# 6384

Bendix Type TE-27
(Generic Type 6AR6-6098)

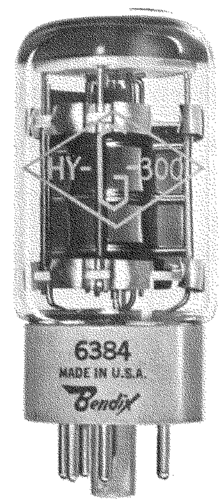
# RELIABLE HARD GLASS BEAM POWER AMPLIFIER

## DESCRIPTION

One of the Bendix line of HY-G-300 tubes, this high-perveance beam power amplifier has been designed as a direct retrofit for the 6AR6 or 6098 in 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 overload, vibration and shock conditions. This run-in serves to reduce early failures by eliminating tubes with any minor defects that might lead to failure under operating conditions.

Since this tube is designed for use in equipment with high ambient temperatures and where high levels of vibration and shock are encountered, special materials and techniques are employed. The hard glass bulb and tungsten stem seal construction are features similar to those found on many high-powered transmitting tubes. Careful exhaust to a high degree of vacuum, with thorough outgassing of all elements by means of electron bombardment, as well as the usual RF induction heating, insures maximum life expectancy. These factors, as well as a conservative design center of cathode temperature, permit operation of the 6384 at bulb temperatures up to 300°C as compared to the 225°C rating of the 6AR6. Moreover, because of the lower expansion (about ⅓ that of conventional receiving tube "soft glass"), greater resistance to thermal shock is attained.

This tube is constructed with ceramic spacers rather than the usual mica. Therefore, one of the most prevalent causes of tube failure is eliminated, namely, gas evolution under vibration (from deteriorated mica) and subsequent loss of cathode emission. In addition, ceramic spacers contribute to a much sturdier structure, which is further strengthened by multi-pillar supports locked together with 18 welded eyelets. Bulb snubbers are made with an alloy which retains its spring properties at the high temperatures under which this tube can operate. These snubbers contact the bulb at 32 separate points and thus effectively cushion the mount structure from shock accelerations as high as 500G.




Other special features include a rugged, pure tungsten, helical heater which is used with a high purity aluminum oxide insulator, enabling reliable operation at high heater-cathode voltages. Also featured is a ceramic shield which prevents getter flash from forming inter-electrode leakage paths. In addition, the ceramic spacers have slots between cathode and grid holes to prevent the development of any leakage during the service life of the tube.

The design of this tube is a result of extensive engineering evaluation on special impact vibration equipment in which the accelerations equal or exceed those encountered in severe aircraft applications. The shake table used for these studies shock excites the tubes at a repetition rate of 15 cycles per second with a minimum peak acceleration of 50G. These tests indicate that the Bendix 6384 will survive thousands of hours longer, under adverse conditions, than the prototype 6AR6 and 6098 tubes.

## CHART 1. ELECTRICAL RATINGS*

| | |
|---|---|
| Heater Voltage (AC or DC)** | 6.3 volts |
| Heater Current | 1.20 amps |
| Plate Voltage (Max DC) | 750 volts |
| Screen Voltage (Max DC) | 325 volts |
| Peak Plate Voltage (Max Instantaneous) | 1500 volts |
| Plate Dissipation (Absolute Max) | 30 watts |
| Screen Dissipation (Absolute Max) | 3.5 watts |
| Cathode Current (Max DC Value) | 125 mA |
| Cathode Current (Max Inst. peak value—of continuous sine wave) | 250 mA |
| Cathode Current (Max Inst. Peak Value) Pulse*** | 1000 mA |
| Heater-Cathode Voltage (Max) | ±450 volts |
| Grid Resistance (Max) | 0.1 megohm |
| Grid Voltage (Max DC) | +5.0 volts |
| (Min DC) | —200 volts |
| Cathode Warm-up Time | 45 seconds |

(plate and heater voltage may be applied simultaneously)

*To obtain greatest life expectancy from tube, avoid designs where the tube is subjected to all maximum ratings simultaneously. See application notes.
**Voltage should not fluctuate more than ±5%.
***See pulse rating chart.

