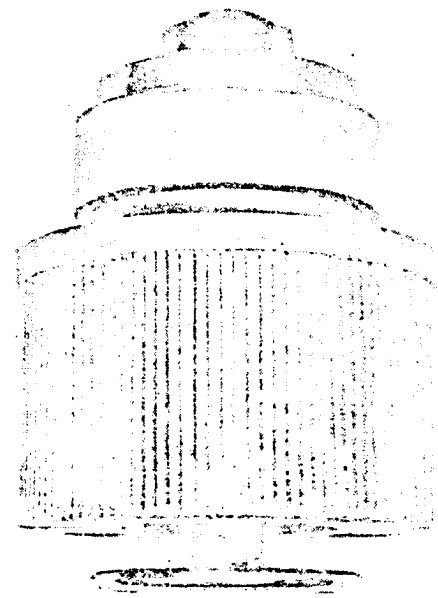
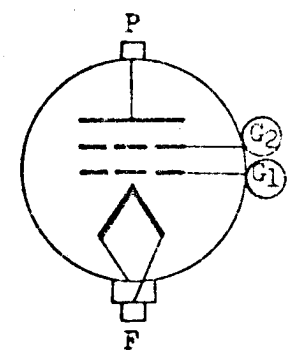
7 F 6 4 R

FORCED-AIR-COOLED TETRODE

The NEC 7F64R is a forced-air cooled tetrode designed for use as an amlifier in VHF, FM and TV equipments. It features rugged coaxial ceramic-to-metal seal construction suitable for cavity operation. The ancde can dissipate 4KW with a moderate rate of air flow through the integral high efficiency radiator brazed directly to the anode. The cathode is a mesh type filament which provides a high transconductance and trouble-free operation. The mesh type grids are fabricated by a novel technique-called photoetching process and assure very reliable performance.



Maximum ratings apply at frequencies up to 250 MHz.



P : Plate (Outer Radiator)
G_2 : Grid No.2
G_1 : Grid No.1
F : Filament

TEMINAL CONNECTIONS

ELECTRICAL DATA:

GENERAL DATA:

Filament: Thoriated Tungsten

Voltage	6	volts
Current	68	amps
Maximum Starting Current ...	140	amps

Transconductance (Ib=1 amp) ..... 36 millimhos

Amplification Factor, Grid No.2 to Grid No.1 ..... 7.5

Interelectrode Capacitances:

Grid No.1 to Plate	0.57	μμF
Filament to Plate	0.08	μμF
Grid No.2 to Plate	17	μμF
Grid No.1 to Filament	48	μμF
Grid No.1 to Grid No.2	70	μμF
Frequency for Maximum Ratings	250	MHz

MECHANICAL DATA:

Dimensions:

Maximum Diameter	124.5	mm
Maximum Overall Length	178	mm
Net Weight (approx.)	2.4	kg

Mounting Position: Vertical, anode up or down

Cooling:

To plate: Forced-air cooling required

Minimum air flow	5	m^3/min
Minimum static pressure (across radiator).	40	mm of water

To filament and grid seals:

Adequate forced-air flow should be delivered uniformly around the circumference of each seal to limit the temperature below their maximum ratings.

Minimum air flow	0.3	m^3/min
Maximum incoming air temperature	40	°C
Maximum radiator temperature (Measured at the upper end of core)	250	°C
Maximum seal temperature	250	°C

RE LINEAR POWER AMPLIFIER - CLASS AB_1

(SSB Suppressed-carrier operation
Single-tone modulation conditions per tube)

MAXIMUM RATINGS: Absolute Values

DC Plate Voltage	7000	volts
DC Grid No.2 Voltage	1200	volts
Max. Signal DC Plate Current	2.8	amps
Plate Dissipation	4	kw
Grid No.2 Dissipation	150	watts

TYPICAL OPERATION: (in grid drive circuit)

