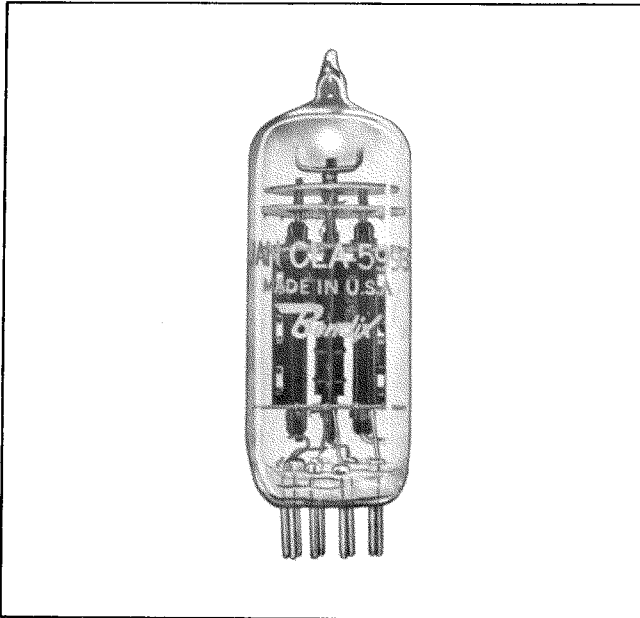


# FULL-WAVE RECTIFIER



## DESCRIPTION

This miniature, full-wave, high-vacuum rectifier is one of the Bendix Red Bank line of reliable vacuum tubes specifically designed for aircraft, military and industrial applications where freedom from early failures, long service life, and uniform operating characteristics are extremely important. Each tube is given a 45-hour run-in under various overload, vibration, and shock conditions likely to be encountered in service. This run-in serves to reduce early failures by eliminating tubes with any minor defects that might lead to failure under actual operating conditions.

Heavy gauge heater construction together with a pure alumina insulator reduces the likelihood of heater failure. A large area cathode operating at moderate temperatures gives longer service life and freedom from arc-overs. A four-pillar mount structure provides a strong assembly that will stand up under extreme conditions of vibration and shock. The tube requires a 9-pin miniature socket and can be mounted in any position. Adequate ventilation should be provided.

The tube is designed to replace the 6X4 and similar types in applications where severe environmental conditions are encountered, especially in airborne equipment. The cathode type structure instead of a filament structure insures against filament breakage under shock and vibration. When conservatively used, this tube has a life expectancy of 10,000 hours.

## ELECTRICAL RATINGS\*

Heater voltage**	6.3 volts
Heater current	0.80 amps.
Peak inverse voltage	1500 volts (max.)
Peak plate current—(per plate)	230 mA. (max.)
Peak surge current—(per plate)	1.6 amps. (max.)
DC heater-cathode potential	500 volts (max.)
Cathode heating time	45 sec.
Total effective plate supply impedance—per plate	See Rating Chart 3

For maximum current and voltage ratings, refer to Rating Chart 1.

\*To obtain greatest life expectancy from tube, avoid designs where the tube is subjected to all maximum ratings simultaneously.

\*\*Voltage should not fluctuate more than  $\pm 5\%$ .

## TYPICAL OPERATION

*Input to Filter*

	Capacitor	Choke
Heater voltage (volts)	6.3	6.3
Heater current (amperes)	0.8	0.8
RMS plate supply voltage (volts per plate)	325	450
Input capacitor ( $\mu$ f)	8	—
Input choke (henries)	—	10
DC output current (mA)	70	70
DC output voltage (volts)		
At half-load current (35 mA)	375	395
At full-load current (70 mA)	325	385

## PHYSICAL CHARACTERISTICS

Base	9-pin miniature
Bulb	T-6 $\frac{1}{2}$
Max. overall length	2 $\frac{5}{8}$ in.
Max. seated height	2 $\frac{3}{8}$ in.
Max. diameter	$\frac{7}{8}$ in.
Mounting position	Any
Max. altitude (See chart on page 3)	80,000 ft.
Max. bulb temperature	180°C.
Life expectancy***	10,000 hours

\*\*\*See application notes.

