File Catalog: Special Purpose Electron Tubes
Section: Amplifier Tubes

RETMA 6094

Bendix Red Bank Type TE-18
(Generic Type 6AQ5 6005)

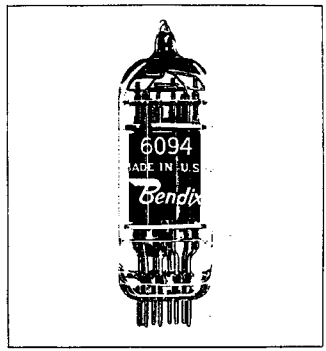
RELIABLE HARD GLASS MINIATURE BEAM POWER AMPLIFIER

DESCRIPTION

This miniature beam power amplifier 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 average 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 operating conditions.

In addition, this tube is designed for use in equipment with high ambient temperatures and where high levels of vibration, shock and other accelerations are encountered. Careful exhaust to a high degree of vacuum with thorough outgassing of all elements with electron bombardment is employed to ensure long life expectancy. A hard glass (nonex) bulb and stem with tungsten pins are used. These, together with a conservative design center of cathode temperature, permit operation of these tubes up to bulb temperatures of 300°C, in contrast to an average of 175°C for soft glass bulbs. In addition, because of the lower expansion of the tungsten-nonex seal (about one-third that of conventional lime or lead glass), greater resistance to thermal shock is obtained. The tungsten pins are gold plated to assure excellent contact resistance throughout life with freedom from corrosion.

This tube employs pressed ceramic spacers, instead of micas, for element separation. Conventional micas are used to snub the tube structure with respect to the bulb. These micas do not touch the hot elements of the tube which avoids deterioration of the mica and consequent loss of emission. Mica in contact with the hot cathode deteriorates even more rapidly under shock and vibration. Ceramic eliminates this problem and, furthermore, reduces damage caused by fatigue failure of parts.



The heavy-gauge heater construction, together with a pure alumina insulator, permits operation at high heater-cathode voltages. The large area cathode operating at moderate temperatures gives long service life. Small mass of the tube elements, multi-pillar mount locked together with eyelets, and increased electrode spacing provide rigidity, strength, and increased ability of the tube to withstand shock and vibration.

See the enlarged view on last page for the many improved features of this tube.

CHART 1. ELECTRICAL RATINGS*

Heater Voltage (AC or DC)**	6.3 volts
Heater Current	0.6 amps
Plate Voltage (Maximum DC)	275 volts
Screen Voltage (Maximum DC)	275 volts
Peak Plate Voltage (Max. Instantaneous)***	550 volts
Plate Dissipation (Absolute Max.)***	12.5 watts
Screen Dissipation (Absolute Max.)***	2.0 watts
Cathode Current (Max. Instantaneous Peak Value)	100.0 ma
Heater-Cathode Voltage (Max.)	±450 volts
Grid Resistance (Max.)	0.1 megohm
Grid Voltage (Max.)	+5.0 volts
(Min.)	−200.0 volts
Cathode Warm-up Time (plate and heater voltage may be applied simultaneously)	45 seconds

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

CHART 2. MECHANICAL DATA

Base	9 Pin Miniature Nonex Glass—Gold Plated Tungsten Pins
Bulb	Nonex Glass—T6½
Max. Overall Length	3"
Max. Seated Height	2¾"
Max. Diameter	⅞"
Mounting Position	any
Max. Altitude***	80,000 feet
Max. Bulb Temperature	300°C
Max. Impact Shock	500 g
Max. Vibrational Acceleration (100 hour shock excited fatigue test, sample basis)	50 g

**Voltage should not fluctuate more than ±5%.
***See altitude chart on page 3.

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ELECTRICAL CHARACTERISTICS AND TEST DATA

CHART 3. TEST CONDITIONS AND CHARACTERISTICS LIMITS

All Tubes are Stabilized for 45 Hours Under Test Conditions and 2 G. Vibration at 30 Cps. Prior to 100% Testing.