DC Plate Voltage	5000	volts
DC Grid No.2 Voltage	900	volts
DC Grid No.1 Voltage	-125	volts
Peak RF Grid No.1 Voltage	125	volts
Max. Signal DC Plate Current	1.58	amps
Zero-Signal DC Plate Current	200	mA
Max. Signal DC Grid No.2 Current	35	mA
Max. Signal Driving Power (approx.)	0	watts
Max. Signal Plate Power Output (approx.)	5.1	kW

RF POWER AMPLIFIER - CLASS B TELEVISION

(Synchronizing-peak level conditions per tube)

MAXIMUM RATINGS: Absolute Values

DC Plate Voltage	7000	volts
DC Grid No.2 Voltage	1200	volts

DC Plate Current	2.8	amps
Plate Dissipation	4	kW
Grid No.2 Dissipation	150	watts
Grid No.1 Dissipation	50	watts

TYPICAL OPERATION: (in cathode drive circuit)

DC Plate Voltage	4500	volts
DC Grid No.2 Voltage	500	volts
DC Grid No.1 Voltage	-70	volts
DC Plate Current:		
Synchronizing-peak level	1.7	amps
Pedestal-level	1.2	amps
DC Grid No.2 Current:		
Synchronizing-peak level	17	mA
Pedestal-level	8	mA
DC Grid No.1 Current:		
Synchronizing-peak level	84	mA
Pedestal-level	28	mA
Driving Power:		
Synchronizing-peak level (approx.)	172	watts
Pedestal-level (approx.)	123	watts
Plate Power Output		
Synchronizing-peak level (approx.)	4	kW
Pedestal-level (approx.)	2.25	kW

RF POWER AMPLIFIER AND OSCILLATOR - CLASS C TELEGRAPHY AND FM TELEPHONY

(Key down conditions per tube without modulation)

MAXIMUM RATINGS: Absolute Values

DC Plate Voltage	7000	volts
DC Grid No.2 Voltage	1200	volts
DC Grid No.1 Voltage	-500	volts
DC Plate Current	2.2	amps
Plate Dissipation	4	kW
Grid No.2 Dissipation	150	watts
Grid No.1 Dissipation	50	watts

TYPICAL OPERATION: (in grid drive circuit)

DC Plate Voltage	5000	6000	volts
DC Grid No.2 Voltage	500	500	volts
DC Grid No.1 Voltage	-170	-185	volts
Peak RF Grid No.1 Voltage	240	275	volts
DC Plate Current	1.39	1.71	amps
DC Grid No.2 Current	60	78	mA
DC Grid No.1 Current	100	140	mA
Driving Power (approx.) (Note 1)	22.8	36.3	watts
Plate Power Output (approx.)	5.56	8.2	kW

(Note 1) Circuit loss is not included.

APPLICATION INSTRUCTIONS

1. INITIAL INSPECTION

When NEC 7F64R is received, it should be unpacked and inspected as soon as possible. In handling the 7F64R, extreme care should be taken to protect the tube from undue shock and vibration, since the thoriated-tungsten filaments, the metal-to-ceramic seals or other intricate tube parts may easily become damaged.

A careful inspection should be made for any visible damage, such as cracked ceramic or deformed metal parts, which may have occured in transit. The tube should then be checked with an ohmmeter to determine if a inter-electrode short-circuit or open-filament has occured. If no failure is assured by the abovementioned inspection, the tube should be installed in the socket and all electrical connections made.

Rated filament voltage should be applied and the filament current checked to see if it agree with the value indicated on the data sheet attached to the tube.

When the filament voltage and current measurement is being performed, care should be taken to calibrate the voltmeter and ammeter accurately and to prevent the errors caused by voltage drops of socket and leads carrying a heavy current.

If there is any evidence of damage in transit, report should be prepared and mailed to the Sales Department, Electron Device Division of NEC, within fifteen-days. The serial number identifying each individual tube appears on the bottom surface of the anode.

2. OPERATION

Before mounting in the socket, following precautions should be observed.