**THE *Bendix* CORPORATION**

*Red Bank* DIVISION, EATONTOWN, NEW JERSEY

## ELECTRICAL CHARACTERISTICS AND TEST DATA

### SPECIAL TESTS\*

In addition to the production and design tests shown under "Electrical Characteristics and Test Data", other tests are performed on a sampling basis to assure a high out-going quality level. See below:

TEST	CONDITION	DURATION
Heater Cycling Life Test	On 2½ min. Off 2½ min. Ef = 7.0 Vac	3,000 On-Off cycles
Glass Strain Test	Boiling water to ice water	3 minutes in each
High Level Fatigue Test	50 G Shock Excitation: 18/sec. rep. rate	100 hours
Altitude Test	60,000 Feet	5 minutes
High Temp. Life Test	Under "Test Conditions" Bulb Temp. 160°C	1,000 Hours
Life Expectancy Test	Under Test Conditions	5,000 hours
Mount Inspection	100% Test-Microscopic Inspection of 15 possible Trouble Points	

### TEST CONDITIONS AND CHARACTERISTIC LIMITS

All Tubes are Stabilized for 45 hours under Test Conditions A & B  
and 2 G Vibration at 30 cps prior to 100 % Testing.

CHARACTERISTIC	TEST CONDITIONS	SYMBOL	MIN.	DESIGN CENTER	MAX.	UNITS
<b>PRODUCTION TESTS</b>						
Heater Current	A	If	.740	.800	.860	Aac
Heater-Cathode Leakage	A	Ihk	—	—	± 50	uAdc
Operation	B	Io	70	75	—	mAdc
Emission	C	Is	110	—	—	mAdc
<b>DESIGN TESTS</b>						
Vibration 2.5 G, 25 cps						
Insulation of Electrodes	D	R	100	—	—	megohms
Heater-Cathode Leakage	E	Ihk	—	—	± 100	uAdc

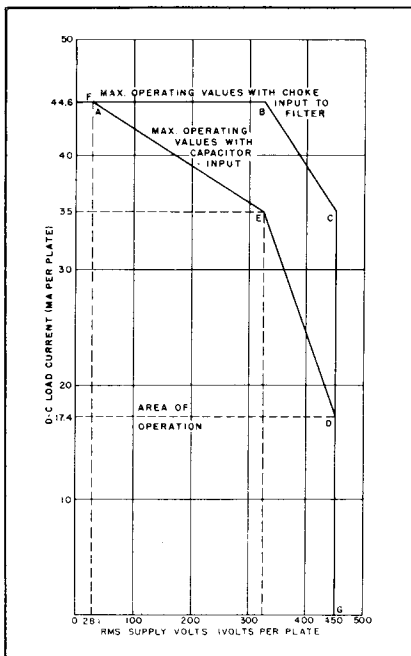
TEST CONDITIONS	Ef	Epp/p	Es	Ep	RL	CL	Zpp/p	Ehk
Units	V	Vac	Vdc	Vdc	ohms	uf	ohms	Vdc
A	6.3							± 400
B	6.3	400			5700	8	265	
C	6.3		40					
D	6.3			1500				
E	6.3							1500

\*For additional specifications consult MIL-E-1/202 specification for the 5993.

