TUNG-SOL / CHATHAM

TECHNICAL DATA

PUBLISHED BY
TUNG-SOL
ELECTRIC INC.

INDEX

TUBES

TYPE NO.	DATE	Hydrogen Thyratrons	Indicating Thyratrons	Miscel-laneous	Power & Relay Thyratrons	Power Triodes	Rectifiers	Telephone Types	Voltage Reference	Voltage Regulators
OB2	2-58									X
OC3W	4-58									X
OD3W	4-58									X
1S22	5-58			X						
1Z2	2-58						X			
2D21W	5-58				X					
3B28	2-58						X			
4B32	2-58						X			
5R4WGA	6-58						X			
5R4WGB	4-58						X			
6AS7G	11-57					X				
6D4	11-57				X					
395A	2-58				X					
407A	5-58							X		
CH1095	10-58			X						
CH1096	10-58			X						
CH1097	10-58			X						
VC1257	5-58	X								
1258	2-59	X								
2050	5-58				X					
2050W	6-58				X					
5517	2-58						X			
5643	2-58				X					
5651	2-58								X	
5651WA	6-58								X	
5696	6-58				X					
5783WA	12-57								X	
5948	10-58	X								
5949	3-59	X								
5998	11-57					X				
6080WA	6-58					X				
6336A	6-58					X				
6394A	6-58					X				
6528	6-58					X				
6542	6-58									X
6627/OB2WA	12-57									X
7105	6-58					X				
7190, 7191, 7192	2-58	X								
7240	12-58	X								
7241	10-58					X				
7242	10-58					X				
7323	2-59		X							
7400	1-59		X							
7401	1-59		X							

CONTINUED ON FOLLOWING PAGE

AIRBORNE EQUIPMENT

RADIAC EQUIPMENT

SELENIUM RECTIFIERS

SILICON RECTIFIERS

COMMERCIAL ENGINEERING DEPARTMENT
TUNG-SOL ELECTRIC, INC., CHATHAM ELECTRONICS DIVISION
630 W. Mt. Pleasant Avenue, Livingston, N. J.
WYman 2-1100

SERIES REGULATOR TUBES

POWER DISSIPATION

Total Plate Dissipation	26 to 30 W.	60 W.	100 W.
Low Mu	6AS7G 6080WA*	6336A*	7241*
Medium Mu	5998	6528*	7242*

TYPICAL VALUES FOR REGULATOR SERVICE PER TUBE

Type	Total Plate Current	Range of Tube Voltage Drop	Minimum Tube Drop	Grid Voltage Swing
6080WA*, 6AS7G	200 mA 100	75 v. 200	35 v. 25	50 v. 140
5998	200 100	80 200	45 30	20 52
6336A*	500 200	50 235	50 35	25 95
6528*	400 200	65 225	70 45	10 35
7241*	750 300	65 270	50 35	25 110
7242*	600 250	80 335	70 40	13 45

OTHER PERTINENT CHARACTERISTICS PER TUBE

Type	Max. Plate Current	Max. Plate Voltage	Mu	Gm	Bulb	Construction
6080WA*, 6AS7G	250. mA	250. V.	2.0	14,000 umhos	T12 | ST16	Twin Triode
5998	280	275	5.5	28,000	ST16	Twin Triode
6336A*	800	400	2.7	27,000	TT16	Twin Triode
6528*	600	400	9.0	74,000	TT16	Twin Triode
7241*	1000	400	2.7	40,500	TT18	Single Anode Three Cathodes
7242*	900	400	9.0	111,000	TT18	Single Anode Three Cathodes

*Rugged, long life tubes.

TUNG-SOL/CHATHAM

TYPE 0B2

MINIATURE VOLTAGE REGULATOR

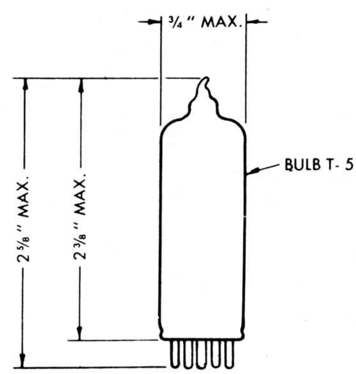
DESCRIPTION—The 0B2 is a two electrode, inert-gas-filled cold cathode miniature tube intended for use as a voltage regulator. The tube has a maintaining voltage of approximately 108 volts over a current range of 5 to 30 milliamperes. The 0B2 is excellent for applications which require good voltage regulation and long life.

ELECTRICAL DATA

Cathode . . . . Cold

MECHANICAL DATA

Mounting Position . . . . Any
Maximum Overall Length . . . . 2⅝ inches
Maximum Seated Length . . . . 2⅜ inches
Maximum Diameter . . . . ¾ inch
Weight (Approx.) . . . . 0.3 oz.
Bulb T-5½
Base . . . . Small-button Miniature 7-Pin (JETEC EZ-1)



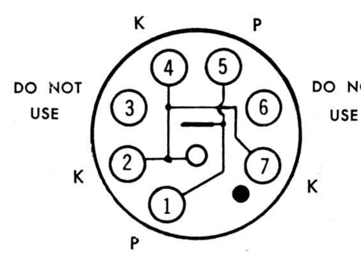
RATINGS, ABSOLUTE VALUES

Maximum Average Starting Current† . . . . 75 ma
Maximum D.C. Cathode Current . . . . 30 ma
Minimum D.C. Cathode Current . . . . 5 ma
Maximum Inverse Voltage . . . . 50 volts
Ambient Temperature . . . . −55 to +90°C

CIRCUIT VALUES

Maximum Shunt Capacitor . . . . 0.1 uf
Series Resistor . . . . See Operation Notes

†Averaged over starting period not exceeding 10 seconds. Normal operation should be continued for at least twenty minutes after passing this current to stabilize the tube.

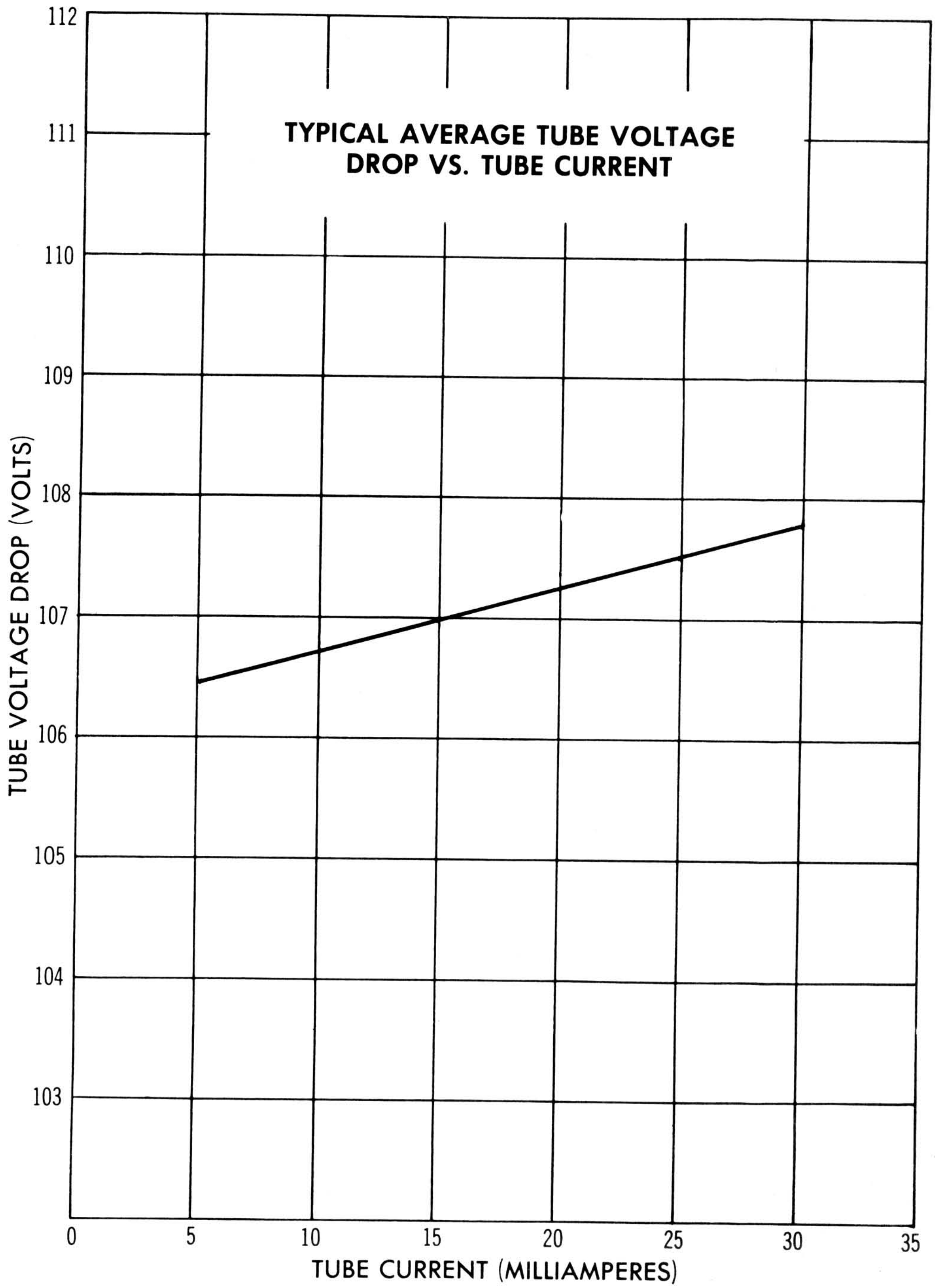


BOTTOM VIEW

EQUIPMENT DESIGN AND RANGE VALUES

	Minimum Volts	Average Volts	Maximum Volts
D.C. Anode Supply Voltage	133*	—	—
Anode Breakdown Voltage	—	114	133
Tube Voltage Drop	101	108	114
Regulation (5 to 30 ma)	—	1.1	4

*In order to assure starting through tube life not less than the specified supply voltage should be provided.



Operating Notes

Special attention should be given to the bulb temperature at which the tubes are to be operated. Reliability will be seriously impaired if the maximum bulb temperature is exceeded.

In the operation of a glow tube there are several requirements which must always be met. The first is that the supply voltage must always be greater than the anode breakdown voltage and the second is that sufficient resistance must always be put in series with the tube in order to limit the current to the minimum and maximum values given in the ratings.

In order to illustrate how to calculate the value of the series resistance a typical regulator circuit is shown in Fig. 1.

From Fig. 1 we see that V_1 is the unregulated supply voltage, V_2 is the tube voltage drop on the regulated voltage supplied to the load, R_1 is the series limiting resistor, R_L is the variable load, I_T is the tube current and I_L is the load current.

We see that the tube current will be a maximum when the supply voltage is a maximum (V_1 max.); when the load current is a minimum (I_L min.); and when the tube voltage drop is a minimum (V_2 min.). Therefore the conditions which determine the lower limit for the series resistance R_1 are that

$$R_1 > \frac{V_1 \text{ max.} - V_2 \text{ min.}}{I_T \text{ max.} + I_L \text{ min.}}$$

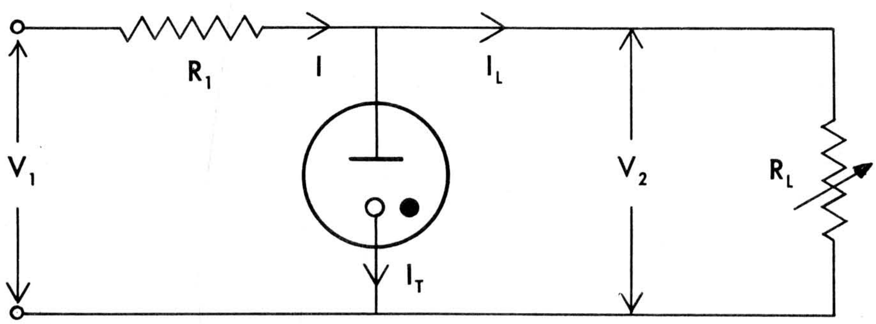
In a like manner it can be shown that the value of R_1 in order to limit the current to the minimum value requires that

$$R_1 < \frac{V_1 \text{ min.} - V_2 \text{ max.}}{I_T \text{ min.} + I_L \text{ max.}}$$

When these values have been computed, one should check to see if there is sufficient starting voltage by the following relation

$$V_1 \text{ min.} \frac{R_L}{R_1 + R_L} > V \text{ Starting}$$

Figure 1



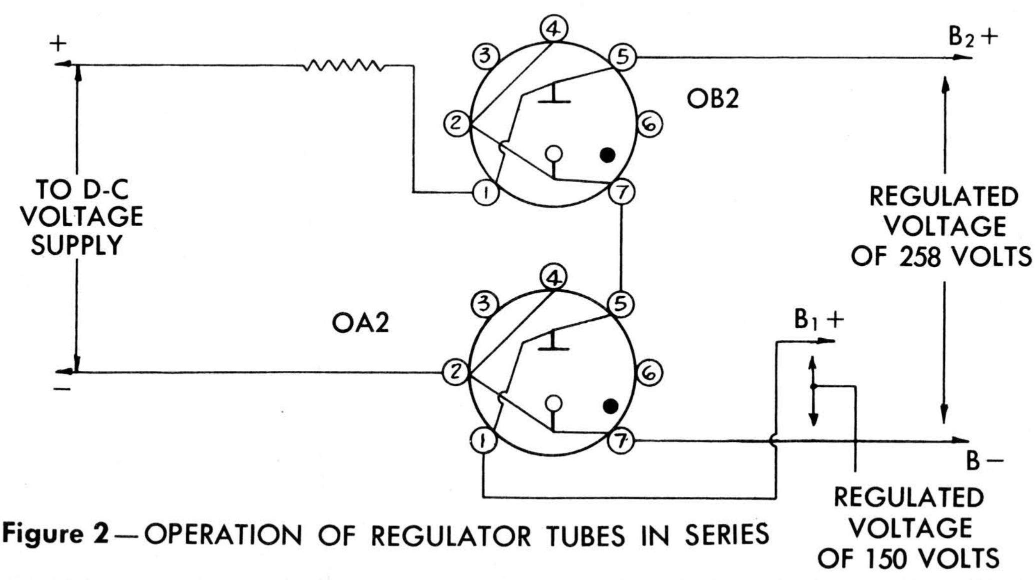


Figure 2—OPERATION OF REGULATOR TUBES IN SERIES

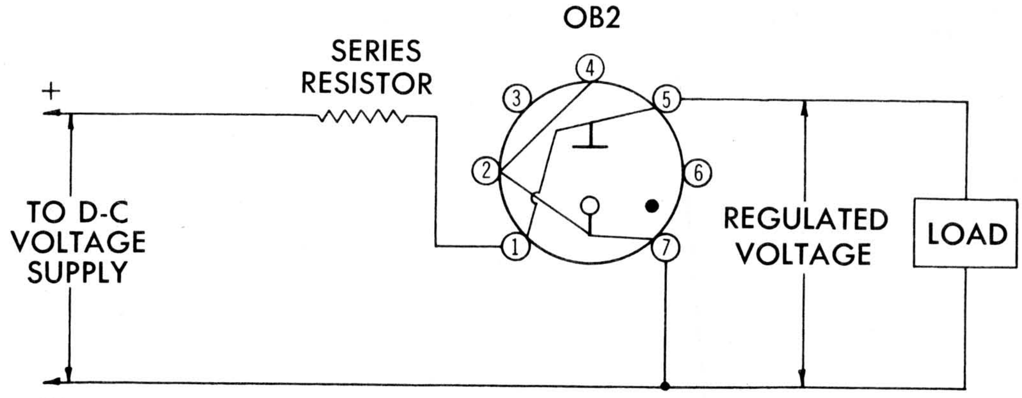


Figure 3—TYPICAL CIRCUIT FOR VOLTAGE REGULATOR

When these calculations have been made and there is insufficient starting voltage, a new load current of lower value must be used and the calculations repeated.

Circuits which have a capacitor in shunt with the 0B2 should be limited in value to 0.1 μf, larger values might cause oscillations.

Operation of the 0B2 in parallel is not recommended unless a resistance of approximately 100 ohms is used in series with each 0B2 to equalize division of current. However, it should be noted that while this enables one to handle more load current it reduces the regulation that can be obtained.

If it is desired to obtain higher regulating voltages, tubes may be operated in series as indicated in Fig. 2. However, care should be taken to see that sufficient supply voltage is available to start both tubes.

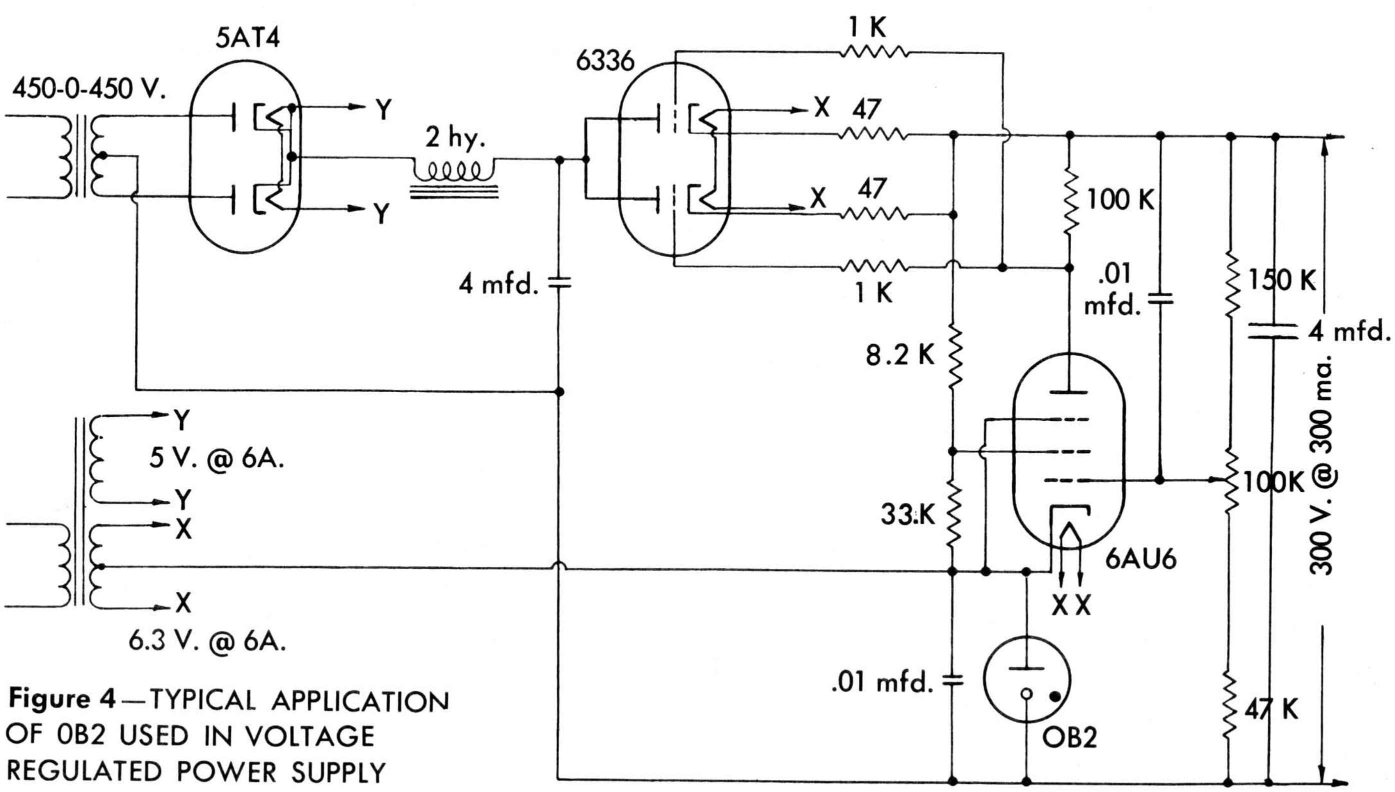


Figure 4—TYPICAL APPLICATION OF 0B2 USED IN VOLTAGE REGULATED POWER SUPPLY

TUNG-SOL / CHATHAM

TYPE
OC3W

RUGGEDIZED VOLTAGE REGULATOR

DESCRIPTION—The OC3W is a two electrode, inert gas filled cold cathode tube intended for use as a voltage regulator. The tube has a maintaining voltage of approximately 108 volts over a current range of 5 to 40 milliamperes.

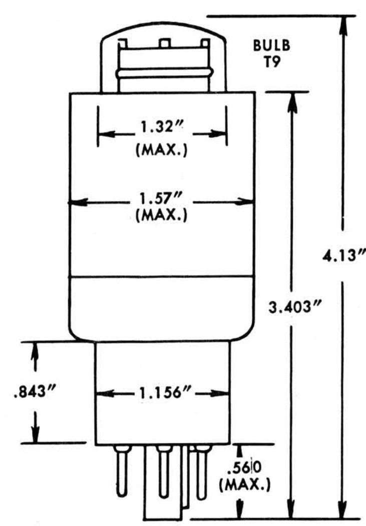
The OC3W is excellent for applications which require good voltage regulation and long life. Tube envelope is floated within the base shell by a sponge rubber filler. This cushion dampens vibration and decreases the transmission of shock to the active tube elements. Both the basing arrangement and heavy duty parts construction make the OC3W especially suited for use in applications where severe mechanical punishment will be encountered.

ELECTRICAL DATA

Cathode............................Cold

MECHANICAL DATA

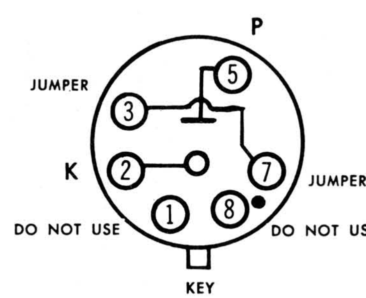
Mounting Position	Any
Maximum Overall Height	$4\frac{1}{8}$ inches
Maximum Seated Height	$3\frac{9}{16}$ inches
Maximum Diameter	$1\frac{9}{16}$ inches
Weight (Approx.)	2 ounces
Bulb	T-9
Base	Special Skirted, small shell octal, 6-pin Low Loss phenolic material.



RATINGS, ABSOLUTE VALUES

Maximum Average Starting Current†	100 mA.d.c.
Maximum D.C. Cathode Current	40 mA.d.c.
Minimum D.C. Cathode Current	5 mA.d.c.
Ambient Temperature	—55 to 70° C
Maximum Altitude	10,000 ft.
Maximum Inverse Voltage	—50 V.d.c.
Shock Impact	900 G/msec.
Maximum Vibration Ratings (D=0.08" @ 50 cps)	10 G

†Averaged over a starting period not exceeding 10 seconds. Normal operation should be continued for at least twenty minutes after passing this current to stabilize the tube.



Bottom View

Additional Tests to Insure Reliability

Randomly Selected Samples are Subjected to the Following Tests.

Shock: 60° Hammer angle in Navy, Flyweight, High Impact Machine (900 G/msec.)

Vibration: 10-50-10 cps, 0.08″ Total displacement, in each of three mutually perpendicular planes (10 G).

Fatigue Vibration: 25 cps, 0.08″ Total displacement, for 32 hours in each of three mutually perpendicular planes (2.5 G).

Life Test 500 hours: $R_p/I_b = 30$ mA.d.c.

Post Shock and Fatigue, and Life Test Limits:

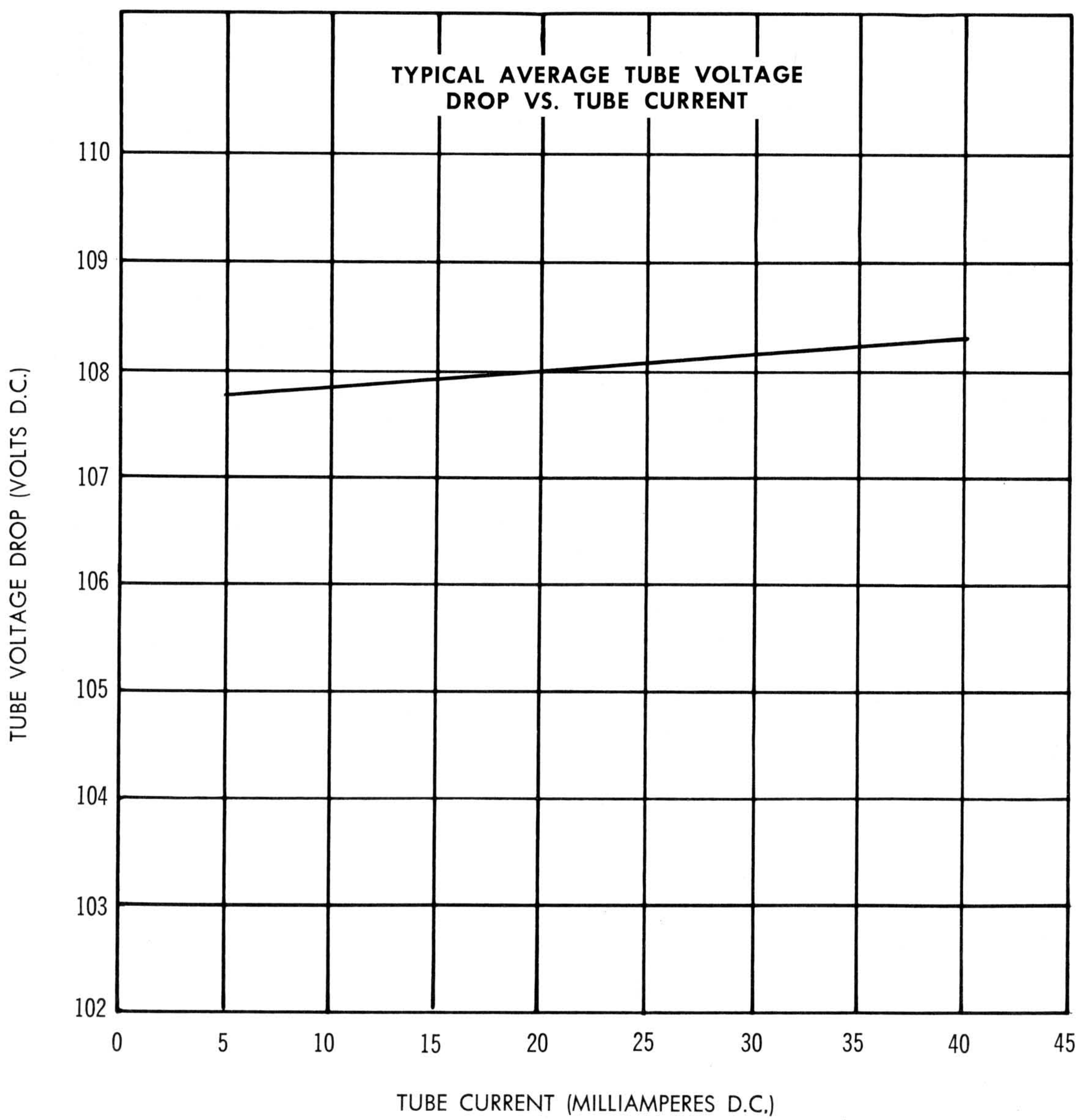
Ionization Voltage	133 v.d.c. max.
Tube Voltage Drop	103 to 113 v.d.c.
Regulation (5 to 40 mA)	4.0 v.d.c.
Regulation (5 to 30 mA)	2.5 v.d.c.

Equipment Design and Range Values

	Min.	Ave.	Max.	
D.C. Anode Supply Voltage in Darkness	210*	—	—	Volts
D.C. Anode Supply Voltage in Light	133*	—	—	Volts
Anode Breakdown Voltage	—	123	133	Volts
Tube Voltage Drop (1) at 40 mA	—	108.5	114	Volts
Tube Voltage Drop (2) at 30 mA	—	—	113	Volts
Tube Voltage Drop (3) at 5 mA	103	107.8	—	Volts
Regulation	—	0.7	4.0	V.d.c.
Oscillation (Aural Check)	—	—	—	
Noise	—	—	15	mV.a.c.
Leakage Current $E_b = 50$ V.d.c.; $R_p = 100K\ \Omega$)	—	—	10	μA.d.c.
Series Resistor	**	—	—	
Shunt Capacitor	—	—	0.1	mfd
Current through interconnecting leads	—	—	2.0	Amperes

* To assure starting throughout tube life, the supply voltage should not be less than this value.

** Sufficient series resistance must be used to limit the current to a maximum of 40 mA.d.c. at the highest anode supply voltage and to limit the current to a minimum of 5 mA.d.c. at the lowest supply voltage.



Operating Notes

Special attention should be given to the temperature at which the tubes are to be operated. Reliability will be seriously impaired if the maximum temperature is exceeded.

There are several requirements in the operation of a glow discharge tube, like the OC3W, which must always be met. The first condition is that the supply voltage must always be greater than the anode breakdown voltage. The second factor to be considered is that sufficient resistance must always be put in series with the OC3W to limit the current to the minimum and maximum values given in the ratings.

A typical regulator circuit is shown in Fig. 1, in order to illustrate the methods used for determining the correct values for the series limiting resistor, and supply voltage. From Fig. 1 we see that

V_1 = unregulated supply voltage
V_2 = tube voltage drop or regulated voltage supplied to the load.
R_1 = series limiting resistor
R_2 = variable load
I_T = tube current
I_L = load current.

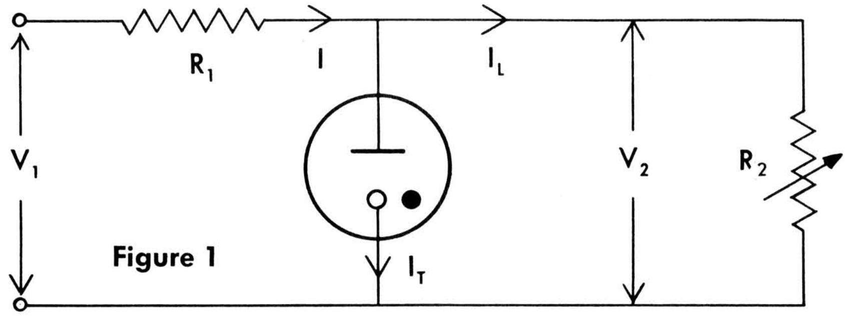


Figure 1

The current in the OC3W will be a maximum when the supply voltage, is a maximum, V_1 max.; when the load current is a minimum, I_T min.; and the tube voltage is a minimum, V_2 min. Therefore the conditions which determine the lower limit for the series resistance R_1 are that

$$R_1 > \frac{V_1 \text{ max.} - V_2 \text{ min.}}{I_T \text{ max.} + I_L \text{ min.}}$$

In a similar manner it can be shown that the value of R_1, in order to limit the current to the minimum value requires that

$$R_1 < \frac{V_1 \text{ min.} - V_2 \text{ max.}}{I_T \text{ min.} + I_L \text{ max.}}$$

With these values computed a check should be made for sufficient starting voltage by the following relation

$$V_1 \text{ min.} \frac{R_2}{R_1 + R_2} > V \text{ Starting}$$

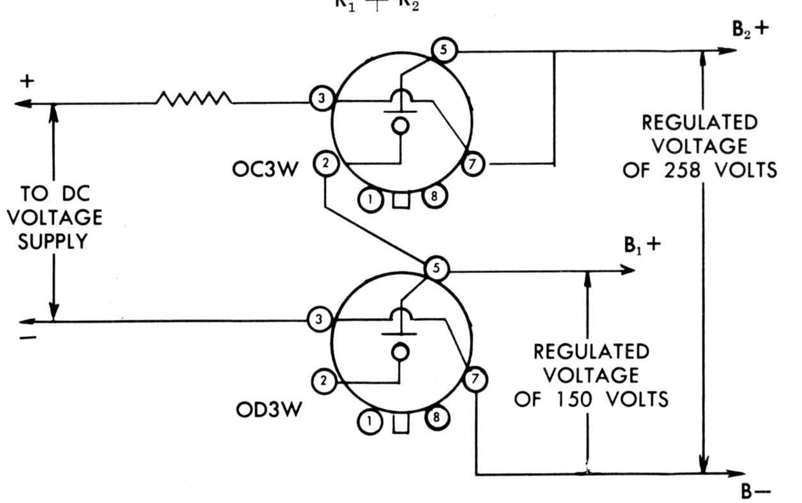


Figure 2 — OPERATION OF REGULATOR TUBES IN SERIES

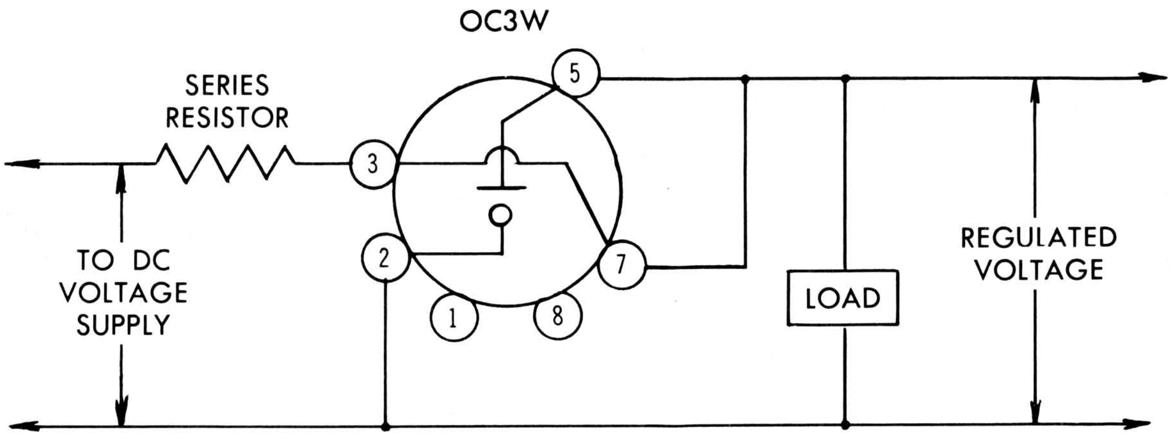


Figure 3 — TYPICAL CIRCUIT FOR VOLTAGE REGULATOR

When these calculations have been made and there is insufficient starting voltage, a new load current of lower value must be used and the calculations repeated.

Circuits which have a capacitor in shunt with the OC3W should be limited in value to 0.1 μfd; larger values may cause the tube to oscillate.

Operation of the OC3W in parallel is not recommended unless a resistance of approximately 100 ohms is used in series with each OC3W to equalize division of the current. However, it should be noted that while this type of operation enables one to handle more load current, it reduces the regulation that can be obtained.

If it is desired to obtain higher regulating voltages, tubes may be operated in series. Care should be taken to see that sufficient supply voltage is available to start both tubes.

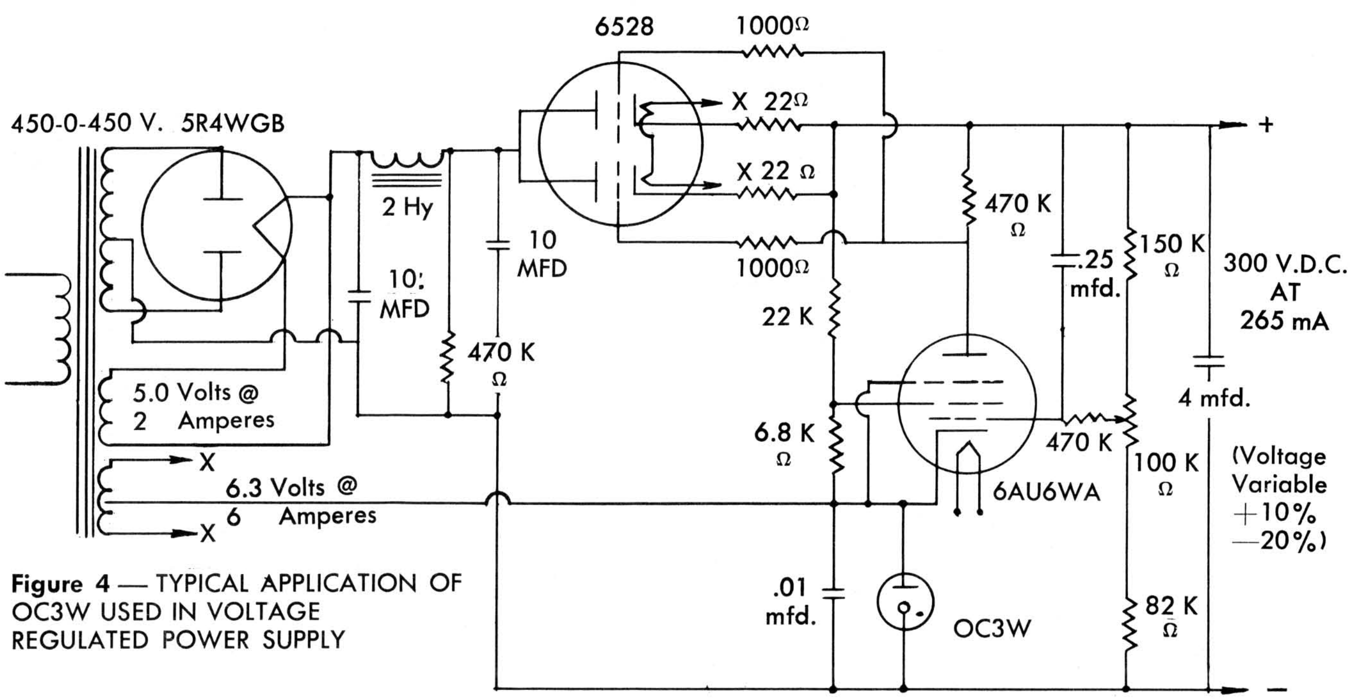


Figure 4 — TYPICAL APPLICATION OF OC3W USED IN VOLTAGE REGULATED POWER SUPPLY

TUNG-SOL / CHATHAM

TYPE OD3W

DESCRIPTION—The OD3W is a two electrode, inert gas filled cold cathode tube intended for use as a voltage regulator. The tube has a maintaining voltage of approximately 150 volts over a current range of 5 to 40 milliamperes.

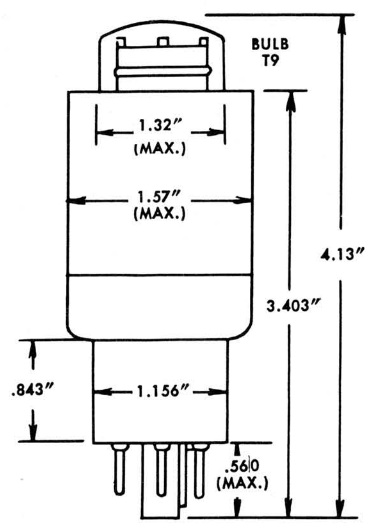
The OD3W is excellent for applications which require good voltage regulation and long life. The tube envelope is floated within the base shell by a sponge rubber filler. This cushion dampens vibration and decreases the transmission of shock to the active tube elements. Both the basing arrangement and the heavy duty parts construction make the OD3W especially suited for use in applications where severe mechanical punishment will be encountered.

ELECTRICAL DATA

Cathode . . . . Cold

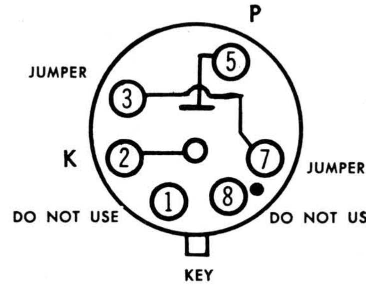
MECHANICAL DATA

Mounting Position . . . . Any
Maximum Overall Height . . . . $4\frac{1}{8}$ inches
Maximum Seated Height . . . . $3\frac{9}{16}$ inches
Maximum Diameter . . . . $1\frac{9}{16}$ inches
Weight (Approx.) . . . . 2 ounces
Bulb (See Outline) T-9
Base . . . . Special Skirted, small shell octal 6-pin, Low Loss phenolic material.



RATINGS, ABSOLUTE VALUES

Maximum Average Starting Current† . 100 mA.d.c.
Maximum D.C. Cathode Current . . . . . 40 mA.d.c.
Minimum D.C. Cathode Current . . . . . . 5 mA.d.c.
Ambient Temperature . . . . —55 to 70° C
Maximum Altitude . . . . 10,000 ft.
Maximum Inverse Voltage . . . . —50 V.d.c.
Shock Impact . . . . 900 G/m sec.
Maximum Vibration Rating
(D=0.08″ @ 50 cps) . . . . 10 G



Bottom View

†Average over a starting period not exceeding 10 seconds. Normal operation should be continued for at least twenty minutes after passing this current to stabilize the tube.

Additional Tests to Insure Reliability

Ramdomly selected samples are subjected to the following test.

Shock: 60° Hammer angle in Navy, Flyweight, High Impact Machine (900 G/msec.)

Vibration: 10-50-10 cps, 0.08″ Total Displacement, in each of three mutually perpendicular planes. (10 G)

Fatigue Vibration: 25 cps, 0.08″ Total displacement, for 32 hours in each of three mutually perpendicular planes (2.5 G).

Life Test 500 hours: $R_p/I_b = 30$ mA.d.c.

Post Shock and Fatigue, and Life Test Limits:

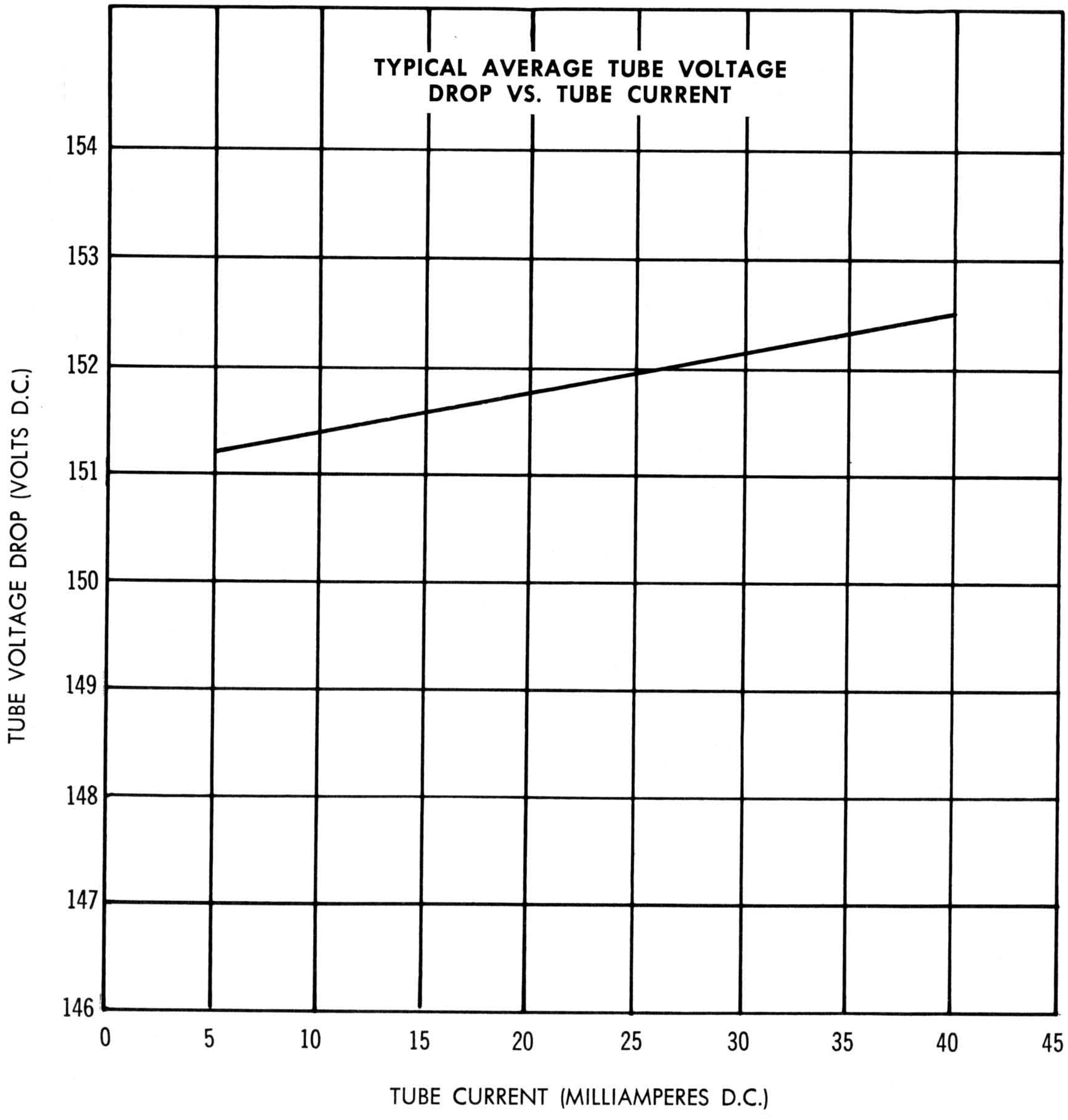
Ionization Voltage	185 v.d.c. max.
Tube voltage drop (5 to 30 mA)	142 to 163 v.d.c.
Regulation (5 to 40 mA)	5.5 v.d.c. max.
Regulation (5 to 30 mA)	4.5 v.d.c. max.

Equipment Design and Range Values

	Min.	Ave.	Max.	
D.C. Anode Supply Voltage in Darkness:	225*	—	—	volts
D.C. Anode Supply Voltage in Light:	185*	—	—	volts
Anode Breakdown Voltage:	—	158	185	volts
Tube Voltage Drop (1) at 40 mA	—	153	165	volts
Tube Voltage Drop (2) at 30 mA	—	—	163	volts
Tube Voltage Drop (3) at 5 mA	142	151	—	volts
Regulation	—	2.0	5.5	volts
Oscillation (Aural Check)	—	—	—	
Noise	—	0	15	mV.a.c.
Leakage Current ($E_b = 50$ V.d.c.; $R_p = 100K\ \Omega$)	—	0	10	uA
Series Resistor	**	—	—	
Shunt Capacitor	—	—	0.1	mfd
Current through interconnected Leads	—	—	2.0	Amperes

* To assure starting throughout tube life, the supply voltage should not be less than this value.

** Sufficient series resistance must be used to limit the current to a maximum of 40 mA.d.c. at the highest anode supply voltage and to limit the current to a minimum of 5 mA.d.c. at the lowest supply voltage.



Operating Notes

Special attention should be given to the temperature at which the tubes are to be operated. Reliability will be seriously impaired if the maximum temperature is exceeded.

There are several requirements in the operation of a glow discharge tube, like tthe OD3W, which must always be met. The first condition is that the supply voltage must always be greater than the anode breakdown voltage. The second factor to be considered is that sufficient resistance must always be put in series with the OD3W to limit the current to the minimum and maximum values given in the ratings.

A typical regulator circuit is shown in Fig. 1, in order to illustrate the methods used for determining the correct values for the series limiting resistor, and supply voltage. From Fig. 1 we see that

V_1 = unregulated supply voltage
V_2 = tube voltage drop or regulated voltage supplied to the load.
R_1 = series limiting resistor
R_2 = variable load
I_T = tube current
I_L = load current.

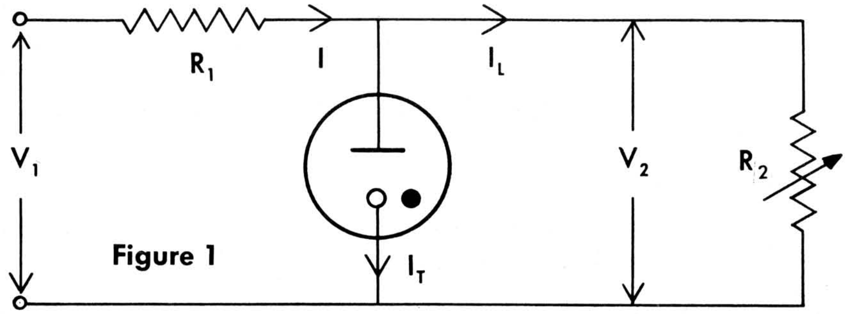


Figure 1

The current in the OC3W will be a maximum when the supply voltage, is a maximum, V_1 max.; when the load current is a minimum, I_T min.; and the tube voltage is a minimum, V_2 min. Therefore the conditions which determine the lower limit for the series resistance R_1 are that

$$R_1 > \frac{V_1 \text{ max.} - V_2 \text{ min.}}{I_T \text{ max.} + I_L \text{ min.}}$$

In a similar manner it can be shown that the value of R_1, in order to limit the current to the minimum value requires that

$$R_1 < \frac{V_1 \text{ min.} - V_2 \text{ max.}}{I_T \text{ min.} + I_L \text{ max.}}$$

With these values computed a check should be made for sufficient starting voltage by the following relation

$$V_1 \text{ min.} \frac{R_2}{R_1 + R_2} > V \text{ Starting}$$

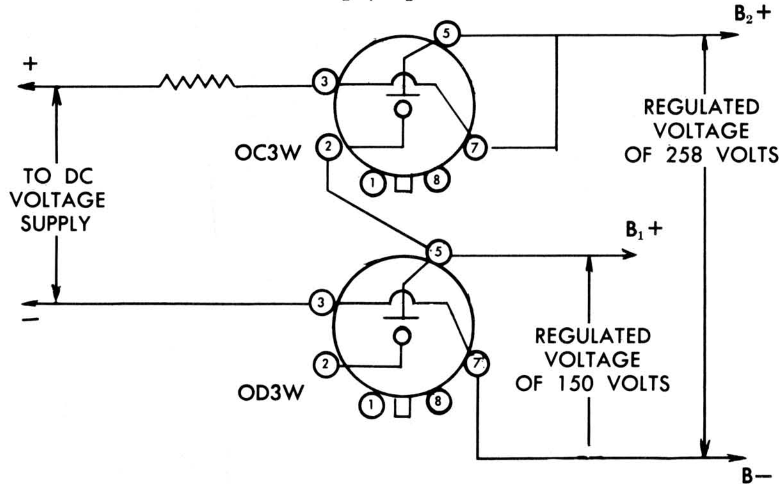


Figure 2 — OPERATION OF REGULATOR TUBES IN SERIES

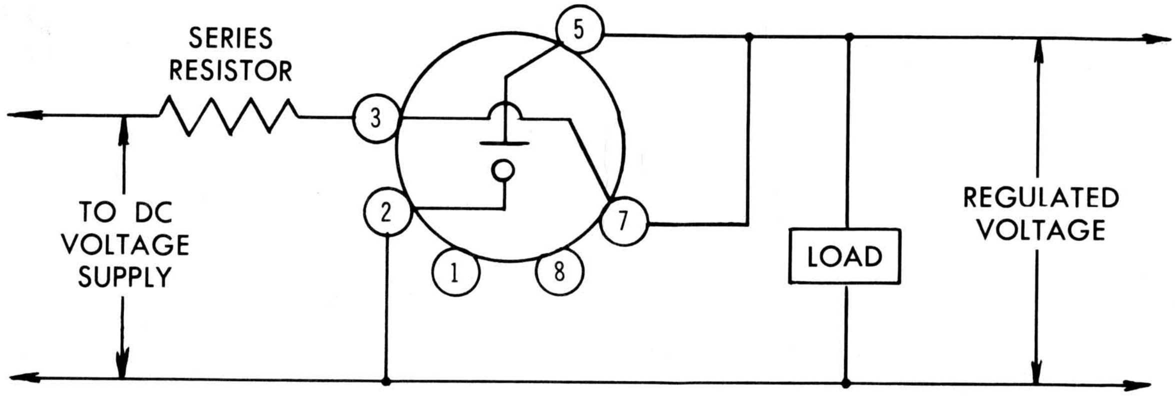


Figure 3 — TYPICAL CIRCUIT FOR VOLTAGE REGULATOR

When these calculations have been made and there is insufficient starting voltage, a new load current of lower value must be used and the calculations repeated.

Circuits which have a capacitor in shunt with the OD3W should be limited in value to 0.1 μfd; larger values may cause the tube to oscillate.

Operation of the OD3W in parallel is not recommended unless a resistance of approximately 100 ohms is used in series with each OD3W to equalize division of the current. However, it should be noted that while this type of operation enables one to handle more load current, it reduces the regulation that can be obtained.

If it is desired to obtain higher regulating voltages, tubes may be operated in series. Care should be taken to see that sufficient supply voltage is available to start both tubes.

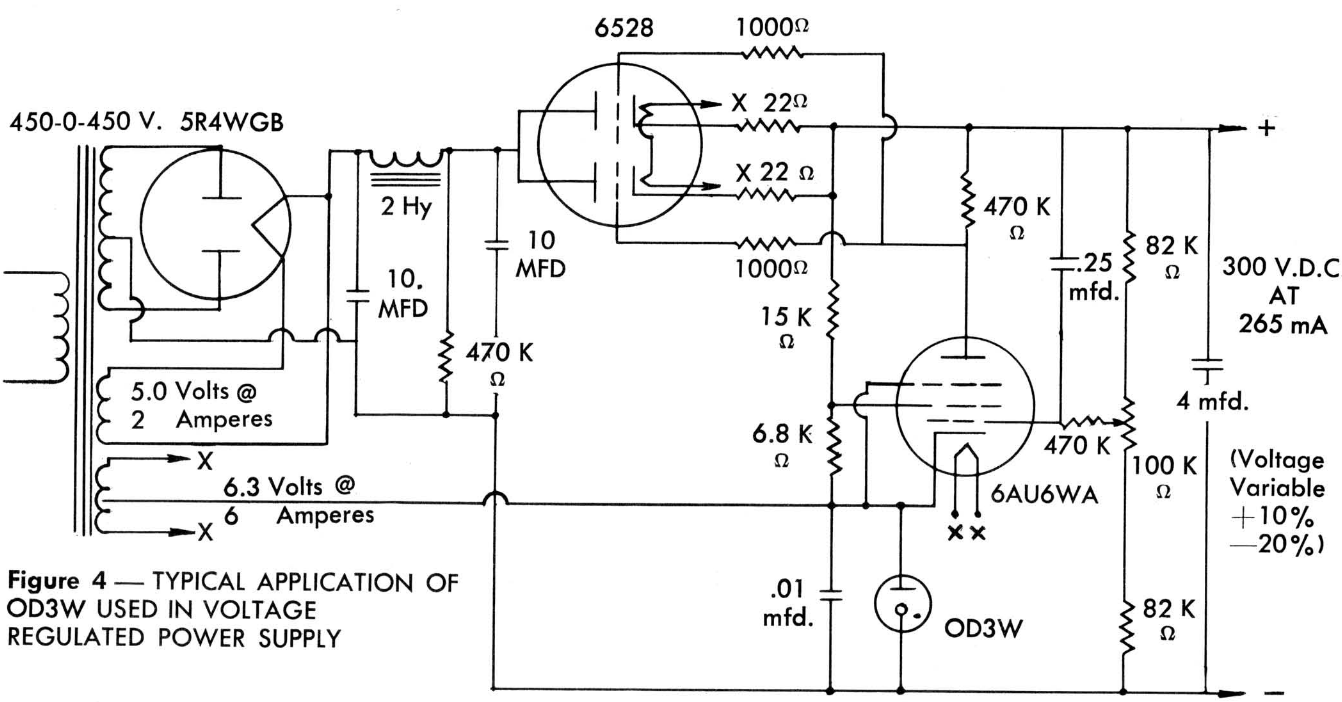


Figure 4 — TYPICAL APPLICATION OF OD3W USED IN VOLTAGE REGULATED POWER SUPPLY

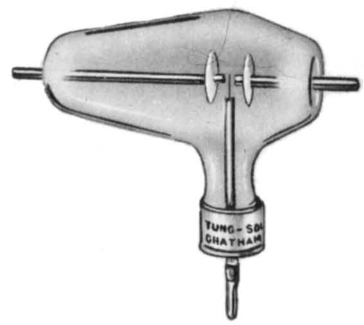
TUNG-SOL / CHATHAM

TYPE 1S22

HIGH VOLTAGE VACUUM SWITCH

DESCRIPTION — The 1S22 is a single pole, double throw, high vacuum switch. The switch is actuated mechanically by means of a lever arm extending through a flexible kovar diaphragm. High currents and high voltages may be switched with a minimum amount of sparking and oxidation at the contact points because of the "break clean" characteristics of a vacuum switch.

The 1S22 has had successful application in airborne equipment particularly as an antenna switch. It has also found application in explosive atmospheres, in corrosive atmospheres and in safety load dumping circuits.



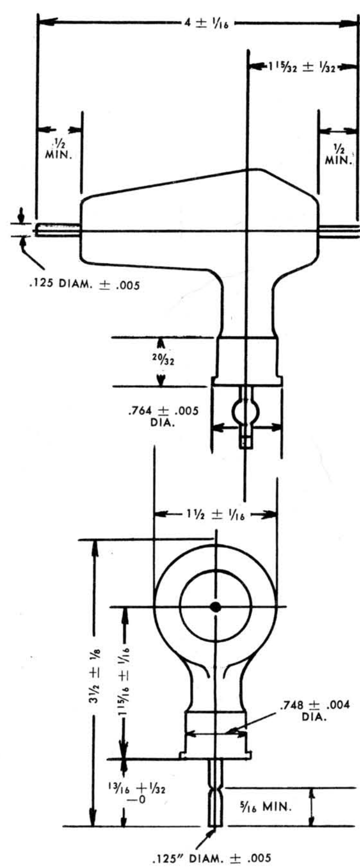
ELECTRICAL DATA

Maximum Continuous Current..........................20 Amperes RMS

Maximum Initial Contact Resistance.....................0.05 Ohms

MECHANICAL DATA

	Min.	Max.
Arm Travel (Measured ⅝″ from diaphragm)......	.009	.017 inches
Actuating Force (Measured ⅝″ from diaphragm)..	200	500 grams
Maximum Allowable Actuating Force............	—	1000 grams



ALTITUDE RATINGS

Altitude	External Hold-Off Voltage (RMS)	Internal Hold-Off Voltage (RMS)
27,000 Ft	10,000 volts	10,000 volts
40,000	7,500	10,000
50,000	5,000	10,000

INTERRUPTING RATINGS (for information only)

With Resistive Load at 10,000 V. RMS at 60 cps.

Operations	Amperes
1000	10.0
1,000,000	3.0
500,000,000	0.1

TUNG-SOL / CHATHAM

TYPE
1Z2

HIGH VOLTAGE, HALF-WAVE RECTIFIER

DESCRIPTION—The 1Z2 is a high voltage low current vacuum rectifier tube in a miniature bulb. This tube features a low drain, thoriated tungsten filament which will work satisfactorily in flyback and RF power supply circuits as well as with conventional transformer or dry battery filament supply. Full anode voltage may be applied to a cold tube simultaneously with the application of filament voltage. Because of the small space and weight of the 1Z2, this tube is especially adaptable to compact and portable equipment.

MAXIMUM RATINGS

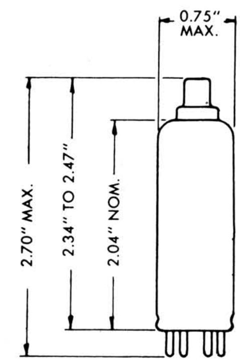
Maximum Peak Inverse Plate Voltage	15,000 Volts
Maximum Steady State Peak Plate Current	8.5 Milliamperes
Maximum D.C. Output Current	1.5 Milliamperes
Maximum Supply Voltage Frequency	200 Kilocycles
Maximum Altitude for Full Ratings	10,000 Feet
Minimum Supply Source Impedance (At epx=15 Kv)	300,000 Ohms

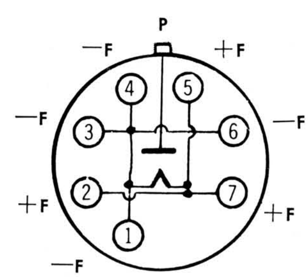
ELECTRICAL DATA

Filament Voltage	1.25 $\pm$ 5% Volts
Filament Current	265 Milliamperes
Tube Voltage Drop at 1.5 ma (Approx.)	18 Volts
Tube Voltage Drop at 8.5 ma (Approx.)	125 Volts
Minimum Filament Heating Time	0 Seconds

MECHANICAL DATA

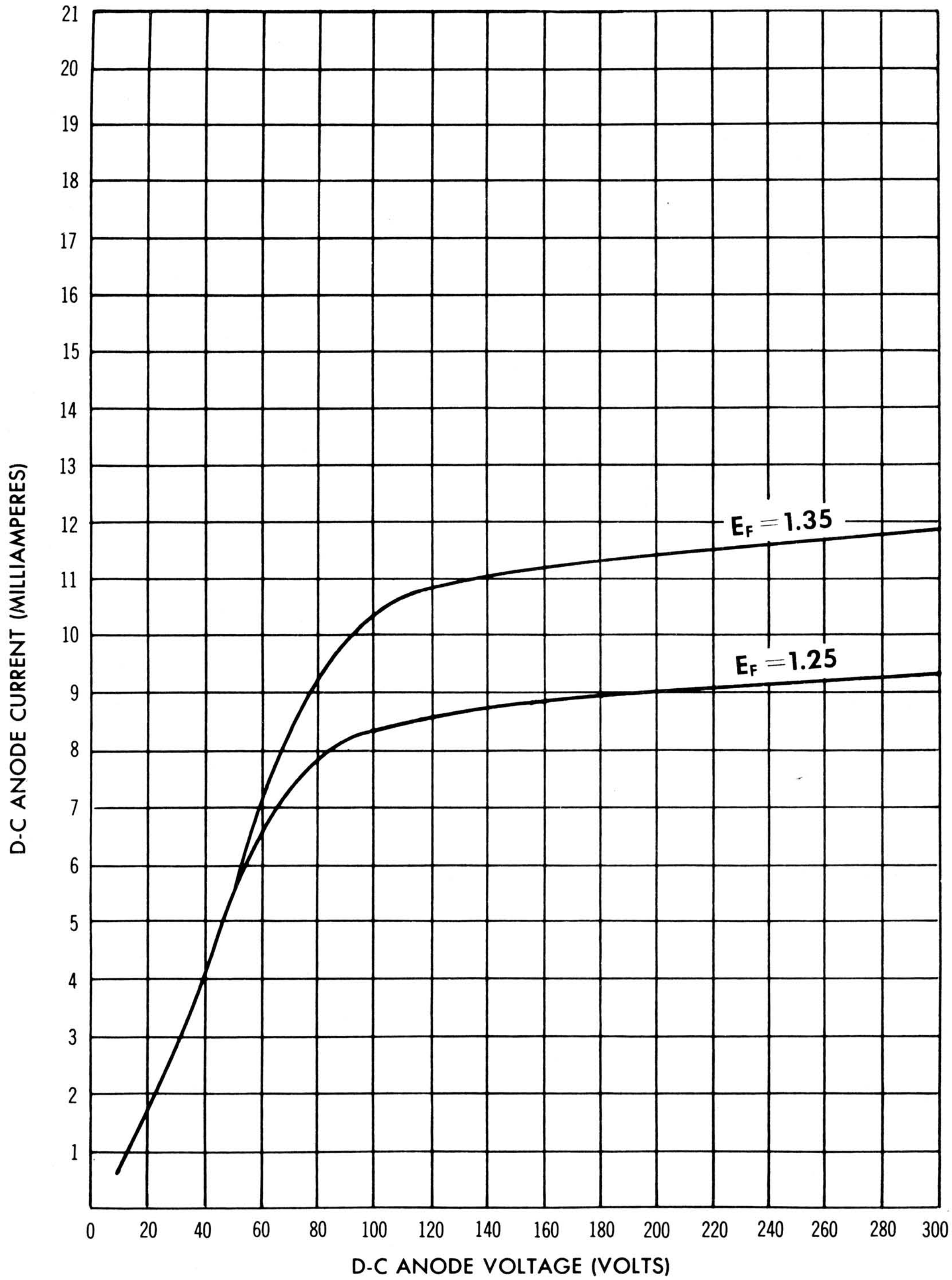
Mounting Position	Any
Maximum Overall Length	2.70″
Seated Length	2.34″ to 2.47″
Maximum Diameter	0.75″
Bulb	T-5½
Cap	Skirted Miniature
Base	Miniature Button 7-Pin
Maximum Weight (Net)	0.5 Ounce



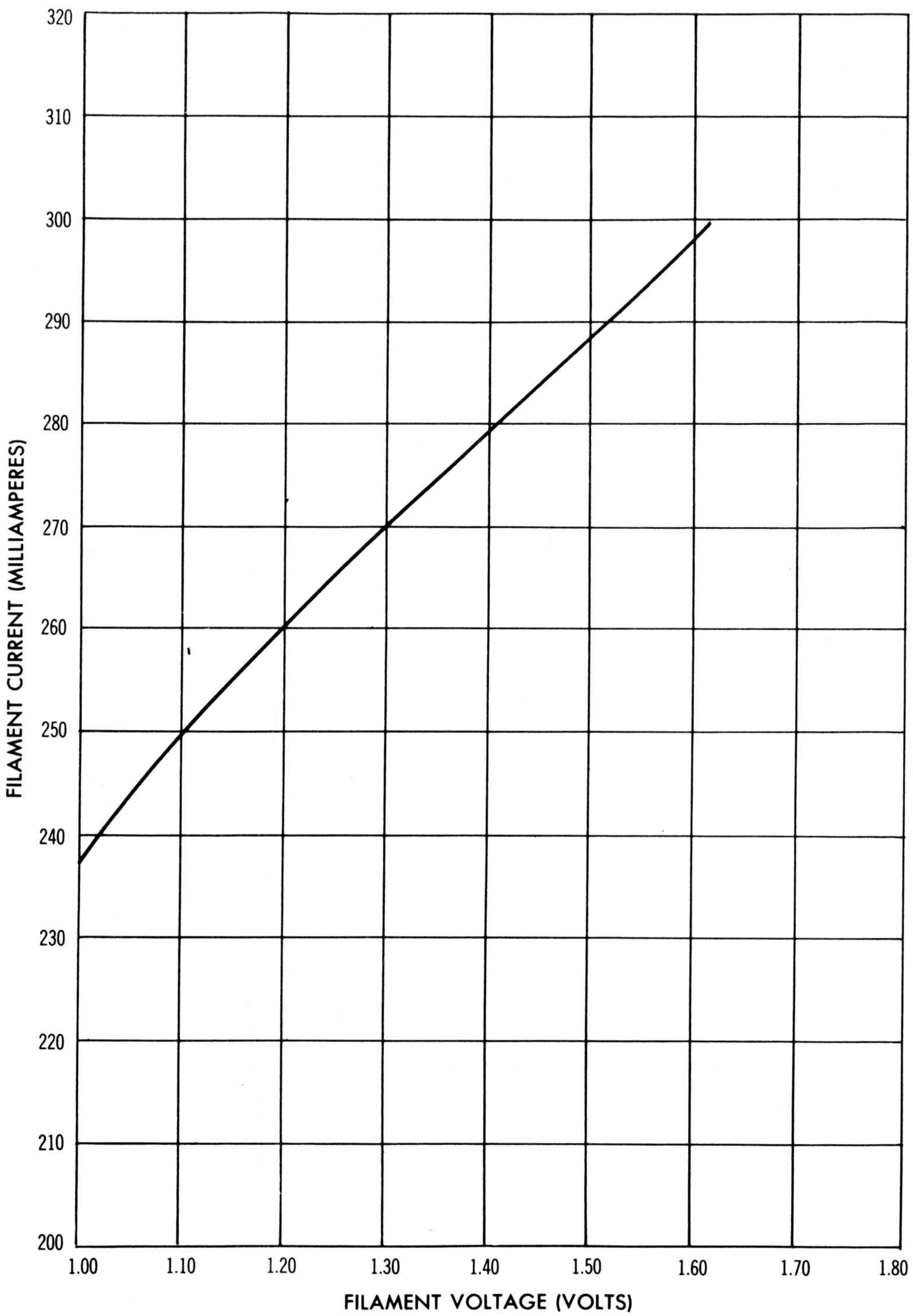


BOTTOM VIEW

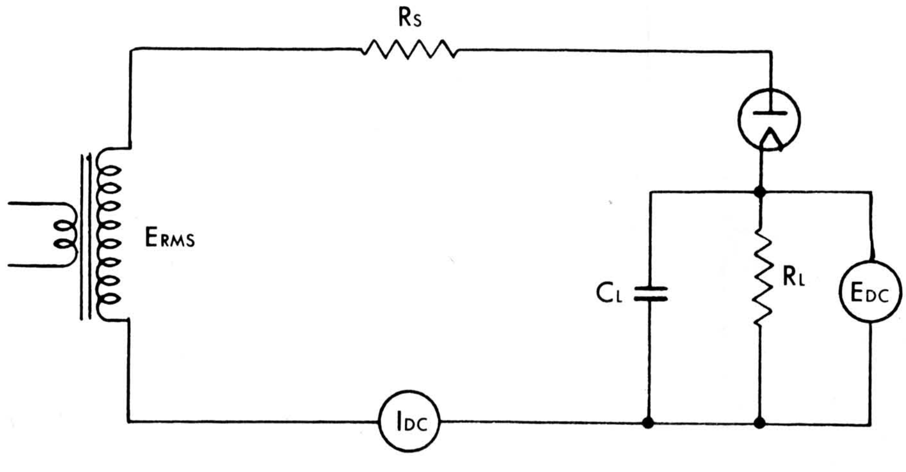
Plate Characteristics



Filament Characteristics



Typical Circuit Values



E_{RMS}	R_S	R_L	C_L	E_{DC}	I_{DC}
KILOVOLTS	MEGOHMS	MEGOHMS	mfd	KILOVOLTS	MILLIAMPS
5.3	0.44	278.	.012	4.15	1.5
5.3	0.3	43.	.024	6.8	0.155

TUNG-SOL/CHATHAM

TYPE
2D21W

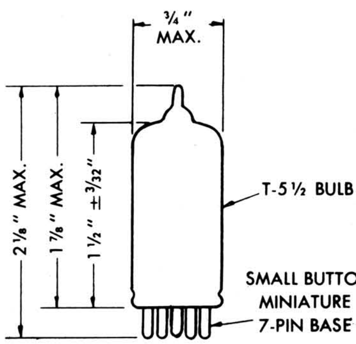
SHIELD GRID THYRATRON

DESCRIPTION — The 2D21W is a ruggedized, xenon filled, four electrode thyratron with negative control characteristics. This tube is electrically equivalent to the popular type 2D21, but has been ruggedized through the use of ceramic insulators and stronger elements to permit the tube to stand high impact shocks and vibration. It has found wide usage as a switching tube, as a pulse modulator, and in grid controlled rectifier service. Because of its shield grid construction, the input of the 2D21W will work directly from a high impedance source such as a phototube. The effective anode to control grid capacity may be reduced by connecting pins No. 5 and 7 to No. 2 and connecting the grid resistor directly at the socket terminal. The small size and light weight of the 2D21W and its relative freedom from temperature restrictions make this tube particularly suited for use in compact equipment.

ELECTRICAL DATA

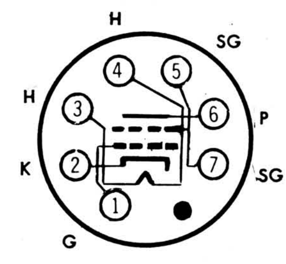
Heater Voltage	6.3 ±10% Volts*
Heater Current (E_f = 6.3 volts)	0.600 Amperes
Minimum Cathode Heating Time	10. Seconds
Anode to Control Grid Capacitance	0.026 Micro-microfarads
Control Grid to Cathode (and shield grid) Capacitance	2.4 Micro-microfarads
Anode to Cathode (and shield grid) Capacitance	1.6 Micro-microfarads
De-ionization Time, Approx. (shield tied to cathode)	
With Grid Volts = −100, Grid Res. = 1000Ω, Anode Volts = 125, Anode Cur. = 0.1 Amps	35 Microseconds
With Grid Volts = −10, Grid Res. = 1000Ω, Anode Volts = 125, Anode Cur. = 0.1 Amps	75 Microseconds
Ionization Time, Approx.	0.5 Microseconds
Anode Voltage Drop, Approx.	8 Volts
Maximum Critical Grid Current (At E_{bb} = 460 v RMS)	0.5 Microamperes

* +10%, −5% in Pulse Modulator Service.



MECHANICAL DATA

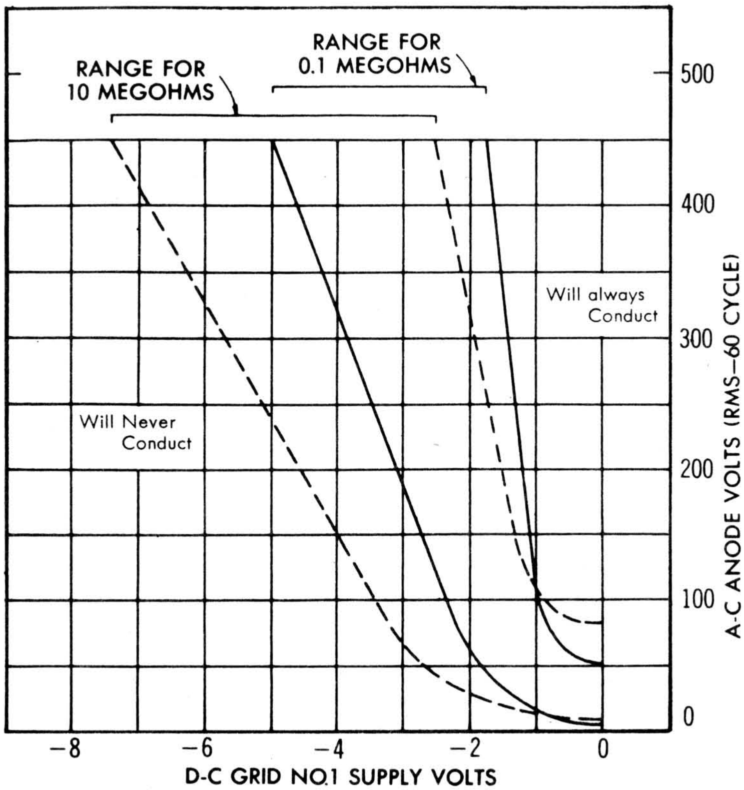
Maximum Shock Rating	720G
Mounting Position	Any
Maximum Overall Length	2.13″
Maximum Seated Length	1.88″
Maximum Diameter	0.75″
Bulb	T-5½
Base	Miniature Button 7-Pin
Weight (net)	0.5 Ounces



BOTTOM VIEW

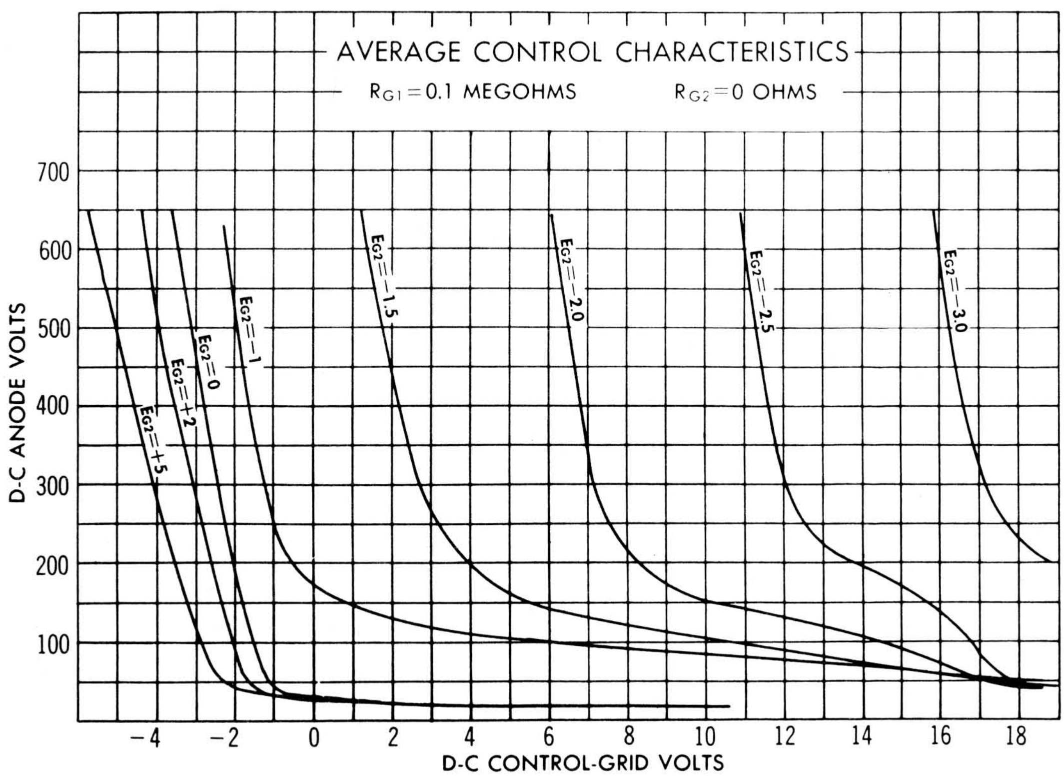
Ratings, Absolute Values

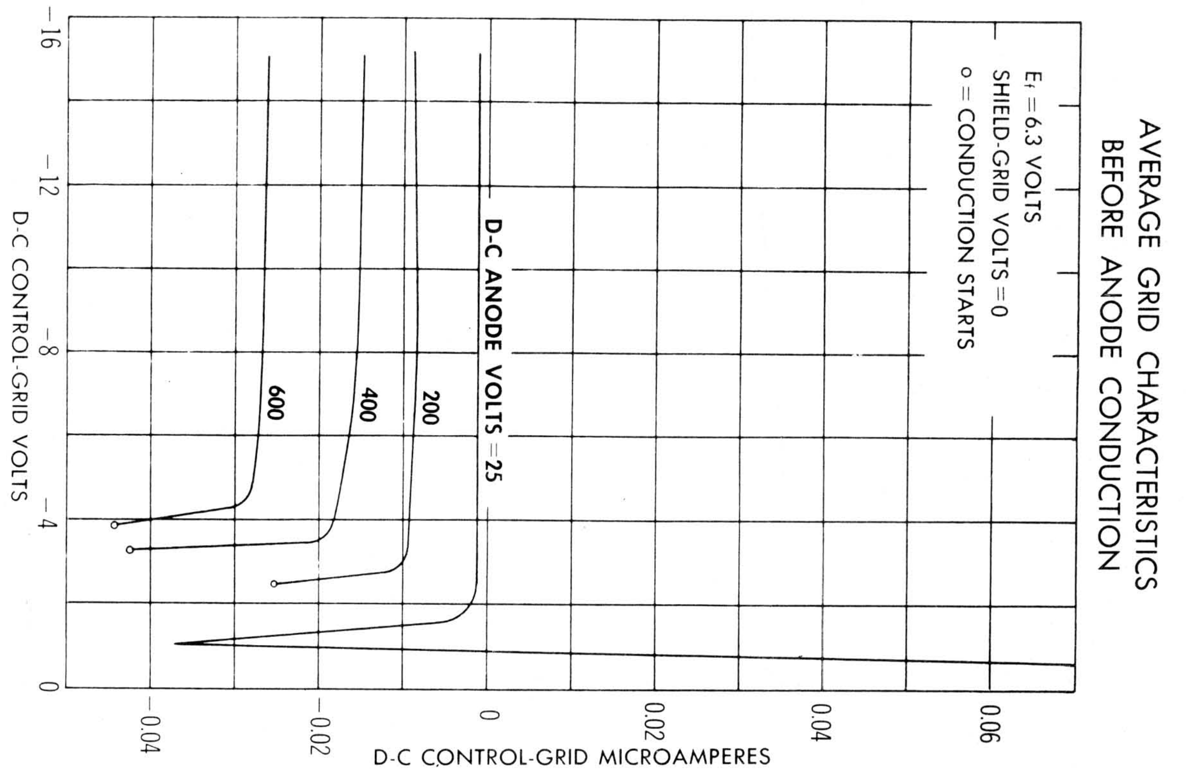
	Relay & Grid Controlled Rectifier Service	Pulse Modulator Service
Maximum Peak Anode Voltage		
Inverse	1300 Volts	100 Volts
Forward	650 Volts	500 Volts
Maximum Cathode Current		
Peak	0.5 Amperes	10. Amperes
Average	100. Milliamperes	10. Milliamperes
Surge (max. duration 0.1 seconds)	10. Amperes	—
Maximum Average Time	30. Seconds	—
Maximum Negative Control Grid Voltage		
Before Conduction	−100 Volts	−100 Volts
During Conduction	− 10 Volts	− 10 Volts
Maximum Positive Control Grid Current		
Average (Averaged over 30 sec. max.)	10 Milliamperes	—
Peak	—	20 Milliamperes
Maximum Negative Shield Grid Voltage		
Before Conduction	−100 Volts	−50 Volts
During Conduction	−10 Volts	−10 Volts
Maximum Positive Shield Grid Current		
Average (Averaged over 30 sec. max.)	10 Milliamperes	—
Peak	—	20 Milliamperes
Maximum Frequency	—	500 pps
Maximum Pulse Time	—	5 Microseconds
Maximum Rate of Rise	—	100 Amperes per Microsecond
Maximum Heater Cathode Voltage		
Heater Negative	−100 Volts	0 Volts
Heater Positive	25 Volts	0 Volts
Ambient Temperature Limits	−75 to +90° Centigrade	−75 to +90° Centigrade
Maximum Control Grid (G1) Circuit Resistance	10 Megohms	0.5 Megohms
Maximum Shield Grid (G2) Circuit Resistance	—	25,000 Ohms
Minimum Shield Grid (G2) Circuit Resistance	—	2,000 Ohms

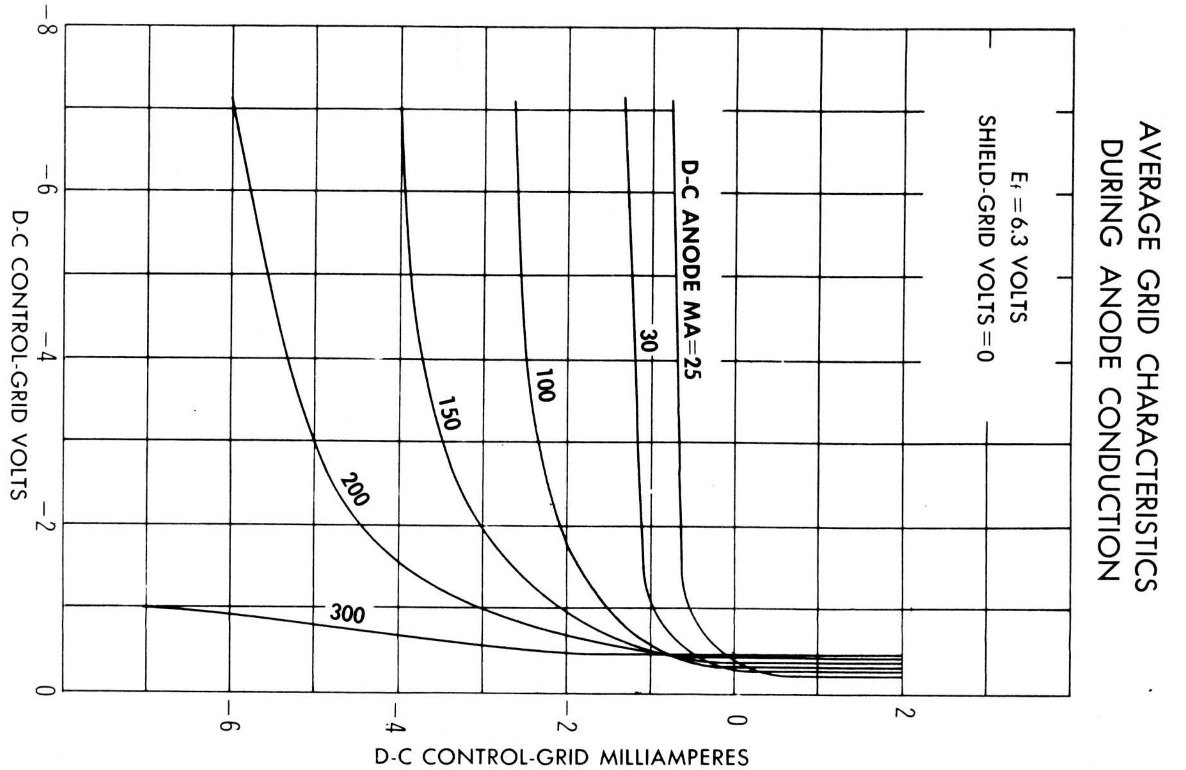


OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE

Ranges shown are for two values of grid resistor, 0.1 megohm and 10 megohm, and take into account initial differences between individual tubes and subsequent differences during tube life for a heater voltage range of 5.7 to 6.9 volts.




AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION
Ef = 6.3 VOLTS
SHIELD-GRID VOLTS = 0
o = CONDUCTION STARTS
D-C ANODE VOLTS = 25
200
400
600
-16
-12
-8
-4
0
D-C CONTROL-GRID VOLTS
-0.04
-0.02
0
0.02
0.04
0.06
D-C CONTROL-GRID MICROAMPERES

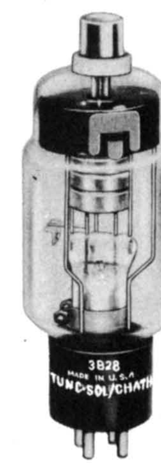

AVERAGE GRID CHARACTERISTICS
DURING ANODE CONDUCTION
Ef = 6.3 VOLTS
SHIELD-GRID VOLTS = 0
D-C ANODE MA=25
30
100
150
200
300
-8
-6
-4
-2
0
D-C CONTROL-GRID VOLTS
-6
-4
-2
0
2
D-C CONTROL-GRID MILLIAMPERES

TUNG-SOL/CHATHAM

TYPE 3B28

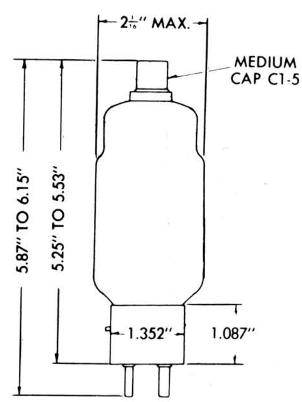
HALF-WAVE GAS RECTIFIER

DESCRIPTION — The 3B28 is a xenon filled half wave rectifier for use in high voltage circuits. The tube is designed to operate over a wide temperature range without the necessity of heating or cooling devices. Its hard glass envelope and well supported mount make it particularly suited for military and industrial use. As contrasted to similar mercury-vapor tubes, the 3B28 may be mounted in any position and is not subject to mercury splash problems. Its efficient oxide coated filament is fast-heating. As consistent with filamentary gas and vapor rectifier tube practice, quadrature excitation of the filament is recommended for obtaining the longest tube life. In quadrature operation, the filament current is phased to be at a minimum when the peak anode current flows. However the tube carries full ratings for in phase operation of the filament.



MAXIMUM RATINGS

Max. Peak Inverse Voltage	5,000 Volts	10,000 Volts
Max. Peak Cathode Current	2. Amperes	1. Amperes
Max. Average Cathode Current	0.5 Amperes	0.25 Amperes
Max. Surge Cathode Current (Max. Duration Time 0.1 Seconds)	20. Amperes	20. Amperes
Max. Averaging Time	30. Seconds	30. Seconds
Max. Supply Frequency	500 cps	150 cps
Ambient Temperature Limits (° Cent.)	−55 to +75	−55 to +75

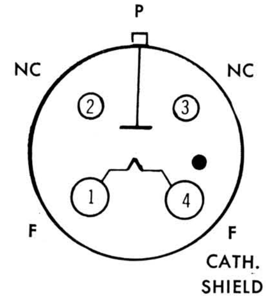


ELECTRICAL DATA

Filament Voltage	2.5 ± 5% Volts
Filament Current at 2.5 Volts	5.0 Amperes
Minimum Cathode Heating Time	5. Seconds
Average Anode Voltage Drop	10. Volts
Peak Anode Voltage Drop	14. Volts
Critical Anode Voltage	50. Volts

MECHANICAL DATA

Mounting Position	Any
Overall Length	5.87″ to 6.15″
Seated Length	5.25″ to 5.53″
Maximum Diameter	2.07″
Bulb	T-16 Nonex
Cap	Medium Metal, C1-5
Base	Medium 4-pin Bayonet, A4-10
Weight (net)	4 oz. Max.



BOTTOM VIEW

MEDIUM SHELL
SMALL 4-PIN
BAYONET BASE

Rectifier Circuits

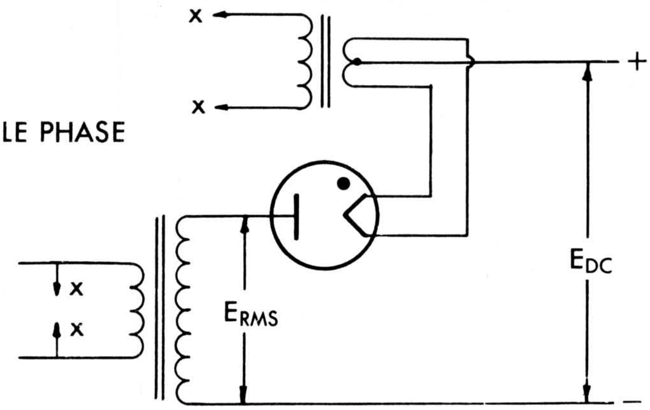


Figure 1—HALF WAVE—SINGLE PHASE

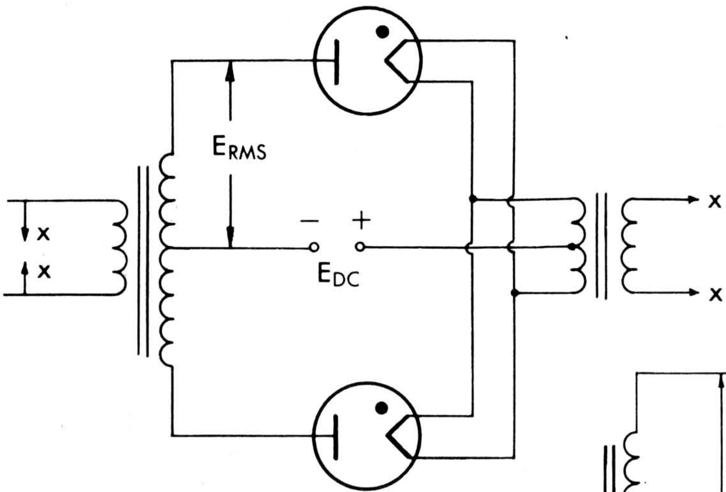


Figure 2—FULL WAVE —SINGLE PHASE

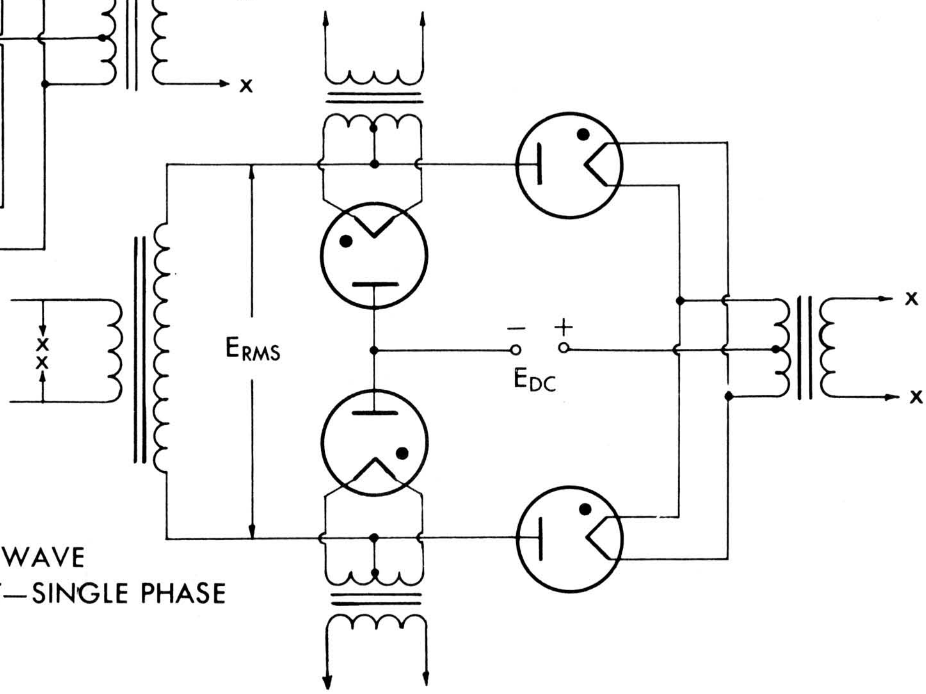


Figure 3—FULL WAVE BRIDGE CIRCUIT—SINGLE PHASE

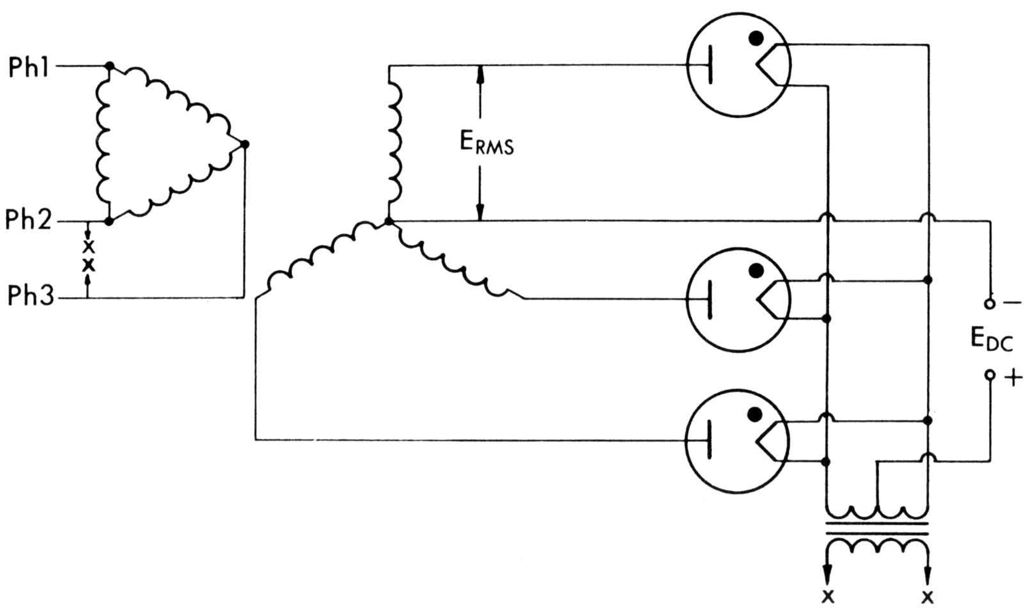


Figure 4—HALF WAVE —THREE PHASE

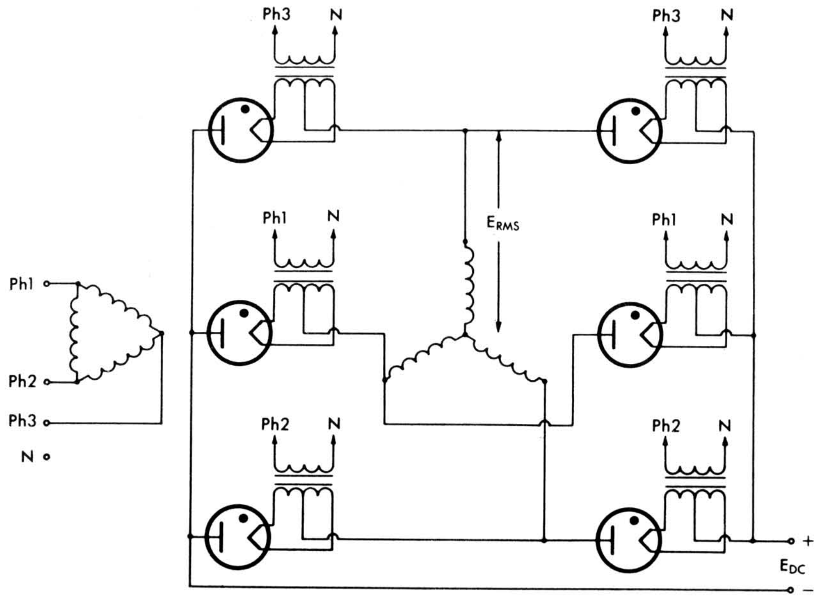


Figure 5—FULL WAVE—THREE PHASE

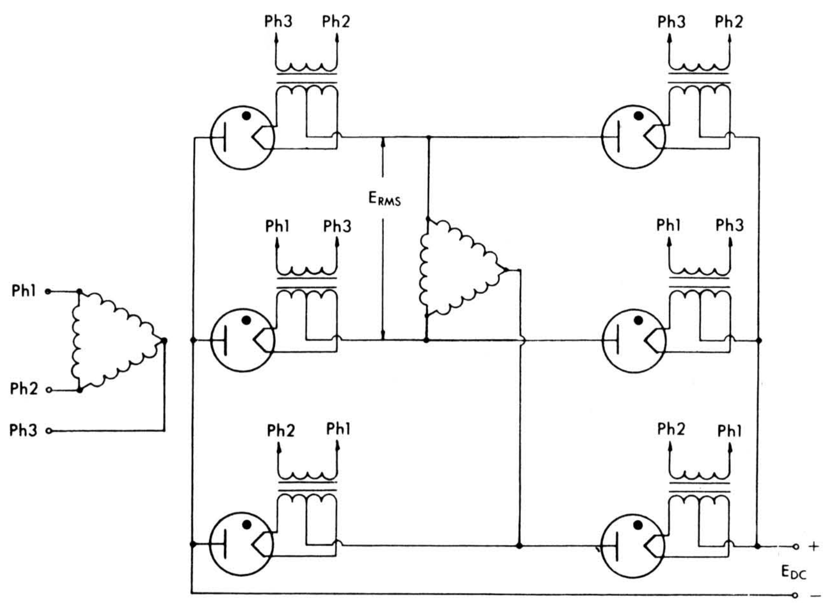


Figure 6—FULL WAVE—THREE PHASE

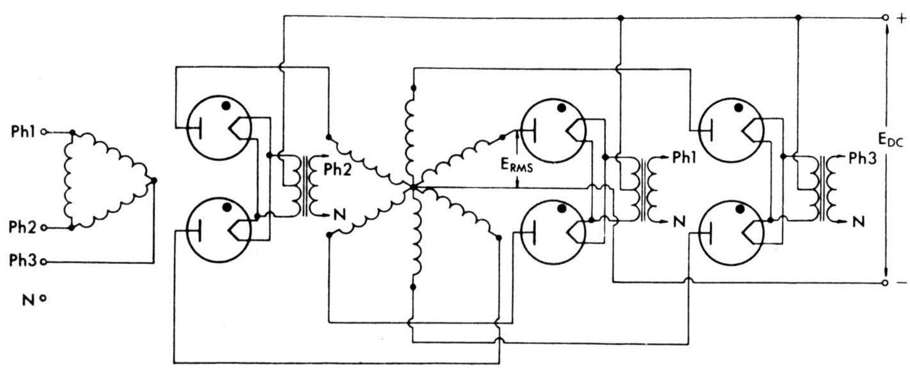


Figure 7—HALF WAVE—SIX PHASE (3 PHASE SUPPLY)

Maximum Circuit Values

Rectifier Circuits are diagrammed on Pages 2 and 3

FIG.	CIRCUIT	TRANSFORMER	FILAMENT OPERATION	NO. OF TUBES	A.C. SECONDARY VOLTAGE	D.C. OUTPUT (APPROX.)		RIPPLE	
					E_{RMS} IN VOLTS	E_{DC} IN VOLTS	I_{DC} IN AMPERES	VOLTS RMS	FREQ.
1	Half Wave Single Phase	Single Phase	In Phase	1	*7000 **3500	3200 1600	0.25 0.50	3500 1750	f
2	Full Wave Single Phase	Single Phase Center Tap	In Phase	2	*3500 **1750	3200 1600	0.50 1.00	1500 750	2f
3	Bridge Circuit Single Phase	Single Phase	In Phase	4	*7000 **3500	6400 3200	0.50 1.00	3000 1500	2f
4	Half Wave Three Phase	Delta-Wye	—	3	*4000 **2000	4800 2400	0.75 1.50	860 430	3f
5	Full Wave Three Phase	Delta-Wye	Quadrature	6	*4000 **2000	9500 4750	0.75 1.50	400 200	6f
6	Full Wave Three Phase	Delta-Delta	Quadrature	6	*7000 **3500	9500 4750	0.75 1.50	400 200	6f
7	Half Wave Six Phase (Three Phase Supply)	Delta-Star	Quadrature	6	*3500 **1750	4800 2400	1.0 2.0	200 100	6f

D.C. output values are those supplied to a choke input filter with a pure sine wave supply.
*Values for a max. of 10 Kv peak inverse voltage per tube and 150 cps. max. supply frequency.
**Values for a max. of 5. Kv peak inverse voltage per tube and 500 cps max. supply frequency.

TUNG-SOL / CHATHAM

TYPE
3C23

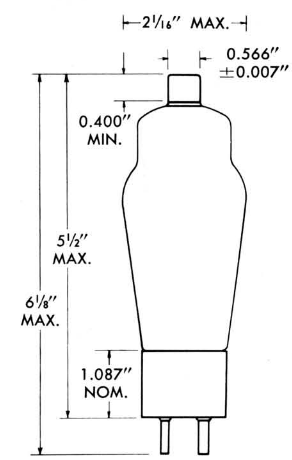
ARGON AND MERCURY-VAPOR THYRATRON

DESCRIPTION — The 3C23 is a three electrode, argon and mercury-vapor filled thyratron with negative control characteristic designed for grid controlled rectifier, motor control, or relay service. The addition of argon gas to the mercury-vapor atmosphere permits the tube to start conduction at low temperatures.

The 3C23 employs a medium, 4-pin bayonet base.

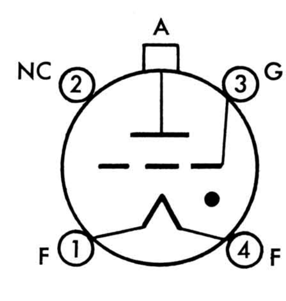
ELECTRICAL DATA

Filament Voltage	2.5 $\pm$0.125 volts
Filament Current @ E_f = 2.5 volts	7 amperes
Cathode Heating Time — Minimum	15 seconds
Anode to Control Grid Capacitance	1.8 micromicrofarads
De-ionization Time — Approximate	
Anode Volts = 120, Anode Current = 1.5 amperes Grid Volts = —20, Grid Resistor = 10,000 ohms	360 microseconds
Anode Volts = 120, Anode Current = 1.5 amperes Grid Volts = —500, Grid Resistor = 100,000 ohms	60 microseconds
Anode Voltage Drop — Approximate	
Initial	10 volts
End of Life	20 volts



MECHANICAL DATA

Mounting Position	Vertical, base down
Type of Cooling	Convection
Bulb	ST16
Base	A4-10 Medium
Cap	C1-5 Medium
Net Weight	3 ounces maximum
Socket	Medium, 4 pin bayonet



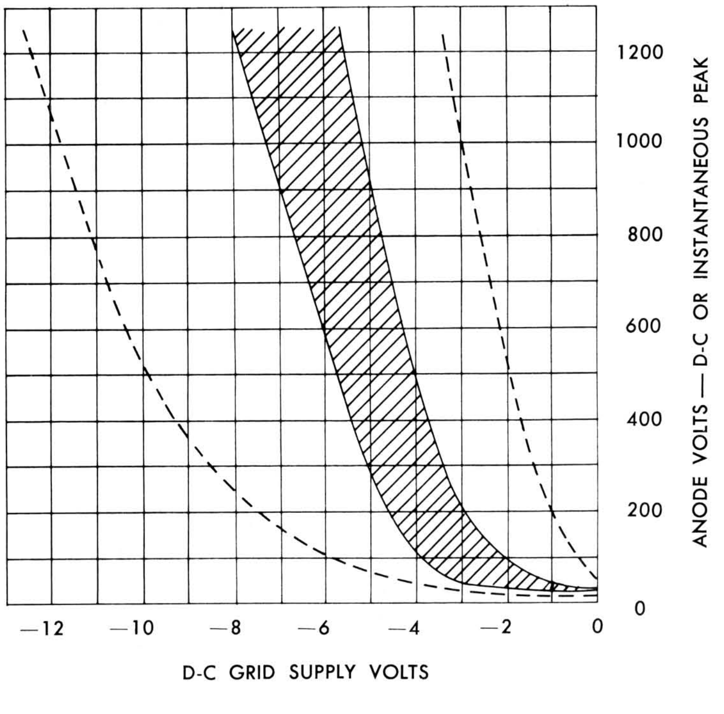
BOTTOM VIEW

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum
Peak Anode Voltage		
Forward	—	1250 volts
Reverse	—	1250 volts
Grid Voltage		
Peak or DC before tube conduction	—	—500 volts
Average during tube conduction — Note 1	—	—10 volts
Anode Current		
Peak	—	6 amperes
Average — Note 2	—	1.5 amperes
Fault — for duration of 0.1 second maximum — Note 3	—	120 amperes
Grid Current		
Average — Note 4	—	+0.01 ampere
Operating Frequency	—	420 cycles per second
Altitude	—	10,000 feet
Temperature Range — Note 5	40	80° Centigrade
Filament Voltage	2.37	2.63 volts

NOTES:
1. Averaged over one conducting period.
2. Averaged over any interval of five seconds maximum.
3. The equipment designer should limit the short circuit current to 120 amperes circuitwise. It should be understood that while the tube may stand several faults at this magnitude of current, each fault will adversely affect tube life.
4. Averaged over the period of grid conduction.
5. The recommended operating range for this tube is from 40° to 80° Centigrade. Operation between —55° and +40° Centigrade at reduced ratings, or "starts" in this temperature range are permissible, but will result in considerably shortened life.

Shaded area shows usual control region. Dotted limits show nominal range of grid control voltage taking into consideration differences between individual tubes, and variations due to filament voltage, temperature and changes during life.



OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE

APPLICATION NOTES

Thyratron tubes, if correctly used, will give many thousands of hours of reliable service. The correct use of a tube involves among other things adherence to the following rules:

1. Avoid cold starts. The heat shielded, oxide coated filament should be energized before the anode voltage is applied in order to obtain maximum life.
2. Avoid operating the tube outside of the specified filament voltage range.
3. Avoid exceeding the rated peak inverse voltage. Excess inverse voltage can cause either an immediate failure or a rapid decline in useful life.

No clear cut method of foretelling tube failure has been devised. Periodic replacement of a tube as a routine preventive maintenance device is not recommended as a tube that has operated for several thousand hours may be good for several more thousand hours of useful operation. Quite often maintenance personnel can, after some experience with a piece of equipment, anticipate tube failure by observation. Visual checks of tube (arc) drop will indicate tubes approaching end of life. Tube drop voltages considerably higher than that of the last readings, or readings above 20 volts indicate tubes that may soon fail. While such a reading can be taken directly at the tube in the operating equipment, it is a dangerous practice. THE VOLTAGES AT WHICH THIS TUBE NORMALLY OPERATES ARE LETHAL. A more practical and exact measurement is observing the tube voltage drop in a test jig while it passes one or two high current pulses. Such a jig is illustrated in figure 1. The oscilloscope is calibrated by first setting switch S2 to CURRENT CHECK. Momentary contact switch S1 is then tapped while CURRENT SET resistor R2 is adjusted until a pattern 8 volts high appears on the oscilloscope screen. This indicates that a peak current of eight amperes is flowing through the tube under test and through calibrating resistor R3. The tube voltage drop can then be read directly in volts on the oscilloscope scale by setting switch S2 to the TEST position and tapping switch S1. A new tube will have a voltage drop of approximately 10 volts. A tube approaching the end of life may have a voltage drop of 20 volts.

Grid-controlled thyratrons can be incorporated into circuits to provide numerous services including the speed control of d-c motors, dc to ac inversion, ac to dc rectification, and supplying variable a-c power from an a-c source.

Figure 2 illustrates one method of converting ac to dc. The magnitude of the d-c output voltage is controlled by the variable resistor which controls the firing angle, or grid voltage phase, of the thyratrons. The use of thyratrons to supply a variable a-c output from a fixed a-c source is shown in figure 3. Again, the variable resistor serves to control the phase angle of the applied grid voltage and thus the output voltage.

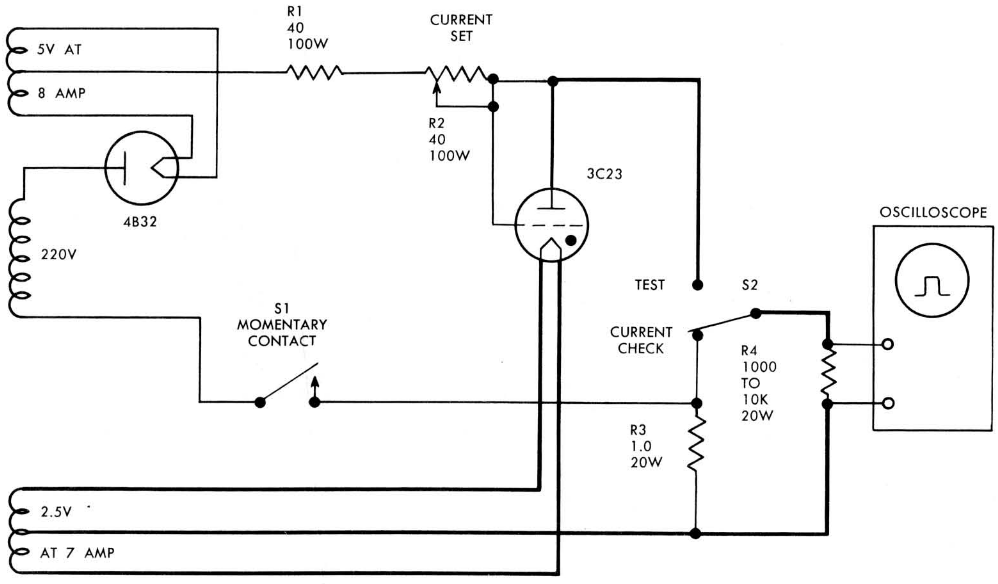


FIGURE 1. TEST JIG FOR MEASURING EMISSION BY TUBE VOLTAGE DROP

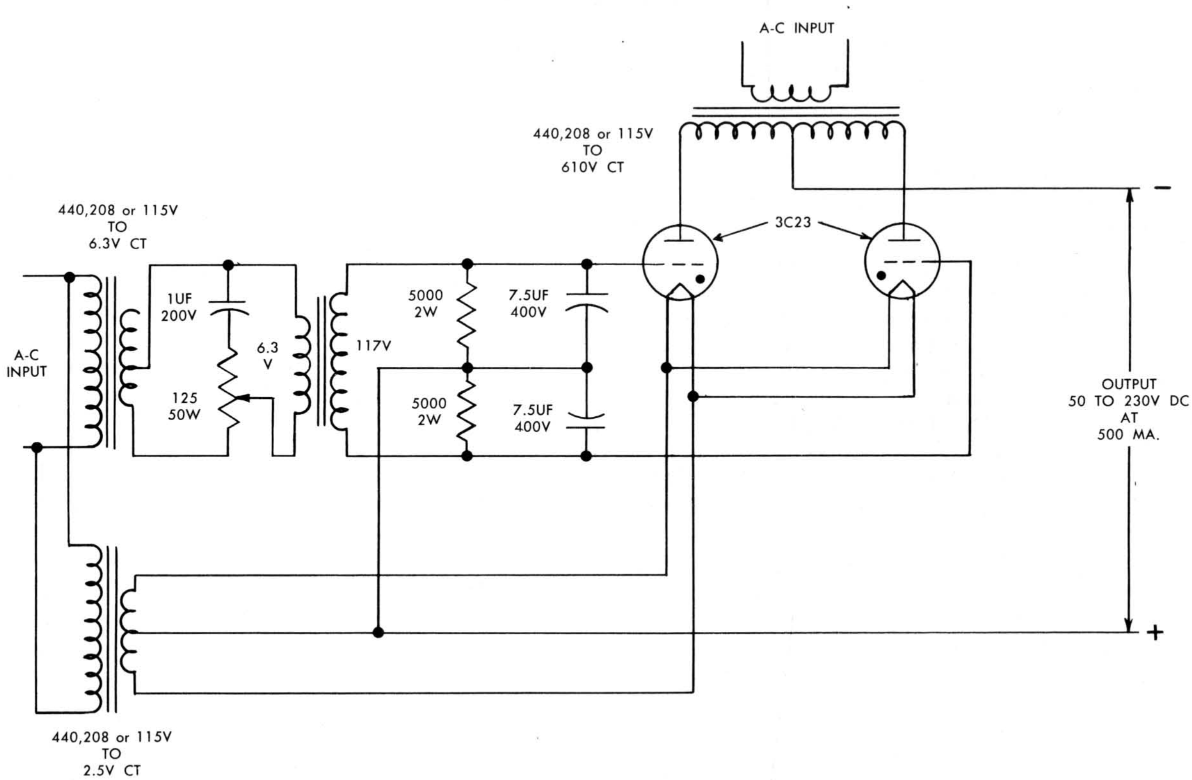


FIGURE 2. THYRATRON POWER SUPPLY PROVIDING VARIABLE D-C OUTPUT FROM A-C INPUT

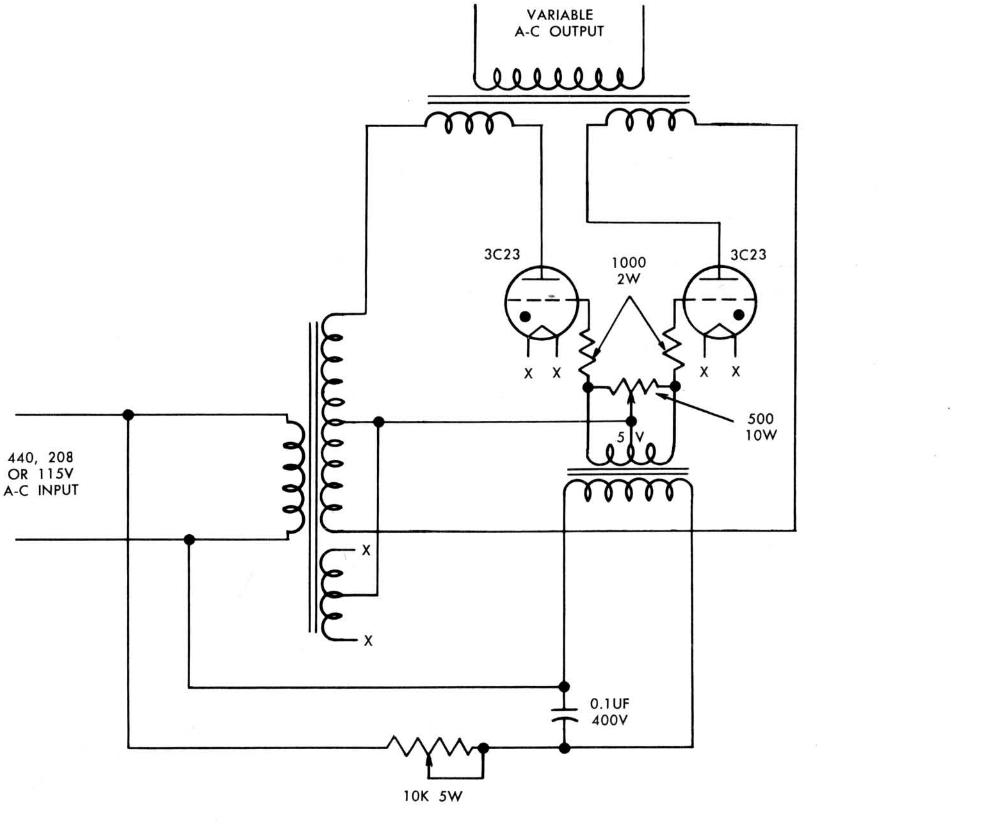


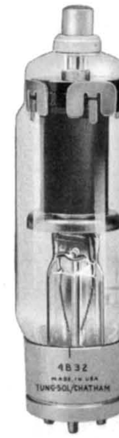
FIGURE 3. THYRATRON POWER SUPPLY PROVIDING VARIABLE A-C OUTPUT FROM A-C INPUT

TUNG-SOL/CHATHAM

TYPE 4B32

HALF-WAVE GAS RECTIFIER

DESCRIPTION — The 4B32 is a xenon filled half wave rectifier for use in high voltage circuits. The tube is designed to operate over a wide temperature range without the necessity of heating or cooling devices. Its hard glass envelope and well supported mount make it particularly suited for military and industrial use. As contrasted to similar mercury-vapor tubes, the 4B32 may be mounted in any position and is not subject to mercury splash problems. Its efficient oxide coated filament is fast heating. As consistent with filamentary gas and vapor rectifier tube practice, quadrature excitation of the filament is recommended for obtaining the longest tube life. In quadrature operation, the filament is phased to be at a minimum when the peak anode current flows. However the tube carries full ratings for in phase operation of the filament.