## CHART 2. MECHANICAL DATA

| | |
|---|---|
| Base | Intermediate (short) Shell Octal (6-pin) (Glass filled Mica) |
| Bulb | Nonex Glass—T-11 |
| Max Overall Length | 3-15/32" |
| Max Seated Height | 2-15/16" |
| Max Diameter | 1-7/16" |
| Mounting Position | Any |
| Max Altitude**** | 80,000 feet |
| Max Bulb Temperature | 300°C |
| Max Impact Shock | 500G |
| Max Vibrational Acceleration | 50G |
| (100-hour shock excited fatigue test, sample basis) | |
| Life Expectancy | 10,000 hours |

****See altitude chart on page 3.

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Red Bank DIVISION, EATONTOWN, NEW JERSEY

Publication No. R610-27 (Supersedes No. R61-4)

Printed in U.S.A.

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## ELECTRICAL CHARACTERISTICS AND TEST DATA

**CHART 3.**

### TEST CONDITIONS AND CHARACTERISTIC 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: | | | | | |
| Short and Continuity | | | | | |
| Heater Current | If | 1.14 | 1.20 | 1.26 | A |
| Heater Cathode Leakage (Ehk = ± 450 Vdc) | Ihk | — | — | 10 | μAdc |
| Grid Current | Ic1 | — | — | —0.2 | μAdc |
| Plate Current | Ib | 66 | 77 | 88 | mAdc |
| Screen Grid Current | Ic2 | 0.5 | 3.5 | 6.5 | mAdc |
| Transconductance (1) | Sm | 4800 | 5400 | 6000 | μmhos |
| Cut off Plate Current (Ec1 = —60 Vdc) | Ib | | | 0.5 | mAdc |
| DESIGN TESTS | | | | | |
| Transconductance (2) (Ef = 5.7 V) | ΔSm | — | — | 5% | |
| Accelerated Grid Current (Ef = 7.0 V) | Ic1 | | | —0.3 | μAdc |
| Primary Screen Grid Emission (Eg2 = 150 Vac) | Ic2 | | | —750 | μAdc |

| ELECTRODE: | Ef | Eb | Ec2 | Ec1 | Ehk |
|---|---|---|---|---|---|
| TEST CONDITIONS: | 6.3 volts | 250 Vdc | 250 Vdc | —22.5 Vdc | 0 Vdc |

**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 1 Min<br>Off 4 Min<br>Ef = 7.0 Ehk = 300 | 2,000 On-Off Cycles |
| High Temp Life Test | Under "Test Conditions" at 30 W Plate Dis. Bulb Temp. 300°C | 1,000 Hours |
| Pulse Life Test | ib = 1.0 A | 500 Hours |
| Life "Expectancy" Test | Under "Test Conditions" | 10,000 Hours |
| High Level Fatigue Test | 50G—Shock Excitation 15 Cycles/Sec. | 100 Hours |
| Shock | 500 G | 20 Impacts |
| Altitude Test | 80,000 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 | |
| Swept Freq Fatigue | 5G—F = 16—512 CPS | 96 Hours |

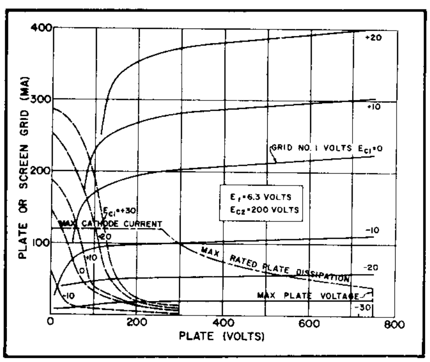



**CHART 5.**

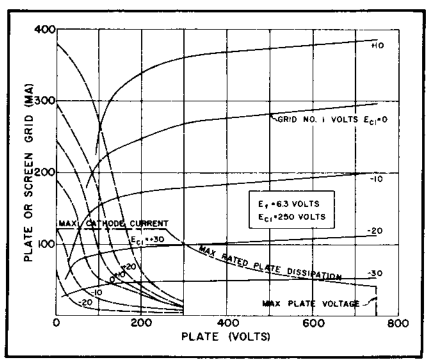
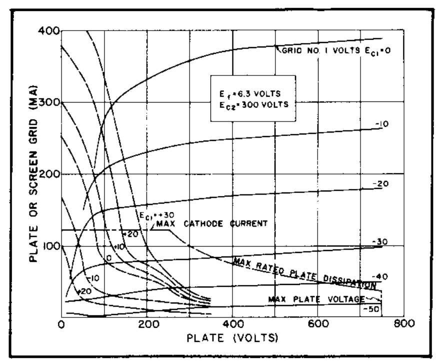



