Emission.

PHOTOTUBE

GL-931-A

SPECIFICATIONS

4-45

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-193.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS					TEST LIMITS			
	See Note	Volts per Stage	E_{bb}	Light Flux Lumens	R_p Meg	Min	Avg	Max	Units
Anode current	1, 2	100	100	0.001	0.01	450	2000	—	μa
Cathode current	2, 3	—	—	0.001	0.01	0.006	0.010	—	μa
Anode leakage	1	100	100	0	0.01	—	—	0.25	μa
Cathode leakage	1	100	100	0	0.01	—	0.1	5.0	μa
Amplification	4	—	—	—	—	75000	200000	—	—

NOTE

1. E_{bb} voltage is measured between ninth dynode and the anode.
2. Light source: MAZDA projection lamp operated at 2870 K. Lighted cathode area shall not be less than 7 square millimeters (approximately 3 millimeter-diameter aperture).

Adjust tube position to give the maximum sensitivity.

3. 100 volts applied between pins 1 and 2 and the cathode.
4. Amplification: Anode current/cathode current.

SPECIFICATIONS

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall have the average characteristics and maximum ratings given on the Description

and Rating Sheet, ETI-184.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E_{bb} Volts	Light Flux Lumens	R_p Meg	Min	Max	Units
Dark Current	1	90	0	1.0	—	0.1	μ a D-c
Emission	2	25	0.1	1.0	1.8	—	μ a D-c
Sensitivity	2	90	0.1	1.0	10.0	20.5	μ a D-c
Gas Amplification	3	—	—	—	—	10.5	—
Interelectrode Capacitance	—	—	—	—	1.9	3.5	μ f

NOTES

1. This test made in absolute darkness.
2. Test made in a light-tight compartment with a Mazda projection lamp operated at 2870 K as a source of light. A diaphragm with an opening $\frac{1}{2}$ -

inch in diameter is located so that the light beam is centered on the cathode.

3. Gas Amplification: $\frac{\text{Sensitivity}}{\text{Emission}}$

SPECIFICATIONS

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall have the average characteristics and maximum ratings given on the Description

and Rating Sheet, ETI-179.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E _{bb} Volts	Light Flux Lumens	R _p Meg	Min	Max	Units
Dark Current	1	90	0	1.0	—	0.1	μa D-c
Emission	2	90	0.5	1.0	3.5	—	μa D-c
Sensitivity	2	200	0.5	1.0	—	—	μa D-c
Gas Amplification	3	—	—	—	—	1.1	—
Interelectrode Capacitance	—	—	—	—	1.9	3.5	μμf

NOTES

1. This test made in absolute darkness.
2. Test made in a light-tight compartment with a Mazda projection lamp operated at 2870 K as a source of light. A diaphragm with an opening $\frac{1}{2}$ -

inch in diameter is located so that the light beam is centered on the cathode.

3. Gas Amplification: $\frac{\text{Sensitivity}}{\text{Emission}}$

Supersedes in part ETI-222 dated 4-45

SPECIFICATIONS

GENERAL

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall have the average characteristics and maximum ratings given on the Description

and Rating Sheet, ETI-181.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E _{bb} Volts	Light Flux Lumens	R _p Meg	Min	Max	Units
Dark Current	1	250	0	1.0	—	0.1	μa D-c
Emission	2	25	0.1	1.0	2.1	—	μa D-c
Sensitivity	2	250	0.1	1.0	2.5	7.0	μa D-c
Gas Amplification	3	—	—	—	—	1.25	—
Interelectrode Capacitance	—	—	—	—	1.9	3.5	μμf

NOTES

1. This test made in absolute darkness.
2. Test made in a light-tight compartment with a Mazda projection lamp operated at 2870 K as a source of light. A diaphragm with an opening $\frac{1}{2}$ -

inch in diameter is located so that the light beam is centered on the cathode.

3. Gas Amplification: $\frac{\text{Sensitivity}}{\text{Emission}}$

Supersedes in part ETI-222 dated 4-45

PHOTOTUBE**GL-868 / PJ-23**

3-47

SPECIFICATIONS**GENERAL**

Equipment using these tubes should be so designed that any tube within the limits specified will operate satisfactorily.

The tube shall have the average characteristics and maximum ratings given on the Description

and Rating Sheet, ETI-182.

MECHANICAL REQUIREMENTS

The tube shall have the dimensions and be within the tolerances shown on the tube outline drawing.

ELECTRICAL REQUIREMENTS

Test	TEST CONDITIONS				TEST LIMITS		
	See Note	E_{bb} Volts	Light Flux Lumens	R_p Meg	Min	Max	Units
Dark Current	1	90	0	1.0	—	0.1	μ a D-c
Emission	2	25	0.1	1.0	0.7	—	μ a D-c
Sensitivity	2	90	0.1	1.0	5.0	14.5	μ a D-c
Gas Amplification	3	—	—	—	—	8.0	
Interelectrode Capacitance	—	—	—	—	1.9	3.5	μ f

NOTES

1. This test made in absolute darkness.
2. Test made in a light-tight compartment with a Mazda projection lamp operated at 2870 K as a source of light. A diaphragm with an opening $\frac{1}{2}$ -

inch in diameter is located so that the light beam is centered on the cathode.