MAXIMUM RATINGS

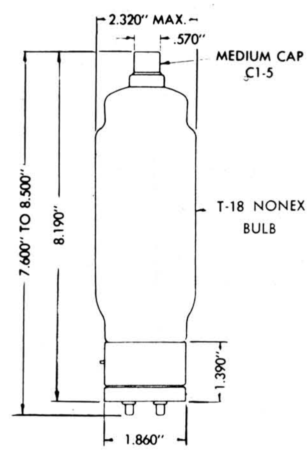
Max. Peak Inverse Voltage	10,000 Volts
Max. Peak Cathode Current	5.0 Amperes
Max. Average Cathode Current	1.25 Amperes
Max. Surge Cathode Current (Max. Duration Time 0.1 Seconds)	50. Amperes
Max. Averaging Time	15. Seconds
Max. Supply Frequency	150. cps
Ambient Temperature Limits	−55 to +70° Centigrade

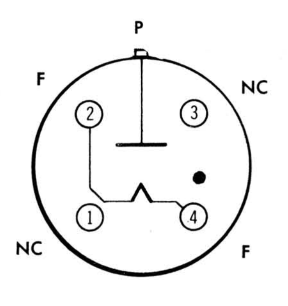
ELECTRICAL DATA

Filament Voltage	5.0 ± 5% Volts
Filament Current at 5.0 Volts	7.25 Amperes
Minimum Cathode Heating Time	30. Seconds
Average Anode Voltage Drop	12. Volts
Peak Anode Voltage Drop	16. Volts
Critical Anode Voltage	50. Volts

MECHANICAL DATA

Mounting Position	Any
Overall Length	7.6 to 8.5 Inches
Maximum Diameter	2.32 Inches
Bulb	T-18 Nonex
Cap	Medium Metal, C-1-5
Base	Jumbo 4-Pin, A4-29
Weight (net)	7½ Ounces Max.





BOTTOM VIEW

JUMBO 4-PIN
BAYONET

Ratings, Absolute Values

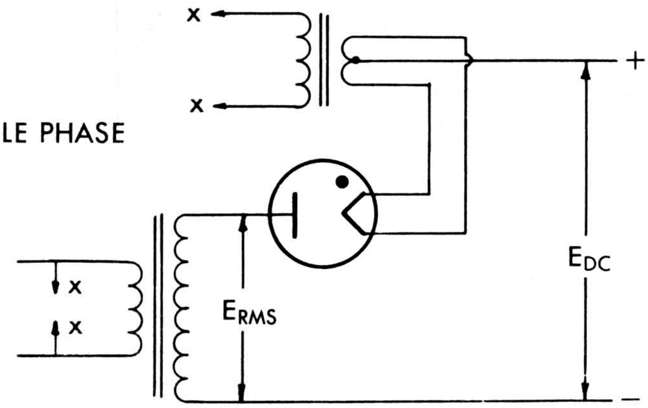


Figure 1—HALF WAVE—SINGLE PHASE

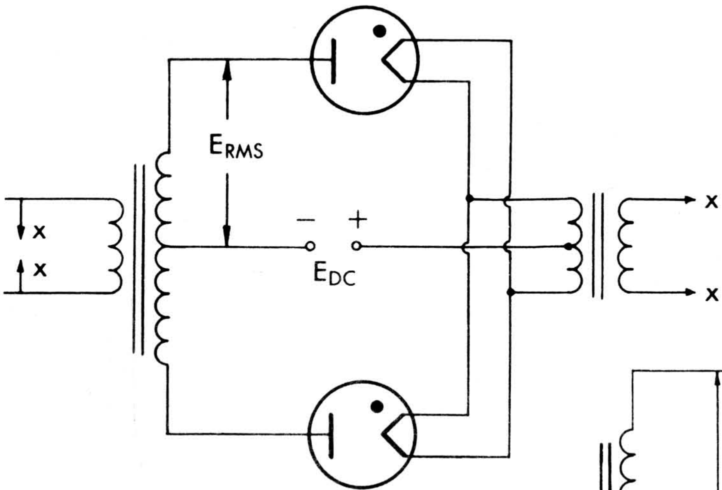


Figure 2—FULL WAVE —SINGLE PHASE

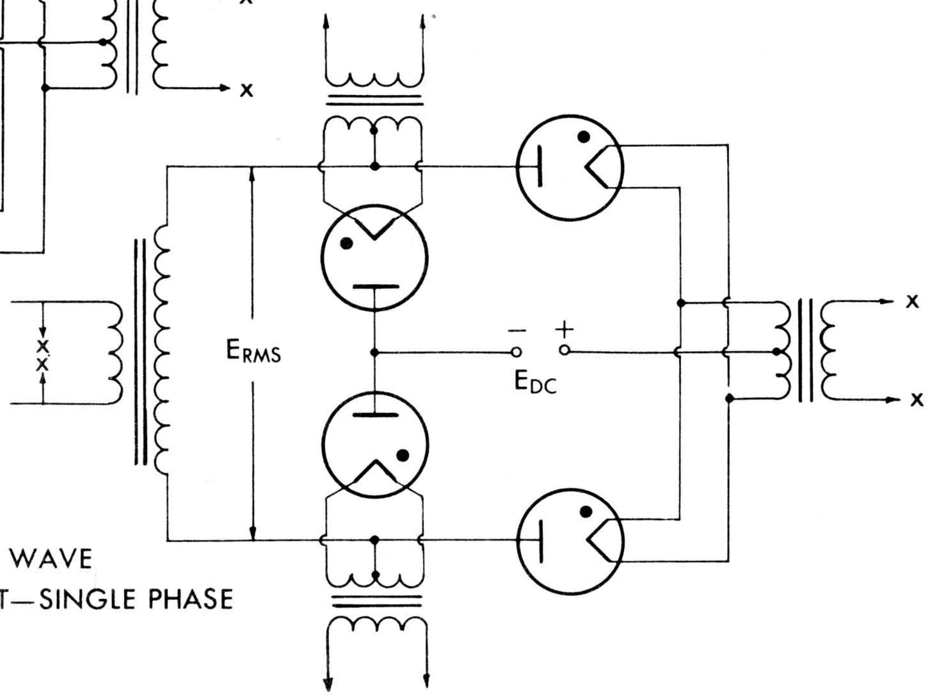


Figure 3—FULL WAVE BRIDGE CIRCUIT—SINGLE PHASE

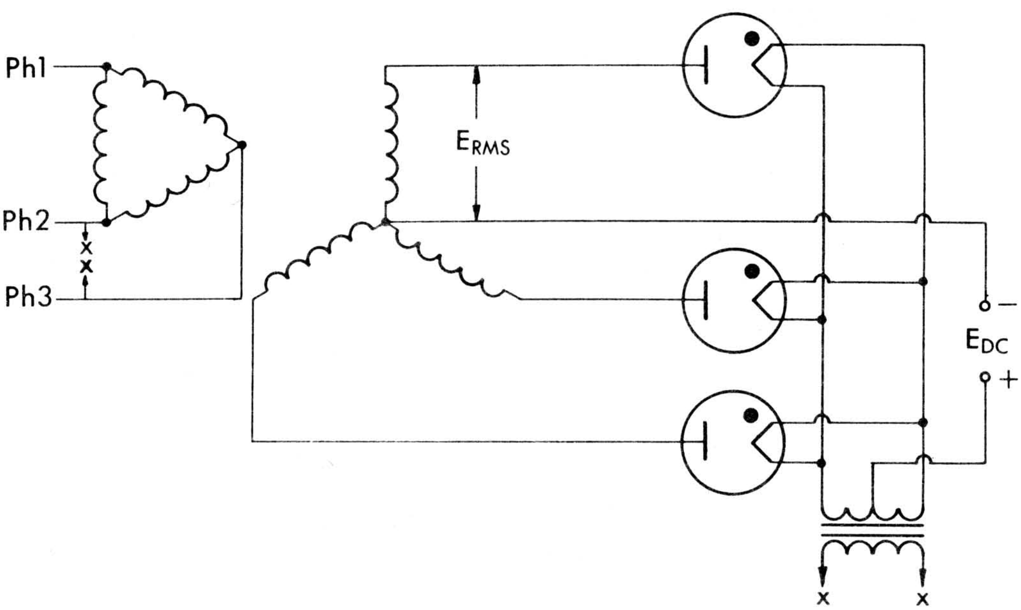


Figure 4—HALF WAVE —THREE PHASE

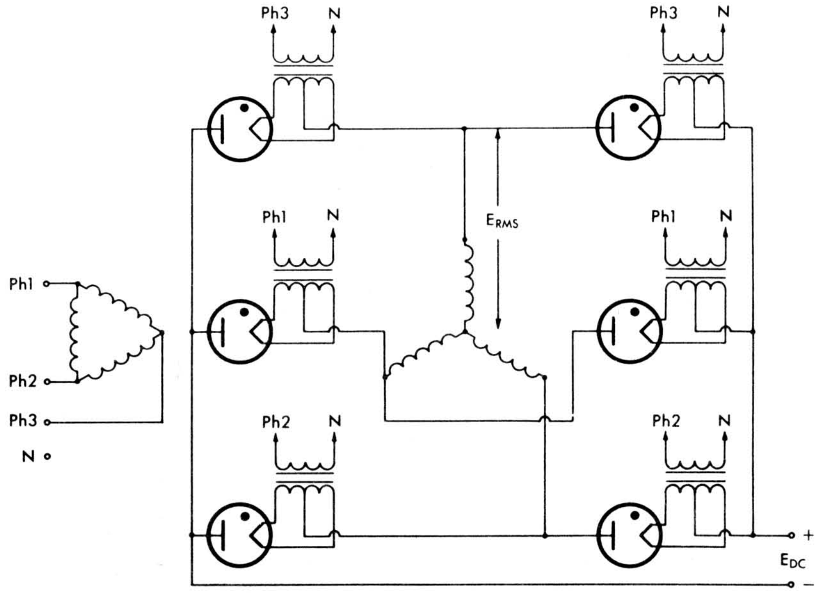
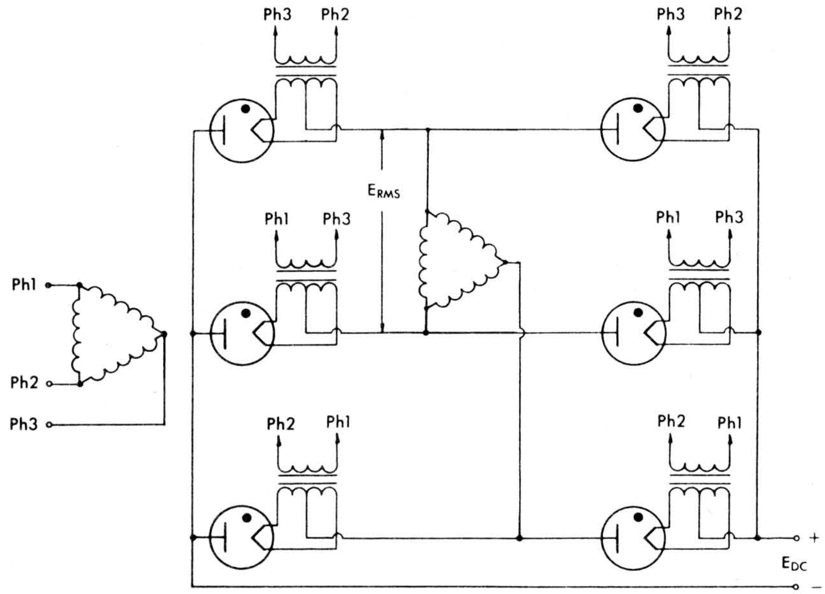


Figure 5—FULL WAVE—THREE PHASE

Figure 6—FULL WAVE—THREE PHASE



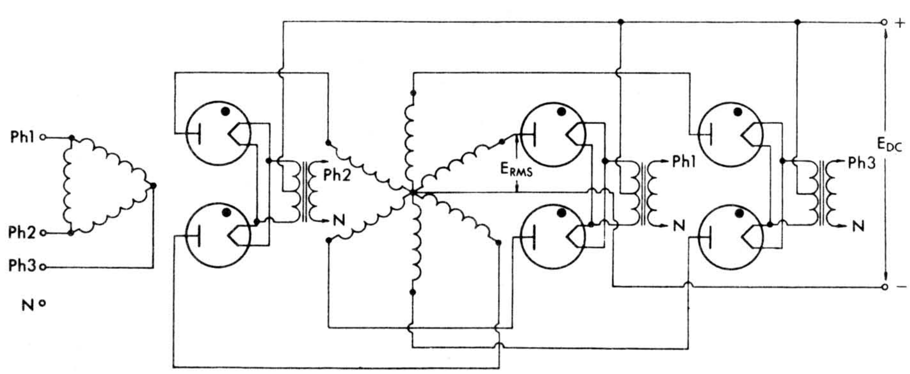


Figure 7—HALF WAVE—
SIX PHASE (3 PHASE SUPPLY)

Maximum Circuit Values

Rectifier Circuits are diagrammed on Pages 2 and 3

FIG.	CIRCUIT	TRANSFORMER	FILAMENT OPERATION	NO. OF TUBES	A.C. SECONDARY VOLTAGE	D.C. OUTPUT (APPROX.)		RIPPLE	
					E_{RMS} IN VOLTS	E_{DC} IN VOLTS	I_{DC} IN AMPERES	VOLTS RMS	FREQ.
1	Half Wave Single Phase	Single Phase	In Phase	1	7000	3200	1.25	3500	f
2	Full Wave Single Phase	Single Phase Center Tap	In Phase	2	3500	3200	2.50	1500	2f
3	Bridge Circuit Single Phase	Single Phase	In Phase	4	7000	6400	2.50	3000	2f
4	Half Wave Three Phase	Delta-Wye	—	3	4000	4800	3.75	860	3f
5	Full Wave Three Phase	Delta-Wye	Quadrature	6	4000	9500	3.75	400	6f
6	Full Wave Three Phase	Delta-Delta	Quadrature	6	7000	9500	3.75	400	6f
7	Half Wave Six Phase (Three Phase Supply)	Delta-Star	Quadrature	6	3500	4800	5.0	200	6f

D.C. output values are those supplied to a choke input filter with a pure sine wave supply.
Values are for a maximum of 10 Kv peak inverse voltage per tube and 150 cps maximum supply frequency.

TUNG-SOL/CHATHAM

TYPE
5R4WGA

HIGH VOLTAGE, FULL-WAVE RECTIFIER

DESCRIPTION — The 5R4WGA is a high vacuum full wave rectifier capable of supplying 950 Vdc at 165 mA or 750 Vdc at 275 mA. This tube type, proven by millions now in field use, features a rugged construction that will withstand a shock impact of 900 G and high vibrational stresses. One of the design features is the shock mounting of the bulb in its skirted base by resilient silicone rubber. Thus, although the base may be securely clamped to the chassis, the tube proper is shock insulated. This type of basing also permits operation at high altitudes without flash over. Other design features are a rugged filament and a "cross-press" stem. The latter keeps electrolysis to a minimum while offering a stable support for the mount structure. The hard glass construction permits the tube to be processed at high temperature during manufacture so that it will remain gas free under high temperature operation during life. The low drain, fast heating, filament permits instant application of plate voltage over a large portion of the operating characteristic (see Curve).

ELECTRICAL DATA

Filament Voltage (± 10%)	5.0 V.a.c.
Filament Current	2.0 A.a.c.
Typical Operation	Input to Filter

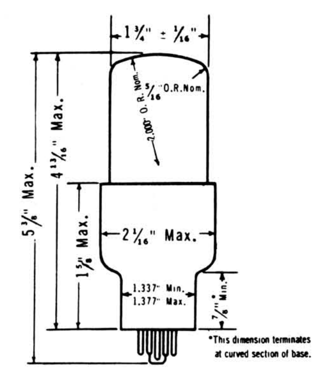
TYPICAL OPERATION

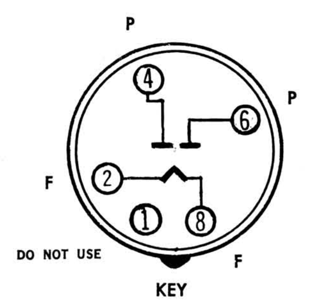
	INPUT TO FILTER CHOKE	CAPACITOR
AC Plate Voltage RMS per plate	900	700 Vac
Input Condenser	–	4 Mfd
Input Choke	10	—H
Effective Plate Supply Impedance per plate	–	100 Ohms
D. C. Output current	165	275 mA
D. C. Output voltage at full load	840	730 Vdc
D. C. Output voltage at half load	860	800 Vdc
Regulation, half load to full load	20	70 Vdc

MECHANICAL DATA

Mounting Position †	Vertical
Maximum Overall Height	5.31″
Maximum Seated Height	4.75″
Maximum Diameter	2.06″
Bulb, Hard Glass	T-16
Base: Special skirted octal 5 pin, glass filled Alkyd, insulation zone 5 or better	See Outline

† Tube may be operated in horizontal position if pins #1 and #4 are in vertical plane.





BOTTOM VIEW

SPECIAL
SKIRTED
SMALL SHELL
OCTAL
LOW-LOSS
BASE

5R4WGA

TUNG-SOL / CHATHAM

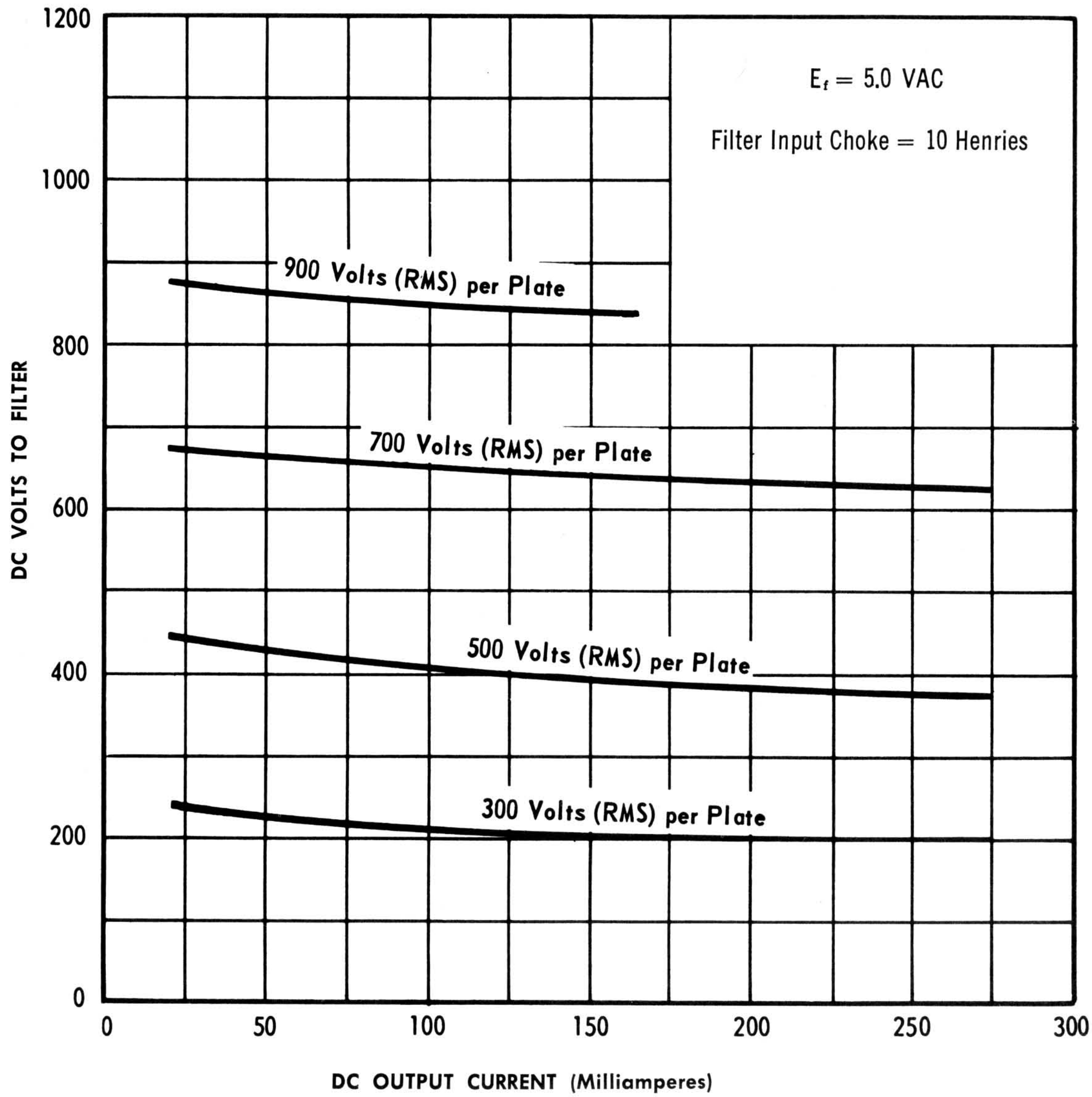
MAXIMUM RATING CHART

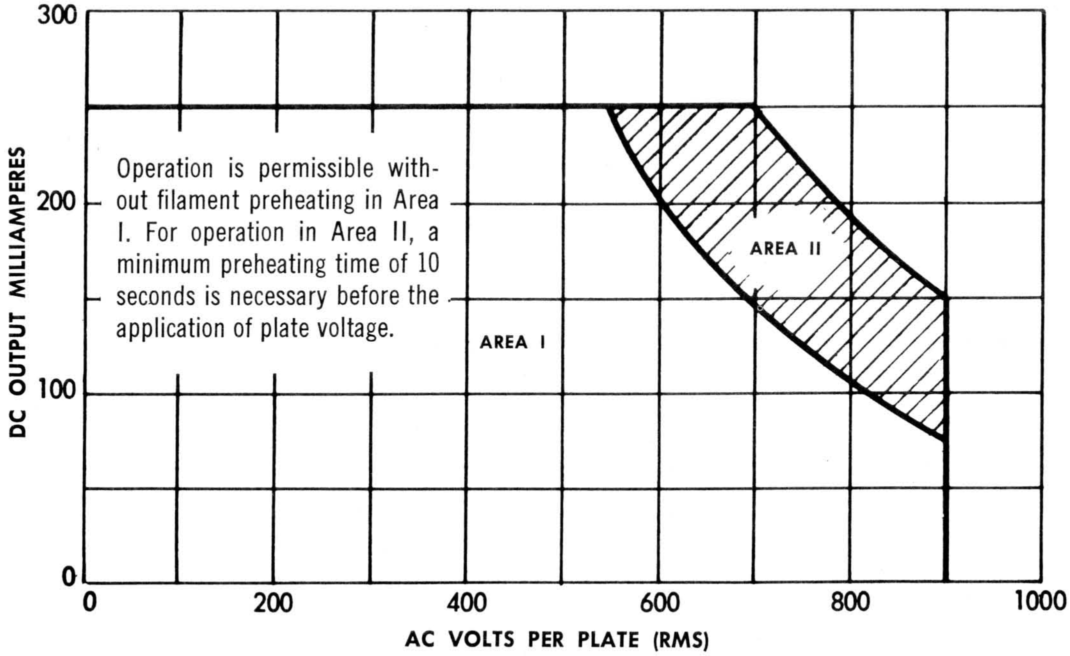
ALTITUDE	FILTER INPUT	PEAK INV. VOLTAGE	VOLTS RMS PER PLATE	MIN. SUPPLY IMPEDANCE PER PLATE	PEAK PLATE CURRENT	DC OUTPUT CURRENT	DC OUTPUT FULL LOAD VOLTAGE
Up to 30,000 ft.	4 uf	**3050v**	1070v	**575 Ω**	0ma	**0**ma	1525v
Up to 40,000 ft.	4 uf	**2150**	760	—	**700**	**275**	770
	5 Henries	**2300**	815	—	—	**275**	650
	4 uf	**2800**	990	**575**	550	**165**	1100
Up to 60,000 ft.	4 uf	**1850**	655	—	**700**	**275**	620

Heavy type indicates maximum ratings; light type indicates approximate values. All values are for $E_f = 5.0v$ and 10 seconds preheating (no preheating is necessary for no *load* conditions). Higher values of filter condenser capacity may be used if plate supply impedance is increased to keep peak plate current within ratings. Filter values given are for 60 cps. supply.

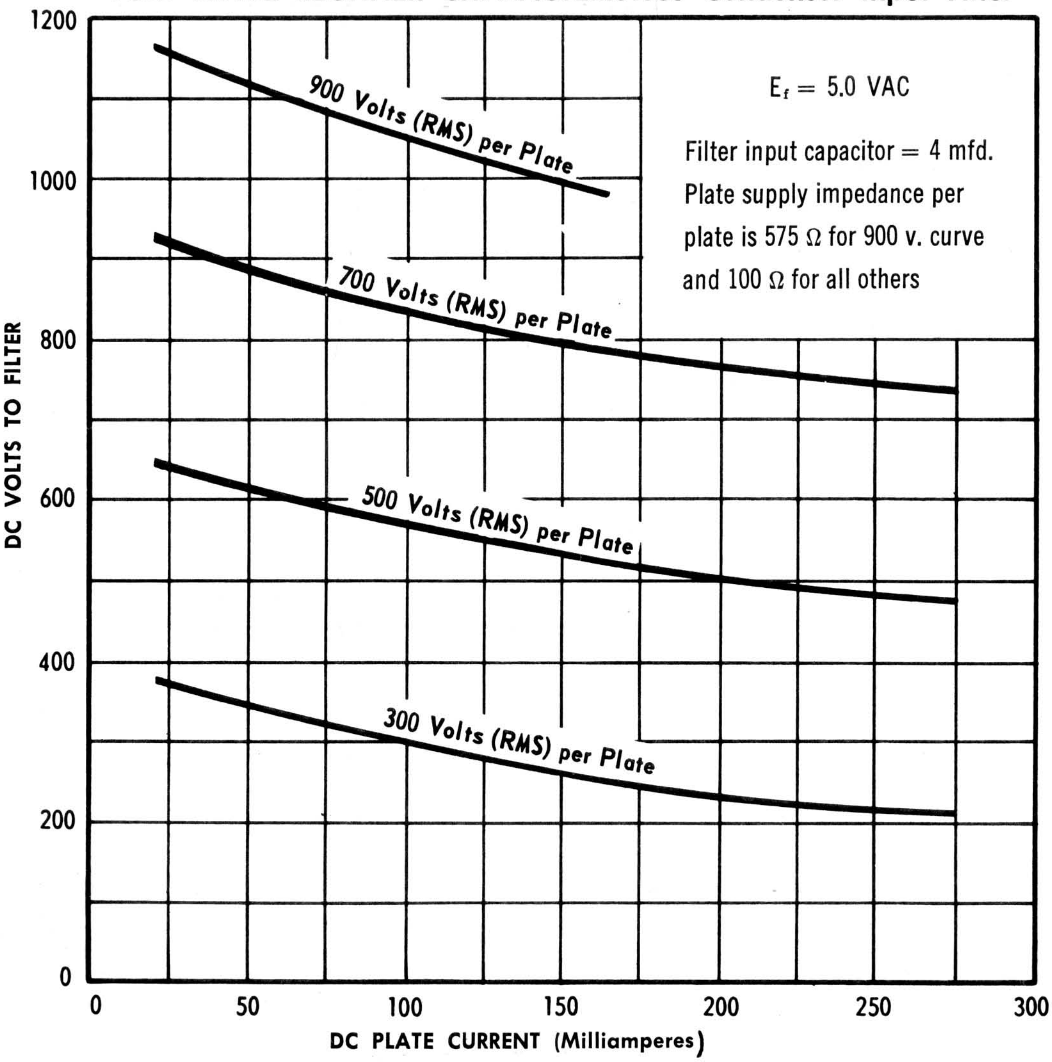
FULL WAVE RECTIFIER CHARACTERISTICS

Choke Input Filter

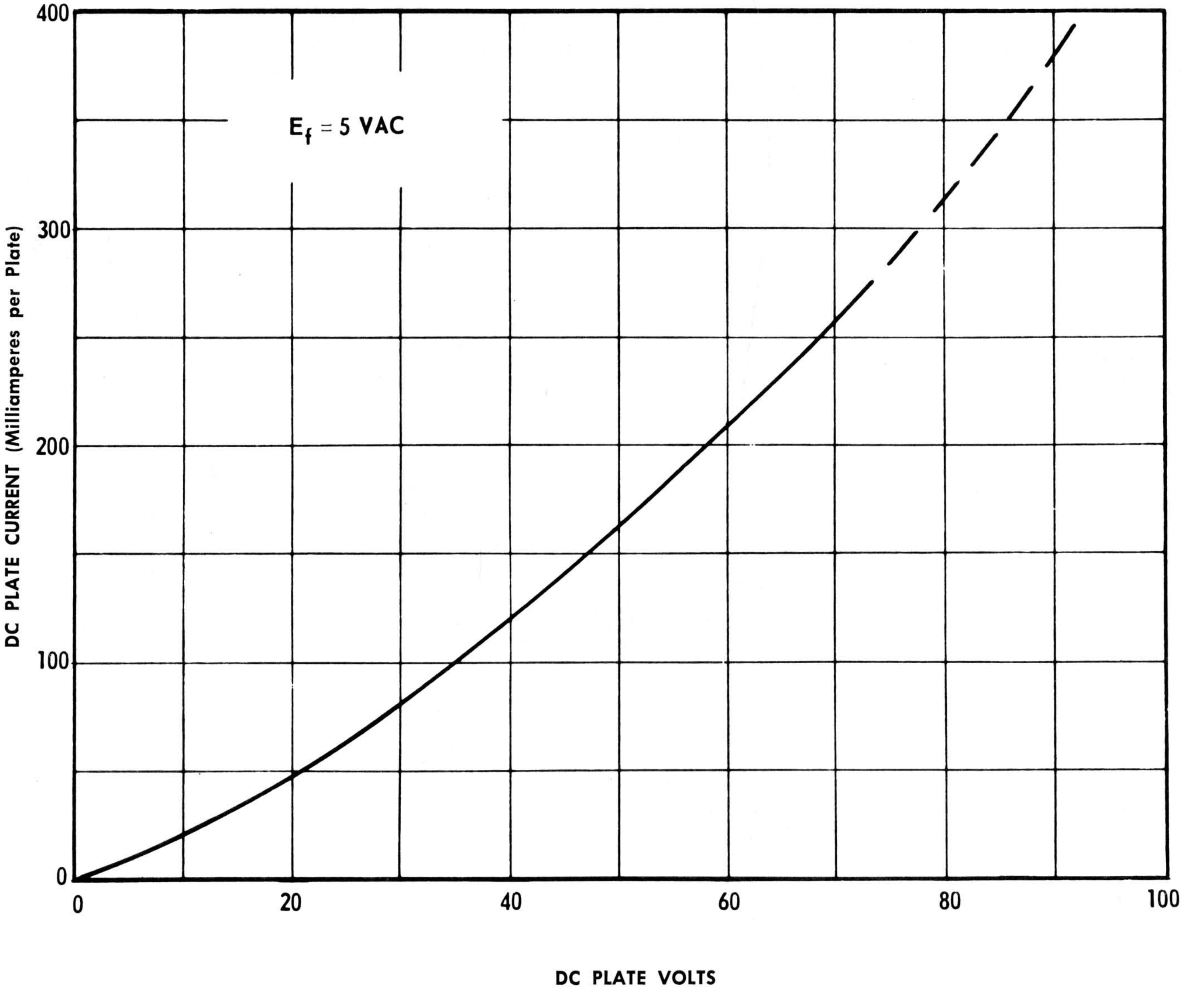




FULL WAVE RECTIFIER CHARACTERISTICS Condenser Input Filter



AVERAGE PLATE CHARACTERISTICS



TYPE 5R4WGB

Ruggedized Reliable High Voltage, Full Wave Rectifier

DESCRIPTION — The 5R4WGB is a long life, ruggedized, reliable full wave rectifier tube. While similar in construction to the popular 5R4WGA, this tube is subjected to more exacting requirements in manufacture. This includes a 100% check of welds under magnification. Every tube is electrically stabilized with repeated cold starts to weed out tubes that are prone to arcing. The 5R4WGB is made in "lots" with an entire lot being rejected upon the rejection of sample tubes. This is of particular importance on destructive tests.

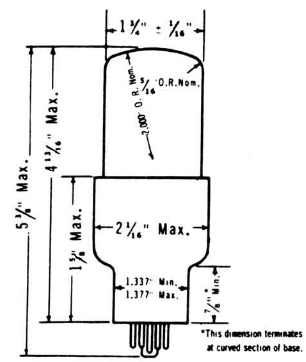
One of the design features is the shock mounting of the bulb in a skirted type base by a resilient silicone rubber. Thus, although the base may be securely clamped to the chassis, the tube proper is insulated against shocks. This type of basing also permits operation at high altitudes without flash over. Another design feature is the "cross press" stem which keeps electrolysis to a minimum while offering a stable support for the mount structure. The use of a hard glass bulb permits the tube to be processed at high temperatures during manufacture so that it will remain gas free under the high temperatures encountered in operation. The low drain, fast heating, rugged filament permits instant application of plate voltage over a large portion of the operating characteristic. (See Curve on page 3.)

Electrical Data

Filament Voltage (±10%)	5.0 V.a.c.
Filament Current	2.0 A.a.c.

Typical Operation

	Input to Filter CHOKE	Input to Filter CAPACITOR
AC Plate Voltage RMS per plate	900	700 Vac
Input Condenser	—	4 Mfd
Input Choke	10	— H
Effective Plate Supply Impedance per plate	—	100 Ohms
D.C. Output current	165	275 mA
D.C. Output voltage at full load	840	730 Vdc
D.C. Output voltage at half load	860	800 Vdc
Regulation, half load to full load	20	70 Vdc



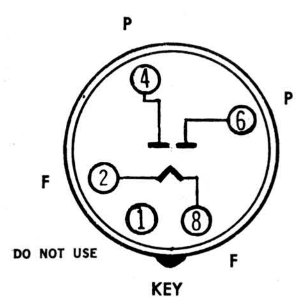
Mechanical Data

Mounting Position†	Vertical
Maximum Overall Height	5.31″
Maximum Seated Height	4.75″
Maximum Diameter	2.06″
Bulb, Hard Glass	T-16

Base: Special skirted octal 5 pin, glass filled

Alkyd, insulation zone 5 or better . . . . See Outline

† Tube may be operated in horizontal position if pins #1 and #4 are in vertical plane.



BOTTOM VIEW

5R4WGB

TUNG-SOL / CHATHAM

MAXIMUM RATING CHART

ALTITUDE	FILTER INPUT	PEAK INV. VOLTAGE	VOLTS RMS PER PLATE	MIN. SUPPLY IMPEDANCE PER PLATE	PEAK PLATE CURRENT	DC OUTPUT CURRFNT	DC OUTPUT FULL LOAD VOLTAGE
Up to 30,000 ft.	4 uf	**3050v**	1070v	**575Ω**	**0Ma**	**0Ma**	1525v
Up to 40,000 ft.	4 uf	**2150**	760	—	**700**	**275**	770
	5 Henries	**2300**	815	—	—	**275**	650
	4 uf	**2800**	990	**575**	550	**165**	1100
Up to 60,000 ft.	4 uf	**1850**	655	—	**700**	**275**	620

Heavy type indicates maximum ratings; light type indicates approximate values. All values are for $E_f = 5.0$v and 10 seconds preheating (no preheating is necessary for *no load* conditions). Higher values of filter condenser capacity may be used if plate supply impedance is increased to keep peak plate current within ratings. Filter values are for 60 cycle operation.

Additional Tests to Insure Reliability

All Tubes: Operation (1): epx = 2800 Vac; Full Wave; $Z_p/_p = 500$; $C_L = 4$ mfd; $R_L = 7000$ ohms; $t_k = 10$ $I_o > 140$ mAdc

Operation (2): $E_{pp}/_p = 850$ Vac, Full Wave; $C_L = 4$ mfd; $R_L = 3500$ ohms, $t_k = 10$; $Z_p/_p$ adjusted for a Bogie Tube to read 260 mAdc, and i_b not less than 630 mA per plate. (A Bogie Tube is a tube with a drop of 75 Vdc at 320 mAdc per plate) $I_o > 245$ mA

Stabilization: 6 Hours at $E_F = 5.0$ Vac; $E_{pp}/_p = 800$ Vac; $I_o = 300$ mAdc; $R_L = 3000$; $t_k = 0$ (cycled 15 minutes on 5 minutes off.)

Random Sample Tested for the Following:

Low pressure Voltage Breakdown:

1). $E_{pp}/_p = 1050$ Vac; Full Wave; $R_L/I_o = 165$ mAdc; $t_k = 10$ sec.; $C_L = 4$ mfd, $Z_{ptotal}/_p = 500$ Ω; Pressure 140 mm (40000 ft).

2). epx = 1850 Vac; $R_L/I_o = 275$ mAdc; $t_k = 10$ sec.; $C_L = 4$ mfd; $Z_{ptotal}/_p = 200$ Ω ; Full Wave; Pressure = 55 mm (60000 ft).

Shock: 60° Hammer Angle in Navy Flyweight, High Impact Machine (900 G/mSec).

Fatigue: 25 cps, 0.80″ Total Displacement, for 32 hours in each of these mutually perpendicular planes (2.5 G).

Post Shock and Fatigue Test End Point:

Operation (2) $I_o > 240$ mAdc.

Life Test:

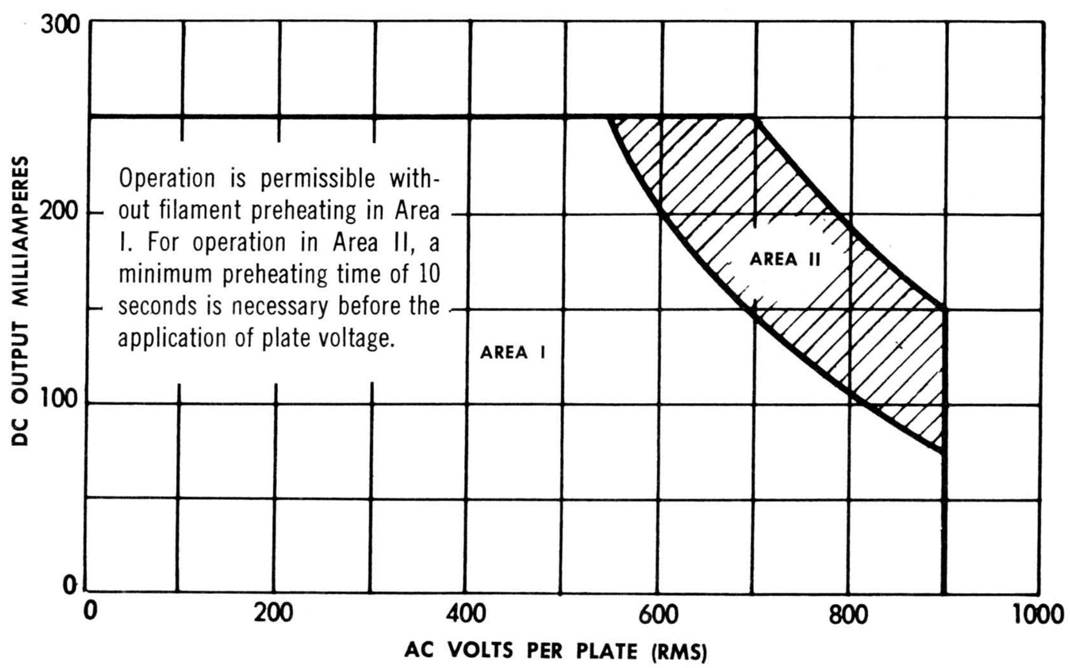
Filament cycling: 2000 cycles; $E_f = 5.5$ Vac; 1 minute on, 1 minute off per cycle. (Filament Voltage Regulation 3% No Load to Full Load).

Intermittent Life Test

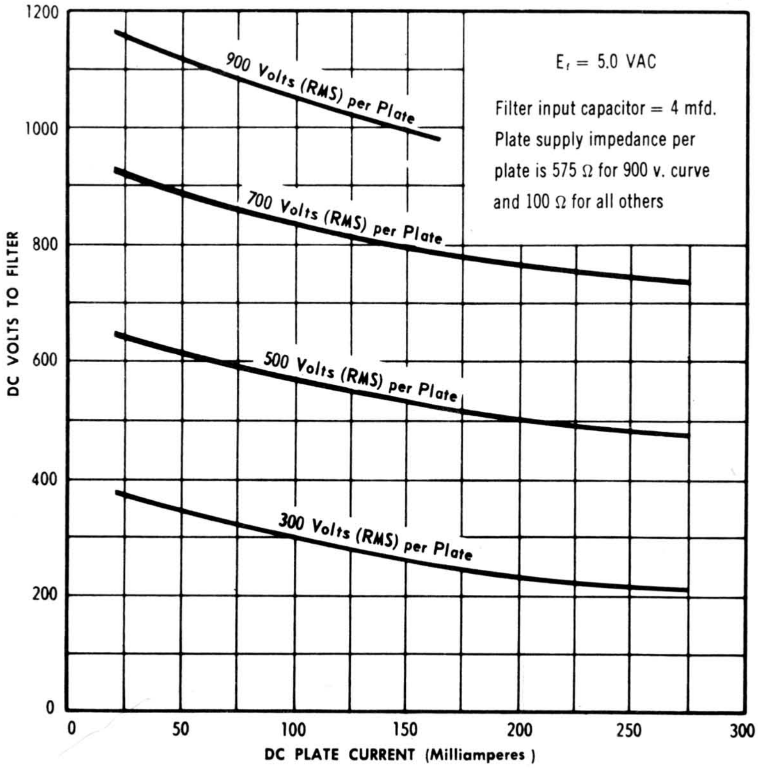
Operation (2) 100 hours .... $I_o > 245$ mAdc.

Operation (2) 500 hours .... $I_o > 240$ mAdc.

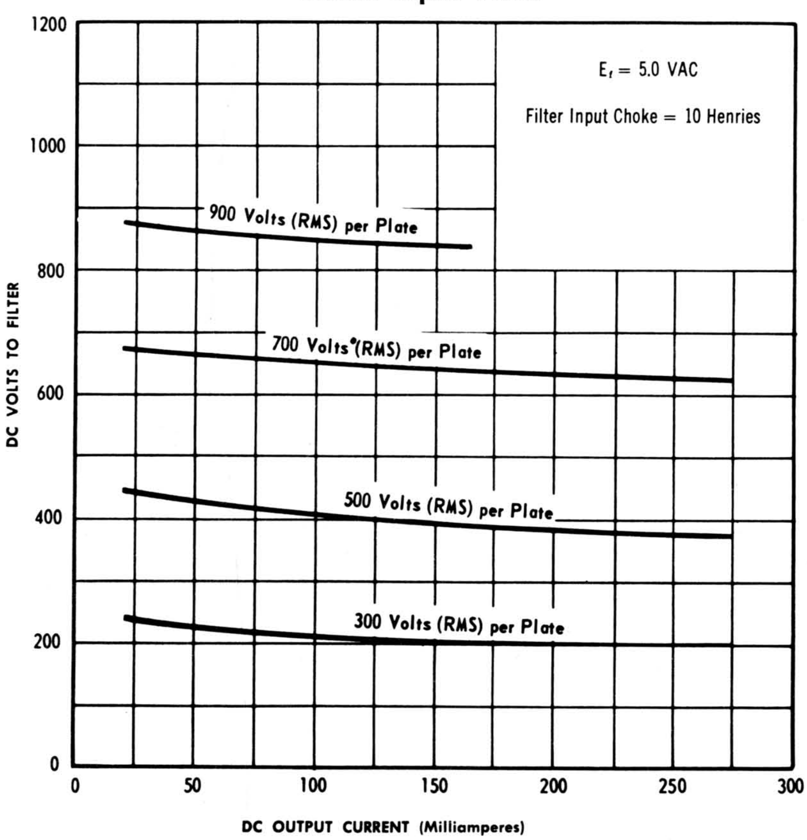
Operation (2) 1000 hours .... $I_o > 240$ mAdc.



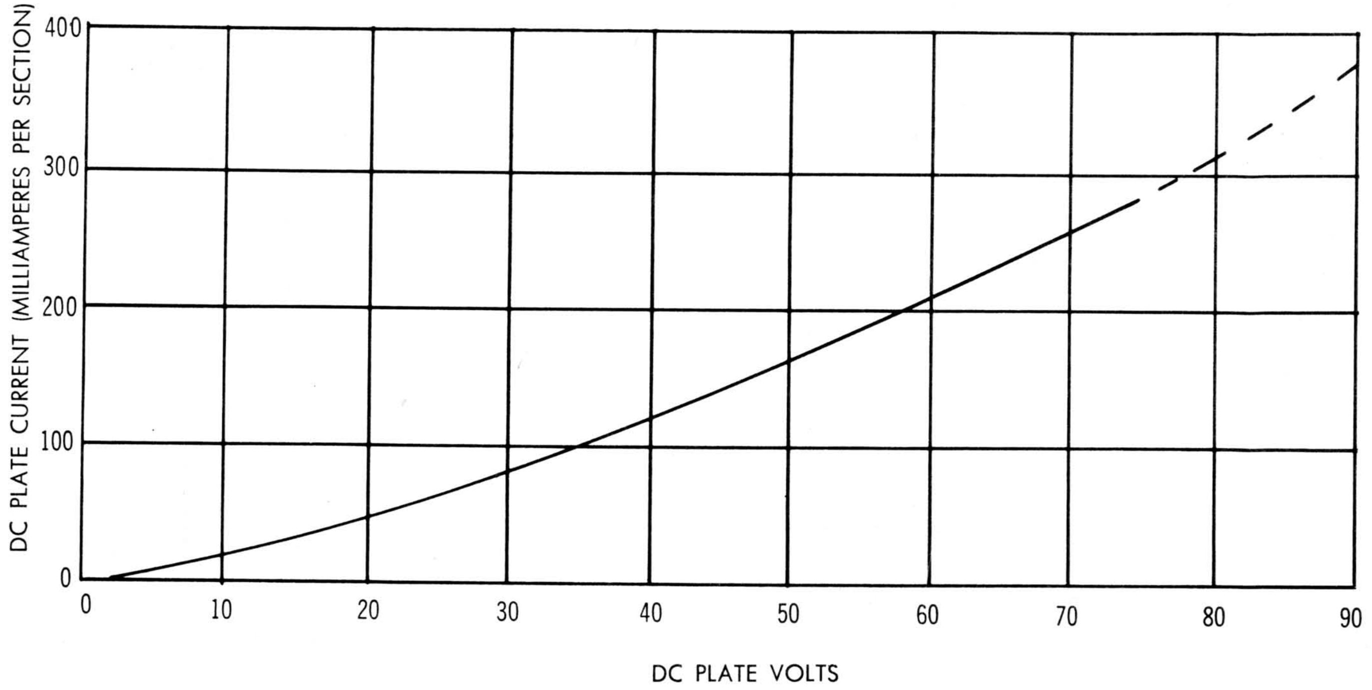
FULL WAVE RECTIFIER CHARACTERISTICS Condenser Input Filter

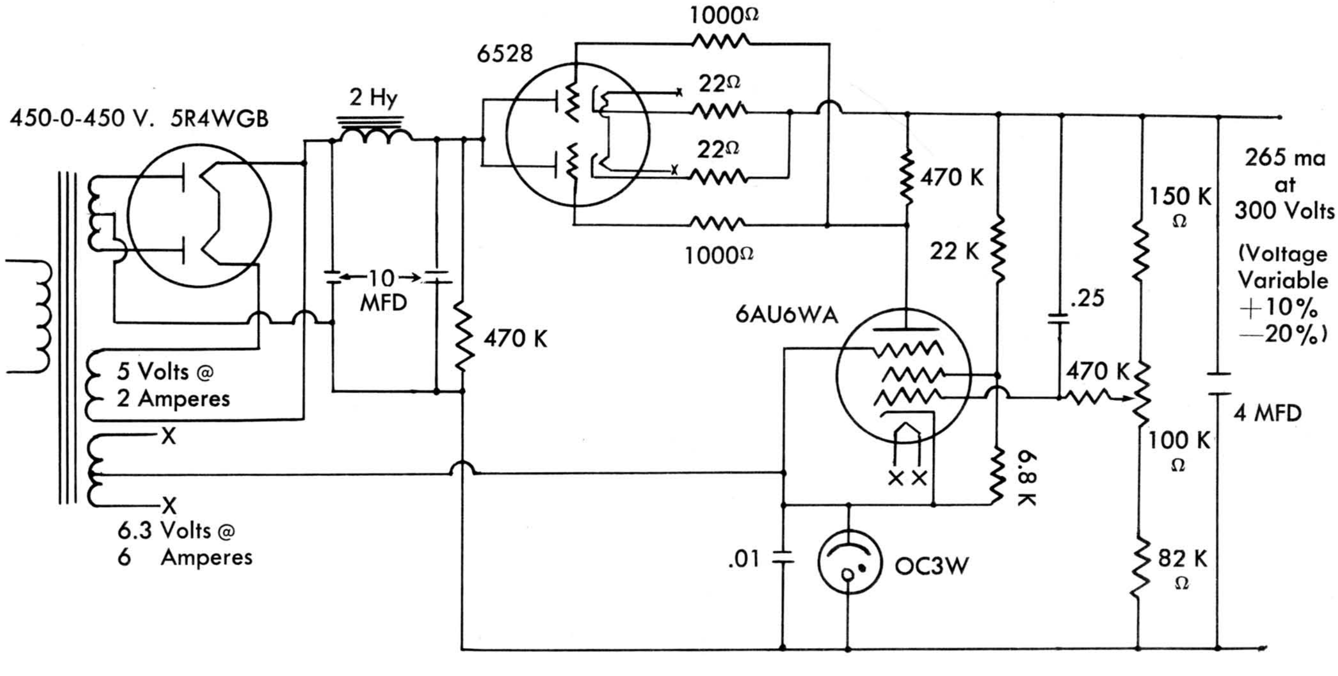


FULL WAVE RECTIFIER CHARACTERISTICS Choke Input Filter



AVERAGE PLATE CHARACTERISTICS

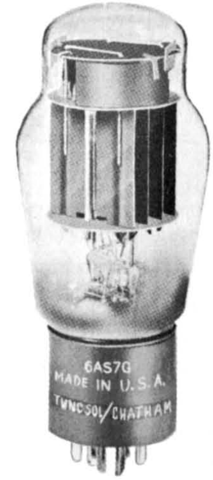




Typical Application of 5R4WGB in a Voltage Regulated Power Supply

TUNG-SOL / CHATHAM

TYPE 6AS7G



LOW-MU TWIN POWER TRIODE

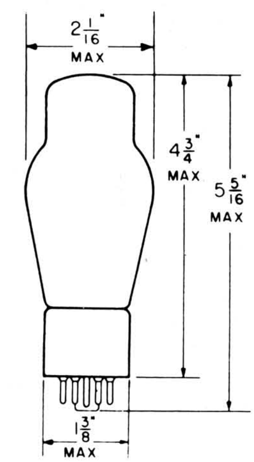
DESCRIPTION—The 6AS7G is a high current, twin power triode widely used in electronically regulated power supplies. The high perveance of this tube permits it to pass large currents at low plate voltages, thus providing for efficient series regulation.

ELECTRICAL DATA

Heater Voltage	6.3 ± 10% volts
Heater Current (E_f = 6.3 volts)	2.5 amperes
Minimum Cathode Heating Time	30 seconds
Transconductance (per section)	7000 umhos
Amplification Factor	2.0
Inter Electrode Capacities per Triode Section	
Grid to Cathode	6.2 uuf
Grid to Plate	8.4 uuf
Cathode to Plate	2.2 uuf
Heater to Cathode	7.0 uuf
Inter Electrode Capacities Between Triode Sections	
Section 1 Grid to Section 2 Grid	0.9 uuf
Section 1 Plate to Section 2 Plate	2.2 uuf

MECHANICAL DATA

Mounting Position (If tube is to be mounted in a horizontal position it is recommended that it be mounted so that the grid plane be vertical.)	Any
Bulb	ST-16
Base	Medium Shell Octal 8 Pin, B8-11 Phenolic
Average Net Weight	2.5 ounces
Maximum Vibration Rating (D-.08" @ 25 cps)	2.5 G

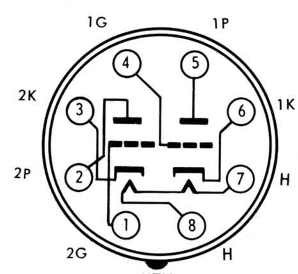


GLASS BULB

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum
Heater Voltage	5.7	6.9 volts
Plate Voltage	—	275 volts d. c.
Grid Voltage	—	0 volts d. c.
Heater-Cathode Voltage	—300	+300 volts d. c.
Grid Current per Grid	—	0 milliamperes
Plate Current per Plate (If several tube sections are to be used in parallel with each other, it is recommended not to exceed 100 mA per plate)	—	125. milliamperes d. c.
Power Dissipation per Plate	—	14 watts
Envelope Temperature	—	200 °C.
Altitude for Full Ratings	—	10,000 feet
Circuit Values*		
Grid Circuit Resistance for Cathode Bias Operation	—	1.0 megohm
Grid Circuit Resistance for Fixed Bias or Combination Fixed and Cathode Bias Operation	—	0.1 megohm

*Fixed bias operation not recommended. When combined fixed and cathode bias is used, the cathode bias portion should be at least 7.5 volts in normal operation.



Bottom View

RANGE OF VALUES

Conditions: $E_f = 6.3V$; $E_b = 135V$;
$E_c = 0$; $R_k/_k = 250\Omega$.
Both sections operating.
Each section read separately.

Individual Plate Current	100 150	Milliamperes d.c.
Individual Section Transconductance	5800 8200	Micromhos
Amplification Factor	1.4 2.6	

Conditions: $E_f = 6.3$; $E_b = 250Vdc$
$E_c = -200Vdc$ $R_k/_k = 0$.

Individual Plate Current .... 10 Milliamperes d.c.

Application Notes

The 6AS7G is widely used as a "passing" tube or series regulator tube in controlled power supplies because of its high transconductance at relatively low plate voltages. To provide the desired output current, many triode sections can be paralleled. If tube sections are to be paralleled however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it helps to provide increasing bias on the sections taking greater plate current. A cathode resistor too, need be only one third the value $\left(\frac{R}{u+1}\right)$ of a plate resistor, and therefore will dissipate only one third the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (less than one watt) and the additional voltage (less than 10 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively tied to the plate. The plate will attempt to draw excessive current from the passing tube's cathode and may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulated output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. If the cathode resistors as suggested on the plate characteristic curve are used, a minimum bias of 7.5 volts will be provided. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be able to swing the passing tube grid far enough to counteract the effect of unbalance due to tube ageing.

A grid resistor should be used for each triode section. This should be high enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 6.3 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

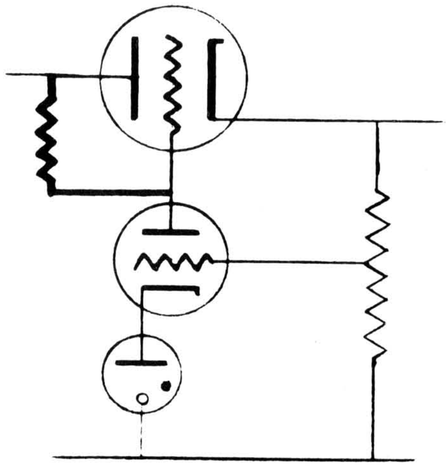


FIGURE 1

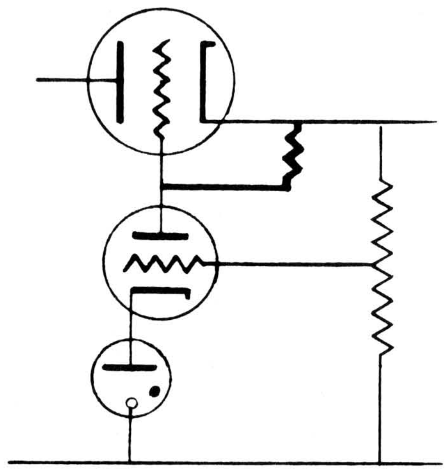


FIGURE 2

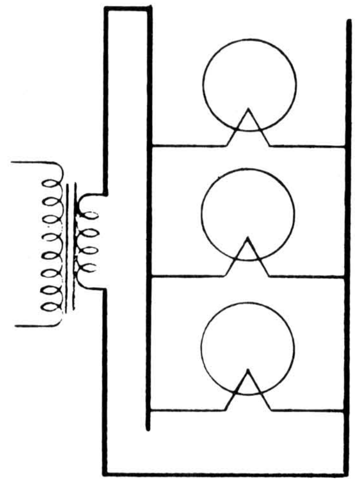
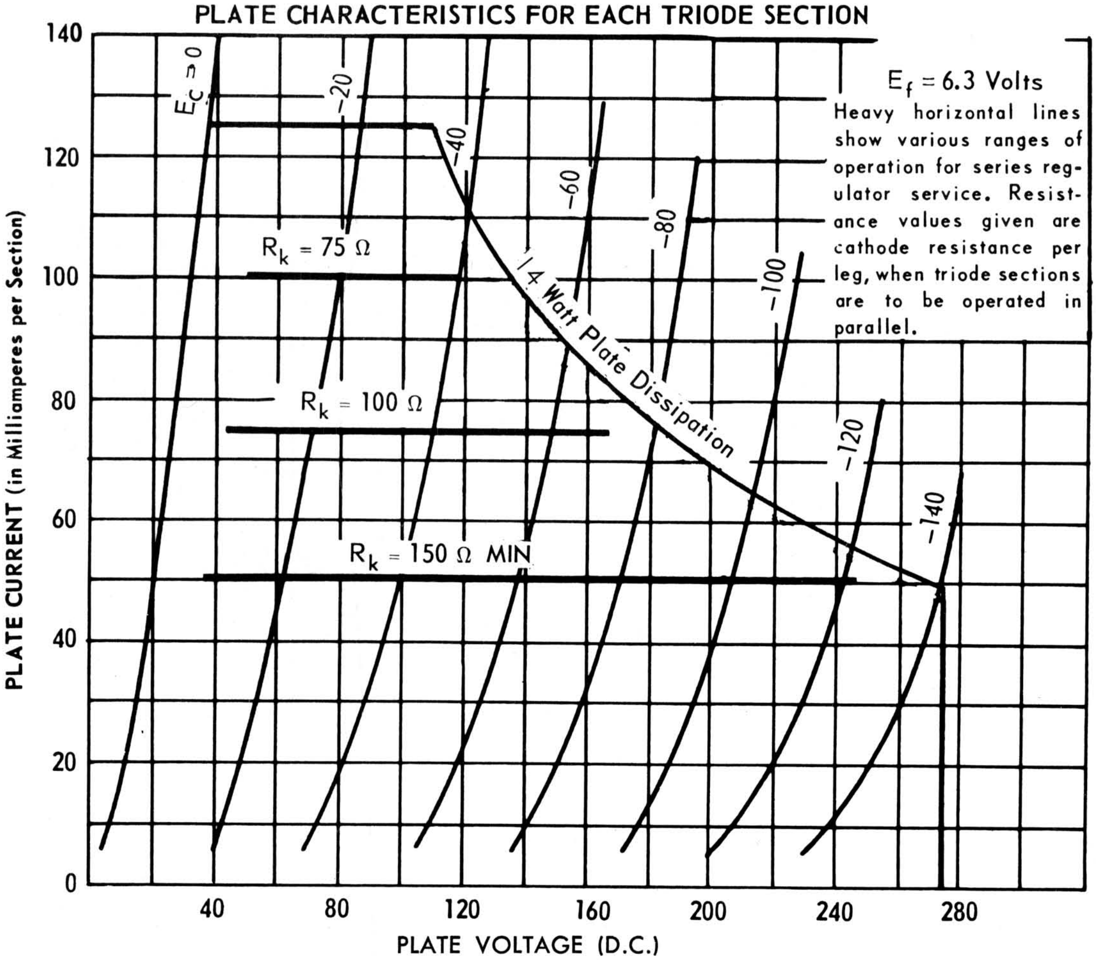
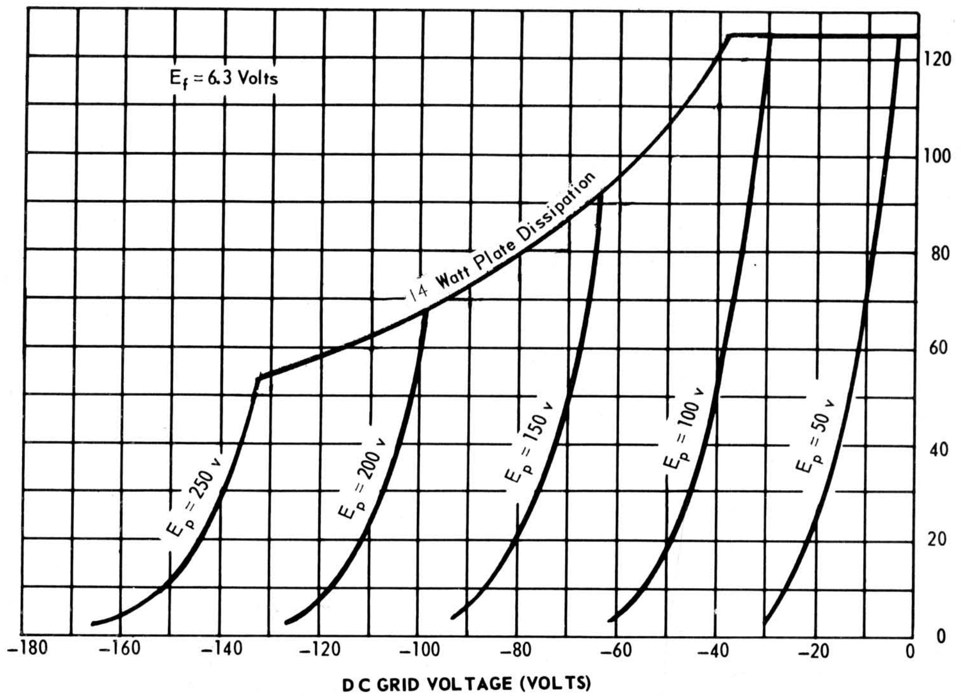


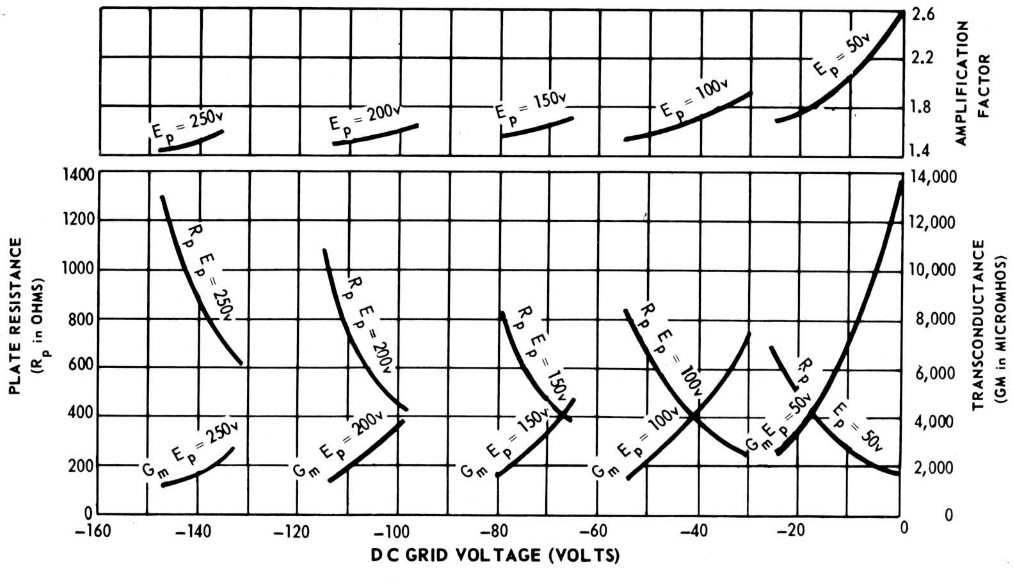
FIGURE 3

PLATE CHARACTERISTICS FOR EACH TRIODE SECTION



TRANSFER CHARACTERISTICS FOR EACH TRIODE SECTION





LITHO IN U.S.A

TUNG-SOL / CHATHAM

MINIATURE ARGON THYRATRON

TYPE

6D4

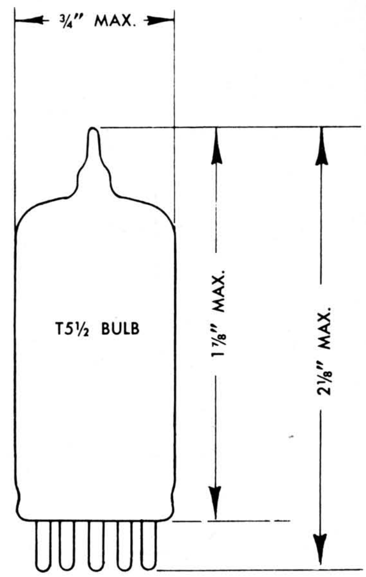
DESCRIPTION — The Type 6D4 is an Argon filled triode thyratron with negative control grid characteristics. Although the 6D4 has found use as a relay tube and saw tooth oscillator, its principal application has been as an RF noise generator. Because of its small size, light weight, and relative freedom from temperature restrictions, this tube is suited particularly for use in compact or portable equipment.

ELECTRICAL DATA

Heater Voltage	6.3 volts ± 10%
Heater Current (E_f = 6.3 volts)	250 mA
Minimum Cathode Heating Time	30 seconds
Anode to Control Grid Capacitance	2.6 μμfd
Control Grid to Cathode Capacitance	1.2 μμfd
Anode to Cathode Capacitance	1.0 μμfd
Heater to Cathode Capacitance	2.9 μμfd
Anode Voltage Drop (at 100 mA d.c.) approx.	12 volts
Noise Output (video band width 4 Mc. Fig. 2 conditions with E_{DC} = 250 V.D.C. and R = 33,000 ohm)	9 v. p. to p. min.

MECHANICAL DATA

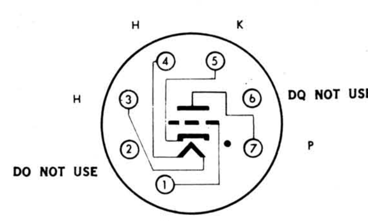
Mounting Position	Any
Average Weight	0.3 oz.
Maximum Vibration Rating (D = .08″, 25 cps)	2.5 g.
Bulb	T-5½
Base	7 Pin Miniature Button



GLASS BULB

RATINGS, ABSOLUTE VALUES

	Min.	Max.
Peak Anode Voltage		
Forward		350 volts
Inverse		350 volts
D.C. Plate Supply Voltage		250 volts d.c.
Cathode Current		
Peak		110 mA
Average		25 mA
Averaging Time		30 seconds
Negative Control Grid Voltage	−150	
Heater Cathode Voltage	−110	0
Ambient Temperature	−55	90° C
Control Grid Circuit Resistance		0.5 meg.



BOTTOM VIEW
SMALL BUTTON 7-PIN
MINIATURE BASE

TYPICAL CONTROL CHARACTERISTICS

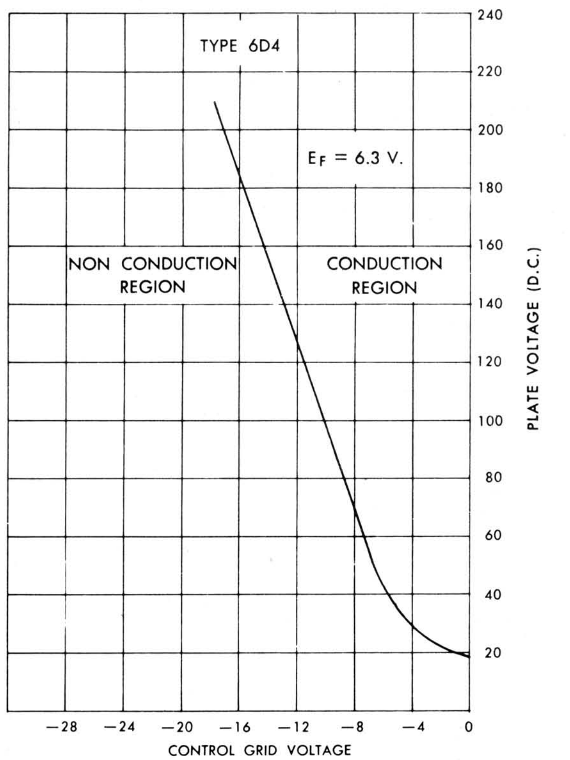


Figure 1

Application Notes

The tube can be used in conjunction with a 375 gauss magnet as an R.F. noise generator. The magnetic field is applied perpendicular to the normal electron path in such a way as to deflect the electrons upward (north pole of the magnet at pin 7). Minimum output figures listed, are as measured through a tuned filter, 1000 cps bandwidth at 3 db points, with R = 56,000 ohms, E_{DC} = 300 V.D.C.

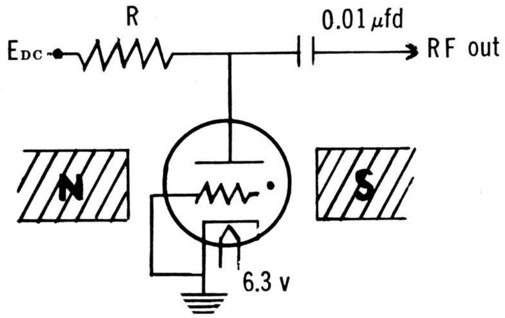


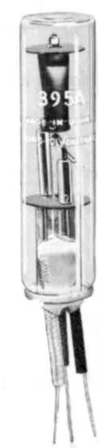
Figure 2

Frequency in Megacycles	Minimum Noise Voltage in Microvolts RMS.
0.1	10,000
0.2	14,000
0.5	25,000
1.0	22,000
2.0	7,000
5.0	500
10.0	70

TUNG-SOL / CHATHAM

SELF INDICATING, COLD CATHODE THYRATRON

TYPE
395-A

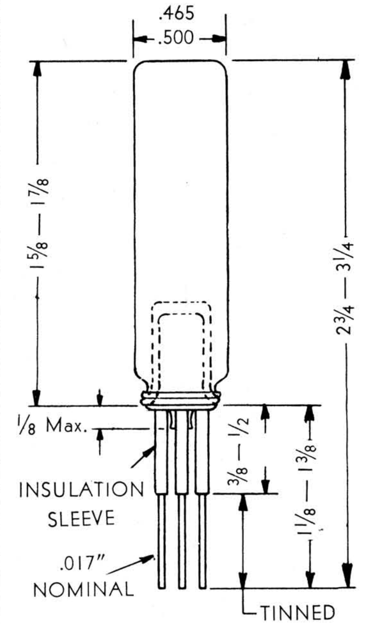


DESCRIPTION——The 395A is a small size, light weight, cold cathode thyratron used primarily in relay service. The characteristic neon glow displayed on the surface of the cathode while the tube is conducting makes the use of auxiliary visual indicating devices unnecessary. The minute triggering current requirements and the lack of necessity for filament power make this tube extremely suitable for use in transistorized equipment or in battery operated equipment. The 395A will fire directly from a signal supplied by either a vacuum photo tube or a cadmium sulphide photo cell.

The 395A has also found use as a trigger tube, as a relaxation oscillator, and as a voltage regulator.

MAXIMUM RATINGS FOR RELAY SERVICE, ABSOLUTE VALUES

Positive Anode Voltage (This rating may be increased to 150 volts provided adequate electrostatic shielding and a low level of illumination is employed. In general this requires a conducting shield in intimate contact with the tube in the area between the two mica discs; the maximum shield potential not to differ from the cathode potential by more than 100 volts; and the peak tube illumination not to exceed five lumens per square foot.)	140 VDC
Negative Anode Voltage (Without discharge to a positive grid)	−60 VDC
Positive Grid Bias Voltage (without grid ionization)	70 VDC
Total Positive Grid Voltage to Insure Breakdown (with $R_g = 0.1$ Megohm Max.)	87 VDC Min.
Negative Grid Voltage (without discharge to a positive anode)	−10 VDC
Grid Transfer Current	5 uAdc
Cathode Current	
Peak, recurring (Averaged over 1 second)	35 mA
Average (See life expectancy curve)	—
Peak Inverse Anode Current	1 mA



GLASS BULB

NOTE:
COLORS INDICATED FOR TUBE LEADS ARE THE COLORS OF THE INSULATION SLEEVES.

TYPICAL OPERATING CONDITIONS

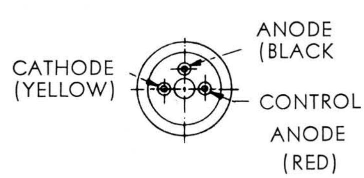
Anode Supply Voltage	130 VDC
Positive Grid Bias	70 VDC
Grid Trigger Voltage	20 V.
Anode Circuit Resistance	6800 ohms
Grid Circuit Resistance	1 Megohm

MECHANICAL DATA

Temperature	−40°C to +60°C
Altitude for Full Ratings	10,000 ft.
Normal Illumination (See application notes)	5 to 150 1m/sq. ft.

ELECTRICAL DATA (Typical Values)

Cathode	Cold
Ionization Time (At $E_b = 130$v, $E_c = 75$v, $e_c = 20$v. pulse, $R_g = 0.1$ megohms.)	23 u Sec.
Anode Voltage Drop, (at Ib = 10. mA)	75 VDC
Grid Voltage Drop (at Ic = 10. mA)	65 VDC
Anode Ionization Voltage (At $E_g = 0$)	170 VDC
Grid Ionization Voltage	75 VDC
Required Transfer Current for transition of discharge to anode at 130 volts DC	2.5 u Amp.



Bottom View

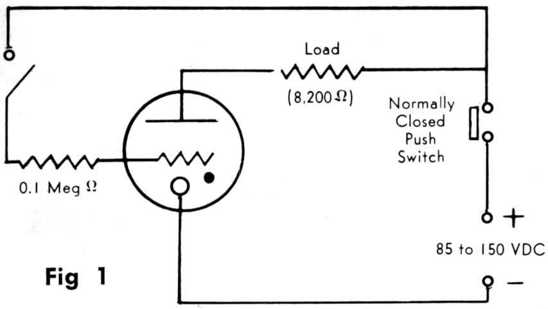


Fig 1

395A Used as a mechanically operated relay

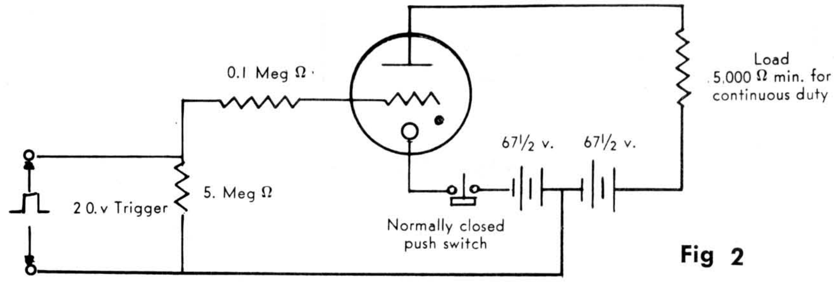


Fig 2

395A Operated from dry batteries

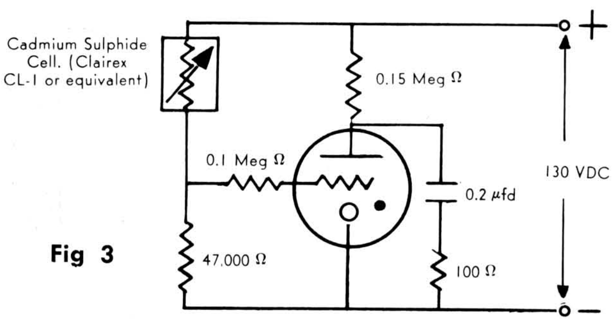


Fig 3

395A Acting as a relay for a Cadmium Sulphide photo cell

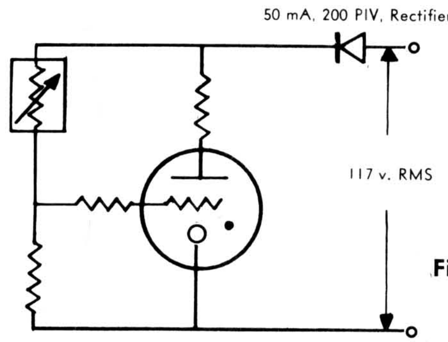


Fig 4

Same as Figure 3 but operated from A.C. line

Application Notes

The 395A thyratron contains a cathode, a trigger grid and an anode within a gaseous atmosphere. If an increasing positive voltage is applied to the grid, a minute pre-ionization current will flow until the critical grid current of about two microamperes is reached. At this point the region between the grid and cathode "breaks down" or ionizes. If the applied anode voltage is equal to or greater than the grid voltage, the glow will then transfer to the cathode-anode region. Thus, a very low energy signal in the grid circuit can control much higher energy in the anode circuit. If, in this illustration an anode current of 10 milliamperes were to flow, the tube has provided current amplification of 5,000.

As with any gas tube, once the tube conducts, the tube voltage drop remains virtually constant and the current through the tube is limited by the circuit resistance. In the anode circuit this may be the resistance of the load itself, or, the load plus additional limiting resistance. The grid circuit should contain a 5,000 ohm series resistance if the source resistance is lower than this figure. If the grid circuit resistance is above 10 megohms, however, it may be necessary to connect a small capacitance between the grid and cathode. This is to store enough energy to insure grid ionization.

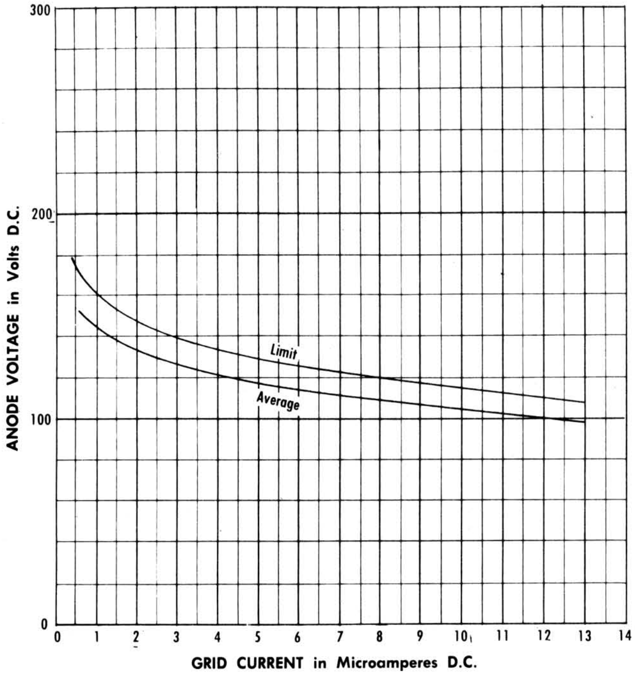
If the 395A is used in totally enclosed equipment there may be a delay of several milliseconds before firing. This can be alleviated by providing over-voltage on the grid signal or locating the tube where it will receive some illumination from pilot lights or the heaters of vacuum tubes. The 395A is radioactively dosed to minimize this delay. The magnitude of activity is not great enough to institute a personal hazard. However, persons are cautioned not to handle broken tubes to avoid getting the active material directly into the bloodstream through cuts. If a person cuts himself on a broken tube, the cut should be cleansed immediately. An open cut can be cleansed by holding it in running water.

For "end on" visual indication, the 395A can be mounted in a recess in a panel. For current levels below two milliamperes, the illumination can be increased by using for the recess, tubing with shiny inner walls. If the tube is not used in a recess, the bulb sides should be shielded (eg: nickel mesh) to prevent hand capacity or strong electric fields from altering firing potentials.

Typical circuit configurations are illustrated above. As with any thyratron circuit, once the tube conducts, the grid will not regain control until the anode voltage falls low enough to extinguish the cathode-anode glow. This is usually accomplished by breaking the anode circuit. However, it can also be done under D.C. operation, by causing the anode current to flow in saw tooth steps. The saw tooth is generated by running the tube as a relaxation oscillator by inserting sufficient capacity between the cathode and anode. Figure 3 illustrates an application of this idea. The 395A will also regain grid control on each cycle if it is run from half wave rectified A.C. Figure 4 illustrates an application of the tube on A.C. Operation of the tube on A.C. without the series diode is not recommended.

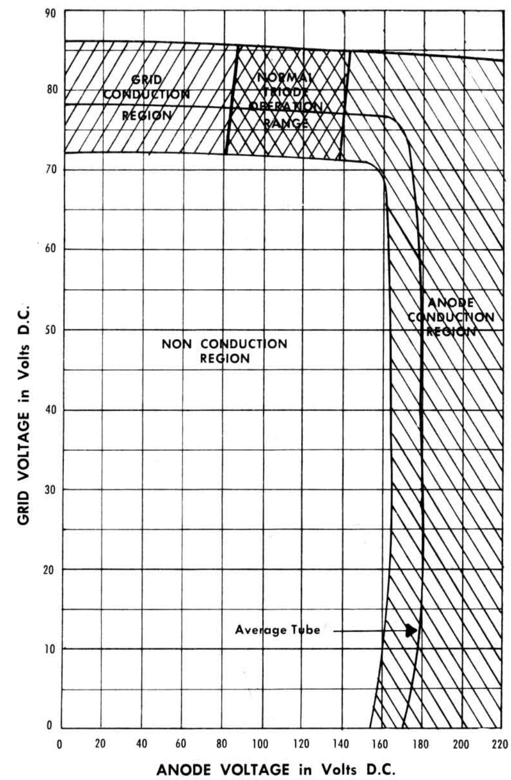
The flat anode voltage-current characteristic of the 395A has led to the use of the tube as a voltage regulator or as an over voltage protective device. The tube has also found use as a trigger device carrying amperes of current for several seconds in "one shot" applications.

TRANSFER CHARACTERISTICS

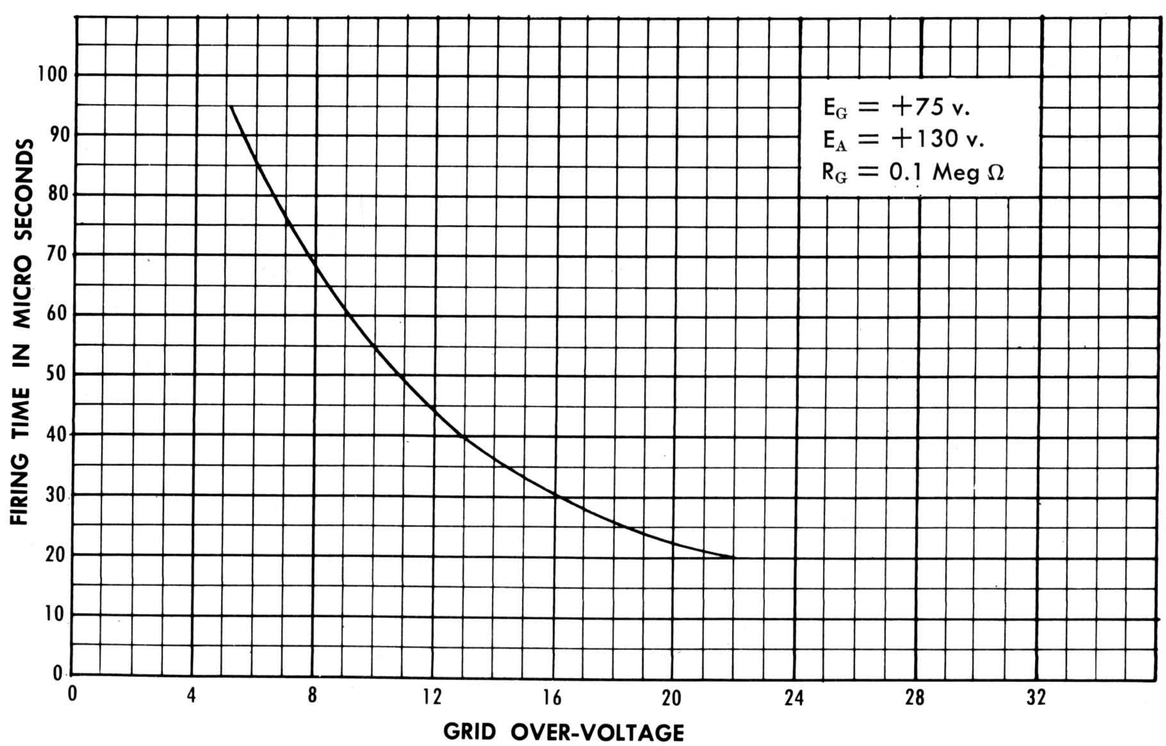


OPERATION CHARACTERISTICS

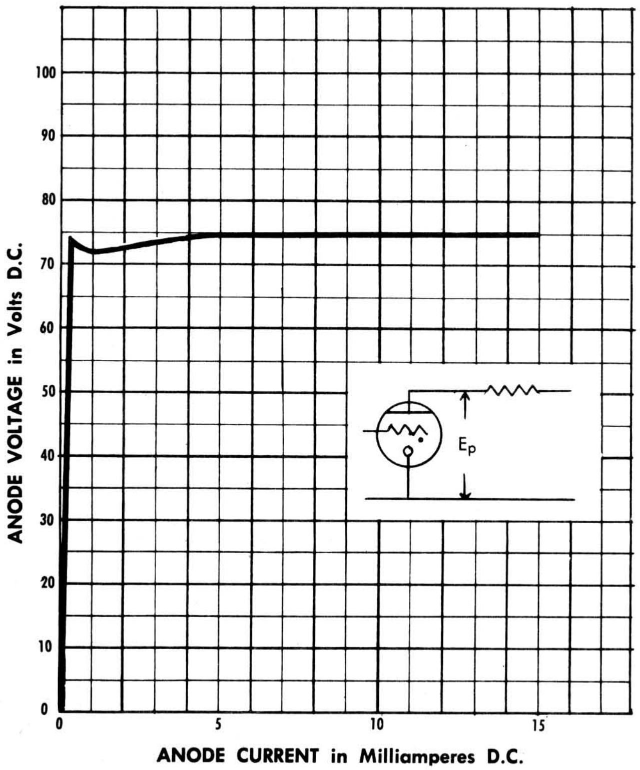
Range includes variations during life.



FIRING TIME CURVE

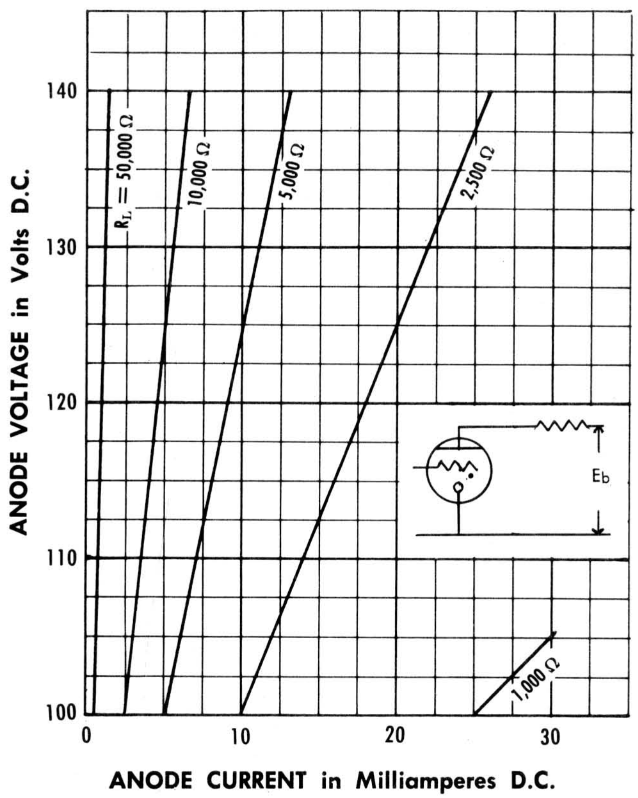


ANODE CHARACTERISTICS

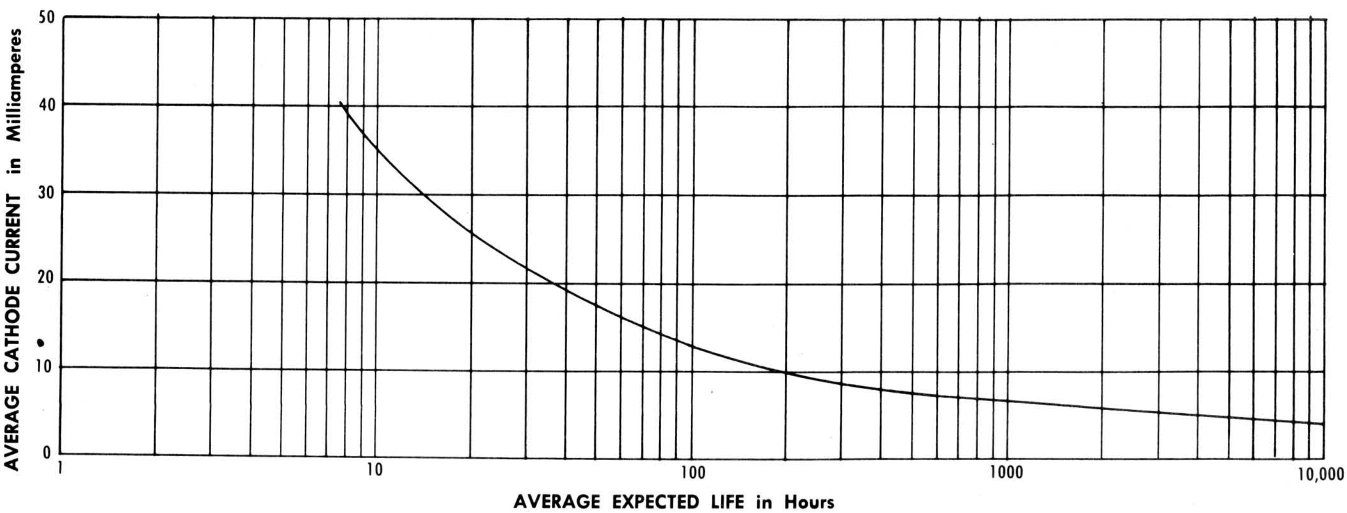


ANODE CIRCUIT VOLTAGE vs CURRENT

For Various Load Resistances



LIFE EXPECTANCY CURVE



TUNG-SOL/CHATHAM

TYPE 407A

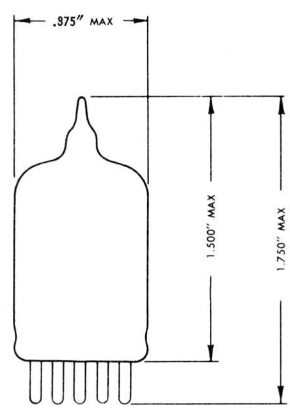
LOW NOISE, MINIATURE TWIN TRIODE

DESCRIPTION—The Type 407A is a nine pin miniature, medium Mu, twin triode, featuring separate cathodes. The heater is designed for parallel operation at 20 volts or for series operation at 40 volts. Other characteristics are similar to those of the 2C51 and the 5670. A shield is attached to the center of the heater to decrease possible interaction between triode sections. The useful frequency range as an amplifier, mixer, oscillator, or multivibrator extends from low frequency to VHF.

Because of the inherent low noise and choice of either 20 volt or 40 volt heater operation, the 407A has found wide use in carrier telephony circuits.

ELECTRICAL DATA

Heater Voltage Series Connection (use pins 1 and 9)	40 volts ±5%
Parallel Connection (tie pin 1 to pin 9; use pin 5 and 1,9)	20 volts ±5%
Heater Current Series Connection (use pins 1 and 9)	50 mA
Parallel Connection (tie pin 1 to pin 9; use pin 5 and 1,9)	100 mA
Characteristics per Section under conditions $E_b = 150$ Vdc, $E_c = 0$, Rk/k = 240 ohms	
Plate Current	8.2 mA d.c.
Transconductance	5500 μmhos
Amplification Factor	35
Plate Resistance (approx.)	6400 ohms
Interelectrode Capacitances (measured with no shield and with heater tied to cathode of unit under test. Each section tested separately.)	
Grid to Plate	1.3 μμfd
Grid to Cathode	2.25 μμfd
Plate to Cathode	1.0 μμfd
Heater to Cathode	2.4 μμfd
Interelectrode Capacities Between Triode Sections	
Plate to Plate	0.1 μμfd
Noise and Microphonics (using Western Electric 2B Noise Measuring Test Set with weighting filter (# F1A)	8 db.



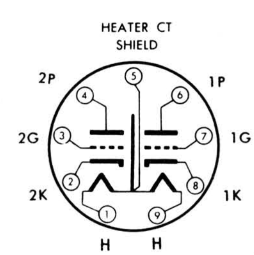
GLASS BULB

MECHANICAL DATA

Mounting Position	Any
Bulb	T-6½
Base	Miniature Button, 9 Pin
Net Weight, Average	0.3 oz.
Maximum Vibration Rating (D = .08" @ 25 cps)	2.5 g.

RATINGS, ABSOLUTE VALUES

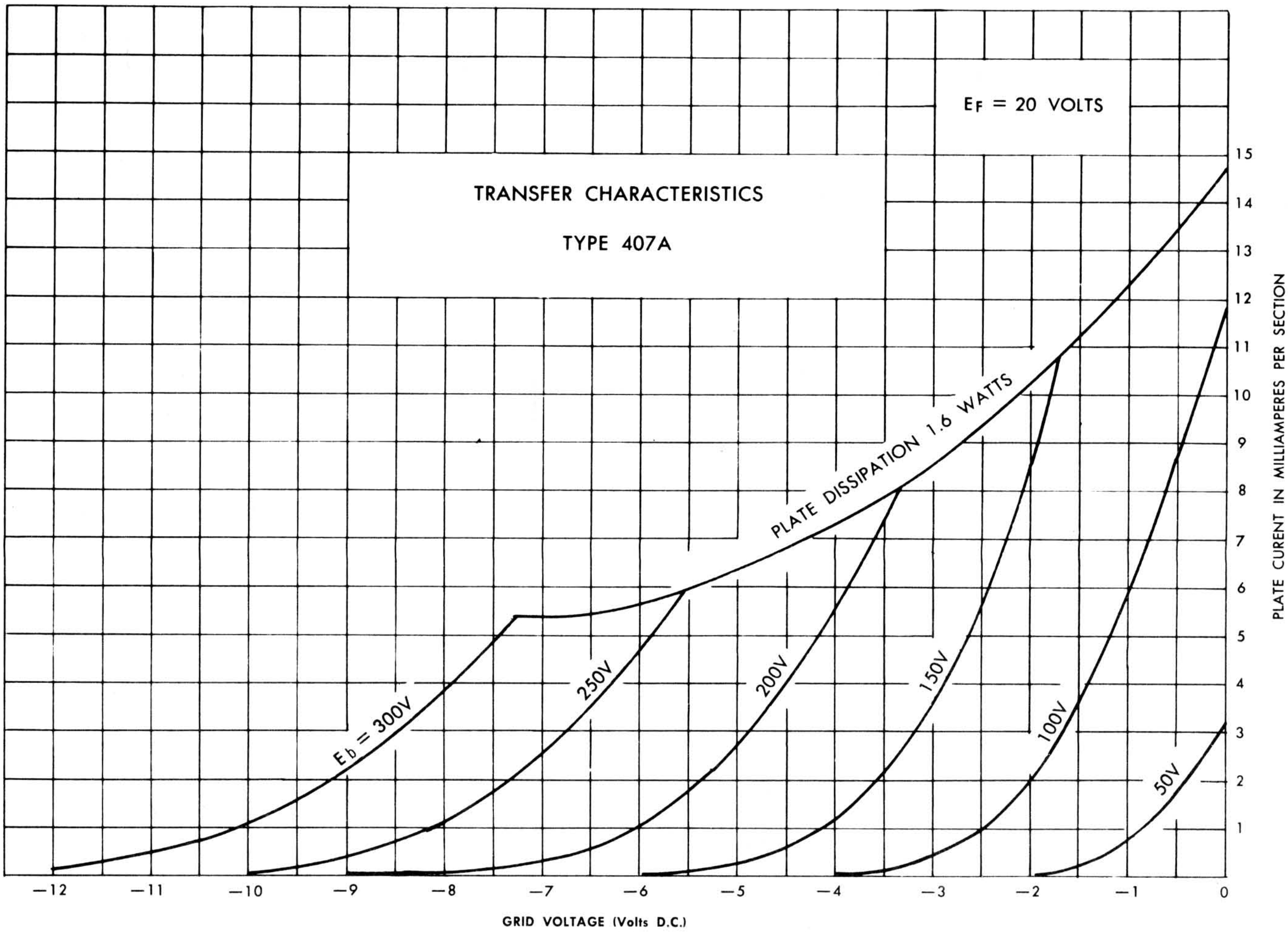
	Min.	Max.
Heater Voltage (20 volts nominal)	19	21 volts
(40 volts nominal)	38	42 volts
Plate Voltage	—	330 volts d. c.
Grid Voltage	−55	0 volts d. c.
Heater-Cathode Voltage	−130	+130 volts d. c.
Grid Current per Grid	—	3.0 ma
Plate Current per Plate	—	18 ma d. c.
Power Dissipation per Plate	—	1.6 watts
Envelope Temperature	—	165 °C
Altitude for Full Ratings	—	60,000 feet
Circuit Values:		
Grid Circuit Resistance per Grid	—	0.5 megohm



BOTTOM VIEW
SMALL BUTTON 9-PIN
MINIATURE BASE

Typical Operation
Class AB_1 Amplifier

Plate Voltage	300 volts
Cathode Resistor	800 ohms
A.F. Grid to Grid Voltage (RMS)	14 volts
Zero—Signal Plate Current per Section	4.9 mA
Maximum Signal Plate Current per Section	6.3 mA
Load Impedance (Plate to Plate)	27,000 ohms
Total Harmonic Distortion	10 per cent
Maximum Signal Power Output	1.0 watt



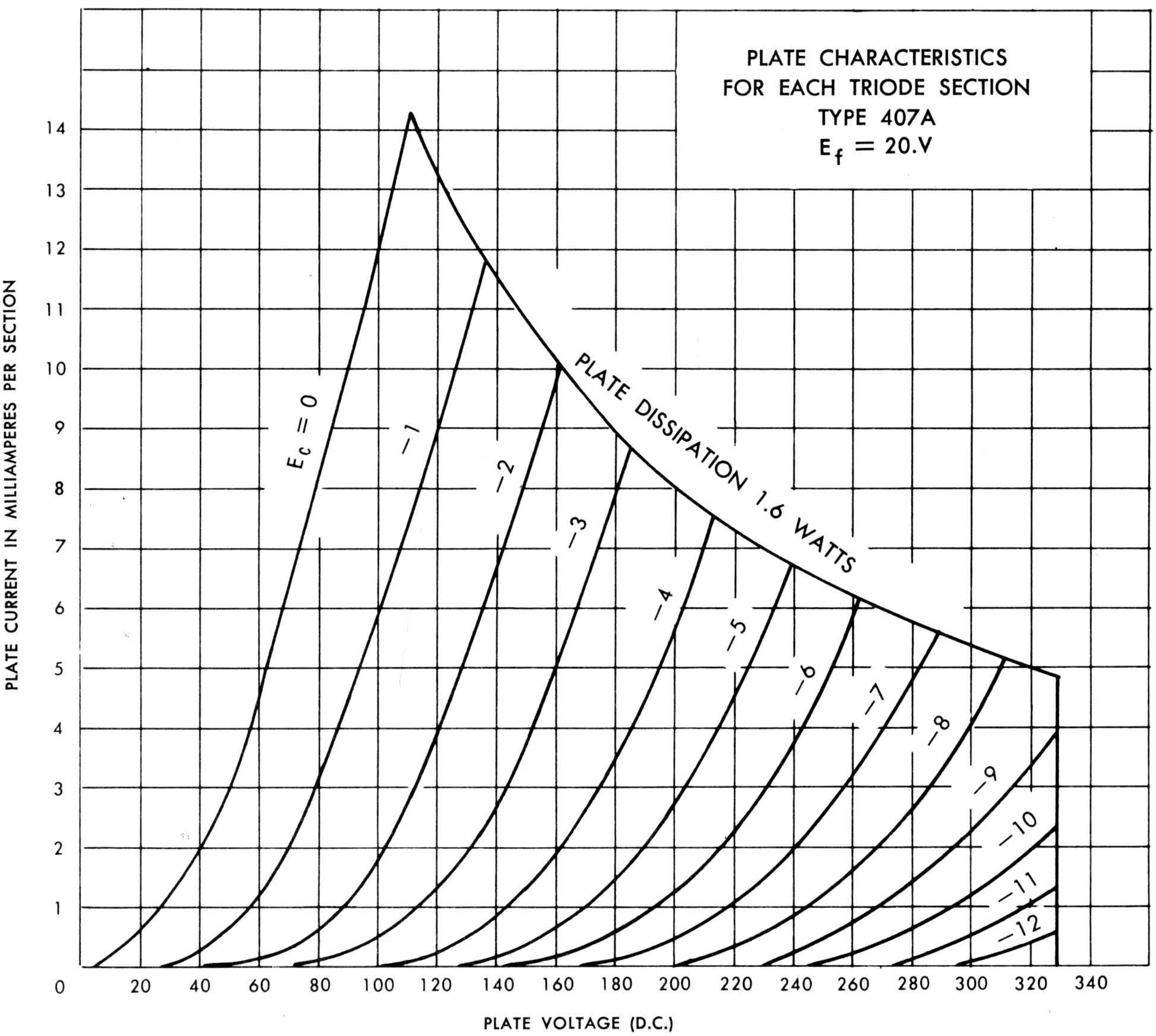
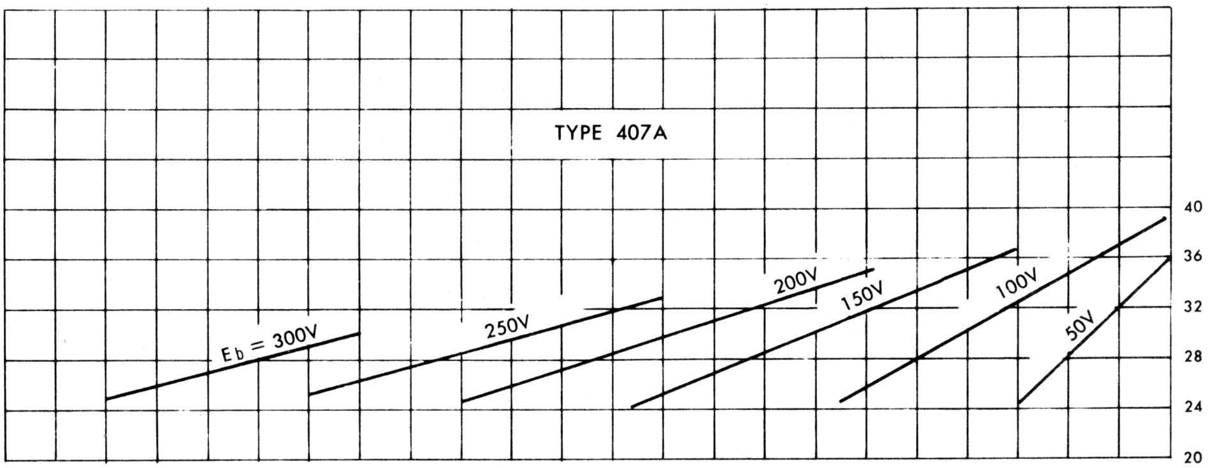
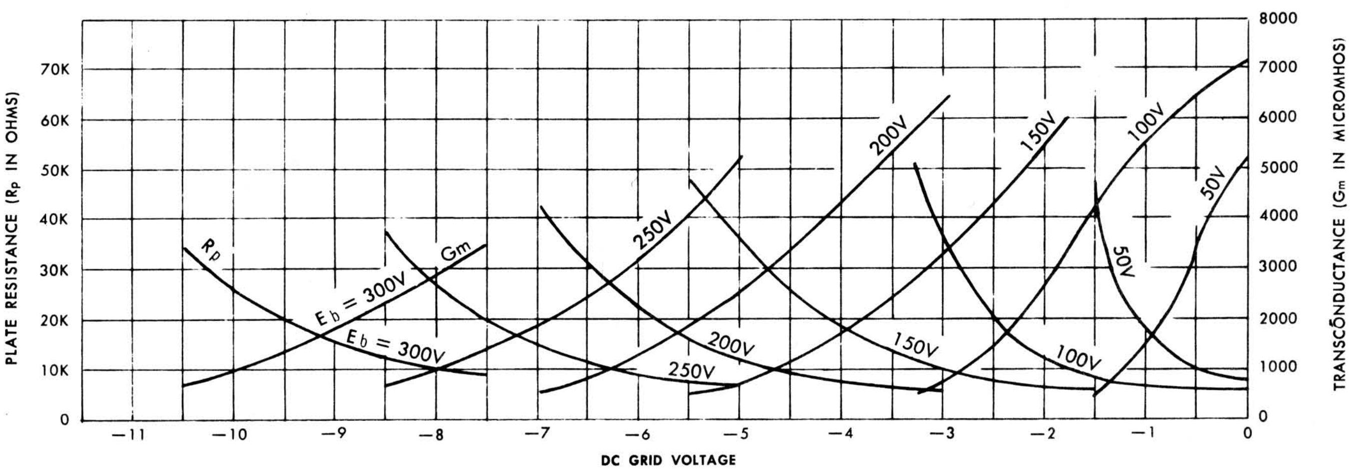


PLATE CHARACTERISTICS
FOR EACH TRIODE SECTION
TYPE 407A
E_f = 20.V
PLATE DISSIPATION 1.6 WATTS
E_c = 0
−1
−2
−3
−4
−5
−6
−7
−8
−9
−10
−11
−12
PLATE CURRENT IN MILLIAMPERES PER SECTION
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
PLATE VOLTAGE (D.C.)

AVERAGE CHARACTERISTICS





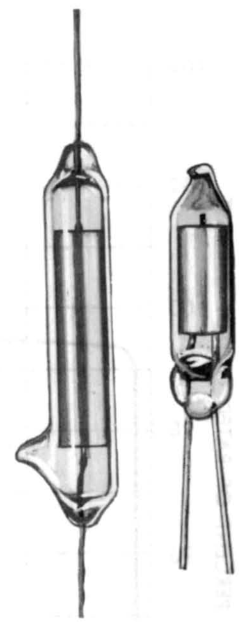
TUNG-SOL/CHATHAM

CURPISTOR, MINUTE CURRENT REGULATOR

DESCRIPTION — The CH1027 Family is a series of subminiature, two electrode, radioactive, nitrogen filled constant current tubes. They are available in current ratings from 10^{-12} to 10^{-9} amperes. For the tolerances shown below, current plateaus can extend as low as 25 volts and as high as 500 volts.

Because of their close tolerances and extremely long life, curpistors provide a circuit function not obtainable by any other simple component.

TYPES
CH 1027-9
CH 1027-10
CH 1027-11
CH 1027-12



DATA

CURRENT RATING

CH1027-9	10^{-9} amps
CH1027-10	10^{-10} amps
CH1027-11	10^{-11} amps
CH1027-12	10^{-12} amps

NET WEIGHT (Approx.)

CH1027-9, -10, & -11	0.03 ounces
CH1027-12	0.06 ounces

BASE

CH1027-9, -10, & -11	Subminiature Flat Press with two Flying Leads
CH1027-12	Double Ended (See diagram)

MOUNTING POSITION .... Any

LIFE .... Unlimited (Half Life = 1620 years)

AMBIENT TEMPERATURE RATING .... −70°C to +80°C

ACTIVE MATERIAL .... Radium 226

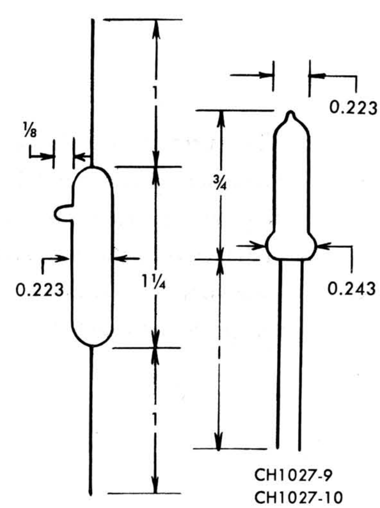
MAXIMUM CURRENT VARIATION FROM CENTER VALUE (for plateaus from 25 to 500 volts)

CH1027-9 & CH1027-10	±1%
CH1027-11 & CH1027-12	±2%

ACTIVITY

CH1027-9	18.75 microcuries
CH1027-10	1.875 microcuries
CH1027-11	0.1875 microcuries
CH1027-12	0.01875 microcuries

LEAD MATERIAL .... Copper (Tinned)



CH1027-12

CH1027-9
CH1027-10
CH1027-11

TYPICAL APPLICATIONS

The curpistor is suitable as a component to be used for:

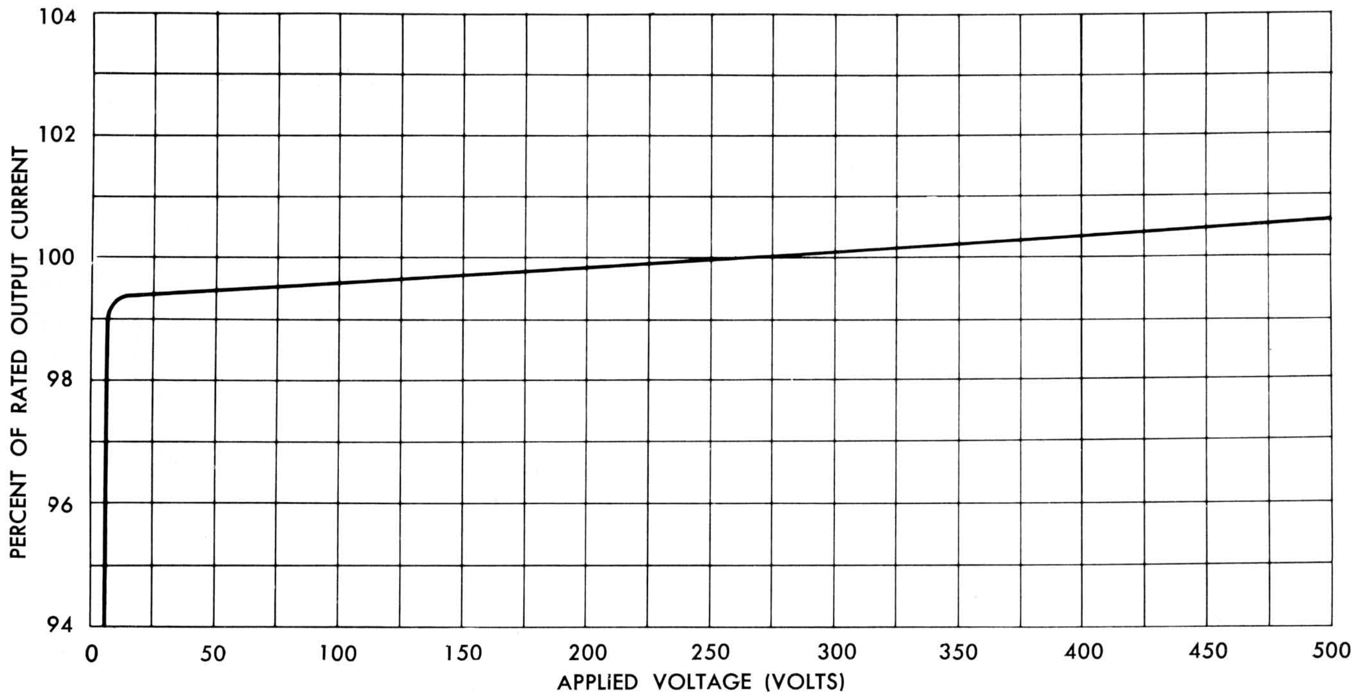
Constant capacitor drain or charge in:
- Missile Timing Circuits
- Ordnance Mine Timing Circuits

Instrument Bias

Ionization Chamber Testing

Calibration (as a standard)

TYPICAL CURVE



Notes

The curpistor should be handled in accordance with the Atomic Energy Commission's regulations for activity of the magnitude indicated for the various units. These magnitudes are not great enough to constitute a hazard to personnel if proper precautions are taken. Personnel are cautioned not to handle broken tubes so as to avoid the entrance of the radioactive material directly into the bloodstream through cuts. If one is cut on a broken tube, the cut should be cleaned immediately. An open cut can be cleaned by holding it in running water. If a tube is broken, care should be taken that the gas is not inhaled.

TUNG-SOL/CHATHAM

CROWBAR THYRATRON

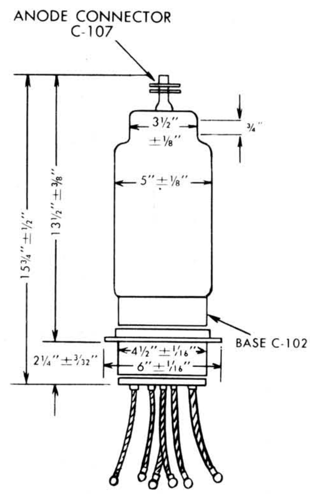
TYPE CH1096

DESCRIPTION: The CH1096 is a zero bias hydrogen thyratron designed to pass high currents in "crowbar" protective circuits. As described in the application notes, destructive arc currents are short circuited by the crowbar tube before damage occurs to other tubes or circuit elements.

The instantaneous response, and ability to repeatedly carry extremely large currents, makes the hydrogen thyratron particularly attractive for this application. One type CH1096 can handle a peak current of 1500 Amperes at 18 Kilovolts. This tube contains a hydrogen reservoir which promotes long life and permits optimum gas pressure adjustment for various conditions of operation.

ELECTRICAL DATA

	Min.	Bogey	Max.
Cathode Heater Voltage	6.0	6.3	6.6 Volts
Cathode Heater Current (at Ef = 6.3 volts)	27.	30.	33. Amperes
Cathode Heating Time	15.		Minutes
Reservoir Voltage	2.5	Marked on base	5.5 Volts
Reservoir Current			12. Amperes
Reservoir Heating Time	15.		Minutes



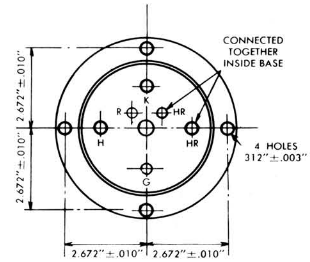
MECHANICAL DATA

Type of Cooling	Convection
Max. Net Weight	4⅝ lbs.
Mounting Position	Vertical, Base dowı

Dimensions: See outline drawings

MAXIMUM RATINGS — ABSOLUTE VALUES

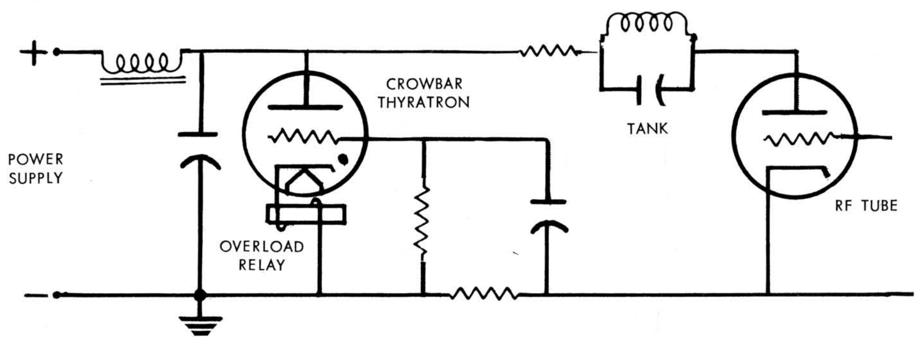
	Min.	Max.
D.C. Anode Voltage		
Forward	5	18 Kilovolts
Inverse		5 Kilovolts
Cathode Current		
Peak		1500 Amperes
Average		2 Amperes
Conduction time per fault		0.1 sec.
Averaging time		75 sec.
Recovery time		50 μ sec.
Grid Signal voltage	1000	2500 Volts
Grid Impedance	50	200 Ohms
Grid Voltage rate of rise	2200	V/μ sec.
Anode Delay time		0.6 μ sec.
Anode Voltage Drop	50	300 Volts
Ambient Temperature Range	−50°	+75° C



BOTTOM VIEW

Application Notes

In a typical application, a crowbar thyratron is connected in series with a suitable impedance across the filter of the high voltage power supply for a high frequency triode oscillator. Whenever an arc occurs in the oscillator tube, the rising current is used to deliver a suitable signal to the grid of the thyratron. The thyratron immediately conducts to short circuit the power supply until the protective circuit breaker opens 0.1 to 0.5 second later. With proper circuitry, the thyratron can be made to recover control before the power supply breaker opens. In this latter case, the oscillator tube is protected with a minimum interruption in operating time.



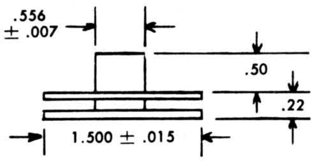
References:

SMITH, BOB:
The Fault Diverter — A Protective Device for High-Power Electron Tubes. Report UCRL-3701 Rev. University of California, Radiation Laboratories, Berkeley, Calif.

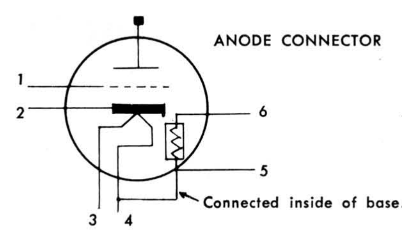
PARKER, W. N.
and
HOOVER, M. V.:
Gas Tubes Protect High-Power Transmitters. Electronics, Jan. 1956.

DOOLITTLE, H. D.:
High Powered Hydrogen Thyratrons. Cathode Press, V1, P6, 1954.