The ceramic envelope and other external parts of the 7F64R should be kept free from accumulated dust to minimize surface leakage and the

possibility of arc-over. It is recommended that dust be wiped from the ceramic envelope and from other external parts of the tube. This should be done when the tube is cold, using a clean soft lint-free cloth (if available, moistened with alcohol). If dust are adhered to the cavity or socket, it should be cleaned and check should be made whether a deformed or damaged contact fingers exists in order to assure good electrical contacts to the tube terminals. When the tube is pushed into the socket, it should be done carefully keeping tube axis right on the axis of the socket. If it is felt excessively tight in inserting the tube never force it down. Check the alignment of the contact fingers of the socket. After filament and grid No.1 low voltage supplies have been on for 10 minutes, apply plate and grid No.2 voltages and operate the tube with reduced driving power for an additional 30 minutes. All tuning adjustments should be made during this period. Normal driving power may then be applied and final tune-up performed.

3. TUBE PROTECTION

All protective circuits and interlocks such as over-current relays, air interlocks etc. to remove power under fault conditions should be checked regularly in order to assure their proper functioning.
If adequate protection is not provided, fault over loads may result in the following conditions.

(a) Liberation of gas in the tube
(b) Gross damage to the internal elements, e.g. burn out of grid wires etc.
(c) External arcing-over between electrode terminals, with damages to seals and possible crack of ceramic envelope.

A tube which became gassy can often be cleaned up successfully by patient reaging, according to the schedule described in the preceding paragraph. The other conditions listed above are usually catastrophic.

4. TUBE CARE

The ceramic envelope and other external parts of the 7F64R should be kept free from accumulated dust to minimize surface leakage and the

possibility of arc-over. The ceramic surface should never come in contact with metallic pieces such as tools, because the contact will leave some traces on the surface which may impair the insulation. On the same reason, writing on the ceramic surface with lead pencil etc. is prohibited. All tube terminals must be kept bright and clean to provide good electrical contacts.

In transportation and storage of the 7F64R, care should be taken to protect the tube from rough handling that would damage the tube. It should be stored in its shipping container with the filament end up and should be protected from moisture, extreme temperature variations and undue shock and vibration. When packing the tube for reshipment, it should be packed in its own shipping container as in the initial shipment. The Tube Return Authorization Sheet supplied together with each tube should be filled out and forwarded, whenever the tube is to be returned to the factory.

EQUIPMENT DESIGN CONSIDERATION

1. MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum values given either for electrical or for mechanical ratings in the tabulated data are limitings values above which, if exceeded, serviceability of any individual tube may be impaired. Maximum rating applies independently on each item and does not form a set of satisfactory operating conditions. When designing circuit, therefore, it is necessary to insure that the maximum ratings will never be exceeded under any conditions, even momentarily. The equipment designer must make allowances for any unusual conditions of supply-voltage fluctuation or load variation and for manufacturing tolerances in the equipment itself and the tube.

The typical operating conditions, given in the tabulated data, do not include the circuit losses, hence usefull power output to the load may be less than that indicated, depending upon the frequency of operation and the circuit efficiency.

2. ELECTRICAL CONDITIONS

FILAMENT VOLTAGE

The cathode of the NEC 7F64R is of mesh type thoriated-tungsten filaments. Since the life of the tube can be prolonged by operating it at the lowest filament voltage which will enable the tube to give satisfactory performance, it is preferable to use with as low filament voltage as possible within the range of 10 percent down from nominal rated value.

The filament should never be operated, under any circumstances, at higher, by 5 percent of rated value, than nominal voltage.

MONITORING OF OPERATION

Suitable meters should be provided for monitoring filament voltage, dc plate voltage, plate current, dc grid No.2 voltage, grid No.2 current, dc grid No.1 voltage and grid No.1 current. Elapsed-time meter should be installed to read total hours of filament operation. The evaporation of active materials from the filament starts to take place even when the filament voltage alone is applied. Therefore, the tube life should be counted by total hours of filament operation.

GRID NO.1 BIAS

In class-AB or class-B RF linear power amplifier service, the 7F64R should be operated with grid bias obtained form a fixed dc source of good voltage regulation. If tubes are used in parallel or in push-pull, the grid circuit of each tube should be provided with a separate bias adjustment to balance the grids and plate currents. The zero signal dc plate current has a critical influence on the linearity. Therefore, grid No.1 bias voltage should be choosen for the best compromise between zero-signal plate dissipation and distortion.