**CHART 6.**

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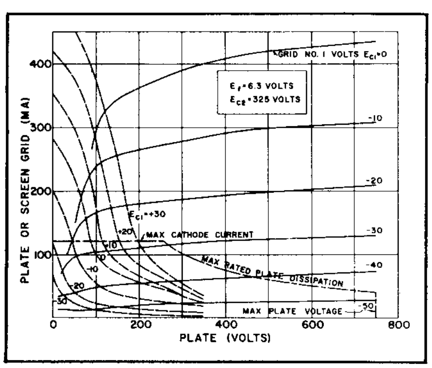


**CHART 8.**

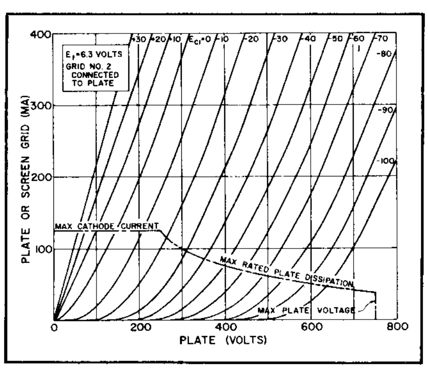


**CHART 9.**

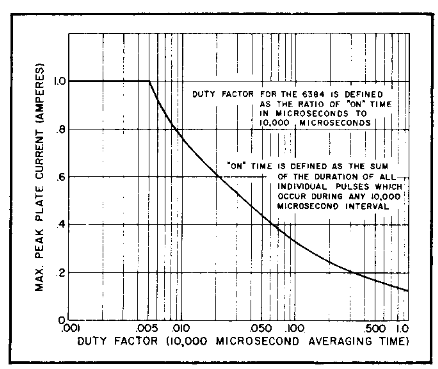


**CHART 10.**

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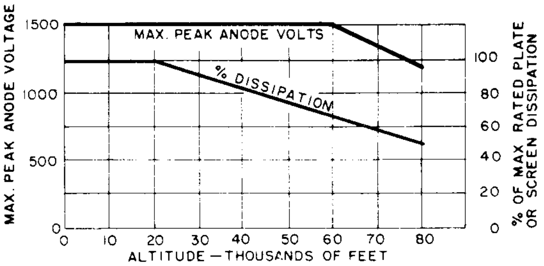
**CHART 11.**

## ALTITUDE RATINGS




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 12.**

## EFFECT ON LIFE OF INCREASED RATINGS

| See also Application Notes | OPERATING CONDITIONS | | |
|---|---|---|---|
| RATING OR CHARACTERISTIC | CONSERVATIVE | TYPICAL | MAXIMUM |
| Heater Voltage | 6.3V ± 2% | 6.3V ± 5% | 6.3V ± 10% |
| Plate Voltage | 300 Vdc | 500 Vdc | 750 Vdc |
| Screen Voltage | 200 Vdc | 275 Vdc | 375 Vdc |
| Peak Plate Voltage | 600 V | 1000 V | 1500 V |
| Plate Current (Av.) | 70 mA | 50 mA | 40 mA |
| Screen Current (Av.) | 3 mA | 4 mA | 6 mA |
| Power Dissipation | 21 W | 25 W | 30 W |
| 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 | 0-20,000′ | 60,000′ | 80,000′ |
| Vibration | 2 G | 5 G | 10 G |
| LIFE EXPECTANCY | MAXIMUM | HIGH | MEDIUM |

## APPLICATION NOTES

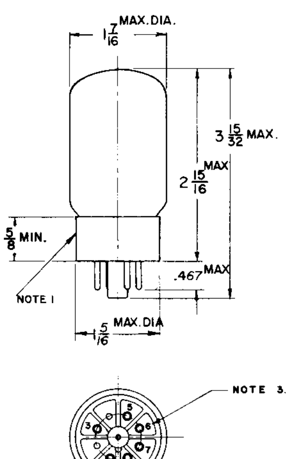
Special attention should be given to the temperatures at which the tubes are to be operated. Reliability will be seriously impaired if maximum bulb temperature is exceeded. The life expectancy will be reduced if conditions other than those specified for life test are imposed on the tube and will be reduced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

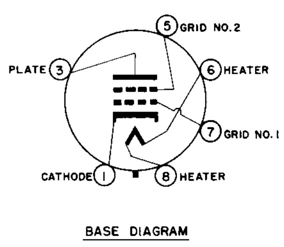
This tube is constructed using nonex glass and thus can withstand higher ambient temperatures in operation. However, the bulb temperature should never exceed 300°C at its hottest point and cooling should be employed if necessitated by the additive effects of operation at high altitudes and high dissipation 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.

The plate voltage rating and high-perveance of the 6384 make it readily adaptable to varied pulse applications. In order to insure maximum reliability in pulse service the peak plate current should not exceed the value shown in Chart 10 for the required duty factor.