Anode Connector



Basing Connections

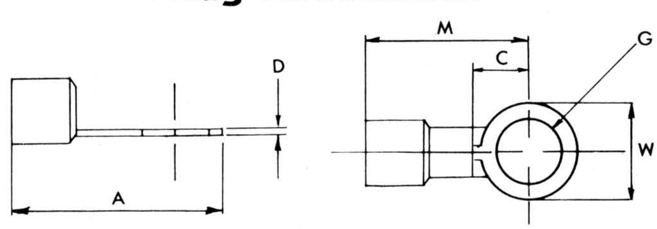


Lead Connections

Lead	Function	Lead Color	Lug Color	Lug
1	Grid	Green	Green	S
2	Cathode & Heater C-T	Black	Black	L
3	Heater	Yellow	Yellow	L
4	Heater	Yellow	Black	L
5	Reservoir	Red	Yellow	S
6	Reservoir	Red	Red	S

Leads are flexible 5½″ ±½″ long from bottom of base to center of lug hole. Color coding as well as base marking identifies the leads.

Lug Dimensions



LUG	G STUD	A MAX.	W MAX.	C MIN.	D	M MAX.
L	¼″	1.21″	.53″	.41″	.04″	.94″
S	#10	.90″	.31″	.30″	.03″	.74″

TUNG-SOL/CHATHAM

TYPE
CH 1097

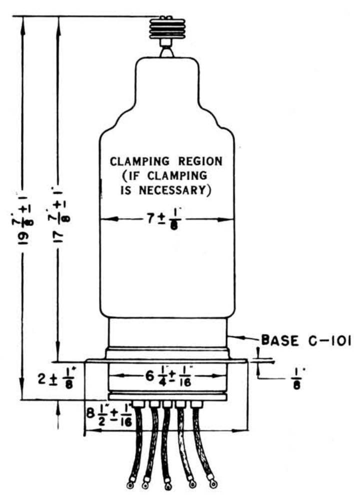
CROWBAR THYRATRON

DESCRIPTION: The CH1097 is a zero bias hydrogen thyratron designed to pass high currents in "crowbar" protective circuits. As described in the application notes, destructive arc currents are short circuited by the crowbar tube before damage occurs to other tubes or circuit elements.

The instantaneous response, and ability to repeatedly carry extremely large currents, makes the hydrogen thyratron particularly attractive for this application. One type CH1097 can handle a peak current of 2500 Amperes at 25 Kilovolts. This tube contains a hydrogen reservoir which promotes long life and permits optimum gas pressure adjustment for various conditions of operation.

ELECTRICAL DATA

	Min.	Bogey	Max.
Cathode Heater Voltage	6.0	6.3	6.6 Volts
Cathode Heater Current (at Ef = 6.3 volts)	20.	23.	40. Amperes
Cathode Heating Time	15.		Minutes
Reservoir Voltage	3.5	Marked on base	6.0 Volts
Reservoir Current			12 Amperes
Reservoir Heating Time	15.		Minutes



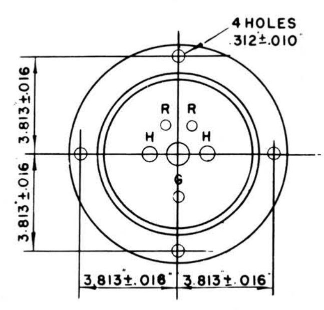
MECHANICAL DATA

Type of Cooling	Convection
Max. Net Weight	10 lbs.
Mounting Position	Vertical, Base down
Dimensions: See outline drawings	

LEAD AND LUG DIMENSIONS ARE GIVEN WITH BASE CONNECTION INFORMATION ON PAGE 2

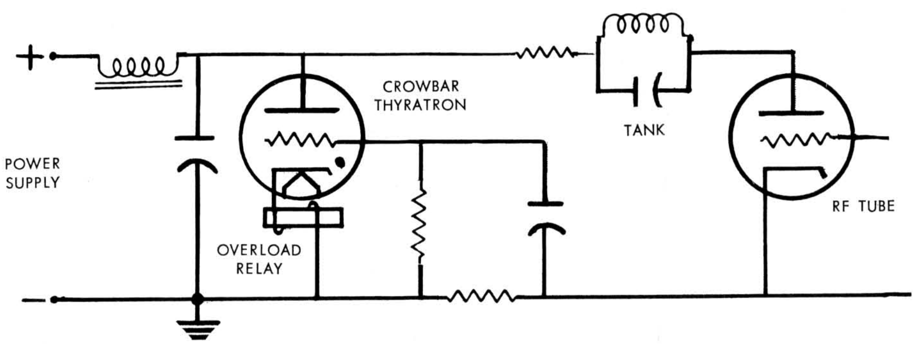
MAXIMUM RATINGS — ABSOLUTE VALUES

	Min.	Max.
D.C. Anode Voltage		
Forward	7	25 Kilovolts
Inverse		5 Kilovolts
Cathode Current		
Peak		2500 Amperes
Average		5 Amperes
Conduction time per fault		0.1 sec.
Averaging time		50 sec.
Recovery time		50 μ sec.
Grid Signal voltage	1400	2500 Volts
Grid Impedance	20	50 Ohms
Grid Voltage rate of rise	2500	V/μ sec.
Anode Delay time		0.6 μ sec.
Anode Voltage Drop	50	300 Volts
Ambient Temperature Range	−55°	+75° C



Application Notes

In a typical application, a crowbar thyratron is connected in series with a suitable impedance across the filter of the high voltage power supply for a high frequency triode oscillator. Whenever an arc occurs in the oscillator tube, the rising current is used to deliver a suitable signal to the grid of the thyratron. The thyratron immediately conducts to short circuit the power supply until the protective circuit breaker opens 0.1 to 0.5 second later. With proper circuitry, the thyratron can be made to recover control before the power supply breaker opens. In this latter case, the oscillator tube is protected with a minimum interruption in operating time.



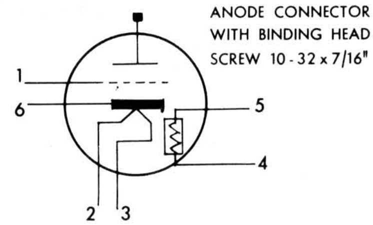
References:

SMITH, BOB:
The Fault Diverter — A Protective Device for High-Power Electron Tubes. Report UCRL-3701 Rev. University of California, Radiation Laboratories, Berkeley, Calif.

PARKER, W. N.
and
HOOVER, M. V.:
Gas Tubes Protect High-Power Transmitters. Electronics, Jan. 1956.

DOOLITTLE, H. D.:
High Powered Hydrogen Thyratrons. Cathode Press, V1, P6, 1954.

Basing Connections

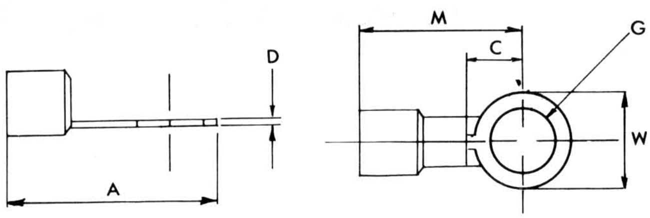


Lead Connections

Lead	Function	Lead Color	Lug Color	Lug
1	Grid	Green	Green	S
2	Heater	Yellow	Yellow	L
3	Heater	Yellow	Yellow	L
4	Reservoir	Red	Red	S
5	Reservoir	Red	Red	S
6	Cathode	Tube Base Flange		

Leads are flexible 8″ ±¾″ long from bottom of base to center of lug hole. Color coding as well as base marking identifies the leads.

Lug Dimensions



LUG	G STUD	A MAX.	W MAX.	C MIN.	D	M MAX.
L	¼″	1.21″	.53″	.41″	.04″	.94″
S	#10	.90″	.31″	.30″	.03″	.74″

TUNG-SOL / CHATHAM

HIGH POWER HYDROGEN THYRATRON

TYPE
VC 1257

DESCRIPTION — The VC-1257 is a three electrode, hydrogen filled, zero bias thyratron designed for the generation of high power pulses. The primary application of the tube is in high power, high voltage radar modulators. The VC-1257 is capable of supplying 33 megawatt pulses in this service. An internal hydrogen reservoir promotes long life and permits optimum pressure adjustment for various conditions of operation. The cathode is unipotential and is connected to the electrical center of the cathode heater circuit in order to minimize time jitter.

Firm electrical connections are made to the cathode heaters, grid and reservoir by means of flexible cables fitted with lugs. The tube is rigidly supported by a base with a flange containing bolt holes. The cathode connection is made through the base flange.

ELECTRICAL DATA

	Symbol	Min.	Bogey	Max.
Heater Voltage	Ef	6.0	6.3	6.6 Volts
Heater Current (With bogie heater and reservoir voltage)	If	20	23	40 Amperes
Cathode Heating Time	tk	15		Minutes
Reservoir Voltage (See application notes)	Eres	3.5	Marked on base	6.0 Volts
Reservoir Current	Ires			12 Amperes
Reservoir Heating Time	tres	15		Minutes
Anode Voltage Drop	etd	100	200	400 Volts

MECHANICAL DATA

Type of Cooling (Forced air cooling across the radiator is recommended for maximum tube life)	Convection
Mounting Position	Vertical, base down
Maximum Net Weight	10 lbs.
Dimensions: See outline drawing.	

RATINGS, ABSOLUTE VALUES

	Symbol	Min.	Max.
Peak Anode Voltage			
Inverse (Note 1)	epx	0.5	33 Kilovolts
Forward (See Application Notes for starting procedure)	epy	7.	33 Kilovolts
Cathode Current			
Peak	ib		2000 Amperes
Average	Ib		2.6 Amperes
RMS (For square pulse applications $I_p = \sqrt{Ib \times ib}$)	I_p		60 Amperes
D.C. Anode Voltage	Ebb	3.5 Kilovolts	
Operating Frequency (This is not necessarily the upper operating frequency limit of the VC-1257 but represents the highest repetition rate extensively life tested to date.)	prr		1500 cps
Peak Grid Voltage (Note 2)	egy	1300 Volts	2500 Volts
Peak Inverse Grid Voltage	egx		650 Volts
Grid Time of Rise of Grid Pulse (Note 5)	tr		0.35 μ sec.
Grid Pulse Width at 70.7% Point		2.0 μ sec.	
Heating Factor (epy x ib x prr. See page 4)	Pb		20 x 10^9
Current Rate of Rise (Note 5)			10,000 amp/μ sec.
Anode Delay Time (Note 3)	tad		0.5 μ sec.
Time Jitter (Note 4)	tj		0.01 μ sec.
Ambient Temperature	TA	−55°C	+75°C

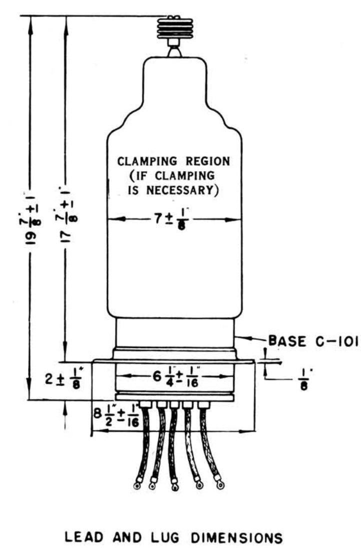
Note 1: In pulsed operation, the peak inverse voltage, exclusive of a spike of 0.05 μ sec. maximum duration, shall not exceed 5.0 kilovolts during the first 25 μ sec. following the anode pulse.

Note 2: The grid drive requirements of a VC-1257 change considerably during the first few minutes of tube operation. In order to reliably trigger a cold tube, the grid pulse voltage and duration and the grid circuit impedance should be chosen according to the limiting curves on page 3.

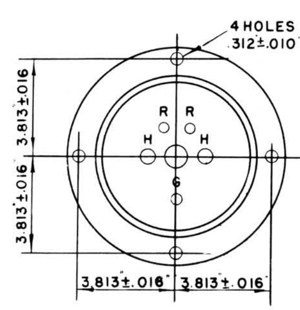
Note 3: Anode delay time is defined as the time interval between the point on the rising portion of the grid voltage pulse which is 26 percent of the maximum unloaded pulse amplitude and the point where anode conduction takes place.

Note 4: Time jitter is measured at 50 percent of the pulse amplitude after the tube has been operating for at least 60 seconds. The limit of 0.01 μ sec. shown is the maximum allowable under specified unfavorable operating conditions. With sufficient grid drive and with anode voltages of 20KV and above, jitter not exceeding 0.005 μ sec. can be easily achieved.

Note 5: Measurement made between 26% and 70.7% points.

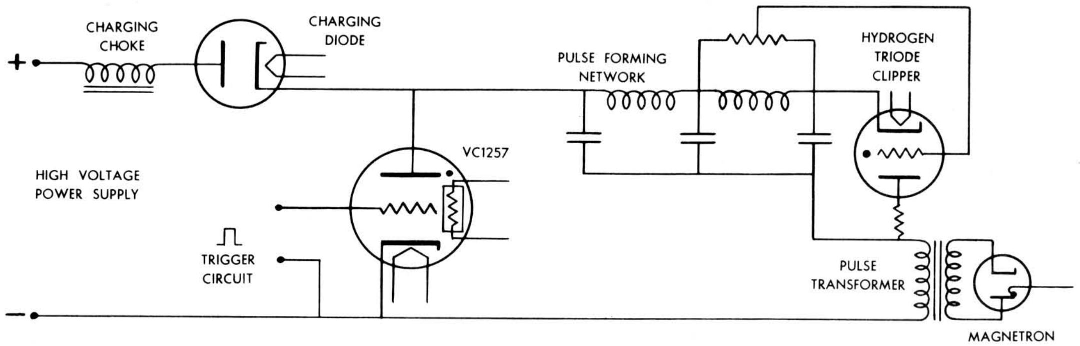


LEAD AND LUG DIMENSIONS ARE GIVEN WITH BASE CONNECTION INFORMATION ON PAGE 4



Application Notes

The VC-1257 hydrogen thyratron is designed primarily for use in high power radar modulator service. A basic circuit for such service is illustrated below. In such a circuit, the hydrogen thyratron serves as a switch to release into the magnatron or other radio frequency generator, the energy stored in the pulse forming network. The VC-1257 is admirably suited for such service by its ability to hold off high voltage, and to pass high peak currents with relatively low tube voltage drop. The tube will operate over a wide range of pulse repetition rates, pulse widths and peak currents, thus providing a very flexible circuit element. Triggering requirements are simplified since the tube operates with zero bias.



The VC-1257 contains a hydrogen reservoir that maintains the gas pressure within the tube in accordance with the voltage impressed across it. Since the reservoir can hold many tube volumes of gas, long tube life is insured. In addition it is possible to set the gas pressure at the optimum value for any particular set of operating conditions. The reservoir heater voltage stamped on the tube base has been determined for a particular set of conditions somewhat beyond the maximum tube ratings and will be satisfactory for most applications. In general, it is desirable to operate at as high a reservoir voltage as possible without obtaining spurious discharges in the grid-anode region. When the VC-1257 is operated at or near maximum ratings, the reservoir voltage regulation should not exceed ±2.5%. If the VC-1257 is operated at reduced duty a wider reservoir operating range can be expected. However, care should be taken when determining the reservoir voltage to insure satisfactory operation with the anticipated reservoir voltage regulation. Under no circumstances should the reservoir voltage be reduced to such an extent that the anode shows color.

The instantaneous application of anode voltage (instantaneous starting or "slap on") is not recommended. When it is absolutely necessary, the maximum permissible epy is 22 kv and this value shall not be attained in less than 0.04 sec. For initial application of maximum rated anode voltage, it is recommended that one of the following starting methods be used:

a) *Step starting.* Apply no more than 22 kv epy initially.
Do not increase in steps greater than 5 kv per minute.

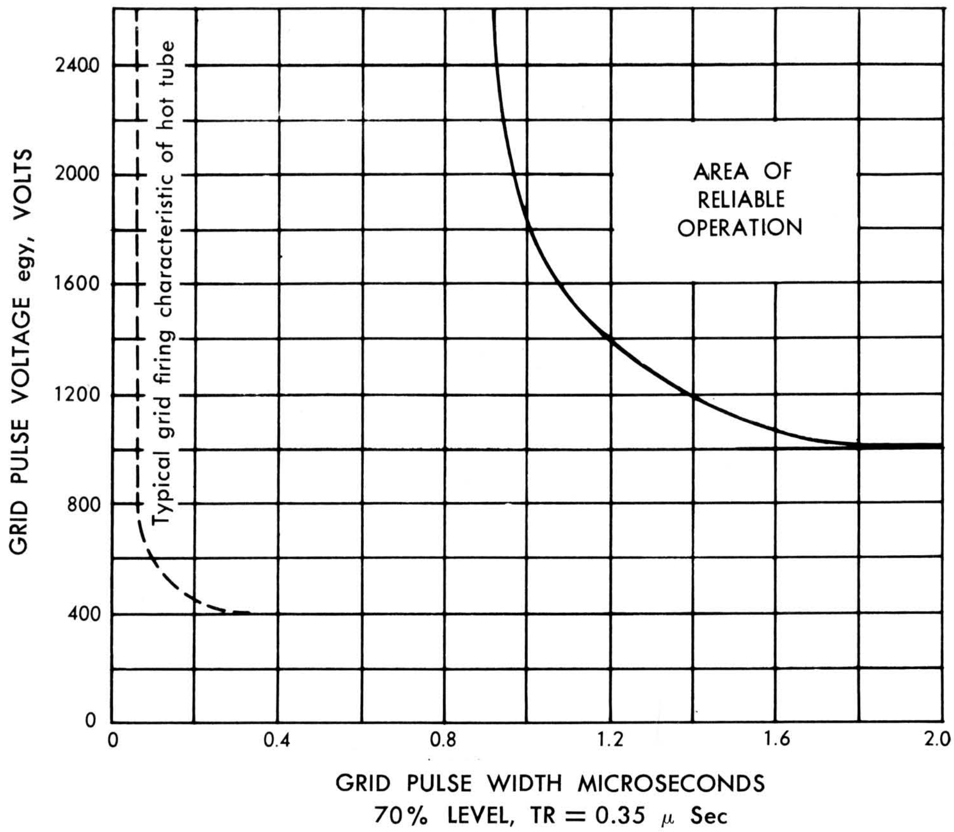
b) *Reduced Reservoir Voltage.* This method is suitable for automatic control. During warm-up and standby periods, the reservoir voltage is held at 92.5 percent of the nominal value. After initial anode voltage application of not greater than 22 kv, the anode voltage may be increased at a maximum rate of 1 kv per second. After 7.5 minutes of anode operation at maximum voltage, the reservoir voltage is increased to its nominal value. Other starting methods can be supplied to meet various particular applications.

Typical Operation

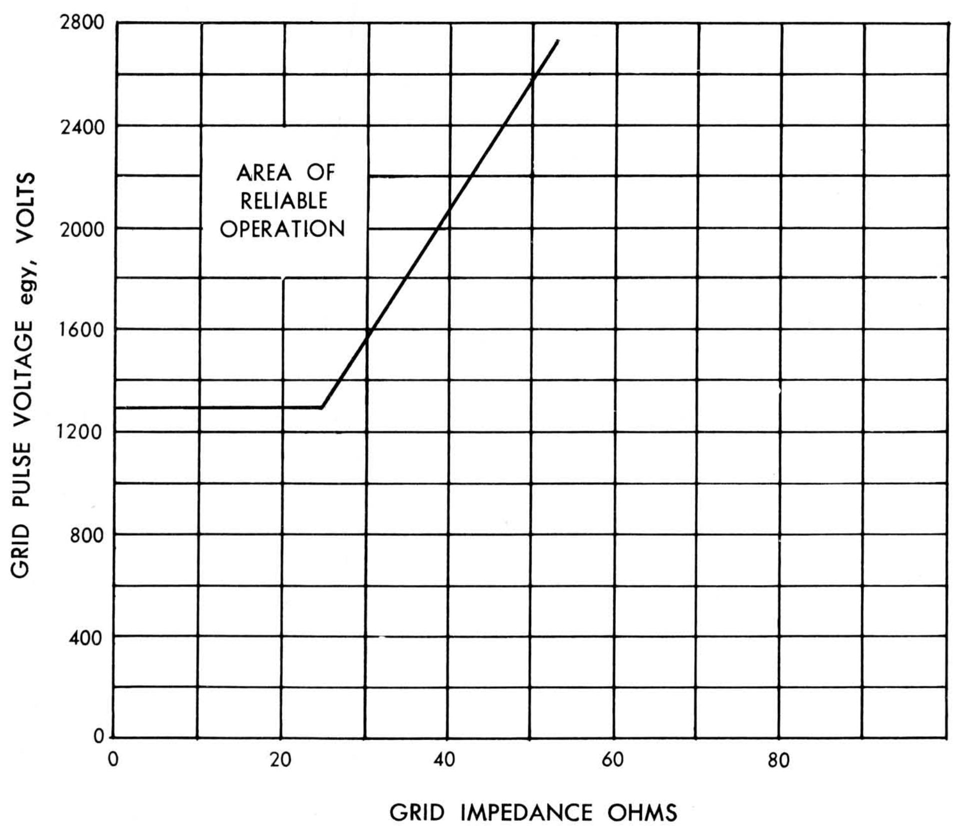
Variations in the operating parameters affect the life expectancy of hydrogen thyratrons; therefore, a simple method of rating for all conditions is difficult. Until such time as sufficient information is available to prepare complete operation rating charts, we list the following typical conditions of operation under which considerable tube life has been obtained. If the VC-1257 is to be employed in an operation differing widely from these conditions (unless the requirements are obviously less severe) it is suggested that the customer request a recommendation for the specific application.

	Peak Anode Voltage		Peak	Pulse Width	di/dt
Prr	Forward	Inverse	Current	70% Point	Amps/μs
pps	kv	kv	Amps	μs	
310	33	5.	2000	2.5	10000
500	30	1.7	1250	3.6	3400
*900	30	1.6	1250	1.0	4200
1500	20	5.	667	1.3	6670

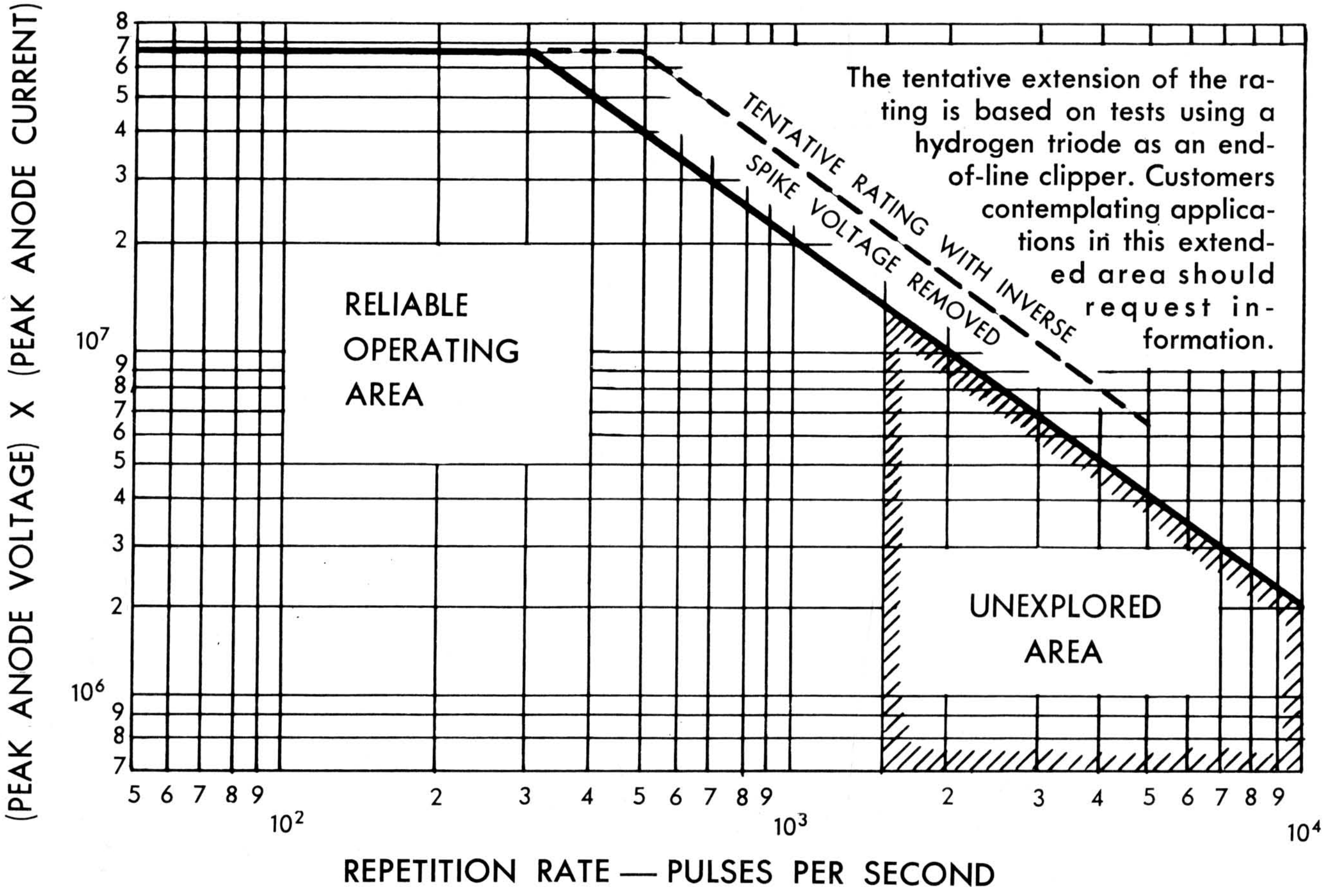
*Operation made possible by use of hydrogen triode clipper.



GRID PULSE REQUIREMENTS

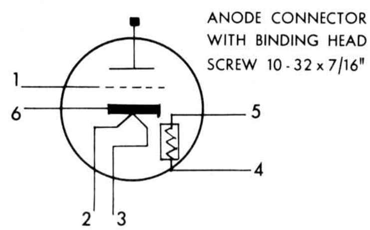


GRID IMPEDANCE REQUIREMENTS



GRAPHICAL REPRESENTATION OF HEAT FACTOR

Basing Connections

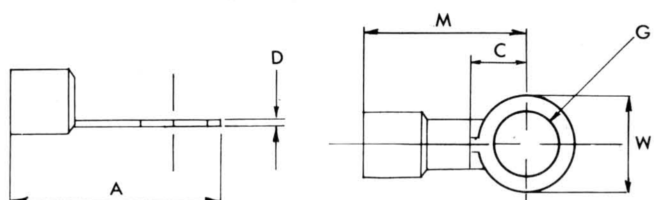


Lead Connections

Lead	Function	Lead Color	Lug Color	Lug
1	Grid	Green	Green	S
2	Heater	Yellow	Yellow	L
3	Heater	Yellow	Yellow	L
4	Reservoir	Red	Red	S
5	Reservoir	Red	Red	S
6	Cathode	Tube Base Flange		

Leads are flexible 8″ ±¾″ long from bottom of base to center of lug hole. Color coding as well as base marking identifies the leads.

Lug Dimensions



LUG	G STUD	A MAX.	W MAX.	C MIN.	D	M MAX.
L	¼″	1.21″	.53″	.41″	.04″	.94″
S	#10	.90″	.31″	.30″	.03″	.74″

TUNG-SOL/CHATHAM

MINIATURE HYDROGEN THYRATRON

TYPE
1258

DESCRIPTION—The 1258 is a zero bias miniature hydrogen thyratron designed primarily for use as a pulse modulator tube for low power radar transmitters. This tube can supply peak pulse power of 10 kilowatts and therefore will replace physically larger types in many applications. Because of its close electrode spacing and small size, made possible by hard glass construction, the 1258 is capable of relatively high pulse repetition rates.

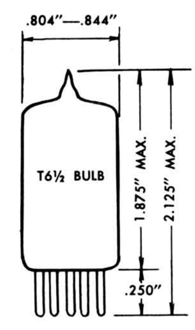
The 1258 has become the industry standard for a small size pulse modulator tube because of its long history of satisfactory service.

ELECTRICAL DATA

	Symbol	Min.	Bogey	Max.
Heater Voltage (When Ip is less than 0.75 Aac, refer to Recommended Heater Voltage Curve on page 3)	Ef	5.7	6.3	6.6 Volts
Heater Current (With bogie heater voltage)	If	1.6	1.8	2.0 Amperes
Cathode Heating Time	tk	60		Seconds
Anode Voltage Drop (At recommended E_f)	etd			175 Volts

MECHANICAL DATA

Type of Cooling (Heat dissipating shields may be used. Forced air cooling is not recommended.)	Convection
Altitude	See Application Notes
Mounting Position	Any
Maximum Net Weight	0.5 ounce
Dimensions: See outline drawings	
Vibration Test Conditions	10-50 cps @ 10 G
Maximum Shock Conditions (48° Hammer blow in Navy Fly Weight, High Impact Shock Machine)	720 G/1 millisec.



Hard Glass Bulb

RATINGS, ABSOLUTE VALUES

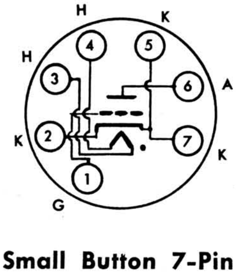
	Symbol	Min.	Max.
Peak Anode Voltage			
Inverse (Note 1)	epx	—	1000 Volts
Forward	epy	200	1000 Volts
Cathode Current			
Peak	ib		20.0 Amp.
Average	Ib		50 ma.
RMS (For square pulse applications $I_p = \sqrt{Ib \times ib}$)	I_p		1.0 Amp.
D.C. Anode Voltage	Ebb		300 Volts
Heater-Cathode Voltage	Ehk	−100	+25 Volts
Operating Frequency (This is not necessarily the upper operating frequency limit but represents the highest repetition rate extensively life tested to date.)	prr		5000 Cps.
Peak Grid Voltage . . . See Recommended Grid Pulse Conditions on page 2	egy	175	500 Volts
Peak Inverse Grid Voltage	egx		150 Volts
Heating Factor (epy x ib x prr. See page 4)	Pb		1×10^8
Current Rate of Rise (Note 2)			400 Amp/μ sec.
Anode Delay Time (Note 3)	tad		0.6 μ sec.
Time Jitter (Note 4)	tj		0.01 μ sec.
Ambient Temperature	TA	−60°C	+125° C

Note 1. In pulsed operation, the peak inverse voltage, exclusive of a spike of 0.05 μ sec. maximum duration, shall not exceed 500 volts during the first 25 μ sec. following the anode pulse.

Note 2: Measurement made between 26% and 70.7% points.

Note 3: Anode delay time is defined as the time interval between the point on the rising portion of the grid voltage pulse which is 26 percent of the maximum unloaded pulse amplitude and the point where anode conduction takes place.

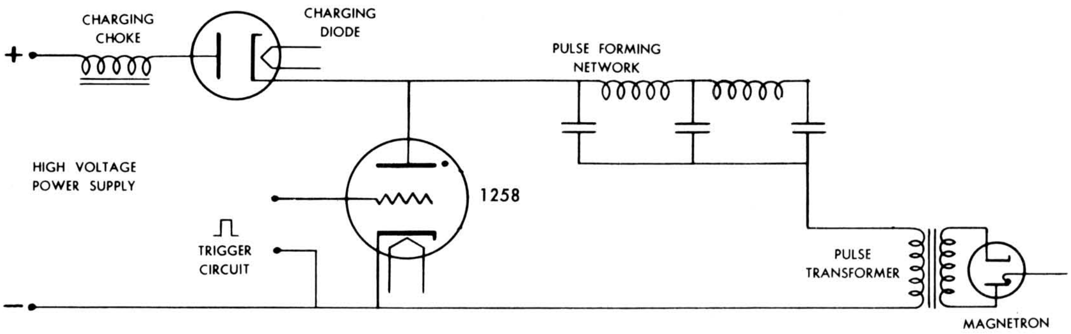
Note 4: Time jitter is measured at 50 percent of the pulse amplitude after the tube has been operating for at least 60 seconds. The limit of 0.01 μ sec. shown is the maximum allowable under specified unfavorable operating conditions. With sufficient grid drive and with anode voltages of 600 volts and above, jitter not exceeding 0.005 μ sec. can be easily achieved.



Small Button 7-Pin Miniature Base (See Application Notes)

Application Notes

The 1258 miniature hydrogen thyratron is designed primarily for use in line type radar modulators. A basic circuit for such service is illustrated below. In such a circuit, the hydrogen thyratron serves as a switch to release into the magnetron or other radio frequency generator, the energy stored in the pulse forming network. This tube is admirably suited for such service by its ability to hold off relatively high voltage, and to pass high peak current with relatively low tube voltage drop. The tube will operate over a wide range of pulse repetition rates, pulse widths and peak currents, thus providing a very flexible circuit element. Triggering requirements are simplified since the tube operates with zero bias.



The 1258 fits a standard 7 pin miniature socket. The tube pins, however, are stiff, and care should be taken to have the socket clips in perfect alignment before attempting to insert a tube. As the tube operates at high temperatures, a ceramic type socket should be employed. Connections to the socket should be made with flexible leads to provide floating action for the socket clips. Pin straighteners should never be used on these tube types, as any attempt to bend the pins will result in cracked button bases!

The nominal altitude rating for the 1258 is 10,000 feet. However, if provision is made to prevent arc-over between pins, these types also will operate at 80,000 feet. One method of preventing arc-over between pins is to pot the base end of the tube. If the entire envelope is to be potted, however, precaution must be taken to keep bulb temperature below 225°C.

Cathode temperature is determined by RMS cathode current as well as by heater power. The bogey heater voltage of 6.3 volts therefore is applicable only near full operating conditions. At light loading it is recommended to operate the heater voltage higher. Recommended figures for various operating conditions are shown on the curves on page 3.

Typical Operation

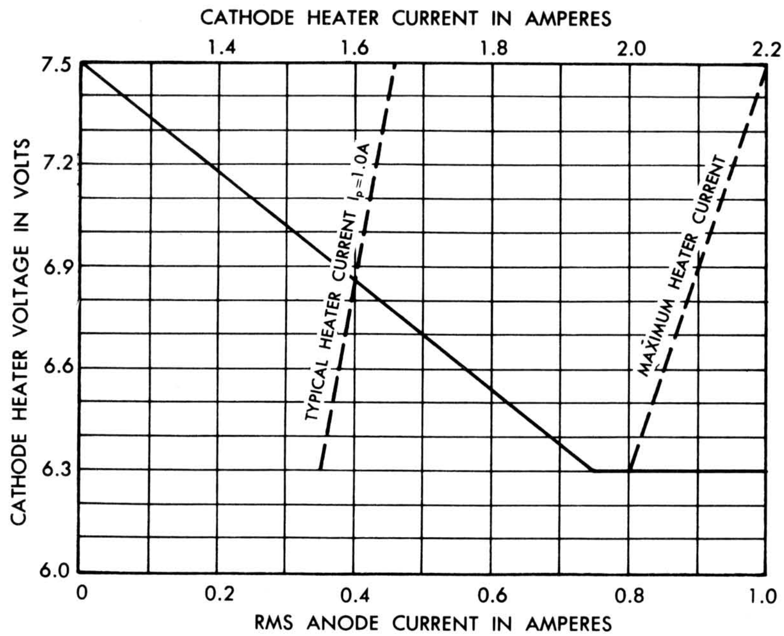
Pulse Repetition Rate	Anode Current			Peak Anode Voltage	Pulse Width	Grid Drive	
	Peak	RMS	Average				
pps	Amps	Amps AC	mAd.c.	Volts	μ sec	μ sec	volts
5,000	20.0	1.0	50.	1,000	0.5	1.0	175
10,000	6.6	0.5	37.	316	0.56	2.0	175
*33,000	3.5	0.46	60.	350	0.5	Blocking Oscillator	200

*Limited test information

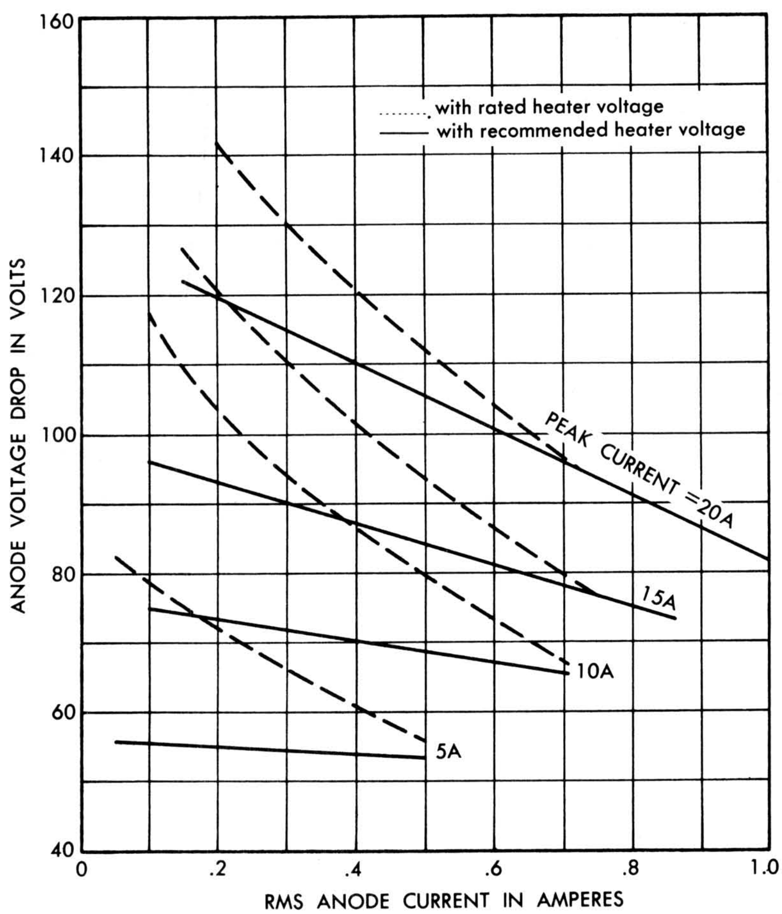
Recommended Grid Pulse Values

	Min.	Max.	
Peak Voltage	200	500	Volts
Driver Circuit Impedance	200	1000	Ohms
Voltage Rate of Rise	350		Volts/μ sec.

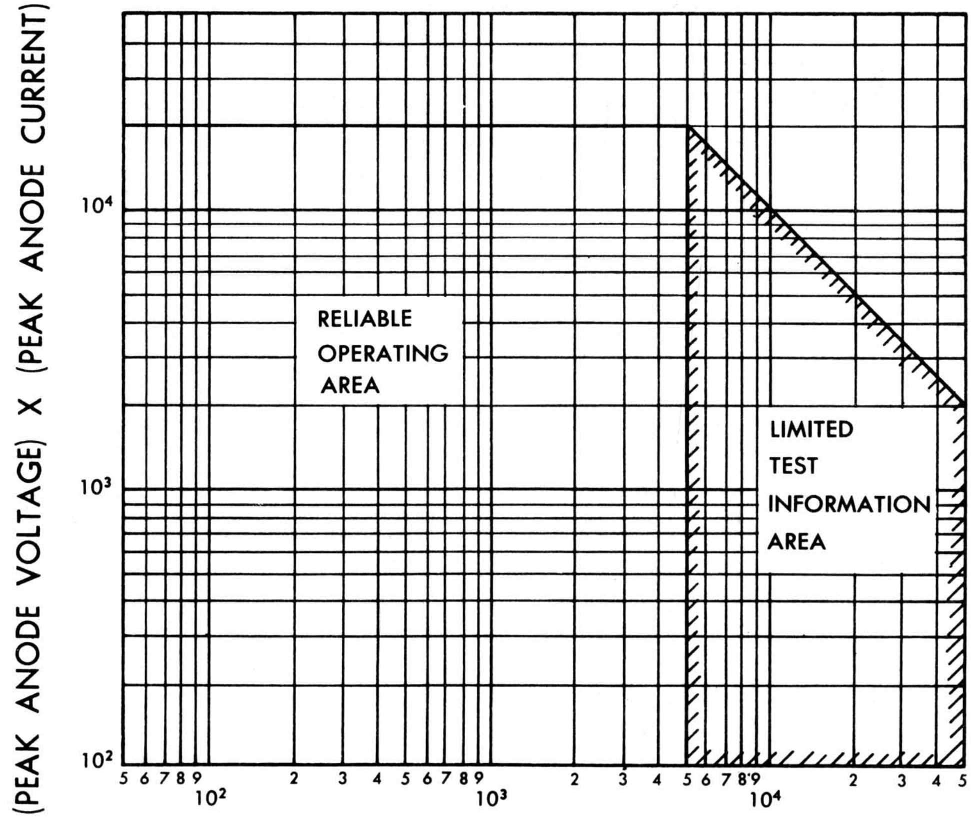
These values are as measured at the tube socket with the thyratron removed. The grid pulse width should not be longer than the anode pulse except in cases where the driver circuit impedance is high. The minimum peak trigger voltage recommended will increase with decreasing trigger pulse width. However, this effect is important only at pulse widths less than 0.5 microseconds.



RECOMMENDED HEATER VOLTAGE CURVE



TYPICAL ANODE VOLTAGE DROP CURVE



REPETITION RATE — PULSES PER SECOND

GRAPHICAL REPRESENTATION OF HEAT FACTOR

TUNG-SOL/CHATHAM

TYPE
2050

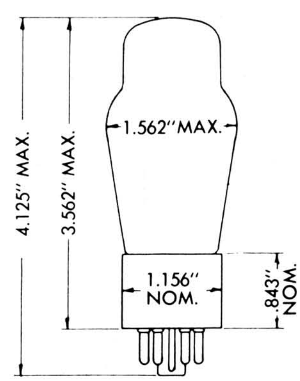
SHIELD GRID THYRATRON

DESCRIPTION — The 2050 is a xenon filled four electrode thyratron with negative control characteristic. This tube is designed for relay applications and for grid controlled rectifier service. With the shield grid type of construction a very low preconduction grid current flows which allows the use of a high resistance in the grid circuit. The grid control characteristic, because of the inert gas filling, is independent of ambient temperature over a wide range.

The effective anode to control grid capacity may be reduced by connecting pin No. 4 to No. 8 and connecting the grid resistor directly at the socket terminal.

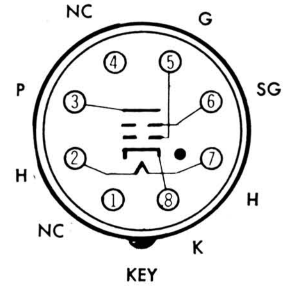
ELECTRICAL DATA

Heater Voltage	6.3 ±10% volts
Heater Current (E_f = 6.3 volts)	0.60 Amperes
Minimum Cathode Heating Time	10. Seconds
Anode to Control Grid Capacitance	0.26 Micro-microfarads
Control Grid to Cathode (and shield grid) Capacitance	4.2 Micro-microfarads
Anode to Cathode (and shield grid) Capacitance	3.6 Micro-microfarads
De-ionization Time, Approx. (shield tied to cathode)	
With Grid Volts = −250, Grid Res. = 1000Ω, Anode Volts = 125, Anode Cur. = 0.1 Amps	50 Microseconds
With Grid Volts = −10, Grid Res. = 1000Ω, Anode Volts = 125, Anode Cur. = 0.1 Amps	100 Microseconds
Ionization Time, Approx.	0.5 Microseconds
Anode Voltage Drop, Approx.	8 Volts
Maximum Critical Grid Current (At E_{bb} = 460 v RMS)	0.5 Microamperes



MECHANICAL DATA

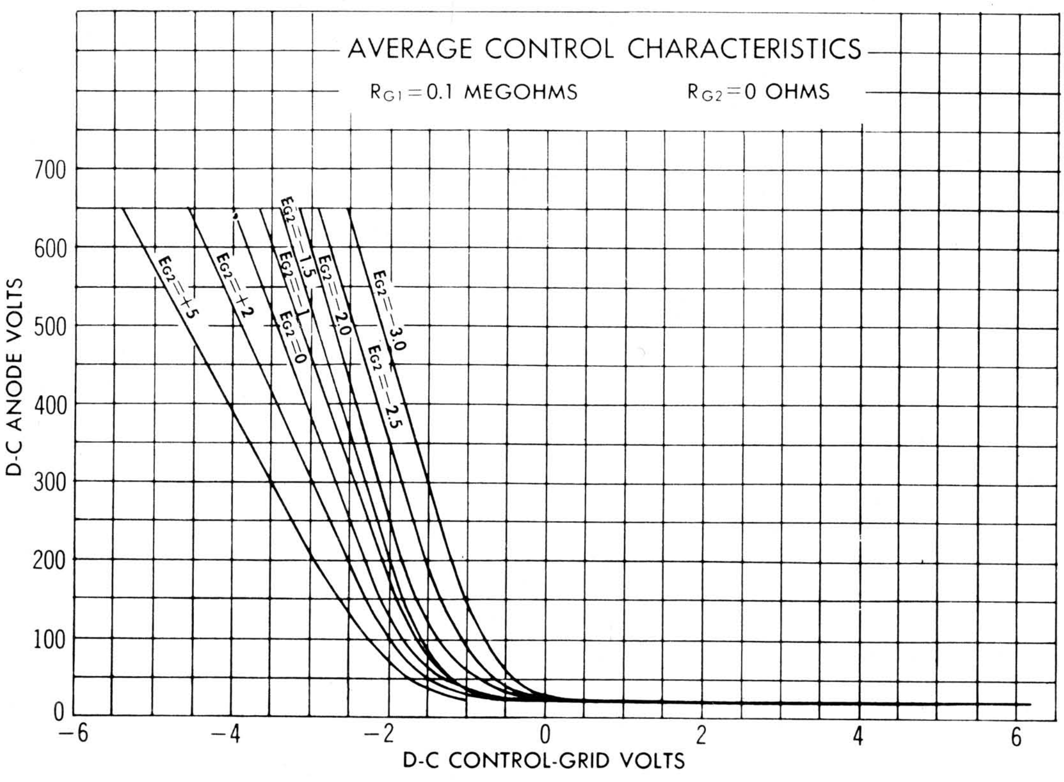
Mounting Position	Any
Maximum Overall Height	4⅛"
Maximum Seated Length	3⁹⁄₁₆"
Maximum Diameter	1⁹⁄₁₆"
Bulb	ST-12
Base	Small Shell Octal 8-Pin
Maximum Net Weight	1.5 Ounces



BOTTOM VIEW

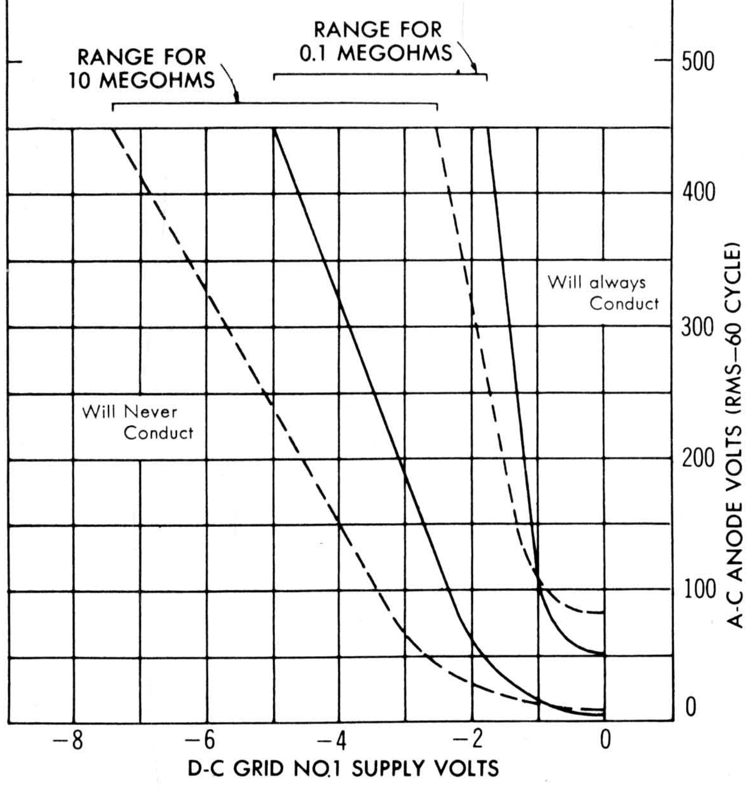
Ratings, Absolute Values

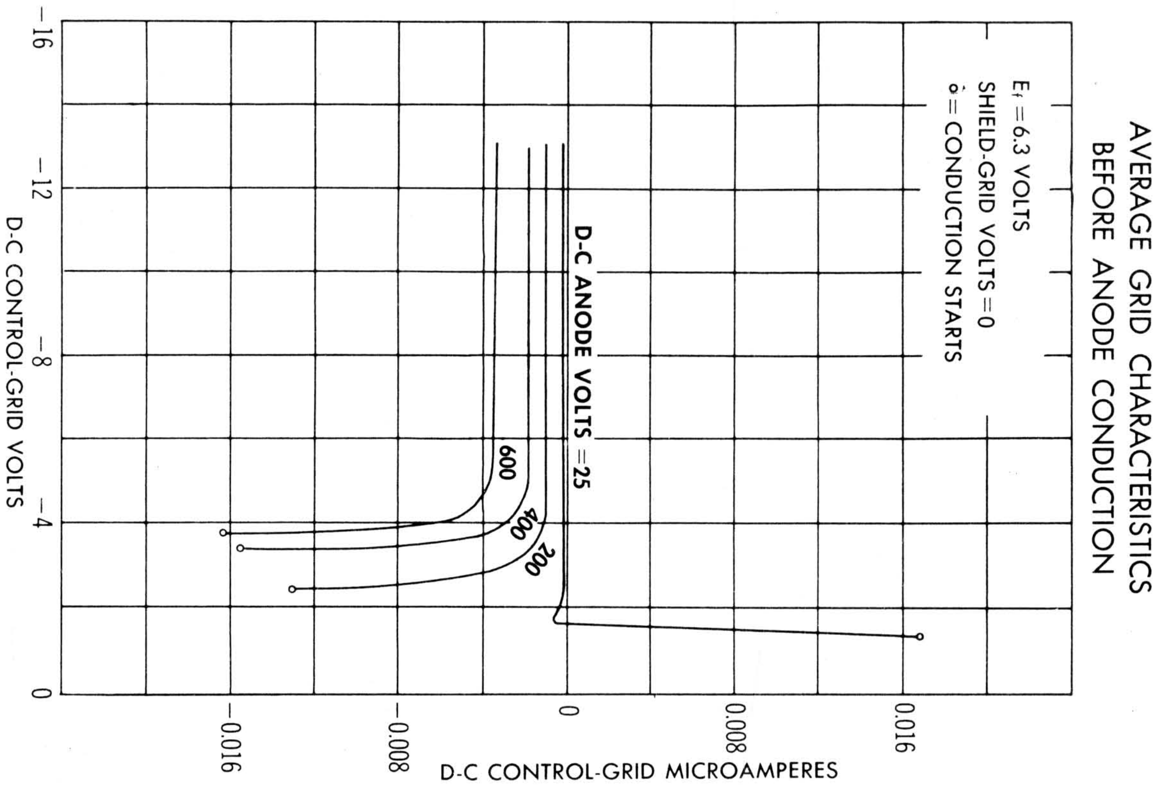
Maximum Peak Anode Voltage			
Inverse	350	1300	Volts
Forward	180	650	Volts
Maximum Cathode Current			
Peak	1.0	1.0	Amperes
Average	0.2	0.1	Amperes
Surge (max. duration 0.1 seconds)	10	10	Amperes
Maximum Averaging Time	30	30	Seconds
Maximum Negative Control Grid Voltage			
Before Conduction	−250	−250	Volts
During Conduction	− 10	− 10	Volts
Maximum Positive Control Grid Current, Average (Averaging time, 1 cycle)	0.01	0.01	Amperes
Maximum Negative Shield Grid Voltage			
Before Conduction	−100	−100	Volts
During Conduction	− 10	− 10	Volts
Maximum Positive Shield Grid Current, Average (Averaging time, 1 cycle)	0.01	0.01	Amperes
Maximum Control Grid Circuit Resistance	1.0	10	Megohms
Maximum Heater-Cathode Voltage			
Heater Negative	−100	−100	Volts
Heater Positive	25	25	Volts
Ambient Temperature Limits	−75 to +90° Centigrade		

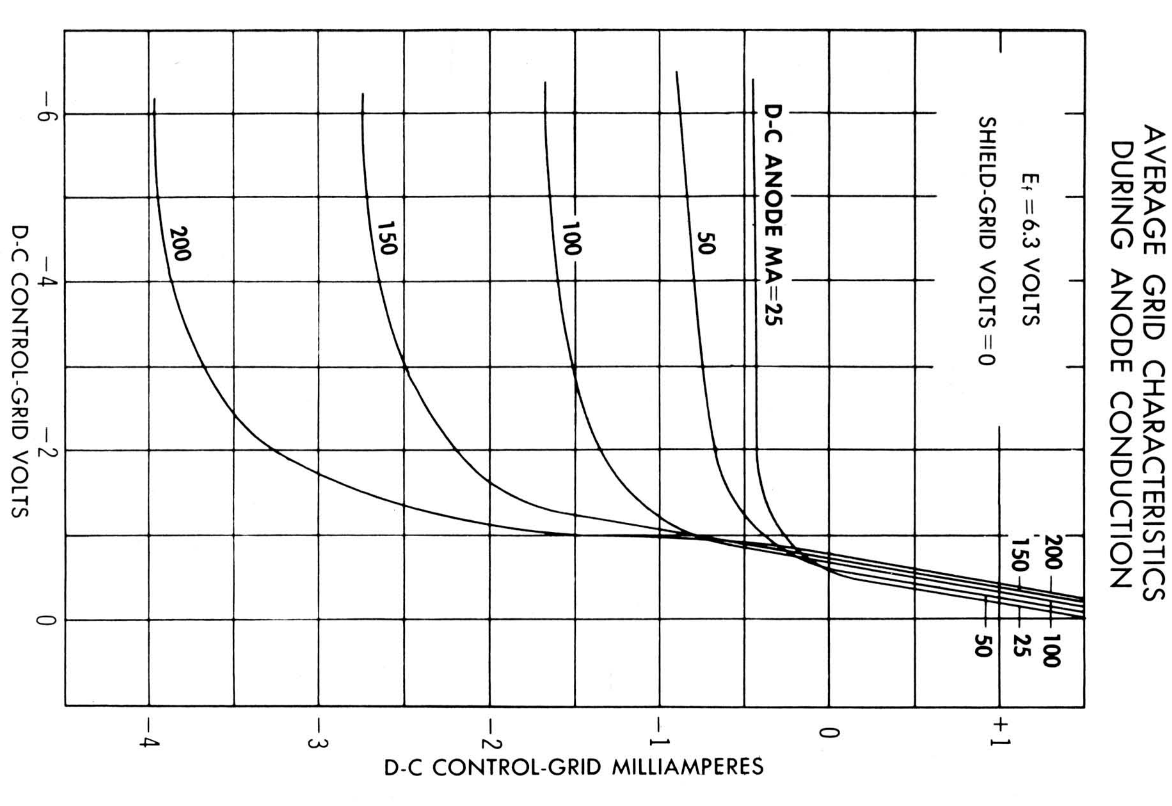


OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE

Ranges shown are for two values of grid resistor, 0.1 megohm and 10 megohm, and take into account initial differences between individual tubes and subsequent differences during tube life for a heater voltage range of 5.7 to 6.9 volts.




AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION
Ef = 6.3 VOLTS
SHIELD-GRID VOLTS = 0
o = CONDUCTION STARTS
D-C ANODE VOLTS = 25
600
400
200
−16
−12
−8
−4
0
D-C CONTROL-GRID VOLTS
−0.016
−0.008
0
0.008
0.016
D-C CONTROL-GRID MICROAMPERES


AVERAGE GRID CHARACTERISTICS
DURING ANODE CONDUCTION
Ef = 6.3 VOLTS
SHIELD-GRID VOLTS = 0
D-C ANODE MA = 25
50
100
150
200
200
150
100
25
50
−6
−4
−2
0
D-C CONTROL-GRID VOLTS
−4
−3
−2
−1
0
+1
D-C CONTROL-GRID MILLIAMPERES

TUNG-SOL/CHATHAM

TYPE 2050W

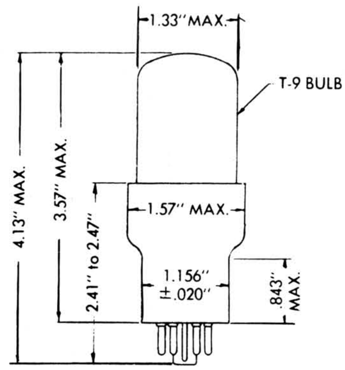
SHIELD GRID THYRATRON

DESCRIPTION — The 2050W is a ruggedized, xenon filled, four electrode thyratron with negative control characteristics. This tube is electrically equivalent to the popular type 2050, but has been ruggedized to permit the tube to stand high impact shocks and vibration. The design features stronger elements and a cushioning silastic rubber filling between the glass envelope and the special skirted low loss base. This tube is designed for relay applications and for grid controlled rectifier service. With the shield grid type of construction, a very low pre-conduction grid current flows which allows the use of a high resistance in the grid circuit. The grid control characteristic, because of the inert gas filling, is independent of ambient temperature over a wide range.

The effective anode to control grid capacity may be reduced by connecting pin No. 4 to No. 8 and connecting the grid resistor directly at the socket terminal.

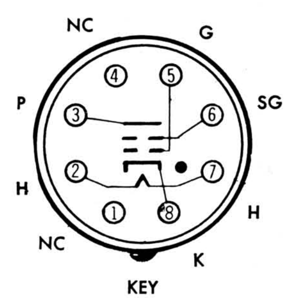
ELECTRICAL DATA

Heater Voltage	6.3 ± 10% volts
Heater Current (E_f = 6.3 volts)	0.60 amperes
Minimum Cathode Heating Time	10. seconds
Anode to Control Grid Capacitance	0.26 micro-microfarads
Control Grid to Cathode (and shield grid) Capacitance	4.2 micro-microfarads
Anode to Cathode (and shield grid) Capacitance	3.6 micro-microfarads
De-ionization Time, approx. (shield tied to cathode)	
With Grid Volts = −250, Grid Res. = 1000 Ω, Anode Volts = 125, Anode Cur. = 0.1 Amps	50 microseconds
With Grid Volts = −10, Grid Res. = 1000 Ω, Anode Volts = 125, Anode Cur. = 0.1 Amps	100 microseconds
Ionization Time, approx.	0.5 microseconds
Anode Voltage Drop, Approx.	8 volts
Maximum Critical Grid Current (At E_{bb} = 460v RMS)	0.5 microamperes



MECHANICAL DATA

Maximum Shock Rating	720G
Mounting Position	Any
Maximum Overall Height	4⅛"
Maximum Seated Length	3 9/16"
Maximum Diameter	1 9/16"
Bulb	T-9
Base	Small Shell Octal 8-Pin
Maximum Net Weight	2.5 Ounces

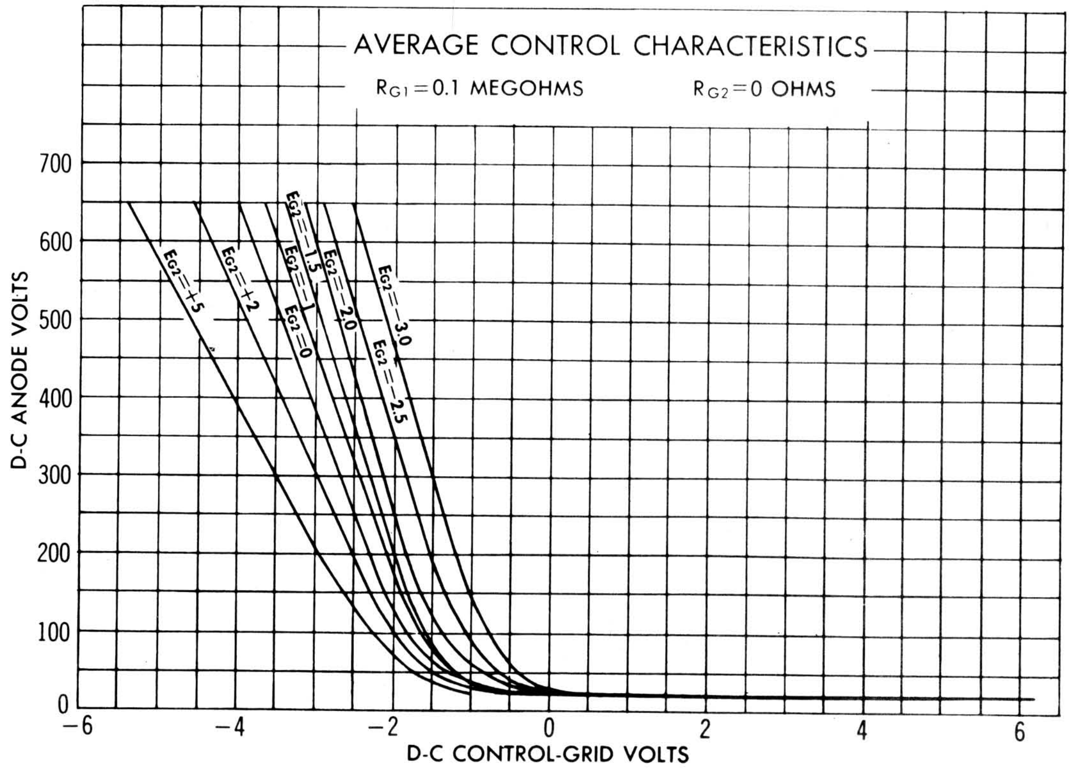


BOTTOM VIEW

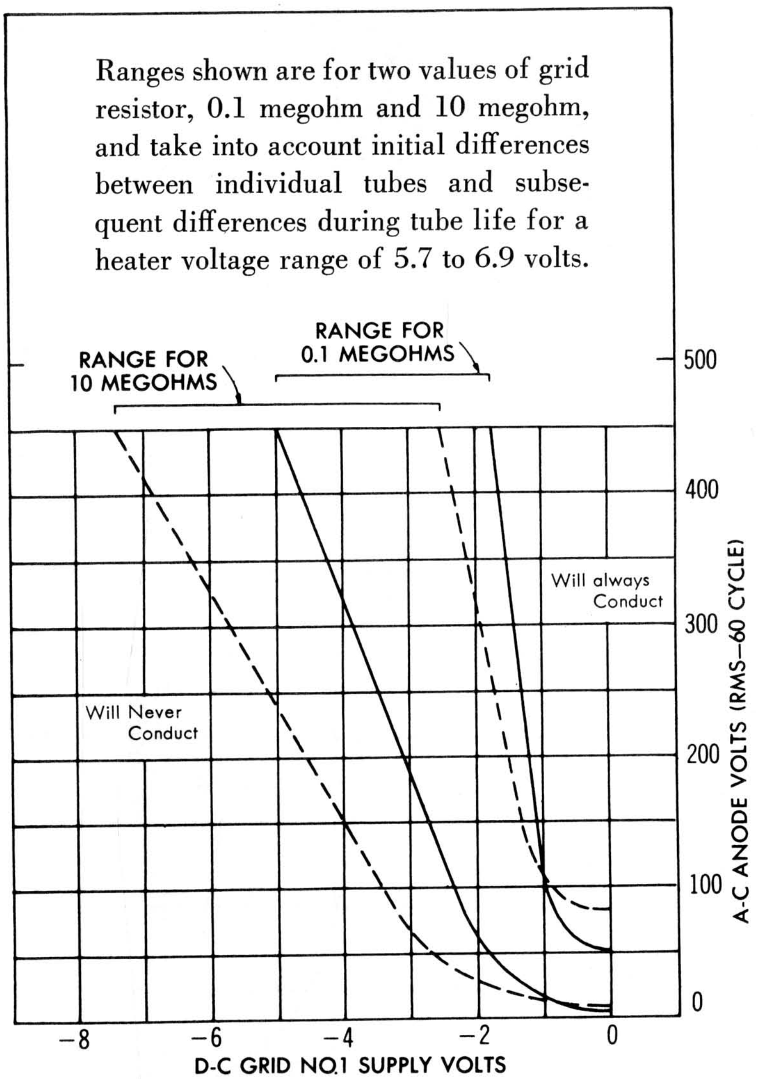
SPECIAL SKIRTED SMALL SHELL OCTAL LOW-LOSS BASE

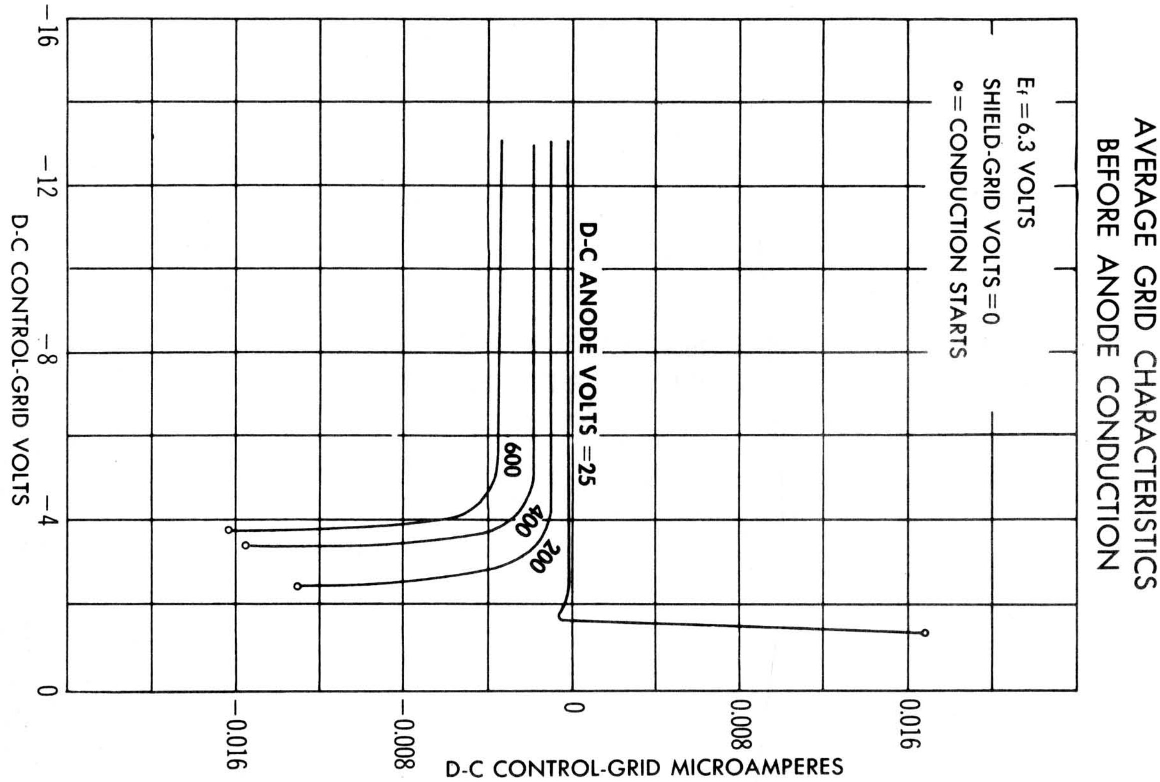
Ratings, Absolute Values

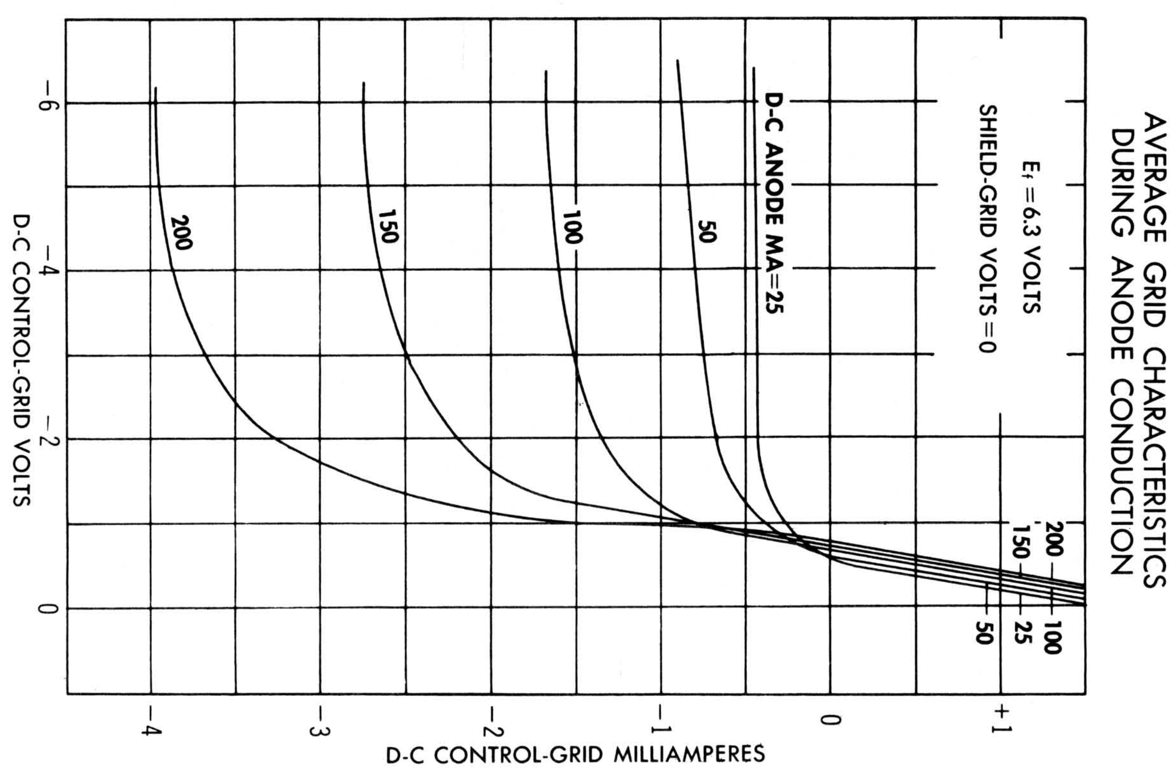
Maximum Peak Anode Voltage			
Inverse	350	1300	Volts
Forward	180	650	Volts
Maximum Cathode Current			
Peak	1.0	1.0	Amperes
Average	0.2	0.1	Amperes
Surge (max. duration 0.1 seconds)	10	10	Amperes
Maximum Averaging Time	30	30	Seconds
Maximum Negative Control Grid Voltage			
Before Conduction	−250	−250	Volts
During Conduction	− 10	− 10	Volts
Maximum Positive Control Grid Current, Average (Averaging time, 1 cycle)	0.01	0.01	Amperes
Maximum Negative Shield Grid Voltage			
Before Conduction	−100	−100	Volts
During Conduction	− 10	− 10	Volts
Maximum Positive Shield Grid Current, Average (Averaging time, 1 cycle)	0.01	0.01	Amperes
Maximum Control Grid Circuit Resistance	1.0	10	Megohms
Maximum Heater-Cathode Voltage			
Heater Negative	−100	−100	Volts
Heater Positive	25	25	Volts
Ambient Temperature Limits	−75 to +90° Centigrade		



OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE




AVERAGE GRID CHARACTERISTICS
BEFORE ANODE CONDUCTION
Ef = 6.3 VOLTS
SHIELD-GRID VOLTS = 0
o = CONDUCTION STARTS
D-C ANODE VOLTS = 25
600
400
200
-16
-12
-8
-4
0
D-C CONTROL-GRID VOLTS
-0.016
-0.008
0
0.008
0.016
D-C CONTROL-GRID MICROAMPERES


AVERAGE GRID CHARACTERISTICS
DURING ANODE CONDUCTION
Ef = 6.3 VOLTS
SHIELD-GRID VOLTS = 0
D-C ANODE MA = 25
50
100
150
200
200
150
100
25
50
-6
-4
-2
0
D-C CONTROL-GRID VOLTS
-4
-3
-2
-1
0
+1
D-C CONTROL-GRID MILLIAMPERES

TUNG-SOL/CHATHAM

TYPE 5517

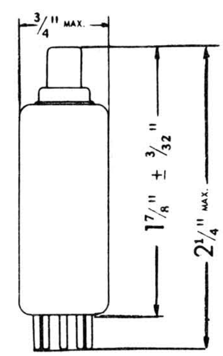
COLD CATHODE, HALF WAVE RECTIFIER

DESCRIPTION — The 5517 is a gas filled, cold cathode, half wave rectifier. This tube features small size, light weight and instant operation. A starting electrode is used to ignite the tube at relatively low voltage, permitting it to operate over a large portion of the AC cycle. One tube in a half wave circuit will supply 10 mADC at more than 1,000 VDC. This tube is used extensively for photoflash work and for other applications where the necessity of filament power during standby would be a disadvantage.

MAXIMUM RATINGS

Maximum Peak Inverse Anode Voltage	2800 Volts
Maximum Starting Voltage (with starter electrode connected to anode through 10 Meg. ohms.)	400 Volts RMS
Maximum Average Anode Current	12 Milliamperes
Maximum Peak Anode Current	100 Milliamperes
Maximum Tube Drop (at I_b = 100 m A)	125 Volts
Maximum Surge Anode Current	300 Milliamperes
Minimum Source Impedance	5000 Ohms

(Source impedance may be less than that specified if circuit constants are such that maximum peak anode current does not exceed 100 m A and that a short circuit current is limited to 300 m A.)



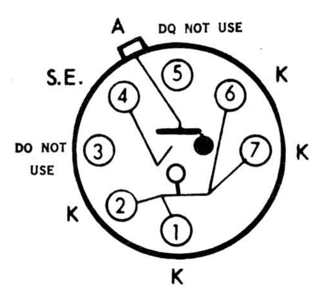
GLASS BULB

ELECTRICAL DATA

Average Tube Drop	100 Volts

MECHANICAL DATA

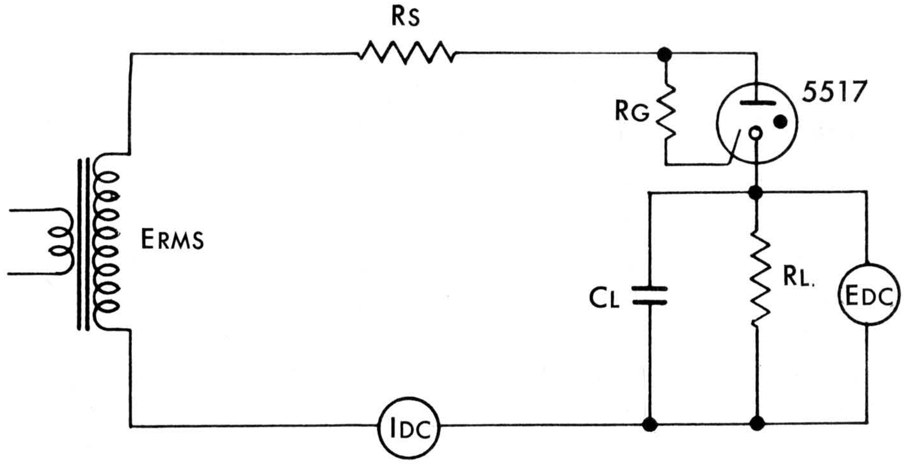
Mounting Position	Any
Maximum Overall Length	2¼″
Seated Length	1⅞″ ± 3/32″
Maximum Diameter	0.75″
Bulb	T-5½
Cap	Skirted Miniature, C1-3
Base	Miniature Button 7 Pin
Average Weight	0.32 ounces



Bottom View

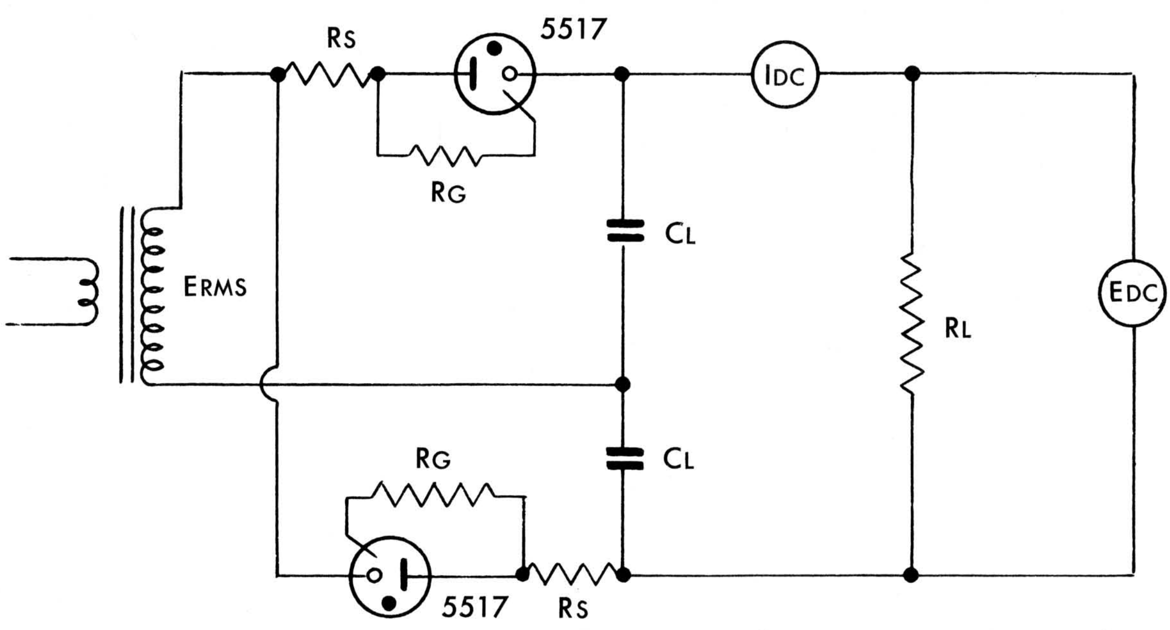
TYPICAL CIRCUIT VALUES

Figure 1 — HALF WAVE RECTIFIER



Erms	Rs	Rg	Rl	Cl	Ed c	Id c
VOLTS	OHMS	MEGOHMS	OHMS	MFD	VOLTS	MILLIAMPS
1,000	6,000*	12†	100,000	2	1000	10

Figure 2 — VOLTAGE DOUBLER, FULL WAVE



Erms	Rs	Rg	Rl	Cl	Ed c	Id c
VOLTS	OHMS	MEGOHMS	OHMS	MFD	VOLTS	MILLIAMPS
1,200	6,000*	12†	255,000	4	2550	10

* INCLUDING TRANSFORMER IMPEDANCE

† USE THREE 3.9 MEGOHM, 350V, ½ WATT RESISTORS IN SERIES.

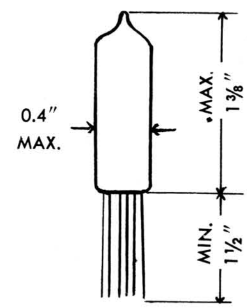
TUNG-SOL/CHATHAM

TYPE 5643

SUBMINIATURE SHIELD GRID THYRATRON

DESCRIPTION— Subminiature type 5643 is a xenon filled, four electrode thyratron with negative control characteristics. It is similar in characteristics to the miniature type 5696. The 5643 is suitable for use as a switching tube, counter, or grid controlled rectifier. Because of its shield grid construction, the input will work directly from a high impedance source such as a vacuum phototube or a cadmium sulphide photo cell. The effective diode to control grid capacity may be reduced by connecting leads 2, 4 and 8 to lead 5, and connecting the grid resistor directly to the socket terminals.

This tube is particularly suited for use in compact and portable equipment, because of its small size and light weight.



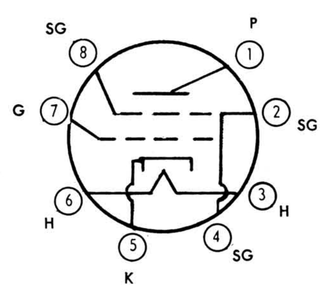
GLASS BULB

ELECTRICAL DATA

Heater Voltage	6.3 ± 5% Volts
Heater Current (E_f=6.3 volts)	0.150 Amperes
Minimum Cathode Heating Time	10. Seconds
Anode to Control Grid Capacitance	0.084 Micro-microfarads
Control Grid to Cathode (and shield grid) Capacitance	1.33 Micro-microfarads
Anode to Cathode (and shield grid) Capacitance	1.27 Micro-microfarads
De-ionization Time, approx. (shield tied to cathode)	
With Grid Volts= −100, Grid Res.=1000 Ω, Anode Volts=500, Anode Cur.=.016 Amps	15 Microseconds
With Grid Volts=−10, Grid Res.=1000 Ω, Anode Volts=500, Anode Cur.=.016 Amps	25 Microseconds
Anode Voltage Drop, Approx.	12.5 Volts
Critical Grid Current (At E_{bb}=350 v RMS)	0.5 Microamperes

MECHANICAL DATA

Maximum Shock Rating	450 G
Mounting Position	Any
Maximum Overall Length	See outline
Maximum Seated Length	1⅜
Maximum Diameter	.40
Bulb	T-3
Base	Subminiature Button 8 Pin Long Leads
Weight (Approx.)	0.12 ounces



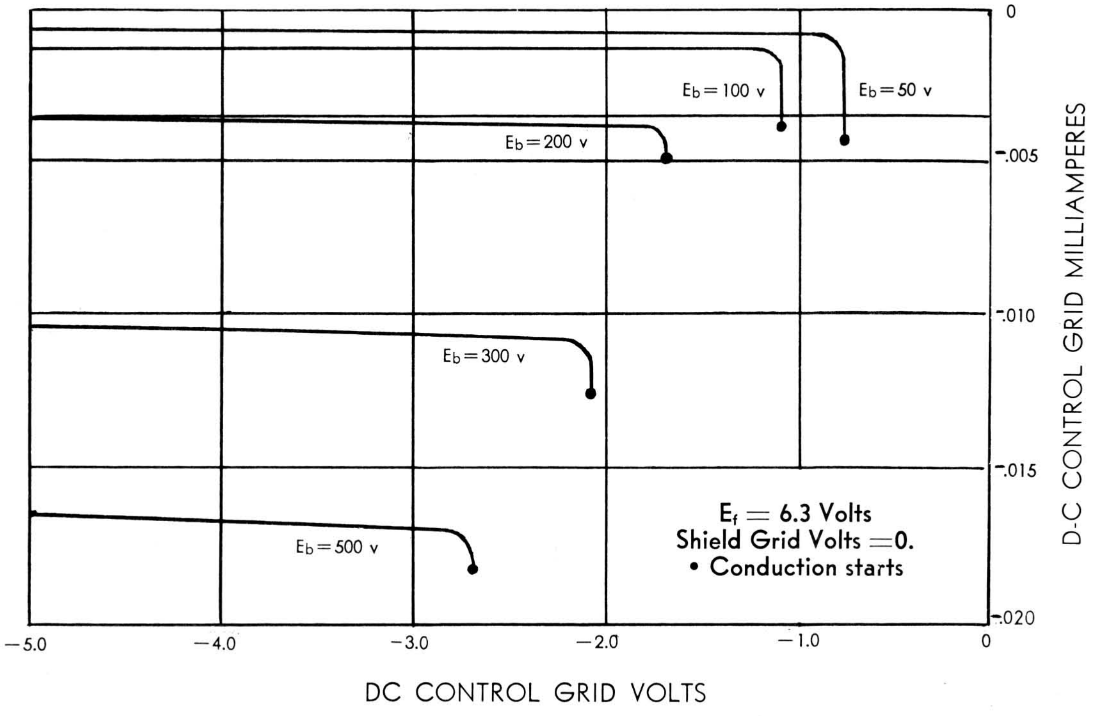
Bottom View

.017″ Tinned flexible leads

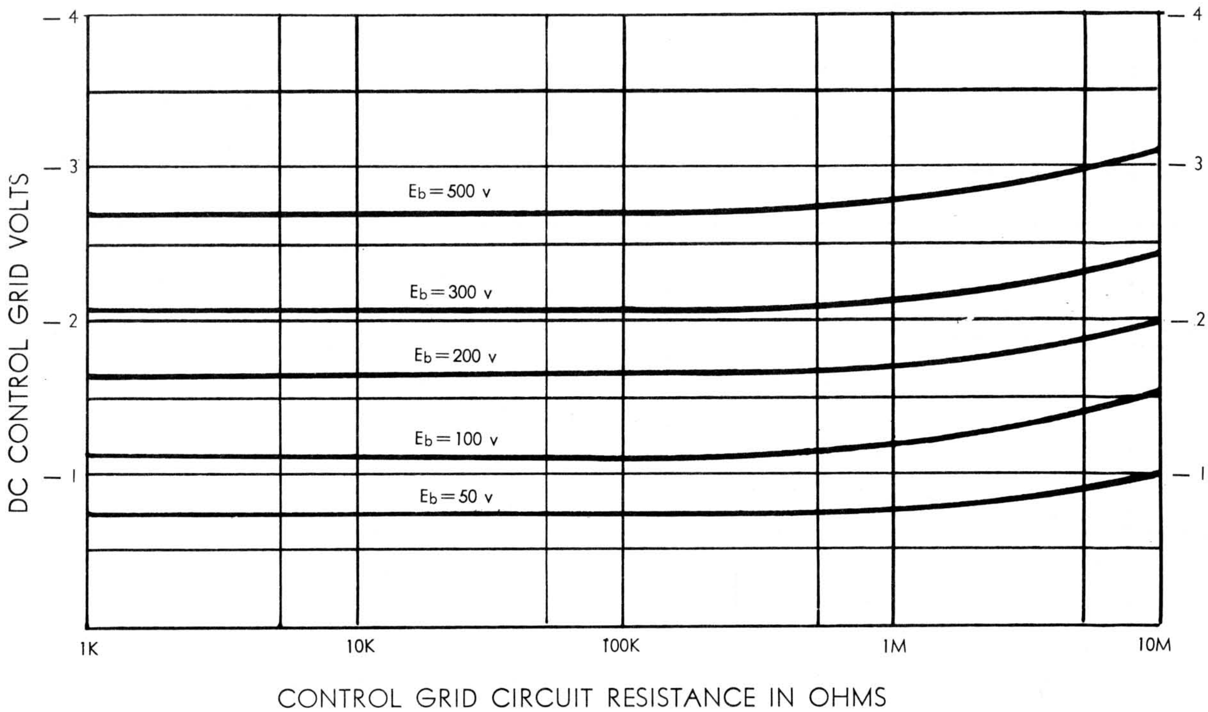
RATINGS, ABSOLUTE VALUES

Maximum Peak Anode Voltage	
Inverse	500 volts
Forward	500 volts
Maximum Cathode Current	
Peak	100 Milliamperes
Average	16 Milliamperes
Surge (max. duration 0.1 Second)	1.0 Ampere
Maximum Average Time	15 Seconds
Maximum Negative Control Grid Voltage	
Before Conduction	−200 volts
During Conduction	−10 volts
Maximum Negative Shield Grid Voltage	
Before Conduction	−100 volts
During Conduction	−10 volts
(The shield grid should not be used for control purposes).	
Maximum Heater Cathode Voltage	
Heater Negative	−100 volts
Heater Positive	25 volts
Ambient Temperature Limits	−55° to +90° Centigrade
Maximum Control Grid (G1) Circuit Resistance	10 Megohms
Altitude For Full Ratings	60,000 Feet

AVERAGE GRID CHARACTERISTICS BEFORE ANODE CONDUCTION

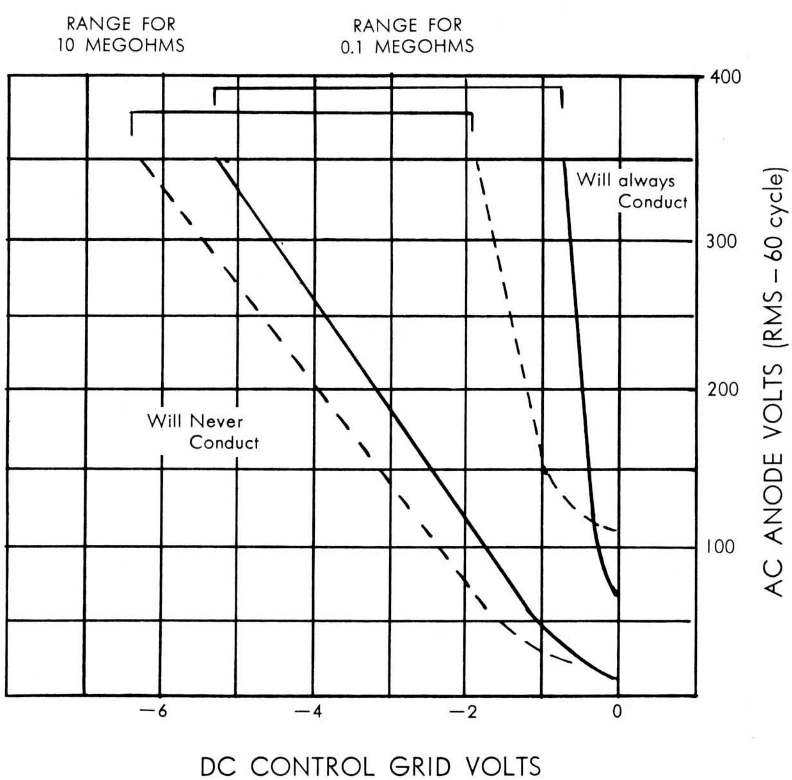


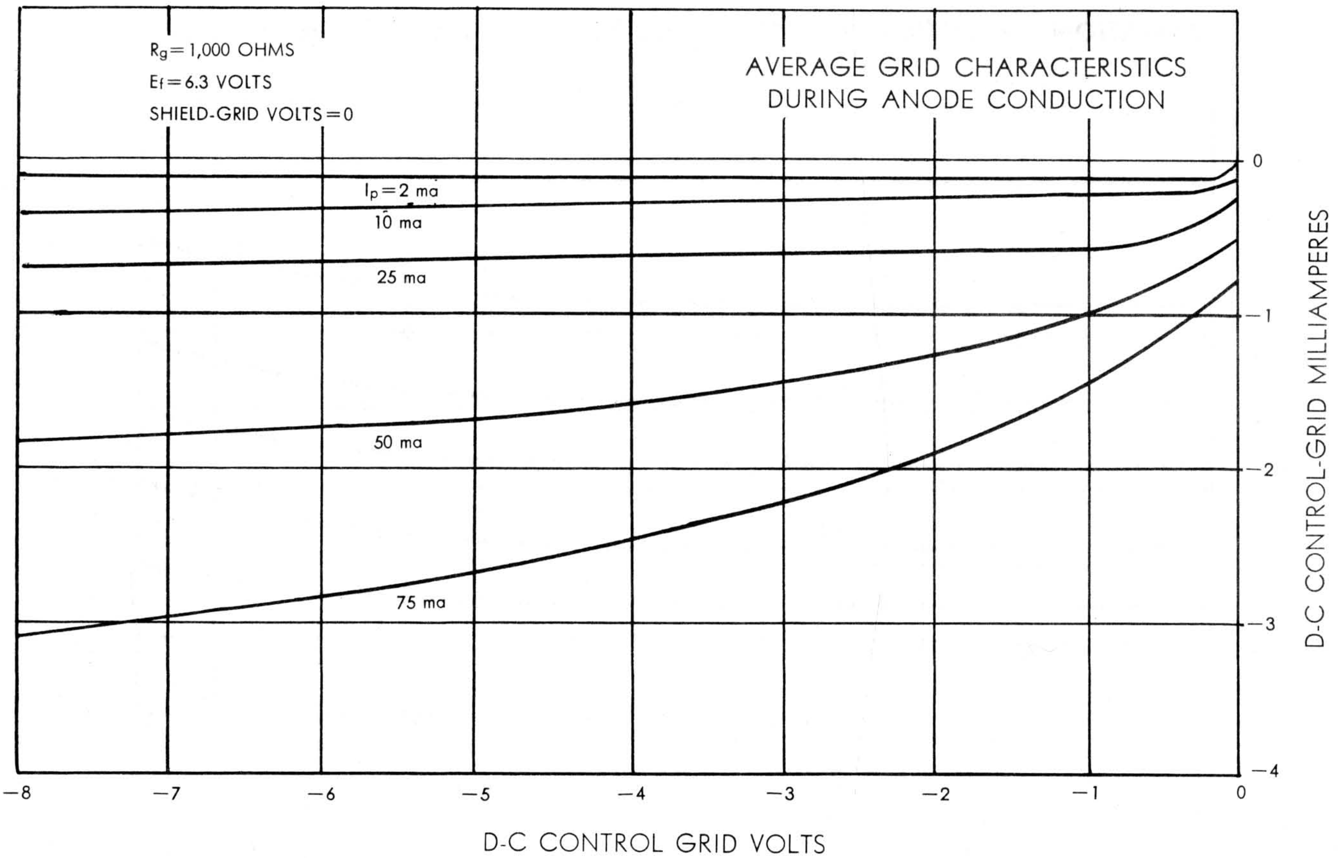
VARIATION OF CRITICAL GRID VOLTAGE WITH GRID CIRCUIT RESISTANCE



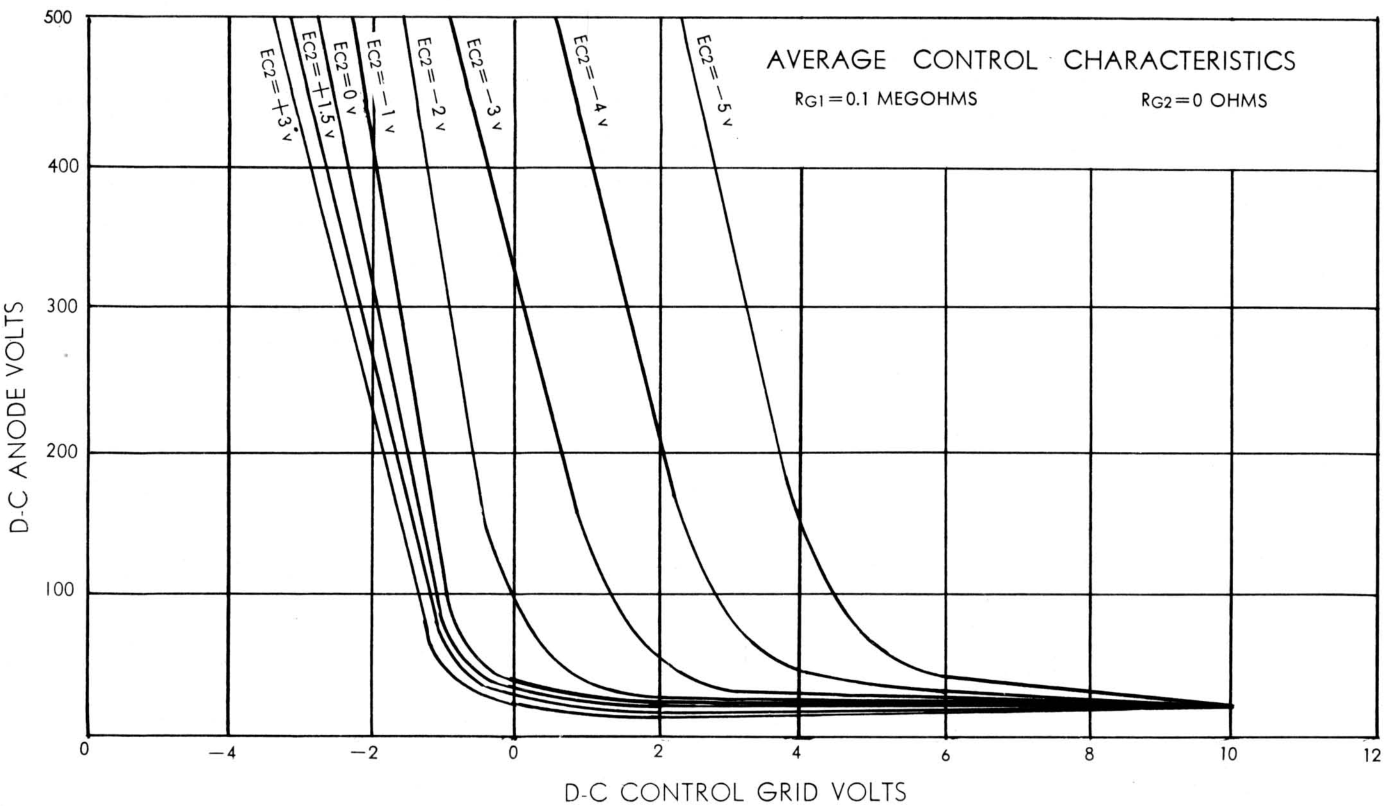
OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE

Ranges shown are for two values of grid resistor, 0.1 megohm and 10 megohm, and take into account initial differences between individual tubes and subsequent differences during tube life for a heater voltage range of 6.0 to 6.6 volts.





Rg = 1,000 OHMS
Ef = 6.3 VOLTS
SHIELD-GRID VOLTS = 0
AVERAGE GRID CHARACTERISTICS
DURING ANODE CONDUCTION
Ip = 2 ma
10 ma
25 ma
50 ma
75 ma
0
−1
−2
−3
−4
D-C CONTROL-GRID MILLIAMPERES
−8
−7
−6
−5
−4
−3
−2
−1
0
D-C CONTROL GRID VOLTS



AVERAGE CONTROL CHARACTERISTICS
RG1 = 0.1 MEGOHMS
RG2 = 0 OHMS
EC2 = +3 v
EC2 = +1.5 v
EC2 = 0 v
EC2 = −1 v
EC2 = −2 v
EC2 = −3 v
EC2 = −4 v
EC2 = −5 v
500
400
300
200
100
D-C ANODE VOLTS
0
−4
−2
0
2
4
6
8
10
12
D-C CONTROL GRID VOLTS

TUNG-SOL/CHATHAM

TYPE
5651

MINIATURE VOLTAGE REFERENCE TUBE

DESCRIPTION — The 5651 is a miniature two electrode inert-gas-filled, cold cathode, glow discharge diode for use as a voltage reference tube in electronic regulated supplies. It has an operating voltage of 86 volts over a current range of 1.5 to 3.5 milliamperes. This tube is ideally suited for applications in which sudden fluctuations must be kept below 0.1 volts over the entire range and which require very low operating voltage drift and long life.

ELECTRICAL DATA

Cathode............................Cold

MECHANICAL DATA

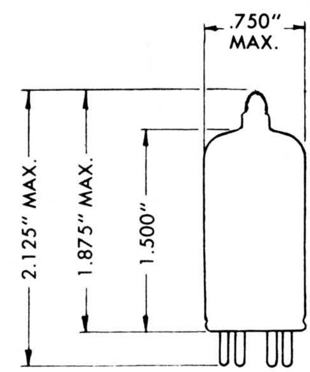
Mounting Position....................Any
Maximum Overall Length...............2⅛ inches
Maximum Seated Length................1⅞ inches
Maximum Diameter.....................¾ inch
Bulb.................................T-5½
Base.................................Small-Button Miniature 7-Pin E7-1

RATINGS, ABSOLUTE VALUES

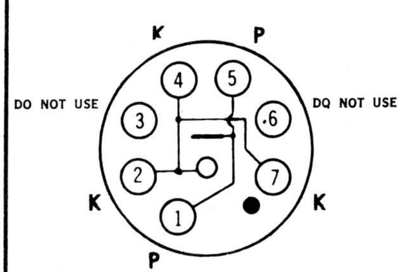
Maximum D. C. Operating Current.......3.5 ma
Minimum D. C. Operating Current.......1.5 ma
Ambient Temperature Range...........—55 to +90°C

CIRCUIT VALUES

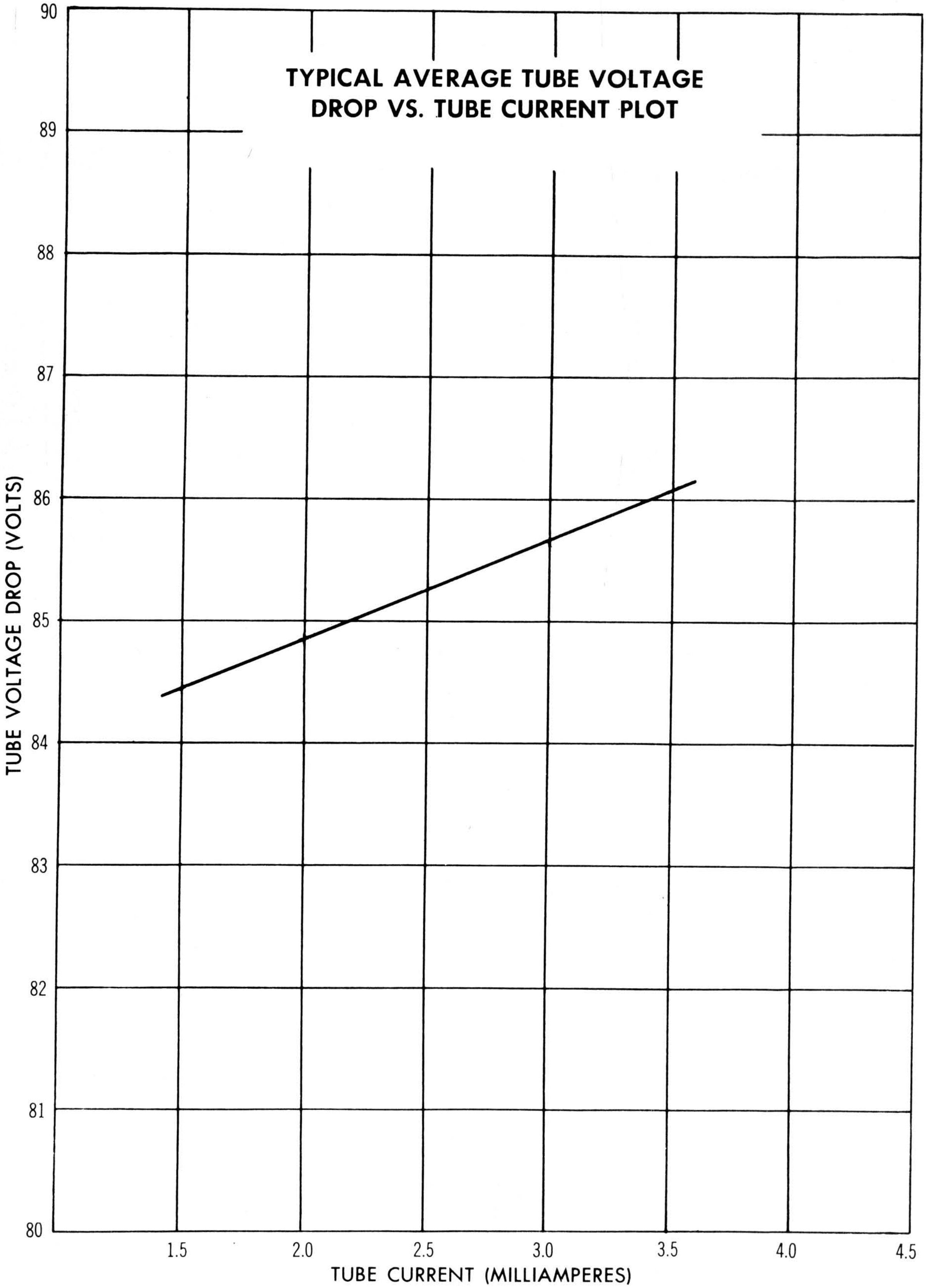
Max. Shunt Capacitor.................02 uf
Series Resistor......................See Note on Following Page



GLASS BULB



Bottom View


TYPICAL AVERAGE TUBE VOLTAGE DROP VS. TUBE CURRENT PLOT
TUBE VOLTAGE DROP (VOLTS)
90
89
88
87
86
85
84
83
82
81
80
1.5
2.0
2.5
3.0
3.5
4.0
4.5
TUBE CURRENT (MILLIAMPERES)

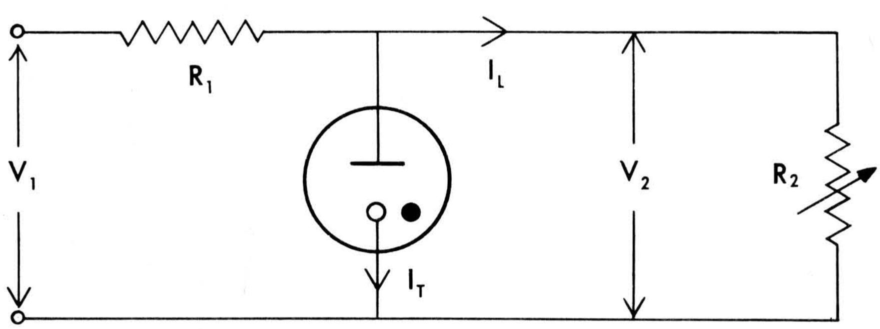
Equipment Design and Range Values

	Minimum Volts	Average Volts	Maximum Volts
D.C. Anode Supply Voltage in Darkness	160*	—	—
D.C. Anode Supply Voltage in Light	115*	—	—
Anode Breakdown Voltage	—	106	115
Tube Voltage Drop (1) at 1.5 ma	82	84.5	—
Tube Voltage Drop (2) at 3.5 ma	—	86.0	92
Regulation (1) (1.5 ma to 3.5 ma)	—	1.5	3
Voltage Jump**	—	0	0.1

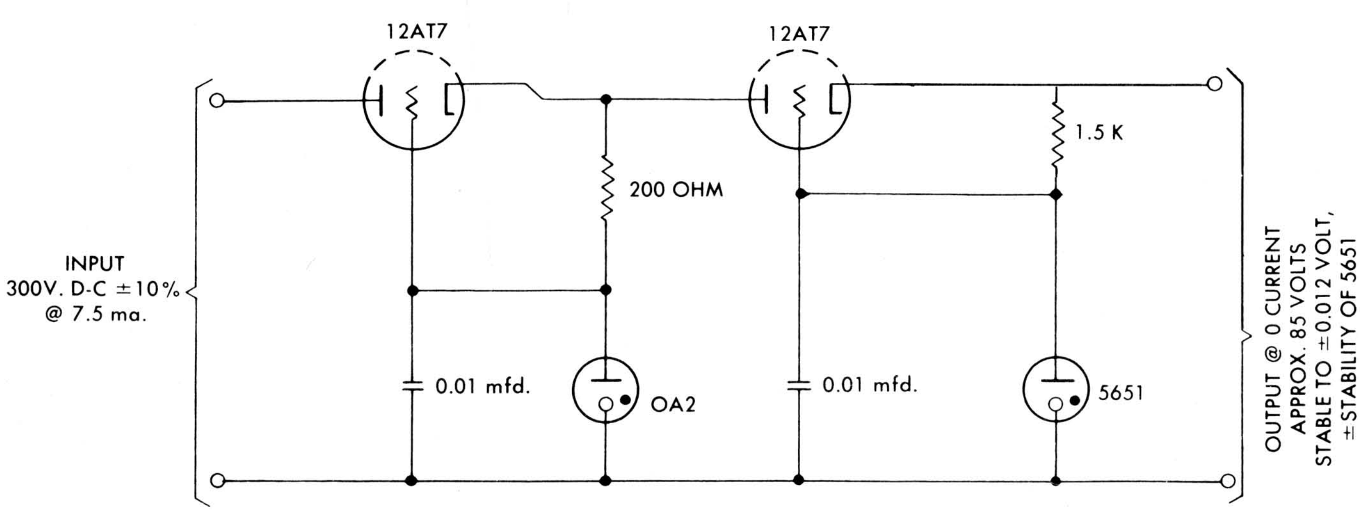
*To assure starting throughout tube life, the supply voltage should not be less than this value.
**Defined as the maximum voltage fluctuation at any current level within the operating current range.

NOTE—A series resistor must always be used with the 5651 in order to limit the current to a maximum of 3.5 ma at the highest anode supply voltage and to limit the current to a minimum of 1.5 ma at the lowest anode supply voltage.

Figure 1



TYPICAL APPLICATION CIRCUIT



Operating Notes

Special attention should be given to the bulb temperature at which the tubes are to be operated. Reliability will be seriously impaired if the maximum bulb temperature is exceeded.

The 5651 voltage reference tube has been designed to give extremely stable tube voltage drops at specific currents within the current range values. It also has been designed to eliminate sudden voltage jumps or fluctuations over its operating current range. The voltage regulation characteristic of a reference tube is not independent of the tube current. The change in tube current through the reference tube should be limited to a percentage less than the allowable percentage voltage change. Under these conditions, changes of the voltage drop across the tube will be in many cases less than 0.2 percent throughout the life of the tube.

TUNG-SOL/CHATHAM

TYPE
5651WA

Rugged, Reliable
Miniature Voltage Reference Tube

DESCRIPTION — The 5651WA is a miniature two electrode inert-gas-filled, cold cathode glow discharge diode for use as a voltage reference tube in electronic regulated supplies. It has an operating voltage of approximately 86 volts over a current range of 1.5 to 3.5 milliamperes. This tube is ideally suited for applications in which sudden fluctuations must be kept below 5 millivolts over the entire range and which require very low operating voltage drift and long life. The 5651WA features high shock and vibration ratings and will "strike" at low voltages in the absence of light.

Electrical Data

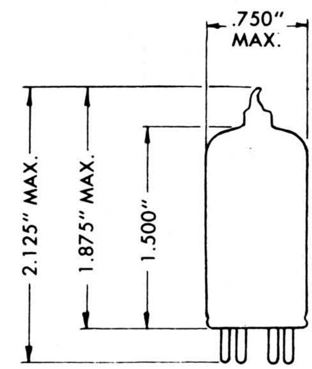
Cathode	Cold

Mechanical Data

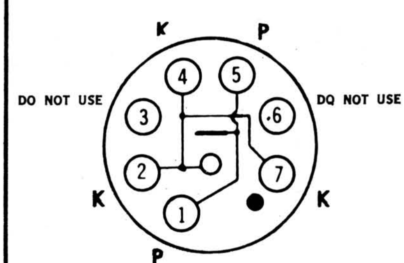
Mounting Position	Any
Maximum Overall Length	2⅛ inches
Maximum Seated Length	1⅞ inches
Maximum Diameter	¾ inch
Bulb	T-5½
Base	Small-Button Miniature 7-Pin E7-1
Net Weight (Approx.)	0.3 Ounces
Maximum Shock Rating	450 G/1 ms
Maximum Vibration Rating (D = .08″ @ 50 cps)	10 G

Ratings, Absolute Values

Maximum D.C. Operating Current	3.5 ma
Minimum D.C. Operating Current	1.5 ma
Ambient Temperature Range	−55 to + 150°C
Altitude	60,000 Ft.



GLASS BULB



Bottom View

Additional Tests to Insure Reliability

Randomly Selected Samples are Subjected to the Following Tests.

Shock: 30° Hammer angle in Navy, Flyweight, High Impact Machine (450 G/msec).

Fatigue: 25 cps, 0.08" Total displacement, for 32 hours in each of three mutually perpendicular planes (2.5G).

Post Shock and Fatigue Limits: Ionization Voltage .... 115 v.d.c. max.
Regulation (1.5 to 3.5 mA) .... 82 to 90 v.d.c.
Tube Voltage Drop (1.5 and 3.5 mA) .... 3.0 v.d.c. max.

Stability Life Test (1 hour): End Point: change in Tube Voltage Drop from Initial Value @ I_b = 2.5 mAdc .... 200 mVdc max.

Survival Rate Life Test (100 hours):
End Point: change in Tube Voltage Drop from Initial Value @ I_b = 2.5 mAdc .... 500 mVdc max.

Intermittent Life Test: End points (500 hours):
Change in Tube Voltage Drop from Initial Value @ I_b = 2.5 mAdc .... 1.5 v.d.c. max.
Tube Voltage Drop .... 82-90 v.d.c.
Regulation .... 3.0 v.d.c. max.
Ionization Voltage .... 115 v.d.c. max.

End Points (1000 hours):
Tube Voltage Drop .... 82-90 v.d.c.
Regulation .... 3.2 v.d.c. max.
Ionization Voltage .... 115 v.d.c. max.

Equipment Design and Range Values

	Min.	Average	Max.	
D.C. Anode Supply Voltage in Darkness	115*	—	—	Volts
D.C. Anode Supply Voltage in Light	115*	—	—	Volts
Anode Breakdown Voltage	—	106	115	Volts
Tube Voltage Drop (1) at 1.5 ma	82	84.5	—	Volts
Tube Voltage Drop (2) at 3.5 ma	—	86.0	88	Volts
Regulation	—	0.8	1.0	Volts/Milliamp.
Voltage Jump**	—	0	5.0	Millivolts
Voltage Repeatability***	—	0.01	0.1	Volts
Oscillation (Aural check)	—	—	—	
Noise	—	0	5.0	Millivolts
Leakage Current (E_b = 50v, Rp = 3000Ω)	—	0	5.0	Microamps
Generated Plate Voltage (when vibrated at 40 cps, 15 G, Rp = 10,000Ω, I_b = 2.5 mAdc)	—	—	5.0	Millivolts
Maximum Shunt Capacitor	—	—	0.02	Microfarads
Series Resistor	****	—	—	
Maximum Current through Interconnected leads	—	—	1.0	Ampere

* To assure starting throughout tube life, the supply voltage should not be less than this value.

** Defined as the maximum voltage fluctuation at any current level within the operating current range.

*** Tube is cycled one minute on and one minute off for five cycles @ Ib = 2.5 mAdc. Readings are taken initially and at the end of each "on" period.

**** Sufficient series resistance must be used to limit the current to a maximum of 3.5 ma at the highest anode supply voltage and to limit the current to a minimum of 1.5 ma at the lowest anode supply voltage.

Application Notes

Voltage reference tubes are often confused with voltage regulator tubes. While a reference tube is a regulator tube, it is a special form of regulator in which current range and regulation is sacrificed to provide voltage repeatability and temperature stability and to minimize voltage jump and long term drift.

The voltage regulation characteristic of a reference tube is not independent of the tube current. Therefore the 5651WA should be run from a constant current source such as a VR tube, a pentode, or a simple series regulator. Practical circuits are given in Figures 1, 2 and 3.

If so desired, "input and output" connections to either the anode or cathode can be made to different internally connected pins, so that the circuit will be broken upon the removal of the tube from its socket. Unused pins should not be used for circuit tie points as voltage on these pins may cause erratic behavior of the 5651WA or even form unwanted circuit connections through gas breakdown. The tube should be shielded if it is to be used in strong RF or magnetic fields.

Many circuits utilizing the 5651WA or its prototype, the 5651, are to be found in the ***Handbook, PREFERRED CIRCUITS, Navy Aeronautical Electronic Equipment (NAVAER 16-1-519).*** This is available from the Superintendent of Documents, US Govt. Printing Office, Washington 25, D. C. at $1.75.