In plate-modulated class-C RF power amplifier service (telephony), the tube should be supplied with bias from a grid resistor,

or from a suitable combination of grid resistor and fixed supply or from grid resistor and cathode resistor. The cathode resistor should be by-passed for both audio and radio frequencies. The combination method of grid resistor and fixed supply has the advantage of not only protecting the tube from damage through loss of excitation but also of minimizing distortion by bias voltage compensation.

In class-C RF telegraphy service, it is similar to plate-modulated class-C RF power amplifier service (telephony).

GRID NO.2 VOLTAGE

Protection against the over loading of grid No.2 should be provided by an over current relay and by interlocking the grid No.2 supply so that plate voltage must be applied before grid No.2 voltage is applied. Variation of load impedance causes variations of plate and grid No.2 currents. Light load increases grid No.2 current while decreasing plate current and results in excessive grid No.2 dissipation. Heavy load tends to increase plate current and decrease grid No.2 current which results in lower efficiency and excessive plate dissipation.

The grid No.2 current may reverse under certain conditions and produce negative current indications on the grid No.2 ammeter. This is a normal characteristic of most tetrodes. Therefore, a current path from grid No.2 to cathode must be provided by a bleeder resistor, and is arranged to pass an adequate bleeder current per connected grid No.2.

In the usual tetrode amplifier, where no signal voltage appears between cathode and grid No.2, grid No.2 dissipation is equal to the product of the dc grid No.2 voltage and the dc grid No.2 current. When signal voltage appears between cathode and grid No.2, as in the case of cathode driven amplifier, grid No.2 dissipation may become much more than the value obtained in the aforementioned case.

In the case of class-AB or class-B RF linear power amplifier, care should be taken to prevent the increase of distortion caused by variation of grid No.2 voltage.

3. COOLING SYSTEM

Sufficient forced-air cooling of 7F64R must be provided the air flow of 5 m^3/min or more through radiator for use with a plate dissipation of 4 kW.

The filament, grid No.1 and grid No.2 seals are cooled by air-flow of not less than 0.3 m^3/min.

When the cooling of filament seals and radiator of this tube is accomplished by the common forced-air supply, forced-air flow should be directed from filament seals to radiator through the grid No.1 and No.2 contacts.

A suitable air filter is required in the air supply system. Care should be given to clean or replace the filter at intervals in order that accumulated dust will not obstruct the flow of air. The required static pressure versus air-flow characteristic of radiator of the NEC 7F64R is shown in Fig. 1. Allowances for pressure drops in an air filter, ducts and louvers etc., should be made in selecting a blower.

Since the cooler operation of the tube prolongs tube life markedly, adequate margin in air flow should be provided. The cooling system should be properly installed to insure safe operation of the tube under all conditions and, for this reason, should be electrically interlocked with the filament, plate and grid No.2 power supplies.

This arrangement is necessary to make sure that the tube is supplied with air before any voltage is applied. Air flow or pressure interlocks which open the filament and plate power transformer primaries is necessary for protecting the tube when the air flow is insufficient or ceases.

4. FAULT PROTECTION

The handling of high power requires particular attention to the removal of power under fault conditions, since the large amount of energy involved can seriously damage the tube or the equipment if not properly controlled.

The ground lead of the plate circuit of each tube should be connected in series with the coil of quick acting overload relay, adjusted to open the circuit breakers in the primary of rectifier transformer at slightly higher than normal operating plate current. The total response time required for the operation of relay and circuit breakers should be 1/10 second or less. As mentioned before the grid No.2 circuit should also be equipped with similar over load relays. Under-voltage relay in the grid No.1 circuit may be required for some application.