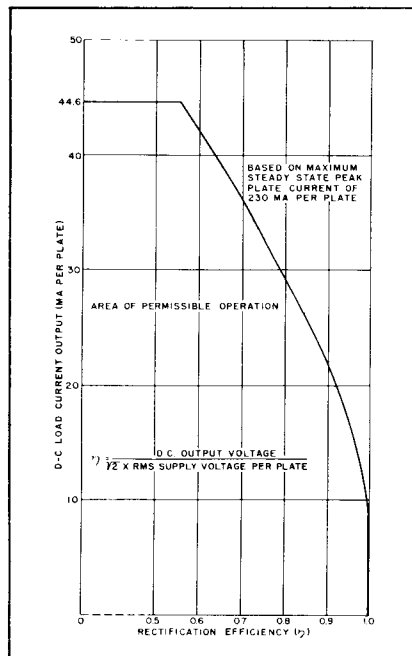
### EFFECT ON LIFE OF INCREASED RATINGS

See also Application Notes

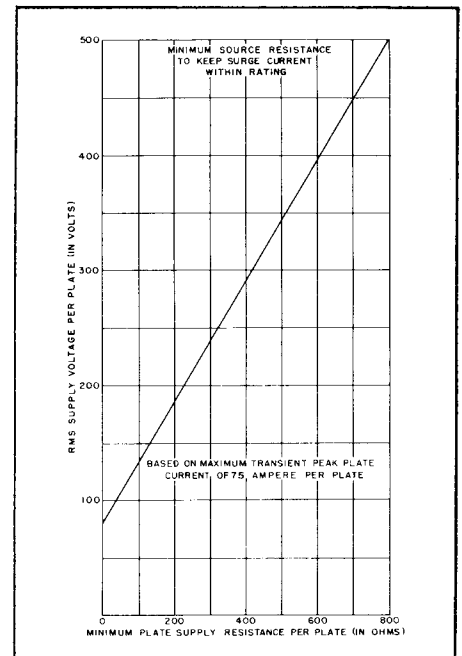
RATING OR CHARACTERISTIC	OPERATING CONDITIONS		
	CONSERVATIVE	TYPICAL	MAXIMUM
Heater Voltage	6.3 V ± 2%	6.3 V ± 5%	6.3 V ± 10%
H-K Voltage	425 V	450 V	500 V
Peak Plate Current (per plate)	175 mA	200 mA	250 mA
Peak Plate Inverse Voltage	900 V	1100 V	1250 V
Output Current (per Tube)	55 mA	65 mA	75 mA
Bulb Temperature	100°C	140°C	180°C
Altitude	0-20,000 ft.	60,000 ft.	80,000 ft.
Vibration	1 G	2.5 G	5 G
LIFE EXPECTANCY	MAXIMUM	HIGH	MEDIUM



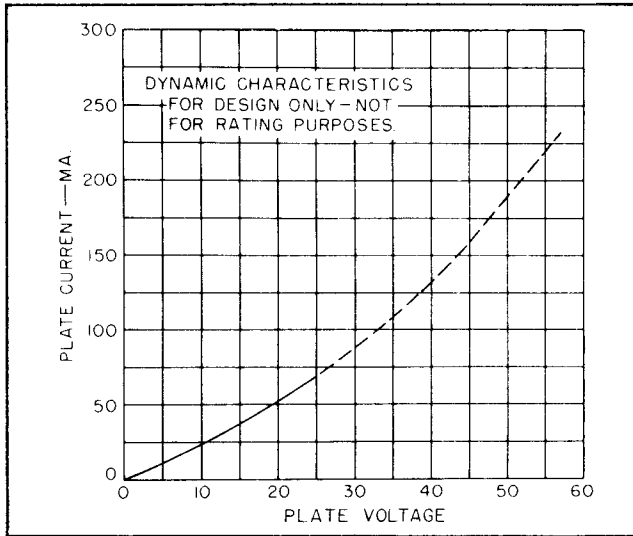
**RATING CHART 1**



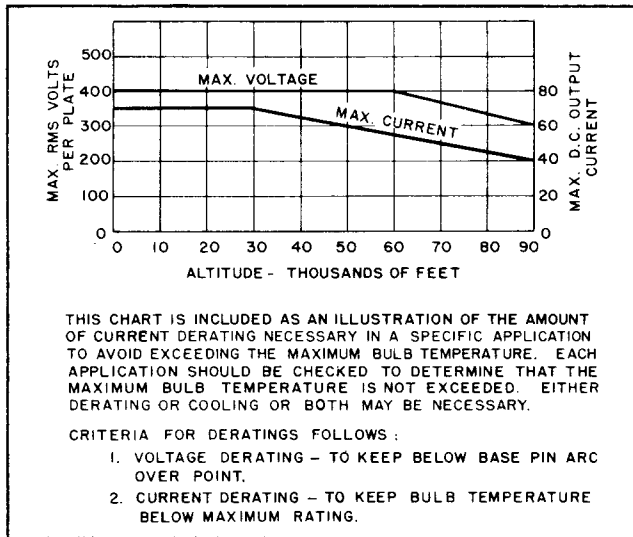
**RATING CHART 2**



**RATING CHART 3**



**AVERAGE PLATE CHARACTERISTICS**



**ALTITUDE RATINGS**

## APPLICATION NOTES

For reliable operation special consideration should be given to the maximum ratings of the 5993. These ratings are limiting absolute values and if exceeded may seriously impair the reliability of the tube. Therefore, the equipment designer should determine an average design value for each rating so that variations in supply voltages, load, and components do not cause the absolute values to be exceeded. The bulb temperature rating is an extremely important characteristic which should not be exceeded if expected life is to be achieved.