Figure 1

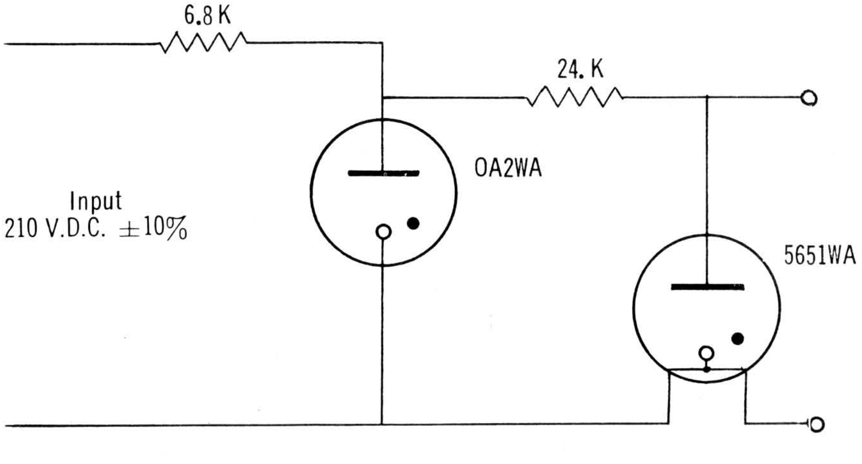


Figure 2

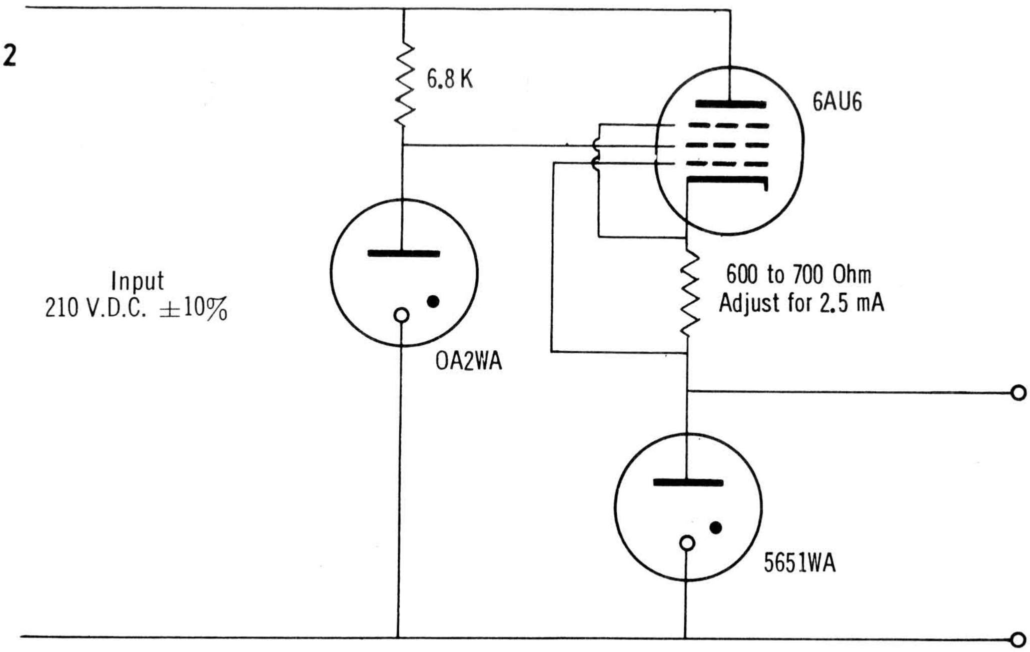


Figure 3

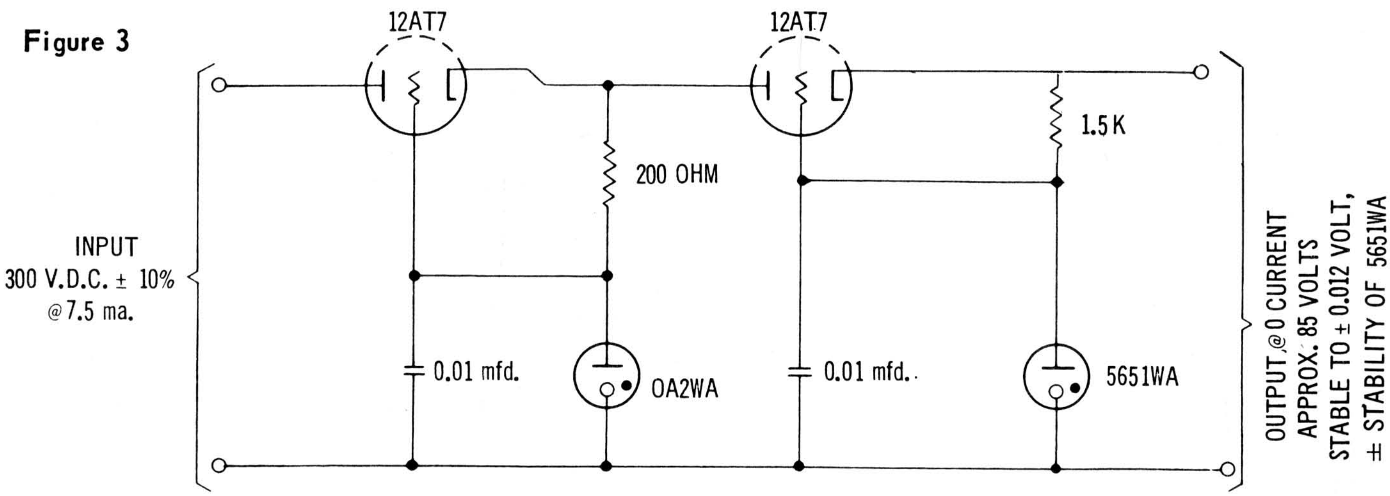
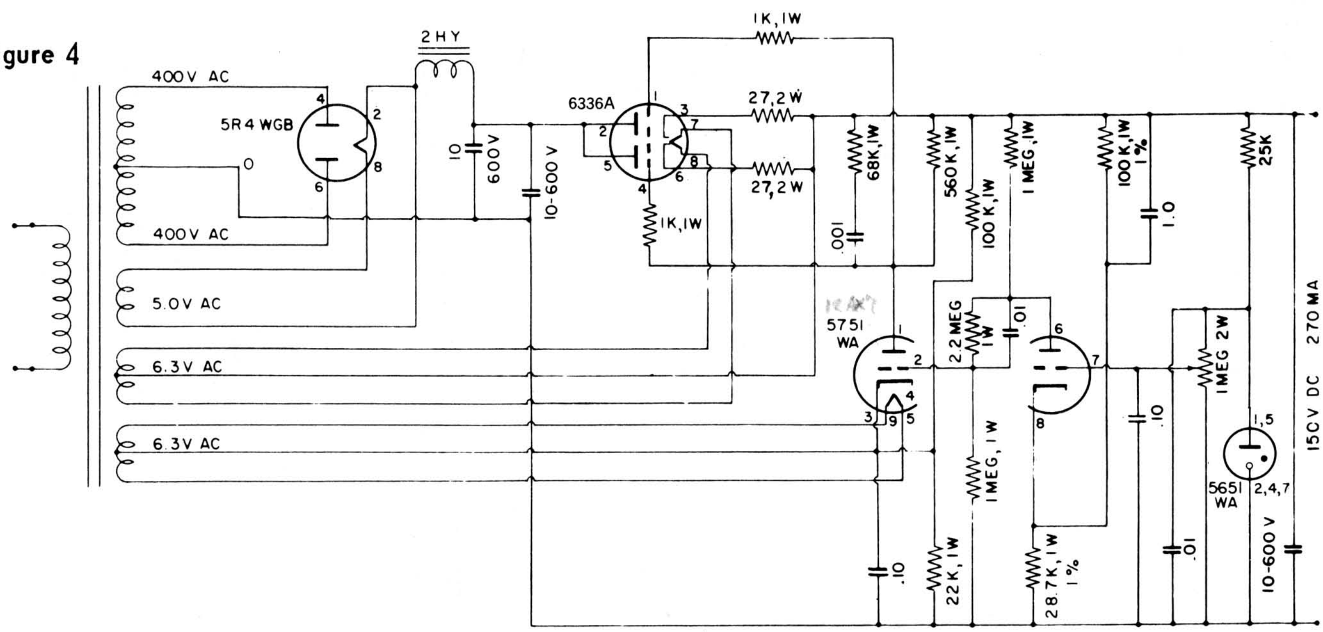
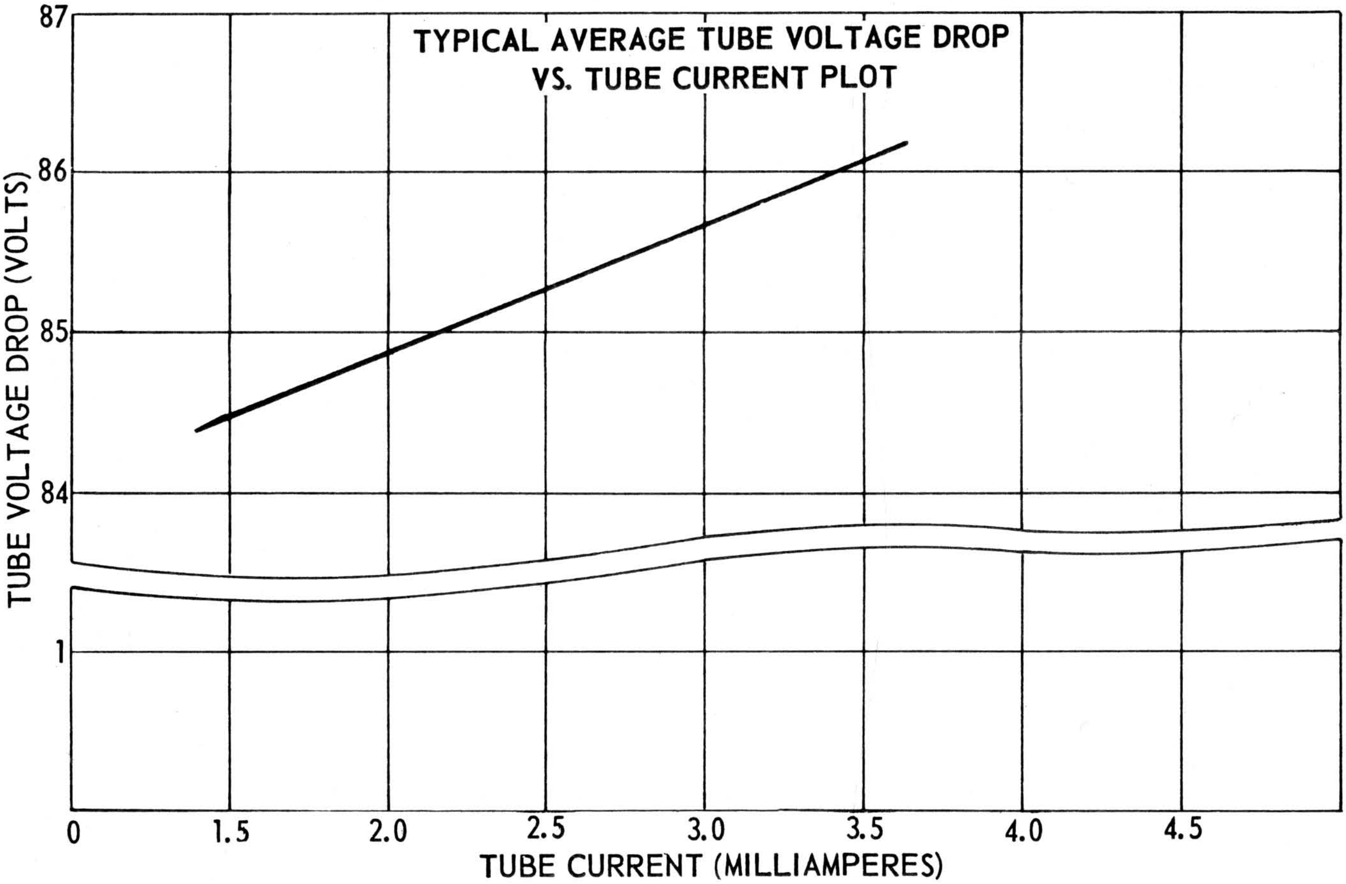
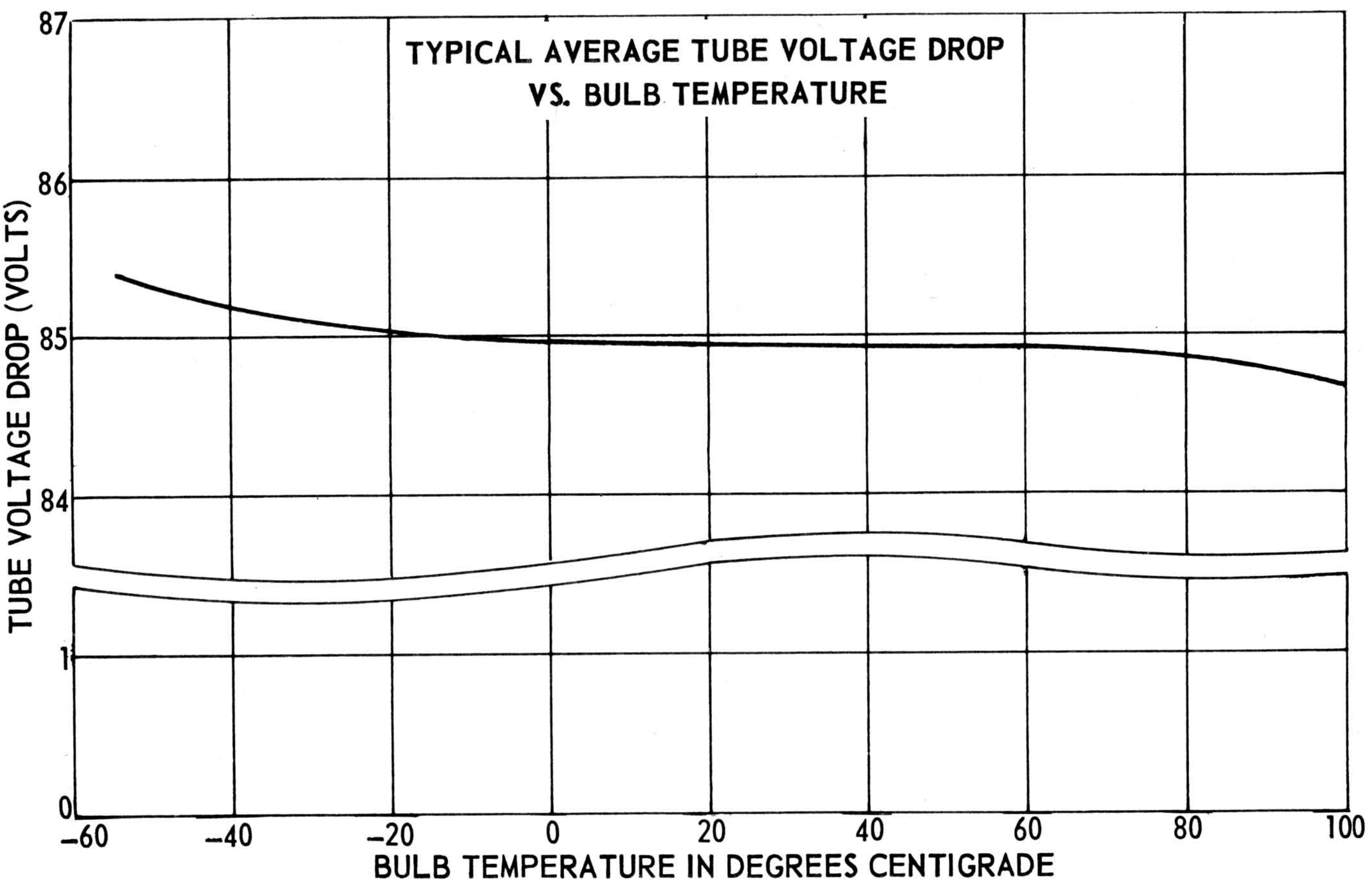


Figure 4




TYPICAL AVERAGE TUBE VOLTAGE DROP
VS. TUBE CURRENT PLOT
TUBE VOLTAGE DROP (VOLTS)
87
86
85
84
1
0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
TUBE CURRENT (MILLIAMPERES)


TYPICAL AVERAGE TUBE VOLTAGE DROP
VS. BULB TEMPERATURE
TUBE VOLTAGE DROP (VOLTS)
87
86
85
84
1
0
−60
−40
−20
0
20
40
60
80
100
BULB TEMPERATURE IN DEGREES CENTIGRADE

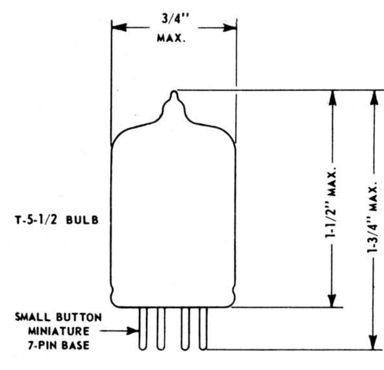
TUNG-SOL/CHATHAM

TYPE 5696

DESCRIPTION — The 5696 is a xenon filled, four electrode thyratron with negative control characteristics. It has found wide usage as a switching tube, and in grid controlled rectifier service. Because of its shield grid construction, the input of the 5696 will work directly from a high impedance source such as a phototube. The effective anode to control grid capacity may be reduced by connecting pins No. 5 and 7 to No. 2 and connecting the grid resistor directly to the socket terminal. The small size and light weight of the 5696 and its relative freedom from temperature restrictions make this tube particularly suited for use in compact equipment.

Electrical Data

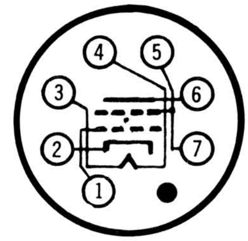
Heater Voltage	6.3 ±10% Volts
Heater Current (E_f = 6.3 volts)	150. Milliamperes
Minimum Cathode Heating Time	10. Seconds
Anode to Control Grid Capacitance	0.03 Micro-microfarads
Control Grid to Cathode (and shield grid) Capacitance	1.8 Micro-microfarads
De-ionization Time, approx. (shield tied to cathode)	
With Grid Volts = −100, Grid Res. = 1000 Ω Anode Volts = 500 Anode Cur. .025 Amps	25 Microseconds
With Grid Volts = −15 Grid Res. = 1000 Ω Anode Volts = 500 Anode Cur. .025 Amps	40 Microseconds
Ionization Time, approx.	0.5 Microseconds
Anode Voltage Drop, approx.	10 Volts
Maximum Critical Grid Current (At E_{bb} = 350 V RMS)	0.5 Microamperes



GLASS BULB

Mechanical Data

Mounting Position	Any
Maximum Overall Length	1.75″
Maximum Seated Length	1.50″
Maximum Diameter	0.75″
Bulb	T-5½
Base	Miniature Button 7-Pin
Weight (net)	0.3 Ounces



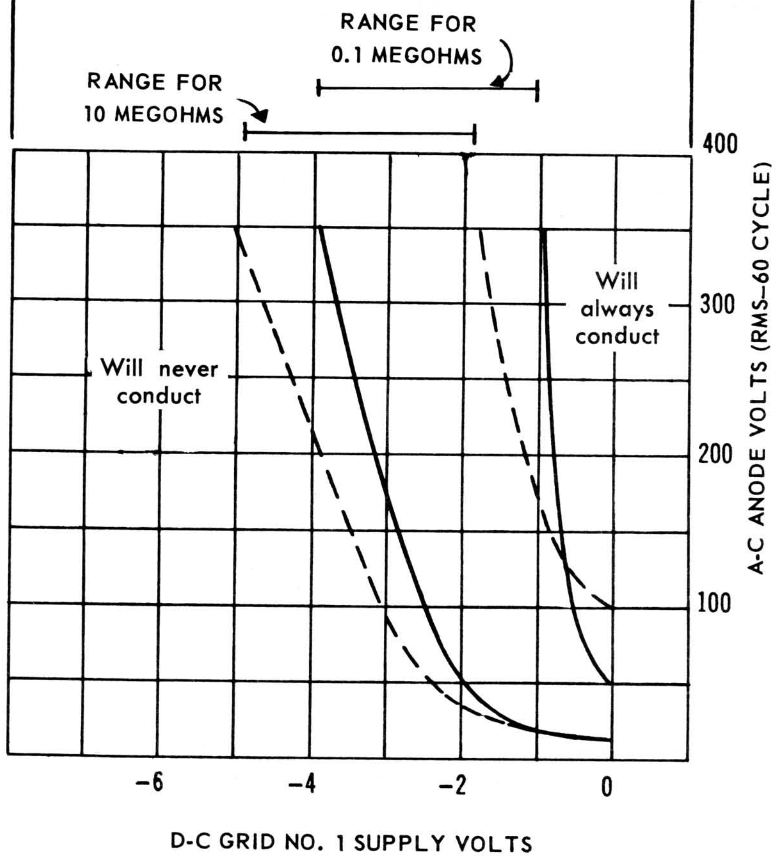
Bottom View

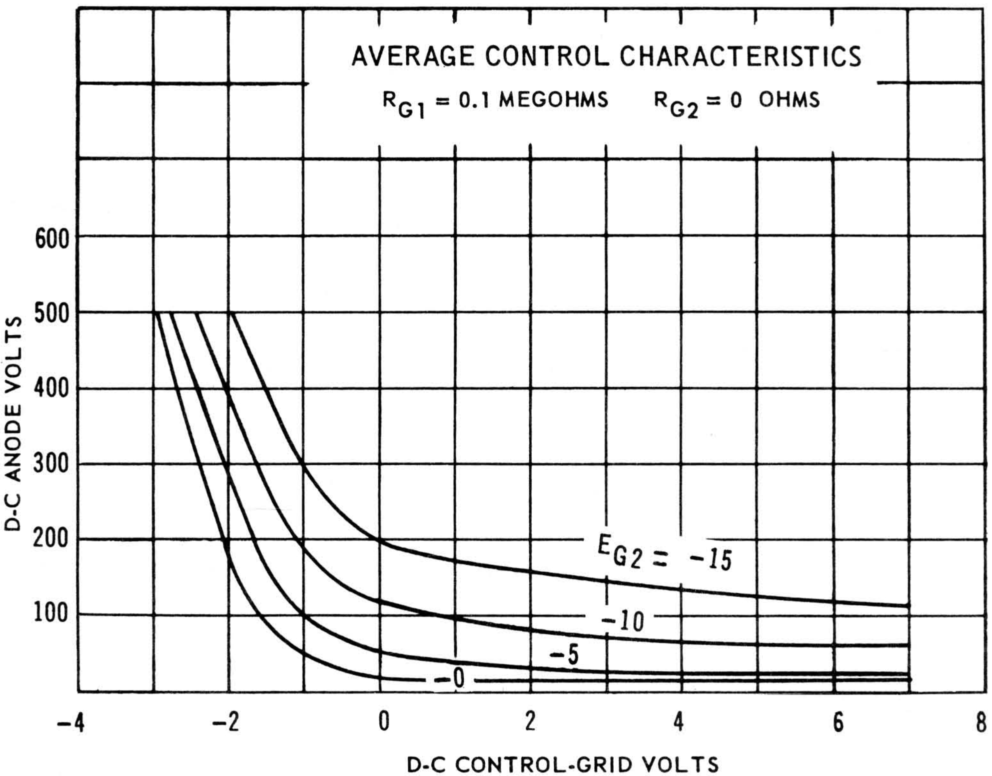
Ratings, Absolute Values

Maximum Peak Anode Voltage	
Inverse	500 Volts
Forward	500 Volts
Maximum Cathode Current	
Peak	100 MA
Average	25 MA
Surge (max. duration 0.1 Seconds)	2.0 Amp
Maximum Average Time	30 Seconds
Maximum Negative Control Grid Voltage	
Before Conduction	—100 Volts
During Conduction	—10 Volts
Maximum Positive Control Grid Current	
Average (Averaged over 30 sec. max.)	5 MA
Maximum Negative Shield Grid Voltage	
Before Conduction	—50 Volts
During Conduction	—10 Volts
Maximum Positive Shield Grid Current	
Average (Averaged over 30 sec. max.)	5 MA
Maximum Heater Cathode Voltage	
Heater Negative	—100 Volts
Heater Positive	25 Volts
Ambient Temperature Limits	—75 to 90° Centigrade
Maximum Control Grid (G1) Circuit Resistance	10 Megohms

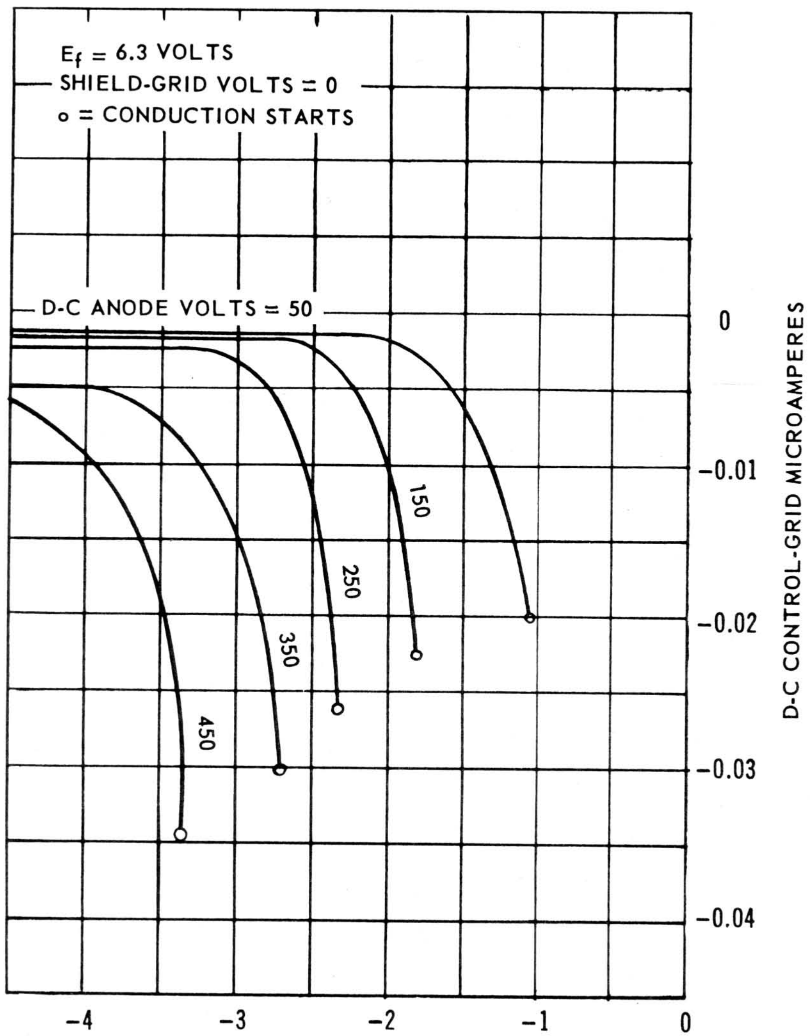
OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE

Ranges shown are for two values of grid resistor, 0.1 megohm and 10 megohm, and take into account initial differences between individual tubes and subsequent differences during tube life for a heater voltage range of 5.7 to 6.9 volts.

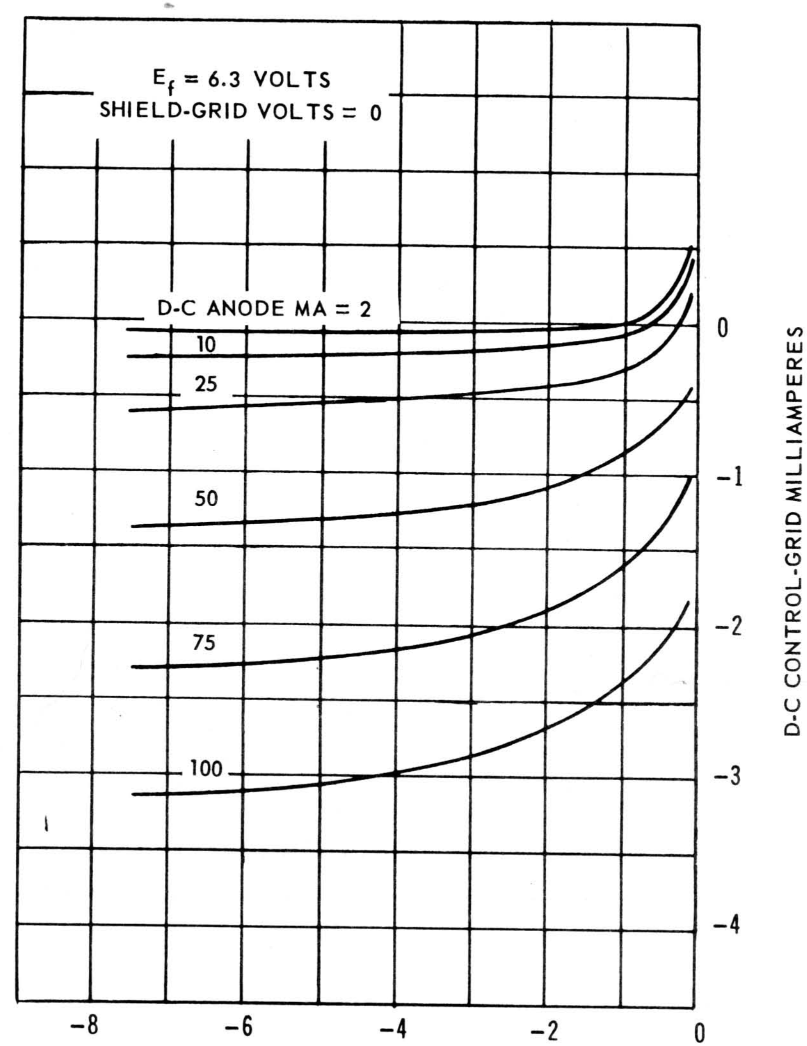




AVERAGE GRID CHARACTERISTICS BEFORE ANODE CONDUCTION



AVERAGE GRID CHARACTERISTICS DURING ANODE CONDUCTION



TUNG-SOL/CHATHAM

RUGGED, RELIABLE SUB-MINIATURE VOLTAGE REFERENCE TUBE

TYPE 5783WA

DESCRIPTION — The 5783WA is a sub-miniature two electrode inert-gas-filled, cold cathode glow discharge diode for use as a voltage reference tube in electronic regulated supplies. It has an operating voltage of approximately 86 volts over a current range of 1.5 to 3.5 milliamperes. This tube is ideally suited for applications in which sudden fluctuations must be kept below 5 millivolts over the entire range and which require very low operating voltage drift and long life.

The 5783WA features high shock and vibration ratings. It is particularly suitable for applications requiring small size and light weight components.

ELECTRICAL DATA

Cathode....................................Cold

MECHANICAL DATA

Mounting Position...........................Any

Maximum Overall Length excluding leads......1½ inches

Maximum Diameter.........................0.40 inches

Bulb.......................................T-3

Base......................................Subminiature Flat Press with three Flying Leads

Net Weight (Approx.).......................0.1 Ounces

Maximum Shock Rating.....................450 G/1 ms

Maximum Vibration Rating D=.08″ @ 50 cps...10 G

RATINGS, ABSOLUTE VALUES

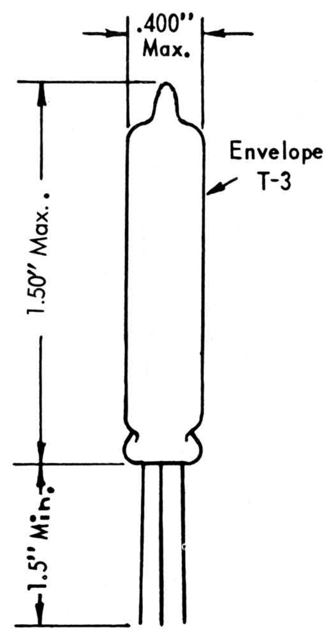
Maximum D.C. Operating Current.............3.5 ma

Minimum D.C. Operating Current.............1.5 ma

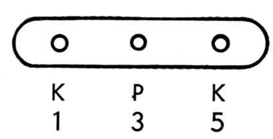
Maximum Inverse Voltage...................—50. v.

Ambient Temperature Range.................—55 to +155°C

Altitude...................................60,000 Ft.



PIN CONNECTIONS
(Bottom View)



0.016" TINNED FLEXIBLE LEADS
0.1" CENTER TO CENTER

Additional Tests to Insure Reliability

Randomly Selected Samples are Subjected to the Following Tests.

Shock: 30° Hammer angle in Navy, Flyweight, High Impact Machine (450 G/msec).

Fatigue: 25 cps, 0.08″ Total displacement, for 32 hours in each of three mutually perpendicular planes (2.5 G).

Post Shock and Fatigue Limits:
- Ionization Voltage.......120 v.d.c. max.
- Tube Voltage Drop (1.5 and 3.5 mA).......81 to 91 v.d.c.
- Regulation (1.5 to 3.5 mA).......4.0 v.d.c. max.
- Generated Plate Voltage.......100 m.V.a.c. max.

Stability Life Test (1 hour):
- End Point: Change in Tube Voltage Drop from Initial Value @ Ib = 2.5 mAdc.......200 mVdc max.

Survival Rate Life Test (100 hours):
- End Point: Change in Tube Voltage Drop from Initial Value @ Ib = 2.5 mAdc.......1.0 Vdc max.

Intermittent Life Test: End Points (500 hours):
- Change in Tube Voltage Drop from Initial Value.......4.0 v.d.c. max.
- Tube Voltage Drop.......81 to 91 v.d.c.
- Regulation.......4.0 v.d.c. max.
- Ionization Voltage.......120 v.d.c. max.

Equipment Design and Range Values

	Min.	Average	Max.	
D.C. Anode Supply Voltage in Darkness	140*	—	—	volts
D.C. Anode Supply Voltage in Light	120*	—	—	volts
Anode Breakdown Voltage	—	106	120	volts
Tube Voltage Drop (1) at 1.5 ma	81	84.5	—	volts
Tube Voltage Drop (2) at 3.5 ma	—	86.0	91	volts
Regulation	—	0.8	2.0	volts/milliamp.
Voltage Jump**	—	0	5.0	millivolts
Voltage Repeatability***	—	0.01	0.1	volts
Oscillation (Aural check)	—	—	—	
Noise	—	0	20	millivolts
Leakage Current (Eb = 50v, Rp = 3000Ω)	—	0	20	microamps
Generated Plate Voltage (when vibrated at 40 cps, 15 G, Rp = 10,000Ω, Ib = 2.5 mAdc)	—	—	50	millivolts
Maximum Shunt Capacitor	—	—	0.02	microfarads
Series Resistor	****	—	—	
Maximum Current through Interconnected leads	—	—	0.2	ampere

* To assure starting throughout tube life, the supply voltage should not be less than this value.

** The maximum voltage fluctuation at any current level within the current operating current range.

*** Tube is cycled one minute on and one minute off for five cycles at Ib = 2.5 mAdc. Readings are taken initially and at the end of each "on" period.

**** Sufficient series resistance must be used to limit the current to a maximum of 3.5 ma at the highest anode supply voltage and to limit the current to a minimum of 1.5 ma at the lowest anode supply voltage.

Application Notes

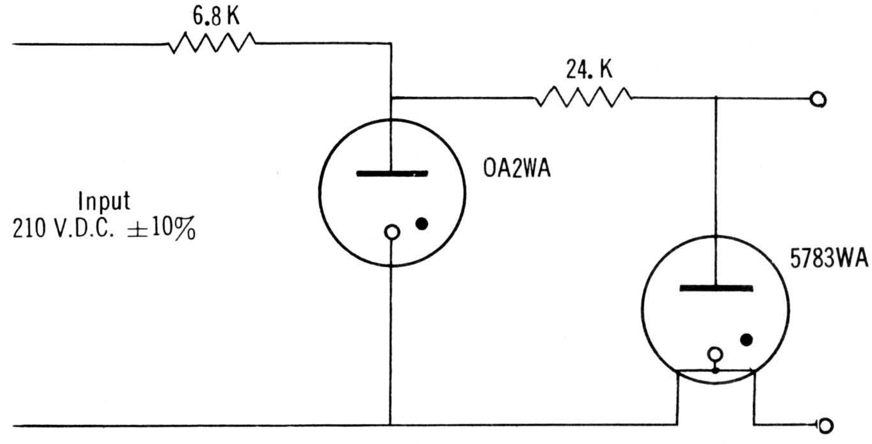
Voltage reference tubes are often confused with voltage regulator tubes. While a reference tube is a regulator tube, it is a special form of regulator in which current range and regulation are sacrificed to provide voltage repeatability and temperature stability, and to minimize voltage jump and long term drift.

The voltage regulation characteristic of a reference tube is not independent of the tube current. Therefore the 5783WA should be run from a constant current source such as a VR tube, a pentode, or a simple series regulator. Practical circuits are given in Figures 1, 2 and 3.

If so desired, "input and output" connections to the cathode can be made to different internally connected leads, so that the circuit will be broken upon the removal of the tube from its socket. The tube should be shielded if it is to be used in strong RF or magnetic fields.

The principal use of the 5783WA is to supply a reference voltage in an electronically regulated power supply. This use is illustrated in Figure 4. The 5783WA may also be substituted for the miniature type 5651WA in many circuits found in the ***Handbook, PREFERRED CIRCUITS, Navy Aeronautical Electronic Equipment (NAVAER 16-1-519).*** This is available from the Superintendent of Documents, US Govt. Printing Office, Washington 25, D. C. at $1.75.

Figure 1



TUNG-SOL / CHATHAM

Figure 2

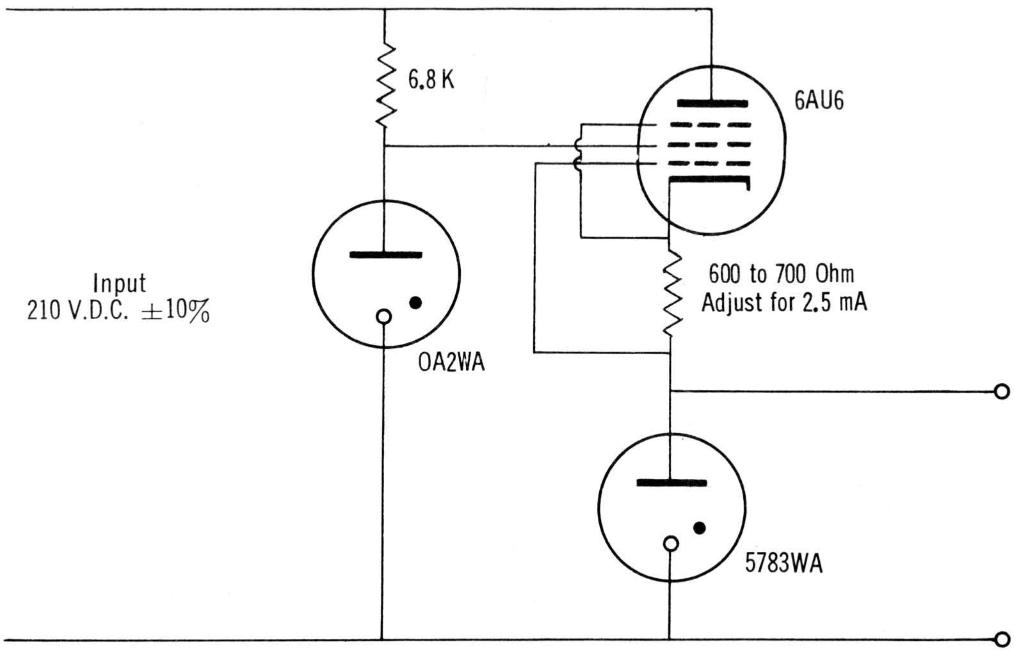


Figure 3

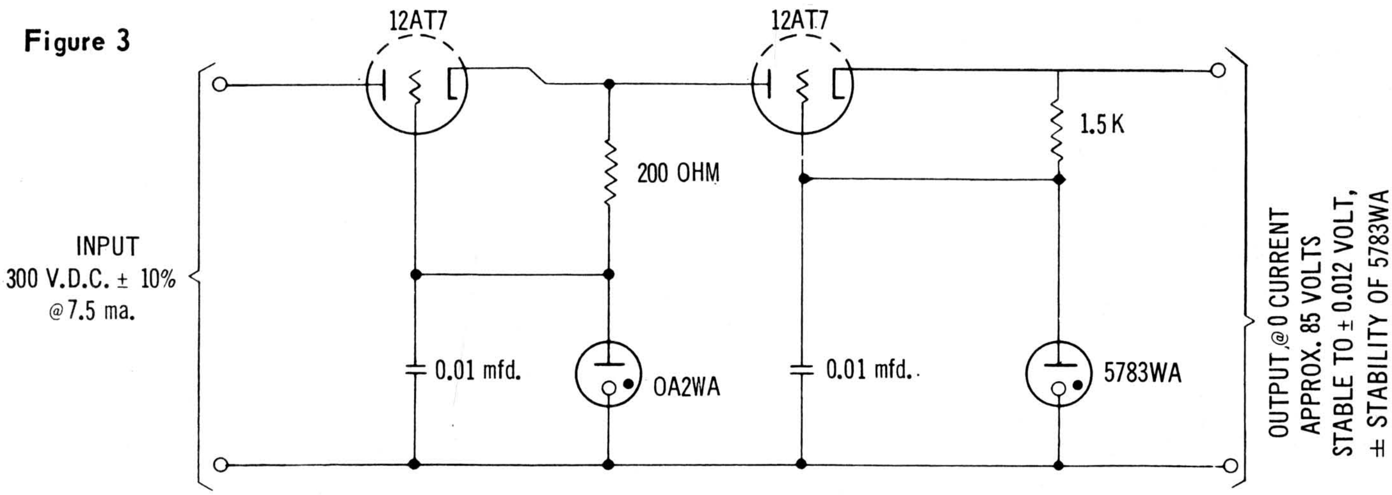
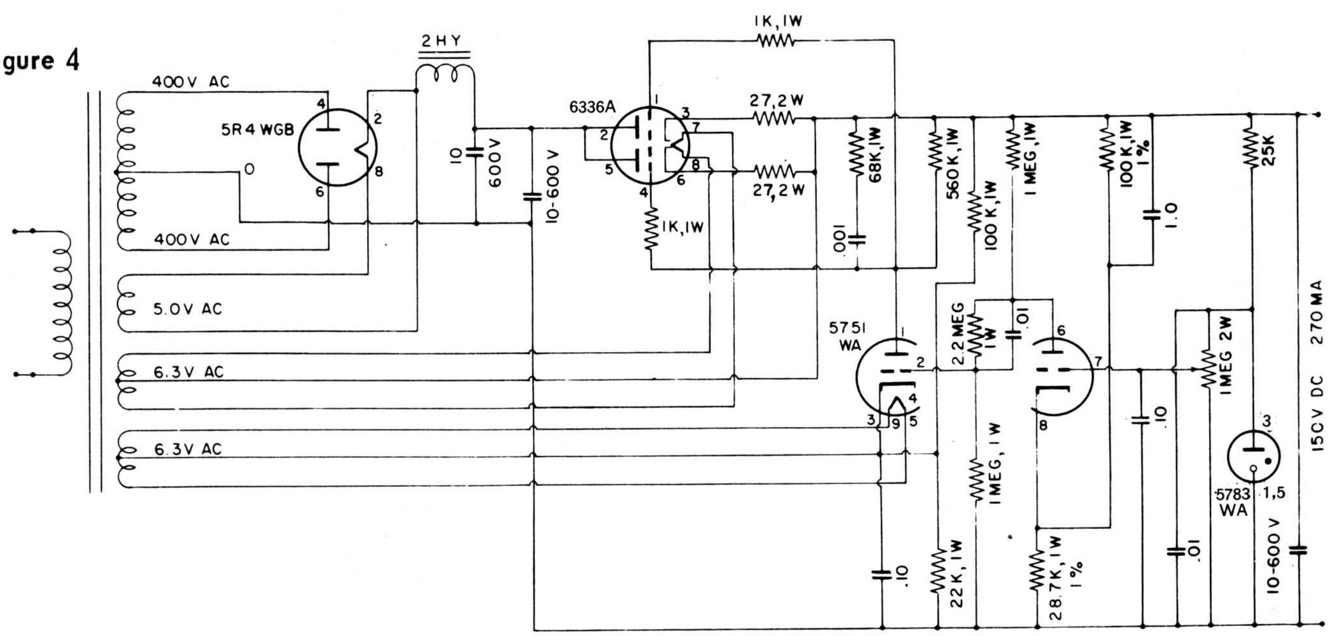
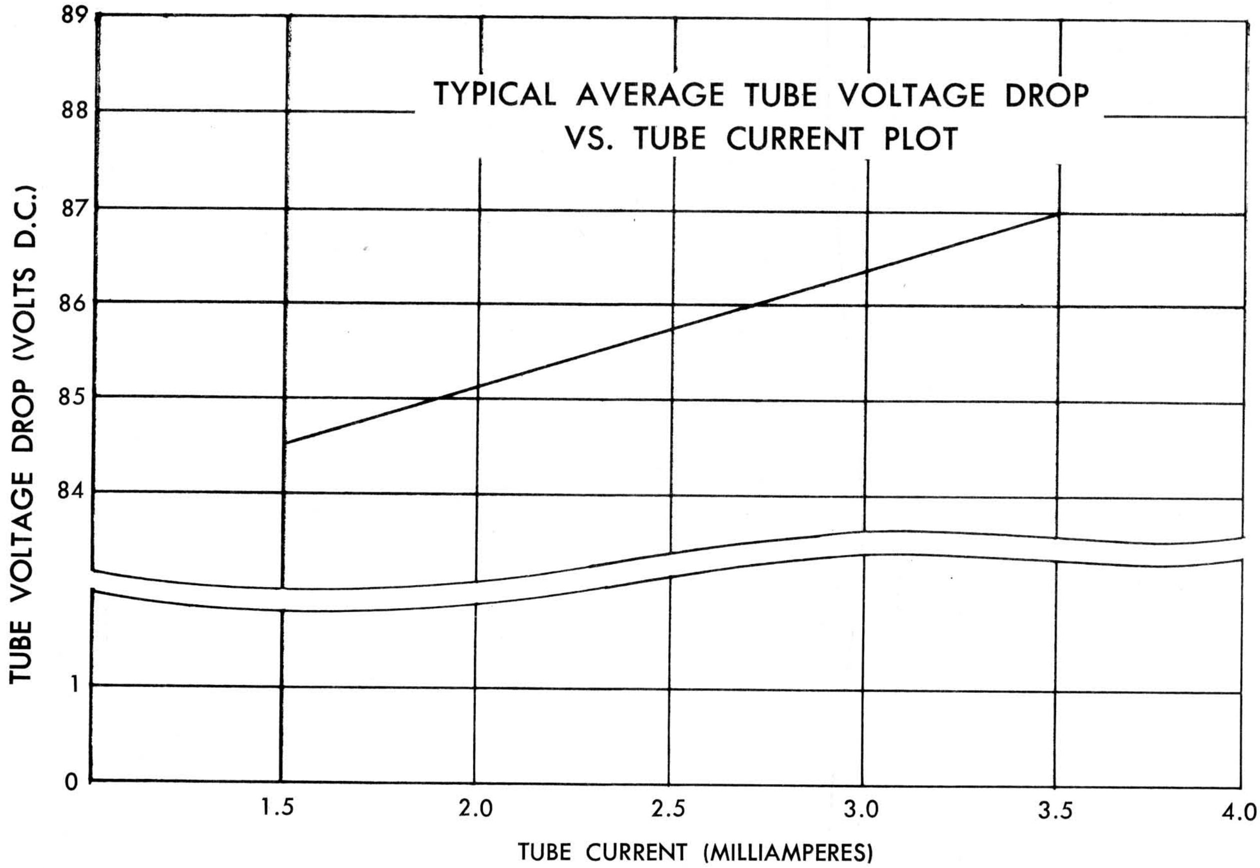
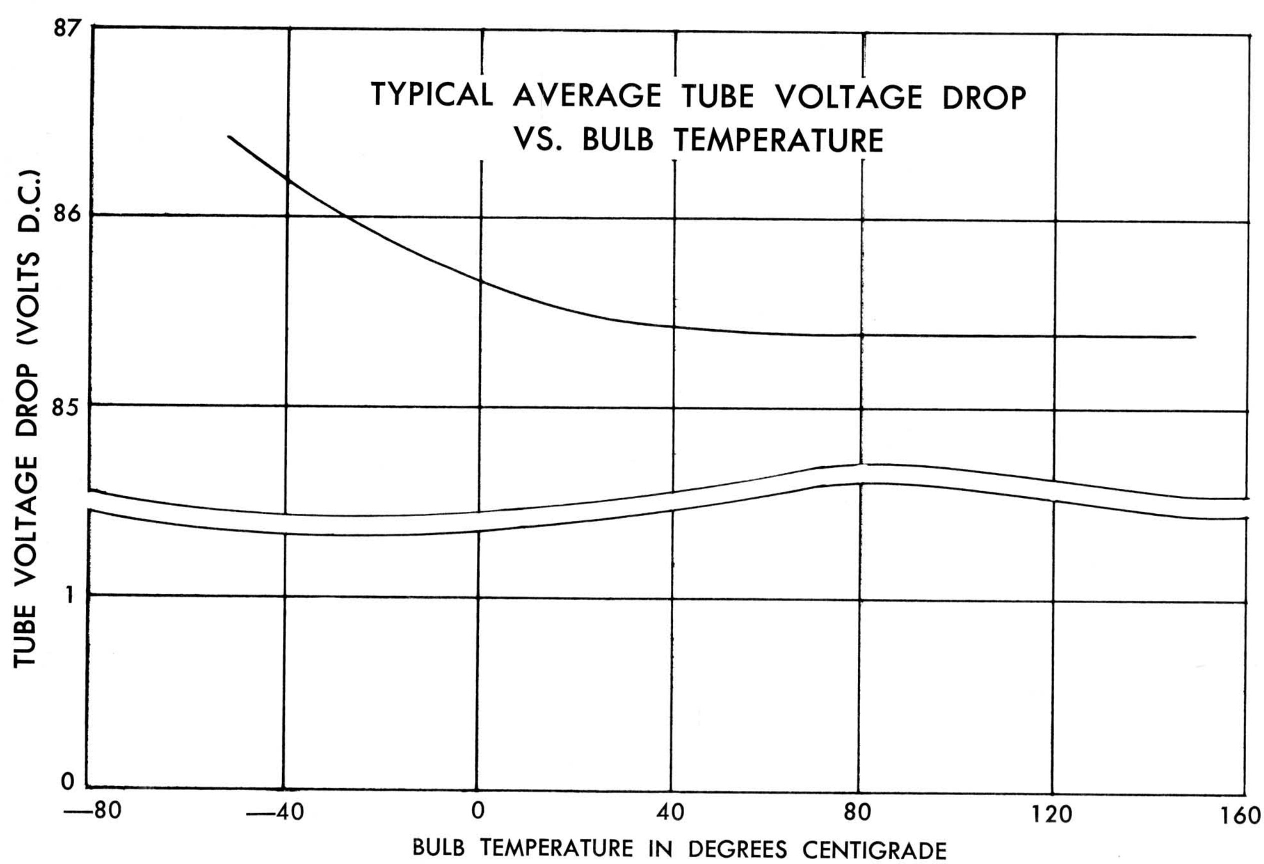


Figure 4




TYPICAL AVERAGE TUBE VOLTAGE DROP
VS. TUBE CURRENT PLOT
TUBE VOLTAGE DROP (VOLTS D.C.)
89
88
87
86
85
84
1
0
1.5
2.0
2.5
3.0
3.5
4.0
TUBE CURRENT (MILLIAMPERES)


TYPICAL AVERAGE TUBE VOLTAGE DROP
VS. BULB TEMPERATURE
TUBE VOLTAGE DROP (VOLTS D.C.)
87
86
85
1
0
—80
—40
0
40
80
120
160
BULB TEMPERATURE IN DEGREES CENTIGRADE

TUNG-SOL/CHATHAM

HIGH POWER HYDROGEN THYRATRON

TYPE 5948

DESCRIPTION — The 5948 is a three electrode, hydrogen filled, zero bias thyratron designed for the generation of high power pulses. The primary application of the tube is in high power, high voltage radar modulators. The 5948 is capable of supplying 12 megawatt pulses in this service. An internal hydrogen reservoir promotes long life and permits optimum pressure adjustment for various conditions of operation. The cathode is unipotential and is connected to the electrical center of the cathode heater circuit in order to minimize time jitter.

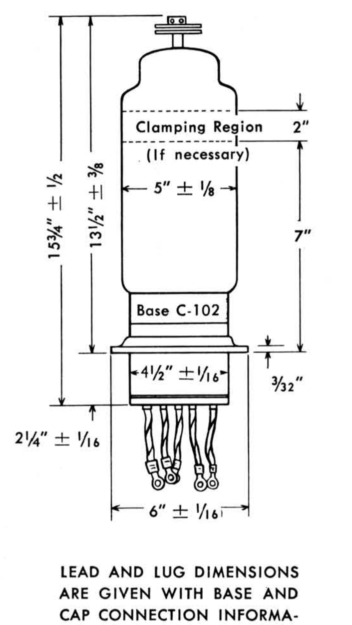
Firm electrical connections are made to the cathode, cathode heaters, grid and reservoir by means of flexible cables fitted with lugs. The tube is rigidly supported by a base with a flange containing bolt holes.

ELECTRICAL DATA

	Symbol	Min.	Bogey	Max.
Heater Voltage	Ef	5.83	6.3	6.77 Volts
Heater Current	If	25	29	33 Amperes
(With bogie heater and reservoir voltage)				
Cathode Heating Time	tk	15		Minutes
Reservoir Voltage (See application notes)	Eres	2.5	Marked on base	5.5 Volts
Reservoir Current	Ires			11.0 Amperes
Reservoir Heating Time	tres	15		Minutes
Anode Voltage Drop	etd	100	200	400 Volts

MECHANICAL DATA

Type of Cooling	Convection
(Forced air cooling across the radiator is recommended for maximum tube life)	
Mounting Position	Vertical, base down
Maximum Net Weight	4 lbs., 10 oz.
Dimensions: See outline drawing.	



LEAD AND LUG DIMENSIONS ARE GIVEN WITH BASE AND CAP CONNECTION INFORMATION ON PAGE 4

RATINGS, ABSOLUTE VALUES

	Symbol	Min.	Max.
Peak Anode Voltage			
Inverse (Note 1)	epx	5% epy	25 Kilovolts
Forward (See Application Notes for starting procedure)	epy	10	25 Kilovolts
Cathode Current			
Peak	ib		1000 Amperes
Average	Ib		1 Ampere
RMS (For square pulse applications $I_p = \sqrt{Ib \times ib}$)	I_p		33 Amperes
D.C. Anode Voltage	Ebb	5.0 Kilovolts	
Operating Frequency	prr		1500 cps
(This is not necessarily the upper operating frequency limit of the 5948 but represents the highest repetition rate extensively life tested to date.)			
Peak Grid Voltage (Note 2)	egy	700 Volts	1800 Volts
Peak Inverse Grid Voltage	egx		650 Volts
Time of Rise of Grid Pulse (Note 5)	tr		0.35 μ sec.
Grid Pulse Width at 70.7% Point		2.0 μ sec.	
Heating Factor (epy x ib x prr. See page 4)	Pb		9×10^9
Current Rate of Rise (Note 5)			5,000 amp/μ sec.
Anode Delay Time (Note 3)	tad		1.0 μ sec.
Time Jitter (Note 4)	tj		0.01 μ sec.
Ambient Temperature	TA	−55°C	+75°C

Note 1: In pulsed operation, the peak inverse voltage, exclusive of a spike of 0.05 μ sec. maximum duration, shall not exceed 5.0 kilovolts during the first 25 μ sec. following the anode pulse.

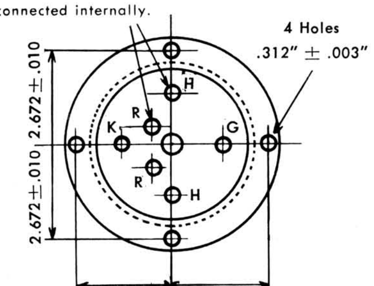
Note 2: The grid drive requirements of a 5948 change considerably during the first few minutes of tube operation. In order to reliably trigger a cold tube, the grid pulse voltage and duration and the grid circuit impedance should be chosen according to the limiting curves on page 3.

Note 3: Anode delay time is defined as the time interval between the point on the rising portion of the grid voltage pulse which is 26 percent of the maximum unloaded pulse amplitude and the point where anode conduction takes place.

Note 4: Time jitter is measured at 50 percent of the pulse amplitude after the tube has been operating for at least 60 seconds. The limit of 0.01 μ sec. shown is the maximum allowable under specified unfavorable operating conditions. With sufficient grid drive and with anode voltages of 15KV and above, jitter not exceeding 0.005 μ sec. can be easily achieved.

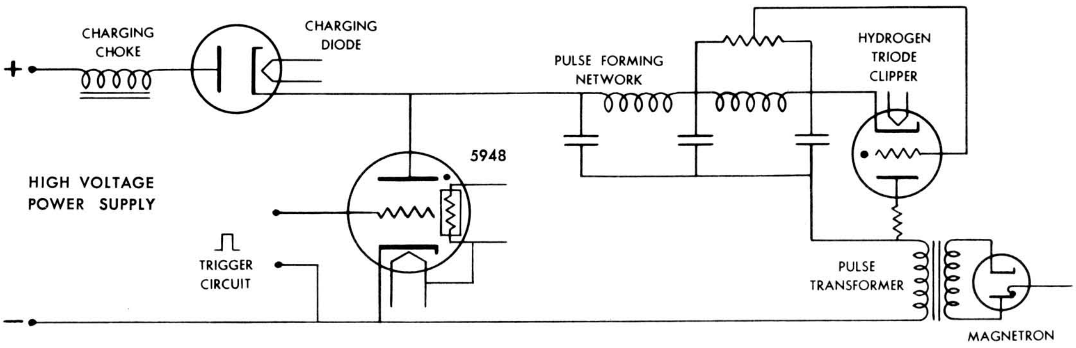
Note 5: Measurement made between 26% and 70.7% points.

These leads are connected internally.



Application Notes

The 5948 hydrogen thyratron is designed primarily for use in high power radar modulator service. A basic circuit for such service is illustrated below. In such a circuit, the hydrogen thyratron serves as a switch to release into the magnetron or other radio frequency generator, the energy stored in the pulse forming network. The 5948 is admirably suited for such service by its ability to hold off high voltage, and to pass high peak currents with relatively low tube voltage drop. The tube will operate over a wide range of pulse repetition rates, pulse widths and peak currents, thus providing a very flexible circuit element. Triggering requirements are simplified since the tube operates with zero bias.



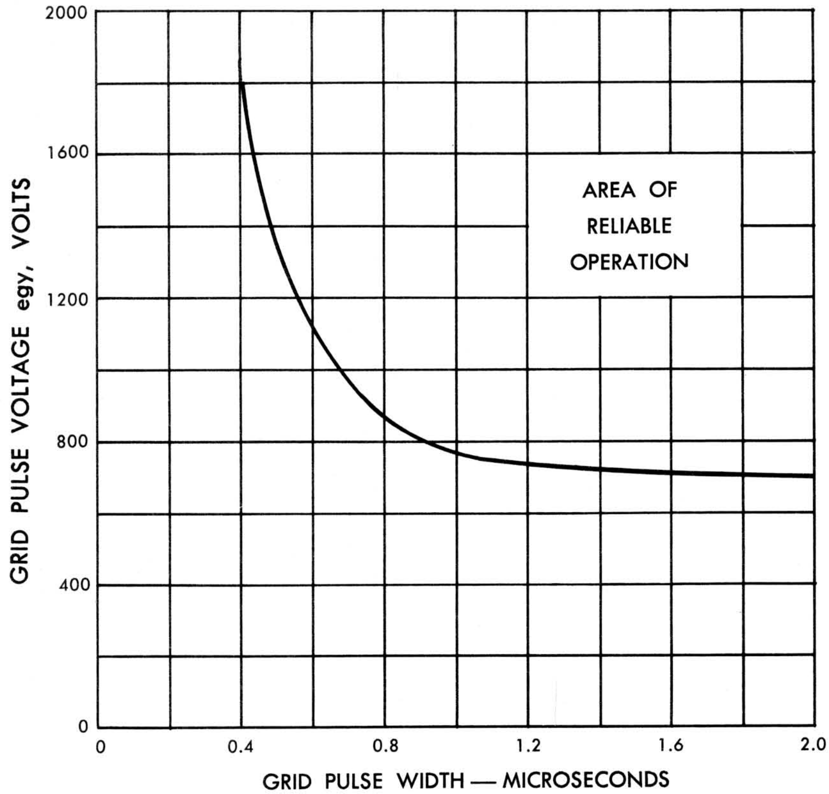
The 5948 contains a hydrogen reservoir that maintains the gas pressure within the tube in accordance with the voltage impressed across it. Since the reservoir can hold many tube volumes of gas, long tube life is insured. In addition it is possible to set the gas pressure at the optimum value for any particular set of operating conditions. The reservoir heater voltage stamped on the tube base has been determined for a particular set of conditions somewhat beyond the maximum tube ratings and will be satisfactory for most applications. In general, it is desirable to operate at as high a reservoir voltage as possible without obtaining spurious discharges in the grid-anode region. When the 5948 is operated at or near maximum ratings, the reservoir voltage regulation should not exceed ±2.5%. If the 5948 is operated at reduced duty a wider reservoir operating range can be expected. However, care should be taken when determining the reservoir voltage to insure satisfactory operation with the anticipated reservoir voltage regulation. Under no circumstances should the reservoir voltage be reduced to such an extent that the anode shows color.

The instantaneous application of anode voltage (instantaneous starting or "slap on") is not recommended. When it is absolutely necessary, the maximum permissible epy is 18 kv and this value shall not be attained in less than 0.04 sec. For initial application of maximum rated anode voltage, it is recommended that the following starting method be used: Apply no more than 18 kv epy initially. Do not increase in steps greater than 5 kv per minute.

Typical Operation

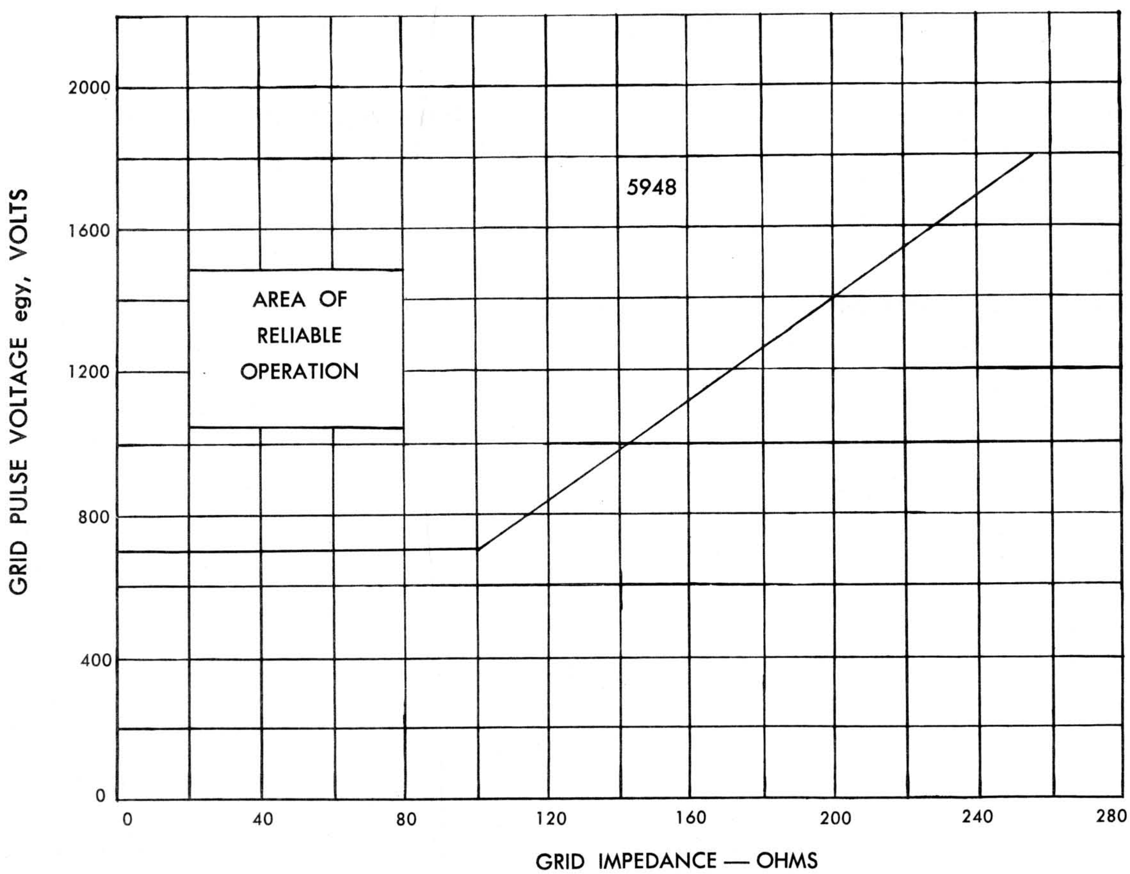
Variations in the operating parameters affect the life expectancy of hydrogen thyratrons; therefore, a simple method of rating for all conditions is difficult. Until such time as sufficient information is available to prepare complete operation rating charts, we list the following typical conditions of operation under which considerable tube life has been obtained. If the 5948 is to be employed in an operation differing widely from these conditions (unless the requirements are obviously less severe) it is suggested that the customer request a recommendation for the specific application.

	Peak Anode Voltage		Peak	Pulse Width	di/dt
Prr	Forward	Inverse	Current	70% Point	
pps	kv	kv	Amps	μs	Amps/μs
360	25	3	1000	2.5	5000
1500	15	5	500	1.3	5000

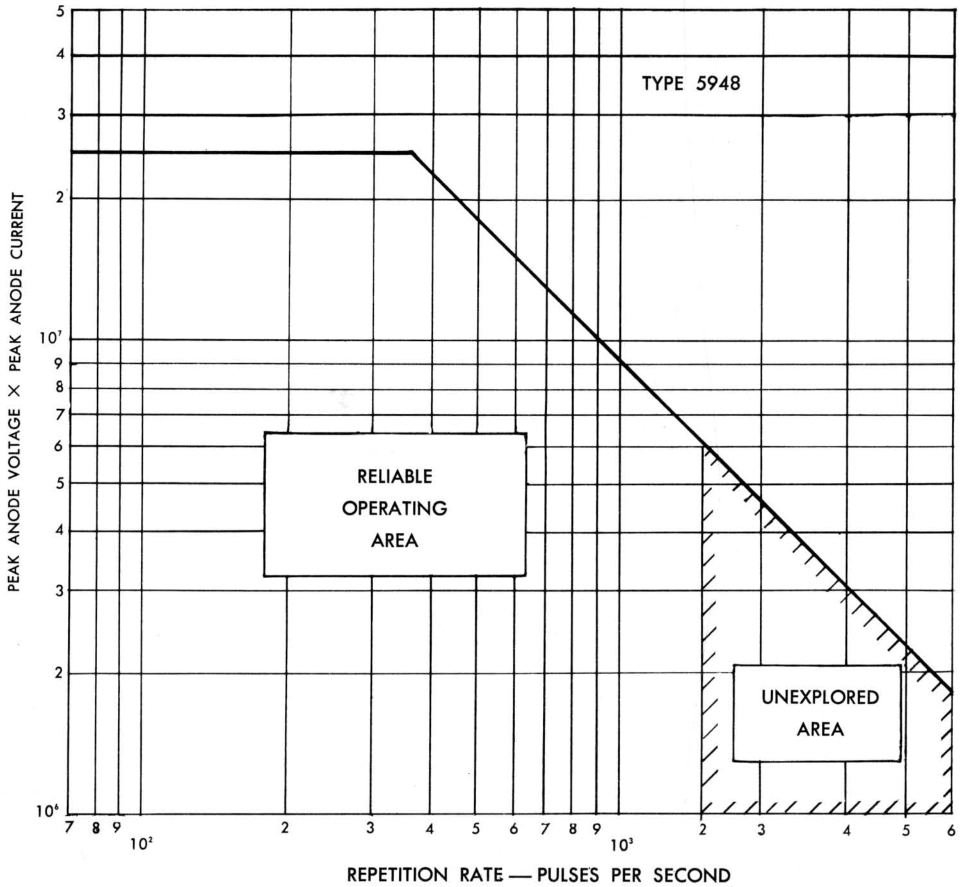


70% LEVEL TR = 0.35 MICROSECOND

GRID PULSE REQUIREMENTS

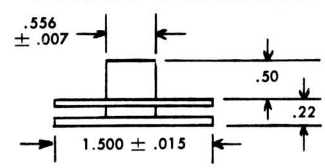


GRID IMPEDANCE REQUIREMENTS



GRAPHICAL REPRESENTATION OF HEAT FACTOR

Anode Connector

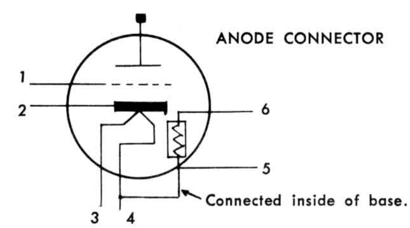


Lead Connections

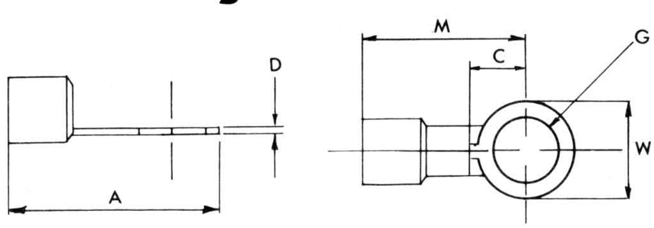
Lead	Function	Lead Color	Lug Color	Lug
1	Grid	Green	Green	S
2	Cathode & Heater C-T	Black	Black	L
3	Heater	Yellow	Yellow	L
4	Heater	Yellow	Black	L
5	Reservoir	Red	Yellow	S
6	Reservoir	Red	Red	S

Leads are flexible 5½″ ±½″ long from bottom of base to center of lug hole. Color coding as well as base marking identifies the leads.

Basing Connections



Lug Dimensions

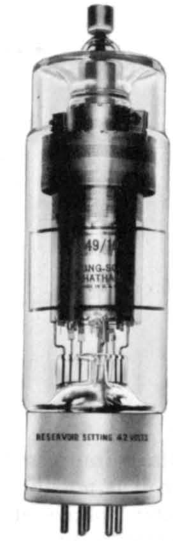


LUG	G STUD	A MAX.	W MAX.	C MIN.	D	M MAX.
L	¼″	1.21″	.53″	.41″	.04″	.94″
S	#10	.90″	.31″	.30″	.03″	.74″

TUNG-SOL/CHATHAM

HIGH POWER HYDROGEN THYRATRON

TYPE 5949



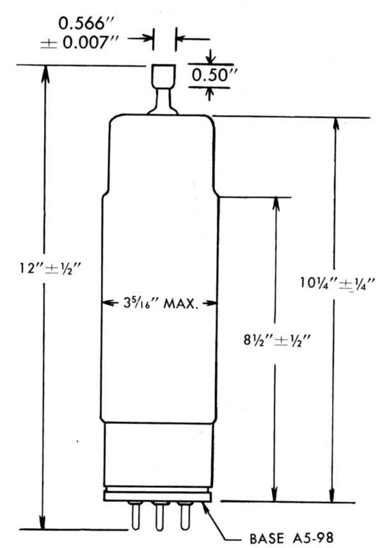
DESCRIPTION — The 5949 is a three electrode, hydrogen filled, zero bias thyratron designed for the generation of high power pulses. The primary application of the tube is in high power, high voltage radar modulators. The 5949 is capable of supplying 6.25 megawatt pulses in this service. An internal hydrogen reservoir promotes long life and permits optimum pressure adjustment for various conditions of operation. The cathode is unipotential and is connected to the electrical center of the cathode heater circuit in order to minimize time jitter.

ELECTRICAL DATA

	Symbol	Min.	Bogey	Max.
Heater Voltage	Ef	6.0	6.3	6.6 Volts
Heater Current	If	15	18.5	22 Amperes
(With bogey heater and reservoir voltage)				
Cathode Heating Time	tk	15		Minutes
Reservoir Voltage (See Application Notes)	Eres	3	Marked on base	5.5 Volts
Reservoir Current	Ires	2		5 Amperes
Reservoir Heating Time	tres	15		Minutes
Anode Voltage Drop	etd	75	125	250 Volts

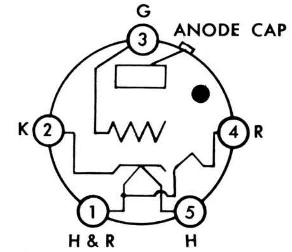
MECHANICAL DATA

Type of Cooling	Convection
Mounting Position	Any
Maximum Net Weight	2¼ pounds
Dimensions	See outline drawing
Socket	E. F. Johnson Co. No. 122-275 or equivalent
Anode Connector	Eitel-McCullough, Inc. No. HR-8, or equivalent



MAXIMUM ABSOLUTE RATINGS

	Symbol	Min.	Max.
Peak Anode Voltage			
Inverse (Note 1)	epx	5% epy	25 Kilovolts
Forward (See Application Notes for starting procedure)	epy	10	25 Kilovolts
Cathode Current			
Peak	ib		500 Amperes
Average	Ib		0.5 Ampere
RMS (For square pulse applications $I_p = \sqrt{Ib \times ib}$)	Ip		16 Amperes
D-C Anode Voltage	Ebb	5	Kilovolts
Operating Frequency	prr		2000 cps
(This is not necessarily the upper operating frequency limit of the 5949 but represents the highest repetition rate extensively life tested to date.)			
Peak Grid Voltage (Note 2)	egy	550	1500 Volts
Peak Inverse Grid Voltage	egx		450 Volts
Grid Pulse Rise Time (Note 5)	tr		0.14 μ sec.
Grid Pulse Width at 70.7% Point	tp	2	μ sec.
Heating Factor (epy x ib x prr. See page 4)	Pb		6.25×10^9
Current Rate of Rise (Note 5)	dik/dt		2500 amp/μ sec.
Anode Delay Time (Note 3)	tad		1.0 μ sec.
Time Jitter (Note 4)	tj		0.01 μ sec.
Ambient Temperature	TA	−55°C	+75°C



BOTTOM VIEW

Note 1: In pulsed operation, the peak inverse voltage, exclusive of a spike of 0.05 μ sec. maximum duration, shall not exceed 5.0 kilovolts during the first 25 μ sec. following the anode pulse.

Note 2: The grid drive requirements of a 5949 change considerably during the first few minutes of tube operation. In order to reliably trigger a cold tube, the grid pulse voltage and duration and the grid circuit impedance should be chosen according to the limiting curves on page 3.

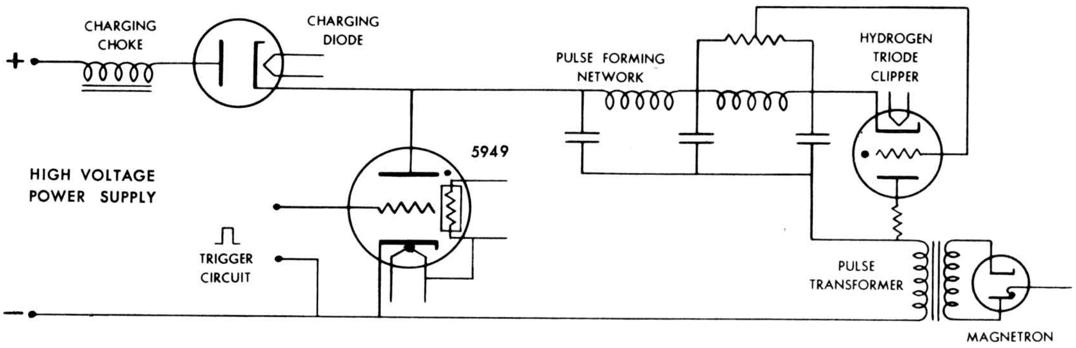
Note 3: Anode delay time is defined as the time interval between the point on the rising portion of the grid voltage pulse which is 26 percent of the maximum unloaded pulse amplitude and the point where anode conduction takes place.

Note 4: Time jitter is measured at 50 percent of the pulse amplitude after the tube has been operating for at least 60 seconds. The limit of 0.01 μ sec. shown is the maximum allowable under specified unfavorable operating conditions. With sufficient grid drive and with anode voltages of 15KV and above, jitter not exceeding 0.005 μ sec. can be easily achieved.

Note 5: Measurement made between 26% and 70.7% points.

Application Notes

The 5949 hydrogen thyratron is designed primarily for use in high power radar modulator service. A basic circuit for such service is illustrated below. In such a circuit, the hydrogen thyratron serves as a switch to release into the magnetron or other radio frequency generator, the energy stored in the pulse forming network. The 5949 is admirably suited for such service by its ability to hold off high voltage, and to pass high peak currents with relatively low tube voltage drop. The tube will operate over a wide range of pulse repetition rates, pulse widths and peak currents, thus providing a very flexible circuit element. Triggering requirements are simplified since the tube operates with zero bias.



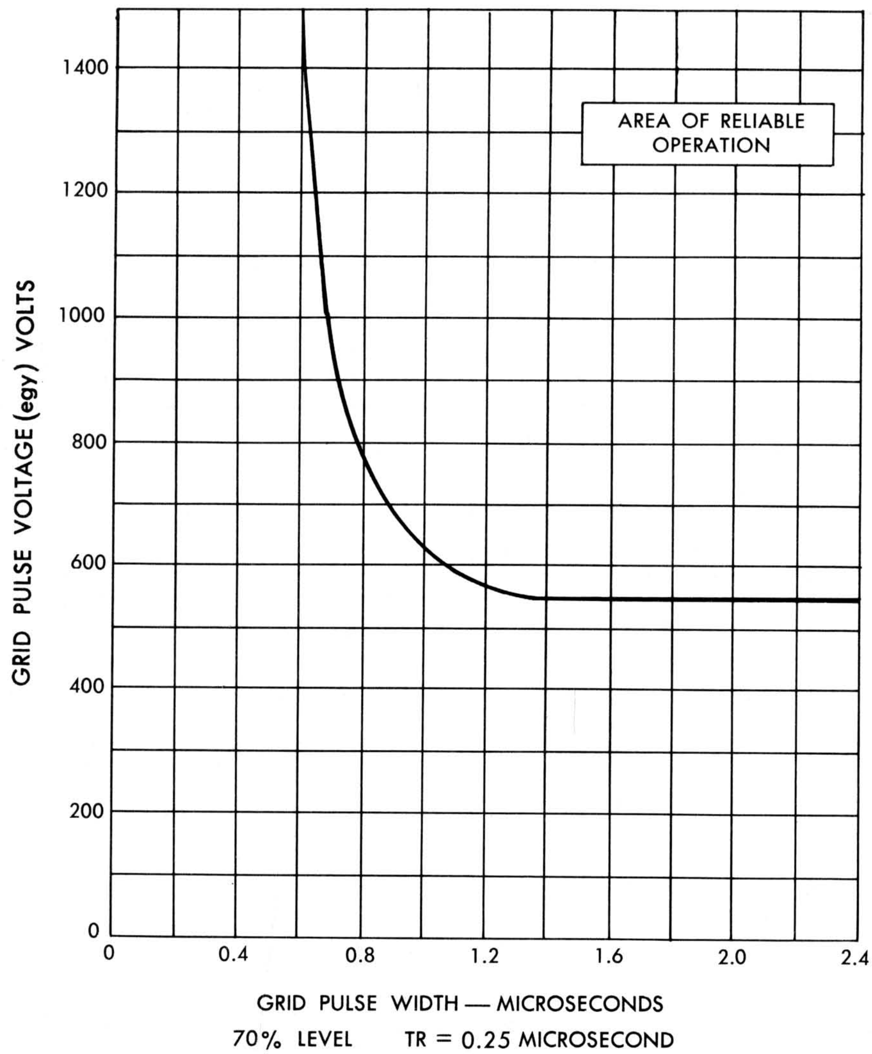
The 5949 contains a hydrogen reservoir that maintains the gas pressure within the tube in accordance with the voltage impressed across it. Since the reservoir can hold many tube volumes of gas, long tube life is insured. In addition it is possible to set the gas pressure at the optimum value for any particular set of operating conditions. The reservoir heater voltage stamped on the tube base has been determined for a particular set of conditions somewhat beyond the maximum tube ratings and will be satisfactory for most applications. In general, it is desirable to operate at as high a reservoir voltage as possible without obtaining spurious discharges in the grid-anode region. When the 5949 is operated at or near maximum ratings, the reservoir voltage regulation should not exceed ±2.5%. If the 5949 is operated at reduced duty a wider reservoir operating range can be expected. However, care should be taken when determining the reservoir voltage to insure satisfactory operation with the anticipated reservoir voltage regulation. Under no circumstances should the reservoir voltage be reduced to such an extent that the anode shows color.

The instantaneous application of anode voltage (instantaneous starting or "slap on") is not recommended. When it is absolutely necessary, the maximum permissible epy is 18 kv and this value shall not be attained in less than 0.04 sec. For initial application of maximum rated anode voltage, it is recommended that the following starting method be used: Apply no more than 18 kv epy initially. Do not increase in steps greater than 5 kv per minute.

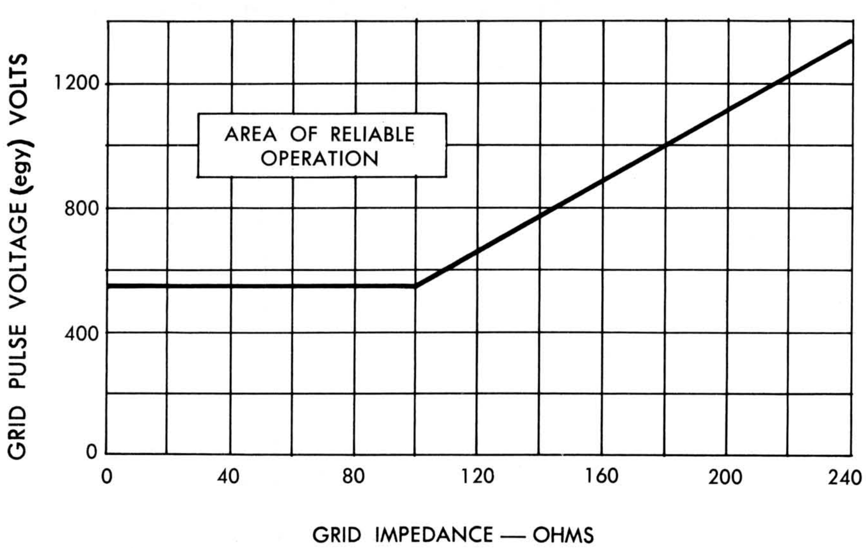
Typical Operation

Variations in the operating parameters affect the life expectancy of hydrogen thyratrons; therefore, a simple method of rating for all conditions is difficult. Until such time as sufficient information is available to prepare complete operation rating charts, we list the following typical conditions of operation under which considerable tube life has been obtained. If the 5949 is to be employed in an operation differing widely from these conditions (unless the requirements are obviously less severe) it is suggested that the customer request a recommendation for the specific application.

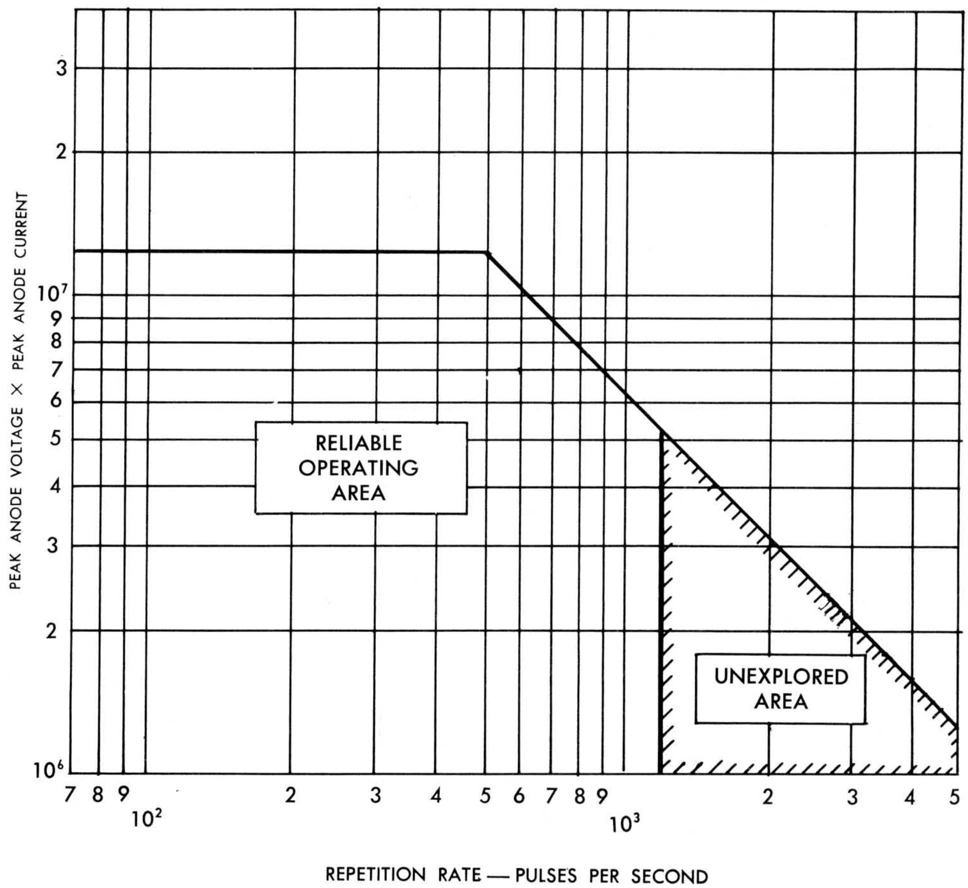
PRR	Peak Anode Voltage Forward	Peak Anode Voltage Inverse	Peak Current	Pulse Width 70% Point	di/dt
pps	kv	kv	amp	μsec	amp/μsec
360	25	1.25	500	2	2500
1500	20	7.0	200	1	2500



GRID PULSE REQUIREMENTS



GRID IMPEDANCE REQUIREMENTS



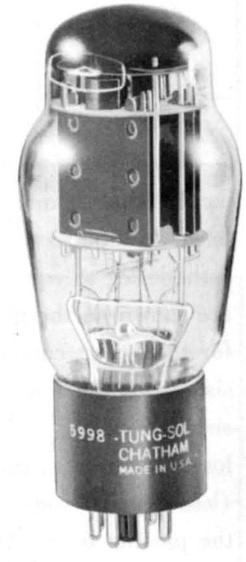
GRAPHICAL REPRESENTATION OF HEAT FACTOR

TUNG-SOL / CHATHAM

TWIN POWER TRIODE

TYPE 5998

DESCRIPTION — The 5998 is a medium mu twin power triode used primarily as a passing tube in series regulated power supplies. For this service, a tube must be able to pass large currents over a wide voltage range and still exhibit a low intrinsic voltage drop when operated "wide open." The 5998 not only meets these requirements but possesses the additional advantage of requiring little grid voltage swing to control these currents. This permits the use of simpler control amplifier circuits in the regulated supply.

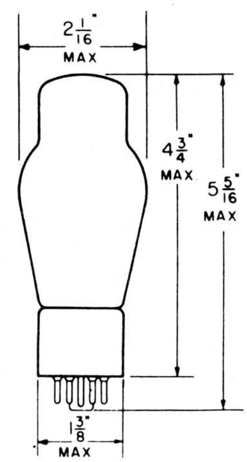


ELECTRICAL DATA

Heater Voltage	6.3 ±10% Volts
Heater Current (E_f = 6.3 volts)	2.4 Amperes
Minimum Cathode Heating Time	30 Seconds
Transconductance (per section)	14,000 μmhos
Amplification Factor	5.5
Inter-Electrode Capacities per Triode Section:	
Grid to Cathode	7.7 μμf
Grid to Plate	18.3 μμf
Cathode to Plate	2.5 μμf
Heater to Cathode	10.0 μμf
Inter-Electrode Capacities Between Triode Sections:	
Section 1 Plate to Section 2 Plate	1.7 μμf

MECHANICAL DATA

Mounting Position	Base Down
Bulb	ST 16
Base	Medium Shell Octal—8 Pin JETC # B8-11
Average Net Weight	2.4 Ounces
Maximum Vibration Rating (D = .08″ @ 25 cps)	2.5 G



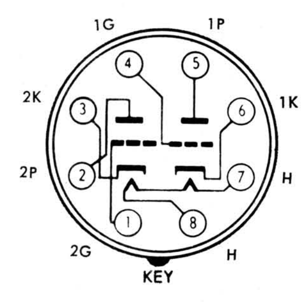
GLASS BULB

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum	
Power Dissipation per Plate	—	15	Watts
Plate Current per Plate	—	140	Milliamperes D.C.
If tube voltage drop is to be swung more than 50 volts, this current cannot be realized. See Plate Characteristics Curve			
Plate Voltage	—	275	Volts D.C.
Heater-Cathode Voltage	−100	+100	Volts D.C.
Grid Voltage	—	0	Volts
Heater Voltage	5.7	6.9	Volts
Envelope Temperature	—	*	°C.
Altitude for Full Ratings	—	10,000	Feet
Circuit Values:			
Total Grid Circuit Resistance	500	500,000	Ohms
Resistance per grid leg when triode sections are paralleled	500	—	Ohms

Cathode Resistance: Minimum cathode resistance per cathode leg shall be 15 ohms or that resistance necessary to provide 10% of the grid bias voltage, whichever is greater.

*For optimum tube life bulb temperature should not exceed 150° C. At full dissipation on both triode sections it will be necessary to provide forced air cooling to keep the bulb temperature within this rating.



Bottom View

RANGE OF VALUES

	Minimum	Maximum	
Conditions: $E_f = 6.3$ V, $E_b = 120$ V, $E_c = -14$V.			
Plate Current per Section	50	125	Milliamperes, D.C.
Amplification Factor	4.8	6.2	
Transconductance	11,000	17,000	Micromhos
Heater Current per Tube	2.20	2.60	Amperes
Conditions: $E_f = 6.3$ V, $E_b = 200$ V, $E_c = -55$ V, $R_k = 0$			
Plate Current per Section	0	10	Milliamperes, D.C.
Conditions: $E_f = 6.3$ V, $E_b = 60$ V, $E_c = 0$ V			
Plate Current per Section	135	—	Milliamperes, D.C.

Application Notes

The 5998 is used as a "passing" tube or series regulator in regulated power supplies because of its high transconductance at moderately low plate voltages. To provide the desired output current, many triode sections can be paralleled. If tube sections are to be paralleled, however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it provides more bias on the sections taking greater plate current. A cathode resistor need be only one sixth the value $\left(\frac{R}{u + 1}\right)$ of a plate resistor, and therefore will dissipate only one sixth the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (less than one watt) and the additional voltage (less than 10 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively, tied to the plate. The plate will attempt to draw excessive current from the passing tube's cathode which may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulated output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be designed to provide enough grid swing to counteract the effect of unbalance due to tube aging.

A grid resistor should be used for each triode section. This should be enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 6.3 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

TUNG-SOL / CHATHAM

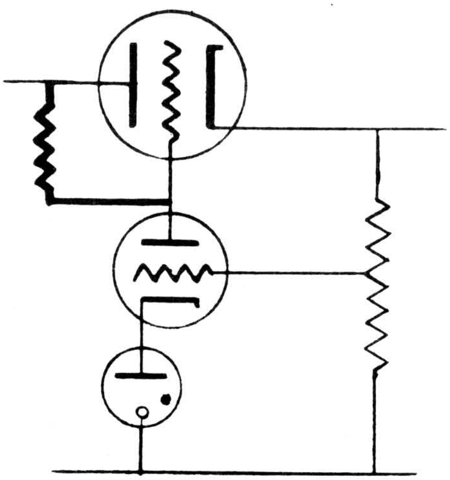


FIGURE 1

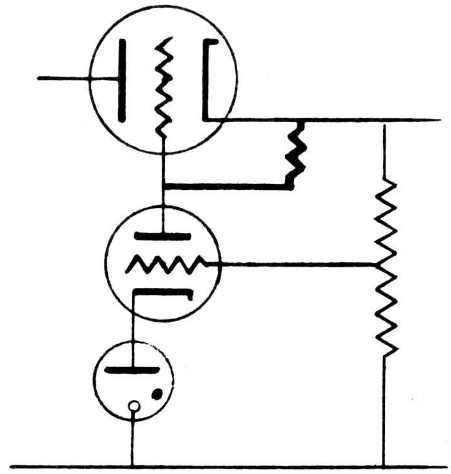


FIGURE 2

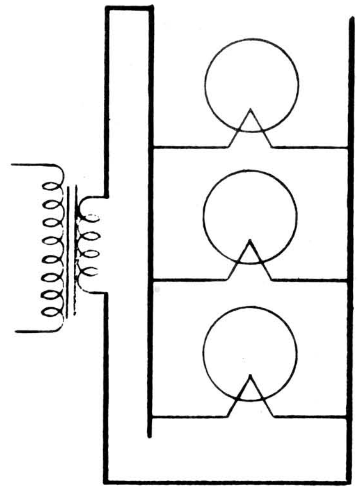
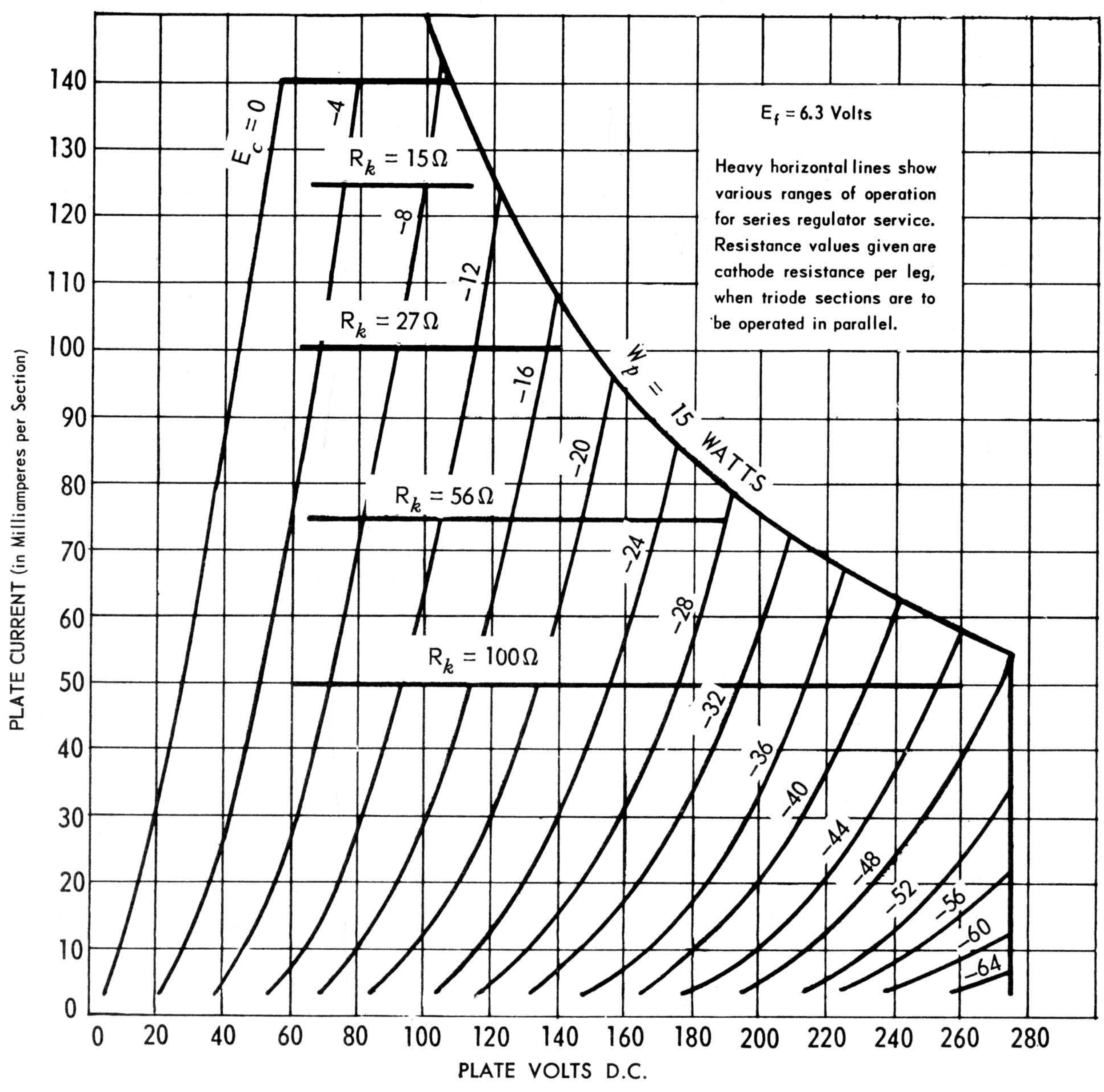
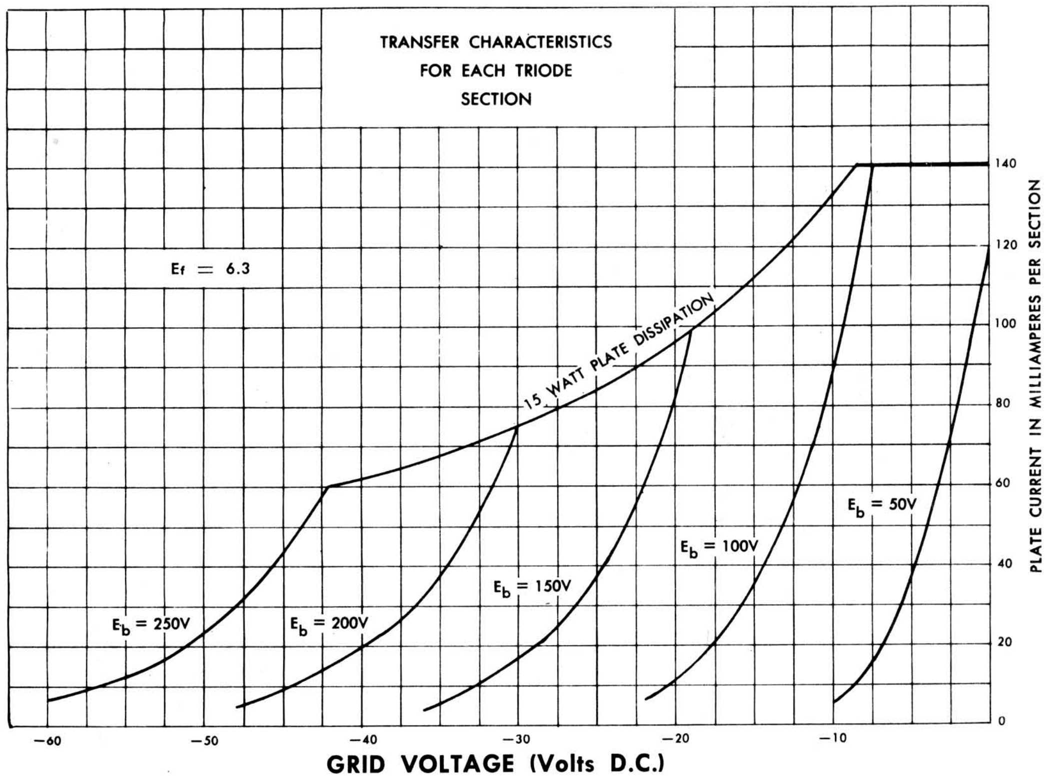
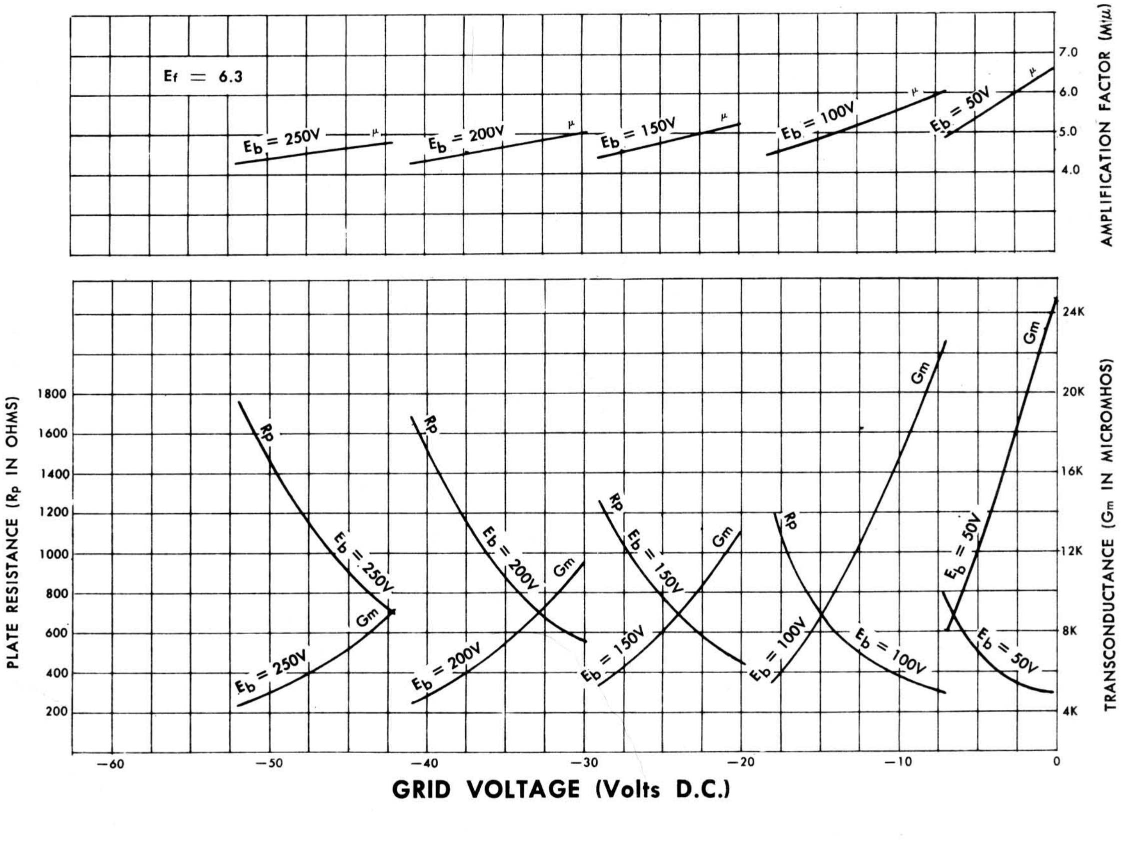


FIGURE 3

AVERAGE PLATE CHARACTERISTICS FOR EACH TRIODE UNIT




TRANSFER CHARACTERISTICS
FOR EACH TRIODE
SECTION
Ef = 6.3
15 WATT PLATE DISSIPATION
Eb = 250V
Eb = 200V
Eb = 150V
Eb = 100V
Eb = 50V
PLATE CURRENT IN MILLIAMPERES PER SECTION
0
20
40
60
80
100
120
140
−60
−50
−40
−30
−20
−10
GRID VOLTAGE (Volts D.C.)


Ef = 6.3
Eb = 250V
Eb = 200V
Eb = 150V
Eb = 100V
Eb = 50V
μ
AMPLIFICATION FACTOR (Mμ)
4.0
5.0
6.0
7.0
PLATE RESISTANCE (Rp IN OHMS)
200
400
600
800
1000
1200
1400
1600
1800
Rp
Gm
TRANSCONDUCTANCE (Gm IN MICROMHOS)
4K
8K
12K
16K
20K
24K
−60
−50
−40
−30
−20
−10
0
GRID VOLTAGE (Volts D.C.)

TUNG-SOL/CHATHAM

SHIELD GRID THYRATRON

DESCRIPTION — The 6012 is a negative control, xenon filled, four electrode thyratron designed for use in relay and grid-controlled rectifier applications. One type 6012 will carry 0.5 ampere in motor-control and in inverter service.

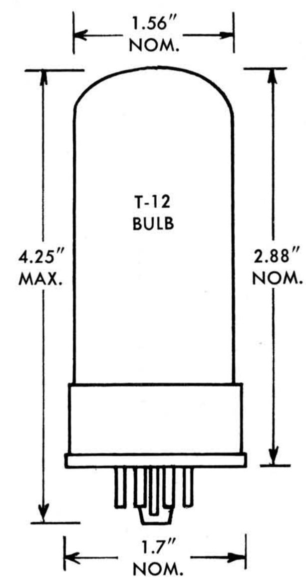
Use of the shield-grid type of construction permits a very low preconduction control grid current to flow. This permits the use of a high resistance in the control grid circuit. The grid control characteristic is independent of ambient temperature over the range from −75 to +90 degrees Centigrade due to the tube's inert gas filling. The 6012 mounts in a standard octal socket.

TYPE 6012

ELECTRICAL DATA

Heater Voltage	6.3 ± 10% Volts
Heater Current (E_f = 6.3 Volts)	2.6 Amperes
Minimum Cathode Heating Time	30 Seconds
Interelectrode Capacitances — Approximate	
Anode to Control Grid	0.65 Micromicrofarads
Control Grid to Cathode (and Shield Grid)	6.5 Micromicrofarads
Anode to Cathode (and Shield Grid)	4.5 Micromicrofarads
Anode Voltage Drop — Approximate	12 Volts
Maximum Critical Grid Current (at Epp = 460 Volts RMS and Ib = 0.5 Ampere)	3 Microamperes
Ionization Time — Approximate	
Anode Volts = 100, Anode Current = 5 Amperes, Shield Grid Volts = 0, Control Grid = + 50 Volt Square Wave Pulse	0.5 Microseconds
Deionization Time — Approximate — Note 1	
Anode Volts = 125, Anode Current = 0.5 Amperes, Shield Grid Resistor = 1000 Ohms, Control Grid Volts = −13, Control Grid Resistor = 1000 Ohms	175 Microseconds
Anode Volts = 125, Anode Current = 0.5 Amperes, Shield Grid Resistor = 1000 Ohms, Control Grid Volts = −100, Control Grid Resistor = 1000 Ohms	100 Microseconds

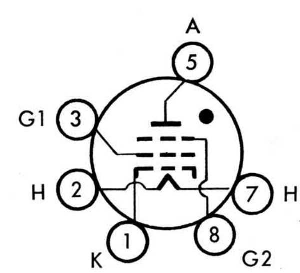
Note 1. Connect shield grid to cathode through series resistor.



GLASS BULB

MECHANICAL DATA

Mounting Position	Any
Bulb	T12
Base	Large-Wafer Octal 6-pin with External Barrier
Maximum Net Weight	2.5 Ounces



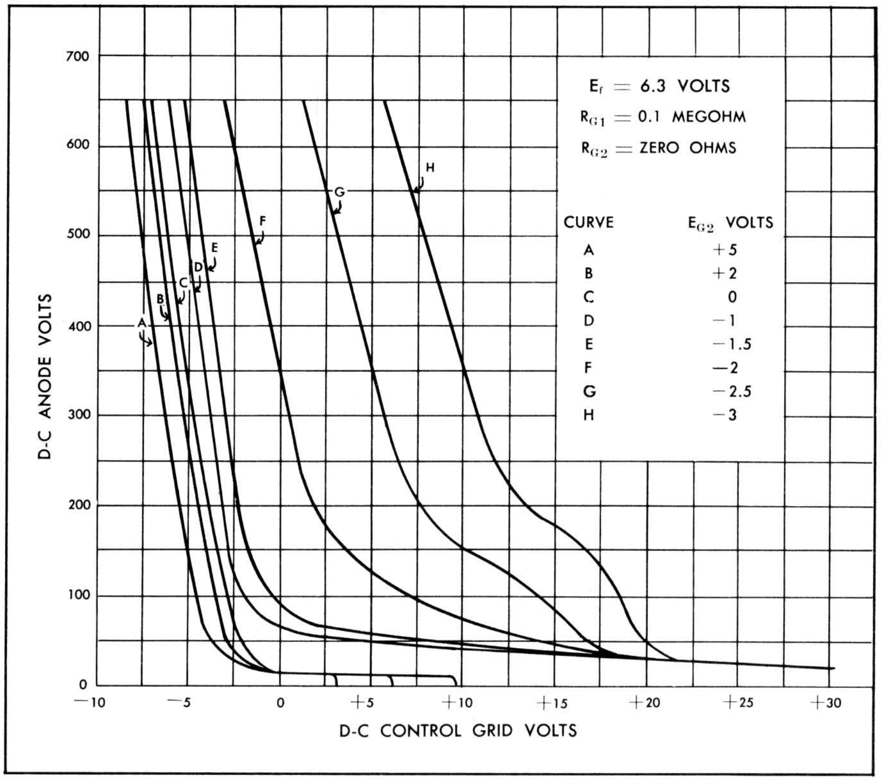
BOTTOM VIEW

RATINGS, ABSOLUTE VALUES
(FOR ANODE-SUPPLY FREQUENCY OF 60 CPS)

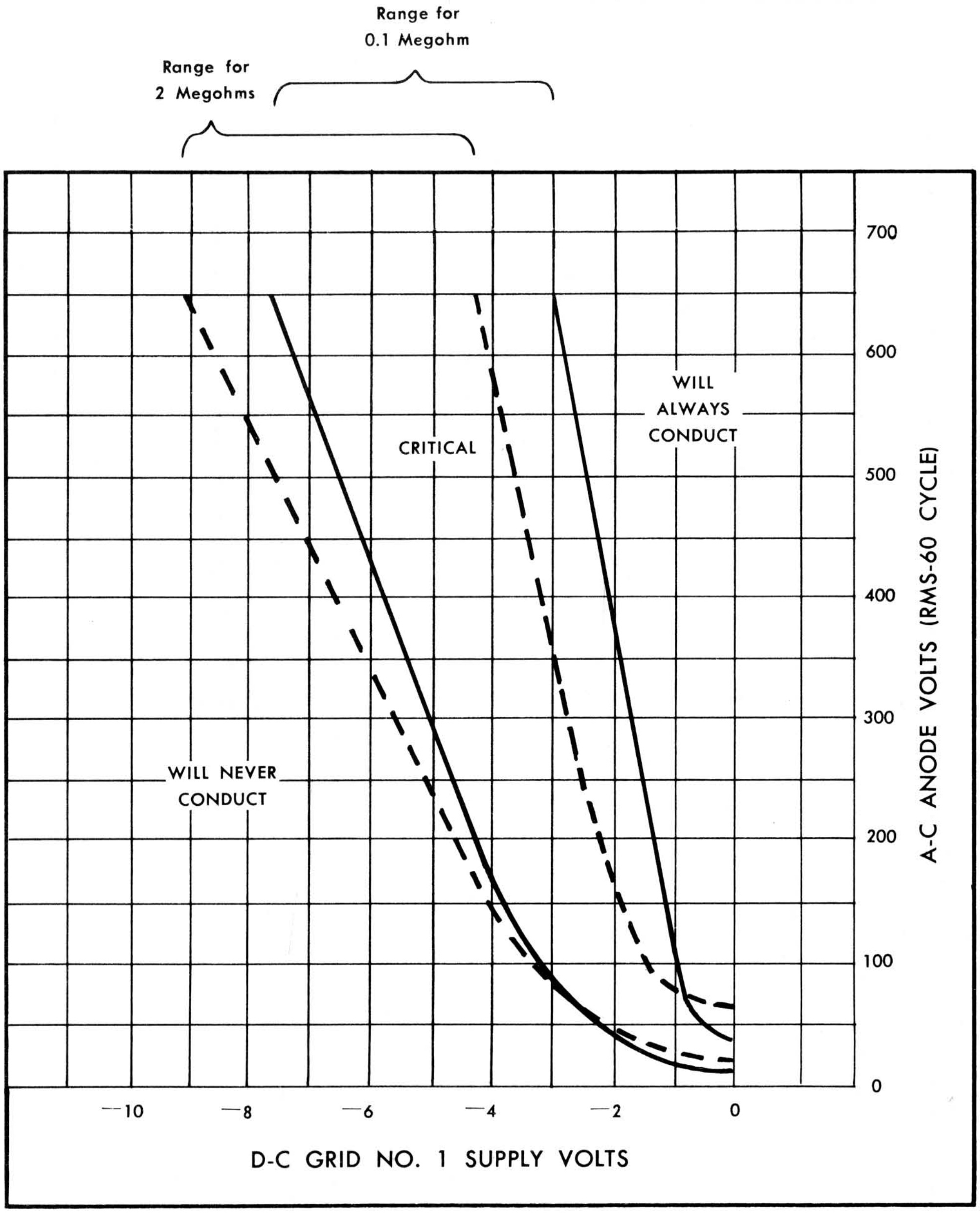
Maximum Peak Anode Voltage	
Forward	650 Volts
Inverse	1300 Volts
Maximum Cathode Current	
Peak	5 Amperes
Average — Note 1	0.5 Ampere
Surge — Maximum Duration 0.1 Second — Note 2	20 Amperes
Maximum Negative Control Grid Voltage	
Before Conduction	200 Volts
During Conduction — Note 1	10 Volts
Maximum Positive Control Grid Current	
Average — Note 1	0.05 Ampere
Maximum Negative Shield Grid Voltage	
Before Conduction	100 Volts
During Conduction — Note 1	10 Volts
Maximum Positive Shield Grid Current — Note 1	0.05 Ampere
Maximum Heater — Cathode Voltage	
Heater Negative	100 Volts
Heater Positive	25 Volts
Maximum Control Grid Circuit Resistance	2 Megohms

Notes 1. Averaged over any interval of 30 seconds maximum.

2. The equipment designer should limit the short circuit current to 20 amperes circuitwise. It should be understood that while the tube may stand several faults at this magnitude of current, each fault will adversely affect tube life.

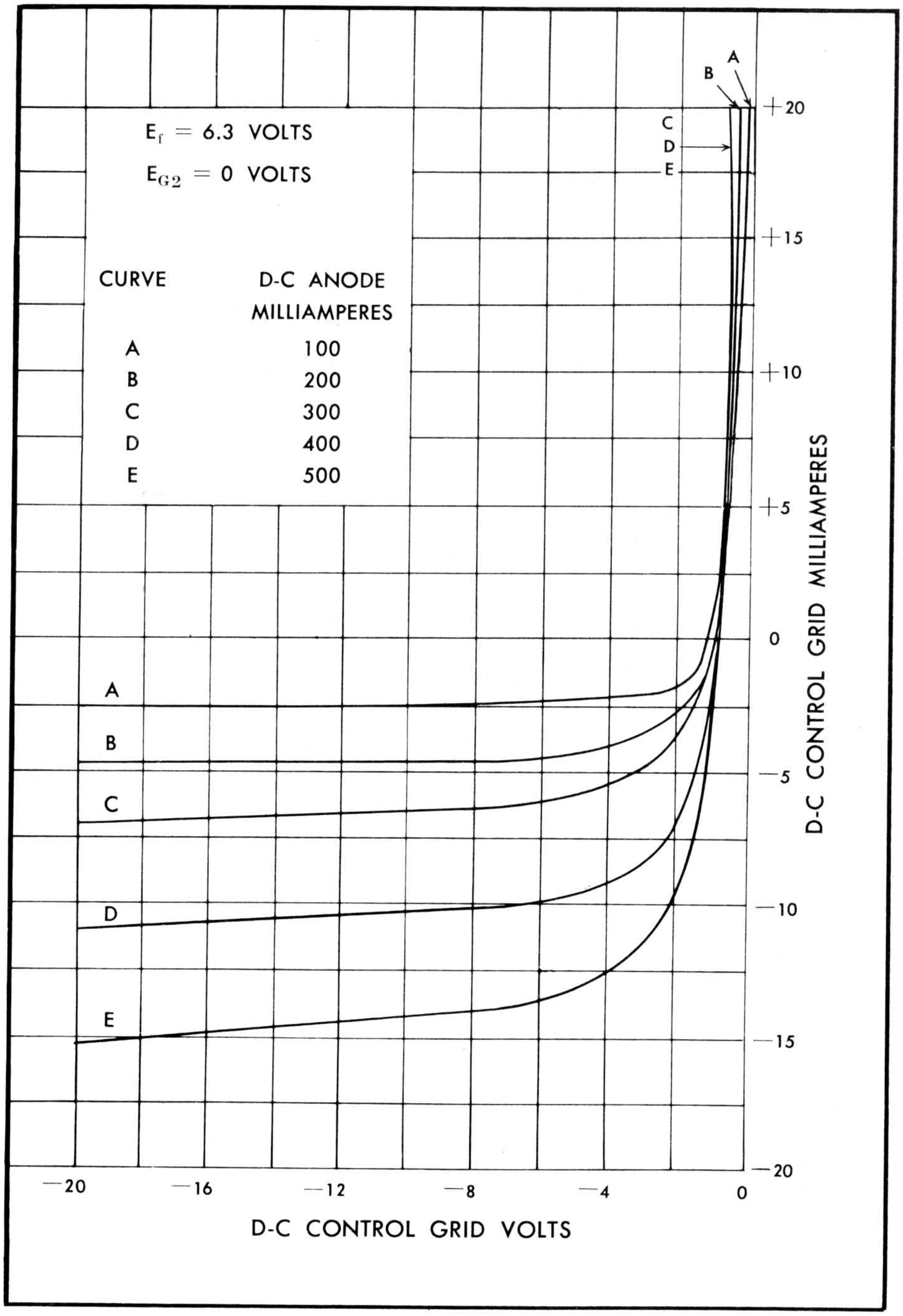


AVERAGE CONTROL CHARACTERISTICS



Critical conduction area is shown for two values of grid resistor, 0.1 megohm and 2 megohms, and zero voltage applied to grid No. 2. Allowance is made for initial differences between individual tubes and variations during tube life for a range of heater voltage from 5.7 to 6.9 volts.

OPERATIONAL RANGE OF CRITICAL GRID VOLTAGE



AVERAGE GRID CHARACTERISTICS DURING ANODE CONDUCTION

TUNG-SOL/CHATHAM

TYPE 6080WA

TYPE 7105
is similar in all respects to the 6080WA but employs a 12.6 volt, 1.25 ampere heater. Heater current range at 12.6 volts is 1.15 to 1.35 amperes. Heater voltage limits are 12.0 to 13.2 volts.

Rugged, Reliable Twin Power Triode

DESCRIPTION——— The 6080WA is a rugged version of the popular 6080, manufactured under the reliable tube program. In this program, tubes are handled in lots with many destructive tests performed on randomly selected samples. Thus a tube may pass all required tests and still be rejected if it is from an unsatisfactory lot.

With the mount shock isolated from the bulb by nine metal spring clips, and by the use of heavy duty parts, the tube will withstand a shock impulse of 450 G and vibration at 50 cps (D = .08″). Additional features are higher altitude and higher bulb temperature limits, and longer life tests with many more life test end points than on the prototype. Plate current and tranconductance are held to closer limits to provide greater balance between tube sections. This is especially advantageous when many tube sections are to be used in parallel.

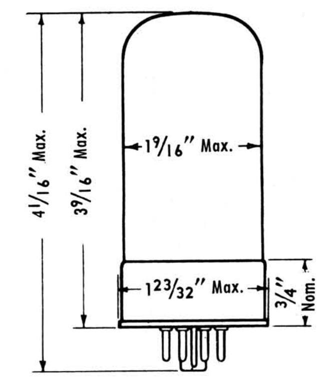
This tube can be used in any application requiring high plate current at low plate voltages. It has found wide use in electronically regulated power supplies.