The above mentioned discussion presents information necessary to obtain satisfactory and economical performance of the NEC 7F64R under normal operating conditions. For information concerning specific tube problem or applications not covered here, consult the Engineering Department, Electron Device Division, Nippon Electric Company Ltd., 1753 Shimo-numabe, Nakahara-ku Kawasaki City, Japan.

Fig 1 AIR FLOW VS PRESSURE DROP CHARACTERISTIC OF RADIATOR

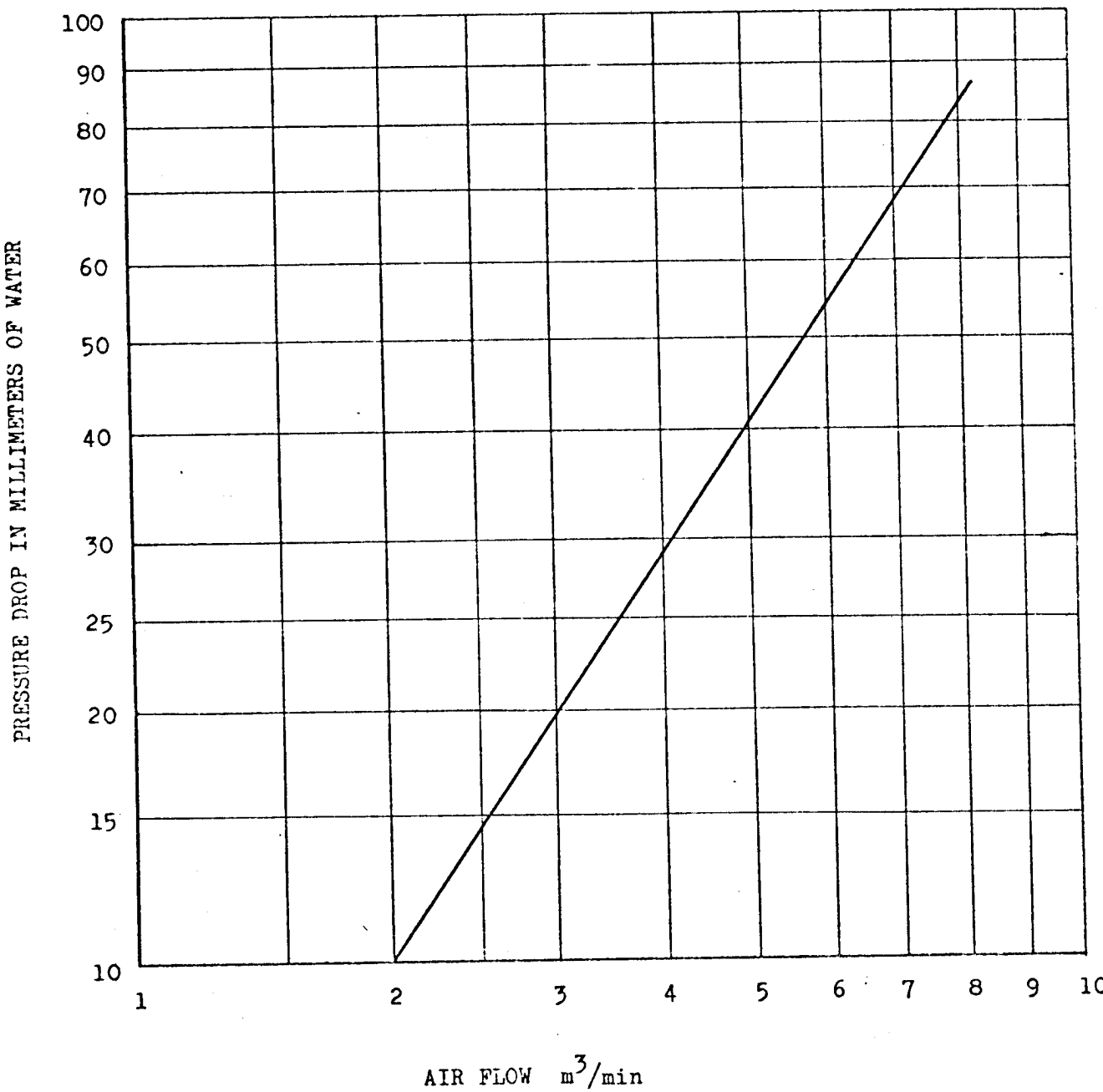


Fig 2 CONSTANT CURRENT CHARACTERISTICS