3. Gas Amplification: $\frac{\text{Sensitivity}}{\text{Emission}}$

Supersedes in part ETI-222 dated 4-45


Electronic
TUBE

**VACUUM
CAPACITORS
GL-1L22, 1L23,
1L24 AND
1L25**

SPECIFICATIONS

GENERAL

Equipment using these types should be so designed that any capacitor within the limits specified will operate satisfactorily.

The capacitor shall be designed to have the average characteristics and maximum ratings given on Description and Rating sheets, ETI-263, 264,

265 and 266.

MECHANICAL REQUIREMENTS

The capacitor shall have the dimensions and be within the tolerances shown on the outline.

ELECTRICAL REQUIREMENTS

Test	Test Condition	LIMITS	
		Min	Max
Capacitance GL-1L22 GL-1L23 GL-1L24 GL-1L25		23.75 47.5 96.0 11.4	26.25 Micromicrofarads 52.5 Micromicrofarads 104.0 Micromicrofarads 12.6 Micromicrofarads
R-F Voltage Breakdown GL-1L22 GL-1L23 GL-1L24 GL-1L25	1.8 Megacycles 1.8 Megacycles 1.8 Megacycles 1.8 Megacycles		20,000 Volts peak 20,000 Volts peak 20,000 Volts peak 20,000 Volts peak
Vibration—High Voltage GL-1L22 GL-1L23 GL-1L24 GL-1L25	20,000 volts peak 60 cycles a-c applied during vibration	Capacitor shall not indicate a prolonged short.	

For Notes see page 2


Electronic
TUBE

NOTES

R-f Voltage Breakdown

The test set consists of a self-excited oscillator operating on 1.8 megacycles. The capacitor is connected in series with an r-f ammeter and connected in parallel with the plate inductance of the oscillator.

With a peak voltage of 20,000 volts applied across the capacitor, there shall be no evidence of internal discharge.

Vibration—High Voltage

For this test the capacitor is fixed in a test set that vibrates the capacitor at a rate of approxi-

mately 20 cycles per second. The capacitor is fixed so that it is shaken in the plane at right angles to the capacitor axis. The throw is approximately $\frac{1}{4}$ inch.

While the vibration is taking place, an a-c 60-cycle voltage of 20,000 volts peak is applied to the tube. In series with this circuit is a 50,000-ohm resistor and a 2-watt neon lamp shunted with a 10,000-ohm resistor.

The vibration shall not cause the capacitor cylinder to be deformed sufficiently to pass a current through the neon lamp which will light both sections of the lamp for five seconds or more.

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.

**VACUUM
CAPACITORS**
GL-1L21, 1L33
1L36 AND
1L38

SPECIFICATIONS

GENERAL

Equipment using these types should be so designed that any capacitor within the limits specified will operate satisfactorily.

The capacitor shall be designed to have the average characteristics and maximum ratings

given on Description and Rating sheets, ETI-262, 267, 268 and 269.

MECHANICAL REQUIREMENTS

The capacitor shall have the dimensions and be within the tolerances shown on the outline.

ELECTRICAL REQUIREMENTS

Test	Test Condition	LIMITS	
		Min	Max
Capacitance GL-1L21 GL-1L33 GL-1L36 GL-1L38		11.4 95.0 23.75 47.5	12.6 Micromicrofarads 105.0 Micromicrofarads 26.25 Micromicrofarads 52.5 Micromicrofarads
R-F Voltage Breakdown GL-1L21 GL-1L33 GL-1L36 GL-1L38	1.8 Megacycles 1.8 Megacycles 1.8 Megacycles 1.8 Megacycles		9000 Volts peak 9000 Volts peak 9000 Volts peak 9000 Volts peak
Vibration—High Voltage GL-1L21 GL-1L33 GL-1L36 GL-1L38	10,000 volts peak 60 cycles a-c applied during vibration	Capacitor shall not indicate a prolonged short.	

For Notes see page 2


Electronic
TUBE

NOTES

R-f Voltage Breakdown

The test set consists of a self-excited oscillator operating on 1.8 megacycles. The capacitor is connected in series with an r-f ammeter and connected in parallel with the plate inductance of the oscillator.

With a peak voltage of 9000 volts applied across the capacitor, there shall be no evidence of internal discharge.

Vibration—High Voltage

For this test the capacitor is fixed in a test set that vibrates the capacitor at a rate of approximate-

ly 20 cycles per second. The capacitor is fixed so that it is shaken in the plane at right angles to the capacitor axis. The throw is approximately $\frac{1}{4}$ inch.

While the vibration is taking place, an a-c 60-cycle voltage of 10,000 volts peak is applied to the tube. In series with this circuit is a 50,000-ohm resistor and a 2-watt neon lamp shunted with a 10,000-ohm resistor.

The vibration shall not cause the capacitor cylinder to be deformed sufficiently to pass a current through the neon lamp which will light both sections of the lamp for five seconds or more.

Electronics Department
GENERAL  ELECTRIC
Schenectady, N. Y.