ELECTRICAL DATA

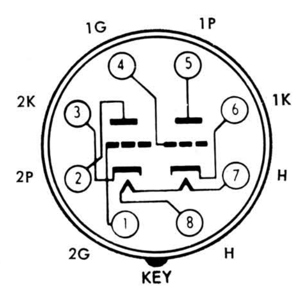
Heater Voltage	6.3 ± 5% volts
Heater Current (E_f=6.3 volts)	2.5 amperes
Minimum Cathode Heating Time	30 seconds
Transconductance (per section)	7000 umhos
Amplification Factor	2.0
Inter Electrode Capacities per Triode Section	
Grid to Cathode	6.2 uuf
Grid to Plate	8.4 uuf
Cathode to Plate	2.2 uuf
Heater to Cathode	6.3 uuf
Inter Electrode Capacities Between Triode Sections	
Section 1 Grid to Section 2 Grid	0.5 uuf
Section 1 Plate to Section 2 Plate	2.2 uuf

MECHANICAL DATA

Mounting Position	Any
(If tube is to be mounted in a horizontal position it is recommended that it be mounted so that the base lug key be either directly up or directly down)	
Bulb	T-12
Base	Large wafer octal with metal sleeve, 8 pin, JETC# B8-86
Maximum Net Weight	3. ounces
Maximum Shock Rating (Navy Hi Impact Shock Machine)	450 G
Maximum Vibration Rating (D-.08″ @ 50 cps)	10 G



GLASS BULB



Bottom View
Large Wafer Octal with Metal Sleeve

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum
Heater Voltage	6.0	6.6 volts
Plate Voltage	—	250. volts d. c.
Grid Voltage	—	0 volts d. c.
Heater-Cathode Voltage	−300	+300 volts d. c.
Grid Current per Grid	—	5. milliamperes
Plate Current per Plate	—	125. ma d. c.
(If several tube sections are to be used in parallel with each other, it is recommended not to exceed 100 mA per plate)		
Power Dissipation per Plate	—	13 watts
Envelope Temperature	—	230 °C.
Altitude for Full Ratings	—	60,000 feet
Circuit Values		
Grid Circuit Resistance for Cathode Bias Operation	—	1.0 megohm
Grid Circuit Resistance for Fixed Bias or Combination Fixed and Cathode Bias Operation	—	0.1 megohm

TUNG-SOL / CHATHAM

ADDITIONAL TESTS TO INSURE RELIABILITY

Randomly Selected Samples Are Subjected to the Following Tests.

Shock: 30° Hammer angle in Navy, Flyweight, High Impact Machine (450 G/msec)

Fatigue: 25 cps, 0.08″ Total displacement, for 32 hours in each of three mutually perpendicular planes (2.5 G)

Post Shock and Fatigue Limits:
- Vibration (R_p = 2000 Ω, E_c = −7vdc, Tie 1k to 2k, 1g to 2g, 1p to 2p), Generated Plate Voltage .... 100 mVac max.
- Heater-Cathode Leakage (E_{hk}=±100 Vdc). 50 uAdc max.
- Change in Transconductance from Initial Value .... 10% max.
- Grid Current .... −3 uA max.

Heater Cycling Life Test (E_f=7.5v, E_{hk}=300 Vdc. Duration of 2000 cycles of 1 min. on and 1 min. off) .. End Point (E_{hk}=±100v.), 50 uAdc max.

Stability Life Test (1 hr.) End Point:
- Change in Transconductance from Initial Value .... 10% max.

Survival Rate Life Test (100 hrs.) End Point:
- Transconductance .... 5800 umhos min.

Intermittent Life Test (1000 hrs.) End Points:
- Grid Current .... 0 min. −10 max. uAdc
- Transconductance .... 5500 umhos min.
- Change in Transconductance by reducing E_f to 5.7v .... 10% max.
- Heater-Cathode Leakage E_{hk} =±100 Vdc .. 25 uAdc max.
- Heater Current .... 2.35 min. 2.75 max. Amperes
- Insulation of Electrodes: Grid to all others and Plate to all others .... 100 Megohm min.

RANGE OF VALUES

Conditions: E_f = 6.3 V, E_b = 135V, E_c = 0, $R_{k/k}$ = 250 Ω. Both sections operating. Each section read separately.

Individual Plate Current	100	150 Milliamperes d. c.
Lot Average Plate Current (same conditions)	115	135 Milliamperes d. c.
Plate Current, Difference between Sections	—	25 Milliamperes d. c.
Individual Section Transconductance	6000	8200 Micromhos
Lot Average Transconductance	6600	7400 Micromhos
Amplification Factor	1.5	2.5
Heater Current @ 6.3 v	2.35	2.65 Amperes

Application Notes

The 6080WA is widely used as a "passing" tube or series regulator tube in controlled power supplies because of its high transconductance at relatively low plate voltages. To provide the desired output current, many triode sections can be paralleled. If tube sections are to be paralleled however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it helps to provide increasing bias on the sections taking greater plate current. A cathode resistor too, need be only one third the value $\left(\frac{R}{u+1}\right)$ of a plate resistor, and therefore will dissipate only one third the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (less than one watt) and the additional voltage (less than 10 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively tied to the plate. This will attempt to draw excessive current from the passing tube's cathode and may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulated output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. If the cathode resistors as suggested on the plate characteristic curve are used, a minimum bias of 7.5 volts will be provided. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be able to swing the passing tube grid far enough to counteract the effect of unbalance due to tube ageing.

A grid resistor should be used for each triode section. This should be high enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 6.3 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

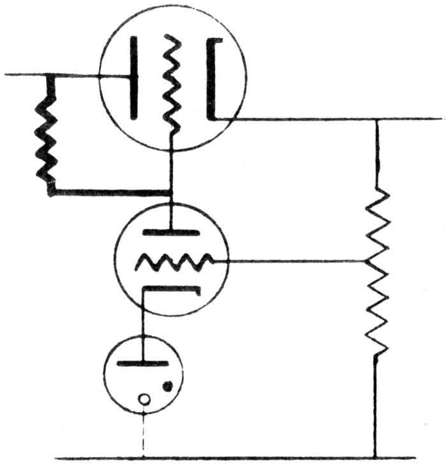


FIGURE 1

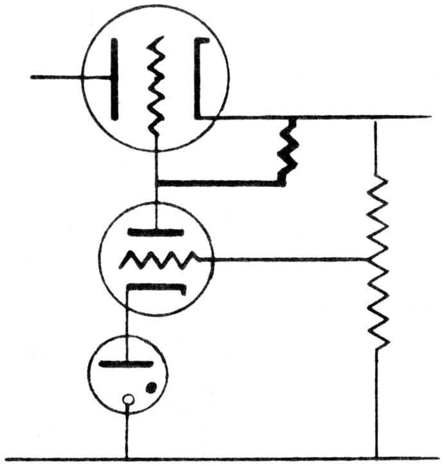


FIGURE 2

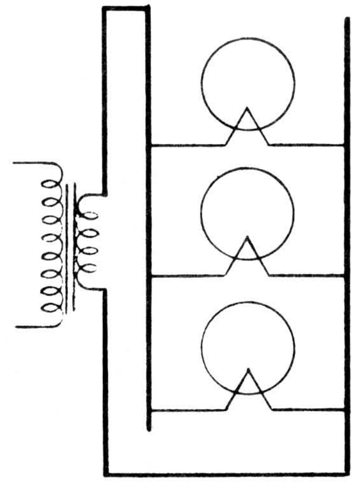
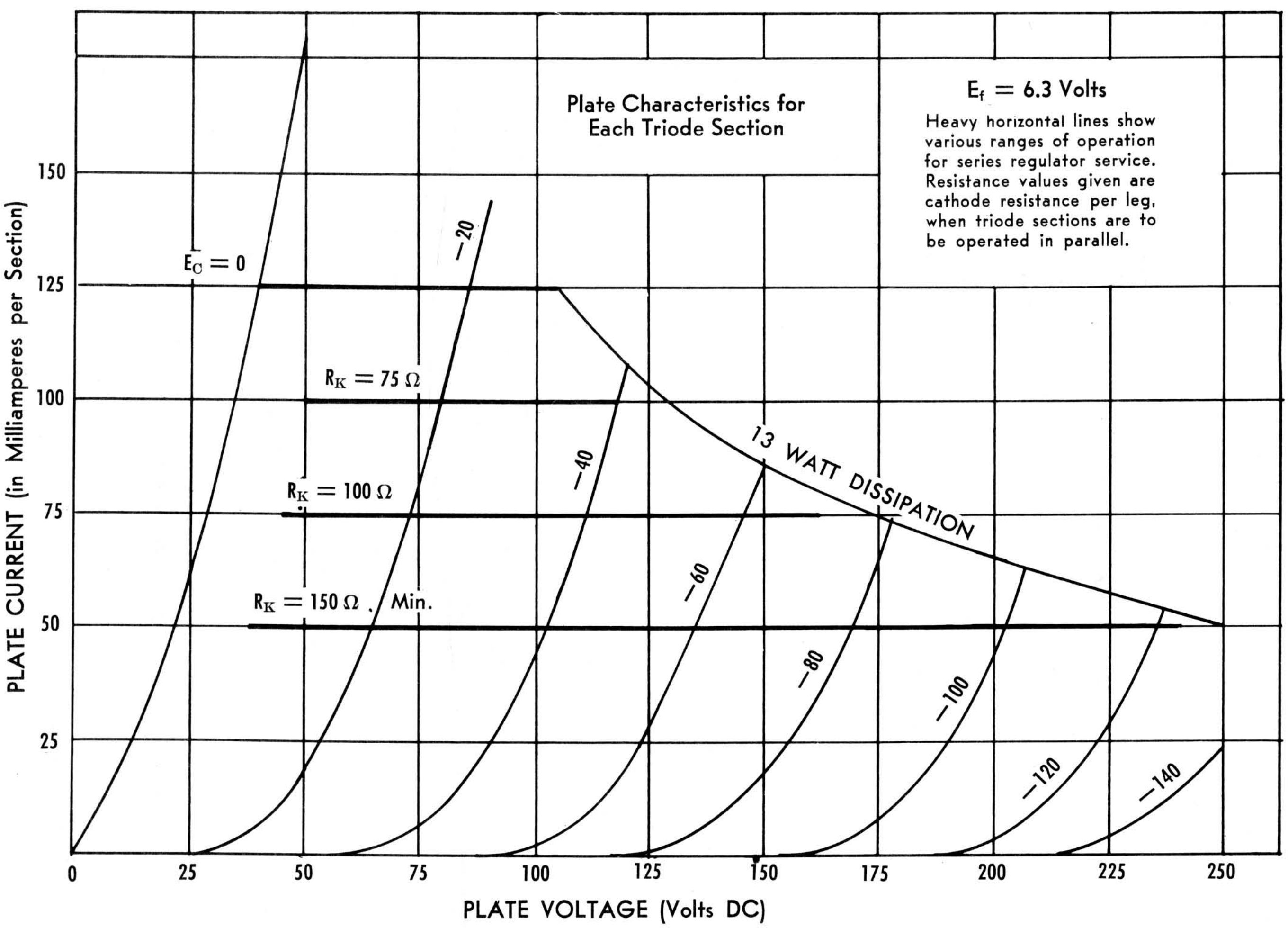
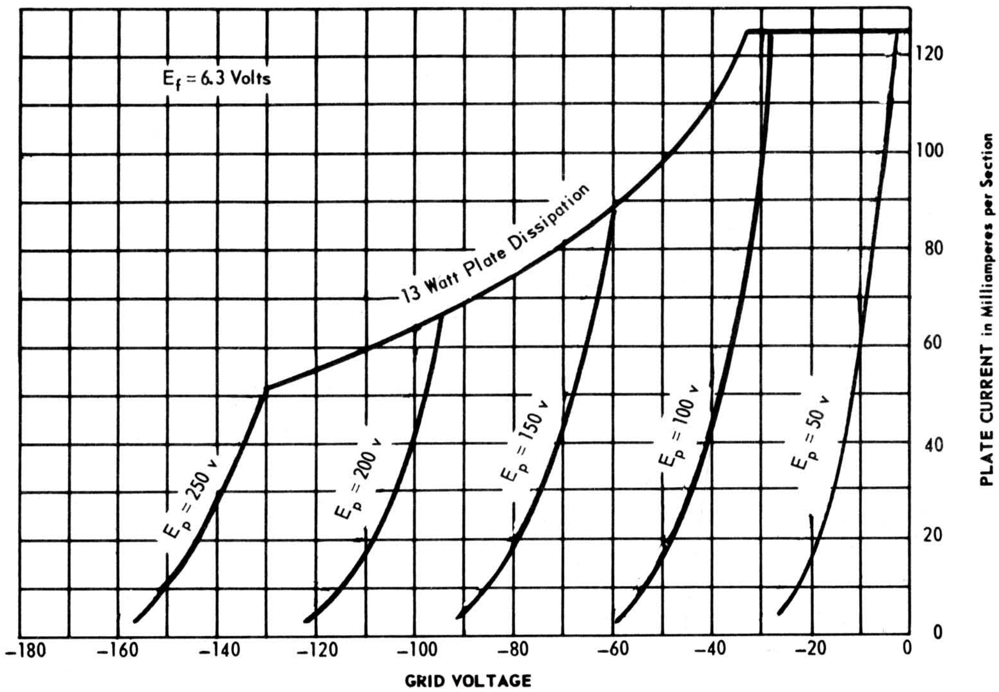


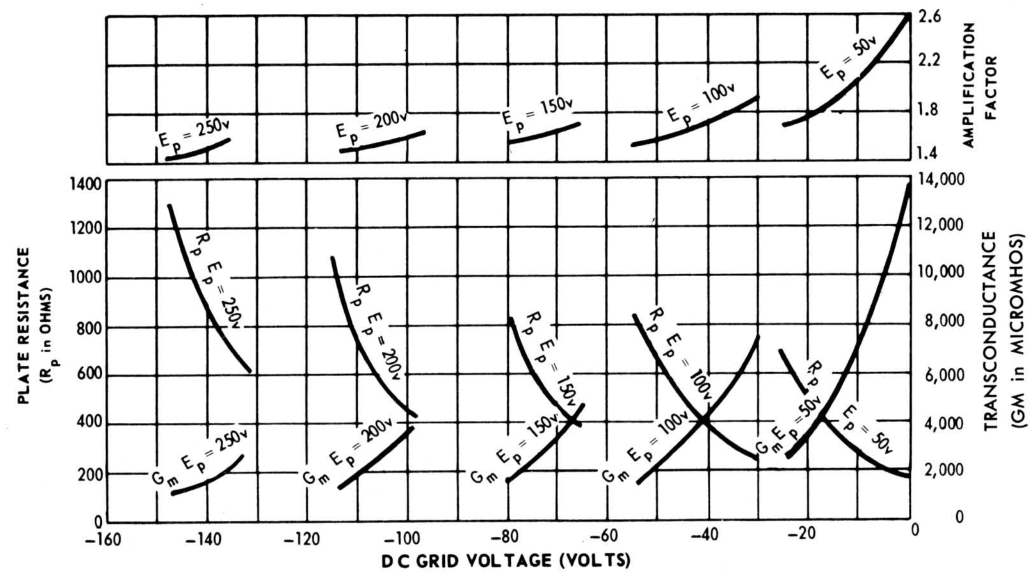
FIGURE 3

PLATE CHARACTERISTICS FOR EACH TRIODE SECTION



TRANSFER CHARACTERISTICS FOR EACH TRIODE SECTION





TUNG-SOL / CHATHAM

TYPE
6336

TWIN POWER TRIODE FOR SERIES REGULATOR SERVICE

DESCRIPTION — The 6336 is a twin power triode developed especially for use as a passing tube in series regulated power supplies. For this service, a tube must be able to pass large currents over a wide voltage range and still exhibit a low intrinsic voltage drop when operated "wide open". The 6336 adequately meets these requirements.

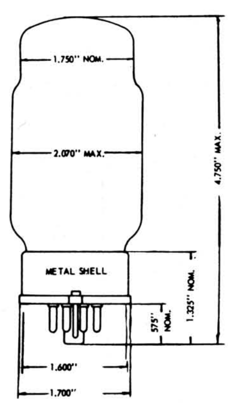
In many circuits, one 6336 has replaced two or three tube type 6080WA or 6AS7G regulator tubes. For even higher levels of current or power, many 6336 tube sections can be paralleled as explained in the application notes.

ELECTRICAL DATA

Heater Voltage	6.3 ±10% volts
Heater Current (E_f = 6.3 volts)	5.0 amperes
Minimum Cathode Heating Time	30 seconds
Transconductance (per section)	13,500 umhos
Amplification Factor	2.7
Inter Electrode Capacities per Triode Section	
Grid to Cathode	13.7 uuf
Grid to Plate	15.8 uuf
Cathode to Plate	5.0 uuf
Heater to Cathode	15.0 uuf
Inter Electrode Capacities Between Triode Sections	
Section 1 Plate to Section 2 Plate	1.8 uuf

MECHANICAL DATA

Mounting Position	Any
(If tube is to be mounted in a horizontal position it is recommended that it be mounted so that the base lug key be either directly up or directly down)	
Bulb	TT 16 Nonex
Base	Large wafer octal with metal sleeve, 8 pin, JETEC # B8-98
Average Net Weight	3.5 ounces
Maximum Shock Rating (Navy Hi Impact Shock Machine)	450 G
Maximum Vibration Rating (D = .08" @ 25 cps)	2.5 G



GLASS BULB

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum
Power Dissipation per Tube	—	60 watts
Power Dissipation per Plate	—	30 watts
Plate Current per Plate	—	400 ma d. c.
If tube voltage drop is to be swung more than 6 volts, this current cannot be realized. See Plate Characteristics Curve		
Plate Voltage	0	400 volts d. c.
Heater-Cathode Voltage	−300	+300 volts d. c.
Grid Voltage	−300	0 volts d. c.
Grid Current per Grid	—	0 milliamperes
Heater Voltage	5.7	6.9 volts
Envelope Temperature	—	250 °C.
Altitude for Full Ratings	—	10,000 feet
If cooling is provided to keep bulb temperature within ratings, altitude rating can be extended to 60,000 feet		
Circuit Values		
Total Grid Circuit Resistance	500	500,000 ohms
Resistance per grid leg when triode sections are paralleled	500	— ohms

Cathode Resistance: Minimum cathode resistance per cathode leg shall be 27 ohms or that resistance necessary to provide 10% of the grid bias voltage, whichever is greater.

RANGE OF VALUES

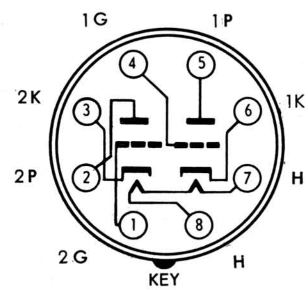
Conditions: $E_f = 6.3V, E_b = 190V$
$E_c = 0, R_k/_k = 200\ \Omega, R_g/_g = 500\ \Omega$
Both sections operating. Readings taken after 5 minutes power preheating. Each section read separately.

Plate Current per Section . . 165 — 200 Milliamperes, d. c.

Amplification Factor	2.0	3.4
Transconductance	11,000	16000 Micromhos
Heater Current per tube	4.75	5.25 Amperes

Conditions: $E_f = 6.3V$, $E_b = 200V$
$E_c = -100V, R_k = 0$

Plate Current per section . . . 0 10 Milliamperes d. c.



Bottom View

Application Notes

The 6336 is widely used as a "passing" tube or series regulator in controlled power supplies because of its high transconductance at relatively low plate voltages. To provide the desired output current, many triode sections can be paralleled. If tube sections are to be paralleled, however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it provides more bias on the sections taking greater plate current. A cathode resistor need be only one fourth the value $\left(\frac{R}{u + 1}\right)$ of a plate resistor, and therefore will dissipate only one fourth the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (about two watts) and the additional voltage (less than 10 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively, tied to the plate. The plate will attempt to draw excessive current from the passing tube's cathode and may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulator output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be able to counteract the effect of unbalance due to tube ageing.

A grid resistor should be used for each triode section. This should be enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 6.3 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

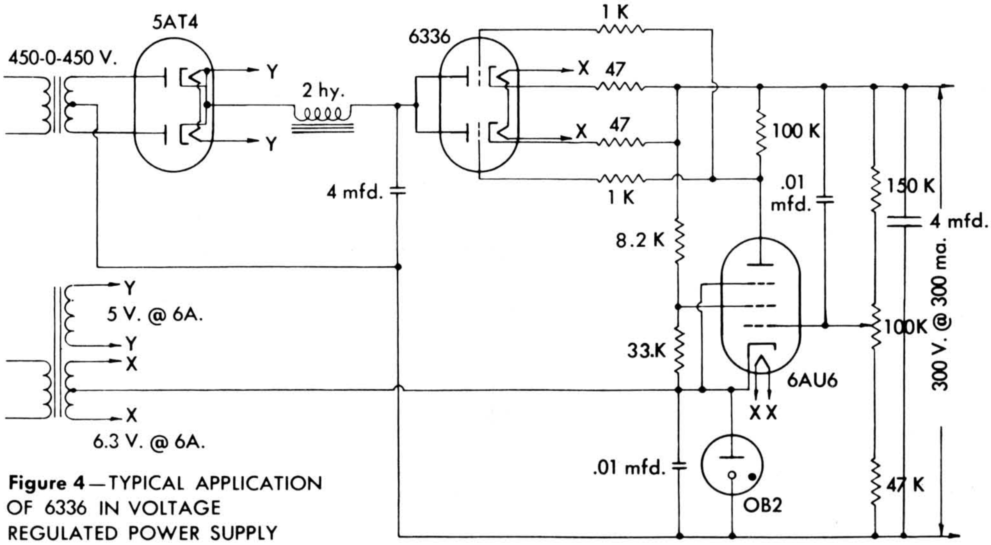


Figure 4—TYPICAL APPLICATION OF 6336 IN VOLTAGE REGULATED POWER SUPPLY

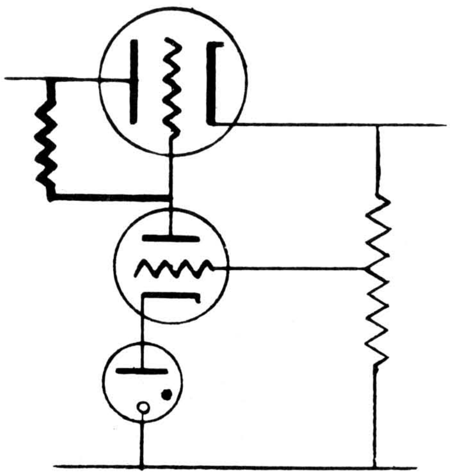


FIGURE 1

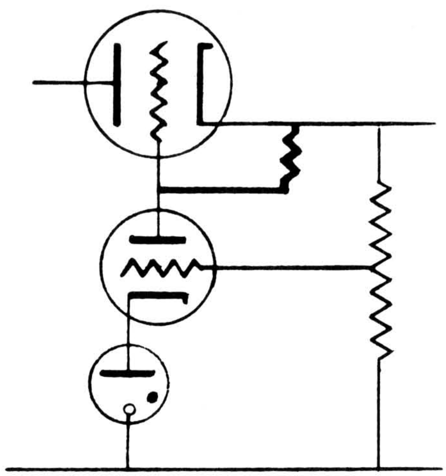


FIGURE 2

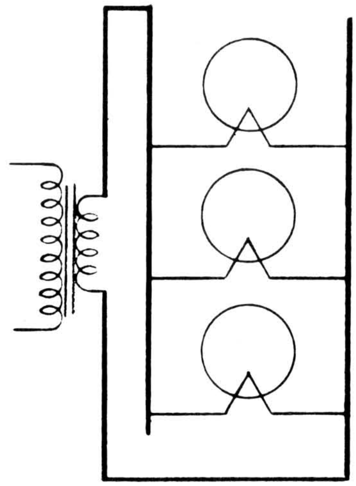
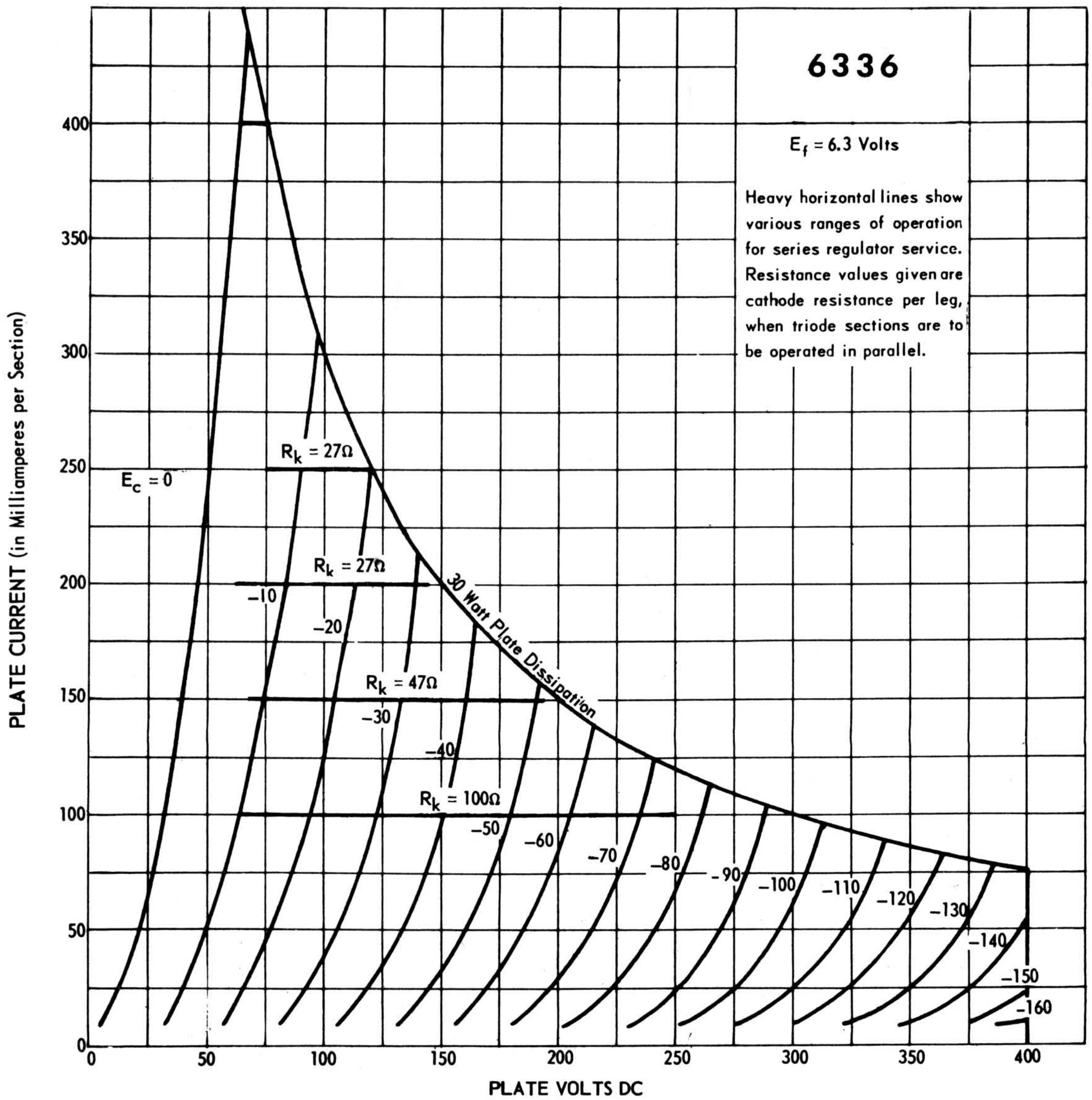
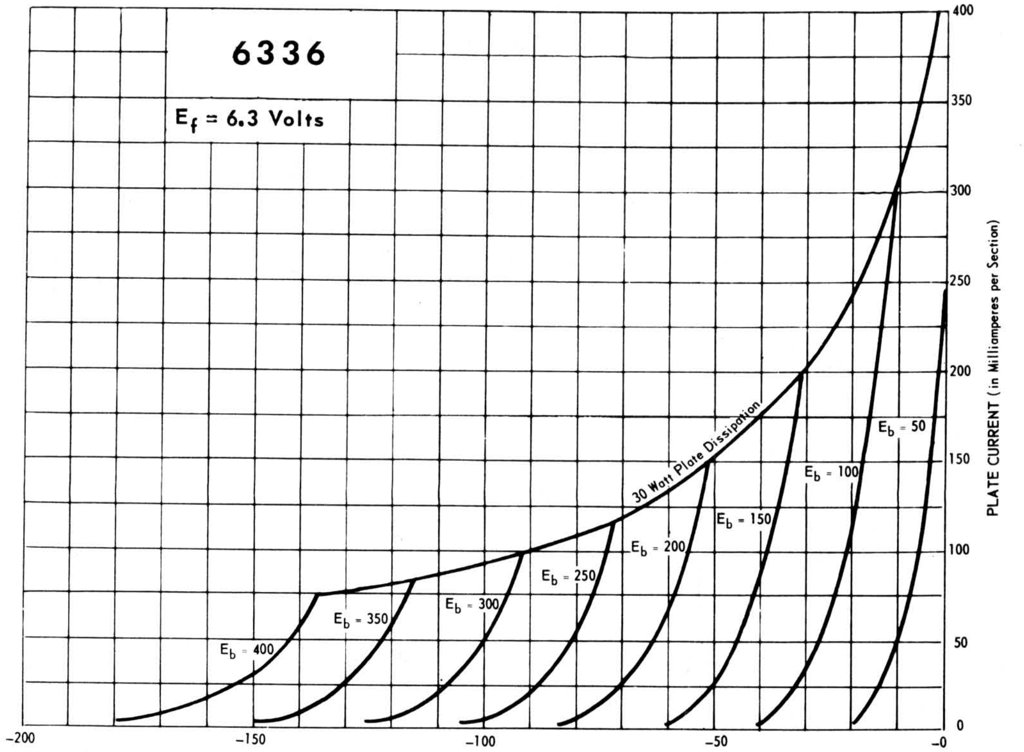


FIGURE 3

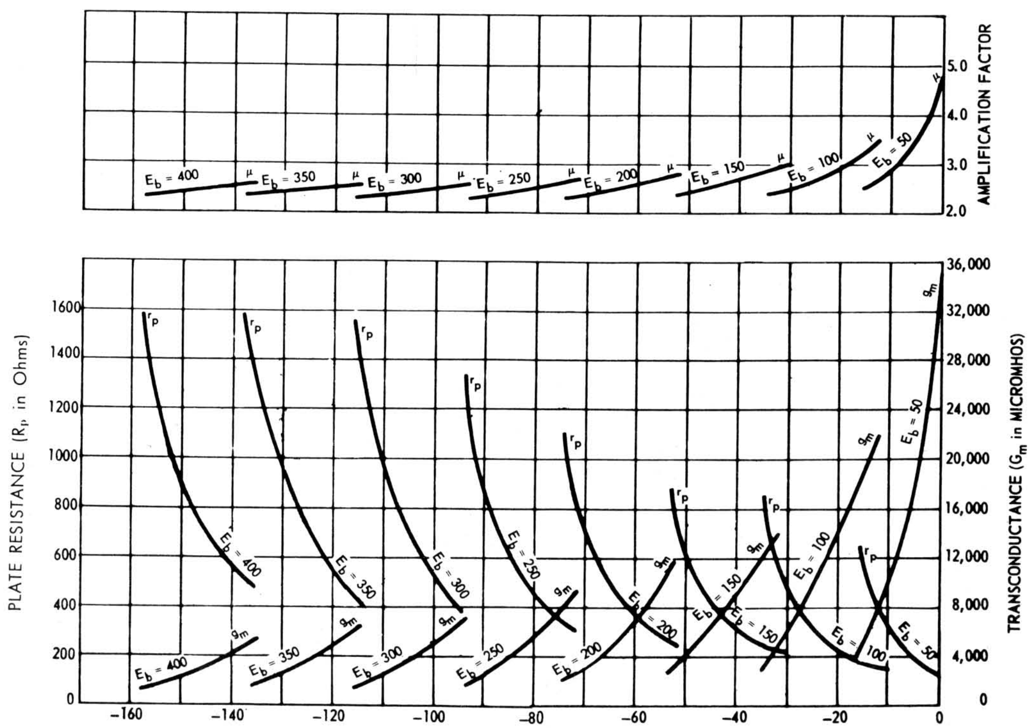
AVERAGE PLATE CHARACTERISTICS FOR EACH TRIODE UNIT



TRANSFER CHARACTERISTICS FOR EACH TRIODE SECTION



AVERAGE CHARACTERISTICS



TUNG-SOL/CHATHAM

TWIN POWER TRIODE FOR SERIES REGULATOR SERVICE

TYPE 6336A

TYPE 6394A

is similar in all respects to the 6336A but employs a 26.5 volt, 1.30 ampere heater. Heater current range at 26.5 volts is 1.20 to 1.40 amperes. Heater voltage limits are 24.0 to 29.0 volts.

DESCRIPTION — The 6336A is a long life, mechanically rugged, twin power triode developed especially for use as a passing tube in series regulated power supplies. For this service, a tube must be able to pass large currents over a wide voltage range and still exhibit a low intrinsic voltage drop when operated "wide open". The 6336A adequately meets these requirements.

The design features zirconium coated graphite anodes that, while lighter in weight than similar metal anodes, remain warp free during life and provide one of the best gas "gettering" means known. The anodes are supported by ceramic insulators. The use of these insulators and the hard glass envelope permit the tube to be outgassed at high temperatures during the manufacturing exhaust process. This allows the tube to be run at high temperatures during operation, without the evolution of harmful gas from the tube parts.

Massive cathodes provide adequate emission current reserve. Gold plated molybdenum wires are employed in the rugged grid structure. The tube mount is built on a rugged button stem, and is supported from the bulb by means of flexible metal vibration snubbers.

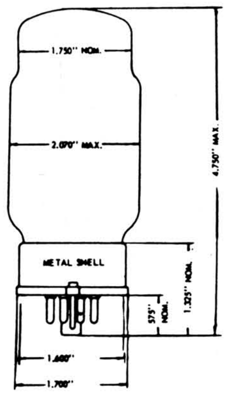
In many circuits, one 6336A has replaced two or three type 6080WA or 6AS7G regulator tubes. For even higher levels of current or power, many 6336A tube sections can be paralleled as explained in the application notes.

ELECTRICAL DATA

Heater Voltage	6.3 ±10% volts
Heater Current (E_f = 6.3 volts)	5.0 amperes
Minimum Cathode Heating Time	30 seconds
Transconductance (per section)	13,500 umhos
Amplification Factor	2.7
Inter Electrode Capacities per Triode Section	
Grid to Cathode	16.7 uuf
Grid to Plate	21.8 uuf
Cathode to Plate	3.8 uuf
Heater to Cathode	15.0 uuf
Inter Electrode Capacities Between Triode Sections	
Section 1 Plate to Section 2 Plate	0.6 uuf

MECHANICAL DATA

Mounting Position	Any
(If tube is to be mounted in a horizontal position it is recommended that it be mounted so that the base lug key be either directly up or directly down)	
Bulb	TT 16 Nonex
Base	Large wafer octal with metal sleeve, 8 pin, JETEC # B8-98
Average Net Weight	3.5 ounces
Maximum Shock Rating (Navy Hi Impact Shock Machine)	720 G
Maximum Vibration Rating (10 to 50 cps)	10 G
(50 to 500 cps)	5 G

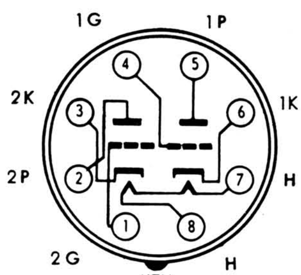


GLASS BULB

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum
Power Dissipation per Plate	—	30 watts
Plate Current per Plate	—	400 ma d. c.
If tube voltage drop is to be swung more than 6 volts, this current cannot be realized. See Plate Characteristics Curve		
Plate Voltage	0	400 volts d. c.
Heater-Cathode Voltage	−300	+300 volts d. c.
Grid Voltage	−300	0 volts d. c.
Grid Current per Grid	—	0 ma.
Heater Voltage	5.7	6.9 volts
Envelope Temperature	—	250 °C
Altitude for Full Ratings	—	10,000 feet
If cooling is provided to keep bulb temperature within ratings, altitude rating can be extended to 60,000 feet		
Circuit Values		
Total Grid Circuit Resistance in Regulator Service or with fixed bias (per grid)	500	200,000 ohms
Total Grid Circuit Resistance with cathode bias only (per grid)	500	500,000 ohms
Resistance per grid leg when triode sections are paralleled	500	— ohms

Cathode Resistance: Minimum cathode resistance per cathode leg shall be 27 ohms or that resistance necessary to provide 10% of the grid bias voltage, whichever is greater.



Bottom View

ADDITIONAL TESTS TO INSURE RELIABILITY

Randomly Selected Samples are Subjected to the Following Tests

Shock: 48° Hammer Angle in Navy, Flyweight, High Impact Machine (720 G/msec)

Life Test: 1000 hours under plate current test conditions

Post Shock and Life Test End Points:

Plate Current	150 mA min.
Transconductance per section	9,000 umho min.
HK Leakage	100 uA max.
Grid Current	−8 uA max.

RANGE OF VALUES

Conditions: E_f = 6.3V, E_b = 190V
E_c = 0, $R_k/_k$ = 200 Ω, $R_g/_g$ = 500 Ω
Both sections operating. Readings taken after 5 minutes power preheating. Each section read separately.

Plate Current per Section	165	200	Milliamperes, d. c.
Amplification Factor	2.0	3.4	
Transconductance	11,000	16000	Micromhos
Heater Current per tube	4.75	5.25	Amperes

Conditions: E_f = 6.3V, E_b= 200V
E_c = −100V, R_k = 0

Plate Current per section	0	10	Milliamperes

Application Notes

The 6336A is widely used as a "passing" tube or series regulator in controlled power supplies because of its high transconductance at relatively low plate voltages. To provide the desired output current, many triode sections can be paralleled. If tube sections are to be paralleled, however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it provides more bias on the sections taking greater plate current. A cathode resistor need be only one fourth the value $\left(\frac{R}{u+1}\right)$ of a plate resistor, and therefore will dissipate only one fourth the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (about two watts) and the additional voltage (less than 10 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively, tied to the plate. The plate will attempt to draw excessive current from the passing tube's cathode and may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulator output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be able to counteract the effect of unbalance due to tube ageing.

A grid resistor should be used for each triode section. This should be enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 6.3 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

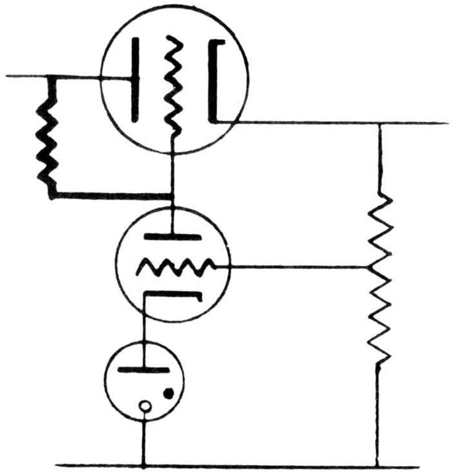


FIGURE 1

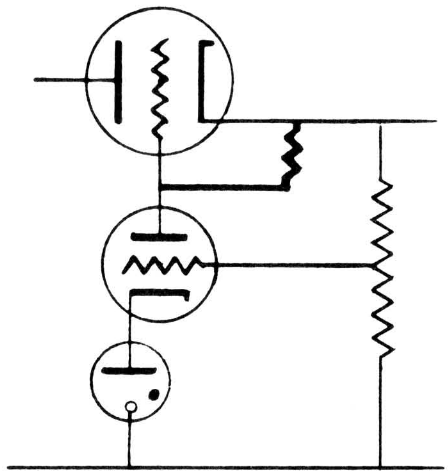


FIGURE 2

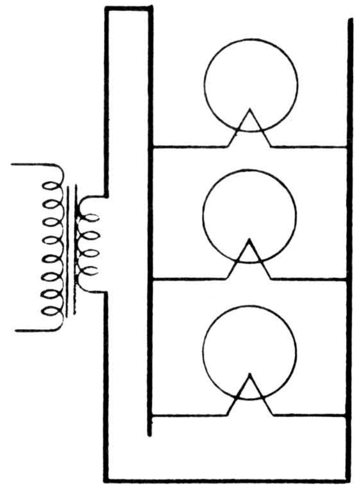
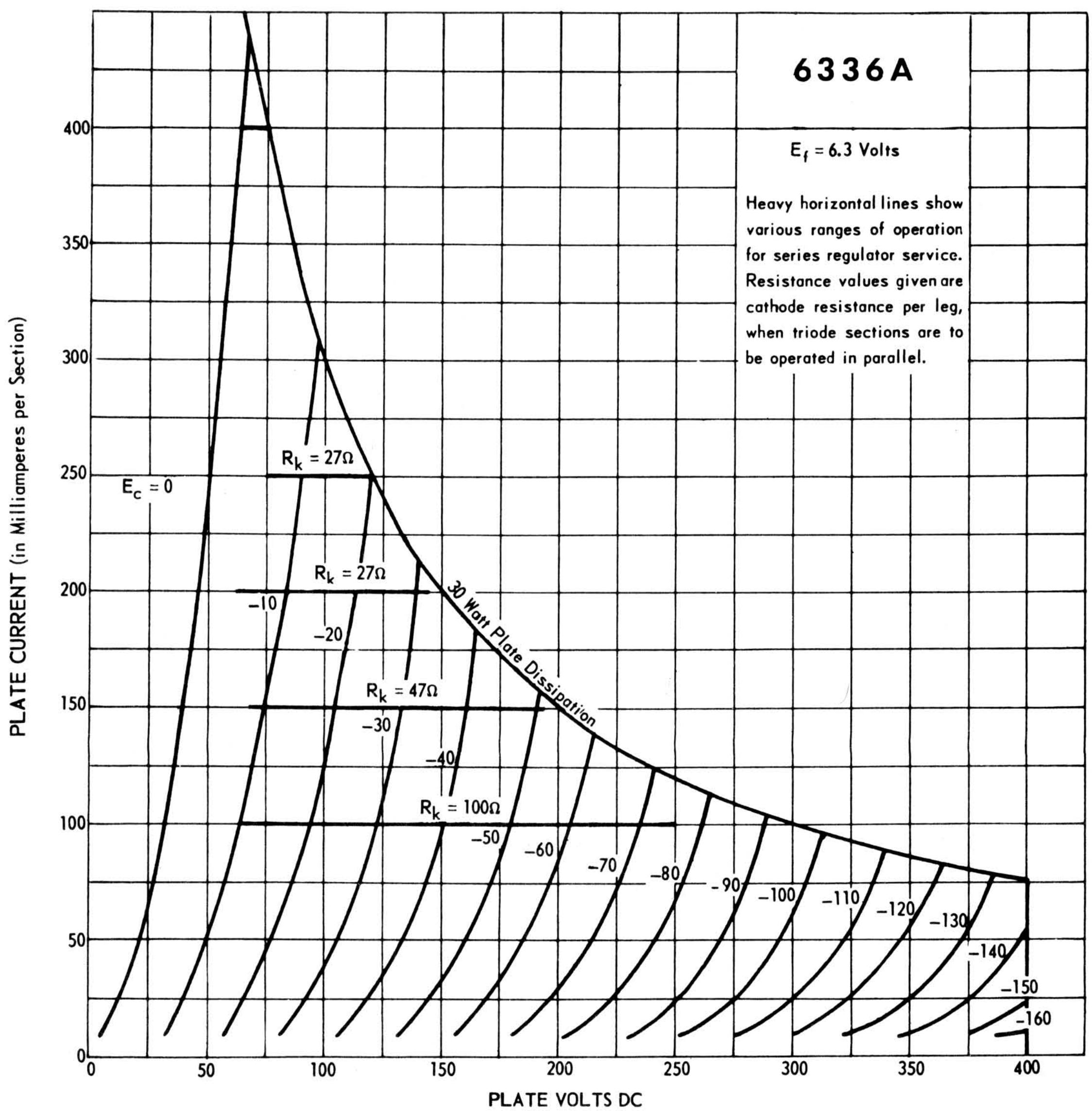
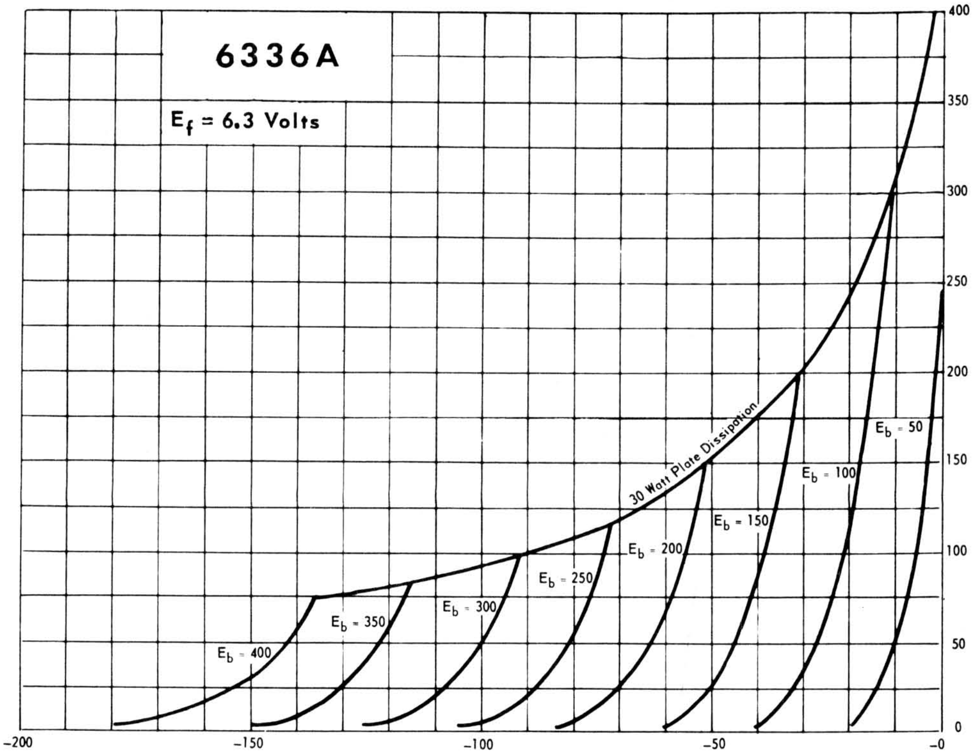


FIGURE 3

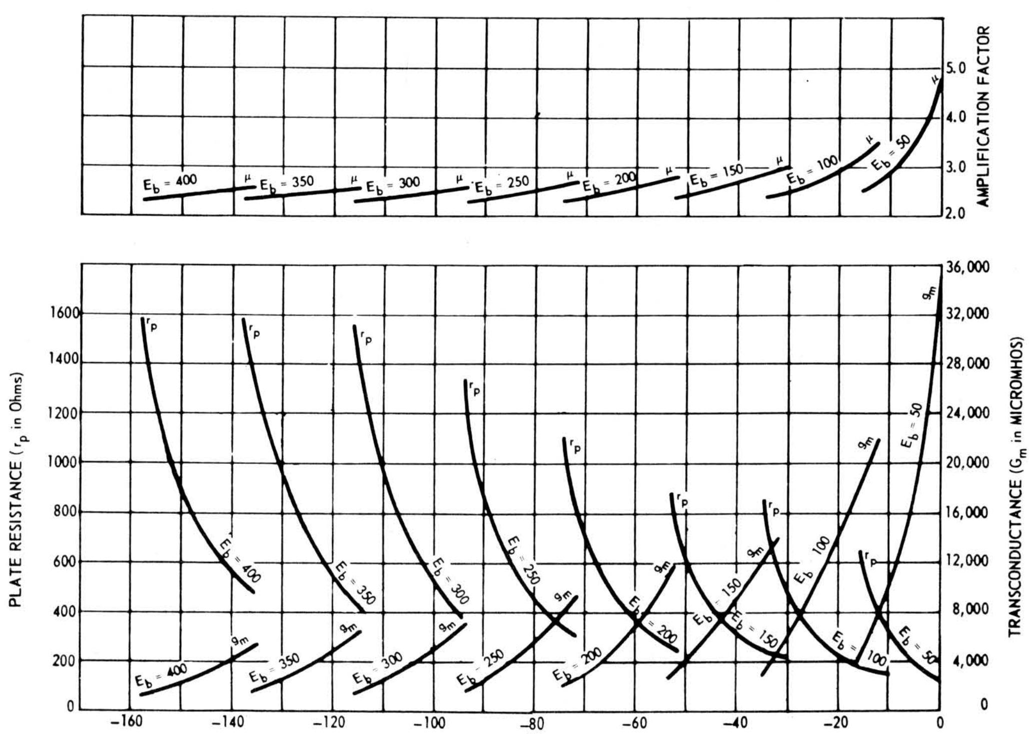
AVERAGE PLATE CHARACTERISTICS FOR EACH TRIODE UNIT



TRANSFER CHARACTERISTICS FOR EACH TRIODE SECTION



AVERAGE CHARACTERISTICS



TUNG-SOL / CHATHAM

TWIN POWER TRIODE FOR SERIES REGULATOR SERVICE

TYPE 6394A

TYPE 6336A is similar in all respects to the 6394A but employs a 6.3 volt, 5 ampere heater. Heater current range at 6.3 volts is 4.75 to 5.25 amperes. Heater voltage limits are 5.7 to 6.9 volts.

DESCRIPTION — The 6394A is a long life, mechanically rugged, twin power triode developed especially for use as a passing tube in series regulated power supplies. For this service, a tube must be able to pass large currents over a wide voltage range and still exhibit a low intrinsic voltage drop when operated "wide open". The 6394A adequately meets these requirements. In addition, its 26.5 volt heater makes it particularly suitable for airborne usage.

The design features zirconium coated graphite anodes that, while lighter in weight than similar metal anodes, remain warp free during life and provide one of the best gas "gettering" means known. The anodes are supported by ceramic insulators. The use of these insulators and the hard glass envelope permit the tube to be outgassed at high temperatures during the manufacturing exhaust process. This allows the tube to be run at high temperatures during operation, without the evolution of harmful gas from the tube parts.

Massive cathodes provide adequate emission current reserve. Gold plated molybdenum wires are employed in the rugged grid structure. The tube mount is built on a rugged button stem, and is supported from the bulb by means of flexible metal vibration snubbers.

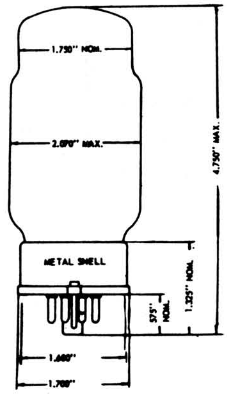
In many circuits, one 6394A has replaced two or three type 6082 regulator tubes. For even higher levels of current or power, many 6394A tube sections can be paralleled as explained in the application notes.

ELECTRICAL DATA

Heater Voltage	26.5 ±10% volts
Heater Current (E_f = 26.5 volts)	1.3 amperes
Minimum Cathode Heating Time	30 seconds
Transconductance (per section)	13,500 umhos
Amplification Factor	2.7
Inter Electrode Capacities per Triode Section	
Grid to Cathode	16.7 uuf
Grid to Plate	21.8 uuf
Cathode to Plate	3.8 uuf
Heater to Cathode	15.0 uuf
Inter Electrode Capacities Between Triode Sections	
Section 1 Plate to Section 2 Plate	0.6 uuf

MECHANICAL DATA

Mounting Position	Any
(If tube is to be mounted in a horizontal position it is recommended that it be mounted so that the base lug key be either directly up or directly down)	
Bulb	TT 16 Nonex.
Base	Large wafer octal with metal sleeve, 8 pin, JETEC # B8-98
Average Net Weight	3.5 ounces
Maximum Shock Rating (Navy Hi Impact Shock Machine)	720 G
Maximum Vibration Rating (10 to 50 cps)	10 G
(50 to 500 cps)	5 G

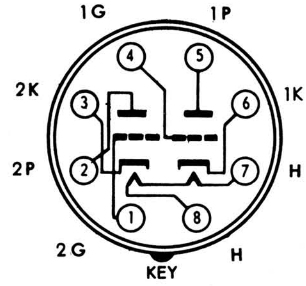


GLASS BULB

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum
Power Dissipation per Plate	—	30 watts
Plate Current per Plate	—	400 ma d. c.
If tube voltage drop is to be swung more than 6 volts, this current cannot be realized. See Plate Characteristics Curve		
Plate Voltage	0	400 volts d. c.
Heater-Cathode Voltage	−300	+300 volts d. c.
Grid Voltage	−300	0 volts d. c.
Grid Current per Grid	—	0 ma.
Heater Voltage	24.0	29.0 volts
Envelope Temperature	—	250 °C.
Altitude for Full Ratings	—	10,000 feet
If cooling is provided to keep bulb temperature within ratings, altitude rating can be extended to 60,000 feet		
Circuit Values		
Total Grid Circuit Resistance in Regulator Service or with Fixed Bias (per grid)	500	200,000 ohms
Total Grid Circuit Resistance with Cathode Bias only (per grid)	500	500,000 ohms
Resistance per grid leg when triode sections are paralleled	500	— ohms

Cathode Resistance: Minimum cathode resistance per cathode leg shall be 27 ohms or that resistance necessary to provide 10% of the grid bias voltage, whichever is greater.



Bottom View

ADDITIONAL TESTS TO INSURE RELIABILITY

Randomly Selected Samples are Subjected to the Following Tests

Shock: 48° Hammer Angle in Navy, Flyweight, High Impact Machine (720 G/msec)

Life Test: 1000 hours under plate current test conditions

Post Shock and Life Test End Points:

Plate Current	150 mA min.
Transconductance per section	9,000 umho min.
HK Leakage	100 uA max.
Grid Current	−8 uA max.

RANGE OF VALUES

Conditions: $E_f = 26.5V, E_b = 190V$
$E_c = 0, R_k/_k = 200\ \Omega, R_g/_g = 500\ \Omega$
Both sections operating. Readings taken after 5 minutes power preheating. Each section read separately.

Plate Current per Section	165	200	Milliamperes, d. c.
Amplification Factor	2.0	3.4	
Transconductance	11,000	16000	Micromhos
Heater Current per tube	1.2	1.4	Amperes

Conditions: $E_f = 26.5V, E_b = 200V$
$E_c = -100V, R_k = 0$

Plate Current per section	0	10	Milliamperes

Application Notes

The 6394A is widely used as a "passing" tube or series regulator in controlled power supplies because of its high transconductance at relatively low plate voltages. To provide the desired output current, many triode sections can be paralleled. If tube sections are to be paralleled, however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it provides more bias on the sections taking greater plate current. A cathode resistor need be only one fourth the value $\left(\frac{R}{u+1}\right)$ of a plate resistor, and therefore will dissipate only one fourth the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (about two watts) and the additional voltage (less than 10 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively, tied to the plate. The plate will attempt to draw excessive current from the passing tube's cathode and may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulator output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be able to counteract the effect of unbalance due to tube ageing.

A grid resistor should be used for each triode section. This should be enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 26.5 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

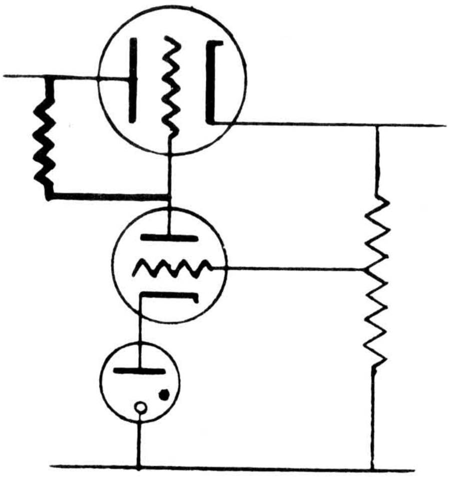


FIGURE 1

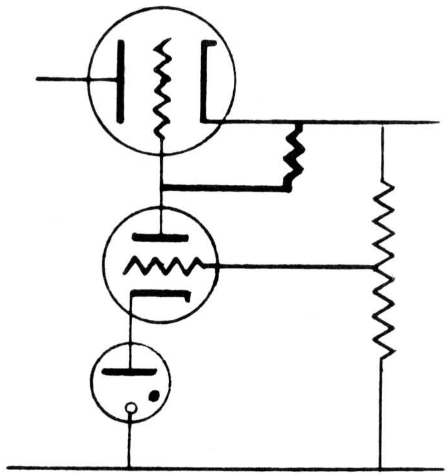


FIGURE 2

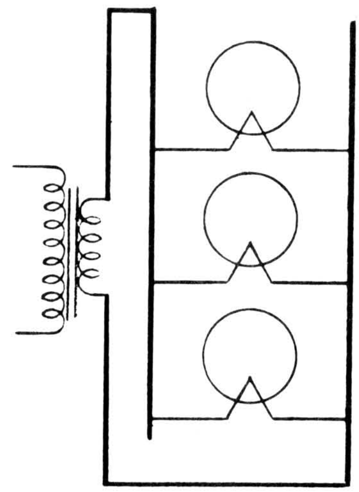
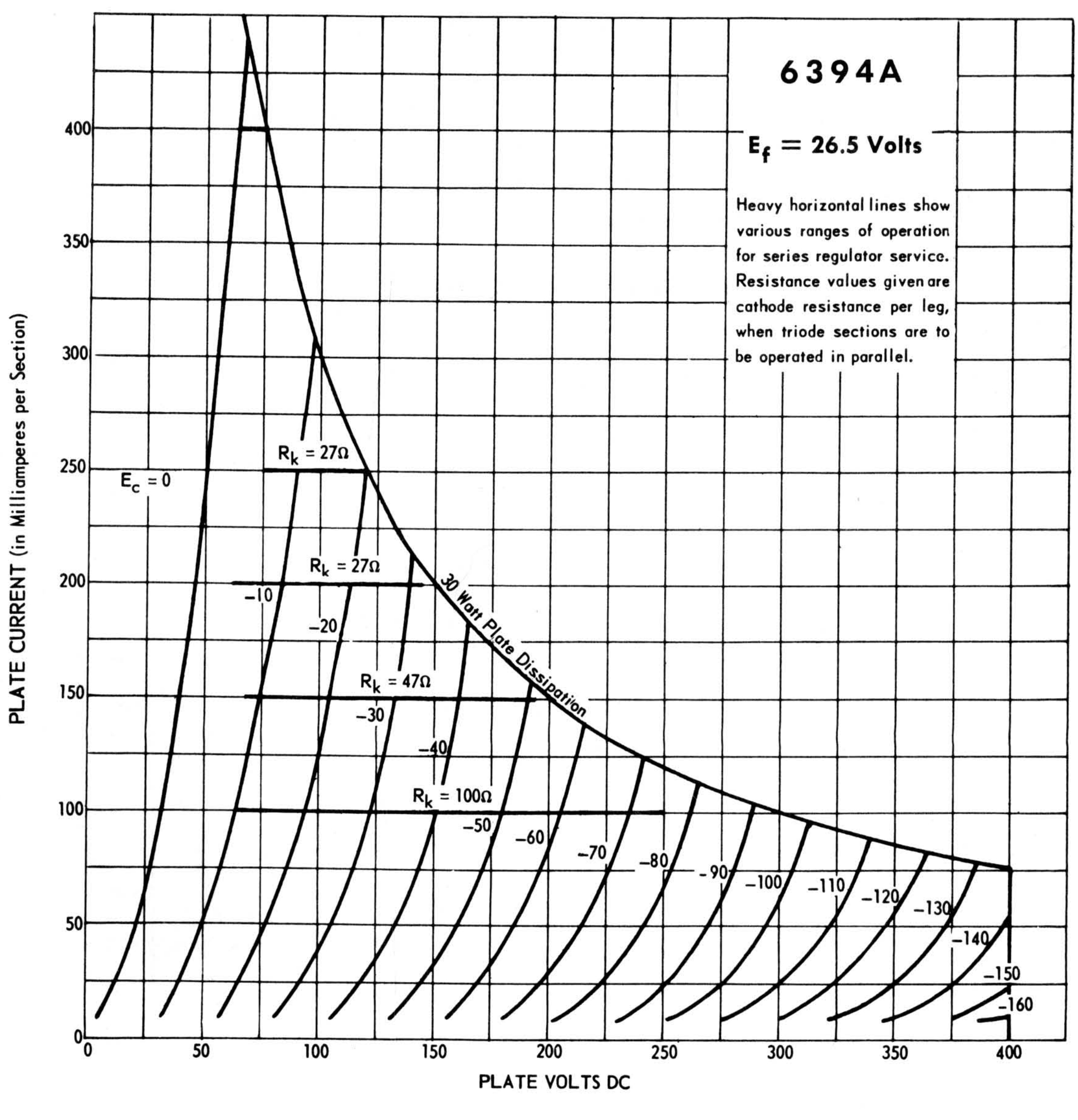
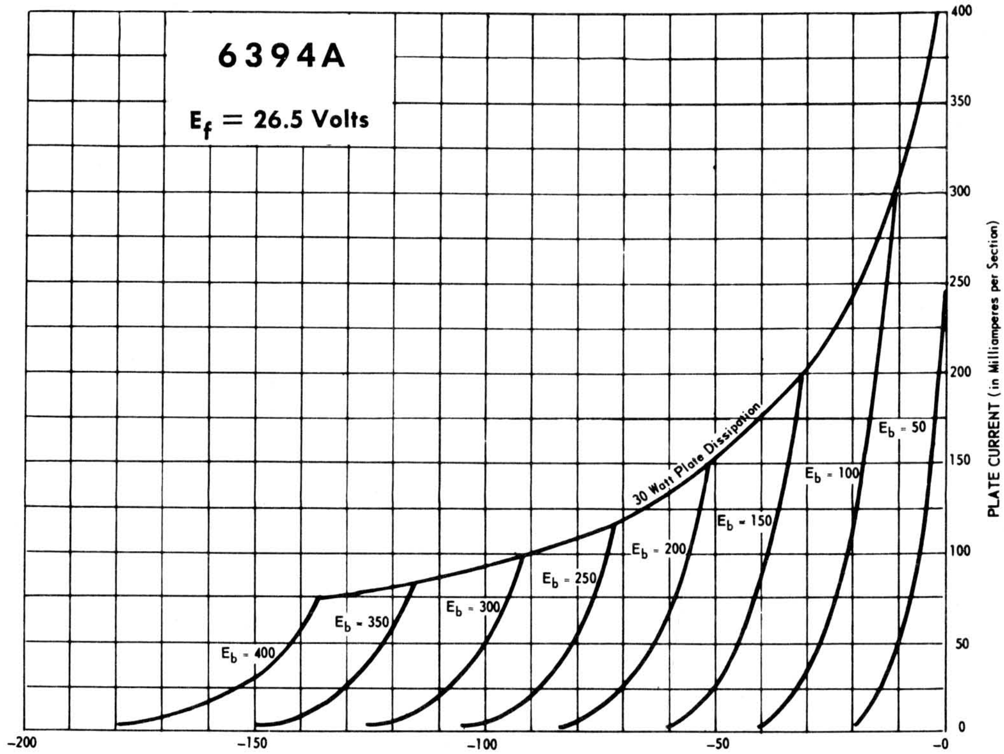


FIGURE 3

AVERAGE PLATE CHARACTERISTICS FOR EACH TRIODE UNIT

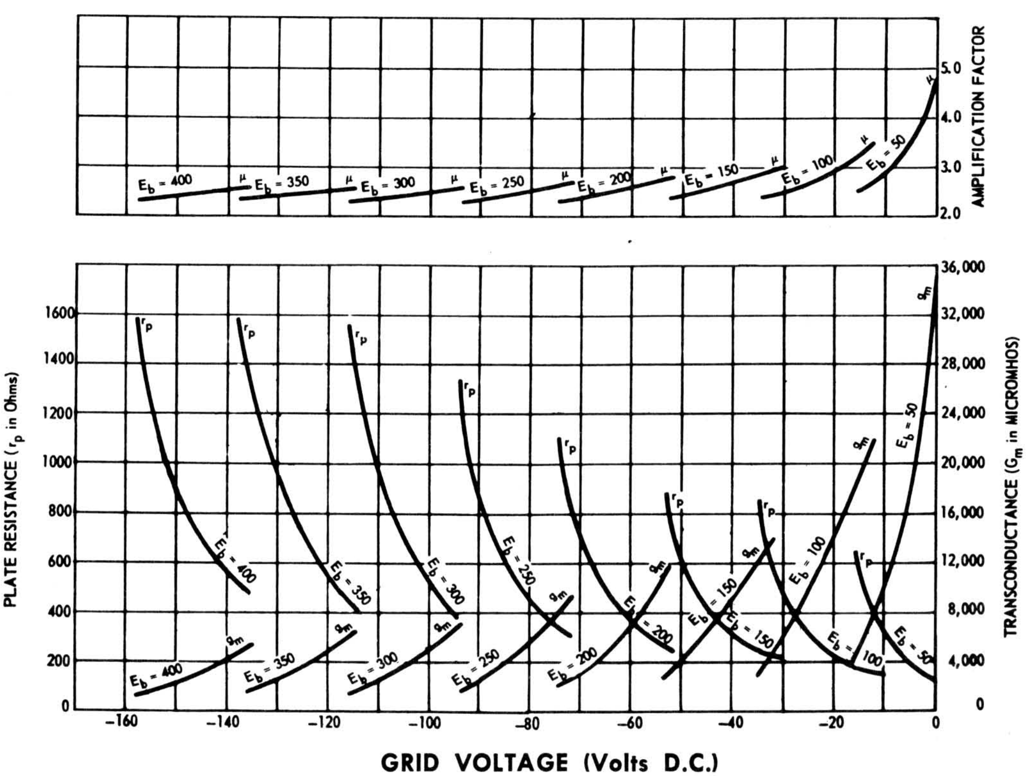


TRANSFER CHARACTERISTICS FOR EACH TRIODE SECTION



GRID VOLTAGE (Volts D.C.)

AVERAGE CHARACTERISTICS



GRID VOLTAGE (Volts D.C.)

TUNG-SOL/CHATHAM

MEDIUM MU TWIN POWER TRIODE FOR SERIES REGULATOR SERVICE

TYPE 6528

DESCRIPTION ———— The 6528 is a long life, mechanically rugged, twin power triode developed especially for use as a passing tube in series regulated power supplies. For this service, a tube must be able to pass large currents over a wide voltage range and still exhibit a low intrinsic voltage drop when operated "wide open." The 6528 not only meets these requirements but possesses the additional advantage of requiring little grid voltage swing to control these currents. This permits the use of simpler control amplifier circuits in the regulated supply.

The design features zirconium coated graphite anodes that, while lighter in weight than similar metal anodes, remain warp free during life and provide one of the best gas "gettering" means known. The anodes are supported by ceramic insulators. The use of these insulators and the hard glass envelope permit the tube to be outgassed at high temperatures during the manufacturing exhaust process. This allows the tube to be run at high temperatures during operation, without the evolution of harmful gas from the tube parts.

Massive cathodes provide adequate emission current reserve. Gold plated molybdenum wires are employed in the rugged grid structure. The tube mount is built on a rugged button stem, and is supported from the bulb by means of flexible metal vibration snubbers.

In Regulator circuits one 6528 will replace two or three type 6080 WA or three or four beam power tubes. For even higher levels of current or power, many 6528 tube sections can be paralleled as explained in the application notes.

ELECTRICAL DATA

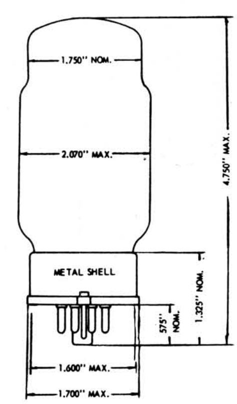
Heater Voltage	6.3 ±10% volts
Heater Current (E_f = 6.3 volts)	5.0 amperes
Minimum Cathode Heating Time	30 seconds
Transconductance (per section)	37,000 umhos
Amplification Factor	9.0
Plate Resistance	245 ohms

Inter Electrode Capacities per Triode Section	
Grid to Cathode	17.8 uuf
Grid to Plate	23.8 uuf
Cathode to Plate	2.9 uuf
Heater to Cathode	15.0 uuf
Inter Electrode Capacities Between Triode Sections	
Section 1 Plate to Section 2 Plate	0.6 uuf

MECHANICAL DATA

Mounting Position (If tube is to be mounted in a horizontal position it is recommended that it be mounted so that the base lug key be either directly up or directly down)	Any
Bulb	TT 16 Nonex
Base	Large wafer octal with metal sleeve, 8 pin, JETC # B8-86

Average Net Weight	3.5 ounces
Maximum Shock Rating (Navy Hi Impact Shock Machine)	720 G
Maximum Vibration Rating	
(10 to 50 cps)	10 G
(50 to 500 cps)	5 G

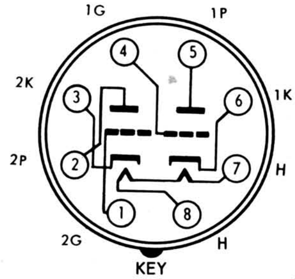


GLASS BULB

RATINGS, ABSOLUTE VALUES

	Min.	Max.	
Power Dissipation per Plate	—	30	watts
Plate Current per Plate	—	300	milliamperes d. c.
If tube voltage drop is to be swung more than 6 volts, this current cannot be realized. See Plate Characteristics Curve.			
Plate Voltage	0	400	volts d. c.
Heater-Cathode Voltage	−300	+300	volts d. c.
Grid Voltage	−300	0	volts d. c.
Grid Current per Grid	—	0	milliamperes
Heater Voltage	5.7	6.9	volts
Envelope Temperature	—	250	°C.
Altitude for Full Ratings	—	10,000	feet
If cooling is provided to keep bulb temperature within ratings, altitude rating can be extended to 60,000 feet.			
Circuit Values			
Total Grid Circuit Resistance in Regulator Service or with fixed bias	500	50,000	ohms
Total Grid Circuit Resistance with cathode bias only	500	500,000	ohms
Resistance per grid leg when triode sections are paralleled	500	—	ohms

Cathode Resistance: Minimum cathode resistance per cathode leg shall be 10 ohms or that resistance necessary to provide 10% of the grid bias voltage, whichever is greater.



Bottom View
Large Wafer Octal with Metal Sleeve

Additional Tests to Insure Reliability

Randomly Selected Samples are Subjected to the Following Tests

Shock: 48° Hammer Angle in Navy, Flyweight, High Impact Machine (720 /Gmsec)

Life Test: 1000 hours under plate current test conditions ($R_g/_g$ =.05 Meg.)

Post Shock and Life Test End Points:

Plate Current	130 mA min.
Transconductance per section	23,500 umho min.
HK Leakage	100 uA max.
Grid Current per Section	—4 uA max.

Range of Values

Conditions: $E_f = 6.3$ V, $E_b = 100$ V
$E_c = -4$, $R_g/_g = 500\ \Omega$
Both sections operating. Readings taken after 2 min. preheating under conditions of $E_f = 6.3$, $E_{bb} = 190$ V, $E_c = 0$, $R_k = 200$ ohms. Each section read separately.

Plate Current per Section	140	230	Milliamperes, d.c.
Amplification Factor	7.0	11.0	
Transconductance	29,000	45,000	Micromhos
Heater Current per tube	4.75	5.25	Amperes

Conditions: $E_f = 6.3$ V, $E_b = 400$ V
$E_c = -75$ V, $R_k = 0$

Plate Current per section	0	3	Milliamperes

Application Notes

The 6528 is admirably suitable for use as a "passing" tube or series regulator in electronically controlled power supplies because of its ability to pass large currents and to easily control them. To provide the desired output current, many triode sections can be paralleled. If tube sections are to be paralleled, however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it provides more bias on the sections taking greater plate current. A cathode resistor need be only one tenth the value $\left(\frac{R}{u+1}\right)$ of a plate resistor, and therefore will dissipate only one tenth the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (less than one watt) and the additional voltage (less than 6 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively, tied to the plate. The plate will attempt to draw excessive current from the passing tube's cathode which may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulated output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be able to counteract the effect of unbalance due to tube ageing.

A grid resistor should be used for each triode section. This should be enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 6.3 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

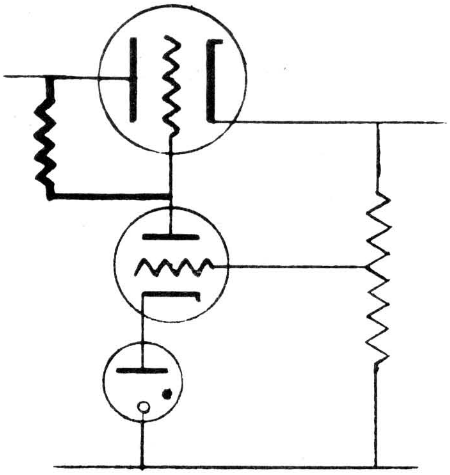


FIGURE 1

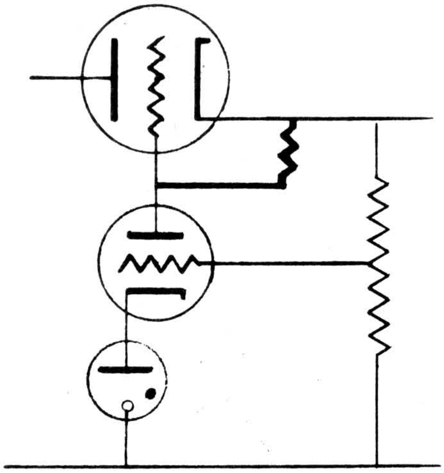


FIGURE 2

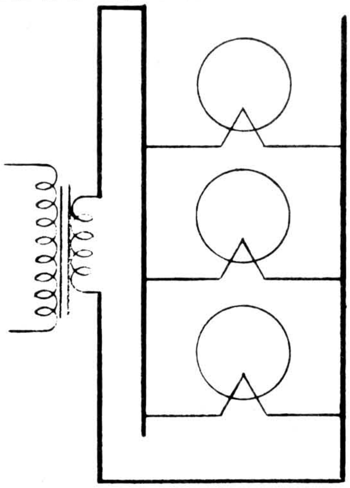
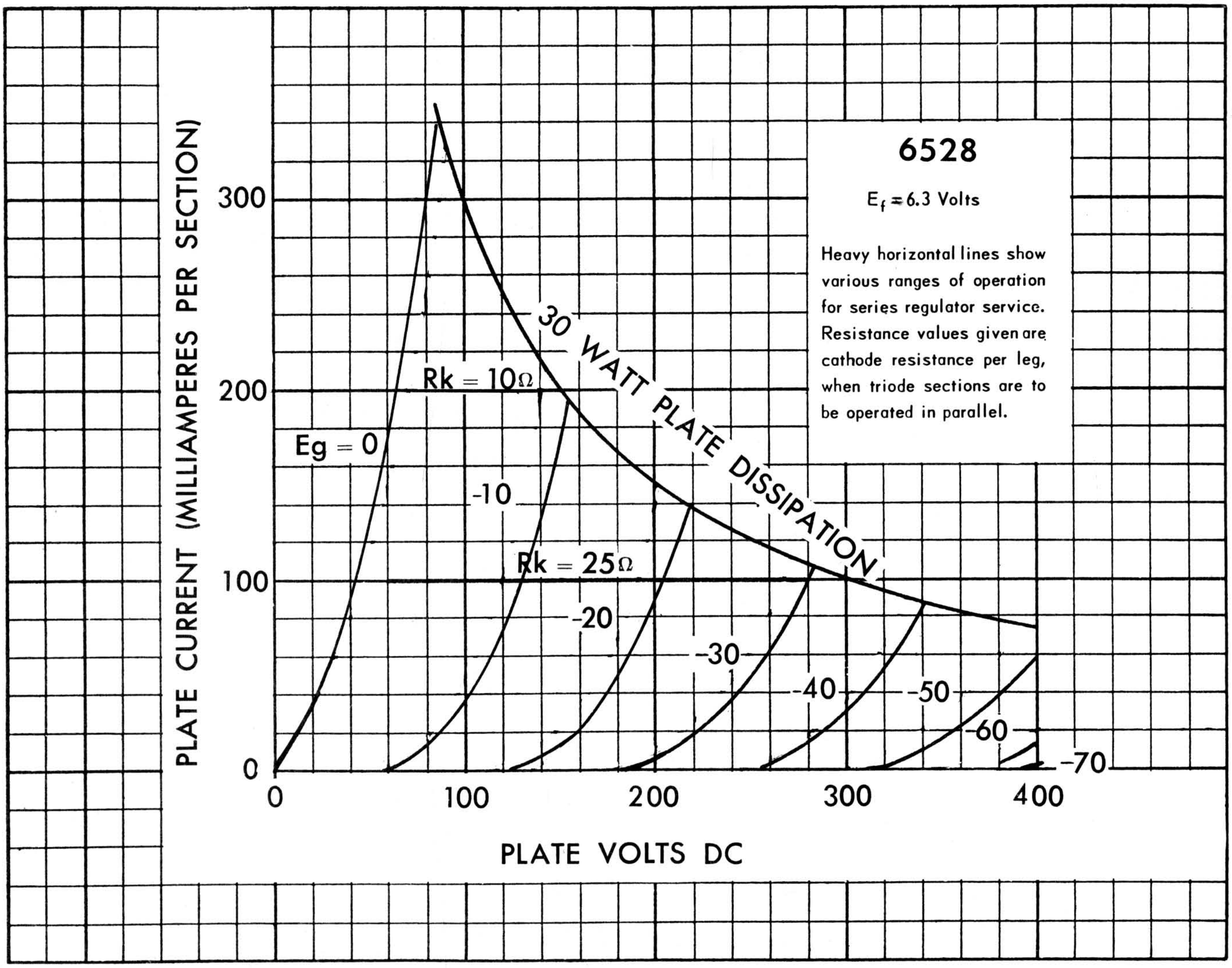
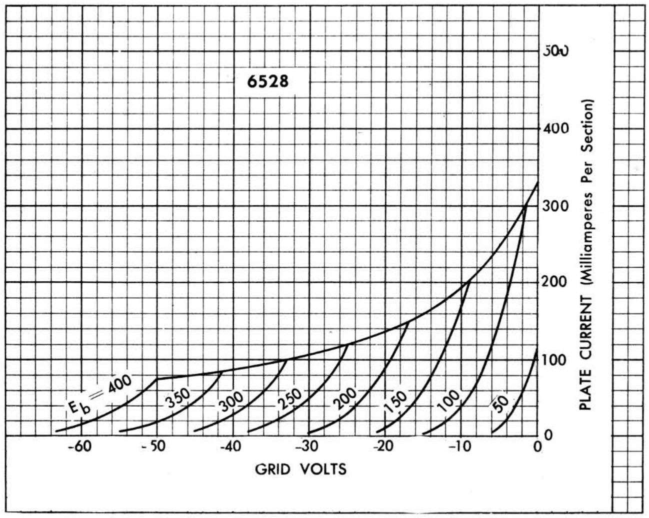


FIGURE 3

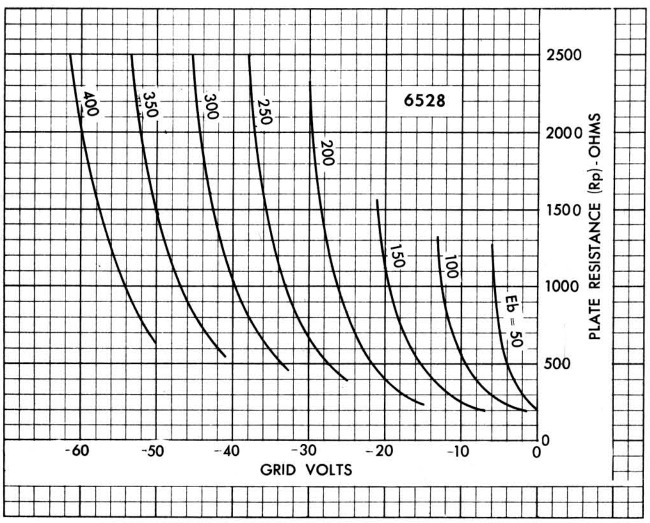
AVERAGE PLATE CHARACTERISTICS FOR EACH TRIODE UNIT

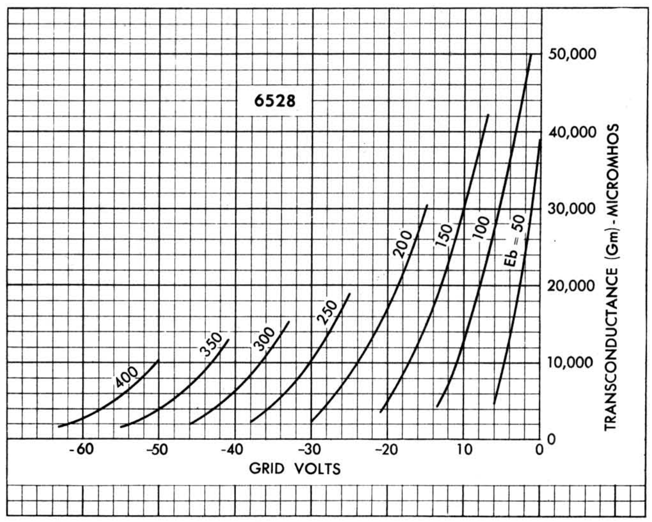


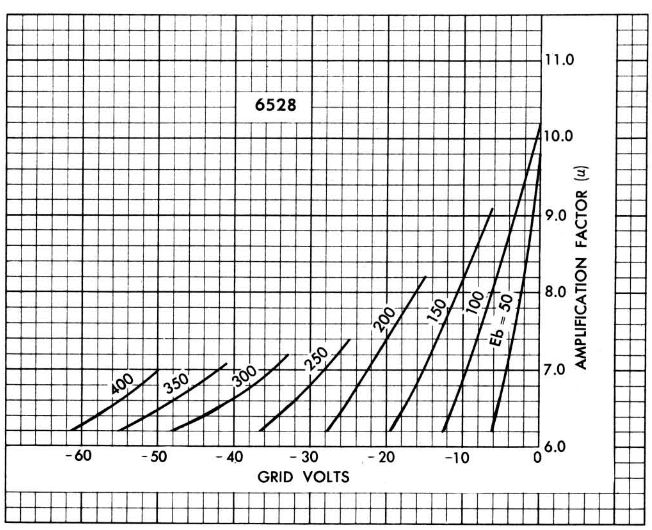
TRANSFER CHARACTERISTICS FOR EACH TRIODE SECTION



AVERAGE CHARACTERISTICS







LITHO IN U.S.A

TUNG-SOL/CHATHAM

TYPE 6542

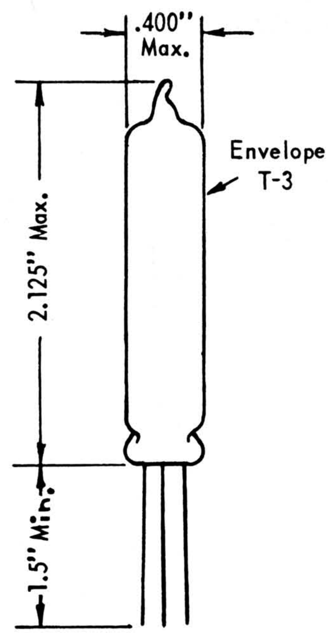
DESCRIPTION — The 6542 is a two electrode, inert-gas-filled cold cathode subminiature tube intended for use as a voltage regulator. The tube has a maintaining voltage of approximately 150 volts over a current range of 5 to 25 milliamperes. The 6542 is excellent for applications which require good voltage regulation and long life, consistent with small size and low weight.

ELECTRICAL DATA

Cathode .... Cold

MECHANICAL DATA

Mounting Position .... Any
Maximum Overall Length .... See Outline
Maximum Diameter .... 0.400"
Weight (Approx.) .... 0.16 oz.
Bulb T-3
Base .... Sub-Miniature Flat Press With 3 Flying Leads



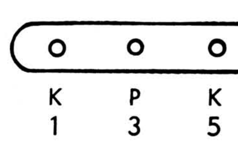
RATINGS, ABSOLUTE VALUES

Maximum D.C. Cathode Current .... 25 ma
Minimum D.C. Cathode Current .... 5 ma
Maximum Bulb Temperature .... 155°C
Minimum Ambient Temperature .... —55°C
Maximum Altitude .... 60,000 ft.

CIRCUIT VALUES

Maximum Shunt Capacitor .... 0.1 uf
Series Resistor .... See Operation Notes

PIN CONNECTIONS
(Bottom View)

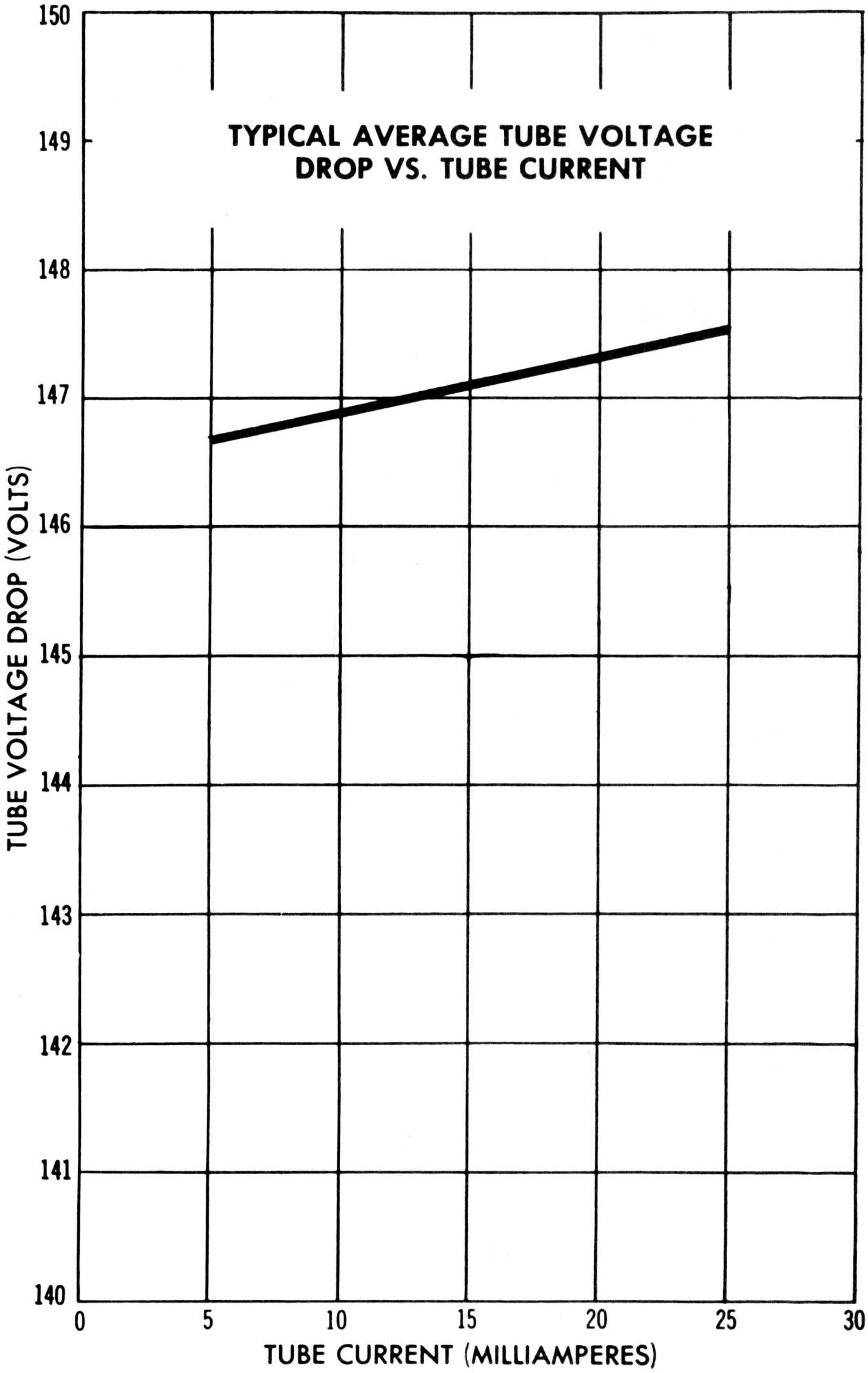


0.016" TINNED FLEXIBLE LEADS
0.096" CENTER TO CENTER

Equipment Design and Range Values

	Minimum Volts	Average Volts	Maximum Volts
D.C. Anode Supply Voltage	185*	—	—
Anode Breakdown Voltage	—	150	180
Tube Voltage Drop	140	147	168
Regulation (5 to 25 ma)	—	0.8	6

*In order to assure starting through tube life not less than the specified supply voltage should be provided.



Operating Notes

Special attention should be given to the bulb temperature at which the tubes are to be operated. Reliability will be seriously impaired if the maximum bulb temperature is exceeded.

In the operation of a glow tube there are several requirements which must always be met. The first is that the supply voltage must always be greater than the anode breakdown voltage and the second is that sufficient resistance must always be put in series with the tube in order to limit the current to the minimum and maximum values given in the ratings.

In order to illustrate how to calculate the value of the series resistance a typical regulator circuit is shown in Fig. 1.

From Fig. 1 we see that V_1 is the unregulated supply voltage, V_2 is the tube voltage drop on the regulated voltage supplied to the load, R_1 is the series limiting resistor, R_L is the variable load, I_T is the tube current and I_L is the load current.

We see that the tube current will be a maximum when the supply voltage is a maximum (V_1 max.); when the load current is a minimum (I_L min.); and when the tube voltage drop is a minimum (V_2 min.). Therefore the conditions which determine the lower limit for the series resistance R_1 are that

$$R_1 > \frac{V_1 \text{ max.} - V_2 \text{ min.}}{I_T \text{ max.} + I_L \text{ min.}}$$

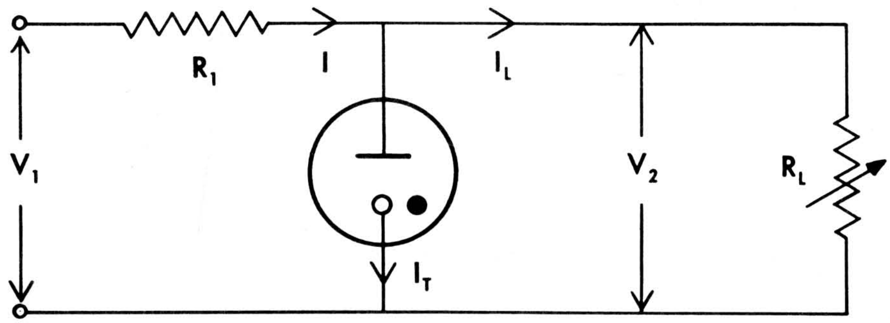
In a like manner it can be shown that the value of R_1 in order to limit the current to the minimum value requires that

$$R_1 < \frac{V_1 \text{ min.} - V_2 \text{ max.}}{I_T \text{ min.} + I_L \text{ max.}}$$

When these values have been computed, one should check to see if there is sufficient starting voltage by the following relation

$$V_1 \text{ min.} \frac{R_L}{R_1 + R_L} > V \text{ Starting}$$

Figure 1



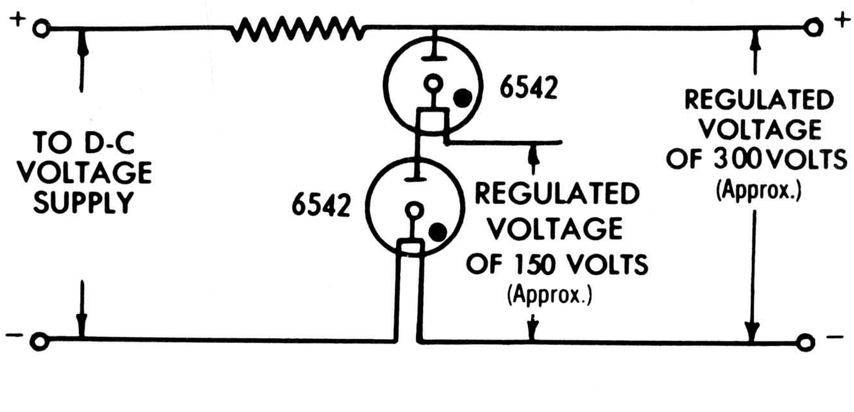


Figure 2—OPERATION OF REGULATOR TUBES IN SERIES

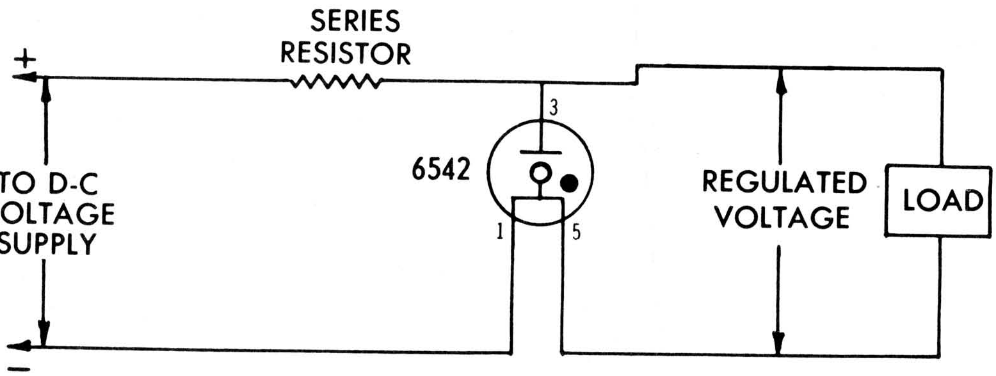


Figure 3—TYPICAL CIRCUIT FOR VOLTAGE REGULATOR

When these calculations have been made and there is insufficient starting voltage, a new load current of lower value must be used and the calculations repeated.

Circuits which have a capacitor in shunt with the **6542** should be limited in value to 0.1 μf, larger values might cause oscillations.

Operation of the **6542** in parallel is not recommended unless a resistance of approximately 100 ohms is used in series with each **6542** to equalize division of current. However, it should be noted that while this enables one to handle more load current it reduces the regulation that can be obtained.

If it is desired to obtain higher regulating voltages, tubes may be operated in series as indicated in Fig. 2. However, care should be taken to see that sufficient supply voltage is available to start both tubes.

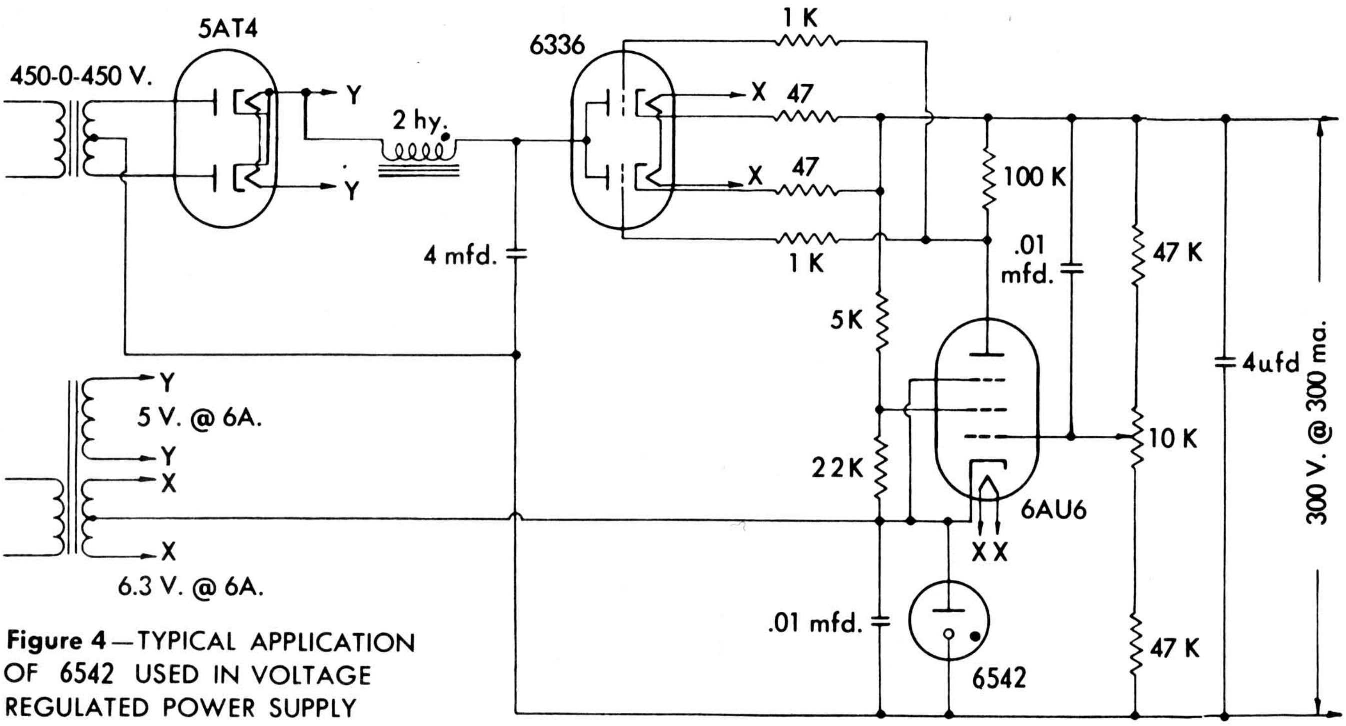


Figure 4—TYPICAL APPLICATION OF 6542 USED IN VOLTAGE REGULATED POWER SUPPLY

TUNG-SOL/CHATHAM

TYPE 6627/OB2WA

RELIABLE MINIATURE VOLTAGE REGULATOR

DESCRIPTION—The 6627/OB2WA is a miniature, two electrode, inert-gas-filled, cold cathode tube for use as a voltage regulator. It maintains practically constant operating voltage over a current range of 5 to 30 milliamperes. It has been designed to give extremely small voltage drift throughout life by controlled manufacturing processes. This tube has been specially designed to maintain stable operating voltages through life, even in applications which require tubes to operate continuously under environmental conditions which raise the bulb temperature to a maximum of 150° C.

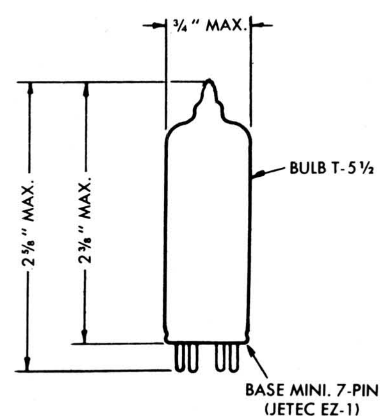
Over the range of 6 to 10 milliamperes, this tube exhibits reference tube characteristics. The 6627/OB2WA also has improved characteristics for shock, vibration, and dark breakdown voltage.

ELECTRICAL DATA

Cathode	Cold

MECHANICAL DATA

Mounting Position	Any
Maximum Overall Length	2⅝ inches
Maximum Seated Length	2⅜ inches
Maximum Diameter	¾ inch
Weight (Approx.)	0.3 oz.
Bulb	T-5½
Base	Small-button Miniature 7-Pin (JETEC EZ-1)

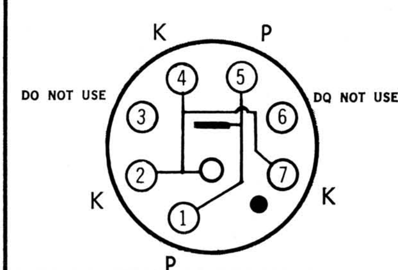


RATINGS, ABSOLUTE VALUES

Maximum D.C. Cathode Current	30 ma
Minimum D.C. Cathode Current	5 ma
Maximum Bulb Temperature	150°C
Minimum Ambient Temperature	—55°C
Maximum Altitude	120,000 ft.
Maximum Inverse Voltage	—50. v.
Shock Impact	450 G/ms
Vibration Fatigue	2.5 G

PIN CONNECTIONS

(Bottom View)



Circuit Values

Maximum Shunt Capacitor	0.1 uf
Series Resistor	See Operation Notes

Additional Tests to Insure Reliability

Randomly Selected Samples are Subjected to the Following Tests.

Shock: 30° Hammer angle in Navy, Flyweight, High Impact Machine (450 G/msec).

Fatigue: 25 cps, 0.08″ Total displacement, for 32 hours in each of three mutually perpendicular planes (2.5 G).

Post Shock and Fatigue Limits:
- Ionization Voltage .... 130 v.d.c. max.
- Tube Voltage Drop (5. and 30. mA) .... 105 to 111 v.d.c.
- Regulation (5. to 30. mA) .... 2.5 v.d.c. max.

Survival Rate Life Test (100 hours): End Point:
- Change in Tube Voltage Drop from Initial Valve 5%
- Voltage Repeatability .... 0.4 v.d.c. max.

Intermittent Life Test: End Points (500 hours):
- Change in Tube Voltage Drop from Initial Value .... 3% max.
- Tube Voltage Drop .... 103 to 113 v.d.c.
- Regulation .... 3.0 v.d.c. max.
- Ionization Voltage .... 130 v.d.c. max.
- Voltage Repeatability .... 0.4 v.d.c. max.

End Points (1000 hours):
- Change in Tube Voltage Drop from Initial Value .... 4% max.
- Tube Voltage Drop .... 103 to 116 v.d.c.
- Regulation .... 3.0 v.d.c. max.
- Ionization Voltage .... 130 v.d.c. max.
- Voltage Repeatability .... 0.4 v.d.c. max.

Equipment Design and Range Values

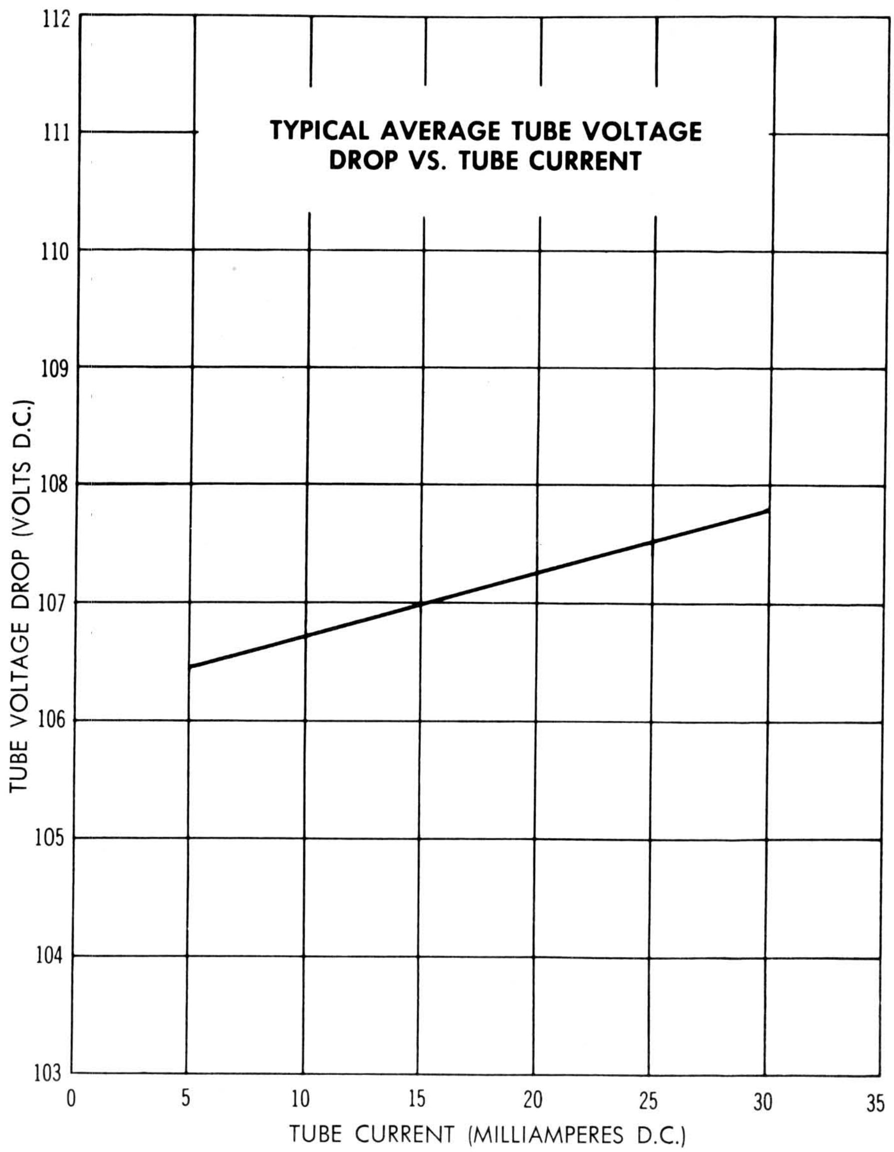
	Min.	Average	Max.	
D.C. Anode Supply Voltage in Darkness	130*	—	—	volts
D.C. Anode Supply Voltage in Light	130*	—	—	volts
Anode Breakdown Voltage	—	118	130	volts
Tube Voltage Drop (1) at 5. ma	103	107	—	volts
Tube Voltage Drop (2) at 30. ma	—	108	116	volts
Regulation	—	1.1	2.5	volts
Voltage Jump**	—	0	100	millivolts
Voltage Repeatability***	—	0.1	0.4	volts
Oscillation (Aural check)	—	—	—	
Noise	—	0	5.0	millivolts
Leakage Current (Eb = 50v, Rp = 3000Ω)	—	0	5.0	microamps
Maximum Shunt Capacitor	—	—	0.1	microfarads
Series Resistor	****	—	—	
Maximum Current through Interconnected leads	—	—	1.0	ampere

* To assure starting throughout tube life, the supply voltage should not be less than this value.

** The maximum voltage fluctuation at any current level within the current range of 6 to 10 milliamperes.

*** Tube is cycled one minute on and one minute off for five cycles. Readings are taken initially and at the end of each "on" period.

**** Sufficient series resistance must be used to limit the current to a maximum of 30. ma at the highest anode supply voltage and to limit the current to a minimum of 5. ma at the lowest anode supply voltage.



Operating Notes

Special attention should be given to the bulb temperature at which the tubes are to be operated. Reliability will be seriously impaired if the maximum bulb temperature is exceeded.

There are several requirements in the operation of a glow discharge tube, like the 6627/OB2WA, which must always be met. The first condition is that the supply voltage must always be greater than the anode breakdown voltage. The second factor to be considered is that sufficient resistance must always be put in series with the 6627/OB2WA to limit the current to the minimum and maximum values given in the ratings.

A typical regulator circuit is shown in Fig. 1, in order to illustrate the methods used for determining the correct values for the series limiting resistor, and supply voltage. From Fig. 1 we see that

V_1 = unregulated supply voltage
V_2 = tube voltage drop or regulated voltage supplied to the load.
R_1 = series limiting resistor
R_2 = variable load
I_T = tube current
I_L = load current.

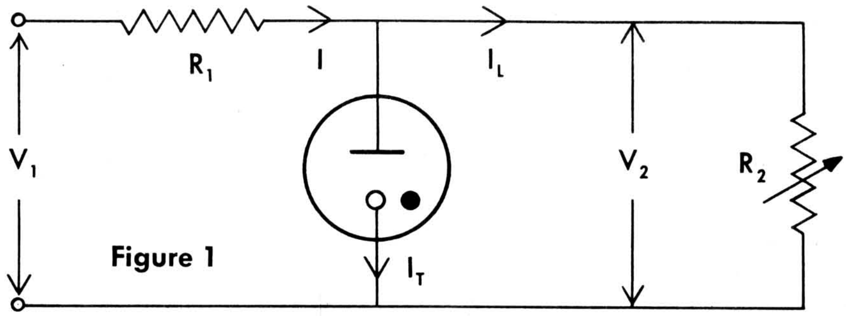


Figure 1

The current in the 6627/OB2WA will be a maximum when the supply voltage is a maximum, V_1 max.; when the load current is a minimum, I_L min.; and the tube voltage is a minimum, V_2 min. Therefore the conditions which determine the lower limit for the series resistance R_1 are that

$$R_1 > \frac{V_1 \text{ max.} - V_2 \text{ min.}}{I_T \text{ max.} + I_L \text{ min.}}$$

In a similar manner it can be shown that the value of R_1, in order to limit the current to the minimum value requires that

$$R_1 < \frac{V_1 \text{ min.} - V_2 \text{ max.}}{I_T \text{ min.} + I_L \text{ max.}}$$

With these values computed a check should be made for sufficient starting voltage by the following relation

$$V_1 \text{ min.} \frac{R_2}{R_1 + R_2} > V \text{ Starting}$$

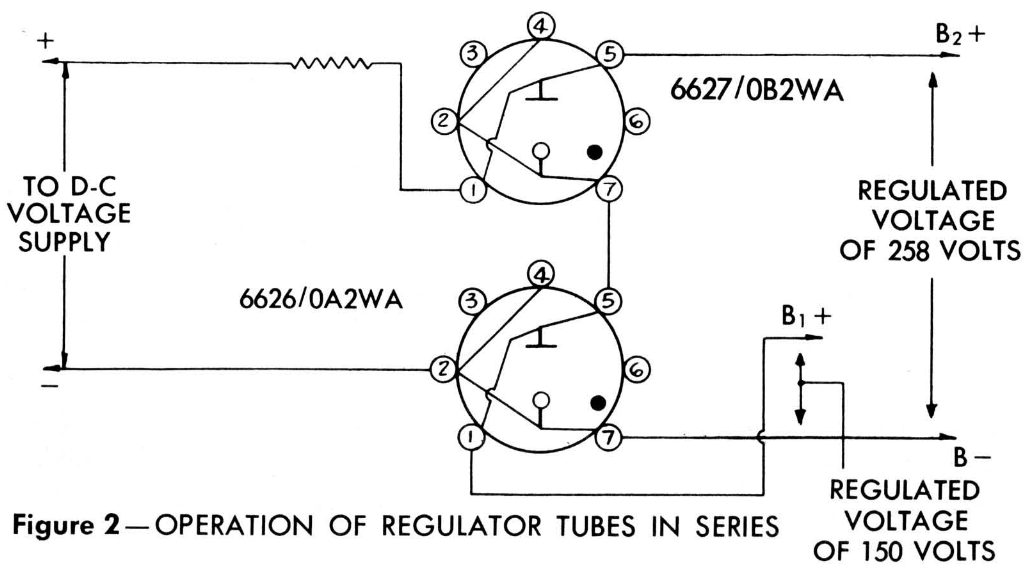


Figure 2—OPERATION OF REGULATOR TUBES IN SERIES

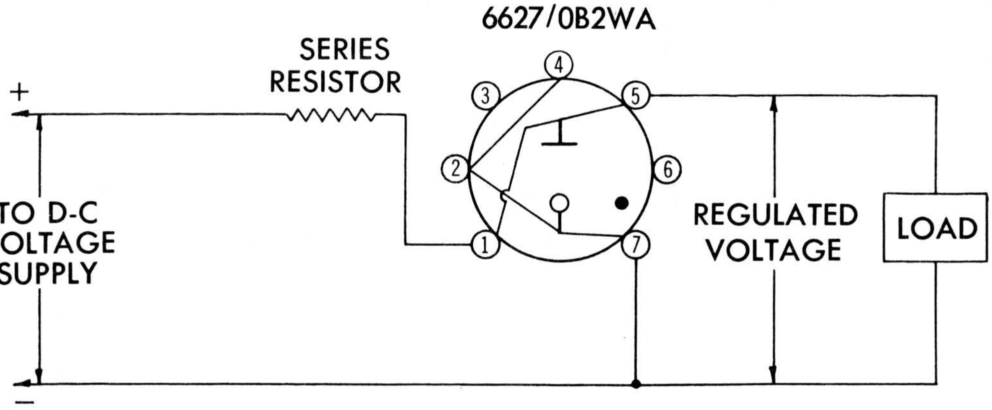


Figure 3—TYPICAL CIRCUIT FOR VOLTAGE REGULATOR

When these calculations have been made and there is insufficient starting voltage, a new load current of lower value must be used and the calculations repeated.

Circuits which have a capacitor in shunt with the 6627/OB2WA should be limited in value to 0.1 μfd; larger values may cause the tube to oscillate.

Operation of the 6627/OB2WA in parallel is not recommended unless a resistance of approximately 100 ohms is used in series with each 6627/OB2WA to equalize division of the current. However, it should be noted that while this type of operation enables one to handle more load current, it reduces the regulation that can be obtained.

If it is desired to obtain higher regulating voltages, tubes may be operated in series. Care should be taken to see that sufficient supply voltage is available to start both tubes.

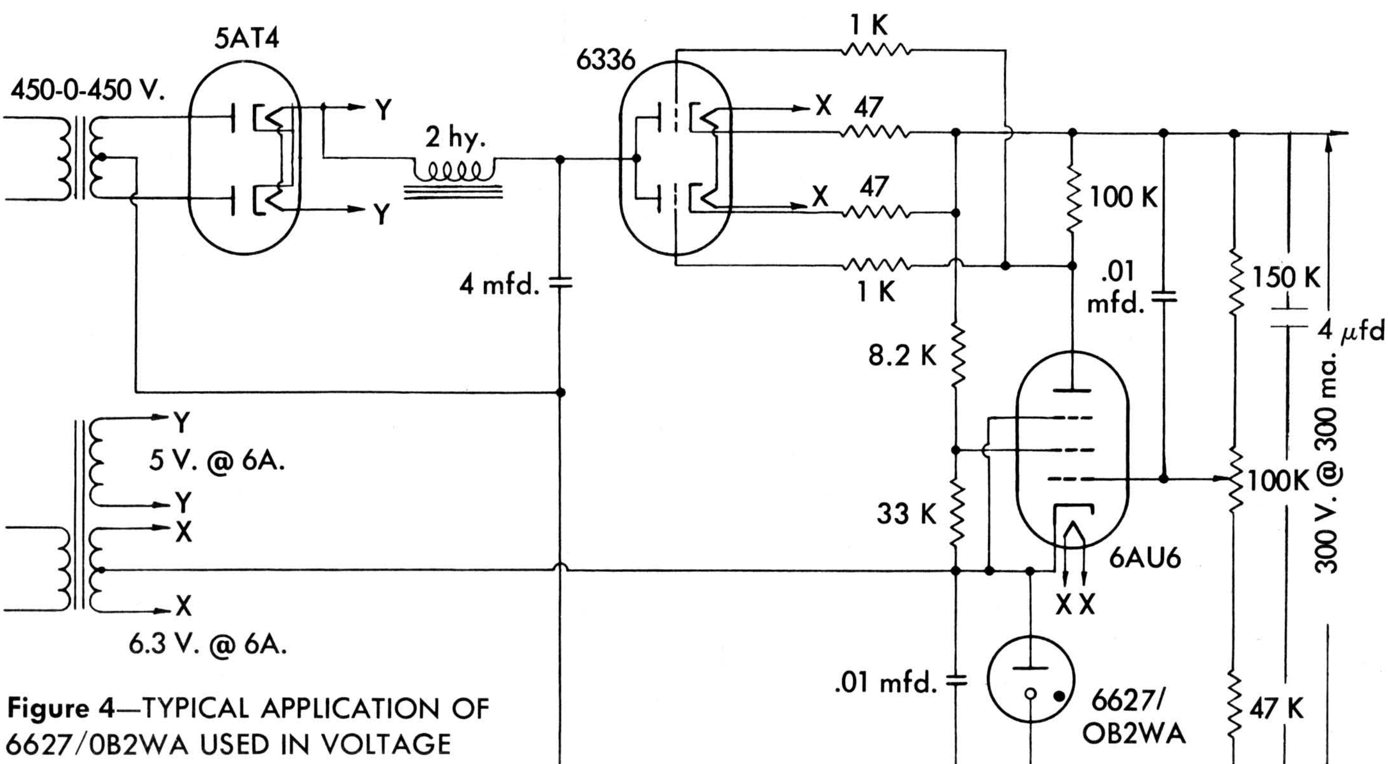


Figure 4—TYPICAL APPLICATION OF 6627/OB2WA USED IN VOLTAGE REGULATED POWER SUPPLY

TUNG-SOL/CHATHAM

TYPE
7099

SUBMINIATURE VOLTAGE REFERENCE TUBE

DESCRIPTION — The 7099 is a low current, two element, inert-gas-filled, cold cathode, voltage regulator tube. The tube covers a range not adequately handled by other VR tubes or by zener diodes. It has a maintaining voltage of approximately 155 volts over a current range from 0.075 to 0.300 milliamperes.

The 7099 provides a high degree of stability and voltage repeatability over its operating temperature range. It is especially suited for service in applications which require long life, and minimum size and weight. Its flying leads can be soldered directly into a circuit or can be clipped to one-quarter inch for insertion in a standard subminiature socket.