Reliability and performance will be jeopardized if filament voltage ratings are exceeded. Life and reliability of performance are directly related to the degree that regulation of the heater voltage is maintained at its center rated value.

From Rating Chart I, operating conditions should be selected to insure usage within the area of permissible operation with choke or capacitor inputs.

To insure that the maximum peak plate current is not exceeded a choice of operating values of d-c output current per plate and rectification efficiency should be made such that they fall within the area of permissible operation of Rating Chart II.

Rating Chart III graphically represents the relationship between the maximum a-c plate supply voltage per plate and the minimum plate supply resistance per plate to prevent maximum transient currents from exceeding the peak surge current rating of the tube. The plate supply resistance  $R_s = R(\text{sec}) + N^2R(\text{pri}) + R_a$ , where

$R(\text{sec})$  = d-c resistance of each section of transformer secondary,

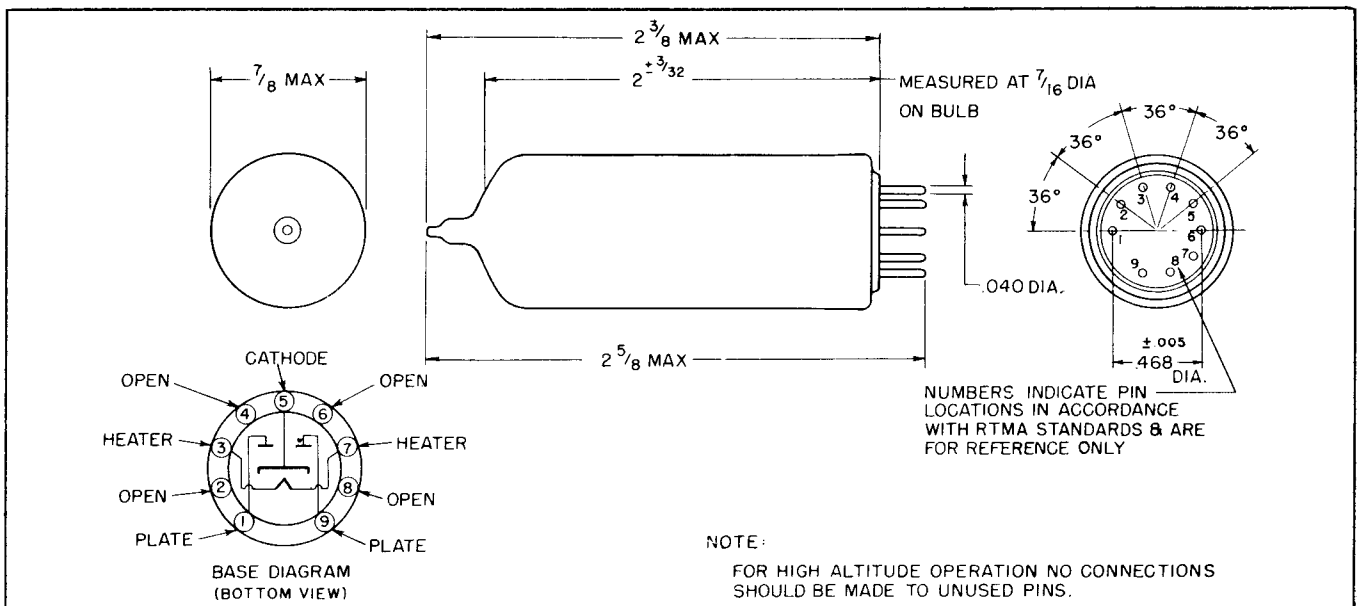
$N$  = Transformer voltage step-up ratio per section,