CHARACTERISTIC		SYMBOL	MIN.	DESIGN CENTER	MAX.	UNITS
PRODUCTION TESTS						
Heater Current		If	560	600	640	mA
Heater-Cathode Leakage		Ihk	—	—	± 25	uAdc
Grid Current		Ic1	—	—	−1.0	uAdc
Plate Current		Ib	32	45	60	mAdc
Screen Current		Ic2	0	3.0	6.0	mAdc
Transconductance		Sm	3200	4200	5500	umhos
Trans. Et = 5.7 v.		△ Sm	—	—	15%	
Power Output		Po	3.5	—	—	watts
Cut off Plate Current (Ec1 = −60 v. D.C.)		Ib			200	uAdc
Shock and Continuity						
A. F. Noise						
DESIGN TESTS						
Vibration: 25 cps., 2.5 g. Ec1 = −25 v. D.C. Rp = 2,000 ohms Eb = Ec2 = 250 v. D.C.		Ep	—	—	50	mVac
Grid Emission Test Et = 7.0 v. Time = 2 minutes		Ic1			−2.0	uAdc
Capacitance		Cgp	1.2	1.45	1.6	uufds
		Cin	7.0	8.5	10.0	uufds
		Cout	4.0	5.2	6.0	uufds
Plate Resistance		Rp	32,000	—	—	ohms
ELECTRODE:	Et	Eb	Ec2	Ec1		Ehk
TEST CONDITIONS:	6.3 volts	250 v. D.C.	250 v. D.C.	−12.5 v. D.C.		± 250 v. D.C.

CHART 4. ADDITIONAL TESTS

In addition to the production and design tests shown in Chart 3 other tests are performed on a sampling basis to assure a high outgoing quality level. See below.

TEST	CONDITIONS	DURATION
Heater Cycling Life Test	On 2½ Min. Off 2½ Min. Et = 7.0 Ehk = 300	3,000 On-Off Cycles
High Temp. Life Test	Under "Test Conditions" Bulb Temp. 300°C	1,000 Hours
Life "Expectancy" Test	Under "Test Conditions"	10,000 Hours
High Level Fatigue Test	50G—Shock Excitation 18/sec. rep. rate	100 Hours
Shock	500 g.	20 Impacts
Altitude Test	60,000 Feet	5 Minutes
Glass Strain Test	Boiling Water to Ice Water	3 Minutes in Each
Mount Inspection	100% Test—Microscopic Inspection of 30 Possible Trouble Points	

CHART 5

AVERAGE PLATE CHARACTERISTICS
PENTODE CONNECTION
E_f = 6.3 VOLTS SCREEN = 250 VOLTS

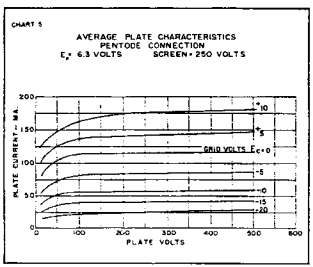

CHART 6

AVERAGE PLATE CHARACTERISTICS
TRIODE CONNECTION
E_f = 6.3 VOLTS

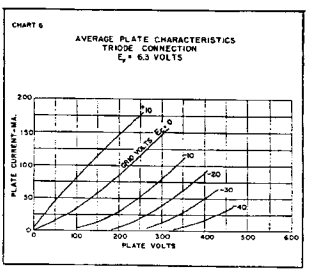

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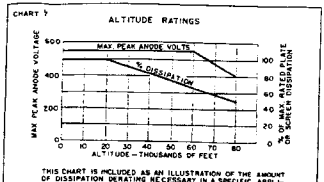
CHART 7



THIS CHART IS INCLUDED AS AN ILLUSTRATION OF THE AMOUNT OF DISSIPATION DERATING NECESSARY IN A SPECIFIC APPLICATION TO AVOID EXCEEDING THE MAXIMUM BULB TEMPERATURE. EACH APPLICATION SHOULD BE CHECKED TO DETERMINE THAT THE MAXIMUM BULB TEMPERATURE IS NOT EXCEEDED EITHER DERATING OR COOLING OR BOTH MAY BE NECESSARY

CRITERIA FOR DERATING FOLLOWS:

1. VOLTAGE DERATING—TO KEEP BELOW BASE PIN ARC OVER POINT
2. DISSIPATION DERATING—TO KEEP BULB TEMPERATURE BELOW MAXIMUM RATING