ELECTRICIAL DATA

Cathode	Cold

MECHANICAL DATA

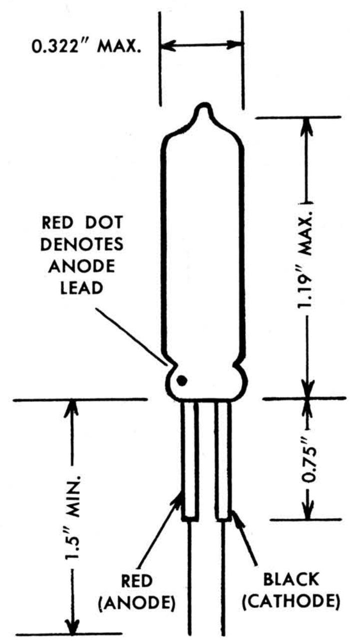
Mounting Position	Any
Length — Overall	See Outline Drawing
Diameter	0.322 inch max
Weight — Approximate	0.16 ounce
Bulb	T-2
Base	Flat Press with 2 Flying Leads

RATINGS, ABSOLUTE VALUES

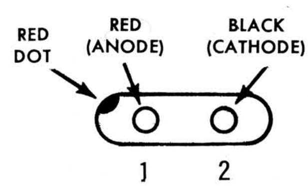
D-C Cathode Current	0.300 Milliamperes max 0.075 Milliamperes min
Bulb Temperature	100°C max
Ambient Temperature	—55°C min
Altitude	60,000 feet max

CIRCUIT VALUES

Shunt Capacitor	0.1 microfarad max
Series Resistor	See Application Notes



PIN CONNECTIONS
(Bottom View)

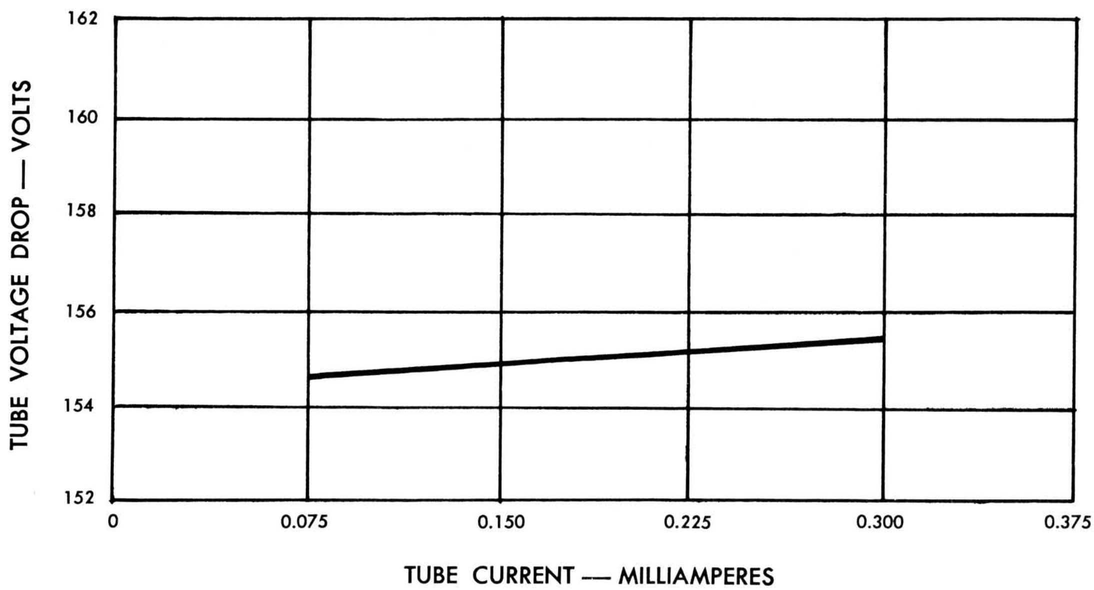


Flat Press with
2 Flying Leads

EQUIPMENT DESIGN AND RANGE VALUES

	MINIMUM VOLTS	BOGEY VOLTS	MAXIMUM VOLTS
D-C Anode Supply Voltage	225*	—	—
Anode Breakdown Voltage......................	—	180	200
Tube Voltage Drop at 0.075 ma.................	152	155.0	—
Tube Voltage Drop at 0.3 ma...................	—	155.5	162
Regulation — 0.075 through 0.150 ma...........	—	0.4	2.5
Regulation — 0.150 through 0.300 ma...........	—	0.6	4.0
Leakage Current at −100 Volts	—	—	2 μamp

*In order to assure starting throughout life of tube, not less than the specified supply voltage should be provided.



TYPICAL AVERAGE TUBE VOLTAGE DROP VERSUS TUBE CURRENT

APPLICATIONS AND NOTES

Special attention should be given to the bulb temperature at which the tubes are to be operated. Reliability will be seriously impaired if the maximum bulb temperature is exceeded.

In the operation of a glow tube there are several requirements which must always be met. The first is that the supply voltage must always be greater than the anode breakdown voltage and the second is that sufficient resistance must always be connected in series with the tube in order to limit the current to the minimum and maximum values given in the ratings.

The recommended method for calculating the value of the current-limiting, series resistor is given below.

In figure 1, E_{BB} is the unregulated supply voltage, E_L is the voltage drop across the regulator tube or the regulated voltage supplied to the load, R is the series limiting resistor, R_L is the variable load, I_T is the regulator tube current and I_L is the load current.

The tube current will be a maximum under three conditions, namely: when the supply voltage is maximum (E_{BB} max), when the load current is a minimum (I_L min), and when the tube voltage drop is a minimum (E_L min). Therefore, the conditions which determine maximum current, or the lower limit for the series resistor, are that

$$R > \frac{E_{BB}\,\text{max} - E_L\,\text{min}}{I_T\,\text{max} + I_L\,\text{min}}$$

Similarly, the value of series resistance required to limit the current to the minimum value requires that

$$R < \frac{E_{BB}\,\text{min} - E_L\,\text{max}}{I_T\,\text{min} + I_L\,\text{max}}$$

After computing these above values, a check must be made to make certain that the value chosen for series resistor R will provide sufficient starting voltage as illustrated in the following relationship:

$$E_{BB}\,\text{min}\ \frac{R_L}{R + R_L} > E\ \text{starting}$$

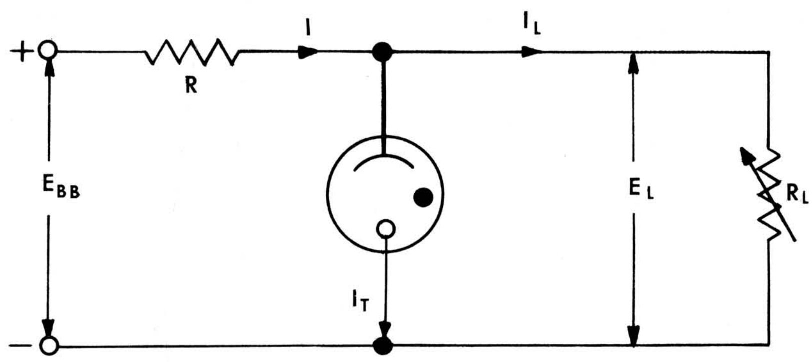


FIGURE 1. TYPICAL CIRCUIT FOR VOLTAGE REGULATOR

Should the above calculations show that there is insufficient starting voltage, a lower value of load current must be used and the calculations repeated.

Where the regulator tube is shunted by a capacitor, the value of such capacitor should be limited to 0.1 microfarad as a larger value might cause oscillation.

Operation of two tubes in parallel to increase the current rating is not recommended unless a resistance of approximately 100 ohms is used in series with each tube to equalize the division of current. It should be noted that parallel operation reduces the regulation that can be obtained.

Higher regulated voltages can be obtained by connecting two tubes in series as shown in figure 2. However, care should be exercised to make certain that sufficient supply voltage is available to start both tubes. This can be accomplished by shunting the lower tube with a high resistance.

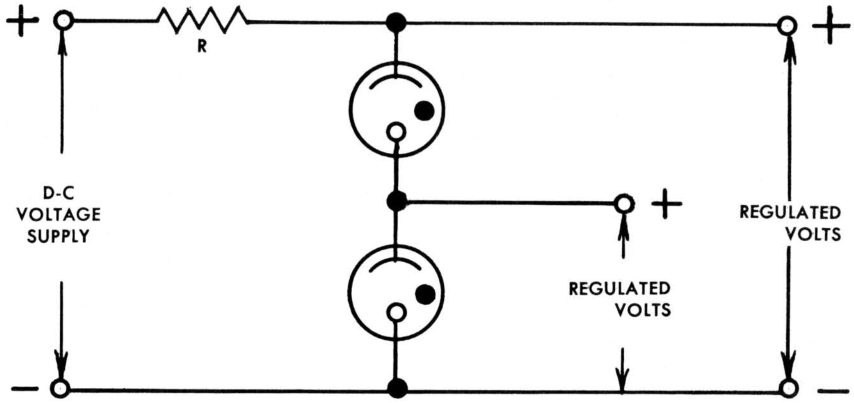
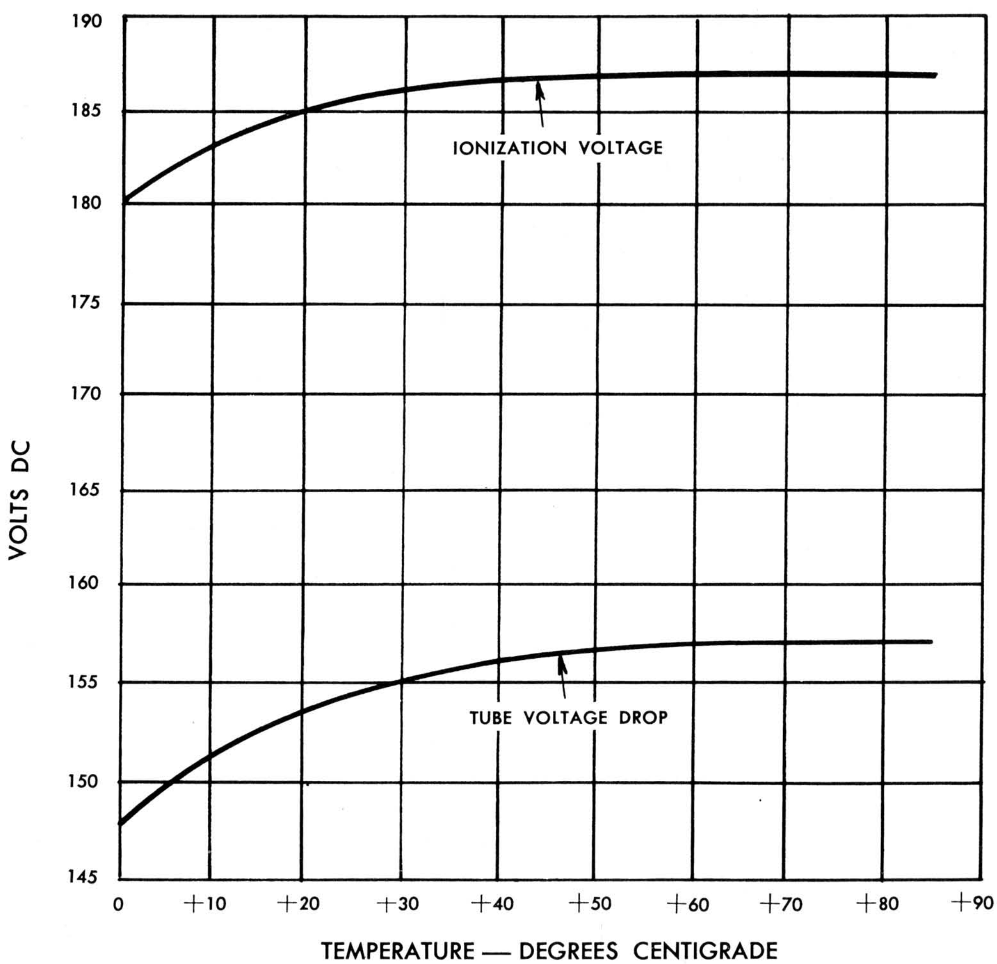


FIGURE 2. OPERATION OF REGULATOR TUBES IN SERIES



TYPICAL TUBE VOLTAGE DROP VERSUS OPERATING TEMPERATURE

TUNG-SOL/CHATHAM

TYPE 7105

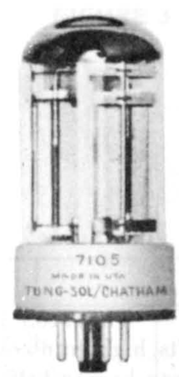
TYPE 6080WA is similar in all respects to the 7105 but employs a 6.3 volt, 2.5 ampere heater. Heater current range at 6.3 volts is 2.35 to 2.65 amperes. Heater voltage limits are 6.0 to 6.6 volts.

Rugged, Reliable Twin Power Triode

DESCRIPTION — The 7105 is a 12.6 volt version of the popular ruggedized reliable type 6080WA. In a reliable program, tubes are handled in lots with many destructive tests performed on randomly selected samples. Thus a tube may pass all required tests and yet be rejected if it is from an unsatisfactory lot.

With the mount shock isolated from the bulb by nine metal spring clips, and by the use of heavy duty parts, the tube will withstand a shock impulse of 450 G and a vibration force of 10 G. Other features are high altitude rating, high bulb temperature limits, and long life tests with many life test end points. Plate current and transconductance are held to close limits to provide greater balance between tube sections. This is especially advantageous when many tubes are to be paralleled in regulated power supply service.

This tube can be used for any application requiring high plate current at low plate voltages. The 12.6 volt filament is particularly adaptable to mobile equipment. Its primary use is in electronically regulated power supplies.

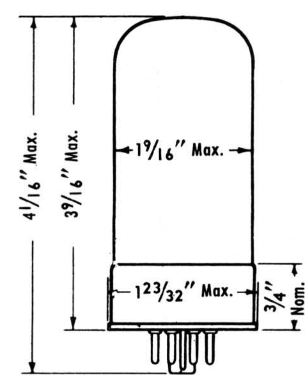


ELECTRICAL DATA

Heater Voltage	12.6 ± 5% volts
Heater Current (E_f=6.3 volts)	1.25 amperes
Minimum Cathode Heating Time	30 seconds
Transconductance (per section)	7000 umhos
Amplification Factor	2.0
Inter Electrode Capacities per Triode Section	
Grid to Cathode	6.2 uuf
Grid to Plate	8.4 uuf
Cathode to Plate	2.2 uuf
Heater to Cathode	6.3 uuf
Inter Electrode Capacities Between Triode Sections	
Section 1 Grid to Section 2 Grid	0.5 uuf
Section 1 Plate to Section 2 Plate	2.2 uuf

MECHANICAL DATA

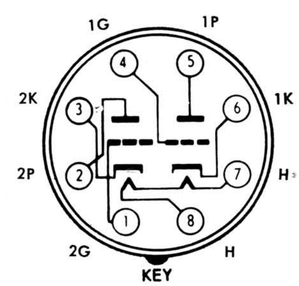
Mounting Position	Any
(If tube is to be mounted in a horizontal position it is recommended that it be mounted so that the base lug key be either directly up or directly down)	
Bulb	T-12
Base	Large wafer octal with metal sleeve, 8 pin, JETC# B8-86
Maximum Net Weight	3. ounces
Maximum Shock Rating (Navy Hi Impact Shock Machine)	450 G
Maximum Vibration Rating (D-.08" @ 50 cps)	10 G



GLASS BULB

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum
Heater Voltage	12.0	13.2 volts
Plate Voltage	—	250. volts d. c.
Grid Voltage	—	0 volts d. c.
Heater-Cathode Voltage	−300	+300 volts d. c.
Grid Current per Grid	—	5. milliamperes
Plate Current per Plate	—	125. ma d. c.
(If several tube sections are to be used in parallel with each other, it is recommended not to exceed 100 mA per plate)		
Power Dissipation per Plate	—	13 watts
Envelope Temperature	—	230 °C.
Altitude for Full Ratings	—	60,000 feet
Circuit Values		
Grid Circuit Resistance for Cathode Bias Operation	—	1.0 megohm
Grid Circuit Resistance for Fixed Bias or Combination Fixed and Cathode Bias Operation	—	0.1 megohm



Bottom View
Large Wafer Octal with Metal Sleeve

TUNG-SOL / CHATHAM

ADDITIONAL TESTS TO INSURE RELIABILITY

Randomly Selected Samples Are Subjected to the Following Tests.

Shock: 30° Hammer angle in Navy, Flyweight, High Impact Machine (450 G/msec)

Fatigue: 25 cps, 0.08″ Total displacement, for 32 hours in each of three mutually perpendicular planes (2.5 G)

Post Shock and Fatigue Limits:
Vibration (R_p = 2000 Ω, E_c = −7vdc, Tie 1k to 2k, 1g to 2g, 1p to 2p), Generated Plate Voltage........ 100 mVac max.
Heater Cycling Life Test (E_f=15v., E_{hk}=300 Vdc. Duration of 2000 cycles of 1 min. on and 1 min. off). . End Point (E_{hk}=±100v.), 50 uAdc max.
Value........................ 10% max.
Grid Current........................ −3 uA max
Heater Cycling Life Test (E_f=15.0 v, E_{hk}=300 Vdc. Duration of 2000 cycles of 1 min. on and 1 min. off). . End Point (E_{hk}=±100v.), 50 uAdc max.

Stability Life Test (1 hr.) End Point:
Change in Transconductance from Initial Value............ 10% max.

Survival Rate Life Test (100 hrs.) End Point:
Transconductance...................... 5800 umhos min.

Intermittent Life Test (1000 hrs.) End Points:
Grid Current.......................... 0 min. −10 max. uAdc
Transconductance...................... 5500 umhos min.
Change in Transconductance by reducing E_f to 11.4 v.................... 10% max.
Heater-Cathode Leakage E_{hk} =±100 Vdc.. 25 uAdc max.
Heater Current.......................... 1.15 min. 1.35 max. Amperes
Insulation of Electrodes: Grid to all others and Plate to all others.......... 100 Megohm min.

RANGE OF VALUES

Conditions: E_f = 12.6 V, E_b = 135V, E_c = 0, $R_{k/k}$ = 250 Ω. Both sections operating. Each section read separately.

	Min.	Max.	Units
Individual Plate Current	100	150	Milliamperes d. c.
Lot Average Plate Current (same conditions)	115	135	Milliamperes d. c.
Plate Current, Difference between Sections	—	25	Milliamperes d. c.
Individual Section Transconductance	6000	8200	Micromhos
Lot Average Transconductance	6600	7400	Micromhos
Amplification Factor	1.5	2.5	
Heater Current @ 12.6 v	1.15	1.35	Amperes

Application Notes

The 7105 is widely used as a "passing" tube or series regulator tube in controlled power supplies because of its high transconductance at relatively low plate voltages. To provide the desired output current, many triode sections can be paralleled. If tube sections are to be paralleled however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it helps to provide increasing bias on the sections taking greater plate current. A cathode resistor too, need be only one third the value $\left(\frac{R}{u+1}\right)$ of a plate resistor, and therefore will dissipate only one third the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (less than one watt) and the additional voltage (less than 10 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively tied to the plate. The plate will attempt to draw excessive current from the passing tube's cathode and may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulated output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. If the cathode resistors as suggested on the plate characteristic curve are used, a minimum bias of 7.5 volts will be provided. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be able to swing the passing tube grid far enough to counteract the effect of unbalance due to tube ageing.

A grid resistor should be used for each triode section. This should be high enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 12.6 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

TUNG-SOL / CHATHAM

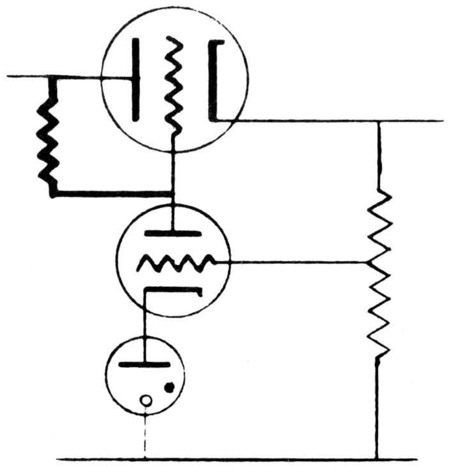


FIGURE 1

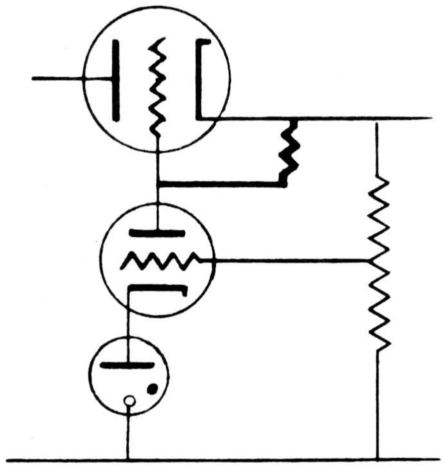


FIGURE 2

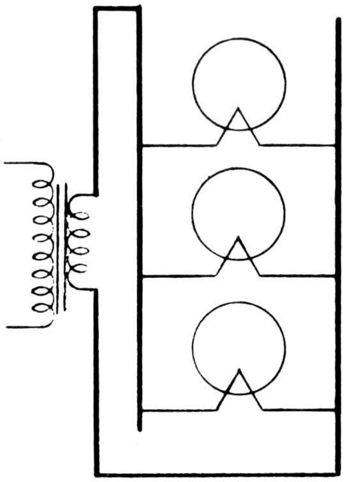
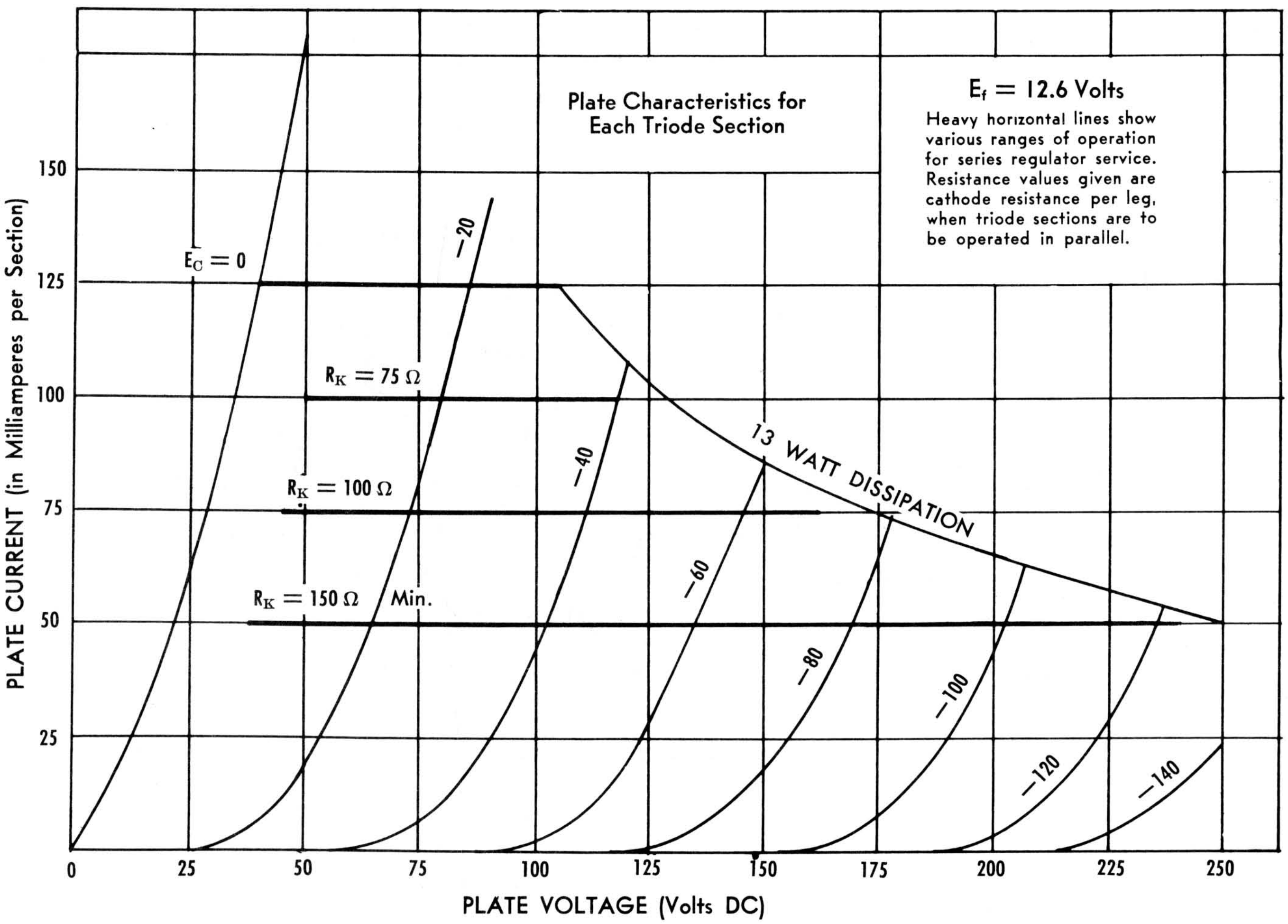
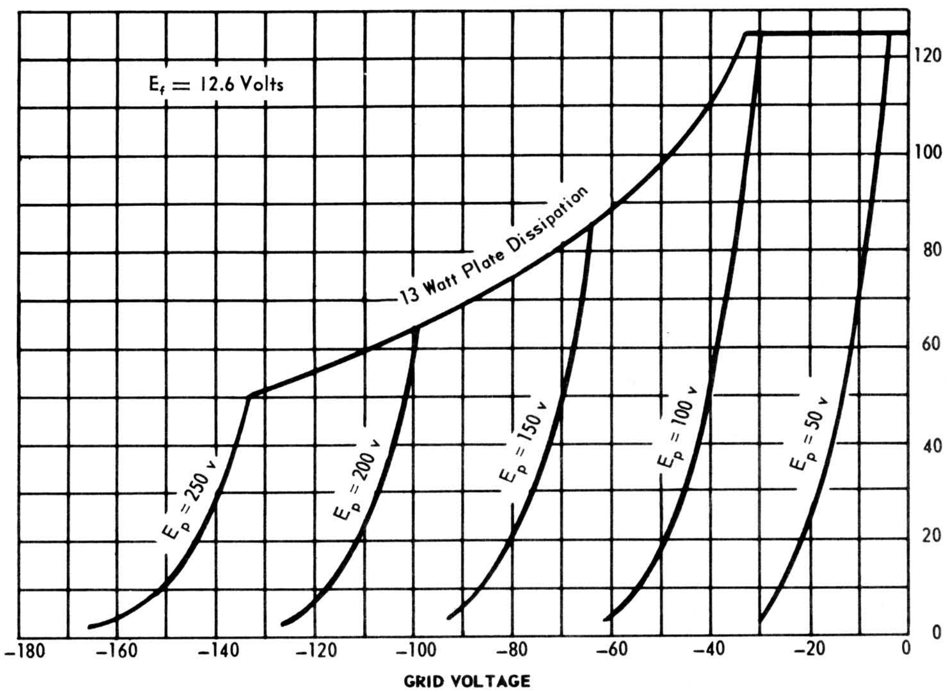


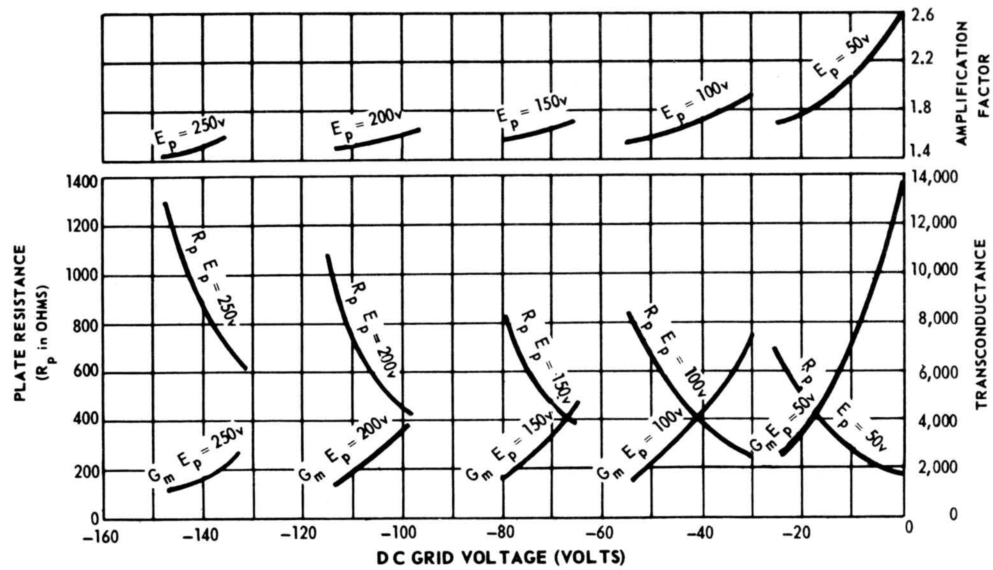
FIGURE 3

PLATE CHARACTERISTICS FOR EACH TRIODE SECTION



TRANSFER CHARACTERISTICS FOR EACH TRIODE SECTION





TUNG-SOL/CHATHAM

RUGGEDIZED MINIATURE HYDROGEN THYRATRON

TYPE 7190

DESCRIPTION — The 7190 is a zero bias miniature hydrogen thyratron designed primarily for the generation of pulse voltages under extreme conditions of mechanical vibration. This tube can supply peak pulse power of 10 kilowatts and therefore will replace physically larger types in many radar applications. Because of its close electrode spacing and small size, made possible by hard glass construction, the 7190 is capable of relatively high pulse repetition rates.

The 7190, 7191 and 7192 differ only in their electrode terminals. All of these types have found use in missile applications. The 7190, 7191, and 7192 have been designed into some equipment under the Chatham developmental designations CH1062, CH1092, and CH1055 respectively.

ELECTRICAL DATA

	Symbol	Min.	Bogey	Max.
Heater Voltage (When Ip is less than 0.75 Aac, refer to Recommended Heater Voltage Curve on page 3)	Ef	6.0	6.3	6.6 Volts
Heater Current (With bogie heater voltage)	If	1.6	1.8	2.0 Amperes
Cathode Heating Time	tk	30		Seconds
Anode Voltage Drop (At recommended E_f)	etd	45		125 Volts

MECHANICAL DATA

Type of Cooling (Heat dissipating shields may be used. Forced air cooling is not recommended.)	Convection
Altitude	See Application Notes
Mounting Position	Any
Maximum Net Weight	0.5 ounce
Dimensions: See outline drawings	
Maximum Vibration Conditions	50-2000 cps @ 15 G
Maximum Shock Conditions (48° Hammer blow in Navy Fly Weight, High Impact Shock Machine)	720 G/1 millisec.
Microscopic Inspection per MIL-E-17751B (N ORD)	See Application Notes

RATINGS, ABSOLUTE VALUES

	Symbol	Min.	Max.
Peak Anode Voltage			
Inverse (Note 1)	epx	—	1200 Volts
Forward	epy	300	1200 Volts
Cathode Current			
Peak	ib		20.0 Amperes
Average	Ib		50 milliamperes
RMS (For square pulse applications $I_p = \sqrt{Ib} \times ib$)	I_p		1.0 Ampere
D.C. Anode Voltage	Ebb	300 Volts	
Heater-Cathode Voltage	Ehk	−100	+25 Volts
Operating Frequency (This is not necessarily the upper operating frequency limit but represents the highest repetition rate extensively life tested to date.)	prr		5000 cps
Peak Grid Voltage . . . See Recommended Grid Pulse Conditions on page 2	egy	175	500 Volts
Peak Inverse Grid Voltage	egx		150 Volts
Heating Factor (epy x ib x prr. See page 4)	Pb		1×10^8
Current Rate of Rise (Note 2)			400 amp/μ sec.
Anode Delay Time (Note 3)	tad		0.6 μ sec.
Time Jitter (Note 4)	tj		0.01 μ sec.
Ambient Temperature	TA	−60°C	+125°C

Note 1. In pulsed operation, the peak inverse voltage, exclusive of a spike of 0.05 μ sec. maximum duration, shall not exceed 500 volts during the first 25 μ sec. following the anode pulse.

Note 2: Measurement made between 26% and 70.7% points.

Note 3: Anode delay time is defined as the time interval between the point on the rising portion of the grid voltage pulse which is 26 percent of the maximum unloaded pulse amplitude and the point where anode conduction takes place.

Note 4: Time jitter is measured at 50 percent of the pulse amplitude after the tube has been operating for at least 60 seconds. The limit of 0.01 μ sec. shown is the maximum allowable under specified unfavorable operating conditions. With sufficient grid drive and with anode voltages of 600 volts and above, jitter not exceeding 0.005 μ sec. can be easily achieved.

TYPE 7191

This tube type is similar in all respects to type 7190 except that the anode connector is a terminal extending from the top of the bulb. This permits operation at high altitudes in unpressurized equipment as explained in the Application Notes. Dimensions and element connections are shown on page 4.

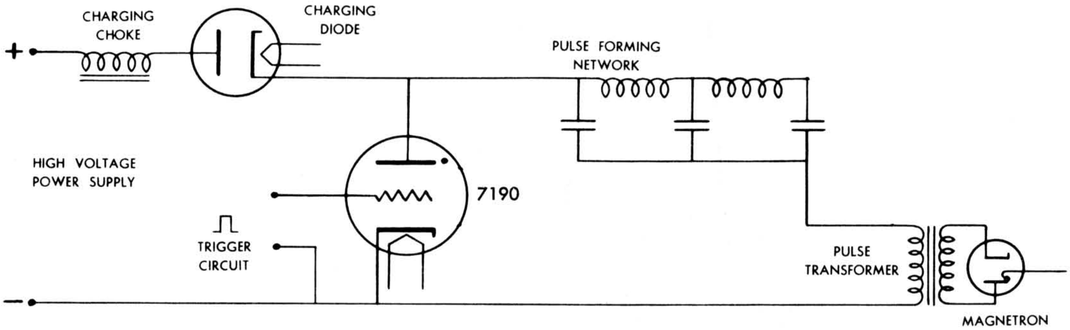
TYPE 7192

This tube type is similar in all respects to type 7190 except that long flexible leads are provided to permit the connection of the tube directly into a circuit without the use of a tube socket. This is discussed in the Application Notes. Dimensions and element connections are shown on page 4.

Outlines and base connections for these tube types are to be found on page 4.

Application Notes

This family of miniature hydrogen thyratrons is designed primarily for use in line type radar modulators. A basic circuit for such service is illustrated below. In such a circuit, the hydrogen thyratron serves as a switch to release into the magnetron or other radio frequency generator, the energy stored in the pulse forming network. These tubes are admirably suited for such service by their ability to hold off relatively high voltage, and to pass high peak current with relatively low tube voltage drop. The tubes will operate over a wide range of pulse repetition rates, pulse widths and peak currents, thus providing very flexible circuit elements. Triggering requirements are simplified since the tubes operate with zero bias.



The small size, light weight, extreme ruggedness, and ability to operate at high ambient temperatures, make these tubes particularly suitable for airborne use. The tubes can be operated in any position. All tubes are tested in accordance with MIL-E-17751B (N ORD), the military specification for Electron Tubes for Guided Missiles. This entails 100% microscopic inspection with a 10 power binocular microscope for such items as seals, leads and spot welds. Sample tubes are vibrated with voltages applied over a range of 50 to 2000 to 50 cps at 15g in 4 minutes.

The 7190 and the 7191 fit a standard 7 pin miniature socket. The tube pins, however, are stiff, and care should be taken to have the socket clips in perfect alignment before attempting to insert a tube. As the tube operates at high temperatures, a ceramic type socket should be employed. Connections to the socket should be made with flexible leads to provide floating action for the socket clips. Pin straighteners should never be used on these tube types, as any attempt to bend the pins will result in cracked button bases!

The anode connection on type 7191 is a soldering terminal brought out the top of the envelope. This design provides a maximum spacing between the anode lead and the grid and cathode pins to prevent arc-over at reduced air pressures. The 7191 will operate for short periods at 80,000 feet without forced air cooling. The nominal altitude rating for the 7190 and 7192 is 10,000 feet. However, if provision is made to prevent arc-over between pins, these types also will operate at 80,000 feet. One method of preventing arc-over between pins is to pot the base end of the tube. If the entire envelope is to be potted, however, precaution must be taken to keep bulb temperature below 225°C.

Type 7192 is supplied with long, flexible stranded lead connectors that may be crimped or soldered directly in the circuit. The tube itself can be secured by any suitable mechanical means. One such method is to hold it in position with a heat dissipating clamp such as the Birtcher 6A3.

Cathode temperature is determined by RMS cathode current as well as by heater power. The bogey heater voltage of 6.3 volts therefore is applicable only near full operating conditions. At light loading it is recommended to operate the heater voltage higher. Recommended figures for various operating conditions are shown on the curves on page 3.

Typical Operation

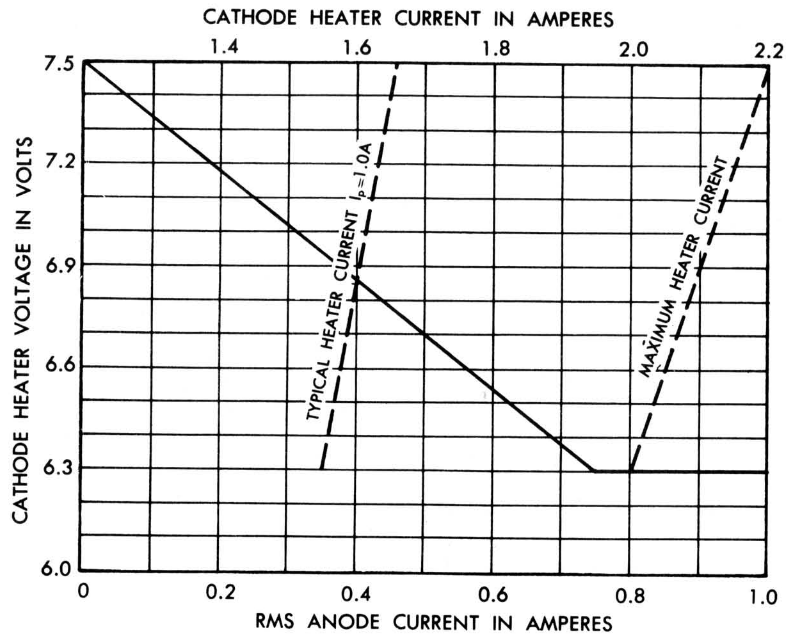
Pulse Repetition Rate	Anode Current Peak	Anode Current RMS	Anode Current Average	Peak Anode Voltage	Pulse Width	Grid Drive	
pps	Amps	Amps AC	mAd.c.	Volts	μ sec	μ sec	volts
5,000	20.0	1.0	50.	1,000	0.5	1.0	250
10,000	6.6	0.5	37.	316	0.56	2.0	250
*33,000	3.5	0.46	60.	350	0.5	Blocking Oscillator	200

*Limited test information

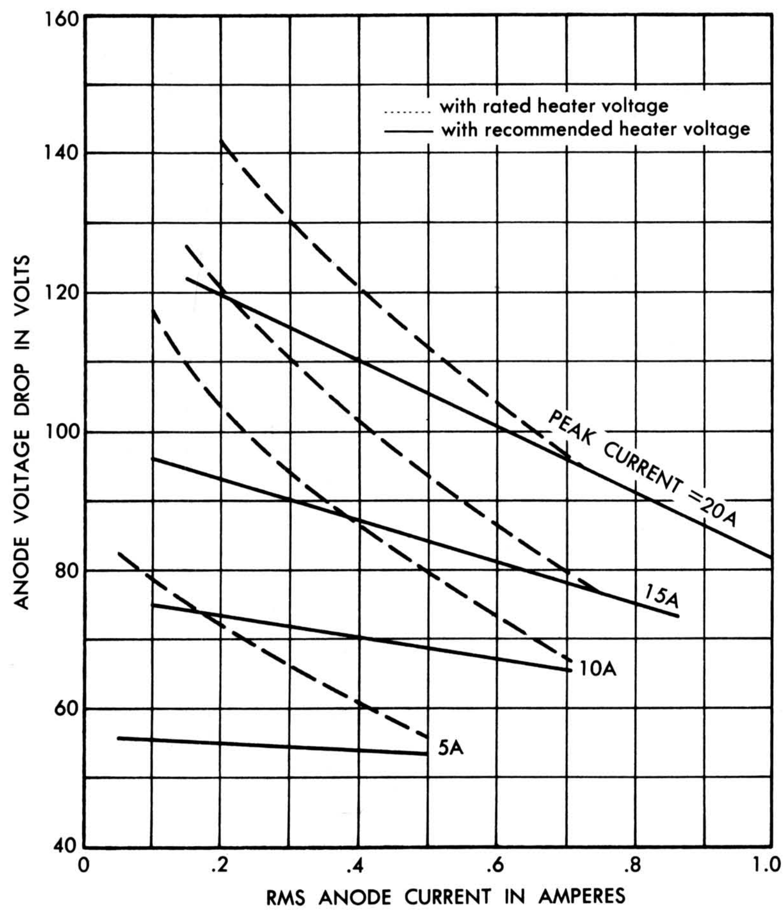
Recommended Grid Pulse Values

	Min.	Max.	
Peak Voltage	200	500	Volts
Driver Circuit Impedance	200	1000	Ohms
Voltage Rate of Rise	350	·	Volts/μ sec.

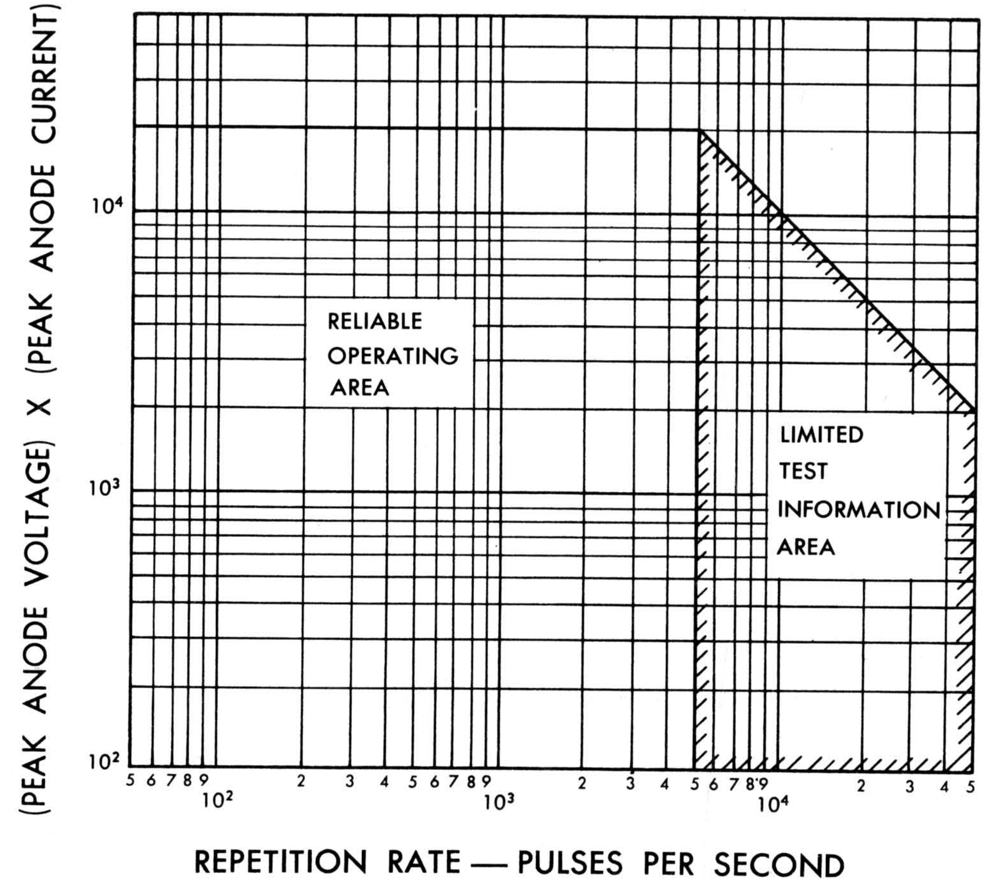
These values are as measured at the tube socket with the thyratron removed. The grid pulse width should not be longer than the anode pulse except in cases where the driver circuit impedance is high. The minimum peak trigger voltage recommended will increase with decreasing trigger pulse width. However, this effect is important only at pulse widths less than 0.5 microseconds.



RECOMMENDED HEATER VOLTAGE CURVE

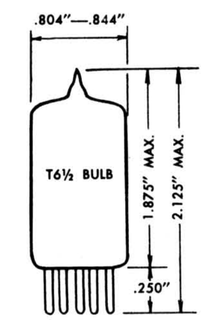


TYPICAL ANODE VOLTAGE DROP CURVE

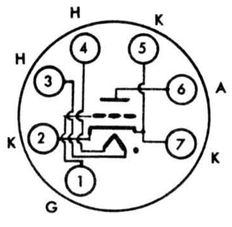


GRAPHICAL REPRESENTATION OF HEAT FACTOR

TYPE 7190

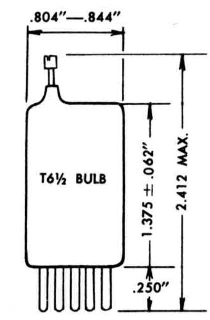


Hard Glass Bulb



Small Button 7-Pin Miniature Base (See Application Notes)

TYPE 7191



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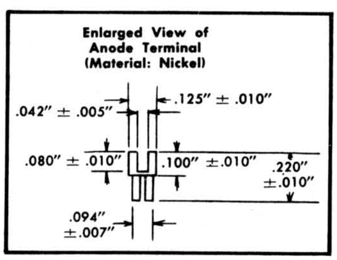
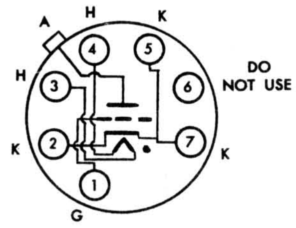
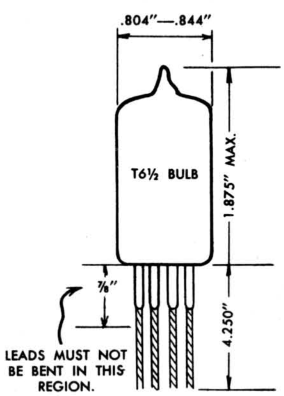
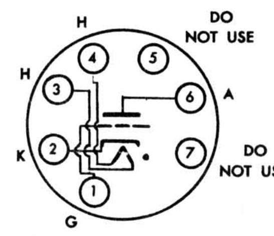




Small Button 7-Pin Miniature Base (See Application Notes)

TYPE 7192





Stranded Leads on Pins 1, 2, 3, 4 and 6

TUNG-SOL/CHATHAM

RUGGEDIZED MINIATURE HYDROGEN THYRATRON

DESCRIPTION—The 7240 is a zero bias miniature hydrogen thyratron designed primarily for the generation of pulse voltages under extreme conditions of mechanical vibration. This tube can supply peak pulse power of 10 kilowatts and therefore will replace physically larger types in many radar applications. Because of its close electrode spacing and small size, made possible by hard glass construction, the 7240 is capable of relatively high repetition rates. In addition its 28 volt heater makes it particularly suitable for use with airborne and missile power supplies. The 7240 has been designed into some equipment under the developmental designation CH-1046.

ELECTRICAL DATA

	Symbol	Min.	Bogey	Max.
Heater Voltage (When I_p is less than 0.75 Aac, refer to recommended Heater Voltage Curve on page 3.)	Ef	26.6	28.0	29.4 Volts
Heater Current (With bogie heater voltage)	If	0.37	0.42	0.46 Amperes
Cathode Heating Time	tk	30		Seconds
Anode Voltage Drop (At recommended E_f)	etd	45		125 Volts

MECHANICAL DATA

Type of Cooling (Heat dissipating shields may be used. Forced air cooling is not recommended.)	Convection
Altitude	See Application Notes
Mounting Position	Any
Maximum Net Weight	0.5 ounce
Dimensions: See outline drawings	
Maximum Vibration Conditions	50-2000 cps @ 15 G
Maximum Shock Conditions (48° Hammer blow in Navy Fly Weight, High Impact Shock Machine)	720 G/1 millisec.
Microscopic Inspection per MIL-E-17751B (N ORD)	See Application Notes

RATINGS, ABSOLUTE VALUES

	Symbol	Min.	Max.
Peak Anode Voltage			
Inverse (Note 1)	epx	—	1200 Volts
Forward	epy	300	1200 Volts
Cathode Current			
Peak	ib		20.0 Amperes
Average	Ib		50 Milliamperes
RMS (For square pulse applications $I_p = \sqrt{Ib \times ib}$)	I_p		1.0 Ampere
D.C. Anode Voltage	Ebb	300 Volts	
Heater-Cathode Voltage	Ehk	−100	+25 Volts
Operating Frequency (This is not necessarily the upper operating frequency limit but represents the highest repetition rate extensively life tested to date.)	prr		5000 cps
Peak Grid Voltage... See Recommended Grid Pulse Conditions on page 2..	egy	175	500 Volts
Peak Inverse Grid Voltage	egx		150 Volts
Heating Factor (epy x ib x prr. See page 4)	Pb		1×10^8
Current Rate of Rise (Note 2)			400 amp/μ sec.
Anode Delay Time (Note 3)	tad		0.6 μ sec.
Time Jitter (Note 4)	tj		.005 μ sec.
Ambient Temperature	TA	−60°C	+125°C

Note 1. In pulsed operation, the peak inverse voltage, exclusive of a spike of 0.05 μ sec. maximum duration, shall not exceed 500 volts during the first 25 μ sec. following the anode pulse.

Note 2. Measurement made between 26% and 70.7% points.

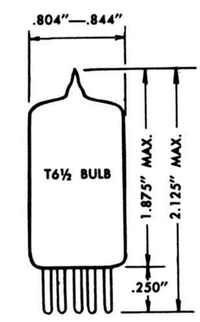
Note 3. Anode delay time is defined as the time interval between the point on the rising portion of the grid voltage pulse which is 26 percent of the maximum unloaded pulse amplitude and the point where anode conduction takes places.

Note 4. Time jitter is measure at 50 per cent of the pulse amplitude after the tube has been operating for at least 60 seconds. With sufficient grid drive and with anode voltages of 600 volts and above, jitter not exceeding 0.005 μ sec. can be easily achieved.

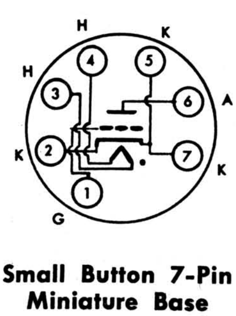
TYPE 7240

TYPE 7190

is similar in all respects to the 7240 but employs a 6.3 volt, 1.8 ampere heater. Heater current range at 6.3 volts is 1.6 to 2.0 amperes. Heater voltage limits are 6.0 to 6.6 volts.



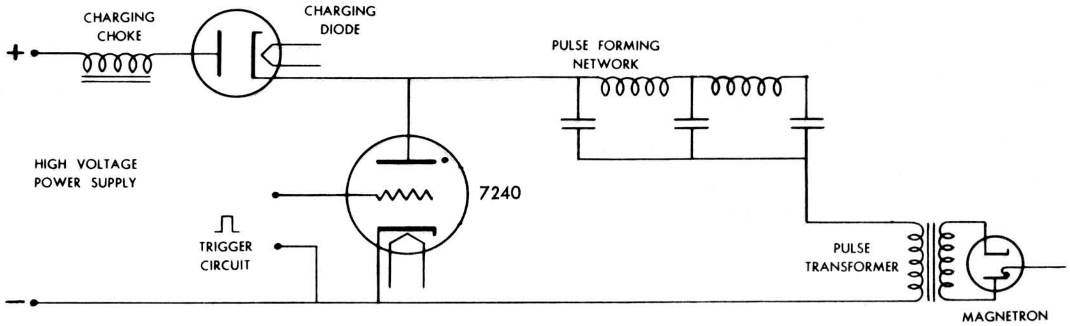
Hard Glass Bulb



Small Button 7-Pin Miniature Base (See Application Notes)

Application Notes

This miniature hydrogen thyratron is designed primarily for use in line type radar modulators. A basic circuit for such service is illustrated below. In such a circuit, the hydrogen thyratron serves as a switch to release into the magnetron or other radio frequency generator, the energy stored in the pulse forming network. This tube is admirably suited for such service by its ability to hold off relatively high voltage, and to pass high peak current with relatively low tube voltage drop. The tube will operate over a wide range of pulse repetition rates, pulse widths and peak currents, thus providing a very flexible circuit element. Triggering requirements are simplified since the tube operates with zero bias.



The small size, light weight, extreme ruggedness, and ability to operate at high ambient temperatures, makes this tube particularly suitable for airborne use. The tube can be operated in any position. The 7240 is tested in accordance with MIL-E-17751B (N ORD), the military specification for Electron Tubes for Guided Missiles. This entails 100% microscopic inspection with a 10 power binocular microscope for such items as seals, leads and spot welds. Sample tubes are vibrated with voltages applied over a range of 50 to 2000 to 50 cps at 15 g in 4 minutes.

The 7240 fits a standard 7 pin miniature socket. The tube pins, however, are stiff, and care should be taken to have the socket clips in perfect alignment before attempting to insert a tube. As the tube operates at high temperatures, a ceramic type socket should be employed. Connections to the socket should be made with flexible leads to provide floating action for the socket clips. Pin straighteners should never be used on this tube type, as any attempt to bend the pins will result in cracked button bases!

The nominal altitude rating for the 7240 is 10,000 feet. However, if provision is made to prevent arc-over between pins, this type will operate at 80,000 feet. One method of preventing arc-over between pins is to pot the base end of the tube. If the entire envelope is to be potted, however, precaution must be taken to keep bulb temperature below 225°C.

Cathode temperature is determined by RMS cathode current as well as by heater power. The bogey heater voltage of 28.0 volts therefore is applicable only near full operating conditions. At light loading it is recommended to operate the heater voltage higher. Recommended figures for various operating conditions are shown on the curves on page 3.

Typical Operation

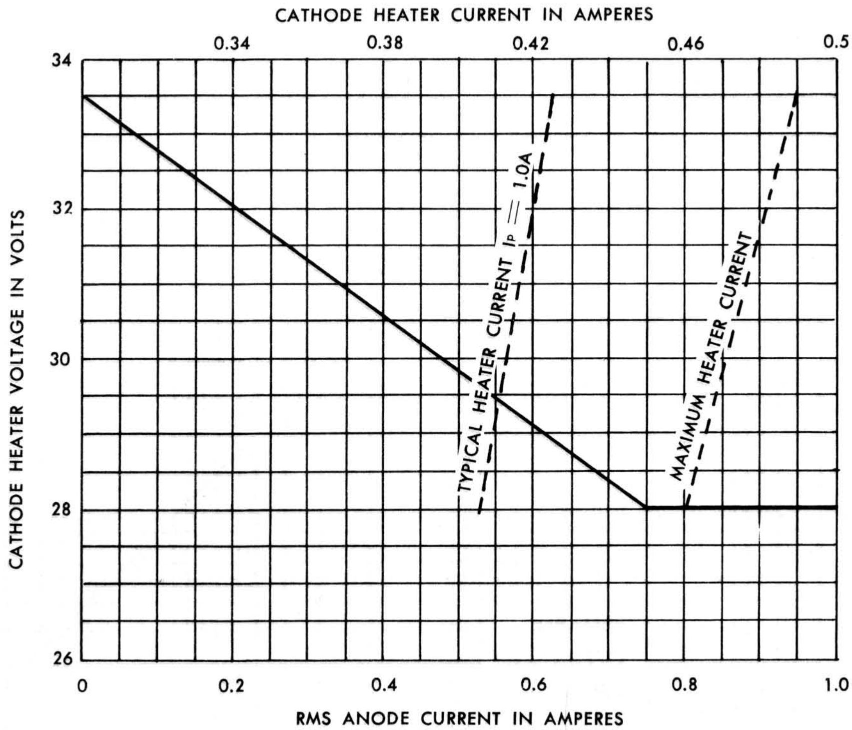
Pulse Repetition Rate	Anode Current			Peak Anode Voltage	Pulse Width	Grid Drive	
	Peak	RMS	Average				
pps	Amps	Amps AC	mAd.c.	Volts	μ sec	μ sec	volts
5,000	20.0	1.0	50.	1,000	0.5	1.0	250
10,000	6.6	0.5	37.	316	0.56	2.0	250
*33,000	3.5	0.46	60.	350	0.5	Blocking Oscillator	200

*Limited test information

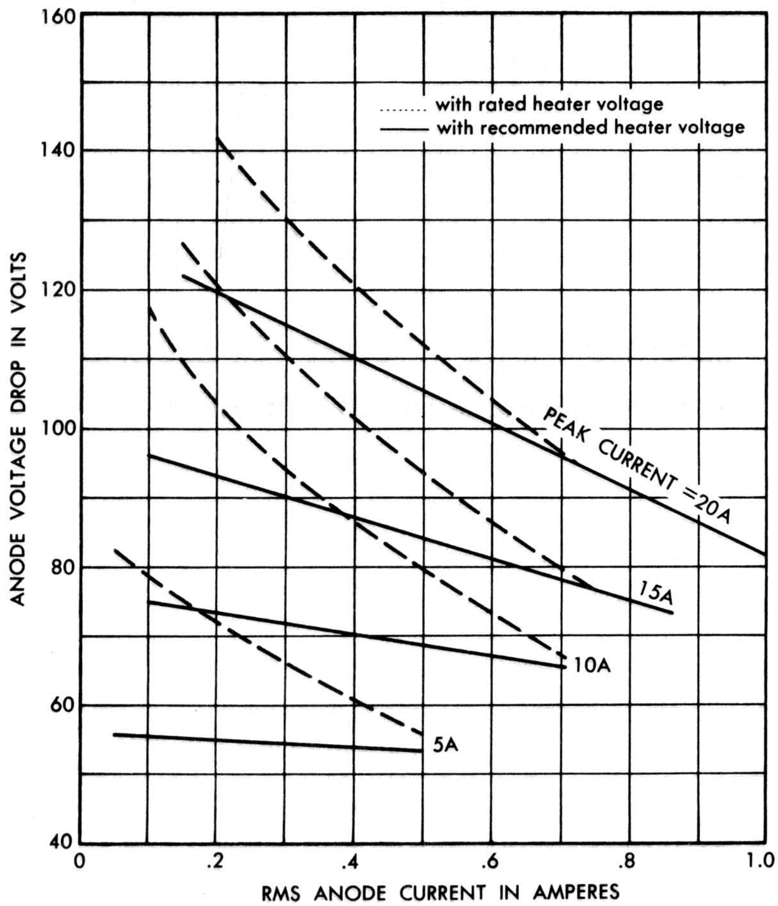
Recommended Grid Pulse Values

	Min.	Max.	
Peak Voltage	200	500	Volts
Driver Circuit Impedance	200	1000	Ohms
Voltage Rate of Rise	350		Volts/μ sec.

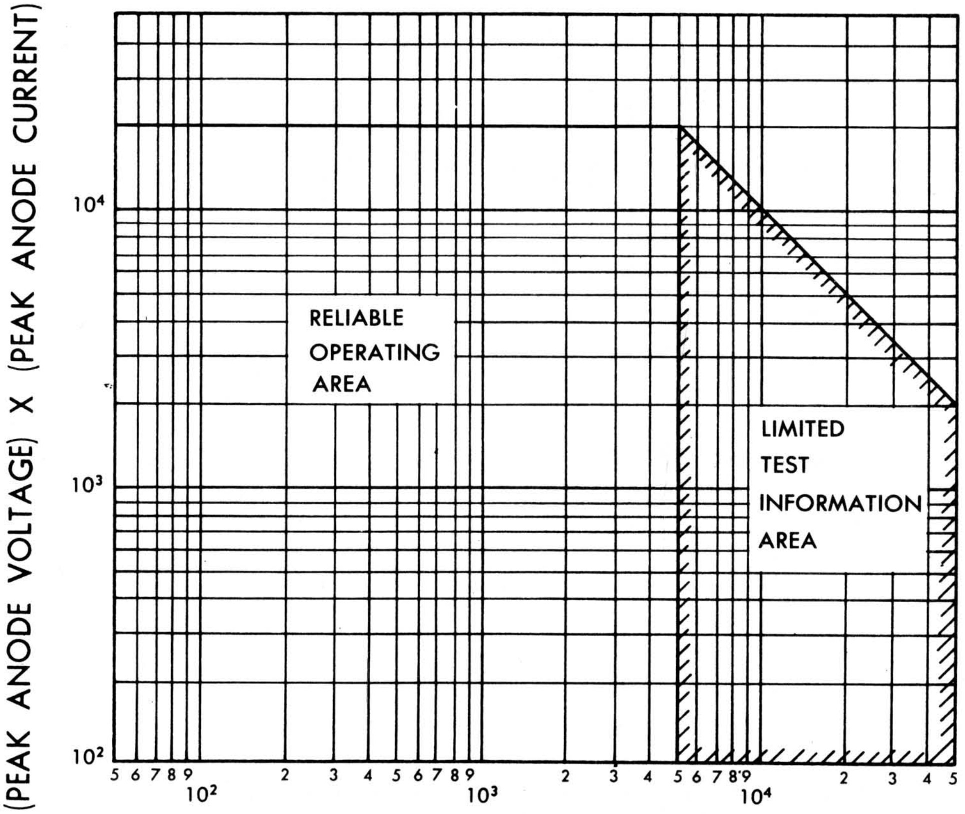
These values are as measured at the tube socket with the thyratron removed. The grid pulse width should not be longer than the anode pulse except in cases where the driver circuit impedance is high. The minimum peak trigger voltage recommended will increase with decreasing trigger pulse width. However, this effect is important only at pulse widths less than 0.5 microseconds.



RECOMMENDED HEATER VOLTAGE CURVE



TYPICAL ANODE VOLTAGE DROP CURVE



REPETITION RATE — PULSES PER SECOND

GRAPHICAL REPRESENTATION OF HEAT FACTOR

TUNG-SOL / CHATHAM

LOW MU HIGH POWER TRIODE FOR SERIES REGULATOR SERVICE

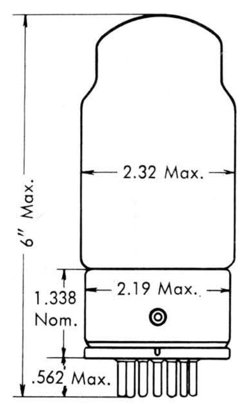
TYPE 7241

DESCRIPTION — The 7241 is a long life, high power triode developed especially for use as a passing tube in series regulated power supplies. For this service, a tube must be able to pass large currents over a wide voltage range and still exhibit a low intrinsic voltage drop when operated "wide open". The 7241 adequately meets these requirements. One type 7241 can pass more than one ampere at 100 watts plate dissipation.

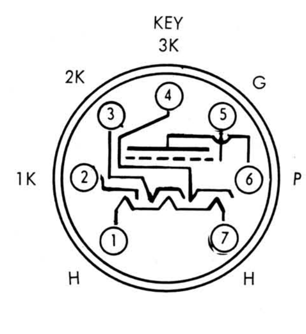
The 7241 features one large zirconium coated graphite anode, with three separate grid-cathodes structures. This anode, while lighter in weight than similar metal anodes, remains warp free during life and provides one of the best gas "gettering" means known. The anode is supported by ceramic insulators. The use of these insulators and the hard glass envelope permit the tube to be outgassed at high temperatures during the manufacturing exhaust process. This allows the tube to be run at high temperatures during operation, without the evolution of harmful gas from the tube parts.

Massive cathodes provide adequate emission current reserve. Gold plated molybdenum wires are employed in the rugged grid structure. The tube mount is built on a rugged button stem, and is supported from the bulb by means of flexible metal vibration snubbers.

In many circuits, one 7241 can replace four type 6080WA or 6AS7G regulator tubes. For even higher levels of current or power, several 7241 tubes can be paralleled as explained in the application notes.



GLASS BULB



Bottom View

ELECTRICAL DATA

Heater Voltage .... 6.3 ±10% volts
Heater Current (E_f = 6.3 volts).... 7.5 amperes
Minimum Cathode Heating Time.... 30 seconds

Transconductance .... 40,000 umhos
Amplification Factor.............. 2.7
Plate Resistance .... 67 ohms

MECHANICAL DATA

Mounting Position .... Any
(If tube is to be mounted in a horizontal position it is recommended that it be mounted so that the bayonet pin points either directly up or directly down)
Bulb .... TT 18 Nonex.
Base .... Giant 7 Pin with Ceramic insert, JETEC #A7-17

Socket .... E. F. Johnson #122-237 or Equivalent
Average Net Weight.................. 6.0 ounces
Maximum Shock Rating (Navy Hi Impact Shock Machine)................ 450 G
Maximum Vibration Rating (10 to 25 cps). 2.5 G

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum	
Total Plate Dissipation	—	100	watts
Total Plate Current	—	1.2	amperes d.c.
If tube voltage drop is to be swung more than 6 volts, this current cannot be realized. See Plate Characteristics Curve			
Current per Cathode	—	400	milliamperes d. c.
Plate Voltage	0	400	volts d. c.
Heater-Cathode Voltage	—300	+300	volts d. c.
Grid Voltage	—300	0	volts d. c.
Grid Current per Grid	—	0	milliamperes
Heater Voltage	5.7	6.9	volts
Envelope Temperature	—	300	°C.
Altitude for Full Ratings	—	10,000	feet
If cooling is provided to keep bulb temperature within ratings, altitude rating can be extended to 60,000 feet			
Circuit Values			
Total Grid Circuit Resistance in Regulator Service or with fixed bias	500	50,000	ohms
Total Grid Circuit Resistance with cathode bias only	500	200,000	ohms
Resistance per grid leg when tubes are paralleled	500	—	ohms

Cathode Resistance: Minimum cathode resistance per cathode leg shall be 27 ohms or that resistance necessary to provide 10% of the grid bias voltage, whichever is greater.

ADDITIONAL TESTS TO INSURE RELIABILITY

Randomly Selected Samples are Subjected to the Following Tests

Shock: 30° Hammer Angle in Navy, Flyweight, High Impact Machine (450 G/msec)

Life Test: 1000 hours under plate current test conditions

Post Shock and Life Test End Points:

Plate Current	450 mA min.
Transconductance	27,000 umho min.
HK Leakage	150 uA max.
Grid Current	—12 uA max.

RANGE OF VALUES

Conditions: $E_f = 6.3$ V, $E_b = 190$ V
$E_c = -0$, $R_k/_k = 200\ \Omega$, $R_g = 500\ \Omega$
Readings taken after
5 minutes power preheating.

Total Plate Current	495	600	Milliamperes, d. c.
Amplification Factor	2.0	3.4	
Transconductance	33,000	48,000	Micromhos
Heater Current per tube	7.12	7.88	Amperes

Conditions: $E_f = 6.3$ V, $E_b = 200$ V
$E_c = -100$ V, $R_k = 0$

Current per Cathode	0	10	Milliamperes

Application Notes

The 7241 was designed expressly for use as a "passing" tube or series regulator tube. Its high current capabilities permit it to replace several tubes of lower current ratings. For even higher current several tubes can be paralleled. If tubes are to be paralleled, however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it provides more bias on the sections taking greater plate current. A cathode resistor need be only one fourth the value $\left(\frac{R}{u+1}\right)$ of a plate resistor, and therefore will dissipate only one fourth the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (about two watts) and the additional voltage (less than 10 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively, tied to the plate. The plate will attempt to draw excessive current from the passing tube's cathode and may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulator output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be able to counteract the effect of unbalance due to tube ageing.

If two or more tubes are used in parallel a grid resistor should be used for each tube. This should be enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 6.3 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

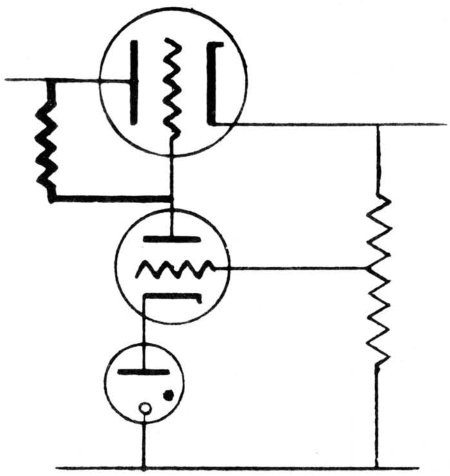


FIGURE 1

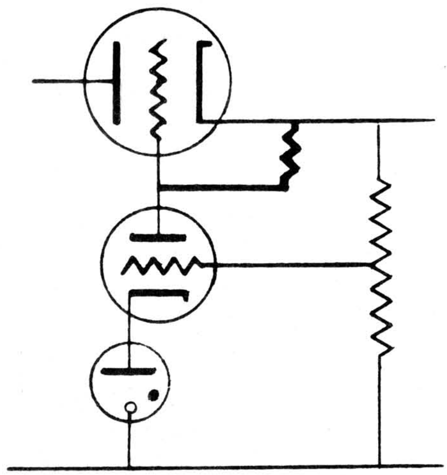


FIGURE 2

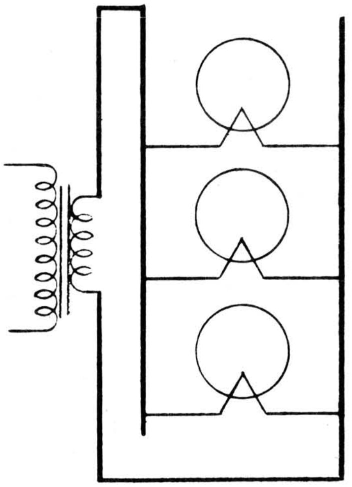
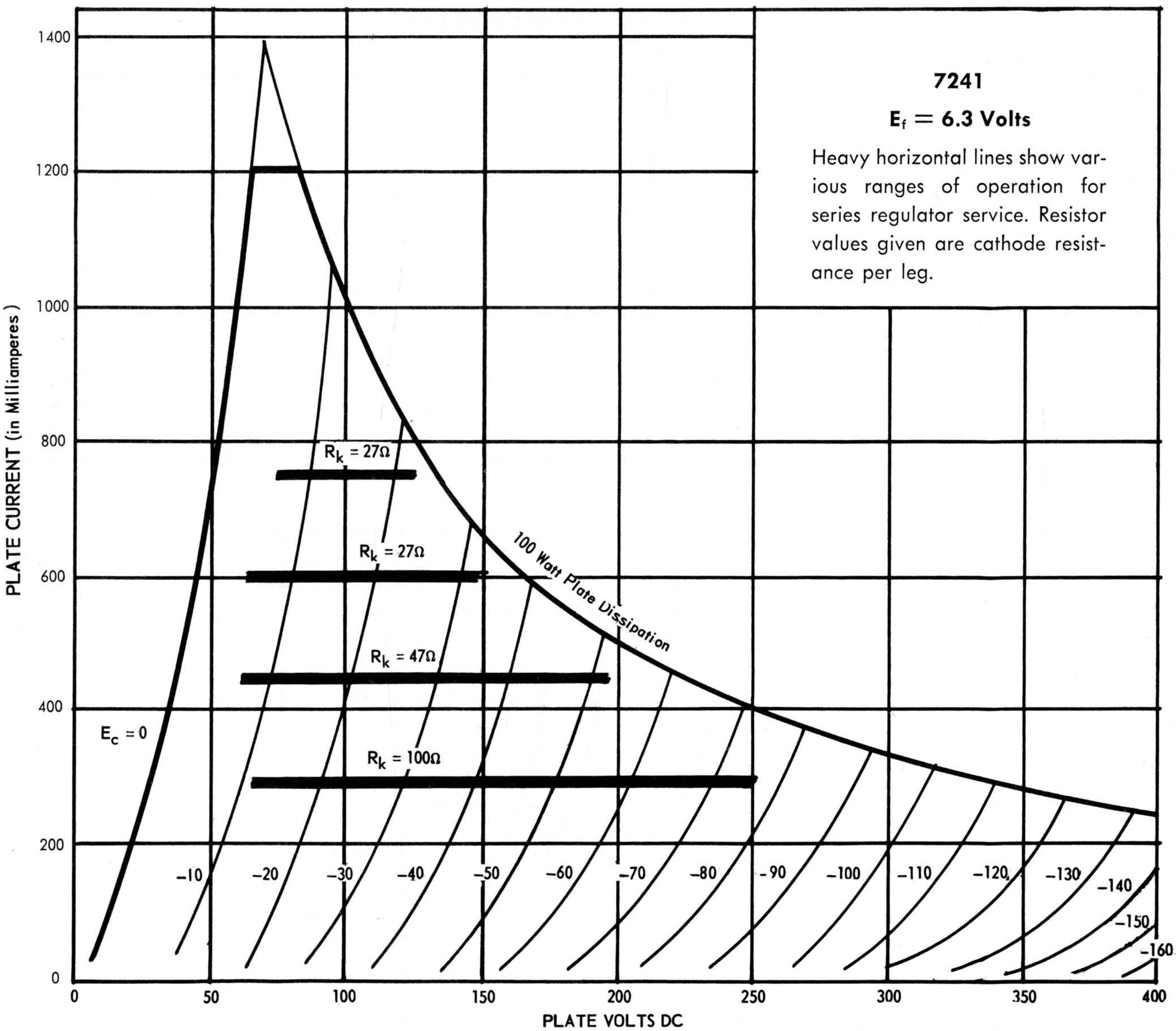
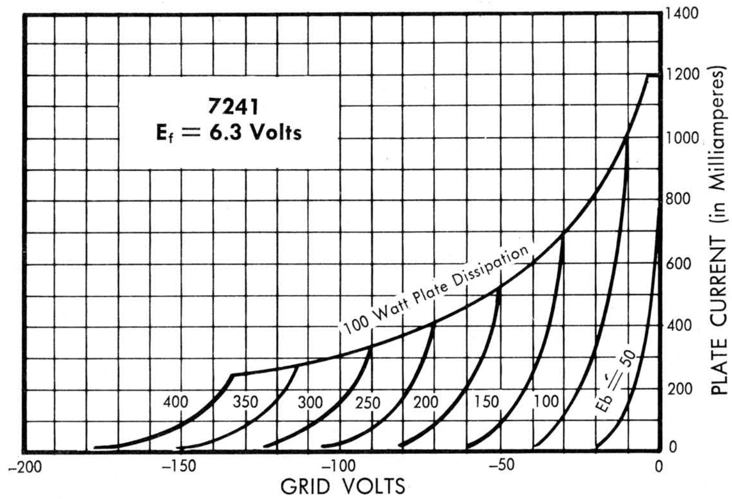


FIGURE 3

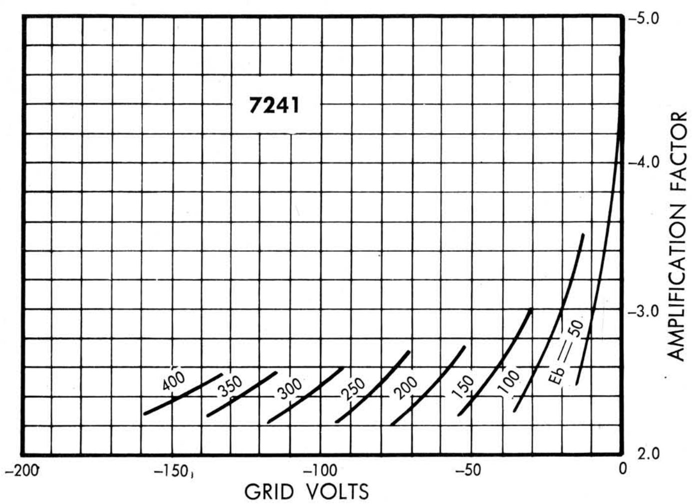
AVERAGE PLATE CHARACTERISTICS

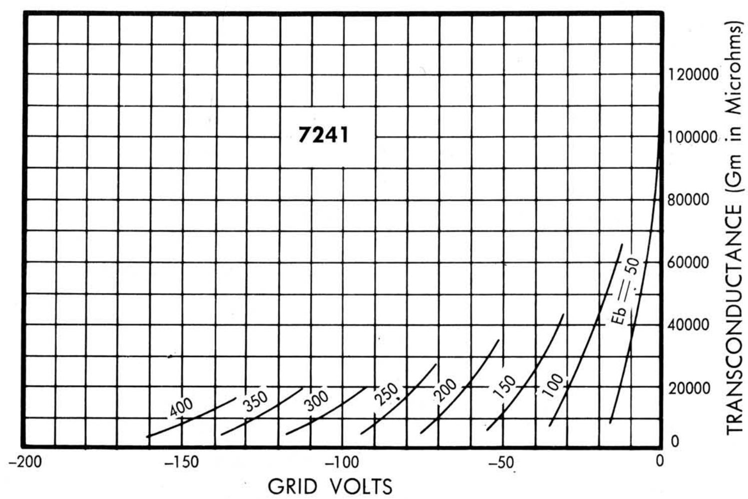


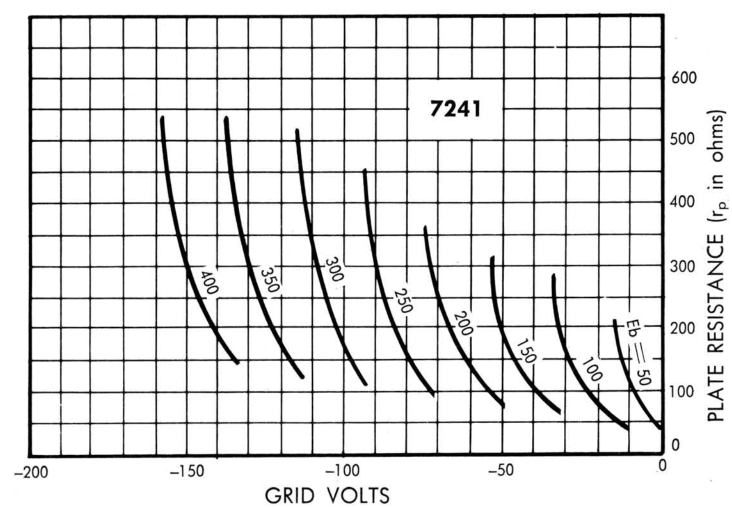
TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS







TUNG-SOL / CHATHAM

MEDIUM MU HIGH POWER TRIODE FOR SERIES REGULATOR SERVICE

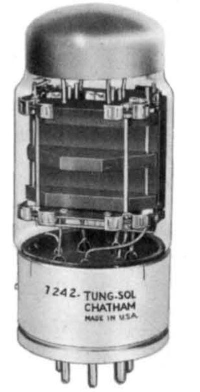
TYPE 7242

DESCRIPTION — The 7242 is a long life, high power triode developed especially for use as a passing tube in series regulated power supplies. For this service, a tube must be able to pass large currents over a wide voltage range and still exhibit a low intrinsic voltage drop when operated "wide open". The 7242 not only meets these requirements but possesses the additional advantage of requiring little grid voltage swing to control these currents. This permits the use of simpler control amplifier circuits in the regulated supply.

The 7242 features one large zirconium coated graphite anode, with three separate grid-cathodes structures. This anode, while lighter in weight than similar metal anodes, remains warp free during life and provides one of the best gas "gettering" means known. The anode is supported by ceramic insulators. The use of these insulators and the hard glass envelope permit the tube to be outgassed at high temperatures during the manufacturing exhaust process. This allows the tube to be run at high temperatures during operation, without the evolution of harmful gas from the tube parts.

Massive cathodes provide adequate emission current reserve. Gold plated molybdenum wires are employed in the rugged grid structure. The tube mount is built on a rugged button stem, and is supported from the bulb by means of flexible metal vibration snubbers.

In many circuits, one 7242 can replace four type 5998 regulator tubes. For even higher levels of current or power, several 7242 tubes can be paralleled as explained in the application notes.

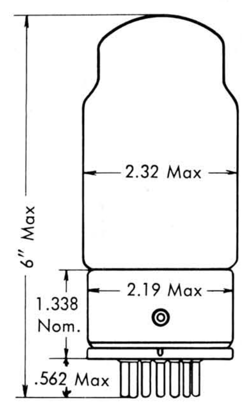


ELECTRICAL DATA

Heater Voltage .... 6.3 ±10% volts
Heater Current (E_f = 6.3 volts) ..... 7.5 amperes
Minimum Cathode Heating Time ...... 30 seconds
Transconductance .... 111,000 umhos
Amplification Factor 9.0
Plate Resistance .... 82 ohms

MECHANICAL DATA

Mounting Position .... Any
(If tube is to be mounted in a horizontal position it is recommended that it be mounted so that the bayonet pin points either directly up or directly down)
Bulb .... TT 18 Nonex
Base .... Giant 7 pin with Ceramic insert, JETEC #A7-17
Socket .... E. F. Johnson #122-237 or Equivalent
Average Net Weight .... 6.0 ounces
Maximum Shock Rating (Navy Hi Impact Shock Machine) .... 450 G
Maximum Vibration Rating (10 to 25 cps) .... 2.5 G



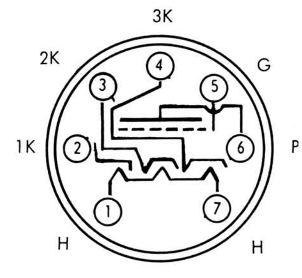
GLASS BULB

RATINGS, ABSOLUTE VALUES

	Minimum	Maximum	
Total Plate Dissipation	—	100	watts
Total Plate Current	—	0.9	amperes d.c.
If tube voltage drop is to be swung more than 6 volts, this current cannot be realized. See Plate Characteristics Curve.			
Current per Cathode	—	300	milliamperes d. c.
Plate Voltage	0	400	volts d. c.
Heater-Cathode Voltage	—300	+300	volts d. c.
Grid Voltage	—300	0	volts d. c.
Grid Current per Grid	—	0	milliamperes
Heater Voltage	5.7	6.9	volts
Envelope Temperature	—	300	°C.
Altitude for Full Ratings	—	10,000	feet
If cooling is provided to keep bulb temperature within ratings, altitude rating can be extended to 60,000 feet.			
Circuit Values			
Total Grid Circuit Resistance in Regulator Service or with fixed bias	500	20,000	ohms
Total Grid Circuit Resistance with cathode bias only	500	200,000	ohms
Resistance per grid leg when tubes are paralleled	500	—	ohms

Cathode Resistance: Minimum cathode resistance per cathode leg shall be 10 ohms or that resistance necessary to provide 10% of the grid bias voltage, whichever is greater.

KEY



Bottom View

Additional Tests to Insure Reliability

Randomly Selected Samples are Subjected to the Following Tests

Shock: 30° Hammer Angle in Navy, Flyweight, High Impact Machine (450/Gmsec)

Life Test: 1000 hours under plate current test conditions (R_g = .05 Meg.)

Post Shock and Life Test End Points:

Plate Current	390 mA min.
Transconductance	70,500 umho min.
HK Leakage	150 uA max.
Grid Current	—12 uA max.

Range of Values

Conditions: $E_f = 6.3$ V, $E_b = 100$ V, $E_c = -4$, $R_g = 500\ \Omega$

Readings taken after 2 min. preheating under conditions of $E_f = 6.3$, $E_{bb} =$ 190 V, $E_c = 0$, $R_k = 200$ ohms.

Total Plate Current	420	690 Milliamperes, d. c.
Amplification Factor	7.0	11.0
Transconductance	87,000	135,000 Micromhos
Heater Current per Tube	7.12	7.88 Amperes

Conditions: $E_f = 6.3$ V, $E_b = 400$ V, $E_c = -75$ V, $R_k = 0$

Total Plate Current	0	9 Milliamperes

Application Notes

The 7242 is admirably suitable for use as a "passing" tube or series regulator in electronically controlled power supplies because of its ability to pass large currents and to easily control them. For even greater current, several tubes can be paralleled. If tubes are to be paralleled, however, the designer is strongly urged to use sufficient resistance in each cathode leg to equalize current division among the triode sections. Recommended values for various operating currents are shown on the plate characteristics curve. If the output current of the supply is not fixed, use the resistance indicated for the lowest current that approaches the maximum plate dissipation line. Cathode resistance is superior to anode resistance because it provides more bias on the sections taking greater plate current. A cathode resistor need be only one tenth the value ($\frac{R}{u+1}$) of a plate resistor, and therefore will dissipate only one tenth the power. In any case, the only losses incurred in using a resistor is the insertion loss of the resistor itself (less than one watt) and the additional voltage (less than 6 volts) necessary from the unregulated supply. A cathode resistor adds a small additional loss by causing the passing tube to work with higher bias and hence with greater tube drop.

A thirty second cathode warmup time is recommended before the plate voltage is applied. This is especially necessary in circuits where the amplifier tube plate resistor is returned to the plate side of the passing tube, as illustrated in the simplified circuit in Figure 1. In this case during warmup the amplifier tube draws little current, there is little IR drop across the resistor, and the grid of the passing tube is effectively tied to the plate. The plate will attempt to draw excessive current from the passing tube's cathode which may seriously impair tube life. The circuit in Figure 2 is preferable from the consideration of the safety of the passing tube both during warmup and in the event of trouble in the amplifier circuit or if the amplifier tube is removed from its socket. It has the additional advantage of providing a constant voltage for the amplifier circuit. However, if the regulated output is low (below 250 volts) it will be necessary to provide additional negative voltage for the reference tube circuit. Also, if the regulated output voltage is to be variable, it may be necessary to follow Figure 1.

Passing tube operation conditions should be chosen to provide as low a tube drop as possible. A safety margin of at least 5 volts from the zero bias line should be allowed however, for variations of individual tubes. Sufficient bias excursion should be allowed for overcoming ripple. The amplifier circuit should be able to counteract the effect of unbalance due to tube ageing.

If two or more tubes are to be used in parallel a grid resistor should be used for each tube. This should be enough to prevent parasitic oscillation but not large enough to prevent loss of control due to a small amount of "gas" grid current. A value of grid resistance that meets both these conditions is 1,000 ohms. Heater voltage should be kept as close as possible to 6.3 volts as measured on the tube pins. When connecting many high drain tube heaters across a single transformer, bus bars feeding from "alternate ends" (Figure 3) should be used with a stranded pair feeding individual sockets.

TUNG-SOL / CHATHAM

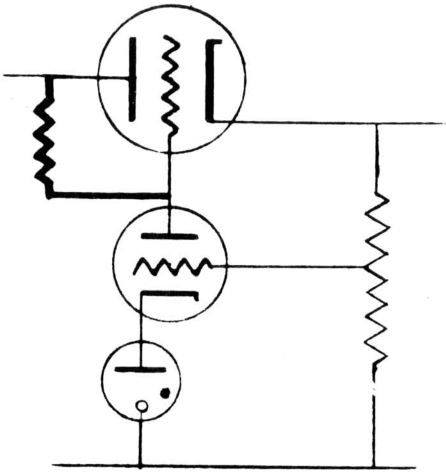


FIGURE 1

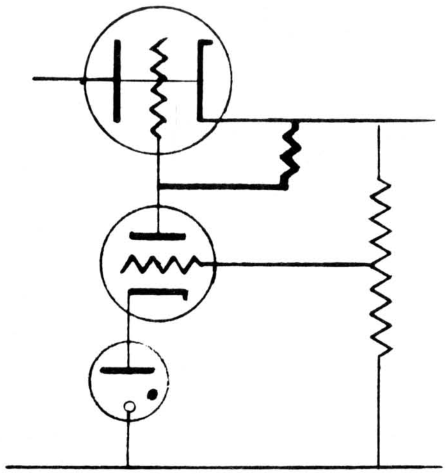


FIGURE 2

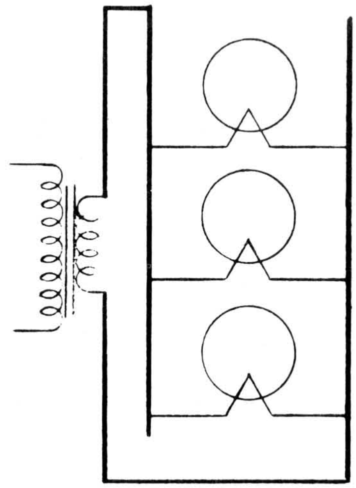
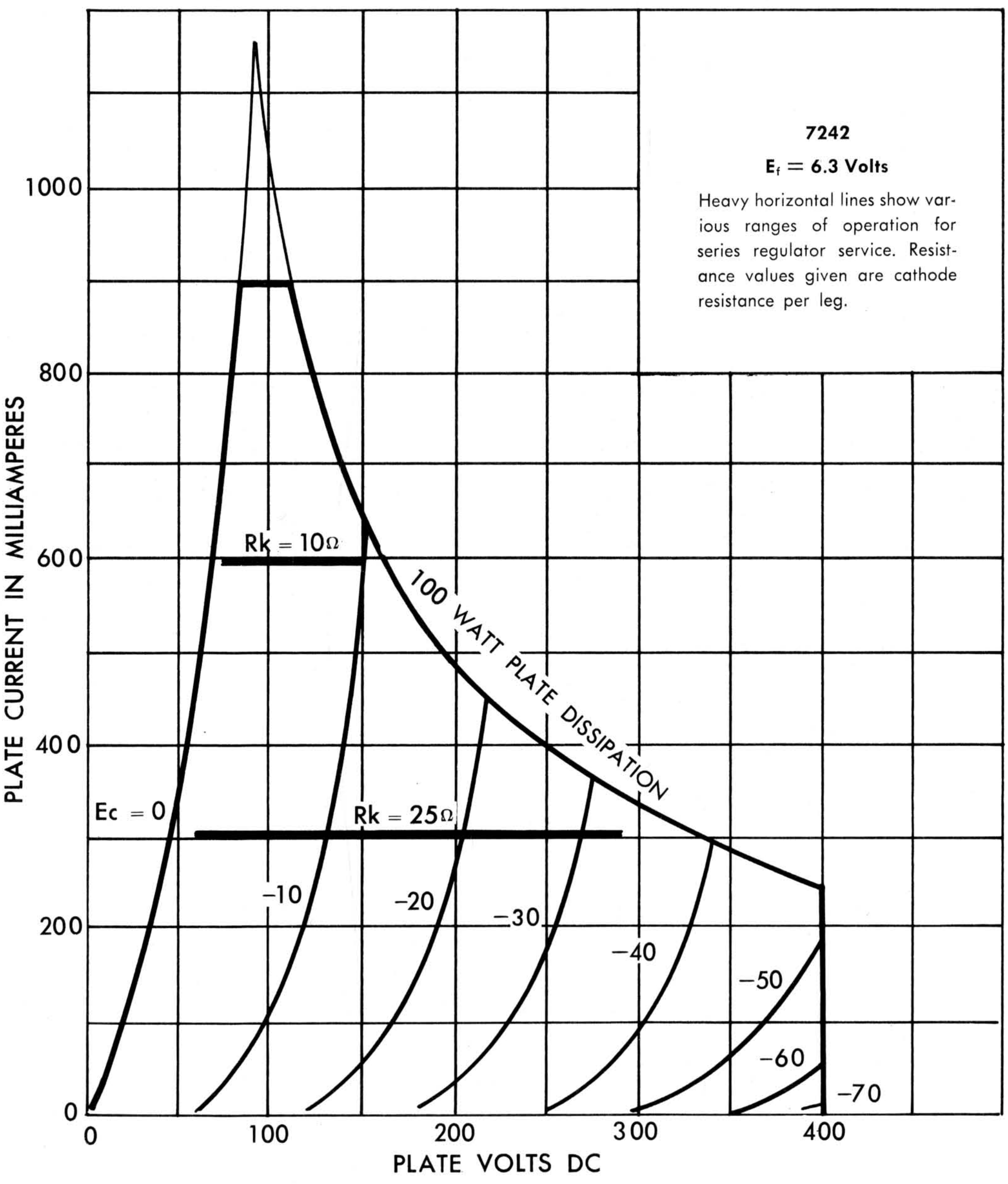


FIGURE 3

AVERAGE PLATE CHARACTERISTICS



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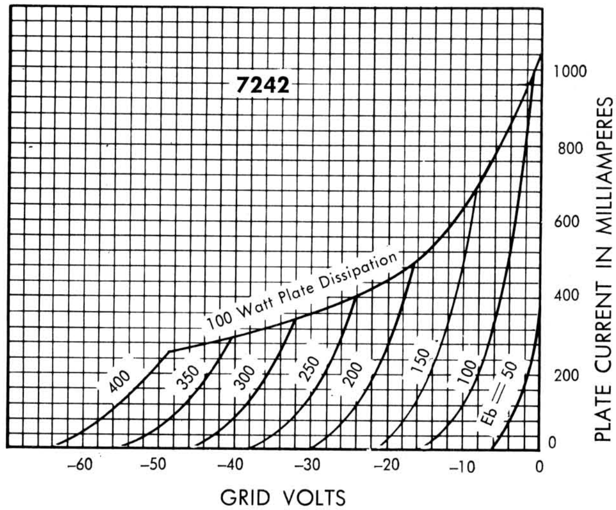
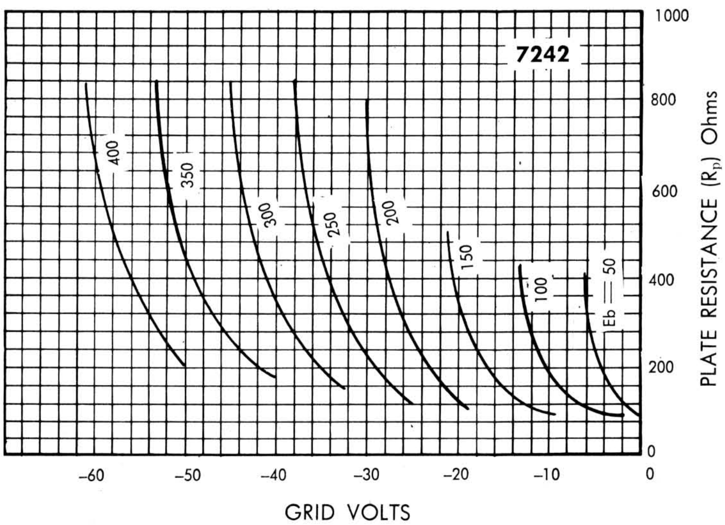
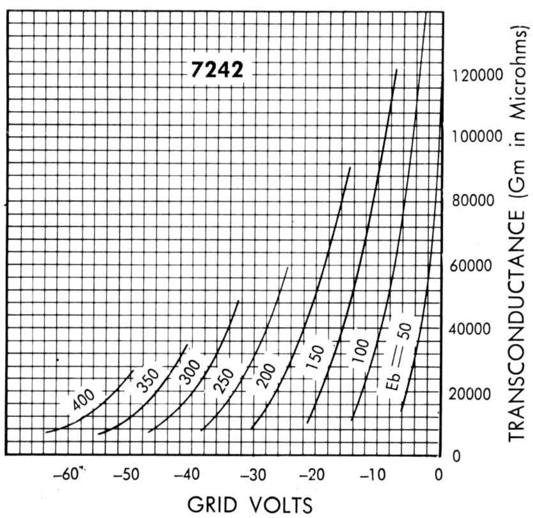
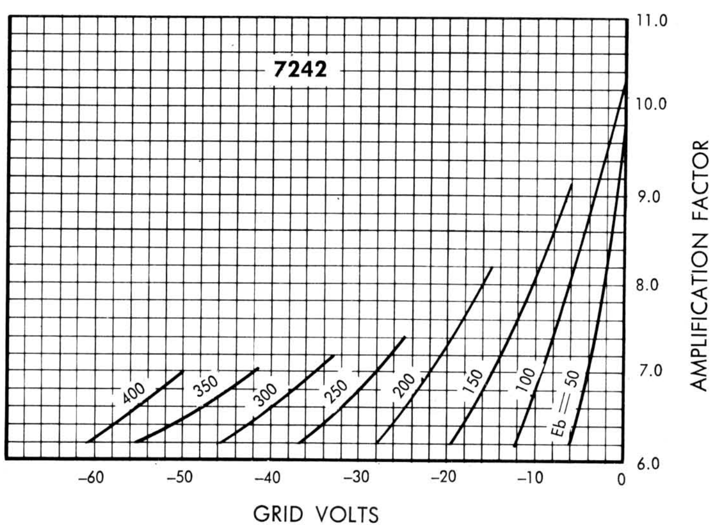
TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS







TUNG-SOL/CHATHAM

TYPE
7323

SUBMINIATURE, SELF INDICATING THYRATRON

DESCRIPTION: The 7323 is a subminiature thyratron with negative control grid characteristics. The gaseous glow it exhibits while conducting is several times brighter than an NE-2 glow lamp (both devices at maximum ratings) and makes the use of auxiliary readout devices unnecessary. It may be viewed either "end on" or from the side.

Because of its small size, low operating voltages, minute triggering requirements and low filament power, the 7323 is particularly suited for use in transistor circuits. The terminal leads may be soldered directly into a circuit or may be clipped for insertion in an in-line subminiature socket.

The 7323 replaces type CK1050 in all applications.

ELECTRICAL DATA

Filament Voltage	1.25 ± 10% V a.c.
Filament Current	280. mA
Anode Voltage Drop @ 3 mA	18 V d.c.

MECHANICAL DATA

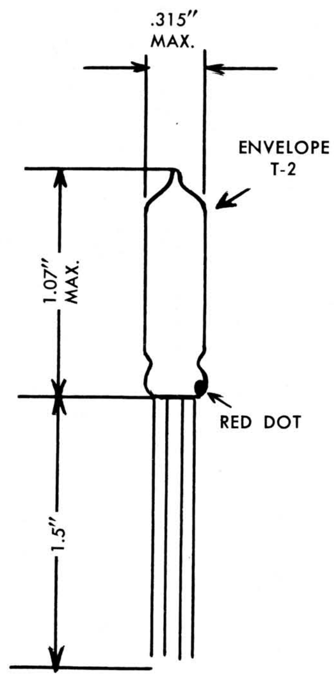
Mounting position	Any
Bulb	T2
Diameter	0.315" Max.
Length (without leads)	1.07" Max.
Connections	Flexible leads
Weight (Approx.)	0.06 oz.

RATINGS, ABSOLUTE VALUES

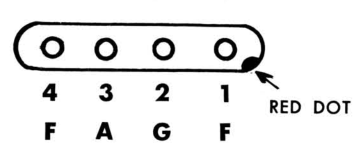
Anode Supply Voltage (RMS)	80. V a.c. Max.
Cathode Current	3 mAdc Max.
Preconduction Grid (Transfer) Current @ E_b = 75 volts RMS	0.5 μAdc Max.

TYPICAL OPERATING CONDITIONS

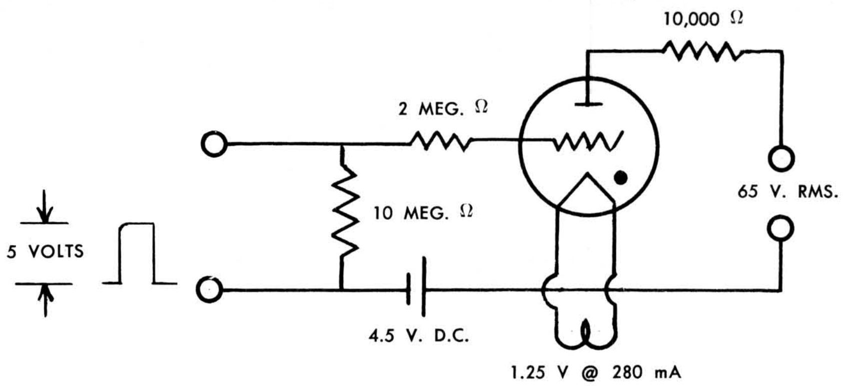
Anode Supply Voltage (RMS)	65 V a.c.
Anode Circuit Resistance	10,000 Ohms
Anode Current	2 mAdc
Grid Bias Voltage	−4.5 V d.c.
Grid Series Resistance	2. Megohms



LEAD CONNECTIONS



0.016" Tinned Flexible Leads
0.048" Center to Center



PULSE OPERATED RELAY

Application Notes

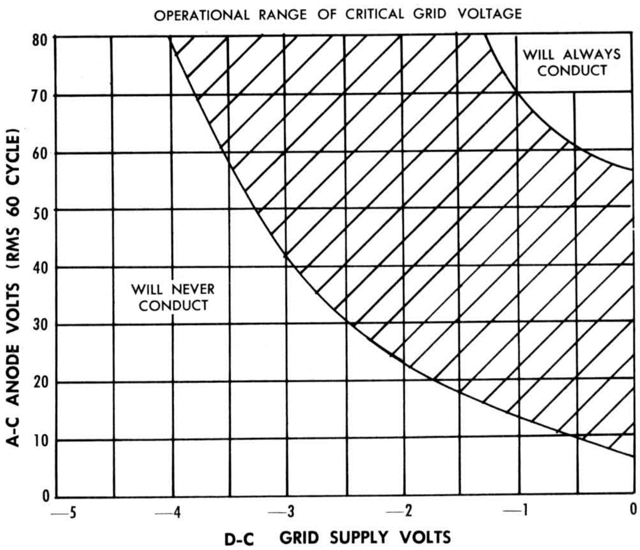
It is often necessary to provide a relay device to operate at low level, low voltage, short duration pulses such as are found in transistor circuits.The 7323 self indicating thyratron performs this function as well as providing an adequate, visual read out indicator. Although not as brilliant an indicator as comparable cold cathode thyratrons, the 7323 operating at 3 milliamperes is many times brighter than an NE-2 neon glow lamp. The efficient filament consumes only about one third watt of heater power.

As with any gas tube, once the tube conducts, the tube voltage drop remains virtually constant and the current through the tube is limited by the circuit resistance. In the anode circuit this may be the resistance of the load itself, or, the load plus additional limiting resistance. The grid circuit should contain a 1,000 ohm series resistance if the source resistance is lower than this figure.

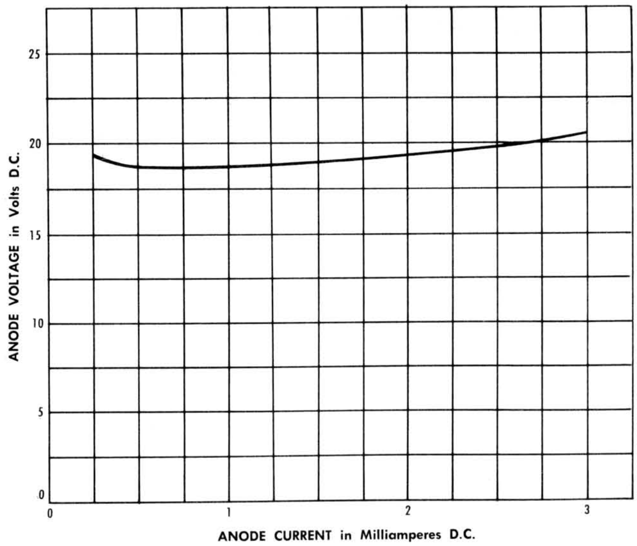
The 7323 is normally mounted behind a panel cut out for either end on or side viewing. A subminiature heat dissipating type of tube clamp provides both a convenient means of mounting as well as shielding to minimize the effect of hand capacity or electrical fields.

The 7323 can be operated from either an A.C. or D.C. anode supply voltage. If D.C. operated, it is necessary to break the anode circuit (either by a mechanical switch or negative pulse) to restore control after the tube has fired. This is particularly advantageous in the "hold until reset" type of application.

CONTROL CHARACTERISTICS



ANODE CHARACTERISTICS



TUNG-SOL/CHATHAM

SELF INDICATING, COLD CATHODE THYRATRON

DESCRIPTION — The 7400 is a small, light weight, cold cathode thyratron for relay service. When the tube is conducting, the disk shaped cathode glows brightly with the characteristic neon color. The tube is designed for end on viewing.

The 7400 has "reference tube" construction and processing to keep its firing characteristics constant during life. This feature, coupled with the low level of trigger pulse voltage, makes the 7400 particularly adaptable to transistor circuits.

This tube type was designed into some circuits under the original development type designation, CH1116.

TYPE

7400

RATINGS, ABSOLUTE VALUES

Positive Anode Voltage	180 VDC Max.
Negative Anode Voltage (without discharge to a positive grid)	100 VDC Max.
Positive Grid Bias Voltage (without grid ionization)	102 VDC Max.
Transfer current @ Eb = 150 VDC	15 uA Max.
Cathode Current	12 mA DC Max.

TYPICAL OPERATING CONDITIONS

Anode Supply Voltage	150 volts d.c.
Anode Circuit Resistance	5,000 ohms
Anode Current	7 milliamperes
Positive Grid Bias	102 volts d.c.
Grid Trigger Signal	5 volts
Grid Transfer Current	7 microamperes
Current Amplification	1,000

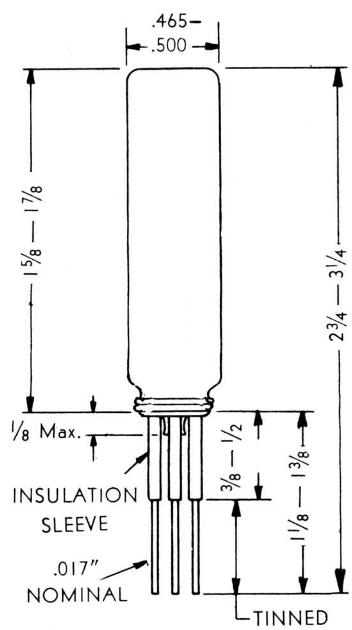
ELECTRICAL DATA

(Typical Values)

Anode Voltage Drop @ 1 mA	102 VDC
Anode Voltage Drop @ 10 mA	117 VDC
Grid Voltage Drop @ 1 mA	88 VDC
Anode Ionization Voltage	210 Volts
Grid Ionization Voltage	109 Volts
Minimum Anode Current for Bright Read Out Indication	250 microamperes

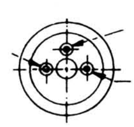
MECHANICAL DATA

Mounting Position	Any
Bulb	Flat end vial
Diameter	0.50″ max.
Length (without leads)	1.88″ max.
Connections	Color coded flexible leads
Weight (approx.)	0.17 oz.



GLASS BULB

NOTE:
COLORS INDICATED FOR TUBE LEADS ARE THE COLORS OF THE INSULATION SLEEVES.



Bottom View

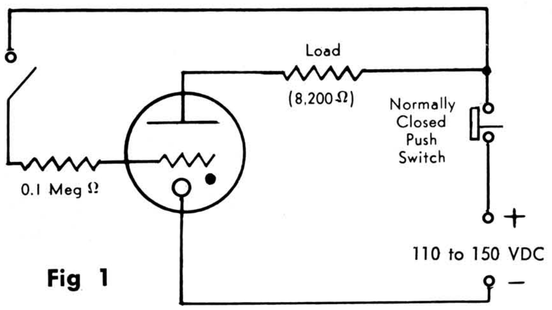
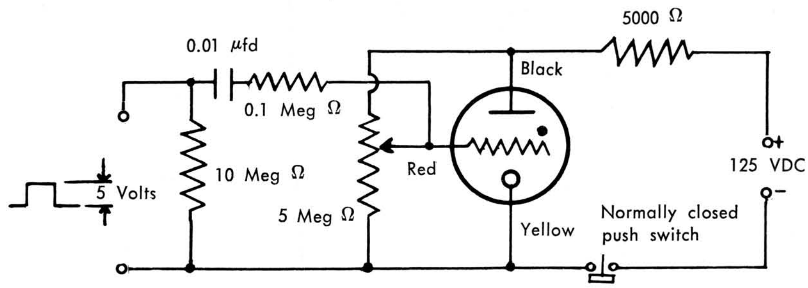


Fig 1

Mechanically operated relay



Pulse operated relay

Fig 2

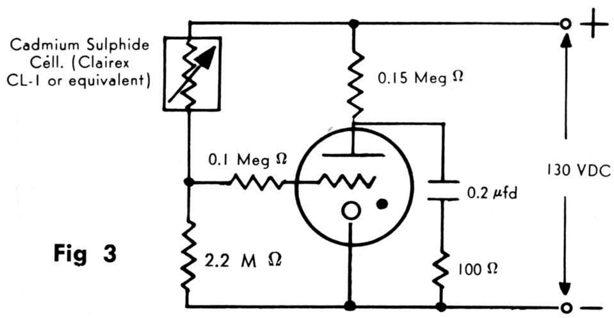


Fig 3

Relay for a Cadmium Sulphide photo cell

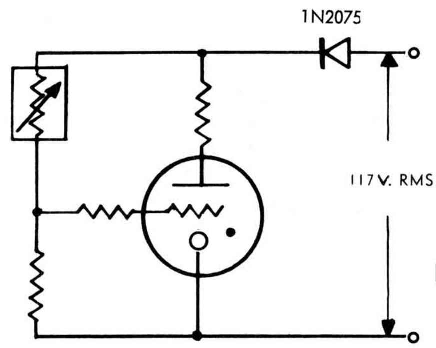


Fig 4

Same as Figure 3 but operated from A.C. line

Application Notes

It is often necessary to provide a relay device for circuitry operating at low power level, low voltage pulses. The 7400 self indicating thyratron performs this circuit function as well as providing a brilliant, visual readout indicator. No heater power is required for its operation.

The 7400 contains a cathode, a trigger grid and an anode within a gaseous atmosphere. If an increasing positive voltage is applied to the grid, a minute pre-ionization current will flow until the critical grid current of about seven microamperes is reached. At this point the region between the grid and cathode "breaks down" or ionizes. If the applied anode voltage is equal to or greater than the grid voltage, the glow will then transfer to the cathode-anode region. Thus, a very low energy signal in the grid circuit can control much higher energy in the anode circuit. If, in this illustration an anode current of seven milliamperes were to flow, the tube has provided current amplification of 1,000.

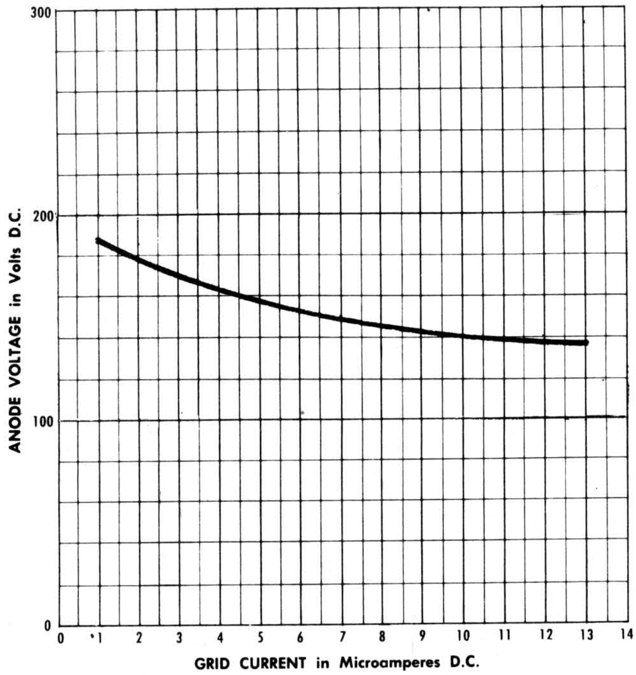
As with any gas tube, once the tube conducts, the tube voltage drop remains virtually constant and the current through the tube is limited by the circuit resistance. In the anode circuit this may be the resistance of the load itself, or, the load plus additional limiting resistance. The grid circuit should contain a 5,000 ohm series resistance if the source resistance is lower than this figure. If the grid circuit resistance is above 10 megohms, however, it may be necessary to connect a small capacitance between the grid and cathode. This is to store enough energy to insure grid ionization.

Radioactive dosing is used to eliminate any change of firing characteristics due to illumination. The magnitude of activity is not great enough to institute a personal hazard. However, persons are cautioned not to handle broken tubes to avoid getting the active material directly into the bloodstream through cuts. If a person cuts himself on a broken tube the cut should be cleansed immediately. An open cut can be cleansed by holding it in running water.

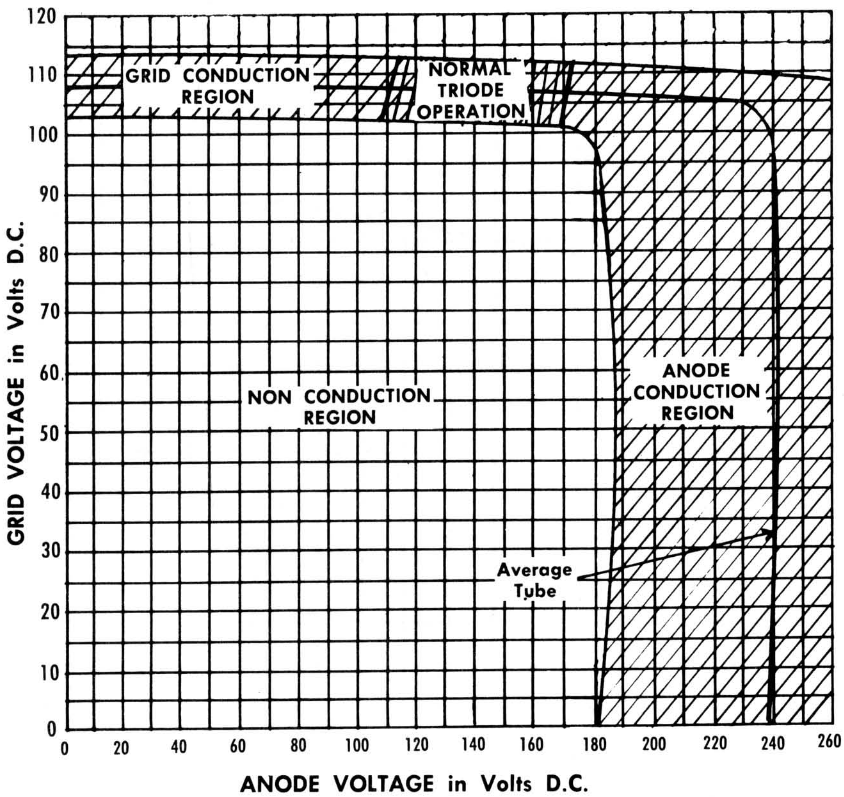
The 7400 is designed for end on viewing and will provide a brilliant surface glow pattern when conducting only a fraction of a milliampere. The tube is normally mounted behind a metal panel with the flat end of the bulb flush with the panel surface. If it is not so mounted, the bulb sides should be shielded (eg: copper mesh) to prevent hand capacity or strong electric fields from altering firing potentials. A heat dissipating type of tube clamp provides a convenient method of tube mounting that requires no further shielding.

Typical circuit configurations are illustrated above. As with any thyratron circuit, once the tube conducts, the grid will not regain control until the anode voltage falls low enough to extinguish the cathode-anode glow. This is usually accomplished by breaking the anode circuit. However, it can also be done under D.C. operation, by causing the anode current to flow in saw tooth steps. The saw tooth is generated by running the tube as a relaxation oscillator by inserting sufficient capacity between the cathode and anode. Figure 3 illustrates an application of this idea. The 7400 will also regain grid control on each cycle if it is run from half wave rectified A.C. Figure 4 illustrates an application of the tube on A.C. Operation of the tube on A.C. without the series diode is not recommended.

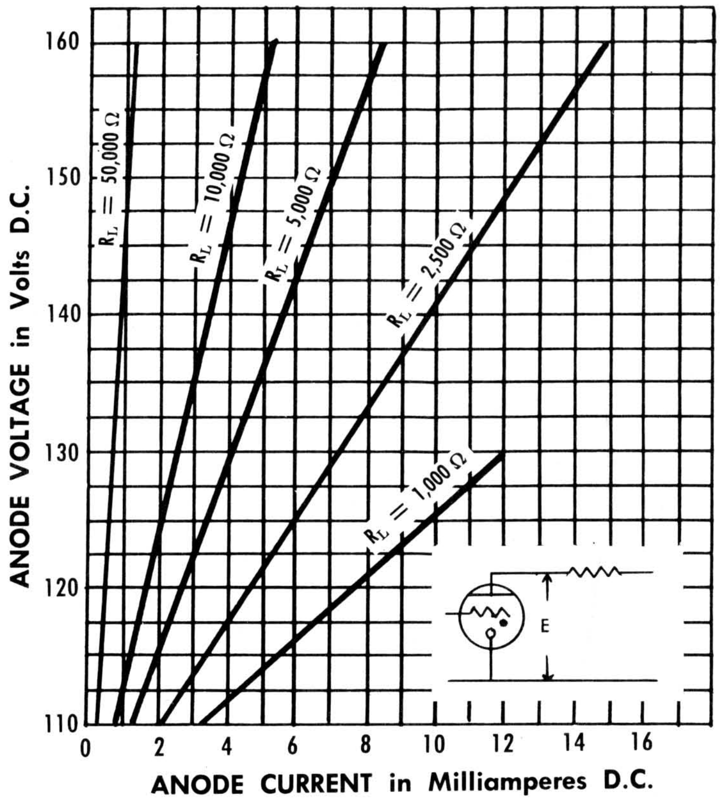
TRANSFER CHARACTERISTICS



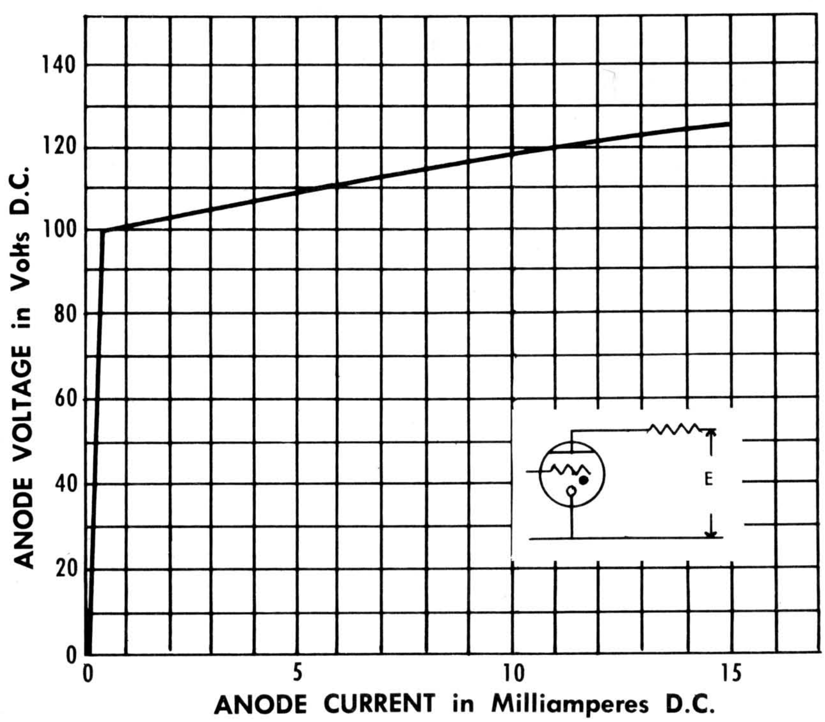
OPERATION CHARACTERISTICS



ANODE CIRCUIT VOLTAGE vs. CURRENT
For Various Load Resistances



ANODE CHARACTERISTICS



TUNG-SOL / CHATHAM

TYPE
7401

SUBMINIATURE, SELF INDICATING COLD CATHODE THYRATRON

DESCRIPTION — The 7401 is a subminiature, light weight, cold cathode thyratron for relay service. When the tube is conducting, the disk shaped cathode glows brightly with the characteristic neon color. The tube is designed for end on viewing in small spaces.