Chart 12 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.




BASE DIAGRAM
(BOTTOM VIEW)

NOTES:

1. SHORT INTERMEDIATE SHELL OCTAL 6-PIN BASE.
2. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
3. NUMERALS ARE FOR REFERENCE ONLY AND DO NOT APPEAR ON TUBE BASE.

OUTLINE DRAWING

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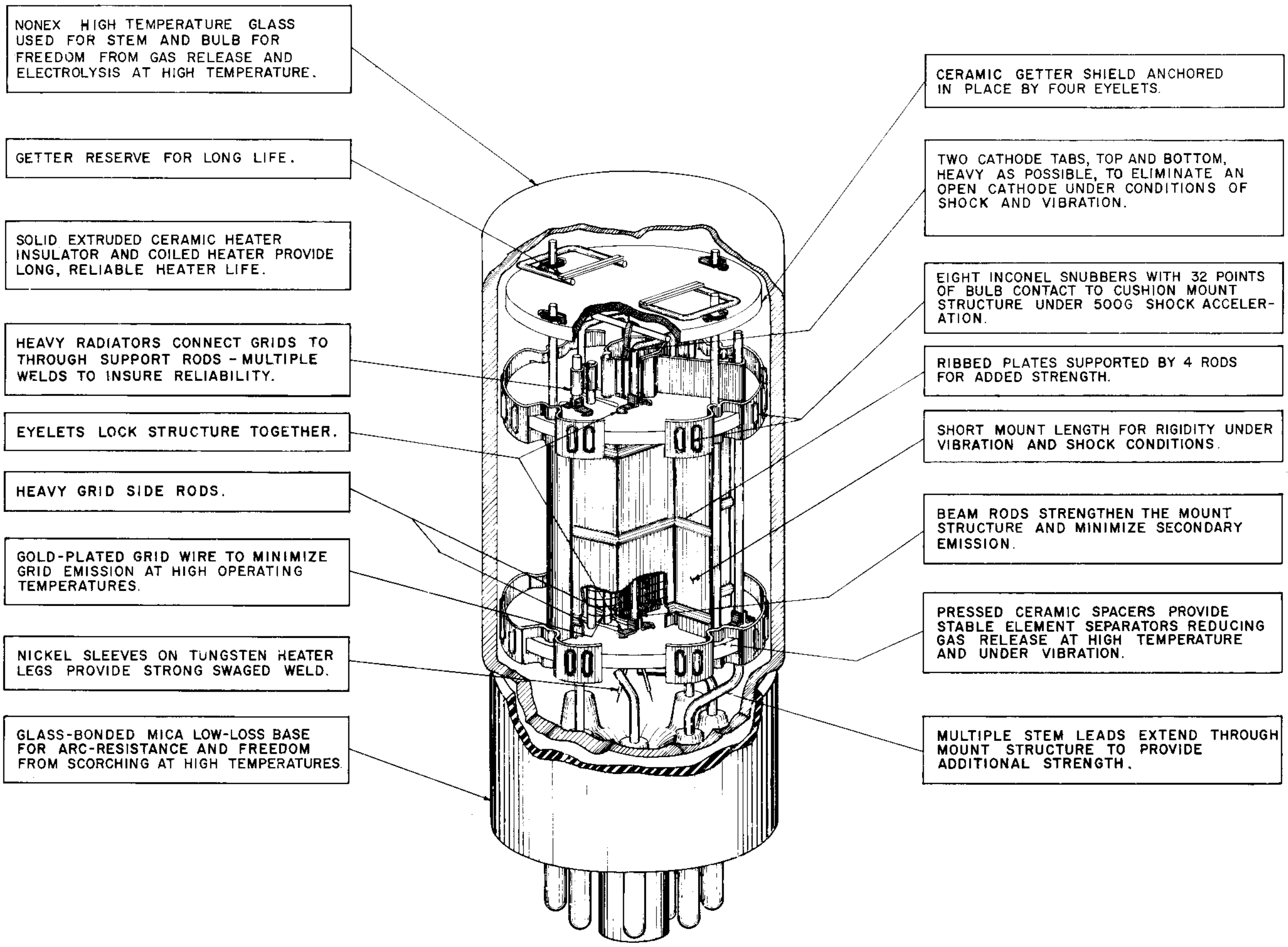


## STRUCTURAL FEATURES OF 6384 PROVIDE HIGH RELIABILITY AND LONG LIFE


THE Bendix CORPORATION

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