SPECIFICATIONS

GENERAL

Equipment in which these switches are used should be so designed that any switch within the limits specified will operate satisfactorily.

The switch shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-197.

MECHANICAL REQUIREMENTS

The switch shall have the dimensions and be within the tolerances shown on the outline drawing.

MECHANICAL TEST REQUIREMENTS

Test	See Note	TEST LIMITS		
		Min	Max	Units
Arm Travel	1	0.007	0.017	inches
Initial Tension	2	—	120	grams
Force	3	—	300	grams

ELECTRICAL REQUIREMENTS

Voltage	4	2100	—	volts a-c rms
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NOTES

1. Arm travel is the motion required to move the operating arm paddle from one stationary contact to the other. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

2. Initial tension is the force required to open the moving contact, if it is initially closed on one side. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

3. Force is the force required to move the operating arm paddle from one stationary contact to the other, including initial tension. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

4. With the operating arm in the neutral position there shall be no external arcing when the voltage specified is applied between the common terminal and the two contact terminals for a period of one second.

SPECIFICATIONS

12-45

GENERAL

Equipment in which these switches are used should be so designed that any switch within the limits specified will operate satisfactorily.

The switch shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-198.

MECHANICAL REQUIREMENTS

The switch shall have the dimensions and be within the tolerance shown on the outline drawing.

MECHANICAL TEST REQUIREMENTS

Test	See Note	TEST LIMITS		
		Min	Max	Units
Arm Travel	1	0.005	0.009	inches
Initial Tension	2	—	100	grams
Force	3	—	300	grams

ELECTRICAL REQUIREMENTS

Voltage	4	3000	—	volts a-c rms
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NOTES

1. Arm travel is the motion required to move the operating arm paddle from one stationary contact to the other. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

2. Initial tension is the force required to open the moving contact, if it is initially closed on one side. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

3. Force is the force required to move the operating arm paddle from one stationary contact to the other, including initial tension. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

4. The switch shall withstand the application of the specified voltage, applied across the stationary contacts, for 10 seconds with no visible arcing or flashing. For the purpose of this test fluorescent spots on the glass envelope of the switch shall not be construed as arcing or flashing.

The test shall be made with the moving contact held firmly against one stationary contact for five seconds. The test shall be repeated with the moving contact held firmly against the other stationary contact for five seconds.

The power supply shall be capable of supplying at least one milliampere of current, and the waveform of the voltage shall be essentially a sine wave with no transient voltage peaks.

The testing shall be conducted in semi-darkness.

SPECIFICATIONS

GENERAL

Equipment in which these switches are used should be so designed that any switch within the limits specified will operate satisfactorily.

The switch shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-197A.

MECHANICAL REQUIREMENTS

The switch shall have the dimensions and be within the tolerances shown on the outline drawing.

MECHANICAL TEST REQUIREMENTS

Test	See Note	TEST LIMITS		
		Min	Max	Units
Arm Travel	1	0.007	0.017	inches
Initial Tension	2	—	120	grams
Force	3	—	300	grams

ELECTRICAL REQUIREMENTS

Voltage	4	2100	—	volts a-c rms
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NOTES

1. Arm travel is the motion required to move the operating arm paddle from one stationary contact to the other. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

2. Initial tension is the force required to open the moving contact, if it is initially closed on one side. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

3. Force is the force required to move the operating arm paddle from one stationary contact to the other, including initial tension. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

4. With the operating arm in the neutral position there shall be no external arcing when the voltage specified is applied between the common terminal and the two contact terminals for a period of one second.

SPECIFICATIONS

GENERAL

Equipment in which these switches are used should be so designed that any switch within the limits specified will operate satisfactorily.

The switch shall be designed to have the average characteristics and maximum ratings given on the

Description and Rating Sheet, ETI-198A.

MECHANICAL REQUIREMENTS

The switch shall have the dimensions and be within the tolerance shown on the outline drawing.

MECHANICAL TEST REQUIREMENTS

Test	See Note	TEST LIMITS		
		Min	Max	Units
Arm Travel	1	0.005	0.009	inches
Initial Tension	2	—	100	grams
Force	3	—	300	grams

ELECTRICAL REQUIREMENTS

Voltage	4	3000	—	volts a-c rms
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NOTES

1. Arm travel is the motion required to move the operating arm paddle from one stationary contact to the other. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

2. Initial tension is the force required to open the moving contact, if it is initially closed on one side. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

3. Force is the force required to move the operating arm paddle from one stationary contact to the other, including initial tension. The measurement shall be made on the operating arm at a point $\frac{5}{8}$ inch from the diaphragm.

4. The switch shall withstand the application of the specified voltage, applied across the stationary contacts, for 10 seconds with no visible arcing or flashing. For the purpose of this test fluorescent spots on the glass envelope of the switch shall not be construed as arcing or flashing.

The test shall be made with the moving contact held firmly against one stationary contact for five seconds. The test shall be repeated with the moving contact held firmly against the other stationary contact for five seconds.

The power supply shall be capable of supplying at least one milliamperere of current, and the waveform of the voltage shall be essentially a sine wave with no transient voltage peaks.

The testing shall be conducted in semi-darkness.