The 7401 has "reference tube" construction and processing to keep its firing characteristics constant during life. This feature, coupled with the low level of trigger pulse voltage, makes the 7401 particularly adaptable to transistor circuits.

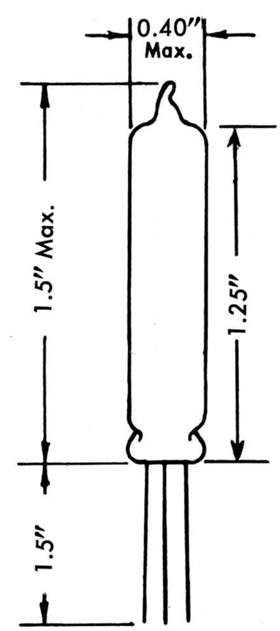
This tube type was designed into some circuits under the original development type designation, CH1125.

RATINGS, ABSOLUTE VALUES

Positive Anode Voltage	180 VDC Max.
Negative Anode Voltage (without discharge to a positive grid)	100 VDC Max.
Positive Grid Bias Voltage (without grid ionization)	102 VDC Max.
Transfer current @ Eb = 150 VDC	15 μA Max.
Cathode Current	8 mA DC Max.

TYPICAL OPERATING CONDITIONS

Anode Supply Voltage	150 volts d.c.
Anode Circuit Resistance	5,000 ohms
Anode Current	7 milliamperes
Positive Grid Bias	102 volts d.c.
Grid Trigger Signal	5 volts
Grid Transfer Current	5 microamperes
Current Amplification	1,400



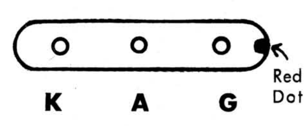
ELECTRICAL DATA
(Typical Values)

Anode Voltage Drop @ 1 mA	105 VDC
Anode Voltage Drop @ 8 mA	115 VDC
Grid Voltage Drop	87 VDC
Anode Ionization Voltage	200 Volts
Grid Ionization Voltage	107 Volts
Minimum Anode Current for Bright Read Out Indication	250 microamperes

MECHANICAL DATA

Mounting Position	Any
Bulb	T3
Diameter	0.40" max.
Length (without leads)	1.50 nom.
Connections	Flexible leads
Weight (approx.)	0.11 oz.

LEAD CONNECTIONS



0.016" TINNED FLEXIBLE LEADS

0.100" Center to Center

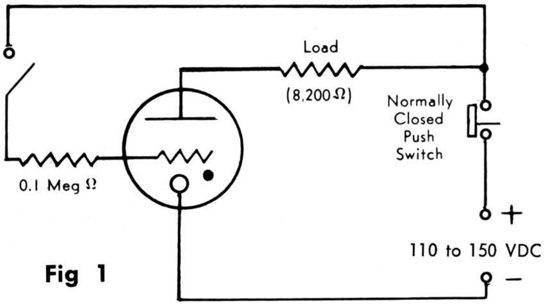
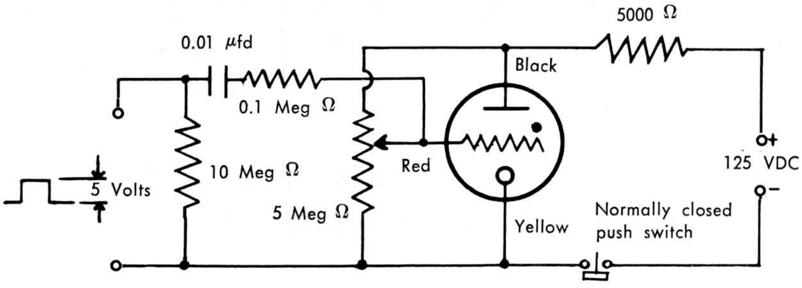


Fig 1

Mechanically operated relay



Pulse operated relay

Fig 2

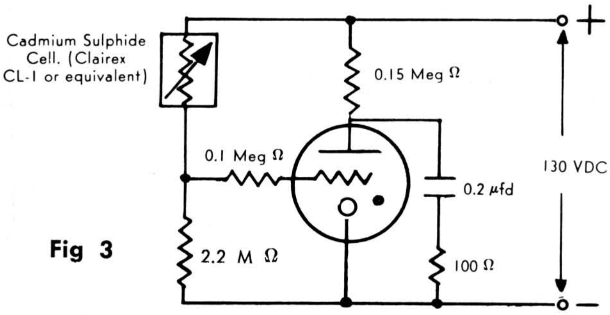


Fig 3

Relay for a Cadmium Sulphide photo cell

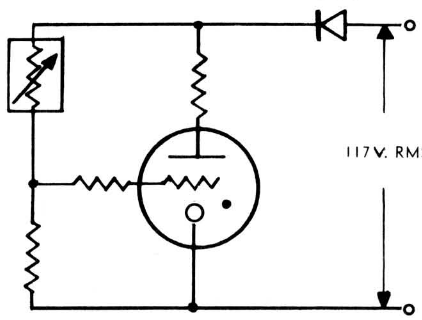


Fig 4

Same as Figure 3 but operated from A.C. line

Application Notes

It is often necessary to provide a relay device for circuitry operating at low power level, low voltage pulses. The 7401 subminiature self indicating thyratron performs this circuit function as well as providing a brilliant, visual readout indicator. No heater power is required for its operation.

The 7401 contains a cathode, a trigger grid and an anode within a gaseous atmosphere. If an increasing positive voltage is applied to the grid, a minute pre-ionization current will flow until the critical grid current of about five microamperes is reached. At this point the region between the grid and cathode "breaks down" or ionizes. If the applied anode voltage is equal to or greater than the grid voltage, the glow will then transfer to the cathode-anode region. Thus, a very low energy signal in the grid circuit can control much higher energy in the anode circuit. If, in this illustration an anode current of seven milliamperes were to flow, the tube has provided current amplification of 1,400.

As with any gas tube, once the tube conducts, the tube voltage drop remains virtually constant and the current through the tube is limited by the circuit resistance. In the anode circuit this may be the resistance of the load itself, or, the load plus additional limiting resistance. The grid circuit should contain a 5,000 ohm series resistance if the source resistance is lower than this figure. If the grid circuit resistance is above 10 megohms, however, it may be necessary to connect a small capacitance between the grid and cathode. This is to store enough energy to insure grid ionization.

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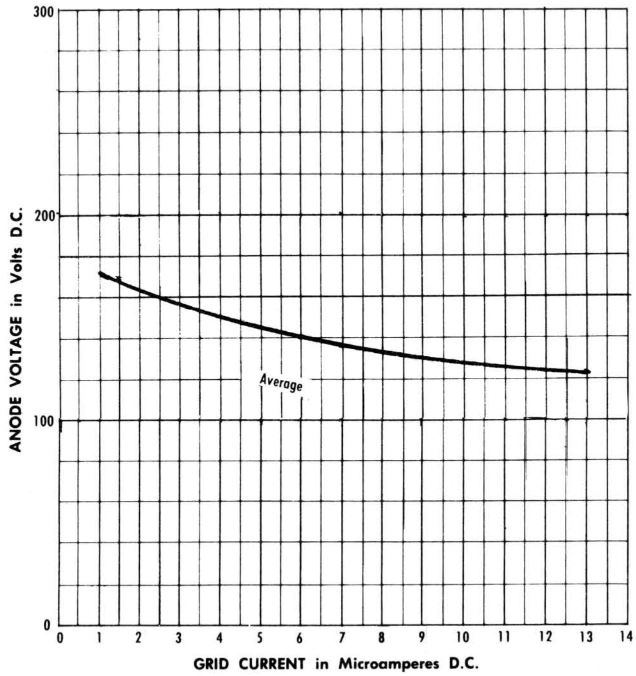
The 7401 is designed for end on viewing and will provide a brilliant surface glow pattern when conducting only a fraction of a milliampere. The tube is normally mounted behind a metal panel with the end of the bulb flush with the panel surface or protruding approximately one-quarter inch. If it is not so mounted, the bulb sides should be shielded (eg: copper mesh) to prevent hand capacity or strong electric fields from altering firing potentials. A heat dissipating type of tube clamp provides a convenient method of tube mounting that requires no further shielding.

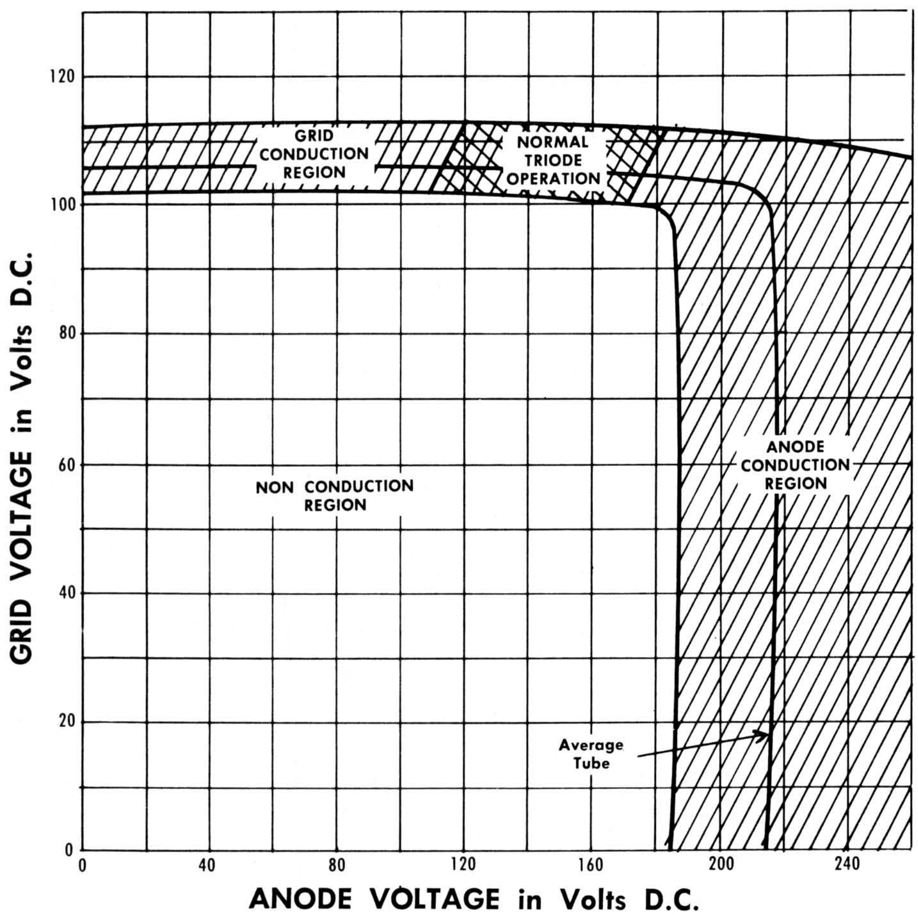
Typical circuit configurations are illustrated above. As with any thyratron circuit, once the tube conducts, the grid will not regain control until the anode voltage falls low enough to extinguish the cathode-anode glow. This is usually accomplished by breaking the anode circuit. However, it can also be done under D.C. operation, by causing the anode current to flow in saw tooth steps. The saw tooth is generated by running the tube as a relaxation oscillator by inserting sufficient capacity between the cathode and anode. Figure 3 illustrates an application of this idea. The 7401 will also regain grid control on each cycle if it is run from half wave rectified A.C. Figure 4 illustrates an application of the tube on A.C. Operation of the tube on A.C. without the series diode is not recommended.

TRANSFER CHARACTERISTICS

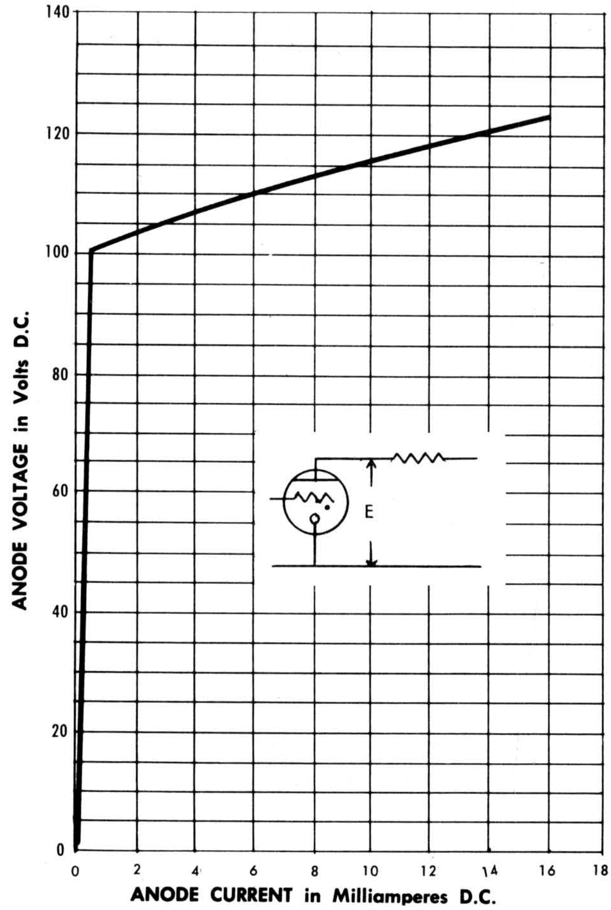


OPERATION CHARACTERISTICS

Range Includes Variations During Life

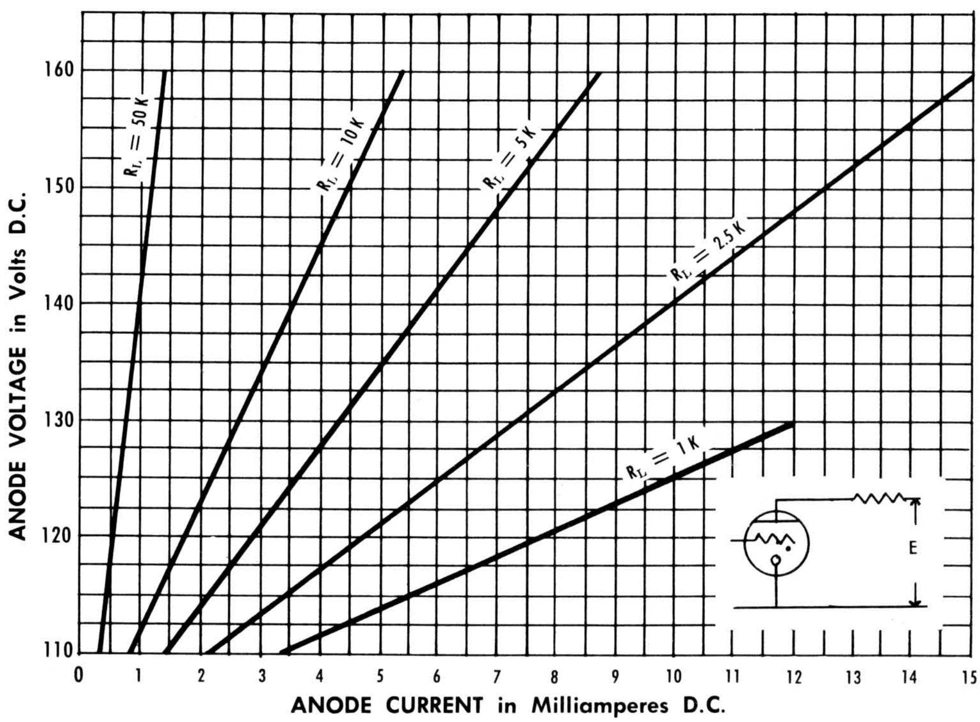


ANODE CHARACTERISTICS



ANODE CIRCUIT VOLTAGE vs. CURRENT

For Various Load Resistances



TUNG-SOL/CHATHAM

HYDROGEN THYRATRON DESIGN QUESTIONNAIRE

1. Company: ____________________

   Address: ____________________

   Name: ____________________ Position: ____________________

2. Type of Circuit — Kindly give the following data:

   Peak Anode Voltage

   Forward — epy ____________________ volts

   Inverse — epx ____________________ volts

   Cathode Current

   Peak — ib ____________________ amperes

   Average — Ib ____________________ amperes

   Peak Grid Voltage — egy ____________________ volts

   Peak Inverse Grid Voltage — egx ____________________ volts

   Grid Pulse

   Rise Time (between 26 and 70% points) — tr ____________________ microseconds

   Width (at 70.7% point) — tp ____________________ microseconds

   Pulse Recurrence Rate — prr ____________________ pulses per second

   Heating Factor (epy x ib x prr) — Pb ____________________

   Heater Voltage — Ef ____________________ volts

   Cathode Heating Time — tk ____________________ seconds/minutes

   Grid Circuit Impedance — Zg ____________________ ohms

   Is Clipper Tube Used ____________________, Gas ____________________ or Vacuum ____________________ Type,

   Where Located ____________________

   Is Anode Saturable Reactor Used ____________________

   Type of Load ____________________

   Pulse Separation For Coded Pulses ____________________

3. Additional Data ____________________

   ____

PLEASE SKETCH SCHEMATIC DIAGRAM OF CIRCUIT ON BACK OF PAGE

SCHEMATIC DIAGRAM

When completed mail to —
COMMERCIAL ENGINEERING DEPARTMENT
TUNG-SOL ELECTRIC, INC., CHATHAM ELECTRONICS DIVISION
630 W. Mt. Pleasant Avenue, Livingston, N. J.
WYman 2-1100

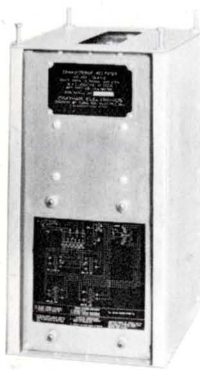
AIRBORNE CONVERSION EQUIPMENT

CHATHAM ELECTRONICS Division of TUNG-SOL ELECTRIC INC.

Chatham

world's leading supplier of power conversion units for military and commercial aircraft: silicon, germanium, selenium, AC-DC, DC-DC, DC-AC

Aircraft designers specify Chatham custom-built power supplies more than any other make. Why? Because Chatham, time after time, best satisfies the vital requirement of missiles . . . jet aircraft . . . commercial airliners for power conversion equipment



MODEL 28V100MBL

Input	115/200 volts, 3 ϕ, 400 c.p.s.	**Weight**	Less than 16 lbs.
Output	100 amp at 28 VDC	**Dimensions**	13⅜″Hx7″Wx7″D
Regulation	12.5% @ 200 volts	**Feature**	Contoured to fit cooling duct system
Cooling	External Blast	**Type**	Selenium TR unit

MODEL 283I50

Input	28 volts DC	**Weight**	Less than 5 lbs.
Output	50va 115/200 VAC 3 ϕ, 400 c.p.s. sine	**Dimensions**	3″H x 4″W x 5″D
Regulation	5% with Load	**Feature**	High efficiency and high temperature operation
Cooling	Convection/Conduction	**Type**	Static DC-AC Inverter

MODEL 75D2D50

Input	28 volts DC	**Weight**	Less than 1.5 lbs.
Output	50 ma @ ± 75 VDC	**Dimensions**	3″Hx2½″Wx5″D
Regulation	± 1%	**Feature**	Dual Output
Cooling	Conduction	**Type**	DC-DC Converter

MODEL 28V20

Input	115/200 volts, 3 ϕ, 300 to 525 c.p.s.	**Weight**	Less than 5.5 lbs.
Output	20 amp at 28 VDC	**Dimensions**	5½″H x 4⅛″W x 8⅝″D
Regulation	15% @ 200 volts	**Feature**	Wide frequency operation
Cooling	Fan	**Type**	Selenium TR unit

MODEL 28VS100C

Input	115/200 volts, 3 ϕ, 400 c.p.s.	**Weight**	Less than 17 lbs.
Output	100 amp @ 28 VDC	**Dimensions**	5″H x 10½″W x 13″D
Regulation	25-30.5 volts DC from 5 to 100 amp @ 195 to 210 volts	**Feature**	Designed to MIL-P-7212B
Cooling	Convection	**Type**	Silicon TR unit

MODEL 7VS20C

Input	115/200 volts, 3 ϕ, 400 c.p.s.	**Weight**	Less than 3 lbs.
Output	20 amp @ 7 VDC	**Dimensions**	3″H x 4″W x 5″D
Regulation	15% @ 200 volts	**Feature**	Voltage stability over wide temperature range.
Cooling	Convection	**Type**	Silicon TR unit

that combines consistent high reliability with minimum bulk and poundage.

Component Control

Chatham tailor-makes its own solid-state components — silicon, germanium, selenium—to fit design requisites of power conversion equipment. Thus, Chatham power conversion units are limited *in no way* by 'specs' of stock components.

Further, through strict control of components, Chatham trims away excess ounces and inches, fulfilling the critical weight and space considerations of airborne operations.

Proved reliability

Design and manufacture cued to do a specific job . . . Chatham's long-standing reputation as a maker of finest quality electronic equipment—these assure the reliability of each Chatham power conversion unit.

In addition, the daily performance of Chatham power supplies gives strong evidence of their capability. In military and commercial aircraft and missiles . . . under adverse conditions of temperature, altitude, shock and vibration, Chatham equipment shows an unblemished record of trustworthiness.

Fill Any Need

Chatham can match any power conversion demand—AC-DC, DC-DC, DC-AC. Many units, silicon and selenium, are immediately available from stock. For specific requirements, Chatham will cooperate to design and make an original unit with minimum delay.

For specific data, contact:

CHATHAM ELECTRONICS
Division of
TUNG-SOL ELECTRIC INC.
Livingston, N. J.—Phone: Wyman 2-1100

MODEL 28VCP-A

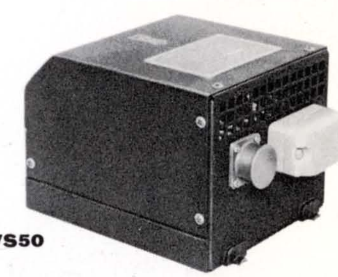
Input	115/200 volts, 3 ϕ, 400 c.p.s.	**Weight**	Less than 22 lbs.
Output	1 amp @ + 400 VDC 1 amp @ + 300 VDC 1.3 amp @ + 150 VDC 3 amp @ + 28 VDC 4 amp @ − 28 VDC	**Dimensions**	14½″H x 9⅜″W x 9⅜″D
		Feature	Low Output Impedance Contoured to fit missile
Cooling	Convection	**Type**	Silicon TR unit

MODEL 28V30BP

Input	115/200 volts, 3 ϕ, 400 c.p.s.	**Dimensions**	8″H x 9″W x 13¾″D
Output	30 amp at 28 VDC	**Feature**	Includes Silver Cell Battery
Cooling	Convection	**Type**	Selenium TR unit
Weight	Less than 29 lbs.		

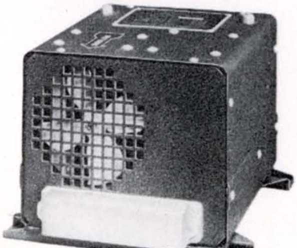
MODEL 28V50C

Input	115/200 volts, 3 ϕ, 400 c.p.s.	**Weight**	Less than 15 lbs.
Output	50 amp at 28 VDC	**Dimensions**	5″H x 9½″W x 14″D
Regulation	10% @ 200 volts	**Feature**	Long life design
Cooling	Convection	**Type**	Selenium TR unit



MODEL 28VS50

Input	115/200 volts, 3 ϕ, 400 c.p.s.	**Weight**	Less than 9.5 lbs.
		Dimensions	5″H x 6″W x 8″D
Output	50 amp @ 28 VDC	**Feature**	NAS-622 Mounting Provisions
Regulation	6% @ 200 volts		
Cooling	Fan	**Type**	Silicon TR unit



MODEL 28V55

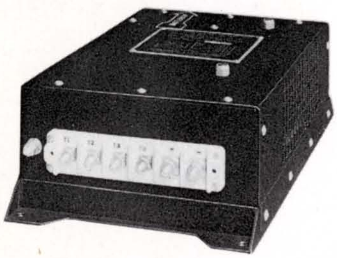
Input	115/200 volts, 3 ϕ, 400 c.p.s.	**Weight**	Less than 12.5 lbs.
Output	55 amp at 28 VDC	**Dimensions**	6⅞″H x 8¾″W x 9½″D
Regulation	12.5% @ 200 volts	**Feature**	Low peak ripple voltage
Cooling	Fan	**Type**	Selenium TR unit

MODEL 28V100-1

Input	115/200 volts, 3 ϕ, 400 c.p.s.	**Weight**	Less than 17 lbs.
Output	100 amp at 28 VDC	**Dimensions**	6⅞″H x 9¼″W x 13⅜″D
Regulation	24-31 volts, 0 to 100 amp @ 195 to 210 volts	**Feature**	Conforms to MIL-P-7212B
Cooling	Fan	**Type**	Selenium TR unit

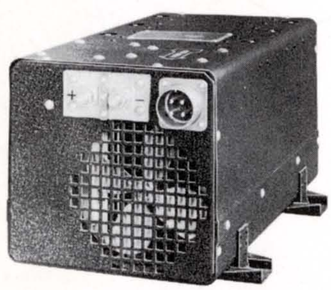
MODEL 28V12

Input	115/200 volts, 3 ø, 400 c.p.s.	**Weight**	Less than 5 lbs.
Output	12 amp at 28 VDC	**Dimensions**	7″H x 4¼″W x 9″D
Regulation	10% @ 200 volts	**Feature**	Low ripple voltage
Cooling	Convection	**Type**	Selenium TR unit



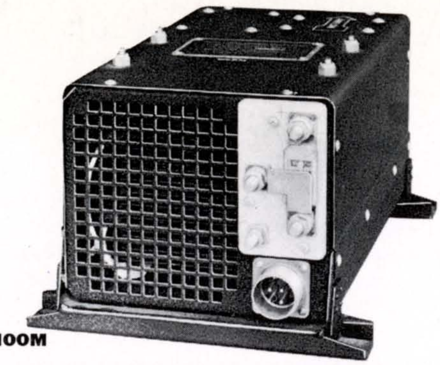
MODEL 28V25

Input	115/200 volts, 3 ø, 400 c.p.s.	**Weight**	Less than 9.5 lbs.
Output	25 amp at 28 VDC	**Dimensions**	4⅜″H x 7⅞″W x 11⅞″D
Regulation	3% from ½ to full load	**Feature**	Low peak ripple voltage
Cooling	Fan	**Type**	Selenium TR unit



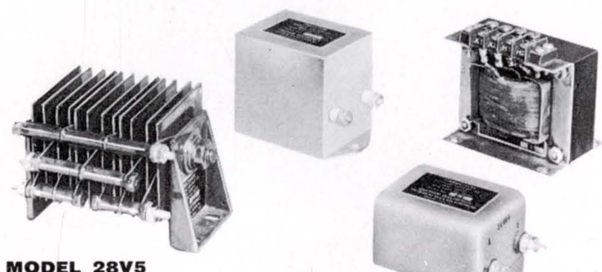
MODEL 28V200

Input	115/200 volts, 3 ø, 400 c.p.s.	**Weight**	Less than 30 lbs.
Output	200 amp at 28 VDC	**Dimensions**	7½″H x 9¼″W x 16⅛″D
Regulation	15% @ 200 volts	**Feature**	Low ripple voltage
Cooling	Fan	**Type**	Selenium TR unit



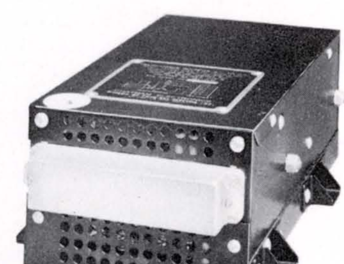
MODEL 28V100M

Input	115/200 volts, 3 ø, 400 c.p.s.	**Weight**	Less than 18 lbs.
Output	100 amp at 28 VDC	**Dimensions**	7″H x 9¼″W x 14⅜″D
Regulation	12.5% @ 200 volts	**Feature**	Fused split bus output
Cooling	Fan	**Type**	Selenium TR unit



MODEL 28V5

Input	115 volts, 1 ø, 400 c.p.s.	**Weight**	Less than 6 lbs.
Output	5 amp at 28 VDC	**Feature**	Kit construction
Cooling	Convection	**Type**	Selenium TR unit



MODEL 28V100BL

Input	115/200 volts, 3 ø, 400 c.p.s.	**Weight**	Less than 10 lbs.
Output	100 amp at 28 VDC	**Dimensions**	4 1/16″H x 7½″W x 11⅛″D
Regulation	25% @ 200 volts	**Feature**	Shelf mounting
Cooling	External Blast	**Type**	Selenium TR unit

THERE ARE CHATHAM DESIGNED POWER CONVERSION UNITS FOR THE FOLLOWING AIRCRAFT AND MISSILES:

- USAF B52 Stratofortress
- Boeing KC135 Stratotanker
- Boeing 707 Stratoliner
- Boeing Bomarc
- Convair B58 Hustler
- Convair F102 Delta Dagger
- Convair F106 Delta Dart
- Convair 880 Jetliner
- McDonnell F101 Voodoo
- McDonnell F3H Demon
- Lockheed F104 Starfighter
- North American Navajo
- Douglas A4D Skyhawk
- Douglas A3D Skywarrior
- Douglas F4D Skyray
- Bell Rascal
- North American F100 Super Sabre

For further information, contact:

CHATHAM ELECTRONICS

Division of

TUNG-SOL ELECTRIC INC.

East Coast: Livingston, N. J.—Phone: Wyman 2-1100
West Coast: Culver City, Calif.—Phone: Texas 0-8711
Southwest: Dallas, Texas—Phone: Fleetwood 2-7358

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5M—1058

CHATHAM AIRBORNE CONVERSION EQUIPMENT

SELENIUM TRANSFORMER-RECTIFIER UNIT

28V12

DESCRIPTION — The Chatham Model 28V12 Transformer-Rectifier is a compact, lightweight, static unit providing 12 amperes at 28 volts DC for motors, control equipment, and battery charging. This unit is designed to operate from a 400 cycle, 200 volt AC aircraft system. Convection cooled, it provides long life, not dependent on forced air.

Noteworthy features of the 28V12 are low ripple voltage, good regulation, vibration and shock resistance, and suitability for continuous duty at full ratings. Low load-differential permits parallel operation of units. This unit is normally supplied in a black wrinkle-finish, lightweight, aluminum housing. The values shown below under "Specifications" are nominal and are intended only as a guide. Conditions can be varied over a considerable range.

SPECIFICATIONS

INPUT (AC)	
Voltage	189 to 208 volts
Phase	3 phase, 4 wire
Line Current (Full Load)	1.2 amperes
Frequency	380 to 420 cycles-per-second
OUTPUT (DC)	
Voltage (See curve, Fig. 2)	28 volts nominal
Current	12 amperes
EFFICIENCY (Full Load)	76%
POWER FACTOR (Full Load)	95%
RIPPLE VOLTAGE	1 volt peak
OVERLOAD	30 amperes DC for 1 minute maximum
WEIGHT	4.8 lbs.
SIZE	7" H x 4 5/16" W x 9" D
MOUNTING PROVISIONS (See diagram, Fig. 4)	Four holes
MOUNTING POSITIONS	Upright or Inverted
COOLING	Convection
ALTITUDE-TEMPERATURE RATING	
At sea level	−65° to +100° Centigrade
At 50,000 ft.	−65° to +10° Centigrade
TRANSFORMER	
Primary	Wye
Secondary	Double, Wye-Delta
RECTIFIER	Selenium Stack
DUTY	Continuous
ELECTRICAL CONNECTIONS (See Fig. 3)	Terminal Board

APPLICATION AND NOTES

The 28V12 Transformer-Rectifier Unit is suitable for both aircraft use and ground testing of airborne equipment. Special emphasis has been placed on designing this unit to take a minimum of space and to have a minimum of weight.

Environmental conditions are no problem with the Chatham 28V12 since it has been designed to operate favorably even under the following conditions:

Exposure to sand and dust particles,
Exposure to atmosphere containing salt laden moisture,
Fungus growth as encountered in tropical climates,
High relative humidity even where condensation is encountered.

Resistance to the above detrimental environmental conditions insures long life without maintenance. The transformer is class H and is silicone impregnated. The rectifier stack is tailor-made by Chatham and is specially finished. All internal wiring on the unit is high temperature military type.

No external cooling is required since cooling takes place by convection. A space of six inches should be allowed both above and to the sides of the unit to insure a natural flow of air.

This unit has three positive output terminals, two of which are fused as shown on Fig. 1. Holders for spare fuses are provided.

Both input and output connections are made at the terminal board. Melamine is the standard material for the terminal board.

Installation is easily accomplished by securing the unit with four bolts.

The 28V12 is one of a complete line of transformer-rectifier units produced by Chatham Electronics and is stocked for quick shipment. This unit can be supplied to military or commercial specifications and can be modified to meet special individual requirements.

CIRCUIT DIAGRAM

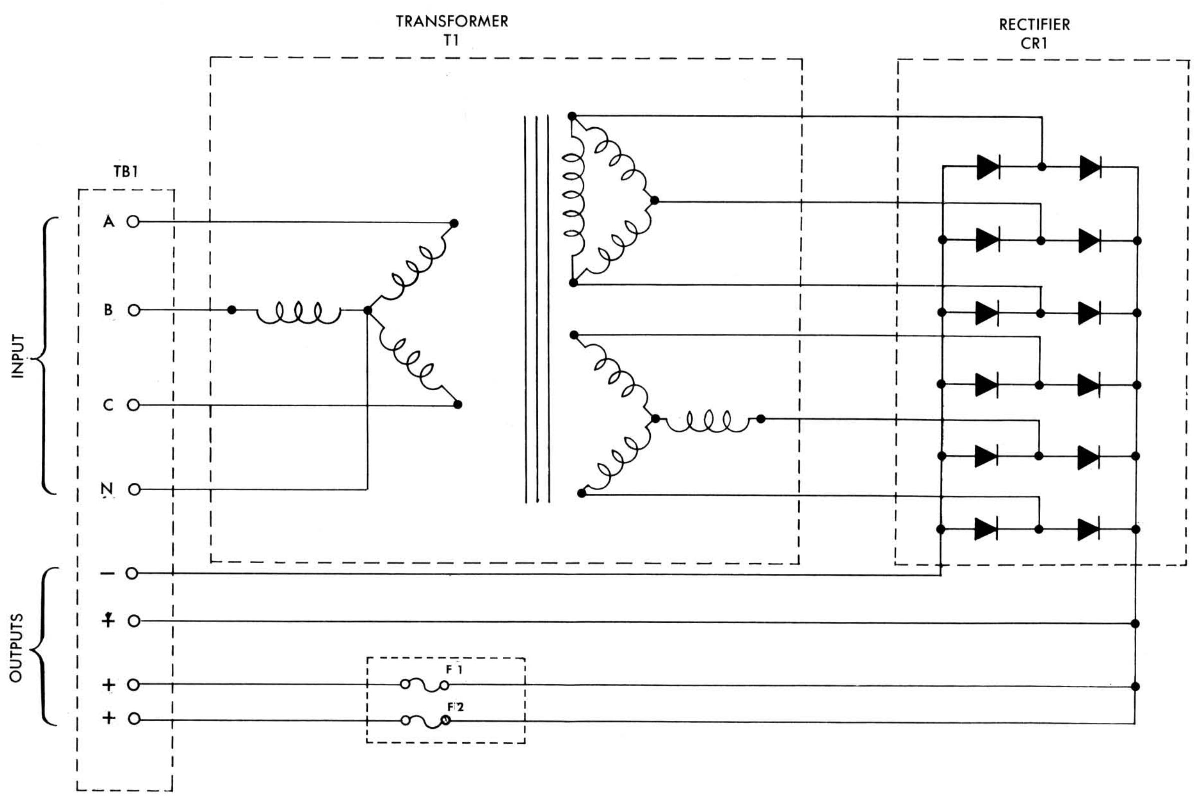


Fig. 1

TYPICAL REGULATION CURVES

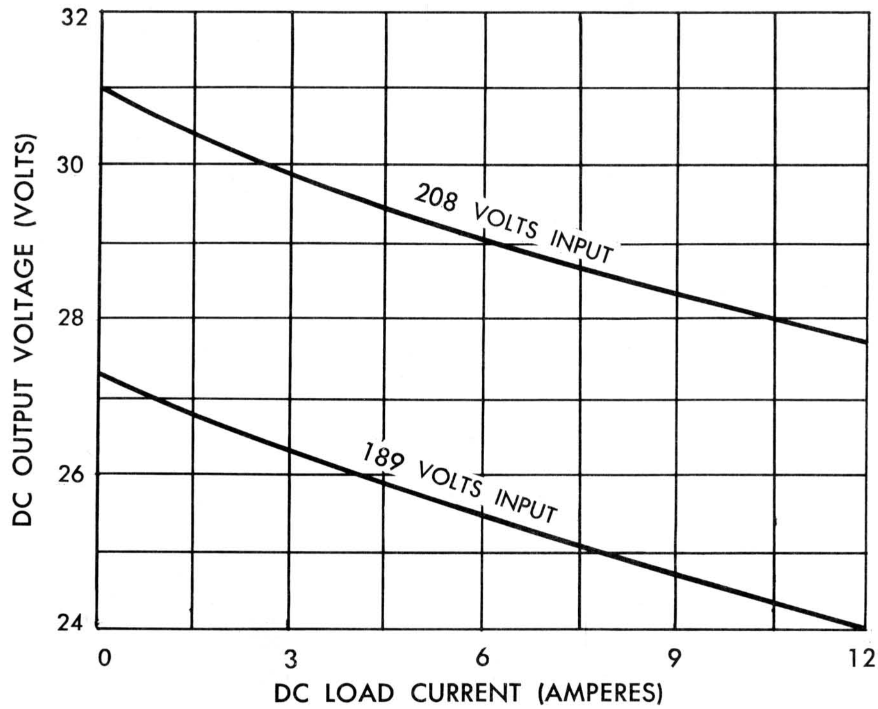


Fig. 2

TERMINAL BOARD DIAGRAM

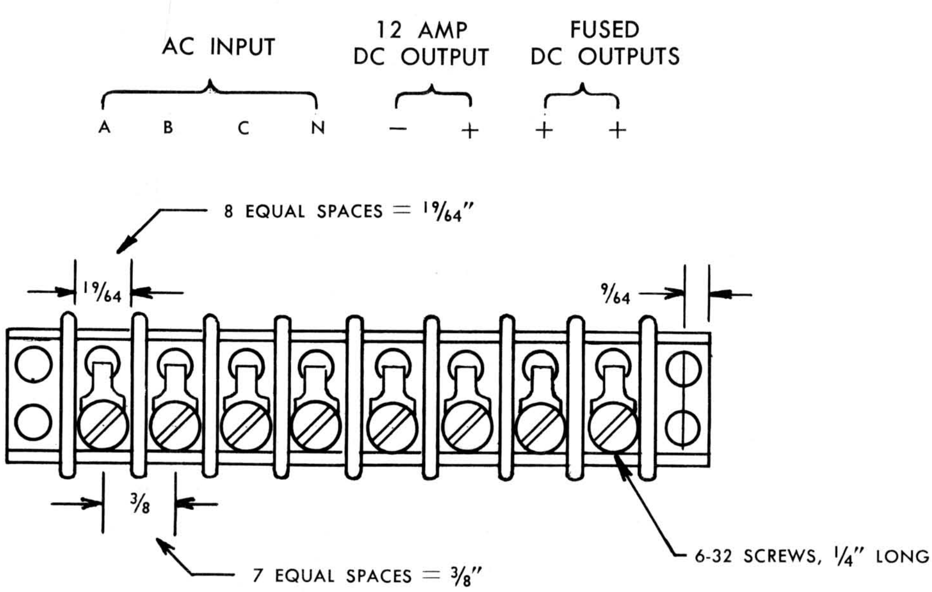


Fig. 3

DIMENSIONAL DIAGRAMS

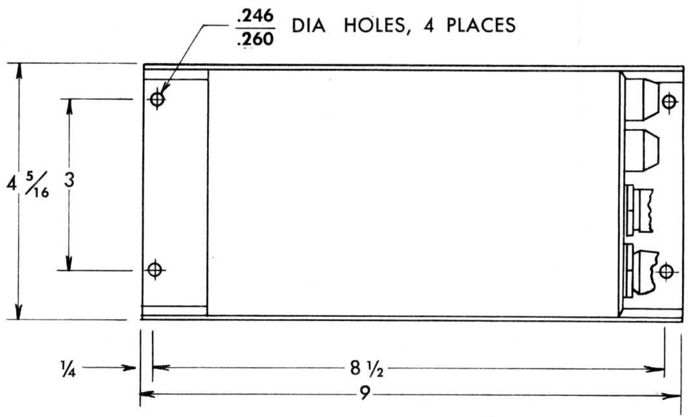


Fig. 4
Top

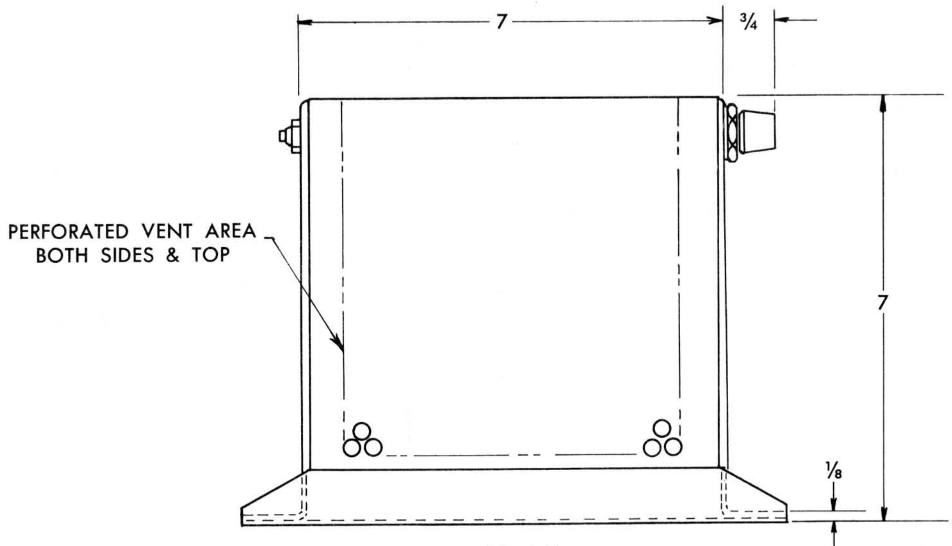


Fig. 5
Side

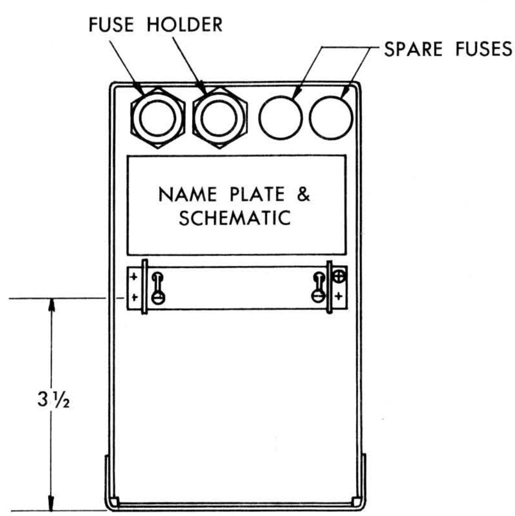


Fig. 6
Front

CHATHAM AIRBORNE CONVERSION EQUIPMENT

SELENIUM TRANSFORMER-RECTIFIER UNIT

28V20

DESCRIPTION — The Chatham Model 28V20 Transformer-Rectifier is a compact, light weight, static unit providing 20 amperes at 28 volts DC for motors, control equipment, and battery charging. This unit is designed to operate from a 400 cycle, 200 volt AC aircraft system. It will provide good regulation and long life. A blower enclosed within the housing circulates air for cooling.

Noteworthy features are vibration and shock resistance and suitability for continuous duty at full ratings. Low load-differential permits parallel operation of units. This unit is normally supplied in an anodized, black wrinkle-finish, light weight aluminum housing.

There are two versions currently available: the 28V20 and the 28V20CV. Both are designed to the requirements of MIL-P-7212. The values shown below under "Specifications" are nominal and are intended only as a guide. Conditions can be varied over a considerable range.

SPECIFICATIONS

MODEL	28V20	28V20CV
INPUT (AC) Voltage .... Phase .... Line Current (at full load)....... Frequency	 195 to 210 volts 3 phase, 4 wire 2.5 amps. 320 to 522 cps	 190 to 210 volts 3 phase, 4 wire 3 amps. 380 to 420 cps
OUTPUT (DC) Voltage (See curves, Figs. 2 & 3) Current	 28 volts nominal 20 amps.	 28 volts nominal 20 amps.
EFFICIENCY (Full Load)	70%	70%
POWER FACTOR (Full Load)	95%	95%
RIPPLE VOLTAGE (RMS)	5%	5%
OVERLOAD	50 amps. DC for 1 min. max.	50 amps. DC for 1 min. max.
WEIGHT	5.5 lbs.	6.0 lbs.
SIZE	5 13/16" H x 4 1/8" W x 8 5/8" D	5 13/16" H x 4 1/8" W x 8 5/8" D
MOUNTING PROVISIONS	Four holes	Four holes
MOUNTING POSITIONS	Any	Any
COOLING	Blower	Blower
TEMPERATURE RATING (at sea level)	 —65°F to +250°F	 —55°C to +71°C
ALTITUDE-TEMPERATURE RATING....	65,000 ft. at 0°C	60,000 ft. at 22°C
TRANSFORMER Primary .... Secondary	 Wye Delta	 Wye Delta
RECTIFIER	Selenium Stack	Selenium Stack
DUTY	Continuous	Continuous
ELECTRICAL CONNECTIONS (See Fig. 4)	 Terminal Board	 Terminal Board

APPLICATIONS AND NOTES

The 28V20 Transformer-Rectifier unit is suitable for both aircraft use and ground testing of airborne equipment. Special emphasis has been placed on designing this unit to take a minimum of space and to have a minimum of weight.

Environmental conditions are no problem with the Chatham 28V20 since it has been designed to operate favorably, even under the following conditions:

Exposure to sand and dust particles,
Exposure to atmosphere containing salt laden moisture,
Fungus growth as encountered in tropical climates,
High relative humidity, even where condensation will be encountered.

Resistance to the above detrimental environmental conditions insures long life without maintenance. The components have been designed to operate at well below their limits. The transformer is class H. The primary and secondary windings are copper with glass-silicone insulation. The transformer has high temperature silicone finish overall impregnation. The rectifier stack is tailor-made by Chatham and is specially finished. All internal wiring on the unit is high temperature military type.

The motor driven cooling blower is internally connected to input power and maintains constant air displacement with increasing altitude. As altitude increases and air density decreases, the speed and volume displacement of the blower increases. Since the unit is blower cooled, it can be mounted in any position, and the size of the components is kept at a minimum.

Installation of the complete unit is easily accomplished by attaching the base with four bolts.

Both input and output connections are made to a terminal board. Melamine plastic is the standard material for the terminal board. A terminal board cover can be supplied if desired.

The 28V20 is one of a complete line of transformer-rectifier units produced by Chatham Electronics and is stocked for quick shipment. This unit can be modified to meet special individual requirements.

CIRCUIT DIAGRAM

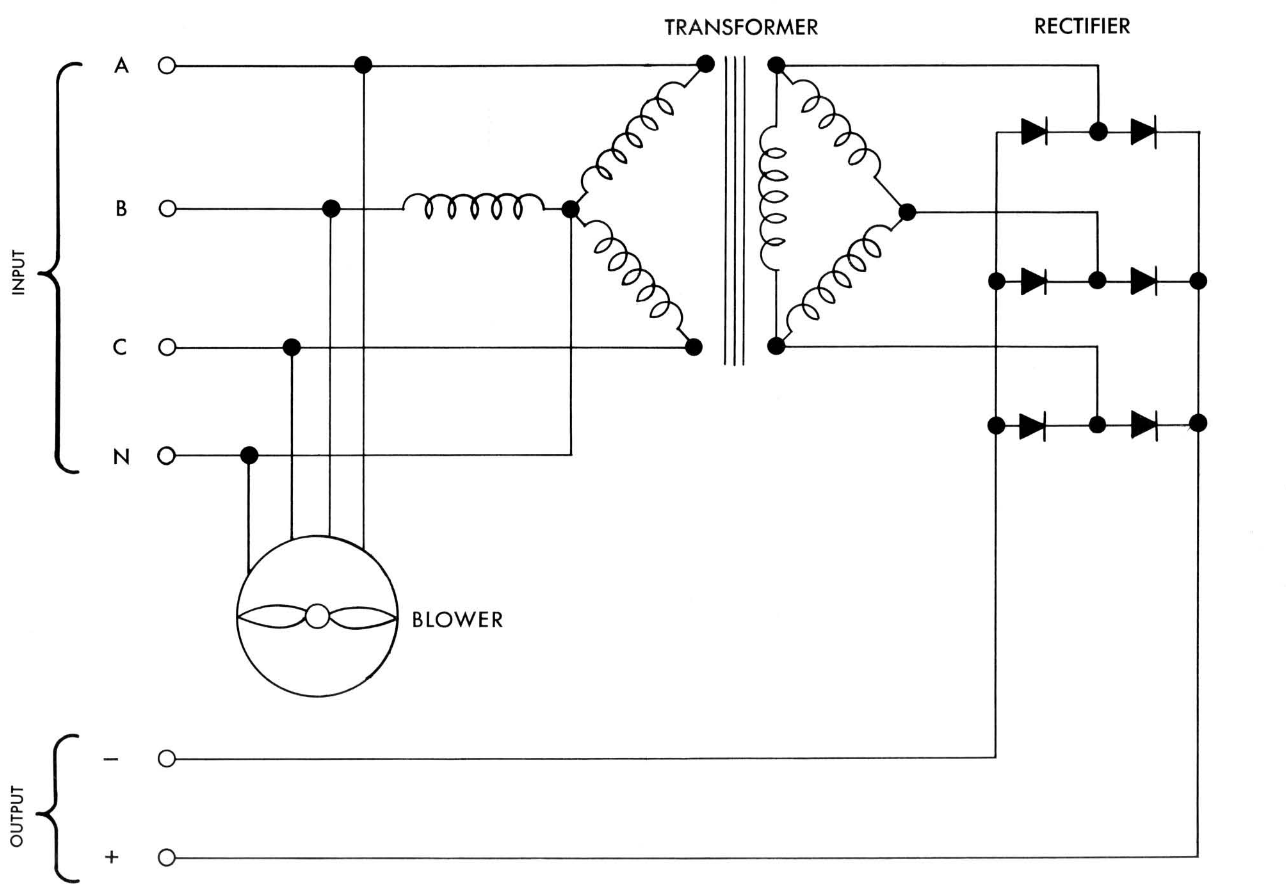


Fig. 1

TYPICAL REGULATION CURVES

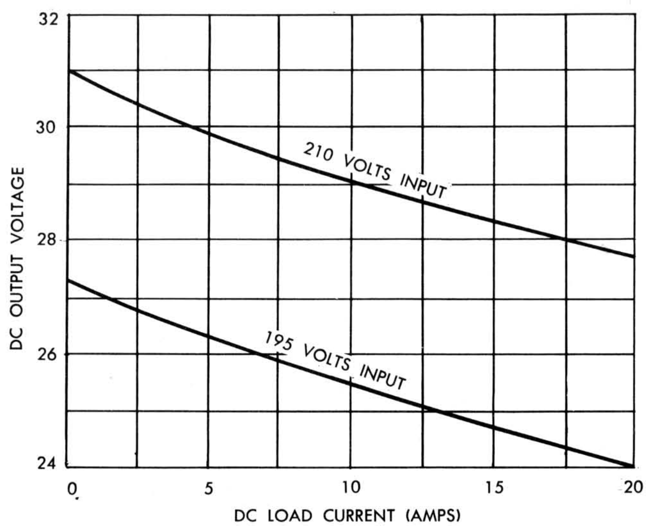


Fig. 2
28V20 UNIT

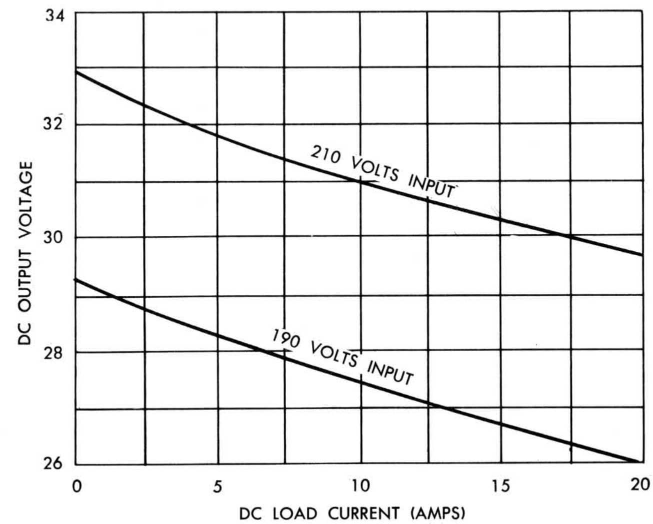


Fig. 3
28V20CV UNIT

TERMINAL BOARD DIAGRAM

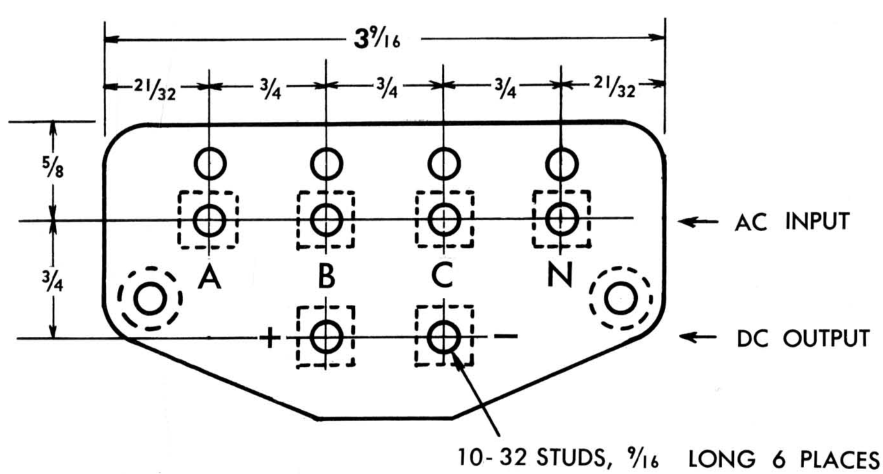


Fig. 4

DIMENSIONAL DIAGRAMS

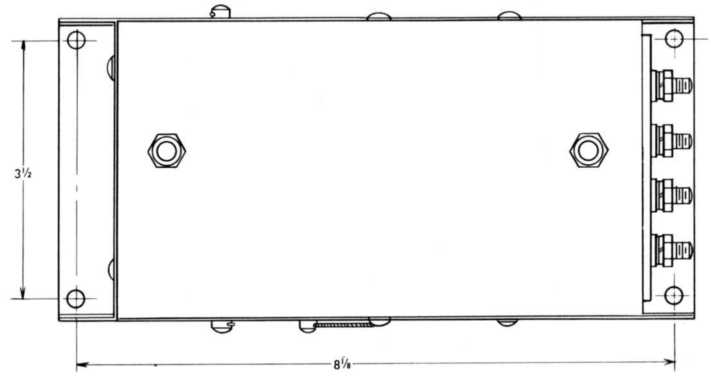


Fig. 5
Top

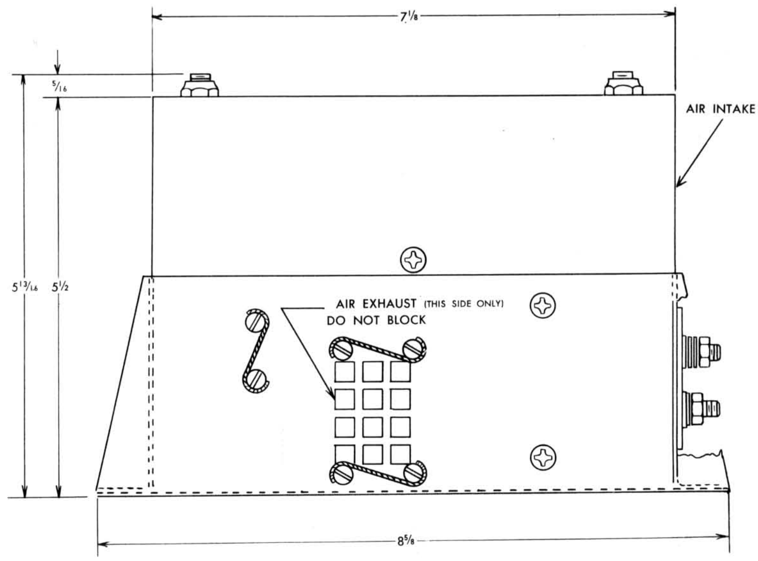


Fig. 6
Left Side

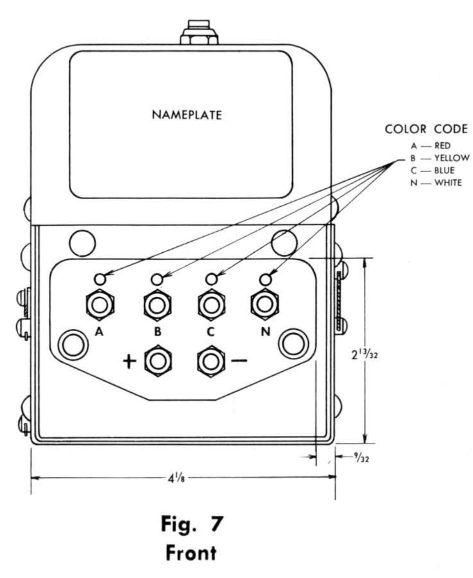


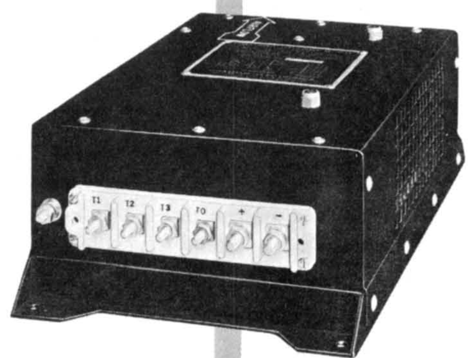
Fig. 7
Front

CHATHAM AIRBORNE CONVERSION EQUIPMENT

SELENIUM TRANSFORMER-RECTIFIER UNIT 28V25

DESCRIPTION — The Chatham Model 28V25 Transformer Rectifier is a compact, lightweight, static unit providing 25 amperes at 28 volts DC for motors, control equipment, and battery charging. This unit is designed to operate from a 400 cycle, 200 volt AC aircraft system. It will provide good regulation and long life. A fan enclosed within the housing circulates air for cooling.

Noteworthy features of the 28V25 are low ripple voltage, vibration and shock resistance, and suitability for continuous duty at full ratings. Low load-differential permits parallel operation of units. This unit is normally supplied in a dull black enamel, lightweight aluminum housing. The values shown below under "Specifications" are nominal and are intended only as a guide. Conditions can be varied over a considerable range.



SPECIFICATIONS

INPUT (AC)	
Voltage	177 to 215 volts
Phase	3 phase, 4 wire
Line Current (Full Load)	2.5 amps
Frequency	380 to 420 cps
OUTPUT (DC)	
Voltage (See curve, Fig. 2)	28 volts nominal
Current	25 amps
EFFICIENCY (Full Load)	75%
POWER FACTOR (Full Load)	95%
RIPPLE VOLTAGE (Peak)	1 volt
OVERLOAD	62 amps DC for 1 min. max.
WEIGHT	9.5 lbs.
SIZE	4⅜" H x 7⅞" W x 11⅞" D
MOUNTING PROVISIONS (See diagram, Fig. 4)	Four ¼" dia. holes
MOUNTING POSITIONS	Any
COOLING	Fan
ALTITUDE-TEMPERATURE RATING	
At sea level	—65°F to +160°F
At 60,000 ft.	—65°F to +77°F
TRANSFORMER	
Primary	Wye
Secondary	Double, Wye-Delta
RECTIFIER	Selenium Stack
DUTY	Continuous
ELECTRICAL CONNECTIONS (See Fig. 3)	Terminal Board

APPLICATIONS AND NOTES

The 28V25 Transformer-Rectifier Unit is suitable for both aircraft use and ground testing of airborne equipment. Special emphasis has been placed on designing this unit to take a minimum of space and to have a minimum of weight.

Environmental conditions are no problem with the Chatham 28V25 since it has been designed to operate favorably even under the following conditions:

Exposure to sand and dust particles,
Exposure to atmosphere containing salt laden moisture,
Fungus growth as encountered in tropical climates,
High relative humidity even where condensation will be encountered.

Resistance to the above detrimental environmental conditions insures long life without the necessity of maintenance on the transformer or rectifier. The transformer is class H and is silicone impregnated. The rectifier stack is tailor-made by Chatham and is specially finished. All internal wiring on the unit is high temperature military type. An interphase transformer maintains low ripple voltage and improves regulation of output from part load to full load.

The motor driven cooling fan is internally connected to input power and maintains constant air displacement with increasing altitude. As altitude increases and air density decreases, the speed and volume displacement of the fan increases. Since the unit is fan cooled, it can be mounted in any position and the size of the components is kept at a minimum.

Both input and output connections are made to a terminal board. Melamine plastic is the standard material for the terminal board and terminal board cover. The terminal board cover can be inverted, thus allowing wiring from either above or below the unit. A bonding connection for grounding the unit is located on the front of the unit. A space of at least two inches should be allowed between the right side and the back of this unit and other equipment or bulkheads for air intake and exhaust.

Installation of the complete unit is easily accomplished by merely attaching the base with four bolts.

The 28V25 is one of a complete line of transformer-rectifier units produced by Chatham Electronics and is stocked for quick shipment. This unit can be supplied to military or commercial specifications and can be modified to meet special individual requirements.

CIRCUIT DIAGRAM

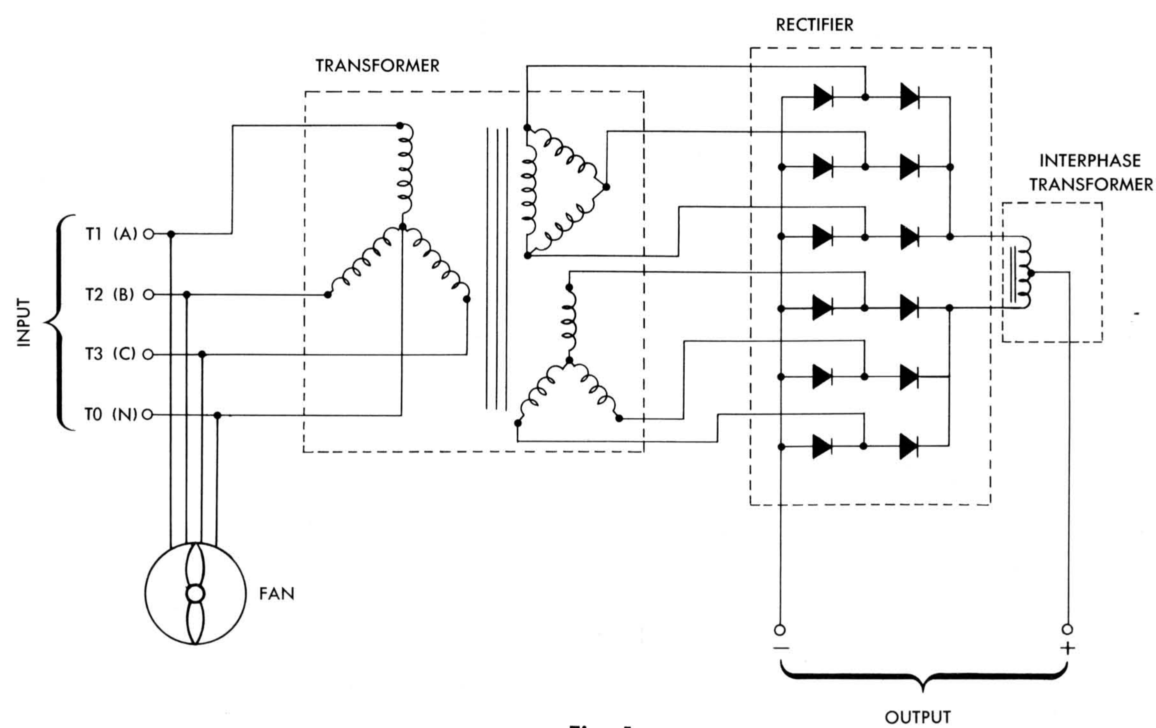


Fig. 1

TYPICAL REGULATION CURVES

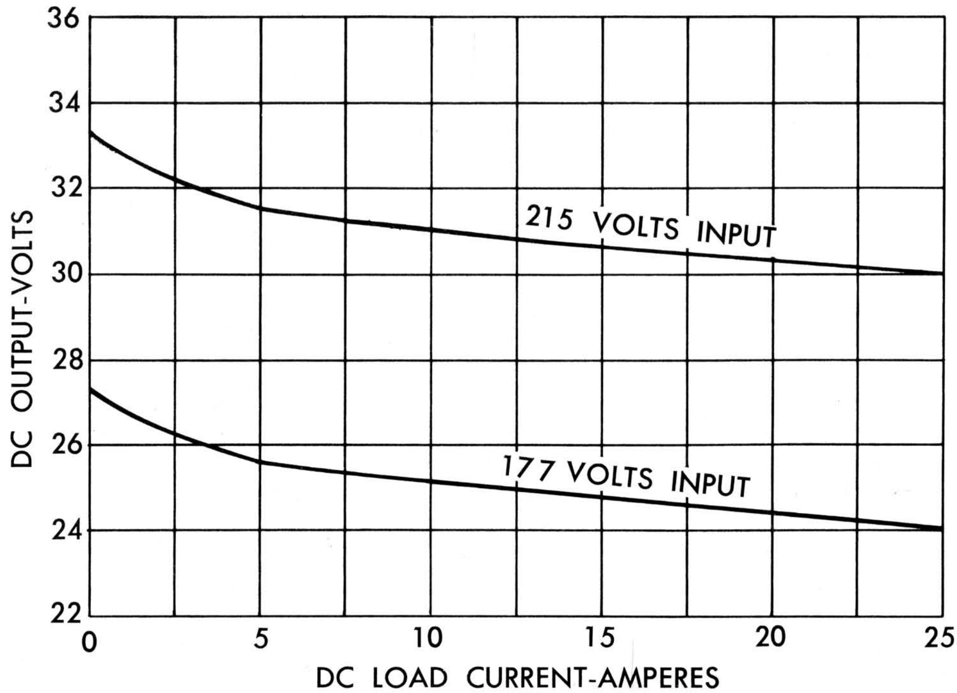


Fig. 2

TERMINAL BOARD DIAGRAM

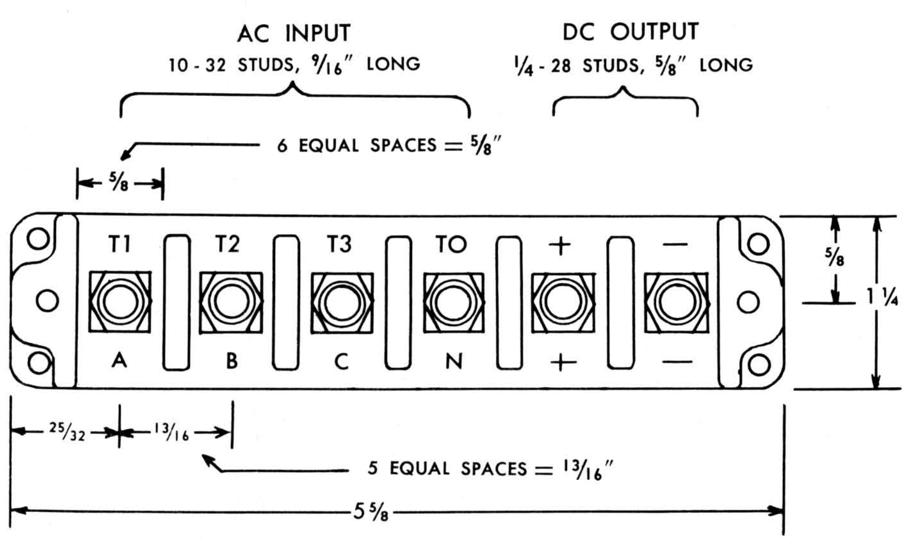


Fig. 3

DIMENSIONAL DIAGRAMS

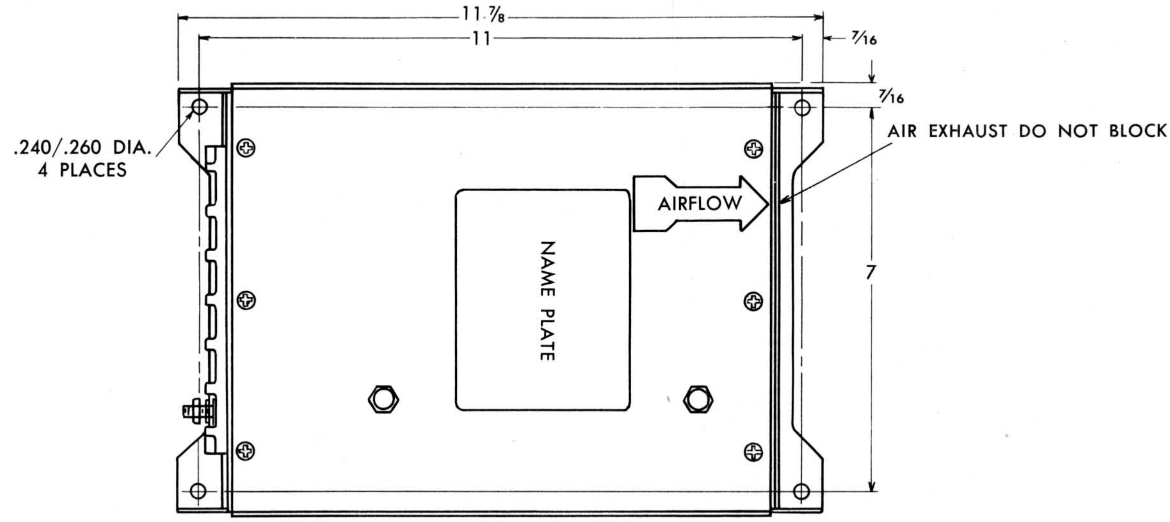


Fig. 4
Top

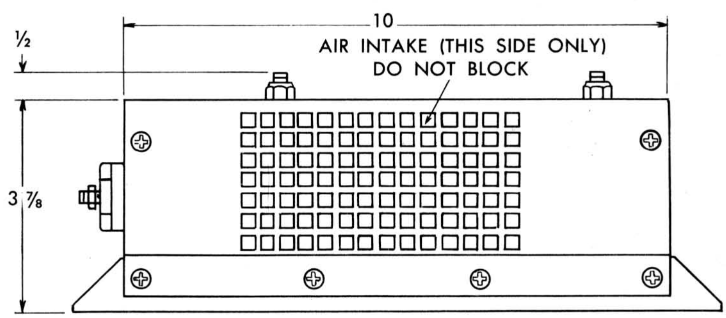


Fig. 5
Right Side

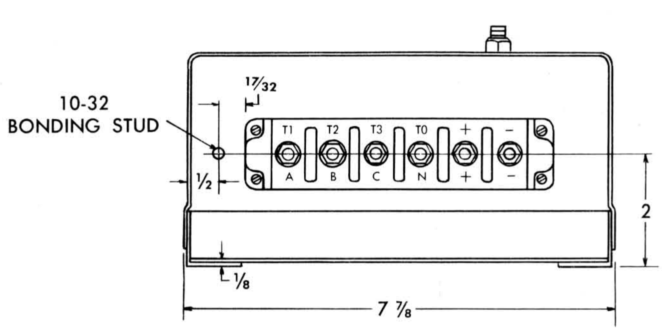


Fig. 6
Front

CHATHAM AIR-BORNE CONVERSION EQUIPMENT

SELENIUM TRANSFORMER-RECTIFIER UNIT 28V50C

DESCRIPTION: The Chatham Model 28V50C Transformer-Rectifier is an unregulated, light weight, static unit providing 50 amperes at 28 volts DC for motors, equipment, and battery charging. This unit is designed to operate from a 400 cycle, 200 volt AC aircraft generator. Convection cooled, it provides long life, not dependent on forced air. It has been generously designed for extreme reliability.

Other noteworthy features are low voltage ripple, vibration and shock resistance, and suitability for maintenance-free continuous duty. Low load-differential permits parallel operation of units. This unit is normally supplied in an anodized, dull black, smooth finish, light weight aluminum housing. The values shown in the specifications below are nominal and are intended only as a guide. Conditions can be varied over a considerable range.

SPECIFICATIONS

INPUT (AC)	
Voltage	195 to 205 volts
Phase	3 phase, 4 wire
Line Current (at full load)	4.5 amps.
Frequency	395 to 405 cps
OUTPUT (DC)	
Voltage (see Curve, Fig. 2)	28 volts nominal
Current	50 amps max.
EFFICIENCY	
Full load	75% min.
Half load	75% min.
POWER FACTOR (full load)	95%
VOLTAGE RIPPLE (RMS)	2.5% max.
OVERLOAD	125 amps DC for 1 min. max.
WEIGHT	15 lbs. max.
SIZE	5″ H x 9½″ W x 14″ D
MOUNTING PROVISIONS (See Outline Drawing, Fig. 4)	Four 11/32″ Dia. holes
MOUNTING POSITIONS	Upright or inverted
COOLING	Convection
TEMPERATURE RATING at 0 to 10,000 ft.	−40°C to +65°C
NOMINAL ALTITUDE RATING	10,000 ft. max.
TRANSFORMER	Core type
Primary	Wye
Secondary	Double, Wye - Delta
RECTIFIER	Selenium Stack
DUTY	Continuous
ELECTRICAL CONNECTIONS (See Fig. 3)	Terminal Board

APPLICATIONS AND NOTES

The 28V50C Transformer-Rectifier unit is suitable for both aircraft use and ground testing of airborne equipment. Special emphasis has been placed on designing this unit to take a minimum of space and to have a minimum of weight.

Environmental conditions are no problem with the Chatham 28V50C since it has been designed to operate favorably, even under the following conditions:

Exposure to sand and dust particles,
Exposure to atmosphere containing salt laden moisture,
Fungus growth as encountered in tropical climates,
High relative humidity, even where condensation will be encountered.

Resistance to the above detrimental environmental conditions insures long life without maintenance. The components have been designed to operate at well below their limits. The transformer is class H and is silicone impregnated. Military type, high temperature wire is used. The rectifier stack is tailor-made by Chatham and is specially finished. An inter-phase transformer maintains low ripple voltage and regulates output.

No external cooling is required since cooling takes place by convection. A space of six inches should be allowed above and below the unit.

Installation of the complete unit is easily accomplished by merely attaching the mounting feet with four bolts.

Both input and output connections are made to a terminal board. Melamine plastic is the standard material for the terminal board and terminal board cover. The terminal board cover can be inverted, thus allowing wiring from either above or below the unit.

The primary transformer is fitted with three voltage adjustment taps. By changing taps it is possible to compensate for input voltage variations of 6%. To change taps it is necessary to remove the cover from the unit. The taps shown on the schematic diagram (Fig. 1) as A_L, A_M, A_H, B_L, etc. With the taps on the subscript "L" terminals, the unit will have lowest output voltage. Connection to the other taps may be made for higher voltage.

An internal ammeter shunt is provided with external terminals on the front of the unit. The shunt is designed to provide a full scale reading at 50 amperes on an ammeter with a 50 millivolt movement.

The 28V50C is one of a complete line of transformer-rectifier units produced by Chatham Electronics and is stocked for quick shipment. This unit can be supplied to military or commercial specifications and can be modified to meet special individual requirements.

CIRCUIT DIAGRAM

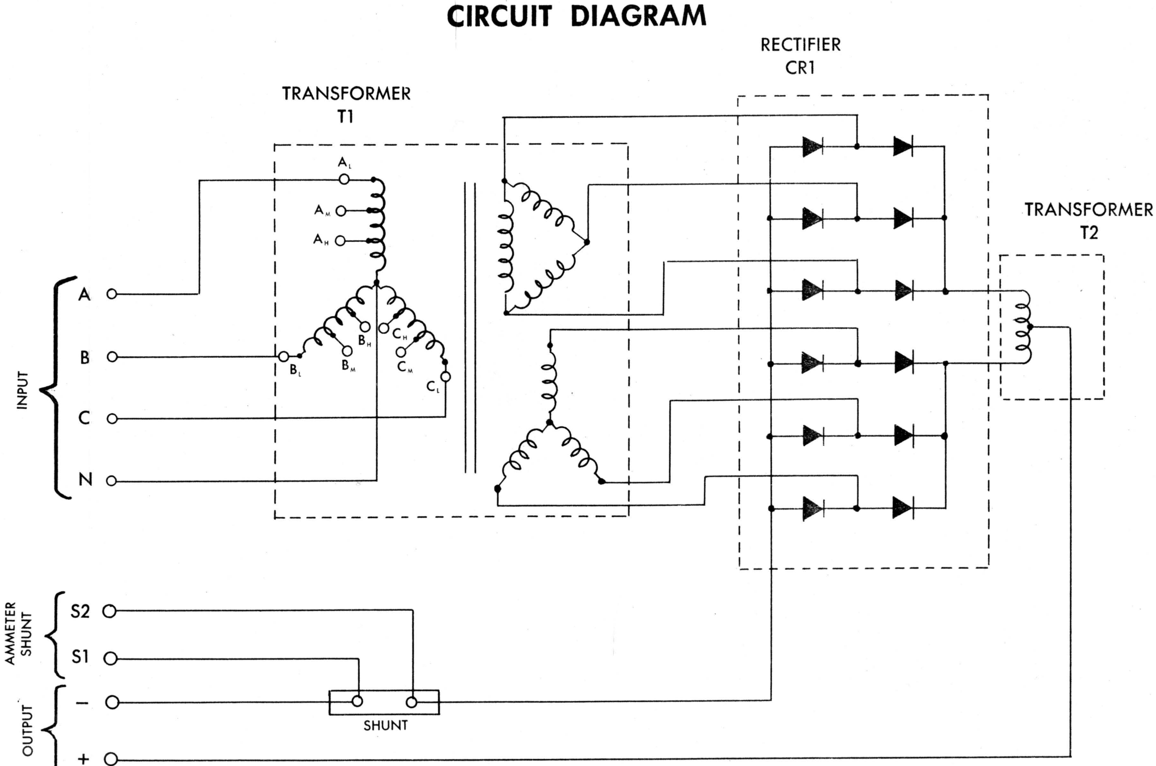


FIG. 1

TYPICAL REGULATION CURVES

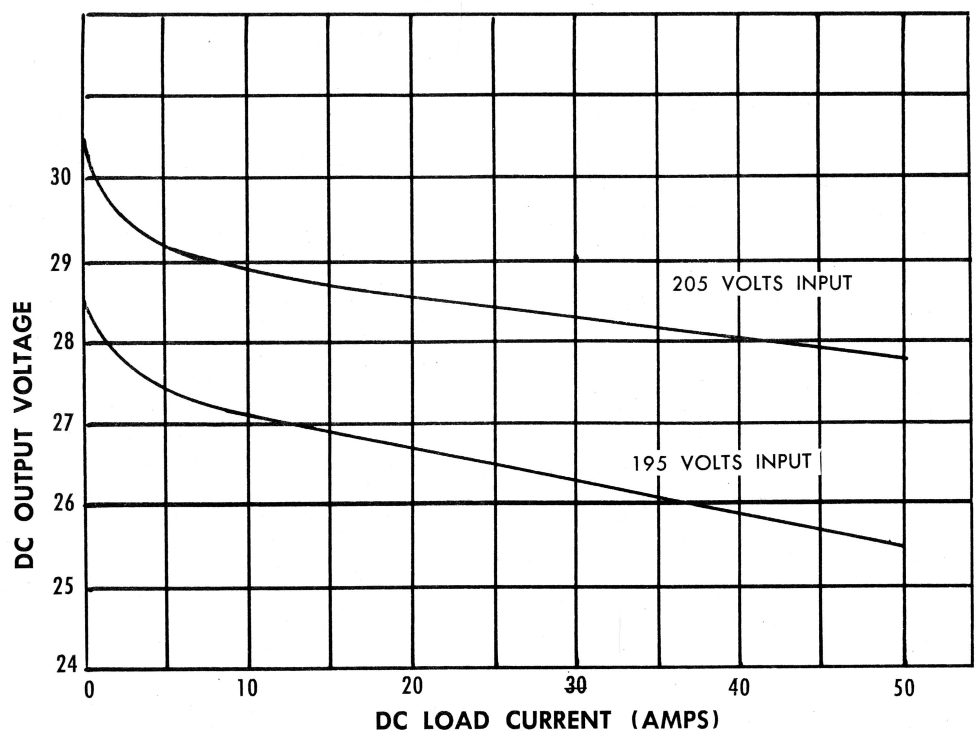


FIG. 2

TERMINAL BOARD DIAGRAM

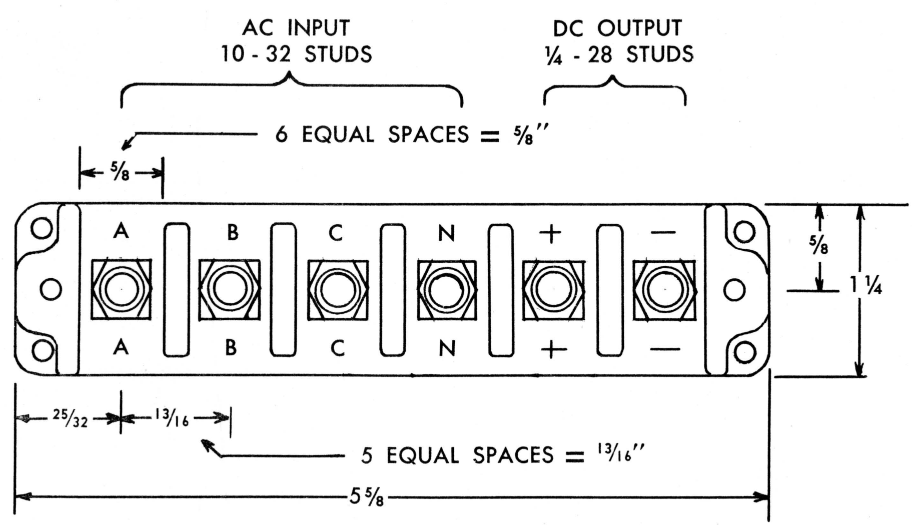
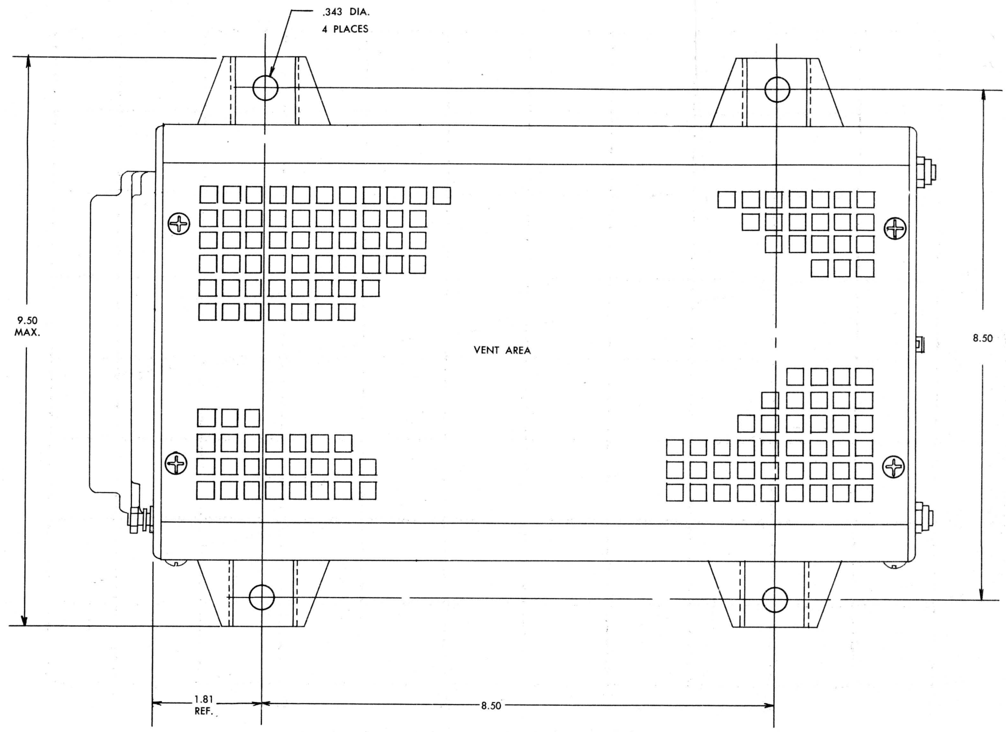
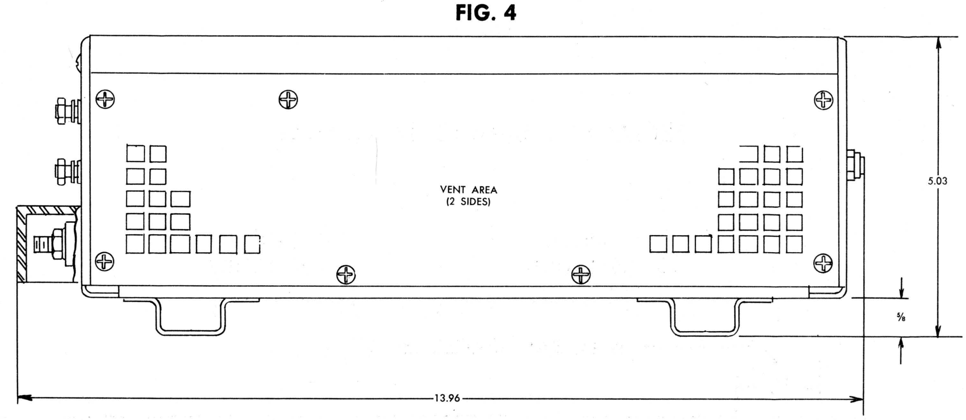


FIG. 3

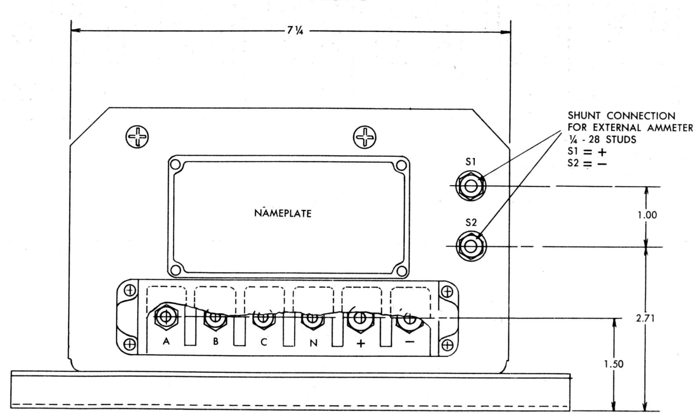
DIMENSIONAL DIAGRAMS



TOP
FIG. 4



SIDE
FIG. 5



FRONT
FIG. 6

CHATHAM AIRBORNE CONVERSION EQUIPMENT

SELENIUM TRANSFORMER-RECTIFIER UNIT

28V100

DESCRIPTION — The Chatham Model 28V100 Transformer-Rectifier is a compact, light weight, static unit providing 100 amperes at 28 volts DC for motors, control equipment, and battery charging. This unit is designed to operate from a 400 cycle, 200 volt AC aircraft system. It will provide good regulation and long life. A fan enclosed within the housing circulates air for cooling.

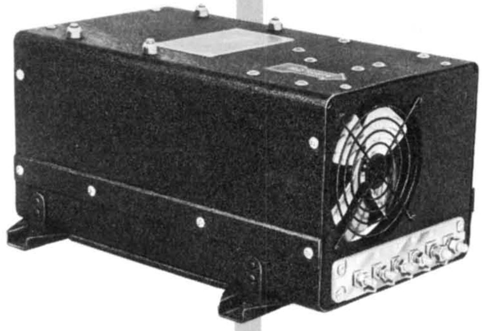
Noteworthy features of the 28V100 are low ripple voltage, vibration and shock resistance, and suitability for continuous duty at full ratings. Low load-differential permits parallel operation of units. This unit is normally supplied in an anodized, black wrinkle-finish, light weight aluminum housing.

There are five versions of this unit currently available:

E10252, designed to modification of MIL-P-7212
E10252-3, designed to modification of MIL-P-7212
28V100-1, conforms to MIL-P-7212B
28V100-5, conforms to MIL-P-7212D
28V100-6, designed to MIL-C-7115 and MS25180

The circuitry is the same for all units except the 28V100-6 and E10252-3 on which an interphase transformer has been included to maintain even lower ripple voltage and improve regulation of output. Input and output connections to the various versions are shown on Figs. 4 through 7.

The values shown below under "Specifications" are nominal and are intended only as a guide. Conditions can be varied over a considerable range.



SPECIFICATIONS

MODEL	28V100-1 28V100-5	28V100-6
INPUT (AC) Voltage Phase Line Current (at full load) Frequency	195 to 210 volts 3 phase, 4 wire 9 amps. 380 to 420 cps*	187 to 203 volts 3 phase, 4 wire 9 amps. 380 to 420 cps
OUTPUT (DC) Voltage (See curves, Figs. 2 & 3) Current	28 volts nominal 100 amps.	28 volts nominal 100 amps.
EFFICIENCY (Full Load)	78%	80%
POWER FACTOR (Full Load)	95%	95%
RIPPLE VOLTAGE	2½% rms**	1 volt peak
OVERLOAD	250 amps DC for 1 min. max.	250 amps DC for 1 min. max.
WEIGHT	17 lbs.	17 lbs.
SIZE	6⅞" H x 9¼" W x 13⅜" D	6⅞" H x 9¼" W x 13⅜" D
MOUNTING PROVISIONS	Four holes	Four holes
MOUNTING POSITIONS	Any	Any
COOLING	Fan	Fan
TRANSFORMER Primary Secondary	Wye Double, Wye-Delta	Wye Double, Wye-Delta
RECTIFIER	Selenium Stack	Selenium Stack
DUTY	Continuous	Continuous
ELECTRICAL CONNECTIONS (See Figs. 4-7) Input Output	} Terminal Board	Receptacle Terminal Board
ALTITUDE-TEMPERATURE RATING	+125°C at sea level. +20°C at 60,000 ft. —65°C from sea level to 60,000 ft.	Temperature per curve I, MS33543 (ASG) except that ambient temperature shall never exceed 85°C. Altitude: To 50,000 ft. as 100 amp unit To 65,000 ft. as 50 amp unit

*E10252 is same as 28V100-1 except line frequency is 350 to 525 cps
**E10252-3 is same as E10252 except ripple voltage is 1½% rms

APPLICATIONS AND NOTES

The 28V100 Transformer-Rectifier Unit is suitable for both aircraft use and ground testing of airborne equipment. Special emphasis has been placed on designing this unit to take a minimum of space and to have a minimum of weight.

Environmental conditions are no problem with the Chatham 28V100 since it has been designed to operate favorably even under the following conditions:

- Exposure to sand and dust particles,
- Exposure to atmosphere containing salt laden moisture,
- Fungus growth as encountered in tropical climates,
- High relative humidity even where condensation will be encountered.

Resistance to the above detrimental environmental conditions insures long life without the necessity of maintenance on the transformer or rectifier. The transformer is class H and is silicone impregnated. The rectifier stack is tailor-made by Chatham and is specially finished. All internal wiring on the unit is high temperature military type.

The motor driven cooling fan is internally connected to input power and maintains constant air displacement with increasing altitude. As altitude increases and air density decreases, the speed and volume displacement of the fan increases. Since the unit is fan cooled, it can be mounted in any position and the size of the components is kept at a minimum.

Installation of the complete unit is easily accomplished by merely attaching the mounting feet with four bolts. The 28V100-5 is equipped with special environment-free, all-attitude shock mounts for extreme vibration conditions.

The 28V100 is one of a complete line of transformer-rectifier units produced by Chatham Electronics and is stocked for quick shipment. This unit can be modified to meet special individual requirements. Other 100 amp units are available with cooling by convection or external blast and with silicon diode rectifiers.

CIRCUIT DIAGRAM

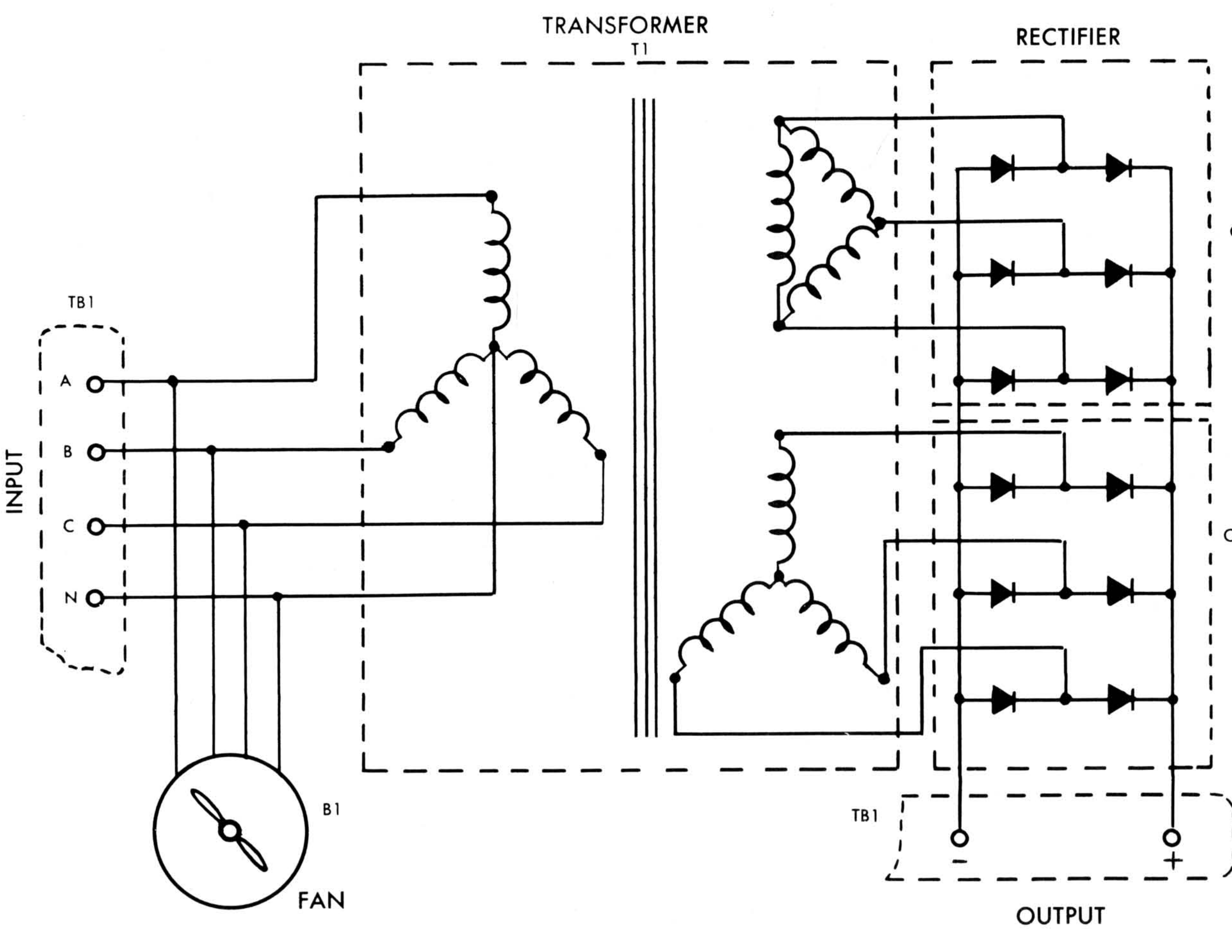


Fig. 1
All Units Except 28V100-6 & E10252-3, Which Include Interphase Transformer

TYPICAL REGULATION CURVES

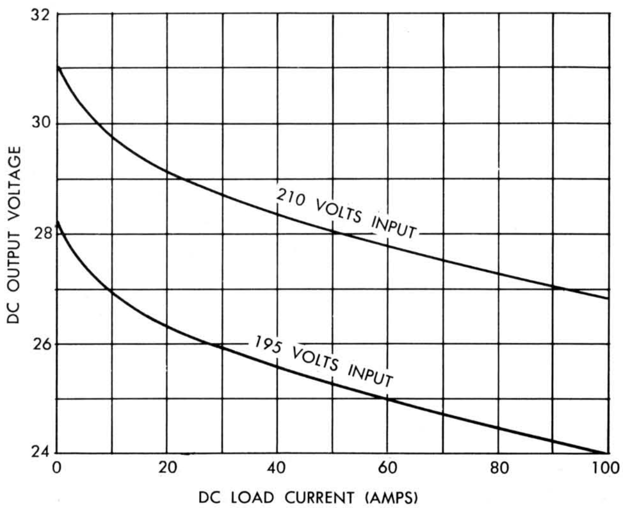


Fig. 2
28V100-1 & 28V100-5 Units

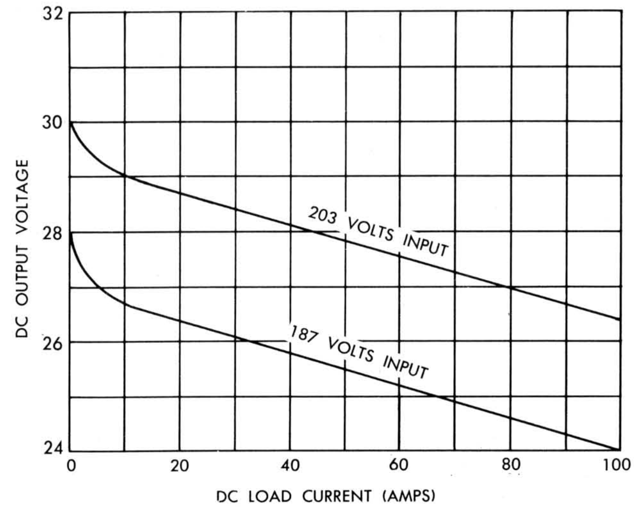


Fig. 3
28V100-6 Unit

CONNECTIONS

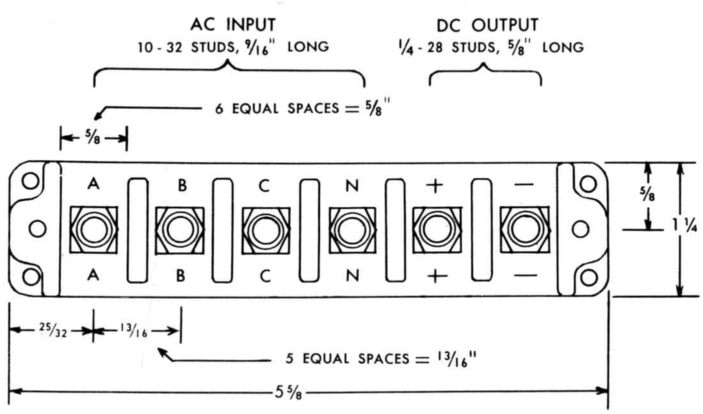


Fig. 4
Terminal Board
E10252 & E10252-3 Units

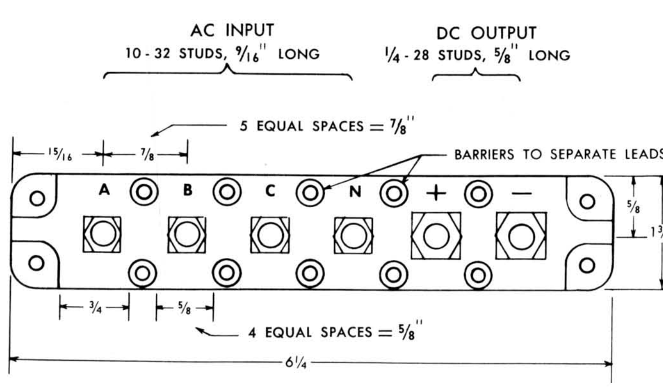


Fig. 5
Terminal Board
28V100-1 & 28V100-5 Units

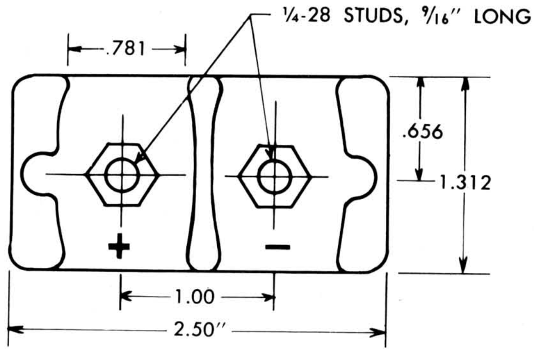


Fig. 6
MS25044-1 Terminal Board
Output — 28V100-6 Unit

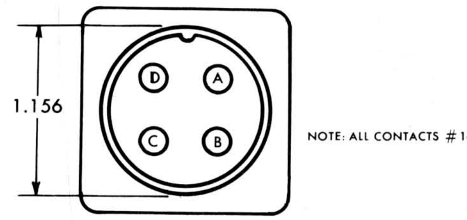


Fig. 7
Outer View
AN3102-18-22P Receptacle
Input — 28V100-6 Unit

DIMENSIONAL DIAGRAMS

NOTE: DIMENSIONS SHOWN FOR 28V100-1 UNIT. SOME OTHER UNITS VARY SLIGHTLY DUE TO DIFFERENT CONNECTIONS.

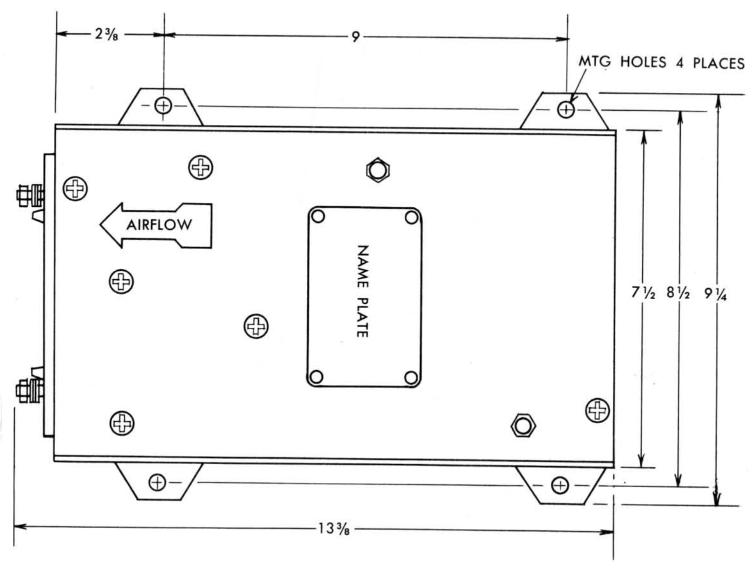


Fig. 8
Top

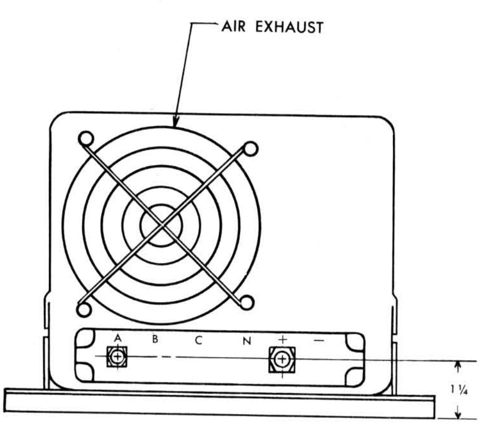


Fig. 9
Front

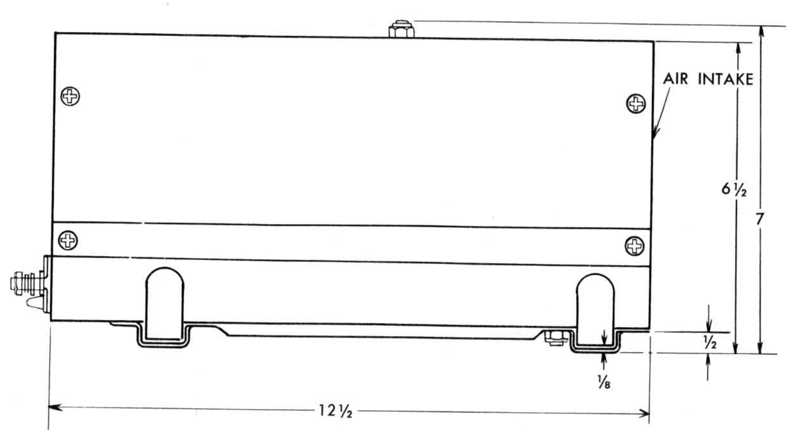
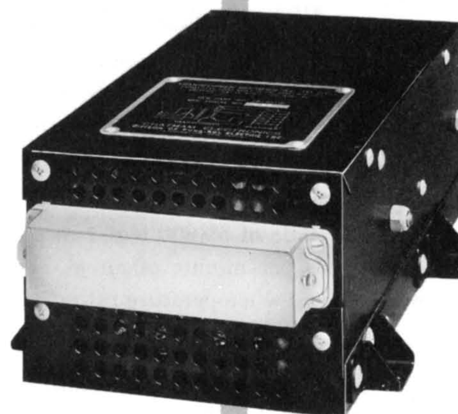


Fig. 10
Side

CHATHAM AIRBORNE CONVERSION EQUIPMENT

SELENIUM TRANSFORMER-RECTIFIER UNIT

28V100BL



DESCRIPTION–The Chatham Model 28V100BL Transformer-Rectifier is a compact, static unit providing 100 amperes at 28 volts DC for motors, control equipment, and battery charging. This unit is designed to operate from a 400 cycle, 200 volt AC aircraft system. Cooling is accomplished by an external blast of air; this results in a unit weighing about one-half as much as similar convection or fan cooled units.

Other noteworthy features are low ripple voltage, vibration and shock resistance, and suitability for continuous duty at full ratings. Low load-differential permits parallel operation of units. This unit is normally supplied in an anodized, smooth black finish, light weight aluminum housing.

This unit is designed to the requirements of MIL-P-7212. The values shown below under "Specifications" are nominal and are intended only as a guide. Conditions can be varied over a considerable range.

SPECIFICATIONS

INPUT (AC)	
Voltage	195 to 210 volts
Phase	3 phase, 4 wire
Line Current (at full load)	9 amps.
Frequency	380 to 420 cps
OUTPUT (DC)	
Voltage (See curve, Fig. 2)	28 volts nominal
Current	100 amps.
EFFICIENCY (Full Load)	75%
POWER FACTOR (Full Load)	95%
RIPPLE VOLTAGE (RMS)	2.5%
OVERLOAD	150 amps. DC for 5 min. max.
WEIGHT	9.5 lbs.
SIZE	$4\frac{1}{16}$" H x $7\frac{1}{2}$" W x $11\frac{1}{8}$" D
MOUNTING PROVISIONS (See diagram, Fig. 4)	Four $\frac{5}{16}$" Dia. holes
MOUNTING POSITIONS	Any
COOLING	External Blast
TEMPERATURE RATING	See paragraph 4, Applications and Notes
NOMINAL ALTITUDE RATING	55,000 ft.
TRANSFORMER	
Primary	Wye
Secondary	Double, Wye-Delta
RECTIFIER	Selenium Stack
DUTY	Continuous
ELECTRICAL CONNECTIONS (See Fig. 3)	Terminal Board

APPLICATIONS AND NOTES

The 28V100BL Transformer-Rectifier Unit is suitable for both aircraft use and ground testing of airborne equipment. Special emphasis has been placed on designing this unit to take a minimum of space and to have a minimum of weight.

Environmental conditions are no problem with the Chatham 28V100BL since it has been designed to operate favorably, even under the following conditions:

Exposure to sand and dust particles,
Exposure to atmosphere containing salt laden moisture,
Exposure to aviation fuel and hydraulic fluid,
Fungus growth as encountered in tropical climates,
High relative humidity, even where condensation will be encountered.

Resistance to the above detrimental environmental conditions insures maintenance-free life. The transformer is class H. The primary and secondary windings are copper with glass-silicone insulation. The transformer has high temperature silicone finish overall impregnation. The rectifier stack is tailor-made by Chatham and is specially finished. All internal wiring on the unit is high temperature military type.

Since the unit is blast cooled, it can be mounted in any position, and the size of the components is kept at a minimum. At an altitude of 55,000 feet, two pounds per minute of air at 30°C should be provided for adequate cooling. At sea level six pounds per minute of air at 71°C should be provided. The pressure drop across the unit is less than two inches of water. The low temperature rating of the unit is −57°C.

Installation of the complete unit is easily accomplished by attaching the mounting feet with four bolts.

Both input and output connections are made to a terminal board. Melamine plastic is the standard material for the terminal board and terminal board cover. The terminal board cover can be inverted, thus allowing wiring from either above or below the unit.

The 28V100BL is one of a complete line of transformer-rectifier units produced by Chatham Electronics and is stocked for quick shipment. This unit can be supplied to military or commercial specifications and can be modified to meet special individual requirements.

CIRCUIT DIAGRAM

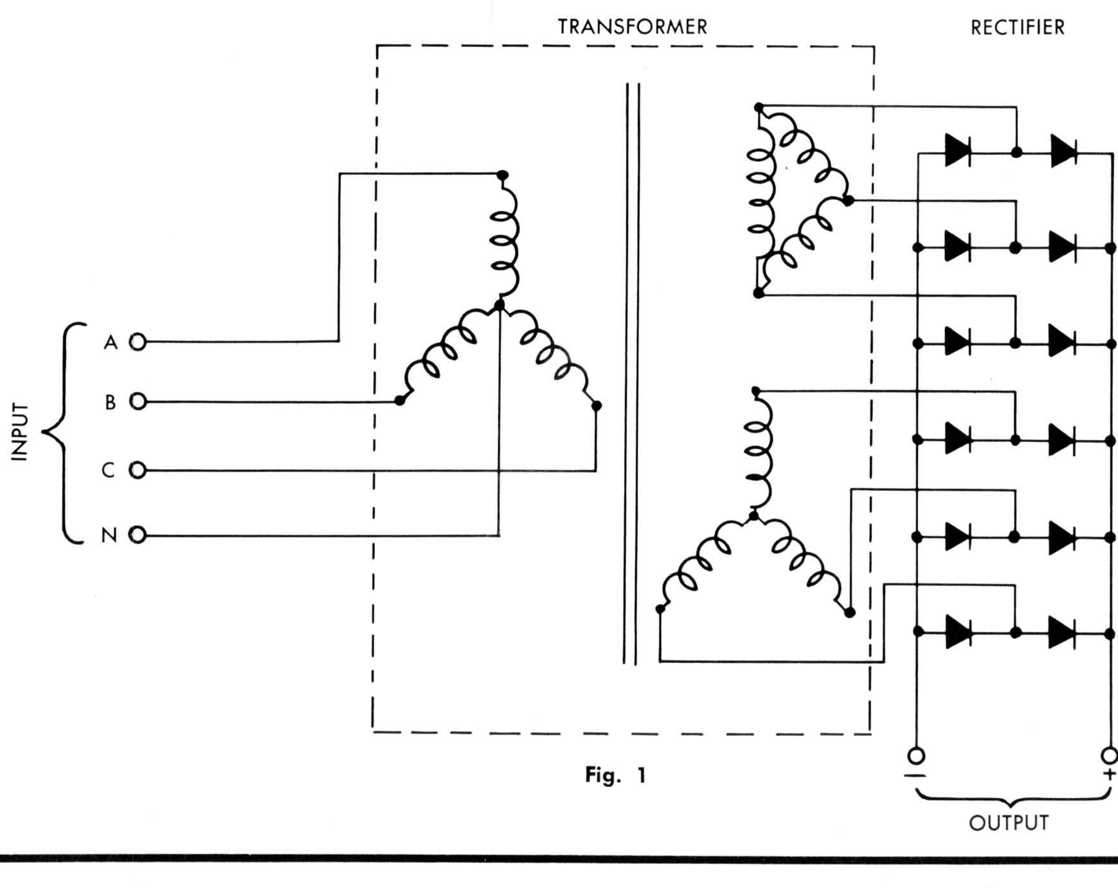


Fig. 1

TYPICAL REGULATION CURVES

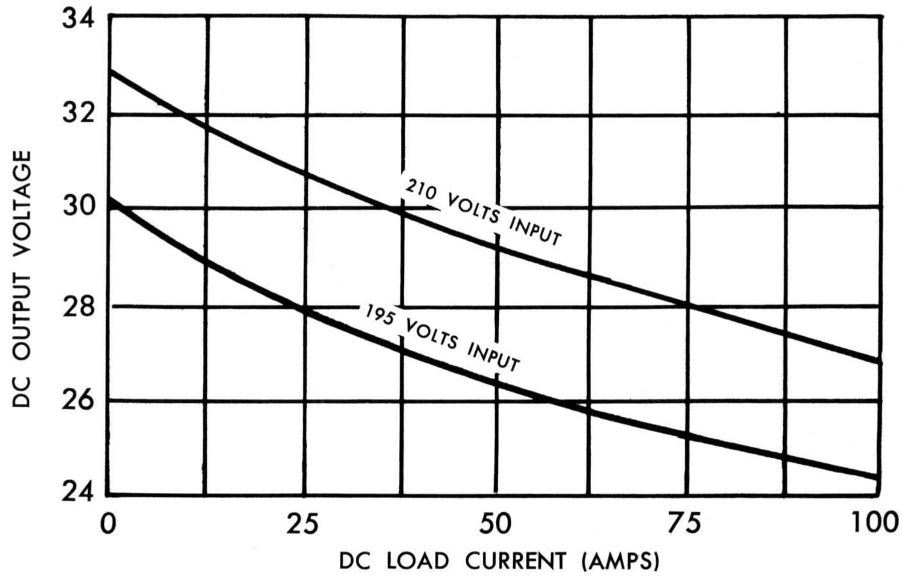


Fig. 2

TERMINAL BOARD DIAGRAM

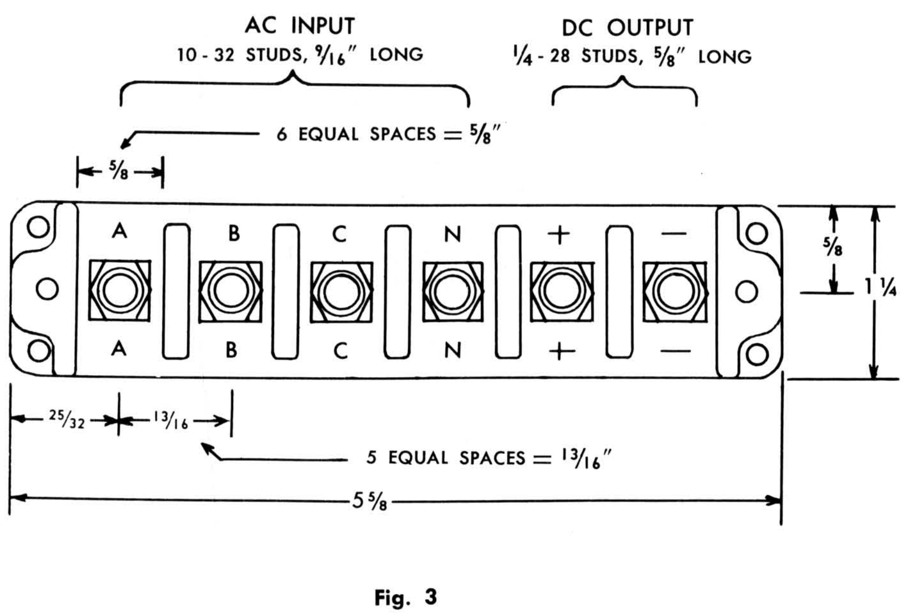


Fig. 3

DIMENSIONAL DIAGRAMS

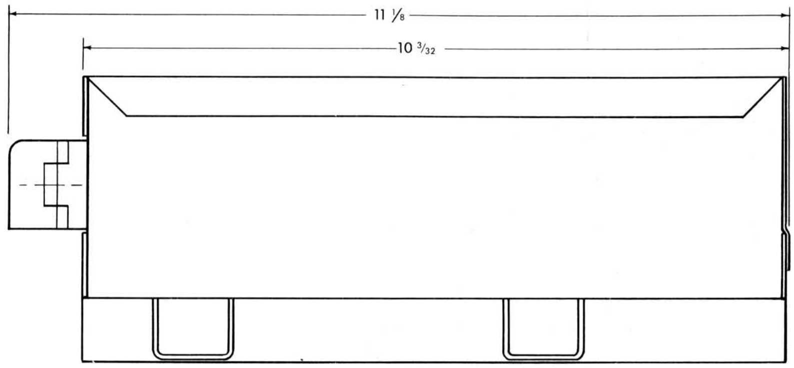


Fig. 4
Side

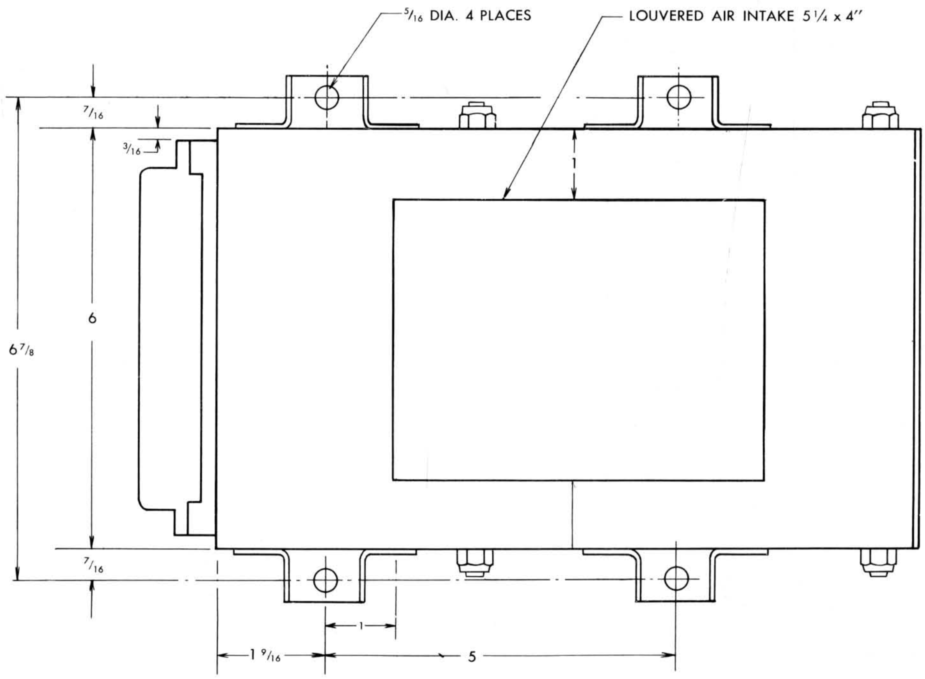


Fig. 5
Bottom

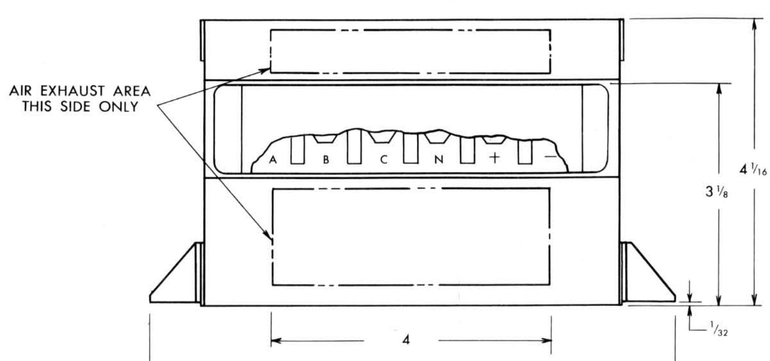


Fig. 6
Front

CHATHAM AIRBORNE CONVERSION EQUIPMENT

SELENIUM TRANSFORMER-RECTIFIER UNIT

28V200

DESCRIPTION— The Chatham Model 28V200 Transformer-Rectifier is a compact, light weight, static unit providing 200 amperes at 28 volts DC for motors, equipment, and battery charging. This unit is designed to operate from a 400 cycle, 200 volt AC aircraft generator. It will provide good regulation and long life. A fan enclosed within the housing circulates air for cooling.