CHART 8. EFFECT ON LIFE OF INCREASED RATINGS

See also Application Notes	OPERATING CONDITIONS		
RATING OR CHARACTERISTIC	CONSERVATIVE	TYPICAL	MAXIMUM
Heater Voltage	6.3 ± 3%	6.3 ± 5%	6.3 ± 10%
Plate Voltage	200 v. D.C.	250 v. D.C.	275 v. D.C.
Screen Voltage	200 v. D.C.	250 v. D.C.	275 v. D.C.
Peak Plate Voltage	400 v.	500 v.	550 v.
Plate Current (Av.)	25 MA.	35 MA.	40 MA.
Screen Current (Av.)	3 MA.	4 MA.	6 MA.
Cathode Current (Peak)	50 MA.	65 MA.	100 MA.
H-K Voltage	200 v.	300 v.	450 v.
Grid Resistance	25,000 ohms	75,000 ohms	100,000 ohms
Bulb Temperature	200°C	250°C	300°C
Altitude	0-70,000'	60,000'	60,000'
Vibration	2 g.	5 g.	10 g.
LIFE EXPECTANCY	MAXIMUM	HIGH	MEDIUM

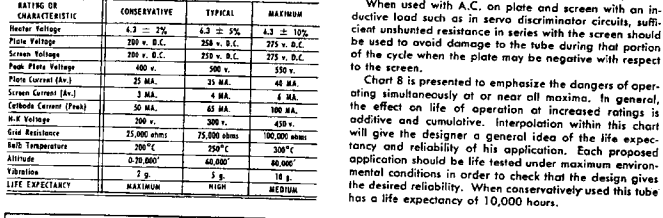
APPLICATION NOTES

Special attention should be given to the temperatures at which the tubes are to be operated. Reliability will be seriously impaired if maximum bulb temperature is exceeded. The life expectancy will be reduced if conditions other than those specified for life test are imposed on the tube and will be reduced appreciably if absolute maximum ratings are exceeded. Both 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.

This tube is constructed using nonex glass and thus can withstand higher ambient temperatures in operation. However, the bulb temperature should never exceed 300°C at its hottest point and cooling should be employed if necessitated by the additive effects of operation at high altitudes and high dissipation simultaneously or by other sources of heat in the equipment. The altitude rating chart shows the correct voltage derating necessary for various altitudes. However, the dissipation derating is only approximate and must be measured for each application because of the additive effects mentioned above.

When used with A.C. on plate and screen with an inductive load such as in servo discriminator circuits, sufficient unshunted resistance in series with the screen should be used to avoid damage to the tube during that portion of the cycle when the plate may be negative with respect to the screen.

Chart 8 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.



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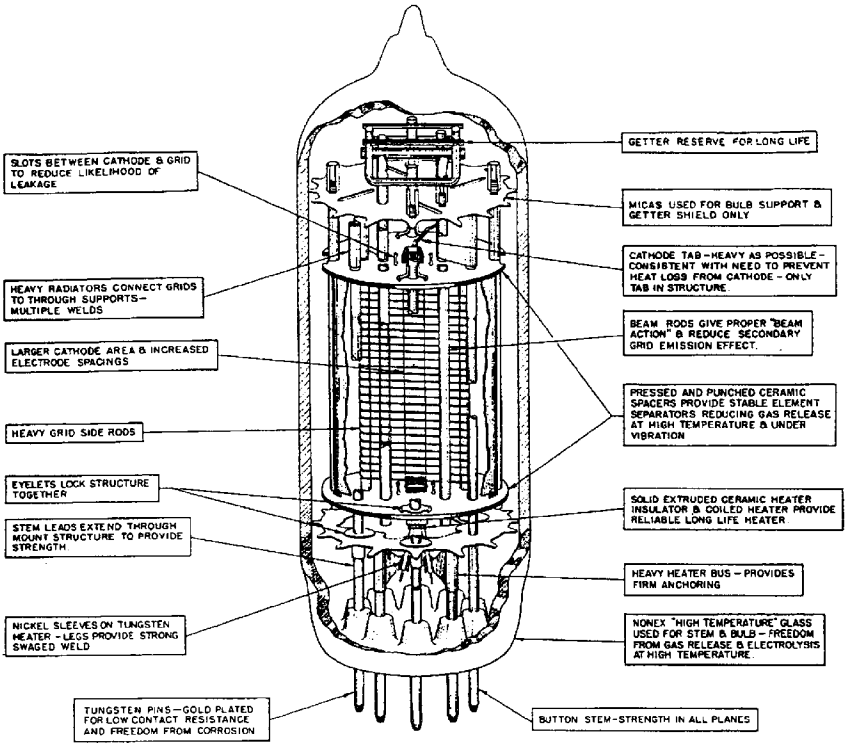

STRUCTURAL FEATURES OF 6094 PROVIDE HIGH RELIABILITY AND LONG LIFE.

Bendix Red Bank

Manufacturers of Special-Purpose Electron Tubes, Inverters, Dynamotors, Voltage Regulators and Fractional HP D.C. Motors

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