$R(\text{pri})$  = d-c resistance of transformer primary,

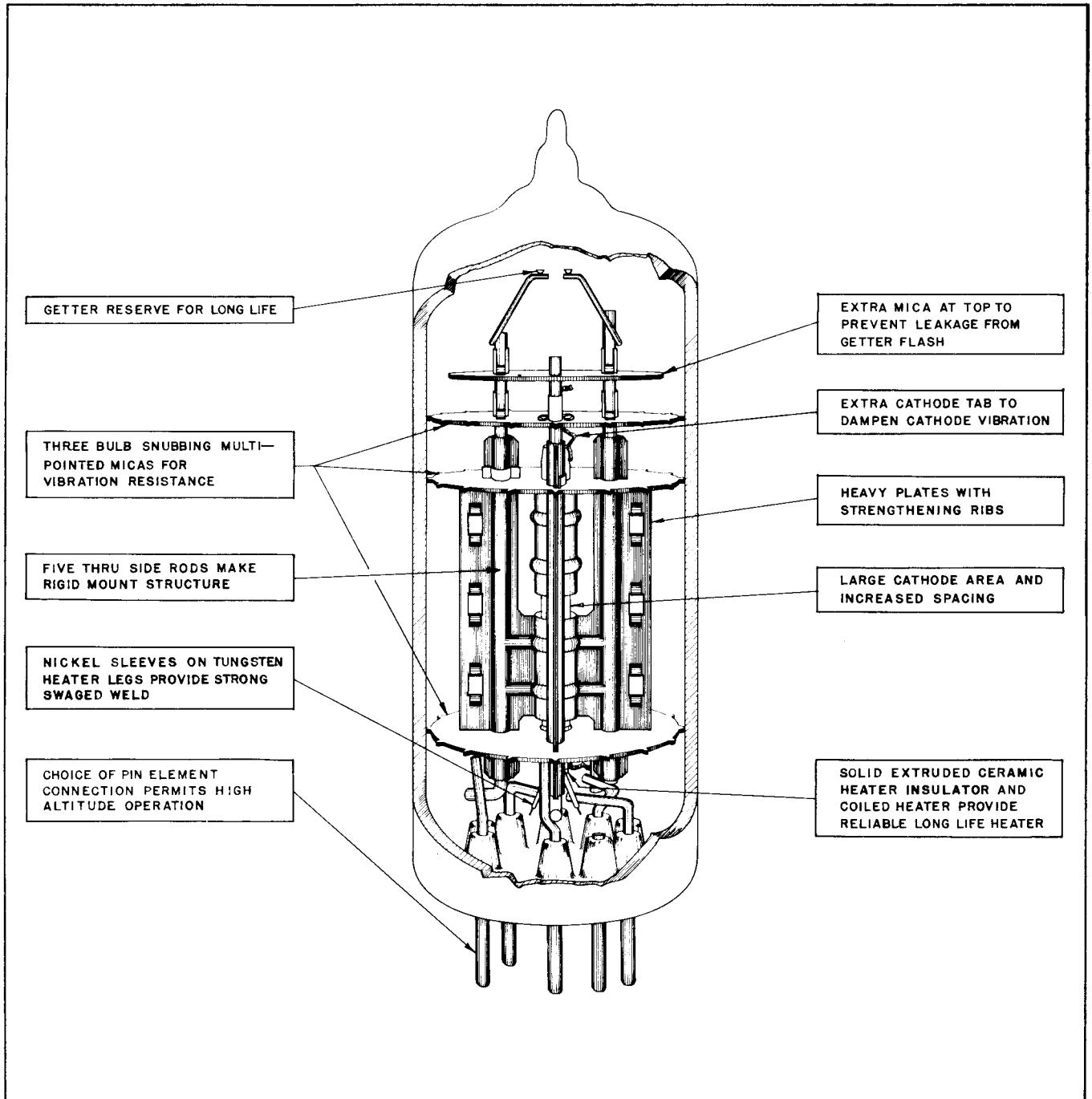
$R_a$  = d-c resistance of added series resistance per plate.

The addition of inductance would allow a reduction of the minimum value specified for  $R_s$  provided the reactance added is not too small as to cause the maximum peak surge plate current and maximum steady-state peak plate current ratings to be exceeded.

The increased rating chart is presented to emphasize the dangers of operating simultaneously at or near all maxima. In general, the effect on life of operation at increased ratings is additive and cumulative. Interpolation within this chart will give the designer a general idea of the life expectancy and reliability of his application. Each proposed application should be life tested under maximum environmental conditions in order to check that the design gives the desired reliability. When conservatively used this tube has a life expectancy of 10,000 hours.



**OUTLINE DRAWING**



## STRUCTURAL FEATURES OF 5993 PROVIDE HIGH RELIABILITY AND LONG LIFE

**THE *Bendix* CORPORATION**

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