Noteworthy features of the 28V200 are low ripple voltage, vibration and shock resistance, and suitability for continuous duty at full ratings. Low load-differential permits parallel operation of units. This unit is normally supplied in an anodized, black wrinkle-finish, light weight aluminum housing.

There are two versions of the 28V200 currently available. The 28V200-1 is designed to the requirements of MIL-C-7115 and MS-16103. The 28V200-2, although essentially the same unit, has been designed for a slightly higher voltage range and uses a modified output terminal board.

The values shown below under "Specifications" are nominal and are intended only as a guide. Conditions can be varied over a considerable range.

SPECIFICATIONS

INPUT (AC)	
Line Voltage (28V200-1)	187 to 203 volts
(28V200-2)	195 to 210 volts
Phase	3 phase, 4 wire
Line Current (at full load)	18 amps
Frequency	380 to 420 cps
OUTPUT (DC)	
Voltage (See curves, Figs. 2 & 3)	28 volts nominal
Current	200 amps
EFFICIENCY (Full Load)	80%
POWER FACTOR (Full Load)	95%
RIPPLE VOLTAGE	1 volt peak
OVERLOAD	500 amps DC for 1 min. max.
WEIGHT	28 lbs.
SIZE	7½" H x 9¼" W x 16⅛" D
MOUNTING PROVISIONS (See diagram, Fig. 7)	Four 5/16" Dia. holes
MOUNTING POSITIONS	Any
COOLING	Fan
TEMPERATURE RATING	Per curve I, MS33543(ASG) (Except that ambient temperature shall never exceed 85°C)
NOMINAL ALTITUDE RATING	
As 200 amp nominal unit	50,000 ft. max.
As 100 amp nominal unit	65,000 ft. max.
TRANSFORMER	
Primary	Wye
Secondary	Double, Wye-Delta
RECTIFIER	Selenium Stack
DUTY	Continuous
ELECTRICAL CONNECTIONS	
Input (See Fig. 4)	"AN" Receptacle
Output (See Figs. 5 & 6)	Terminal Board

APPLICATIONS AND NOTES

The 28V200 Transformer-Rectifier Unit is suitable for both aircraft use and ground testing of airborne equipment. Special emphasis has been placed on designing this unit to take a minimum of space and to have a minimum of weight.

Environmental conditions are no problem with the Chatham 28V200 since it has been designed to operate favorably even under the following conditions:

Exposure to sand and dust particles,
Exposure to atmosphere containing salt laden moisture,
Fungus growth as encountered in tropical climates,
High relative humidity even where condensation will be encountered.

Resistance to the above detrimental environmental conditions insures long life without the necessity of maintenance on the transformer or rectifier. The transformer is class H and is silicone impregnated. The rectifier stack is tailor-made by Chatham and is specially finished. An interphase transformer maintains low ripple voltage and improves regulation of output from part load to full load. All internal wiring is high temperature military type.

The motor driven cooling fan is internally connected to input power and maintains constant air displacement with increasing altitude. As altitude increases and air density decreases, the speed and volume displacement of the fan increases. Since the unit is fan cooled, it can be mounted in any position and the size of the components is kept at a minimum.

Installation of the complete unit is easily accomplished by merely attaching the mounting feet with four bolts.

Input connections are made by means of a standard "AN" receptacle. Output connections are made to a terminal board.

The 28V200 is one of a complete line of transformer-rectifier units produced by Chatham Electronics and is stocked for quick shipment. This unit can be modified to meet special individual requirements.

CIRCUIT DIAGRAM

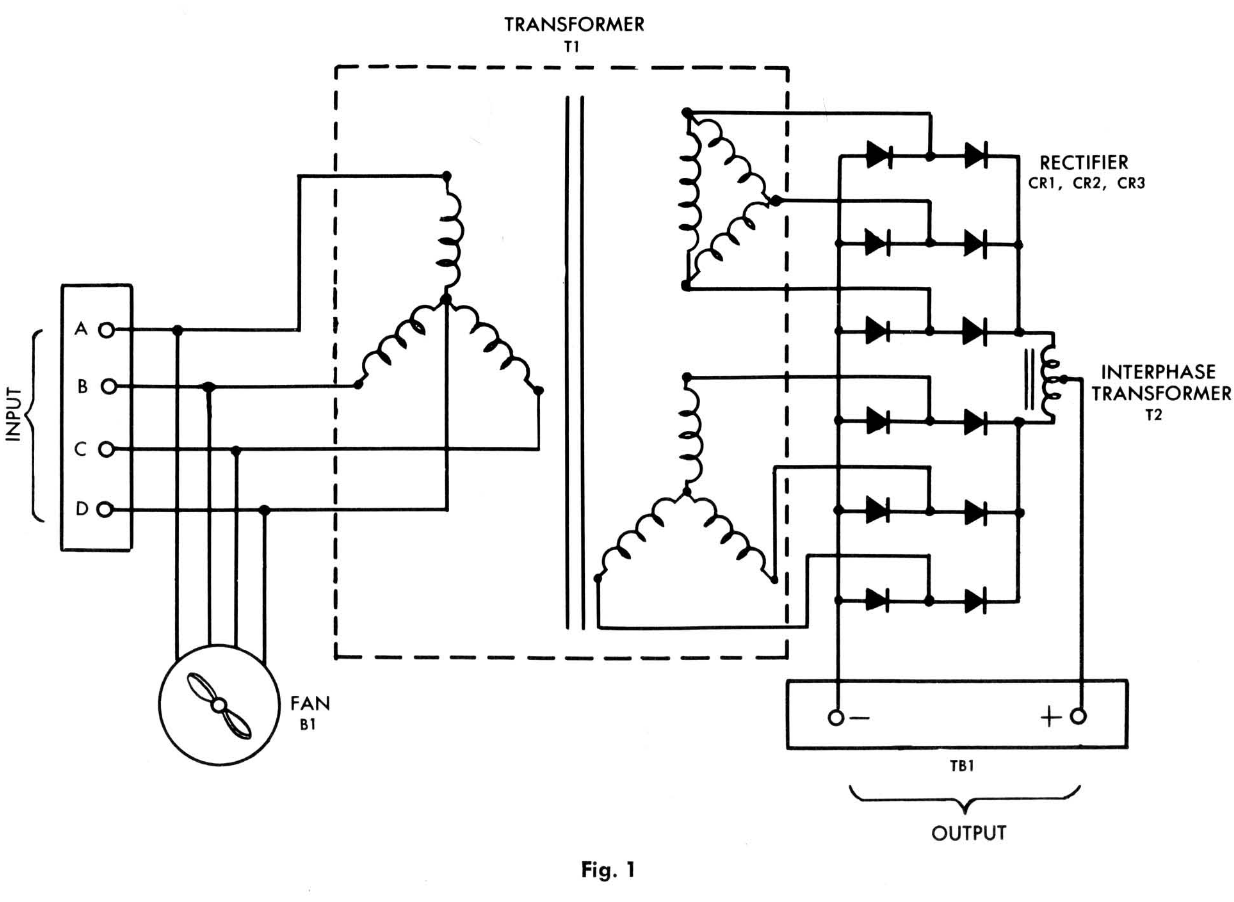


Fig. 1

TYPICAL REGULATION CURVES

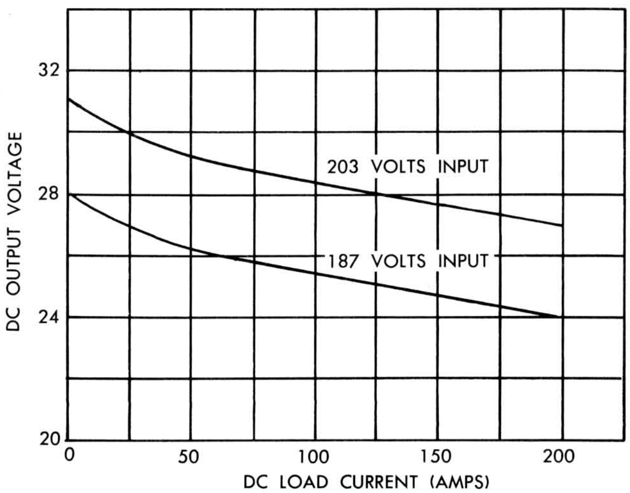


Fig. 2
28V200—1 Unit

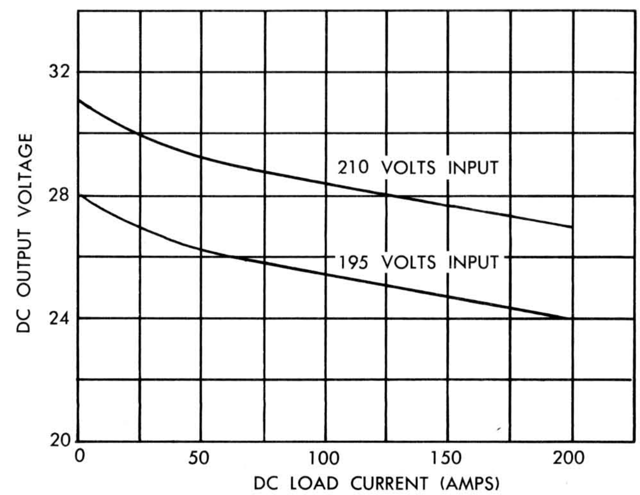


Fig. 3
28V200—2 Unit

INPUT CONNECTIONS

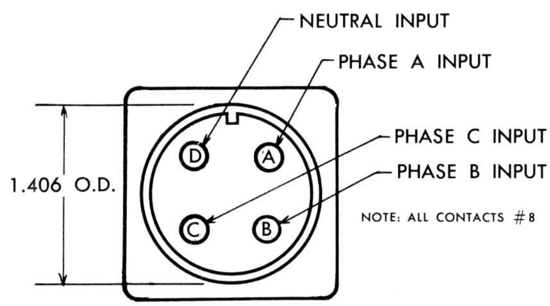


Fig. 4
AN3102A-22-22P Receptacle (Pin Side)

OUTPUT CONNECTIONS

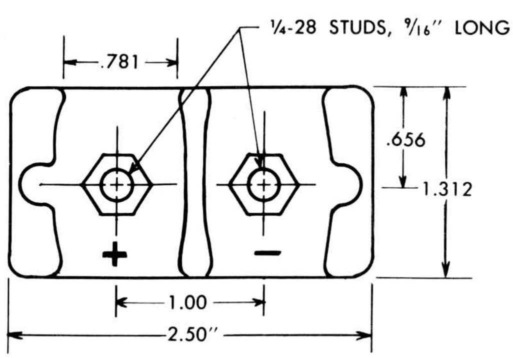


Fig. 5
MS25044—1 Terminal Board
28V200—1 Unit

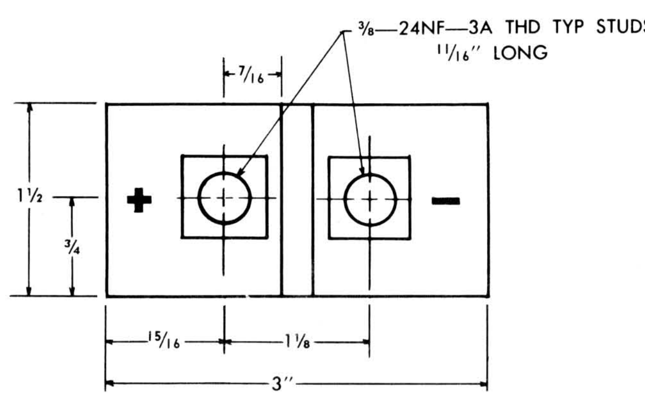


Fig. 6
Terminal Board
28V200—2 Unit

DIMENSIONAL DIAGRAMS

(28V200-2 UNIT)

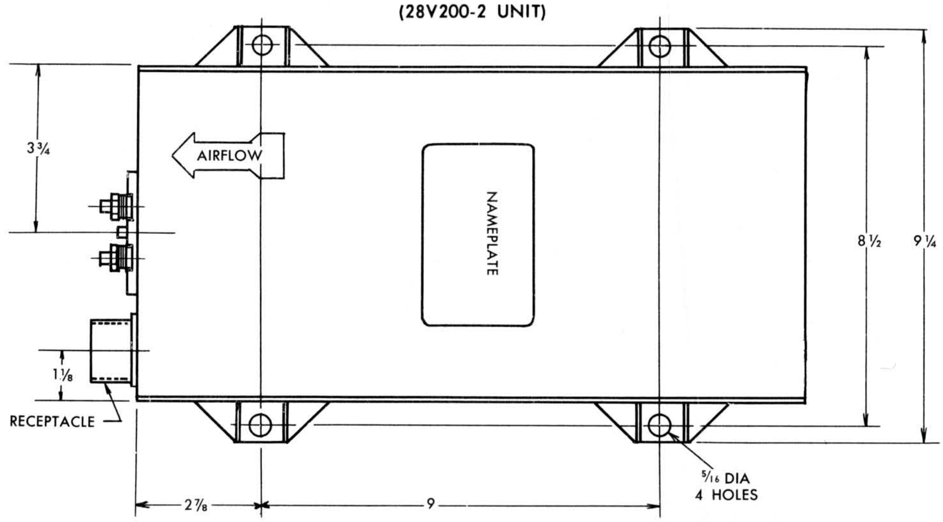


Fig. 7
Top

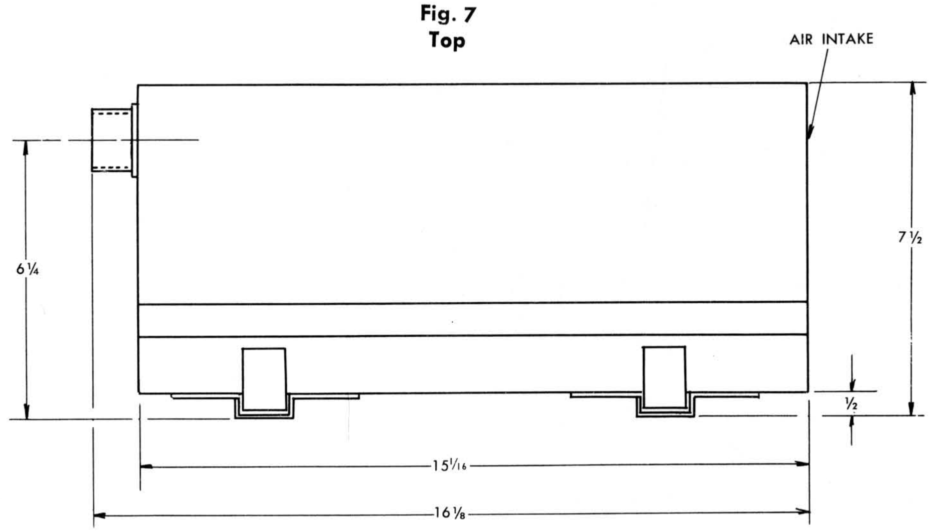


Fig. 8
Side

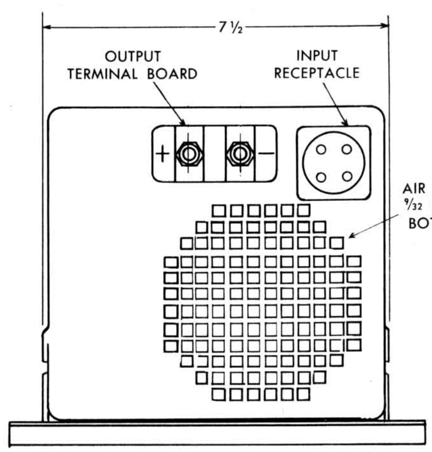


Fig. 9
Front

CHATHAM AIR-BORNE CONVERSION EQUIPMENT

SILICON TRANSFORMER-RECTIFIER UNIT

28VS50

DESCRIPTION: The Chatham Model 28VS50 Transformer-Rectifier is a compact, light weight, static unit providing 50 amperes at 28 volts DC for motors, control equipment, and battery charging. This unit is designed to operate from a 400 cycle, 200 volt AC aircraft generator. It will provide good regulation and long life. A fan enclosed within the housing circulates air for cooling. The rectifier assembly is made up of silicon diodes.

Noteworthy features of this unit are low ripple voltage, vibration resistance, and suitability for continuous duty. Low load-differential permits parallel operation of units. This unit is normally supplied in an anodized, black wrinkle-finish, light weight aluminum housing. The values shown below in the specifications are nominal and are intended only as a guide. Conditions can be varied over a considerable range.

SPECIFICATIONS

INPUT (AC)	
Voltage	195 to 205 volts
Phase	3 Phase, 4 wire
Line Current (at full load)	4 amps
Frequency	380 to 420 cps
OUTPUT (DC)	
Voltage (See curve, Fig. 2)	28 volts nominal
Current	50 amps max.
EFFICIENCY	
Full Load	85% min.
Half Load	80% min.
POWER FACTOR (Full Load)	90%
RIPPLE VOLTAGE	1 volt peak
OVERLOAD	125 amps DC for 1 min. max.
WEIGHT	Less than 9.5 lbs.
SIZE	5 9/16" H x 6" W x 8½" D
MOUNTING PROVISIONS	NAS 622
MOUNTING POSITION	Any
COOLING	Fan
NOMINAL TEMPERATURE RATING	
At Sea Level	−55°C to +85°C
At 60,000 ft.	−55°C to +20°C
TRANSFORMER	
Primary	Delta
Secondary	Fork
RECTIFIER	Silicon Diodes
DUTY	Continuous
ELECTRICAL CONNECTIONS	
Input and Shunt (See Fig. 7)	Receptacle
Output (See Fig. 6)	Terminal board

APPLICATIONS AND NOTES

The 28VS50 Transformer-Rectifier Unit is suitable for both aircraft use and ground testing of airborne equipment. Special emphasis has been placed on designing this unit to take a minimum of space and to have a minimum of weight.

Environmental conditions are no problem with the Chatham 28VS50 since it has been designed to operate favorably even under the following conditions:

- Exposure to sand and dust particles,
- Expose to atmosphere containing salt laden moisture,
- Fungus growth as encountered in tropical climates,
- High relative humidity even where condensation will be encountered.

The transformer is class H. The core is tape wound for high efficiency and low excitation. The primary winding has ceramic insulation and the secondary winding is insulated with silicone impregnated glass. The entire transformer is vacuum impregnated with silicone varnish.

The rectifier consists of stud mounted silicon diodes. They are mounted on a suitable heat sink to provide effective cooling under all operating conditions. The diodes are hermetically sealed and individually replaceable. They are custom-made at Chatham Electronics' own plant. All internal wiring on the unit is high temperature military type.

The motor driven cooling fan is internally connected to the input power and maintains constant air displacement with increasing altitude. As altitude increases and air density decreases, the speed and volume displacement of the fan increases. This increase is approximately three fold from sea level to 40,000 feet. Since the unit is fan cooled, it can be mounted in any position, and the size of the components is kept at a minimum.

Input connections are made by means of a receptacle. The A, B, C and D pins are AC input. Connections for the internal ammeter shunt are made through the same receptacle; the E and F pins are, respectively, the positive and negative shunt connections. The shunt is rated at 75 amps, 50 millivolts.

Output connections are made to terminals on a barrier type, melamine plastic terminal board. The terminal board cover is made of the same plastic and can be inverted thus allowing output wiring to either above or below the unit.

Installation of the complete unit is easily accomplished by sliding the NAS 622 hooks (at front of unit) and the beveled tongue (at back of unit) under mounting brackets and tightening nuts on hold-down clamps.

The 28VS50 is one of a complete line of transformer-rectifier units produced by Chatham Electronics and is stocked for quick shipment. This unit can be supplied to military or commercial specifications and can be modified to meet special individual requirements.

CIRCUIT DIAGRAM

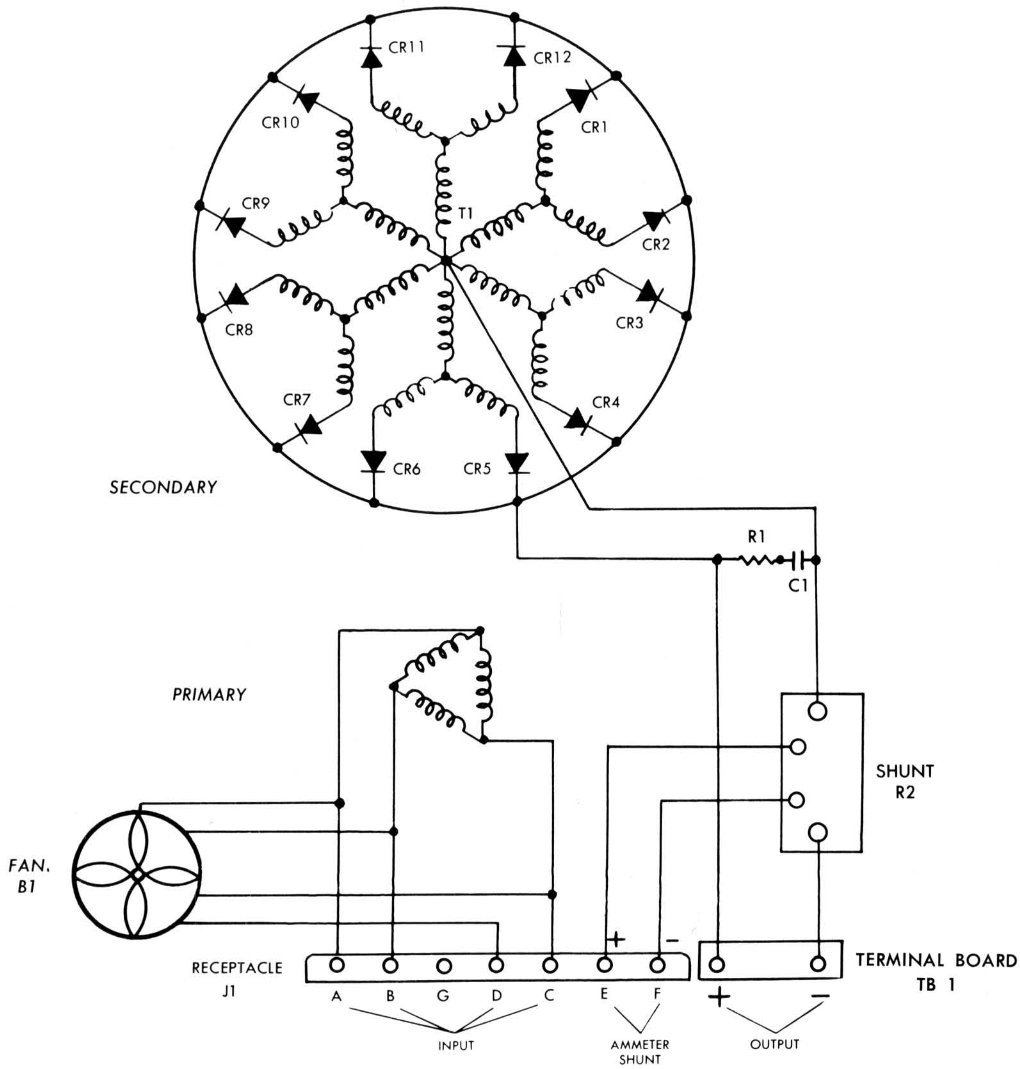


Fig. 1

TYPICAL REGULATION CURVES

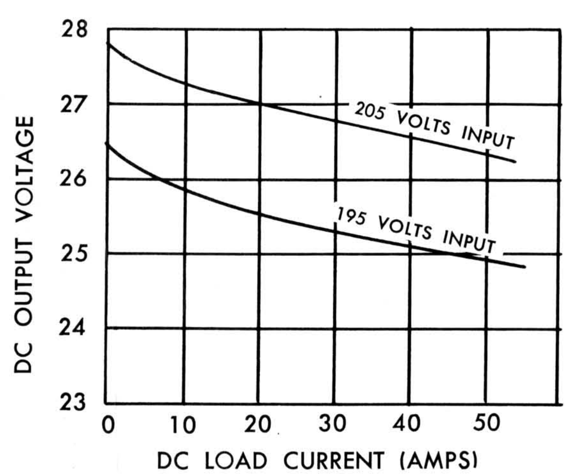
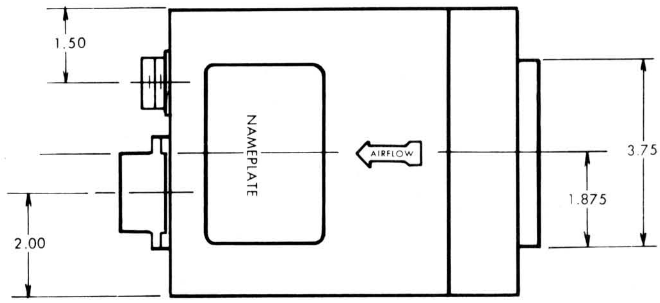
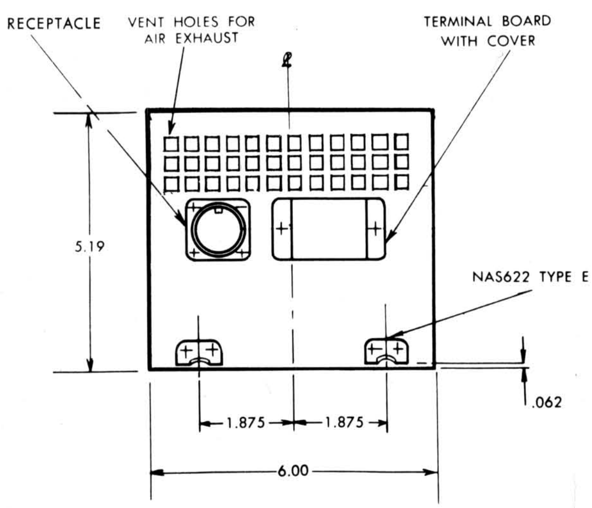


Fig. 2

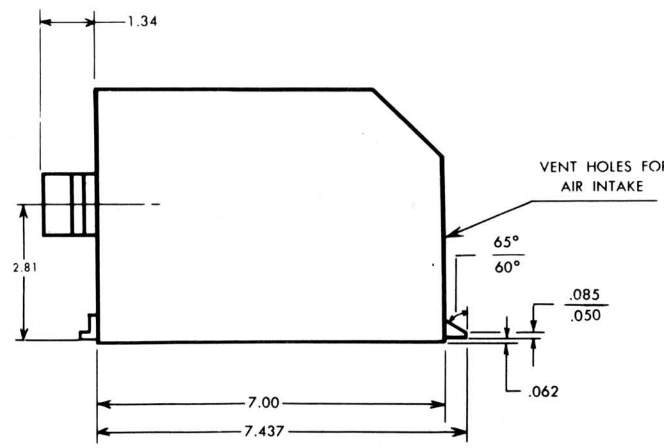
DIMENSIONAL DIAGRAMS



Top
Fig. 3

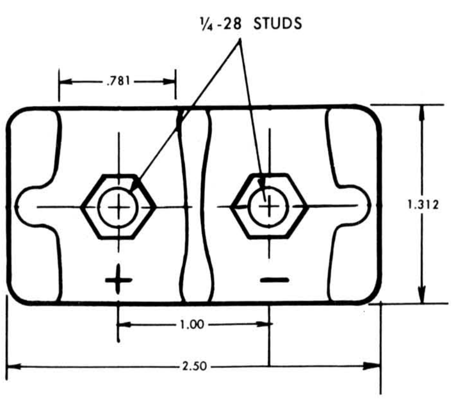


Front
Fig. 4

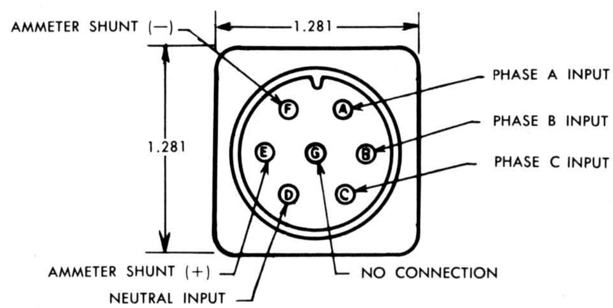


Side
Fig. 5

CONNECTORS



Output Terminal Board
MS25044-1
Fig. 6



Input Receptacle (Pin Side)
MS3102-16S-IP
Fig. 7

CHATHAM

RADIATION DETECTION EQUIPMENT

CHATHAM ELECTRONICS

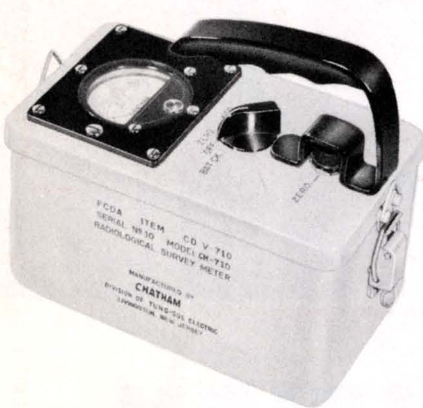
Division of TUNG-SOL ELECTRIC INC.

SURVEY METERS

Mass production of many thousands of Survey Meters for the Federal Civilian Defense Administration and the Services has made **CHATHAM** one of the leaders in the radiation field. This experience in design and production assures a reliable and accurate instrument in every range. Whether a Geiger-Mueller tube or hermetically-sealed ionization chamber is used as the detector, the results are field proven.

MODEL CH-700 Low Range

- A beta-gamma discriminating Geiger-Mueller tube survey meter with probe—.5, 5 and 50 mr/hr full scale.
- Specifically designed to comply with the F.C.D.A. specifications CD V-700 for low range Civil Defense survey meter for operational life, accuracy, spectral response, temperature, immersion, humidity, altitude, shock and vibration.
- Printed circuit and die-cast case assures compact and rugged design.
- Standard batteries easily accessible give 150 hours continuous operation. Small radioactive source attached for checking correct operation.
- Intensity at probe is read on rugged meter or headphone supplied.



MODEL CH-710 Medium Range

- A gamma and X-Ray detecting ionization chamber survey meter with three ranges — .5, 0-5, 0-50 r/hr full scale.
- Specifically designed to comply with the F.C.D.A. specifications CD V-710 for a medium range Civil Defense survey meter for operational life, accuracy, spectral response, temperature, immersion, humidity, altitude, shock and vibration.
- Batteries can be easily replaced without disturbing critical circuit components which are enclosed in a seperate gasketed compartment.
- A battery check position and zeroing adjustment are provided to assure correct operation at all times.
- Also available on special order with the **CHATHAM** exclusive internal calibration check.

MODEL CH-720 High Range

- A beta-gamma discriminating ionization chamber survey meter with three ranges . . . 0-5, 0-50, 0-500 r/hr full scale. Beta excluded by sliding shield.
- Specifically designed to comply with the F.C.D.A. specifications CD V-720 for a high range Civil Defense survey meter for operational life, accuracy, spectral response, temperature, immersion, humidity, altitude, shock and vibration.
- Powered by one "D" size flashlight cell and two 22½ volt hearing aid batteries to give 150 hours continuous operation.
- A battery check position and zeroing adjustment are provided to assure correct operation at all times. Luminous points on the meter scale and needle enable the operator to read the amount of radiation in the dark.
- Also available on special order with the **CHATHAM** exclusive internal calibration check.

ADDITIONAL CHATHAM RADIAC DEVICES

RADIAC SET AN/PDR-27J: A four range Geiger instrument for NAVY Bureau of Ships.

CURPISTORS: Miniature, constant current regulators in ranges of 10^{-9} to 10^{-12} amperes.

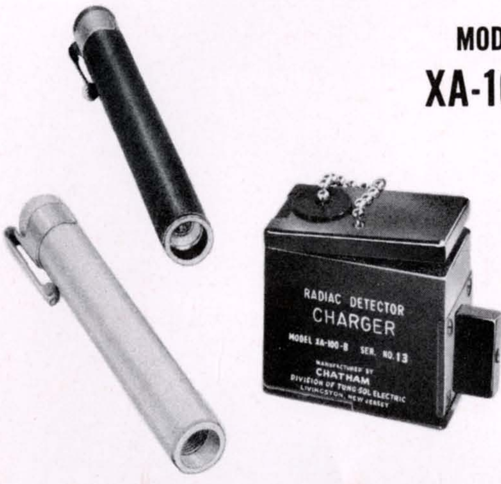
SCINTILLATION COUNTER-MODEL SC-102: A Crystal Scintillator with 6 ranges (.003-1.0 mr/hr) for very low intensity measurement and prospecting.

Write for further information.

DOSIMETER CHARGERS and COMBINATIONS

Most instruments for the detection of nuclear radiations require high voltages but relatively low currents. **CHATHAM** has developed a miniaturized power supply based upon one of the oldest principles of electricity, commonly referred to as *frictional electricity*. By employing some of the new plastic materials, the power supply operates over a wide temperature range (—55° C to +55° C) without batteries or electronic tubes, and with an indefinite shelf life. Our **Model XA-100A** charger has found wide use as a supply for self-indicating dosimeters for the armed services and industry.

Shown below is the improved Model XA-100B Charger with the types of pen dosimeters it so easily and reliably charges.



MODEL XA-100B

- Can accommodate any commercial, Civil Defense or military quartz fiber dosimeter using a diaphragm type switch whose barrel diameter is .497″ to .538″.
- Does not require any batteries of any kind, and life is virtually unlimited.
- Is simple to operate under even the most severe field conditions. Smooth, continuous knob control—both positive and negative, allows fast and accurate zeroing.
- Light, portable unit, completely ruggedized but small enough to be conveniently carried in the user's pocket.
- Approximate size: 2½″ x 1 1/16 x 2″ overall.
- Weight: 5 ounces.
- Built-in voltage regulator to prevent excessive overcharging of the dosimeters.

A recent development combines a dosimeter with a self-contained charger. The result has been a rugged, complete unit which incorporates a self-indicating quartz fiber dosimeter and one of our friction generators. **Model CH-800** can be supplied in ranges of 200 milliroentgens to 1000 roentgens.

MODEL CH-800

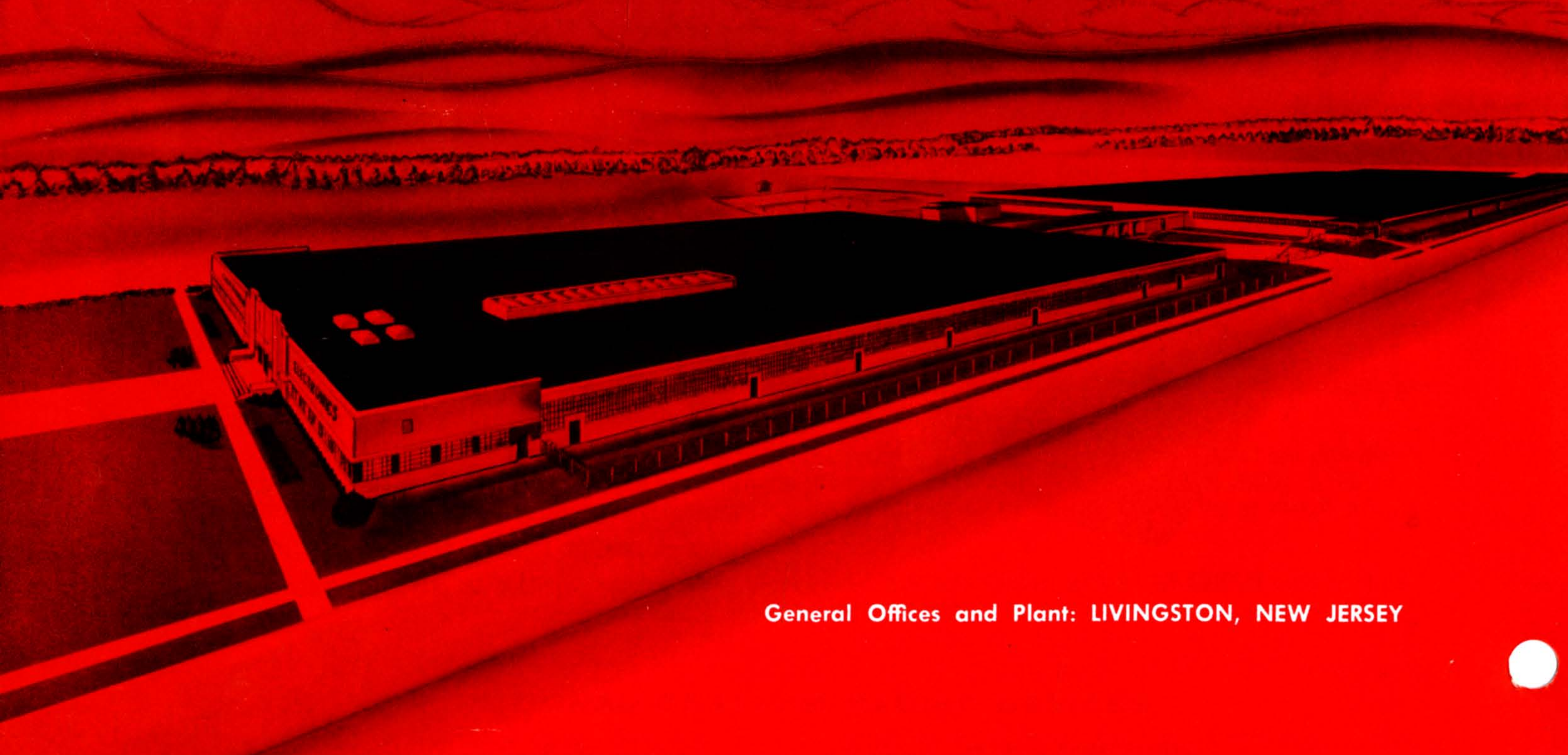
- Completely self-contained charger and quartz fiber dosimeter.
- Increases the usefulness and flexibility of quartz fiber dosimeters by completely eliminating the need for a separate charging unit.
- Instrument can be comfortably clipped into a pocket or on a belt.
- Is simple to operate under even the most severe field conditions. Smooth, continuous knob control—both positive and negative, allows fast and accurate zeroing.
- Can be supplied with dosimeter range to meet customer's requirements.
- Will meet military specifications for accuracy, spectral response, leakage, temperature, immersion, vibration and shock.
- Friction charger. No batteries. Long life.
- Built-in voltage regulator to prevent excessive overcharging of the dosimeters.

SPECIAL PRODUCTS: The radiological group at Chatham who have developed many special instruments for the Air Force, Signal Corps and Navy will be pleased to develop instruments to your specific requirements.

CHATHAM

DIVISION OF **TUNG-SOL ELECTRIC INC.**

- SELENIUM RECTIFIERS
- ELECTRONIC EQUIPMENT
- RADIAC DEVICES
- AIRCRAFT POWER SUPPLIES
- ELECTRON TUBES



General Offices and Plant: LIVINGSTON, NEW JERSEY

Sales Offices: MELROSE PARK, DALLAS, CULVER CITY, LIVINGSTON

TUNG-SOL / CHATHAM

SELENIUM RECTIFIER DESIGN QUESTIONNAIRE

1. Company: ____________________

   Address: ____________________

   Name: ____________________ Position: ____________________

2. Intended Application: ____________________

   Circuit: ____________________

   Type of Load: Resistive ________ Inductive ________ Capacitive ________ Motor ________ Blocking Dc ________

   Battery: Type ________ Amp-Hr ________ No. of Cells ________

   Cell Arrangement ____________________

   Charging Volts/Cell ________ Charging Amp/Cell ________

   Charging Method ____________________

   D-C Output: ________ volts at ________ amperes, ________ % regulation from ________ % load to ________ % load

   Ambient Temperature at Stack: ________ °C ________ °F nominal, ________ °C ________ °F maximum

   Cooling: Convection ________ Forced Air ________ Linear Feet/Minute ________

   Duty Cycle: Continuous ________ Intermittent ________ Describe ________

3. Input Data: ________ volts min ________ volts max ________ peak inverse volts ________ cycles/sec ________ line surge

4. Applicable Military Specifications: ____________________

5. Protective Coating Required: ____________________

6. Space Available: ____________________

7. Type of Mounting Required: ____________________

8. What Is of Prime Importance: Life ________ Compactness ________ Cost ________ Efficiency ________

9. Quantity ________ Delivery ________

10. Customer's Drawing No. ________ Attached ________ To Follow ________

    Customer's Test Spec No. ________ Attached ________ To Follow ________

PLEASE SKETCH SCHEMATIC DIAGRAM AND DESIRED MOUNTING DATA ON BACK OF PAGE

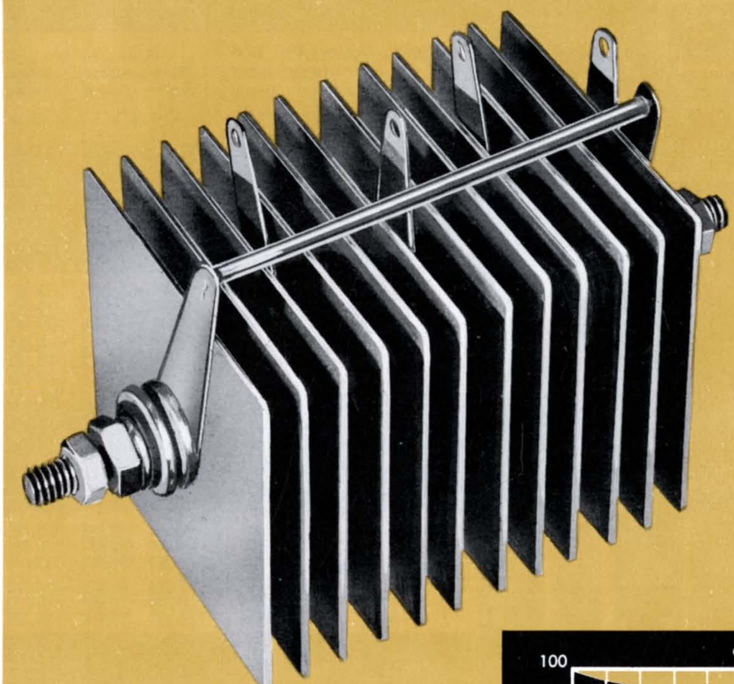
SCHEMATIC DIAGRAM

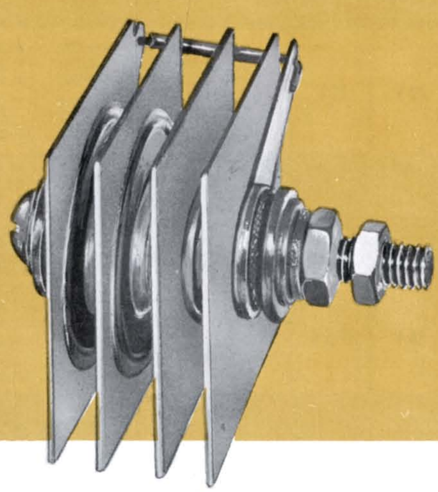
DESIRED MOUNTING DATA

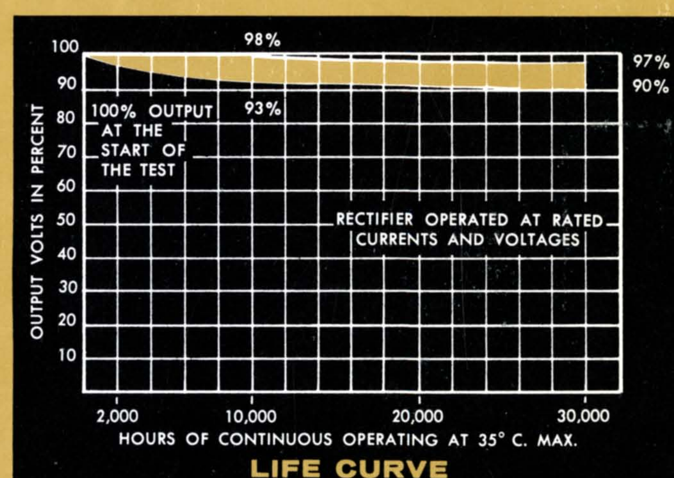
When completed mail to —
COMMERCIAL ENGINEERING DEPARTMENT
TUNG-SOL ELECTRIC, INC., CHATHAM ELECTRONICS DIVISION
630 W. Mt. Pleasant Avenue, Livingston, N. J.
WYman 2-1100

SELENIUM RECTIFIERS

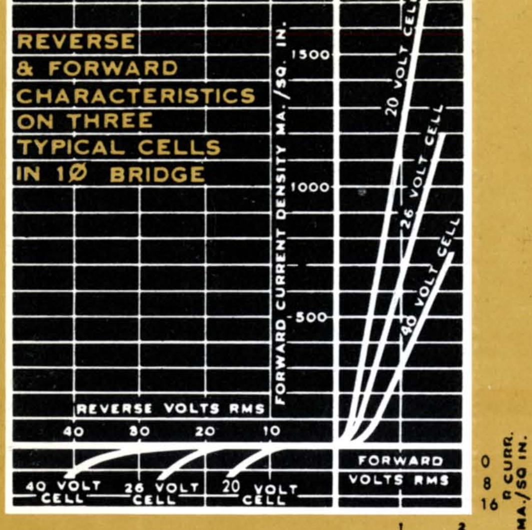
CHATHAM

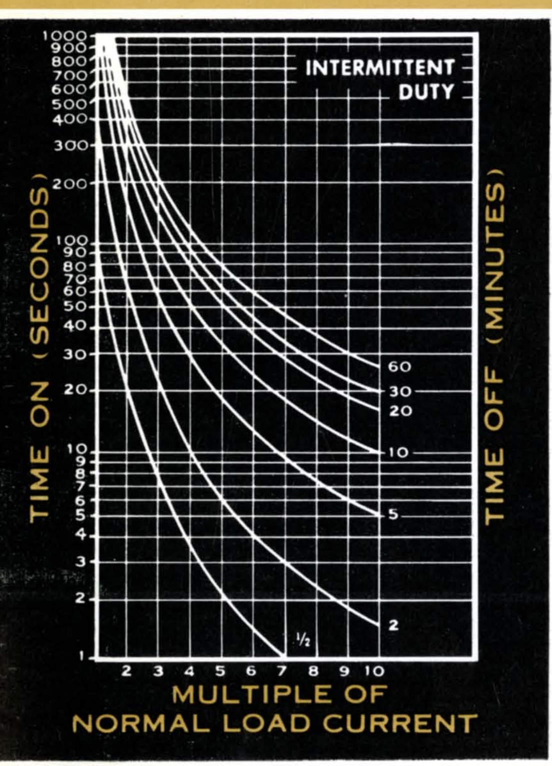


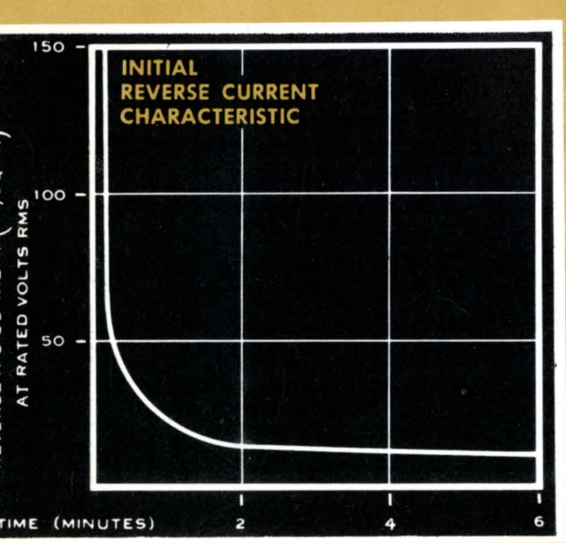




CHATHAM ELECTRONICS
division of TUNG-SOL ELECTRIC INC.







CHATHAM

SELENIUM RECTIFIERS

LIGHTER SMALLER STRONGER

UNEXCELLED IN PERFORMANCE

D. C. CURRENT RATING OF VARIOUS

LOW CURRENT DENSITY CELLS

Voltage Rating Per Cell			B		A		C		P	
RMS	DC Block	Circuit	Norm. Space	Wide Space	Norm. Space	Wide Space	Norm. Space	Wide Space	Norm. Space	Wide Space
			1 X 1		1¼ X 1¼		1⅜ X 1⅜		1½ X 1½	
40 V	32 V	1 φ H	0.085	0.106	0.150	0.187	0.200	0.250	0.250	0.315
		1 φ B	0.170	0.212	0.300	0.375	0.400	0.500	0.500	0.625
		1 φ C	0.170	0.212	0.300	0.375	0.400	0.500	0.500	0.625
		3 φ H	0.233	0.291	0.432	0.540	0.566	0.708	0.713	0.881
		3 φ B	0.256	0.320	0.474	0.592	0.622	0.777	0.784	0.980
		3 φ C	0.310	0.387	0.575	0.575	0.754	0.943	0.950	1.187
38 V	30.5 V	1 φ H	0.091	0.114	0.169	0.211	0.221	0.276	0.279	0.349
		1 φ B	0.183	0.228	0.338	0.422	0.443	0.552	0.559	0.698
		1 φ C	0.183	0.228	0.338	0.422	0.443	0.552	0.559	0.698
		3 φ H	0.249	0.311	0.462	0.577	0.604	0.750	0.762	0.952
		3 φ B	0.274	0.342	0.506	0.632	0.664	0.830	0.838	1.047
		3 φ C	0.331	0.413	0.613	0.766	0.806	1.008	1.016	1.270
36 V	29 V	1 φ H	0.098	0.122	0.182	0.228	0.239	0.299	0.301	0.376
		1 φ B	0.197	0.244	0.364	0.456	0.477	0.598	0.602	0.752
		1 φ C	0.197	0.244	0.364	0.456	0.477	0.598	0.602	0.752
		3 φ H	0.267	0.334	0.496	0.620	0.650	0.812	0.819	1.024
		3 φ B	0.294	0.367	0.546	0.682	0.715	0.883	0.900	1.125
		3 φ C	0.357	0.446	0.662	0.827	0.866	1.083	1.094	1.367
34 V	27 V	1 φ H	0.104	0.130	0.192	0.240	0.252	0.315	0.317	0.396
		1 φ B	0.207	0.260	0.384	0.480	0.504	0.630	0.634	0.792
		1 φ C	0.207	0.260	0.384	0.480	0.504	0.630	0.634	0.792
		3 φ H	0.284	0.355	0.528	0.660	0.691	0.863	0.872	1.090
		3 φ B	0.310	0.387	0.576	0.720	0.754	0.943	0.950	1.185
		3 φ C	0.377	0.471	0.700	0.875	0.916	1.145	1.156	1.445
32 V	25.5 V	1 φ H	0.113	0.141	0.206	0.257	0.270	0.337	0.340	0.425
		1 φ B	0.225	0.282	0.412	0.514	0.540	0.674	0.681	0.850
		1 φ C	0.225	0.282	0.412	0.514	0.540	0.674	0.681	0.850
		3 φ H	0.303	0.379	0.561	0.701	0.735	0.920	0.926	1.156
		3 φ B	0.333	0.416	0.617	0.771	0.809	1.010	1.020	1.275
		3 φ C	0.403	0.504	0.749	0.936	0.992	1.240	1.236	1.546

HIGH CURRENT DENSITY CELLS

Voltage Rating Per Cell			B		A		C		P	
RMS	DC Block	Circuit	Norm. Space	Wide Space	Norm. Space	Wide Space	Norm. Space	Wide Space	Norm. Space	Wide Space
30 V	24 V	1 φ H	0.119	0.148	0.220	0.275	0.289	0.361	0.364	0.455
		1 φ B	0.238	0.296	0.441	0.550	0.578	0.722	0.728	0.910
		1 φ C	0.238	0.296	0.441	0.550	0.578	0.722	0.728	0.910
		3 φ H	0.323	0.404	0.599	0.750	0.783	0.979	0.984	1.230
		3 φ B	0.356	0.445	0.660	0.824	0.864	1.080	1.088	1.360
		3 φ C	0.431	0.538	0.800	1.000	1.047	1.308	1.320	1.650
28 V	22.5 V	1 φ H	0.130	0.162	0.238	0.297	0.311	0.388	0.392	0.490
		1 φ B	0.260	0.324	0.475	0.594	0.622	0.776	0.784	0.988
		1 φ C	0.260	0.324	0.475	0.594	0.622	0.776	0.784	0.988
		3 φ H	0.349	0.436	0.647	0.809	0.848	1.059	1.068	1.350
		3 φ B	0.384	0.480	0.712	0.880	0.932	1.165	1.175	1.470
		3 φ C	0.466	0.583	0.865	1.082	1.131	1.415	1.425	1.781
26 V	20.5 V	1 φ H	0.136	0.170	0.253	0.316	0.331	0.414	0.409	0.511
		1 φ B	0.273	0.340	0.506	0.632	0.663	0.828	0.837	1.022
		1 φ C	0.273	0.340	0.506	0.632	0.663	0.828	0.837	1.022
		3 φ H	0.372	0.465	0.690	0.862	0.905	1.132	1.141	1.426
		3 φ B	0.409	0.511	0.760	0.950	0.992	1.240	1.255	1.568
		3 φ C	0.496	0.620	0.920	1.150	1.205	1.506	1.522	1.903
24 V	19 V	1 φ H	0.148	0.185	0.276	0.345	0.362	0.453	0.456	0.570
		1 φ B	0.297	0.370	0.553	0.690	0.724	0.906	0.913	1.140
		1 φ C	0.297	0.370	0.553	0.690	0.724	0.906	0.913	1.140
		3 φ H	0.407	0.509	0.753	0.942	0.988	1.235	1.245	1.555
		3 φ B	0.448	0.560	0.830	1.036	1.087	1.358	1.371	1.714
		3 φ C	0.543	0.678	1.007	1.258	1.320	1.650	1.662	2.075
22 V	17.5 V	1 φ H	0.165	0.212	0.308	0.385	0.405	0.506	0.510	0.638
		1 φ B	0.330	0.424	0.617	0.770	0.809	1.012	1.020	1.276
		1 φ C	0.330	0.424	0.617	0.770	0.809	1.012	1.020	1.276
		3 φ H	0.454	0.568	0.842	1.051	1.104	1.380	1.390	1.738
		3 φ B	0.498	0.622	0.925	1.156	1.213	1.516	1.528	1.910
		3 φ C	0.605	0.751	1.122	1.403	1.471	1.838	1.853	2.317
20 V	16 V	1 φ H	0.187	0.234	0.348	0.435	0.456	0.570	0.575	0.719
		1 φ B	0.375	0.468	0.696	0.870	0.912	1.140	1.150	1.438
		1 φ C	0.375	0.468	0.696	0.870	0.912	1.140	1.150	1.438
		3 φ H	0.511	0.639	0.950	1.187	1.243	1.554	1.566	1.959
		3 φ B	0.563	0.704	1.045	1.306	1.368	1.721	1.725	2.158
		3 φ C	0.682	0.850	1.265	1.582	1.657	2.070	2.090	2.611
			B		A		C		P	

H-HALF WAVE B-BRIDGE C-CENTER TAP

These exclusive Tung-Sol/Chatham features are the result of years of pioneering achievement in the design, development and production of custom-made Selenium rectifiers to specific applications.

Whatever your requirements, High Current Density—Low Voltage (20 to 30 Volt cells), Low Current Density—High Voltage (32 to 40 Volt cells), or any other combination—Tung-Sol/Chatham's unapproached experience in this highly specialized field is readily yours. Please contact **Engineering Department, CHATHAM ELECTRONICS, Division of TUNG-SOL ELECTRIC, INC., Livingston, N. J.**

TEMP. DERATING TABLE

AMBIENT TEMP.	D-C CURRENT % NORMAL	RMS VOLTAGE PER CELL % NORMAL
40°C - 104°F	100	100
45°C - 113°F	84 100	100 80
50°C - 122°F	75 100	100 80
55°C - 131°F	70 100	80 60
60°C - 140°F	45 75	80 60
65°C - 149°F	45 60	60 50
70°C - 158°F	20 40	60 50

CHATHAM ELECTRONIC CELL SIZES

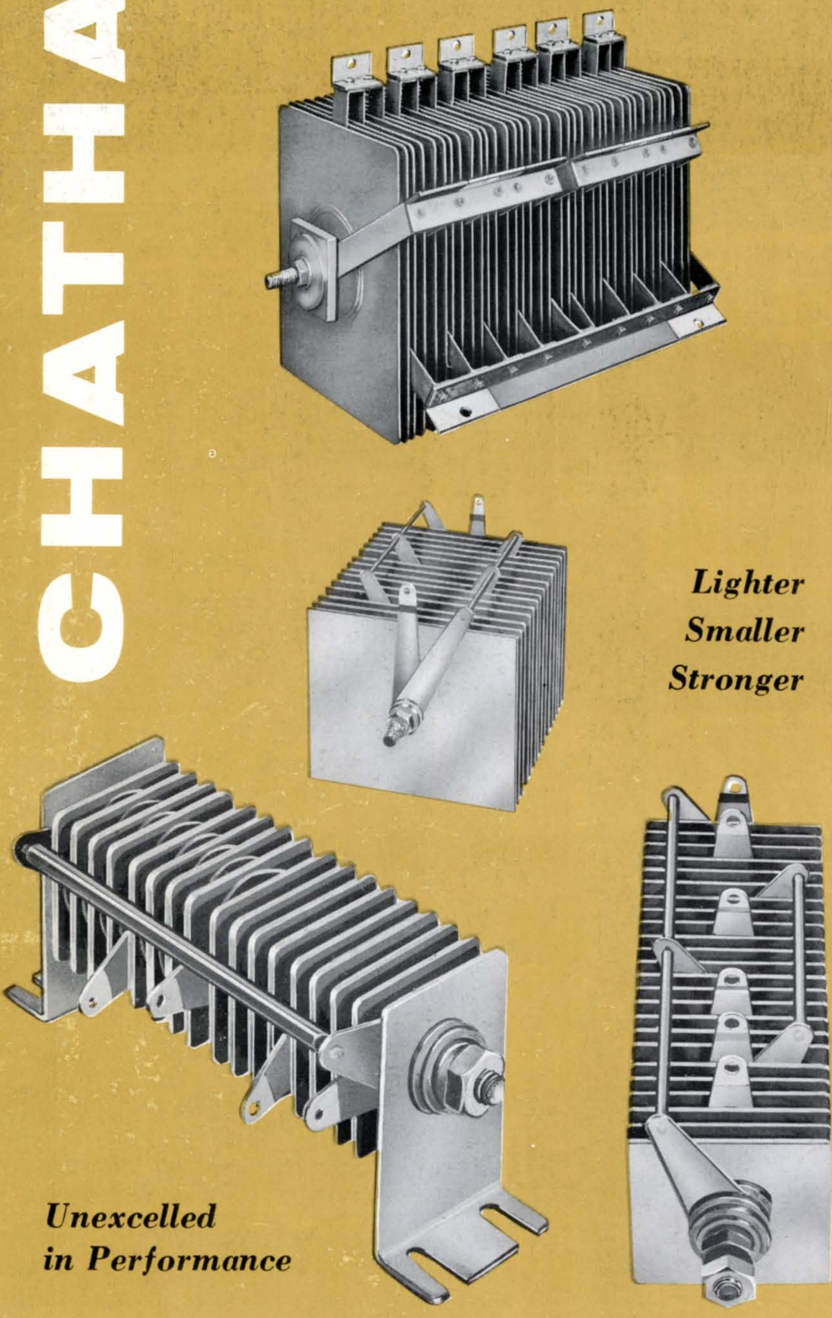
D Norm. Space	D Wide Space	Y Norm. Space	Y Wide Space	E Norm. Space	E Wide Space	M Norm. Space	M Wide Space	F Norm. Space	F Wide Space	N Norm. Space	N Wide Space
1¾ X 1¾		2 X 2		2³⁄₁₆ X 2³⁄₁₆		3 X 3		3⅜ X 3⅜		4 X 4	
0.350	0.437	0.500	0.625	0.600	0.750	1.200	1.50	1.50	1.83	2.25	2.70
0.700	0.875	1.000	1.250	1.200	1.500	2.400	3.00	3.00	3.75	4.5	5.6
0.700	0.875	1.000	1.250	1.200	1.500	2.400	3.00	3.00	3.75	4.5	5.6
1.050	1.310	1.348	1.684	1.681	2.100	3.485	4.355	4.00	5.00	4.75	5.9
1.155	1.444	1.484	1.853	1.681	2.311	3.835	4.800	4.50	5.60	6.5	8.1
1.400	1.750	1.795	2.242	2.240	3.000	4.650	5.810	5.50	6.90	8.0	10.0
0.412	0.515	0.528	0.660	0.659	0.823	1.368	1.709	1.65	2.06	2.5	3.1
0.824	1.030	1.056	1.320	1.318	1.646	2.735	3.418	3.30	4.12	5.0	6.2
0.824	1.030	1.056	1.320	1.318	1.646	2.735	3.418	3.30	4.12	5.0	6.2
1.123	1.403	1.440	1.800	1.795	2.241	3.728	4.655	4.40	5.52	6.3	7.8
1.235	1.544	1.584	1.980	1.975	2.470	4.100	5.126	5.00	6.25	7.0	8.7
1.500	1.875	1.922	2.400	2.400	3.000	4.971	6.215	6.00	7.50	8.5	10.6
0.438	0.547	0.569	0.711	0.710	0.888	1.471	1.840	1.73	2.16	2.6	3.25
0.877	1.094	1.138	2.276	1.420	1.776	2.942	3.680	3.45	4.30	5.2	6.5
0.877	1.094	1.138	2.276	1.420	1.776	2.942	3.680	3.45	4.30	5.2	6.5
1.205	1.506	1.537	1.922	1.930	2.415	4.000	5.000	4.60	5.75	6.6	8.25
1.327	1.657	1.703	2.130	2.125	2.655	4.408	5.500	5.20	6.50	7.3	9.1
1.610	2.013	2.065	2.580	2.578	3.220	5.340	6.680	6.30	7.80	9.0	11.2
0.467	0.584	0.600	0.750	0.797	0.996	1.550	1.938	1.84	2.30	2.75	3.4
0.934	1.168	1.200	1.500	1.494	1.992	3.100	3.876	3.70	4.60	5.5	6.8
0.934	1.168	1.200	1.500	1.494	1.992	3.100	3.876	3.70	4.60	5.5	6.8
1.284	1.604	1.646	2.058	2.052	2.569	4.262	5.330	4.90	6.12	7.2	9.0
1.400	1.750	1.797	2.246	2.240	2.800	4.650	5.810	5.50	6.88	8.0	10.0
1.705	2.130	2.188	2.731	2.725	3.408	5.660	7.075	6.75	8.45	10.0	12.5
0.501	0.626	0.644	0.805	0.803	1.004	1.666	2.082	1.95	2.44	2.92	3.65
1.003	1.252	1.288	1.610	1.606	2.008	3.333	4.164	3.90	4.88	5.85	7.3
1.003	1.252	1.288	1.610	1.606	2.008	3.333	4.164	3.90	4.88	5.85	7.3
1.364	1.705	1.753	2.190	2.185	2.730	4.531	5.660	5.20	6.50	7.7	9.6
1.500	1.875	1.930	2.412	2.405	3.006	4.990	6.240	5.85	7.30	8.5	10.6
1.818	2.275	2.338	2.921	2.913	3.645	6.042	7.560	7.15	8.95	11.1	13.75
0.537	0.672	0.689	0.862	0.858	1.072	1.783	2.230	2.10	2.65	3.1	3.85
1.074	1.344	1.378	1.724	1.717	2.144	3.566	4.460	4.2	5.25	6.3	7.9
1.074	1.344	1.378	1.724	1.717	2.144	3.566	4.460	4.2	5.25	6.3	7.9
1.459	1.822	1.872	2.340	2.334	2.917	4.842	6.055	5.60	7.00	8.0	10.0
1.606	2.008	2.061	2.578	2.570	3.210	5.330	6.660	6.30	7.80	9.0	11.2
1.947	2.432	2.500	3.120	3.114	3.890	6.460	8.070	7.70	9.60	11.0	13.7
0.578	0.722	0.740	0.924	0.924	1.155	1.919	2.395	2.25	2.80	3.37	4.2
1.156	1.444	1.481	1.848	1.848	2.310	3.838	4.790	4.45	5.60	6.75	8.4
1.156	1.444	1.481	1.848	1.848	2.310	3.838	4.790	4.45	5.60	6.75	8.4
1.576	1.970	2.020	2.524	2.519	3.147	5.230	6.540	6.00	7.50	8.6	10.75
1.732	2.167	2.220	2.776	2.770	3.462	5.750	7.190	6.75	8.45	9.5	11.9
2.100	2.625	2.700	3.375	3.360	4.200	6.970	8.720	8.25	10.6	12.1	15.0
0.616	0.770	0.791	0.988	0.986	1.233	2.040	2.550	2.40	3.00	3.60	4.5
1.232	1.540	1.582	1.976	1.973	2.466	4.080	5.100	4.8	6.0	7.20	9.0
1.232	1.540	1.582	1.976	1.973	2.466	4.080	5.100	4.8	6.0	7.20	9.0
1.680	2.100	2.158	2.697	2.690	3.360	5.580	6.975	6.4	8.0	9.2	11.5
1.847	2.310	2.372	2.969	2.958	3.695	6.140	7.680	7.2	9.1	10.2	12.7
2.240	2.800	2.875	3.590	3.588	4.480	7.440	9.300	8.8	11.0	12.4	15.5
0.673	0.841	0.864	1.080	1.077	1.346	2.237	2.795	2.62	3.28	3.90	4.85
1.346	1.682	1.728	2.160	2.155	2.692	4.475	5.590	5.25	6.56	7.80	9.9
1.346	1.682	1.728	2.160	2.155	2.692	4.475	5.590	5.25	6.56	7.80	9.9
1.837	2.295	2.358	2.945	2.940	3.675	6.100	7.520	7.0	8.75	10.0	12.5
2.040	2.550	2.595	3.241	3.235	4.040	6.710	8.380	7.85	9.80	11.1	13.75
2.450	3.120	3.145	3.930	3.925	4.905	8.150	10.170	9.6	12.0	13.5	16.8
0.751	0.949	0.965	1.206	1.203	1.504	2.493	3.117	3.0	3.75	4.5	5.6
1.501	1.898	1.929	2.412	2.405	3.008	4.985	6.234	6.0	7.50	9.0	11.2
1.501	1.898	1.929	2.412	2.405	3.008	4.985	6.234	6.0	7.50	9.0	11.2
2.095	2.620	2.630	3.290	3.280	4.100	6.800	8.500	8.0	10.0	11.5	14.3
2.250	2.810	2.890	3.610	3.605	4.508	7.475	9.340	9.0	11.2	13.0	16.25
2.730	3.411	3.500	4.375	4.365	5.460	9.070	11.330	11.0	13.7	15.5	19.4
0.847	1.057	1.087	1.360	1.355	1.693	2.810	3.514	3.30	4.12	4.9	6.1
1.695	2.114	2.175	2.720	2.710	3.386	5.620	7.028	6.60	8.25	9.9	12.2
1.695	2.114	2.175	2.720	2.710	3.386	5.620	7.028	6.60	8.25	9.9	12.2
2.310	2.890	2.968	3.710	3.695	4.620	7.670	9.590	8.80	11.0	13.0	16.25
2.545	3.181	3.268	4.085	4.070	5.090	8.450	10.560	9.9	12.4	14.5	18.1
3.080	3.850	3.957	4.940	4.928	6.160	10.230	12.780	12.1	15.1	17.5	21.5
D		Y		E		M		F		N	

K Norm. Space	K Wide Space	R Norm. Space	R Wide Space	J Norm. Space	J Wide Space	V Norm. Space	V Wide Space	X Norm. Space	X Wide Space
4½ X 5		4 X 6		5 X 6		6 X 6		6¼ X 7¼	
3.0	3.75	3.45	4.31	4.25	5.3	5.0	6.25	6.37	8.0
6.0	7.5	6.89	8.61	8.5	10.6	10.0	12.5	12.75	15.9
6.0	7.5	6.89	8.61	8.5	10.6	10.0	12.5	12.75	15.9
8.0	10.0	9.39	11.7	11.5	14.4	13.5	16.9	17.2	21.6
9.0	11.2	10.3	12.9	12.75	16.0	15.0	18.75	19.12	24.0
11.0	13.75	12.5	15.6	15.50	19.4	18.2	22.8	23.25	29.1
3.3	4.12	3.68	4.6	4.6	5.75	5.4	6.75	6.9	8.5
6.6	8.25	7.37	9.2	9.3	11.6	11.0	13.75	13.9	17.4
6.6	8.25	7.37	9.2	9.3	11.6	11.0	13.75	13.9	17.4
8.8	11.0	10.00	12.3	12.6	15.75	14.8	18.5	18.9	23.1
9.9	12.4	11.40	14.2	14.0	17.5	16.5	20.6	21.0	25.75
12.0	15.0	13.30	16.6	17.0	21.2	20.0	25.0	25.5	31.8
3.45	4.3	3.92	4.9	4.9	6.1	5.75	7.2	7.3	9.0
6.9	8.6	7.83	9.8	9.8	12.2	11.5	14.4	14.7	18.3
6.9	8.6	7.83	9.8	9.8	12.2	11.5	14.4	14.7	18.3
9.2	11.5	10.8	13.5	13.2	16.5	15.5	19.4	19.8	25.2
10.30	12.9	11.9	14.9	14.7	18.4	17.3	21.6	22.0	27.6
12.60	15.75	14.4	18.0	17.8	22.2	21.0	26.2	28.7	33.3
3.68	4.60	4.17	5.21	5.2	6.5	6.1	7.6	7.8	9.75
7.35	9.2	8.34	10.4	10.4	13.0	12.2	15.25	15.6	19.5
7.35	9.2	8.34	10.4	10.4	13.0	12.2	15.25	15.6	19.5
9.80	12.2	11.5	14.4	14.1	17.6	16.6	20.8	21.15	26.4
11.0	13.75	12.5	15.6	15.6	19.5	18.4	23.0	23.4	27.25
13.5	16.9	15.2	19.0	19.0	23.8	22.4	28.0	28.5	35.7
3.9	4.8	4.49	5.11	5.5	6.8	6.5	8.1	8.25	10.2
7.8	9.75	8.97	10.2	11.0	13.75	13.0	16.25	16.5	20.5
7.8	9.75	8.97	10.2	11.0	13.75	13.0	16.25	16.5	20.5
10.4	13.0	12.8	16.0	15.0	18.75	17.6	22.0	22.5	28.0
11.7	14.6	13.4	16.7	16.6	20.8	19.5	24.4	24.9	31.0
14.3	17.9	16.2	20.5	20.2	25.2	24.0	30.0	30.3	37.8
4.2	5.25	4.80	6.0	6.0	7.5	7.0	8.75	9.0	11.25
8.4	10.5	9.60	12.0	11.9	14.9	14.0	17.5	17.8	22.35
8.4	10.5	9.60	12.0	11.9	14.9	14.0	17.5	17.8	22.35
11.2	14.0	13.0	16.2	16.1	20.0	19.0	23.8	24.15	30.0
12.6	15.75	14.4	18.0	17.8	22.2	21.0	26.2	26.7	33.3
15.4	19.20	17.4	21.7	21.7	27.0	25.5	31.9	32.2	40.5
4.5	5.62	5.2	6.5	6.4	8.0	7.5	9.4	9.6	12.0
9.0	11.2	10.4	13.0	12.75	16.0	15.0	18.75	19.0	24.0
9.0	11.2	10.4	13.0	12.75	16.0	15.0	18.75	19.0	24.0
12.0	15.0	14.1	17.6	17.2	20.4	20.2	25.2	25.8	30.6
13.5	16.9	15.5	19.4	19.1	24.0	22.5	28.1	28.6	36.0
16.5	20.6	18.8	23.5	24.2	30.2	28.5	35.6	36.3	45.3
4.8	6.0	5.5	6.88	6.8	8.5	8.0	10.0	10.2	12.75
9.6	12.0	11.0	13.8	13.6	17.0	16.00	29.00	20.4	25.5
9.6	12.0	11.0	13.8	13.6	17.0	16.00	20.00	20.4	25.5
12.8	16.0	15.0	18.7	18.4	23.0	21.6	27.0	27.6	34.5
14.4	18.0	16.5	21.2	20.4	25.5	24.5	30.6	30.6	38.25
17.6	22.0	20.0	25.0	24.8	31.0	29.0	36.2	37.2	46.5
5.25	6.55	6.0	7.5	7.45	9.3	8.75	11.0	11.1	13.9
10.5	13.1	12.0	15.0	14.9	18.6	17.5	22.0	22.3	27.9
10.5	13.1	12.0	15.0	14.9	18.6	17.5	22.0	22.3	27.9
14.0	17.5	16.4	20.5	20.0	25.0	23.5	29.4	30.0	37.5
15.7	19.6	18.1	22.6	22.3	28.0	26.5	33.1	33.45	42.0
19.2	24.0	21.9	27.4	27.1	34.0	32.0	40.0	40.6	51.0
6.0	7.5	6.8	8.5	8.5	10.6	10.0	12.5	12.75	15.9
12.0	15.0	13.5	17.0	17.0	20.0	20.0	25.0	25.5	30.0
12.0	15.0	13.5	17.0	17.0	20.0	20.0	25.0	25.5	30.0
16.0	20.0	18.3	22.9	23.0	28.8	27.0	33.8	34.5	43.2
18.0	22.5	20.2	25.5	25.5	32.0	30.0	37.5	38.25	48.0
22.0	27.5	24.4	30.5	31.0	38.8	36.5	45.6	46.5	58.2
6.6	8.25	7.6	9.5	9.35	11.7	11.0	13.75	14.1	17.5
13.2	16.5	15.2	19.0	18.7	23.4	22.0	27.5	28.0	35.1
13.2	16.5	15.2	19.0	18.7	23.4	22.0	27.5	28.0	35.1
17.6	22.0	20.7	25.9	25.3	31.6	29.75	37.1	37.95	47.4
19.8	24.6	22.8	28.5	28.0	35.0	33.0	41.3	42.0	52.5
24.2	30.2	27.6	34.5	34.0	42.5	40.0	50.0	51.0	63.75
K		R		J		V		X	

Above ratings are for 8 or more cells per assembly, ambient 35°C, resistive or inductive load, convection cooled for 10,000 hour minimum life, averaging 5% down in output voltage. Ratio of current densities of 20 and 40 volt cells—2.2 to 1.0. Forced air cooling (300 to 400 LFM) multiply normal spaced rating by 2.5.

CHATHAM

SELENIUM RECTIFIERS



Lighter
Smaller
Stronger

Unexcelled in Performance

TUNG-SOL PRODUCTS

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Industrial, Commercial and Military Tubes
Receiving Tubes
Cathode Ray (Picture) Tubes

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Miniature Incandescent Lamps
Neon Indicator Lamps
Miniature "Baseless" Lamps
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Sealed Beam Lamps

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Industrial Flashers
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Silicon Rectifiers

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SALES:

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Tung-Sol Electric Inc.
2334 Havenhurst
P. O. Box 14348
Dallas 34, Texas

Tung-Sol Electric Inc.
630 W. Mt. Pleasant Ave.
Livingston, New Jersey

Withers & Ropek
5439 West Division St.
Chicago 51, Illinois

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8575 Washington Blvd.
Culver City, California

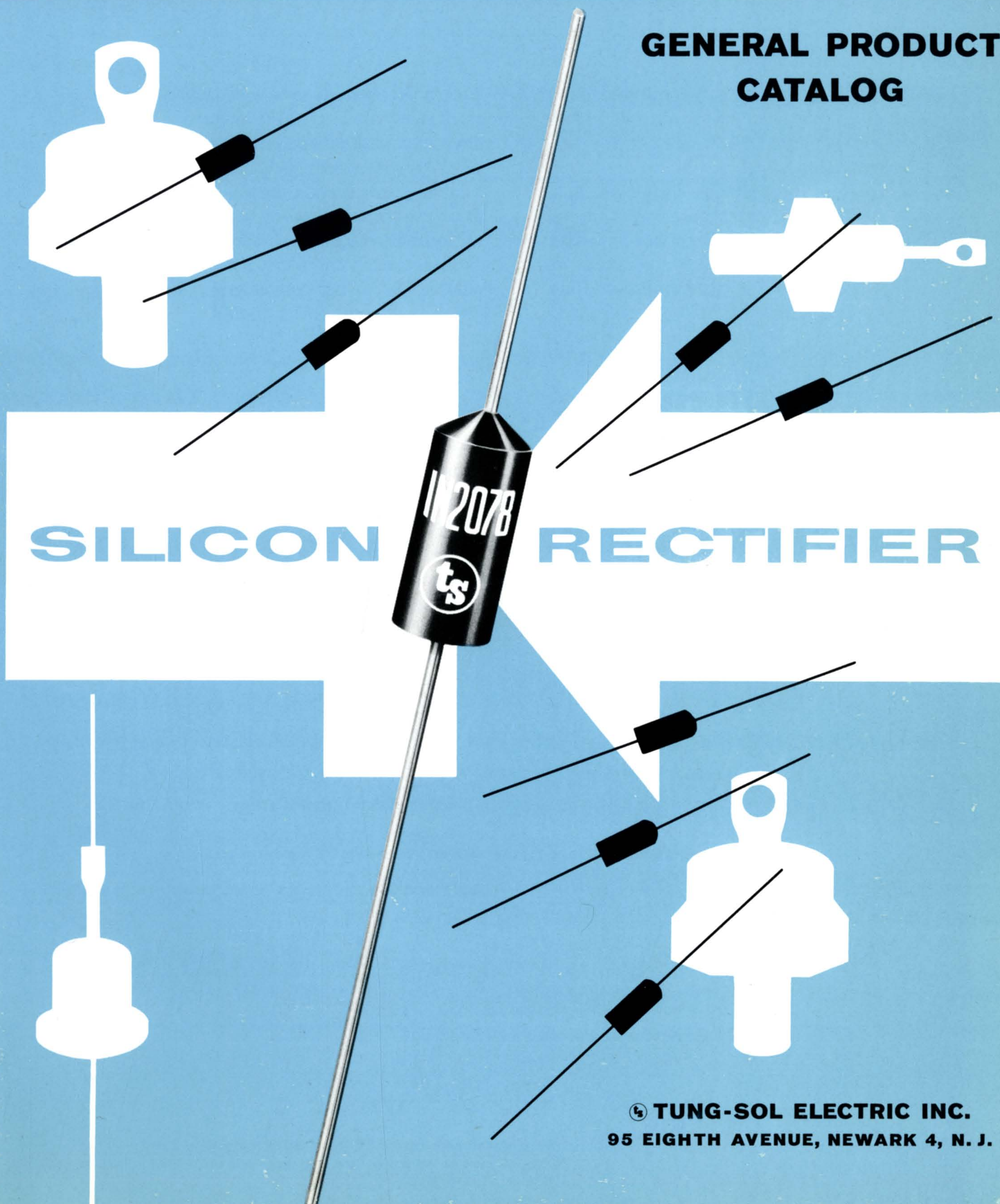
GENERAL OFFICE:

TUNG-SOL ELECTRIC INC.
95 EIGHTH AVENUE
NEWARK 4, NEW JERSEY

Printed in U.S.A. Form No. T-37

TUNG-SOL

GENERAL PRODUCT CATALOG



TUNG-SOL ELECTRIC INC.
95 EIGHTH AVENUE, NEWARK 4, N. J.

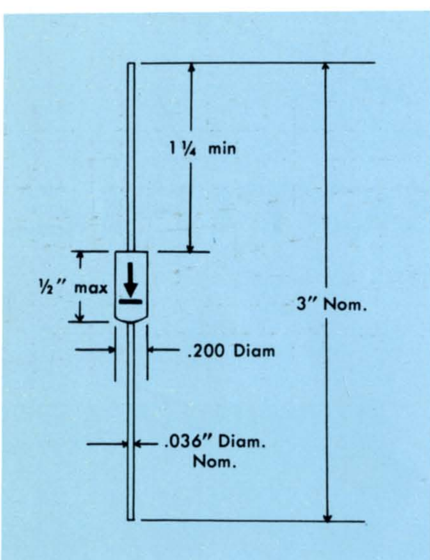
TUNG-SOL®...

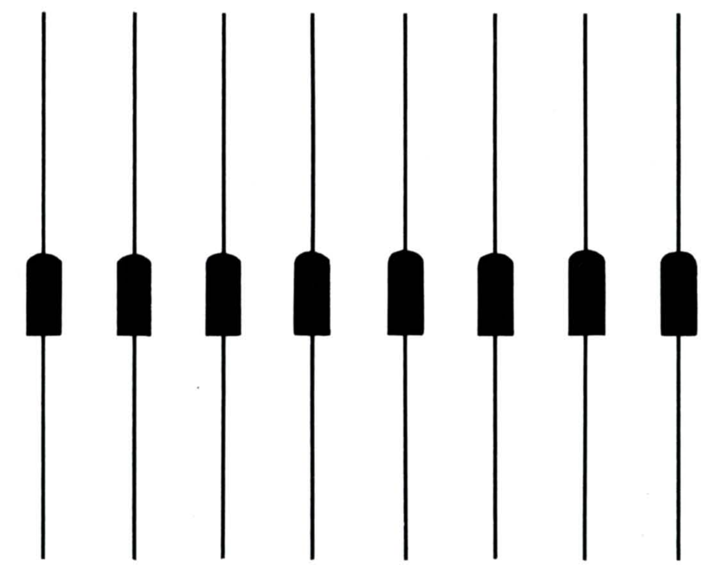
The new Tung-Sol series of diffused junction silicon rectifiers offers controlled quality that surpasses rectifiers made by any other methods.

Negligible voltage drop, stable low leakage, ability to withstand high current surges, freedom from junction stresses resulting from thermal cycling—all contribute to higher-than-standard performance. Plus, low junction power loss holds junction temperature down for overall increased reliability and longer life.

Special insulated epoxy encapsulation fosters excellent electrical behavior and provides top resistance to moisture and thermal shock. Also, it widens mounting flexibility, permitting installation in the same easy manner as resistors and capacitors with no additional hardware.

Transistorized and other power supplies, blockers, DC to DC converters, radio, TV—these represent just a sampling of the many places Tung-Sol's new, special-design silicon rectifiers can be put to good use.





1N2072 1N2073 1N2074 1N2075 1N2076 1N2077 1N2078 1N2079

ABSOLUTE MAXIMUM RATINGS (100°C AMBIENT) RESISTIVE OR INDUCTIVE LOAD

JEDEC Type Number		1N2072	1N2073	1N2074	1N2075	1N2076	1N2077	1N2078	1N2079
Peak Inverse Voltage	Volts	50	100	150	200	250	300	400	500
Continuous DC Working Voltage	Volts	50	100	150	200	250	300	400	500
RMS Applied Voltage (resistive load)	Volts	35	70	105	140	175	210	280	350
Average DC Output Current*	mAdc	625	625	625	625	625	625	625	625
Peak Recurrent Forward Current	Amps.	5	5	5	5	5	5	5	5
Surge Current 4 Milliseconds Max	Amps.	30	30	30	30	30	30	30	30
Forward Voltage Drop @ 1 Ampere and 25°C	Volts	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Average Reverse Current**	uAdc	250	250	250	250	250	250	250	250
Operating and Storage Temperature	°C.	—65 to +125 All Types							

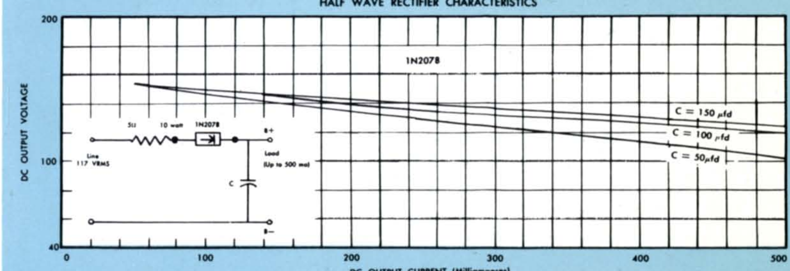
**For capacitive loads Average DC Output current is derated by 20%.*

***Full cycle average for rectifier operating into an inductive or resistive loa d at rated current and voltage.*

...Silicon Rectifiers

The Tung-Sol 1N2078 features distinct advantages benefiting the TV service industry. Optimum physical and electrical characteristics combine to make 1N2078 convenient for the serviceman to handle and install, and give his TV and radio service customers the high grade performance they want and appreciate.

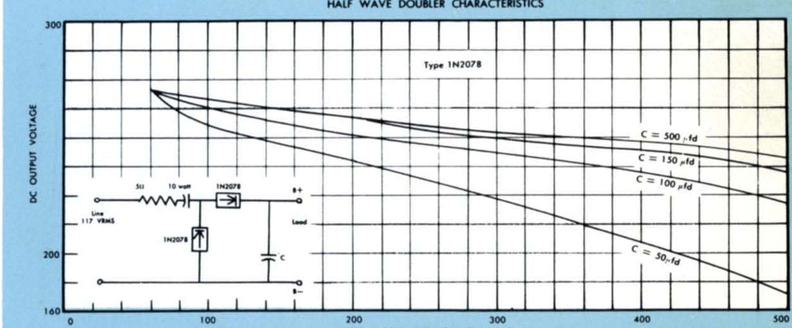
HALF WAVE RECTIFIER CHARACTERISTICS



1N2078

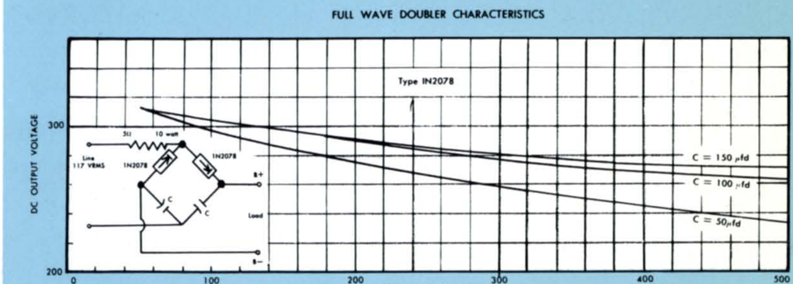
Specially designed and made for simple, speedy TV replacement!

HALF WAVE DOUBLER CHARACTERISTICS



- smaller than most semiconductor rectifying devices with no sacrifice in efficiency.
- flexible leads for quick soldering to existing connections. No hardware needed.
- stable low voltage drop and ability to withstand current surges promote long life.
- special insulated case rules out chassis shorts and dissipates own heat.

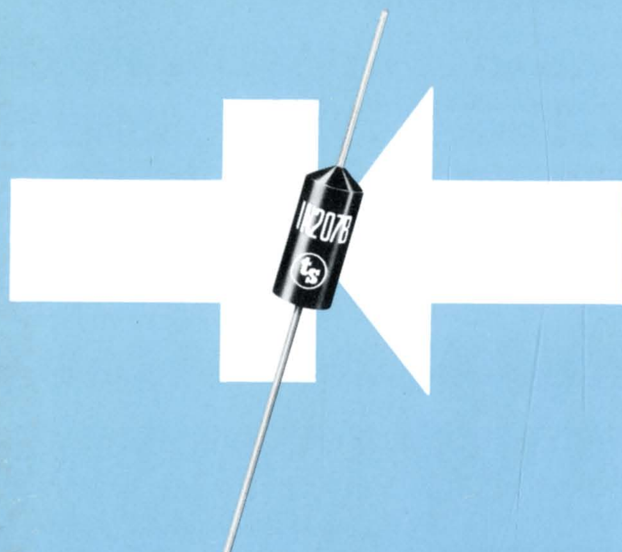
FULL WAVE DOUBLER CHARACTERISTICS



The Tung-Sol Engineering Staff constantly seeks ways to make new . . . to make better semiconductors. The silicon rectifier series 1N2072 through 1N2079 represents the latest results of this concentrated search for new semiconductor products.

Right now, Tung-Sol can supply a silicon rectifier or other semiconductor with exactly the electrical characteristics you require. Many types are available from stock. For special units, our experienced staff will co-operate to design and make the unit you need. In either case, Tung-Sol's sustained program of semiconductor development gives firm assurance all Tung-Sol units incorporate the latest product advances for utmost efficiency once installed.

Check your semiconductor requirements! Silicon rectifiers . . . whatever you need . . . look to Tung-Sol for peak performance.



Higher Power Tung-Sol Silicon Rectifiers for Heavy Duty Industrial Use!

Top hat, axial lead units with ratings up to 750ma and up to 600 Peak Inverse Voltage.

Top hat, stud mounted units with ratings up to one ampere and up to 600 Peak Inverse Voltage.

High current, stud mounted units with ratings up to 35 amperes and up to 600 Peak Inverse Voltage.

For additional data on Tung-Sol silicon rectifiers or any other Tung-Sol semiconductor contact: Tung-Sol Electric Inc., 95 Eighth Avenue, Newark 4, New Jersey.

SALES OFFICES: ATLANTA, GA.; COLUMBUS, OHIO; CULVER CITY, CALIF.; DALLAS, TEXAS; DENVER, COLO.; DETROIT, MICH.; MELROSE PARK, ILL.; IRVINGTON, LIVINGSTON AND NEWARK, NEW JERSEY; SEATTLE, WASHINGTON. IN CANADA: TORONTO, ONT.

ts TUNG-SOL®

TUNG-SOL PRODUCT BULLETIN

TYPES 1N2072 THRU 1N2079

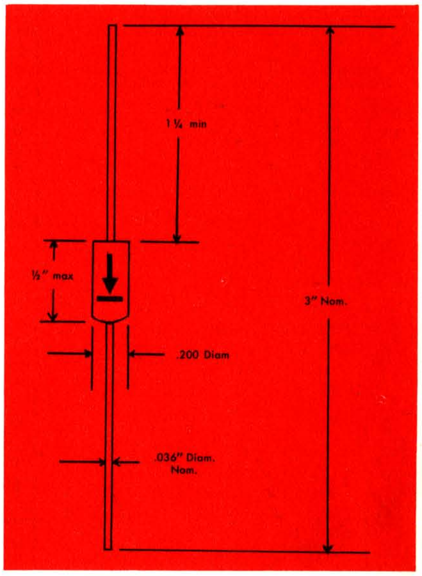
OCTOBER, 1958

POWER RECTIFIERS

This series of diffused junction rectifiers offers controlled quality not possible in rectifiers made by other methods. Among their characteristics are low forward voltage drop, stable leakage, high surge current handling ability and freedom from the stresses produced at the junction by thermal cycling. As the junction power loss in these units is small, the junction temperature is low, and, consequently, higher reliability is obtained.

The method of encapsulation has been chosen to provide the industry with a rectifier which can be installed by the same techniques employed with resistors and capacitors. In avoiding the use of the conventional metal case greater flexibility in mounting is obtained. The type of Epoxy used in the encapsulation has been chosen both for its excellent electrical characteristics and for its resistance to moisture and thermal shock.

These rectifiers are specifically designed to meet requirements for use in power supplies, blockers, DC to DC converters, transistorized power supplies and other general purpose uses.



MECHANICAL DATA

CASE: Plastic encapsulation with pigtail leads.

MOUNTING POSITION: Any.

POLARITY MARKING: The arrow on the rectifier points to the positive terminal.

ABSOLUTE MAXIMUM RATINGS (100°C AMBIENT) RESISTIVE OR INDUCTIVE LOAD

		JEDEC Type Number							
		1N2072	1N2073	1N2074	1N2075	1N2076	1N2077	1N2078	1N2079
Peak Inverse Voltage	Volts	50	100	150	200	250	300	400	500
Continuous DC Working Voltage	Volts	50	100	150	200	250	300	400	500
RMS Applied Voltage (resistive load)	Volts	35	70	105	140	175	210	280	350
Average DC Output Current*	mAdc	625	625	625	625	625	625	625	625
Peak Recurrent Forward Current	Amps.	5	5	5	5	5	5	5	5
Surge Current 4 Milliseconds Max.	Amps.	30	30	30	30	30	30	30	30
Forward Voltage Drop @ 1 Ampere and 25°C.	Volts	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Average Reverse Current**	μAdc	250	250	250	250	250	250	250	250
Operating and Storage Temperature	°C.	—65 to +125							

* For capacitive loads Average DC Output current is derated by 20%.

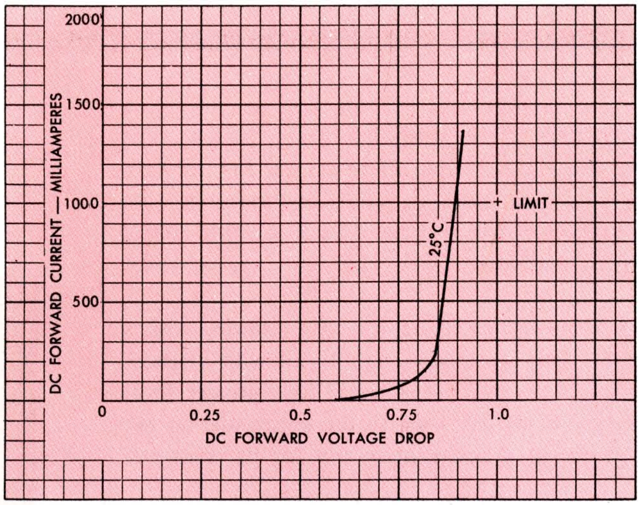
** Full cycle average for rectifier operating into an inductive or resistive load at rated current and voltage.

(Over)

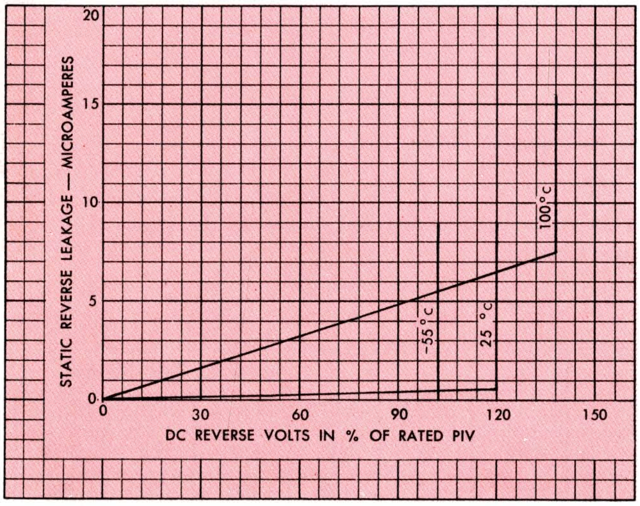
TUNG-SOL ELECTRIC INC.
CHATHAM ELECTRONICS DIVISION
95 EIGHTH AVENUE
NEWARK 4, NEW JERSEY

TUNG-SOL ELECTRIC INC.

TYPICAL FORWARD CHARACTERISTIC

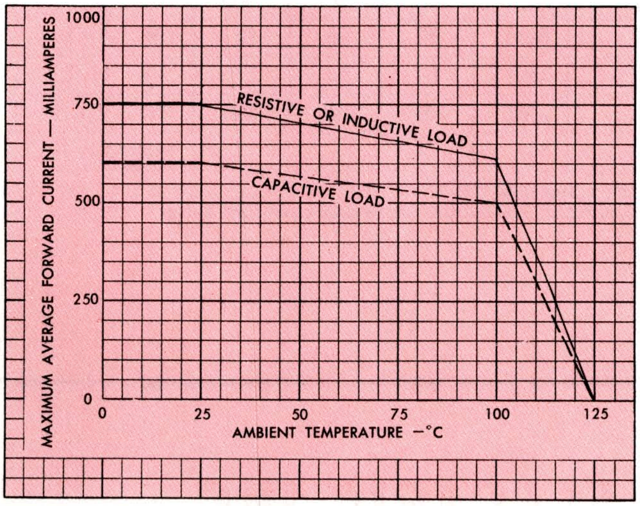


TYPICAL REVERSE CHARACTERISTIC



DERATING CURVE

(FREE AIR TEMPERATURES)



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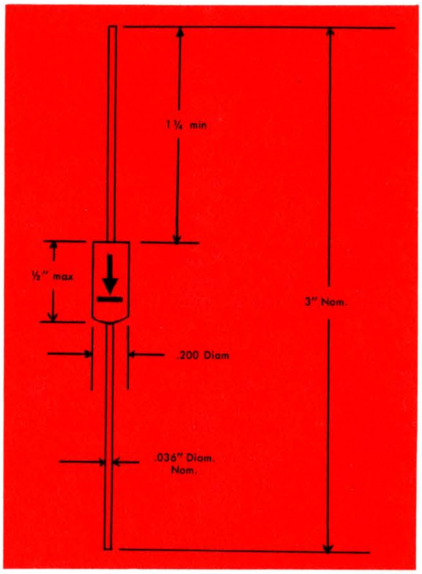
TUNG-SOL PRODUCT BULLETIN

SILICON POWER RECTIFIER TYPE 1N2078

OCTOBER, 1958

POWER RECTIFIER

TYPE 1N2078 is a diffused junction power rectifier specifically designed to meet the stringent surge requirements of radio or television service. In avoiding the use of the conventional metal case, greater flexibility in mounting this unit is obtained. No heat sink or special mounting arrangement need be used with this unit. The low forward voltage drop, which does not change during life, means higher output voltage; and, consequently, better set performance.



MECHANICAL DATA

CASE: Plastic encapsulation with pigtail leads.

MOUNTING POSITION: Any.

POLARITY MARKING: The arrow on the rectifier points to the positive terminal.

ABSOLUTE MAXIMUM RATINGS (100°C) CAPACITIVE LOAD:

Peak Inverse Voltage	400 Volts
Continuous D.C. Reverse Working Voltage	400 Volts
Average D.C. Output Current	500 mAdc
Peak Recurrent Forward Current	5 Amps.
½ Cycle Surge Current	30 Amps.
Full Load Voltage Drop @ 25°C	1.1 Volts
RMS Input Voltage	130 Volts
Minimum Series Resistance (for capacitive filter)	5 ohms, 10 watt

APPLICATION NOTES

The 1N2078 silicon rectifier is recommended as a replacement for selenium rectifiers. It is easily installed in any radio or television set, and will result in higher B+ voltage.

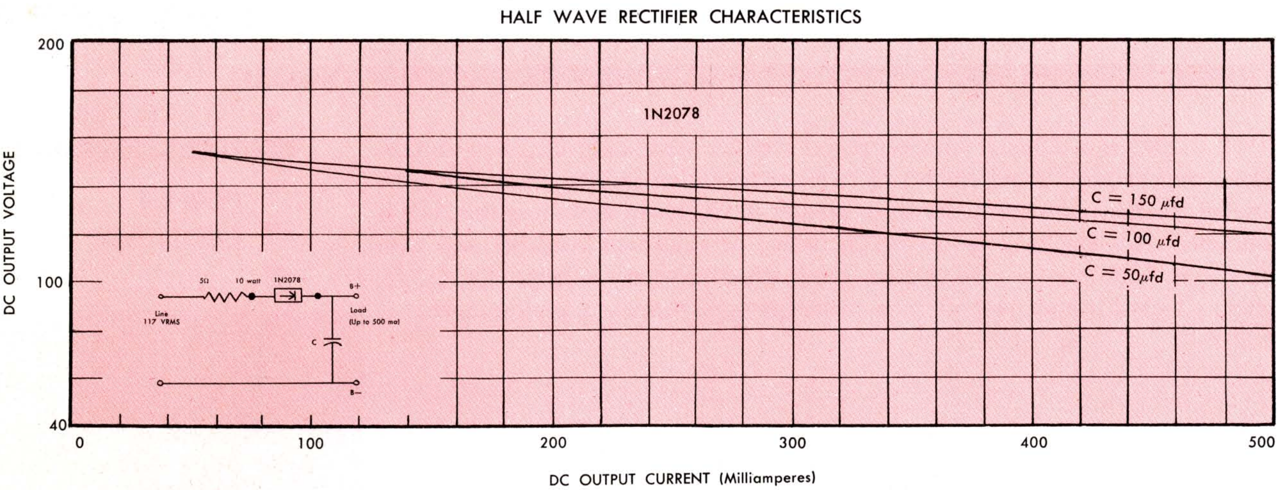
When the 1N2078 is used as a replacement for selenium rectifiers, it is only necessary to solder the leads between the same points from which the selenium rectifier was disconnected. BE CAREFUL TO OBSERVE POLARITY.

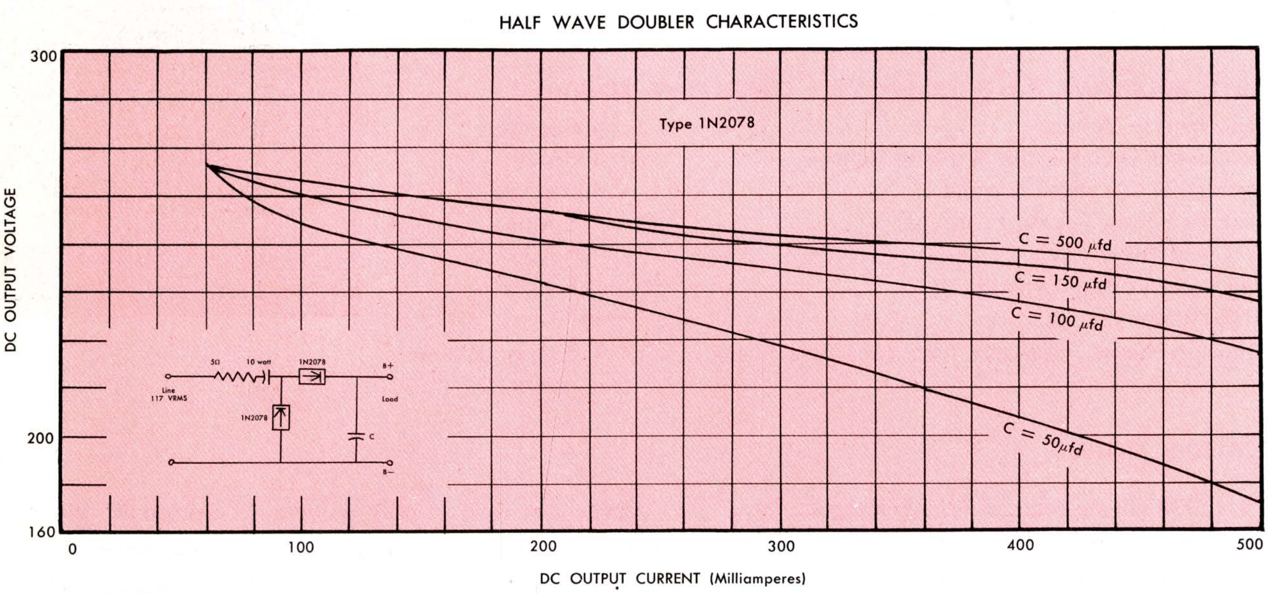
Since the case of this rectifier is electrically insulated from either terminal, it is not necessary to prevent contact between itself and the chassis or other component. However, it should not touch or be mounted near a large source of heat such as a thermionic tube or power transformer. Soldered connections should be made quickly with a minimum amount of excess soldering heat.

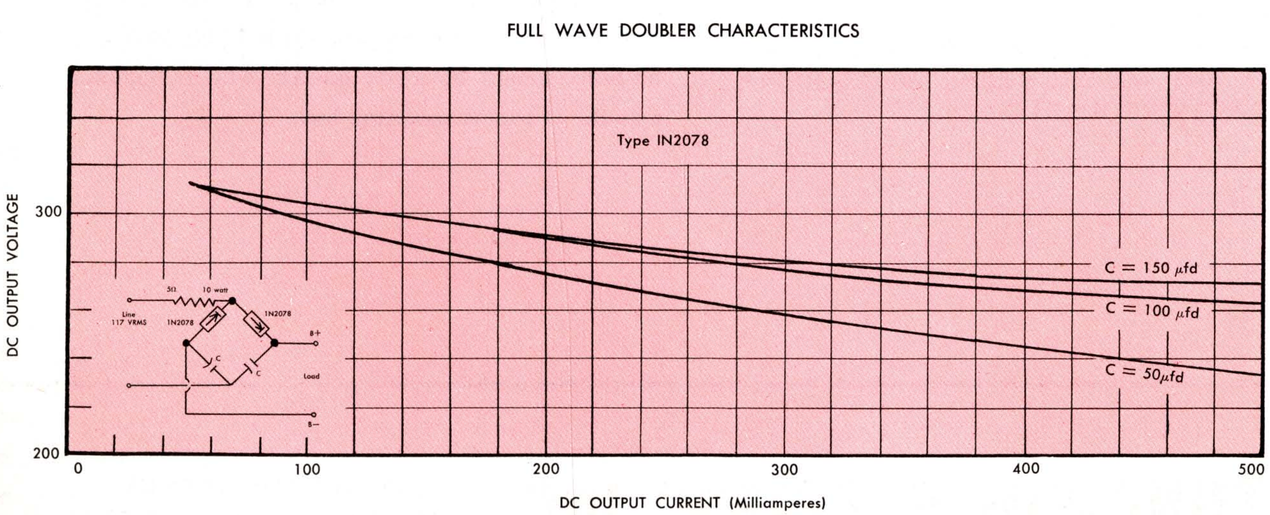
(Over)

TUNG-SOL ELECTRIC INC.
CHATHAM ELECTRONICS DIVISION
95 EIGHTH AVENUE
NEWARK 4, NEW JERSEY

TUNG-SOL ELECTRIC INC.







Printed in U.S.A.

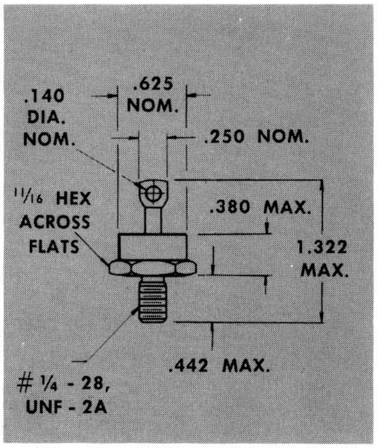
TUNG-SOL TENTATIVE DATA

POWER RECTIFIERS

FEBRUARY 1959

These hermetically sealed silicon alloy junction rectifiers have been designed to meet all applicable military specifications. Features of this series of rectifiers are low forward voltage drop, low reverse leakage, and low thermal impedance. To simplify the assembly of bridge and poly-phase connections, these rectifiers can be supplied with reverse polarity.

SILICON POWER RECTIFIERS
20 Amperes @ 150°C



MECHANICAL DATA

Case: Metal and glass—hermetic seal
Mounting position: Any
Mounting method: 1/4—28UNF Stud
Altitude: 86,000 feet
Weight: Less than 1 oz. (with mounting hardware)

ABSOLUTE MAXIMUM RATINGS (150°C CASE TEMPERATURE) RESISTIVE OR INDUCTIVE LOAD.

Type Number		CH103Z	CH103A	CH103B	CH103C	CH103D	CH103E	CH103F
Peak Inverse Voltage	Volts	50	100	200	300	400	500	600
Average Forward Current	Amps.	20	20	20	20	20	20	20
Peak Recurrent Forward Current	Amps.	90	90	90	90	90	90	90
Forward Voltage Drop @ 50 Amps. D.C. (@ 25°C)	Volts	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Average Reverse Current	MaD.C.*	5	5	5	5	5	5	5

*Full cycle average for rectifier operating into an inductive or resistive load at rated current and voltage.

ADDITIONAL INFORMATION

Maximum half sine wave peak current for one second	100 Amps
Storage temperature range	−65°C to +200°C
Typical forward dynamic resistance	.006Ω
Typical forward voltage temperature coefficient . .	−1 MV/°C

Mounting hardware and insulating washers supplied with each unit.

The material shown here is for your information. Tung-Sol Electric Inc. assumes no liability with respect to its use in the infringement of any patents and reserves the right to change this material at any time without further notice.

TUNG-SOL ELECTRIC INC.
CHATHAM ELECTRONICS DIVISION
95 EIGHTH AVENUE
NEWARK 4, NEW JERSEY

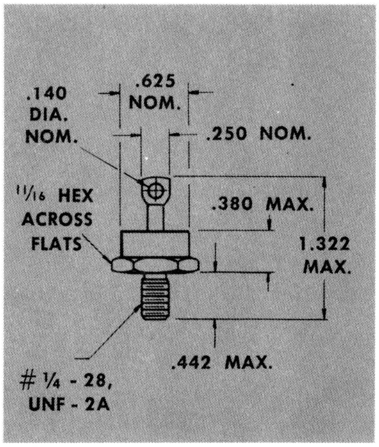
TUNG-SOL TENTATIVE DATA

POWER RECTIFIERS

FEBRUARY 1959

These hermetically sealed silicon alloy junction rectifiers have been designed to meet all applicable military specifications. Features of this series of rectifiers are low forward voltage drop, low reverse leakage, and low thermal impedance. To simplify the assembly of bridge and poly-phase connections, these rectifiers can be supplied with reverse polarity.

SILICON POWER RECTIFIERS
35 Amperes @ 150°C



MECHANICAL DATA

Case: Metal and glass—hermetic seal
Mounting position: Any
Mounting method: ¼—28UNF Stud
Altitude: 86,000 feet
Weight: Less than 1 oz. (with mounting hardware)

ABSOLUTE MAXIMUM RATINGS (150°C CASE TEMPERATURE) RESISTIVE OR INDUCTIVE LOAD.

Type Number		CH104Z	CH104A	CH104B	CH104C	CH104D	CH104E	CH104F
Peak Inverse Voltage	Volts	50	100	200	300	400	500	600
Average Forward Current	Amps.	35	35	35	35	35	35	35
Peak Recurrent Forward Current	Amps.	200	200	200	200	200	200	200
Forward Voltage Drop @ 50 Amps. D.C. (@ 25°C)	Volts	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Average Reverse Current	MaD.C.*	10	10	10	10	10	10	10

* Full cycle average for rectifier operating into an inductive or resistive load at rated current and voltage.

ADDITIONAL INFORMATION

Maximum half sine wave peak current for one second	300 Amps
Storage temperature range	−65°C to +200°C
Typical forward dynamic resistance	.004Ω
Typical forward voltage temperature coefficient	−1 MV/°C

Mounting hardware and insulating washers supplied with each unit.

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CHATHAM ELECTRONICS DIVISION
95 EIGHTH AVENUE
NEWARK 4, NEW JERSEY

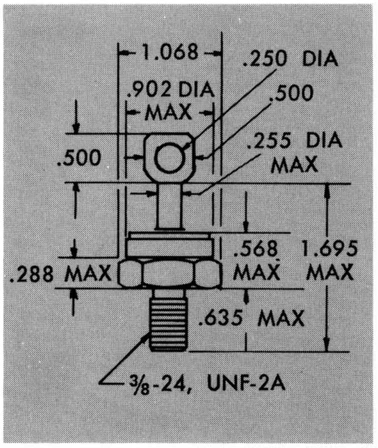
TUNG-SOL TENTATIVE DATA

POWER RECTIFIERS

MARCH 1959

SILICON POWER RECTIFIERS
70 Amperes @ 150°C

This series of rectifiers has been designed specifically to meet the requirements of power supplies where small size and weight are of paramount importance. The rectifiers are conservatively rated to enable peak performance at high altitudes and with the absence of fan cooling. These rectifiers are sealed by the most modern techniques to ensure against junction degradation during operating or storage life. In addition, their rugged construction will enable them to meet the most stringent environmental specifications.



MECHANICAL DATA

Case: Metal and glass—hermetic seal
Mounting position: any
Mounting method: ⅜—24UNF Stud
Altitude: 86,000 feet
Weight: Less than 3 oz. (with mounting hardware)

ABSOLUTE MAXIMUM RATINGS (150°C CASE TEMPERATURE)

Type Number		CH109Z	CH109A	CH109B	CH109C	CH109D	CH109E
Peak Inverse Voltage..................	Volts	50	100	200	300	400	500
Average Forward Current..............	Amps.	70	70	70	70	70	70
Forward Voltage Drop @ 150 Amps. D.C. (@ 25°C)......................	Volts	1.3	1.3	1.3	1.3	1.3	1.3
Average Reverse Current..............	MaD.C.*	30	30	30	30	30	30

*Full cycle average for rectifier operating into inductive or resistive load at rated current and voltage.

ADDITIONAL INFORMATION

Maximum half sine wave peak current for one second 750 Amps
Storage temperature range . . . . −65°C to 200°C

Mounting hardware and insulating washers supplied with each unit.

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TUNG-SOL ELECTRIC INC.
CHATHAM ELECTRONICS DIVISION
95 EIGHTH AVENUE
NEWARK 4, NEW JERSEY

TUNG-SOL / CHATHAM

SILICON RECTIFIER DESIGN QUESTIONNAIRE

1. Company: ____________________

   Address: ____________________

   Name: ____________________ Position: ____________________

2. Intended Application: ____________________

   Circuit: Half-wave ________ Bridge ________ Center-tap ________ Doubler ________ Other ________

   Type of Load: Resistive ________ Inductive ________ Capacitive ________ Motor ________

   Battery: Type ________ Amp-Hr ________ No. of Cells ________

   Cell Arrangement ____________________

   Charging Volts/Cell ________ Charging Amp/Cell ________

   Charging Method ____________________

3. Input Data: ________ volts ± ________ %, ________ cycles/sec, ________ phase

4. Maximum a — Peak Inverse Voltage ________ (Include regenerative voltage)

   b — D-C Blocking Voltage ____________________

   Peak Inverse Voltage Transient: ________ volts, duration ________

   frequency of repetition ________ times per second ________ minute ________

5. D-C Output: ________ volts at ________ amperes at ________ °C for case ________ ambient ________

6. Duty Cycle: Continuous ________ Intermittent ________ Describe ________

7. Fault or Surge Current: ________ amperes, nonrepetitive ________ repetitive ________

   duration ________, other ________

8. Operating Temperature Range: ________ °C ________ °F to ________ °C ________ °F

   Storage Temperature Range: ________ °C ________ °F to ________ °C ________ °F

9. Cooling: Convection ________ Forced Air ________ Linear Feet/Minute ________

   Heat Sink ________ Material and Size ________

10. Applicable Military Specifications: ____________________

11. Customer's Drawing No. ________ Attached ________ To Follow ________

    Customer's Test Spec No. ________ Attached ________ To Follow ________

12. Quantity: ________ Delivery: ________

13. Comments: ____________________

PLEASE SKETCH SCHEMATIC DIAGRAM AND DESIRED MOUNTING DATA ON BACK OF PAGE

SCHEMATIC DIAGRAM

DESIRED MOUNTING DATA

When completed mail to —
COMMERCIAL ENGINEERING DEPARTMENT
TUNG-SOL ELECTRIC, INC., CHATHAM ELECTRONICS DIVISION
630 W. Mt. Pleasant Avenue, Livingston, N. J.
WYman 2-1100