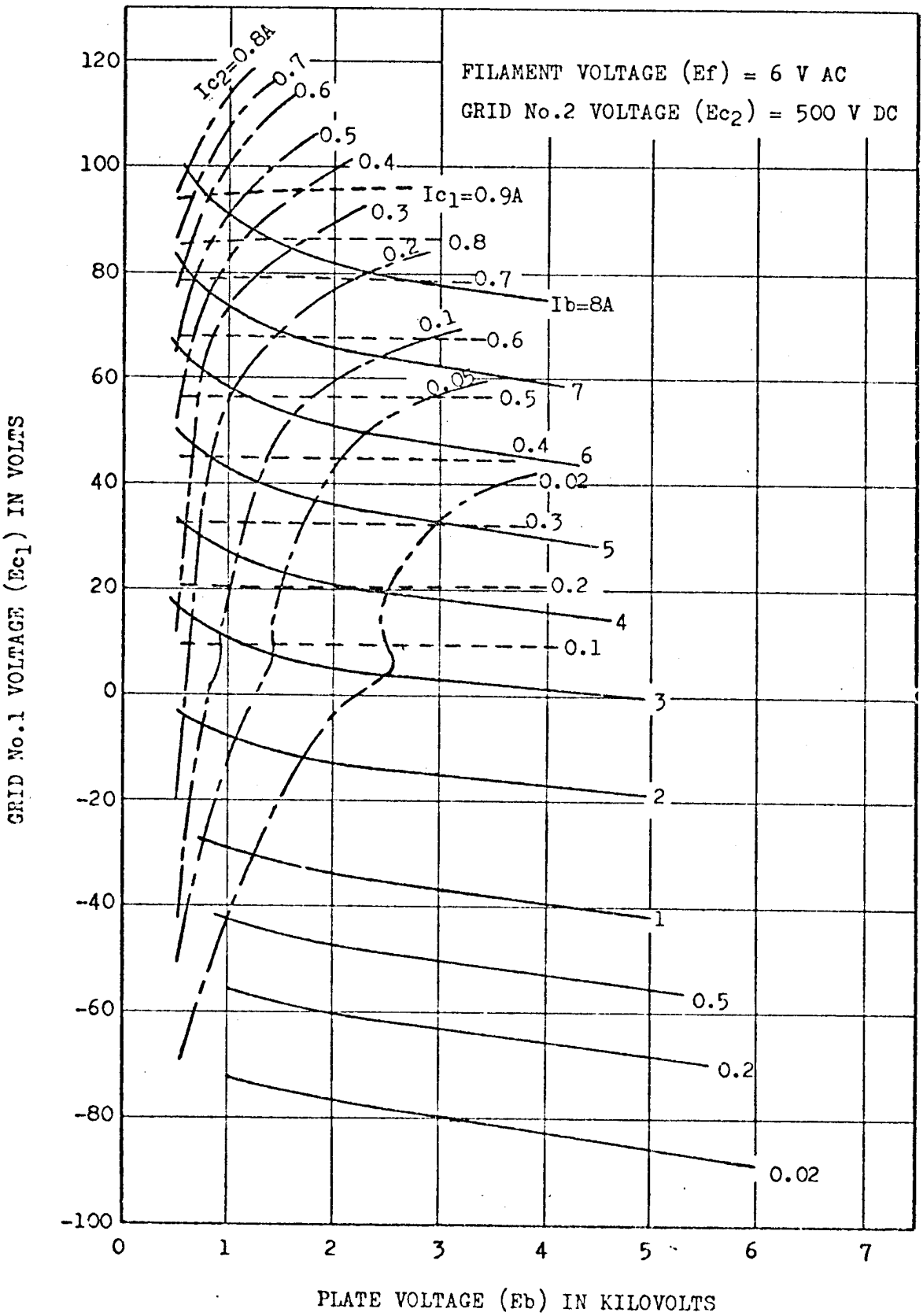


Fig 3 CONSTANT CURRENT CHARACTERISTICS

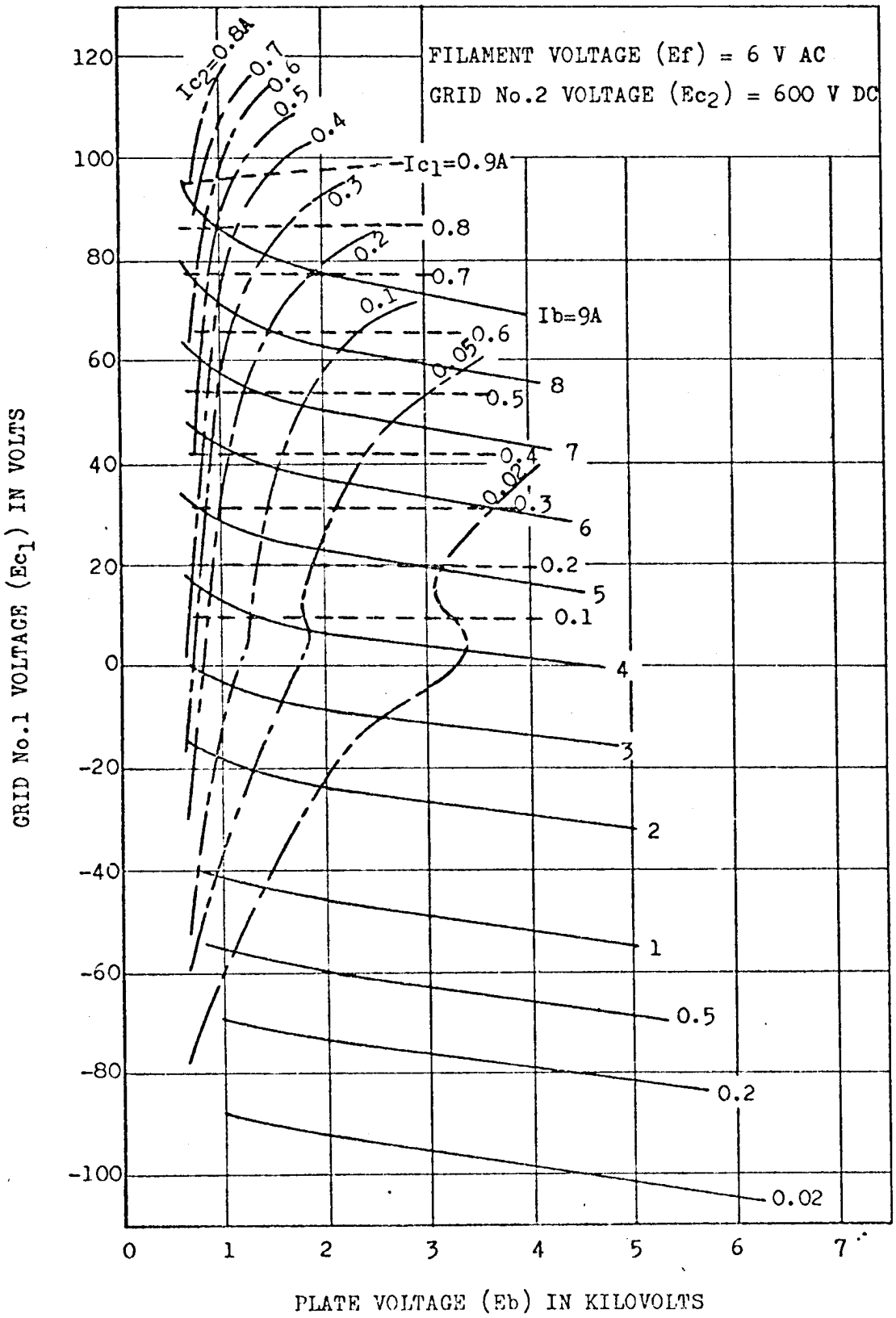
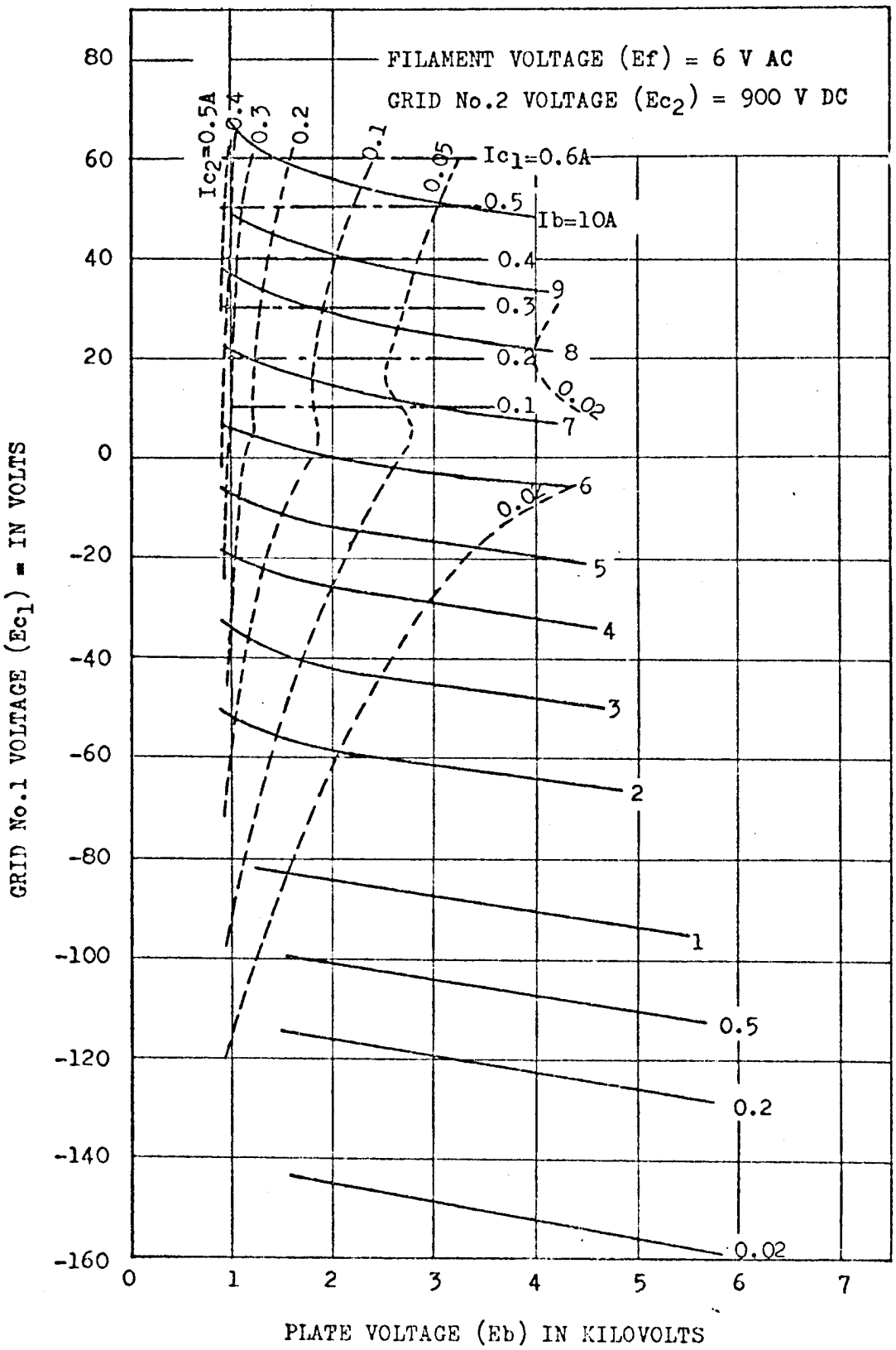
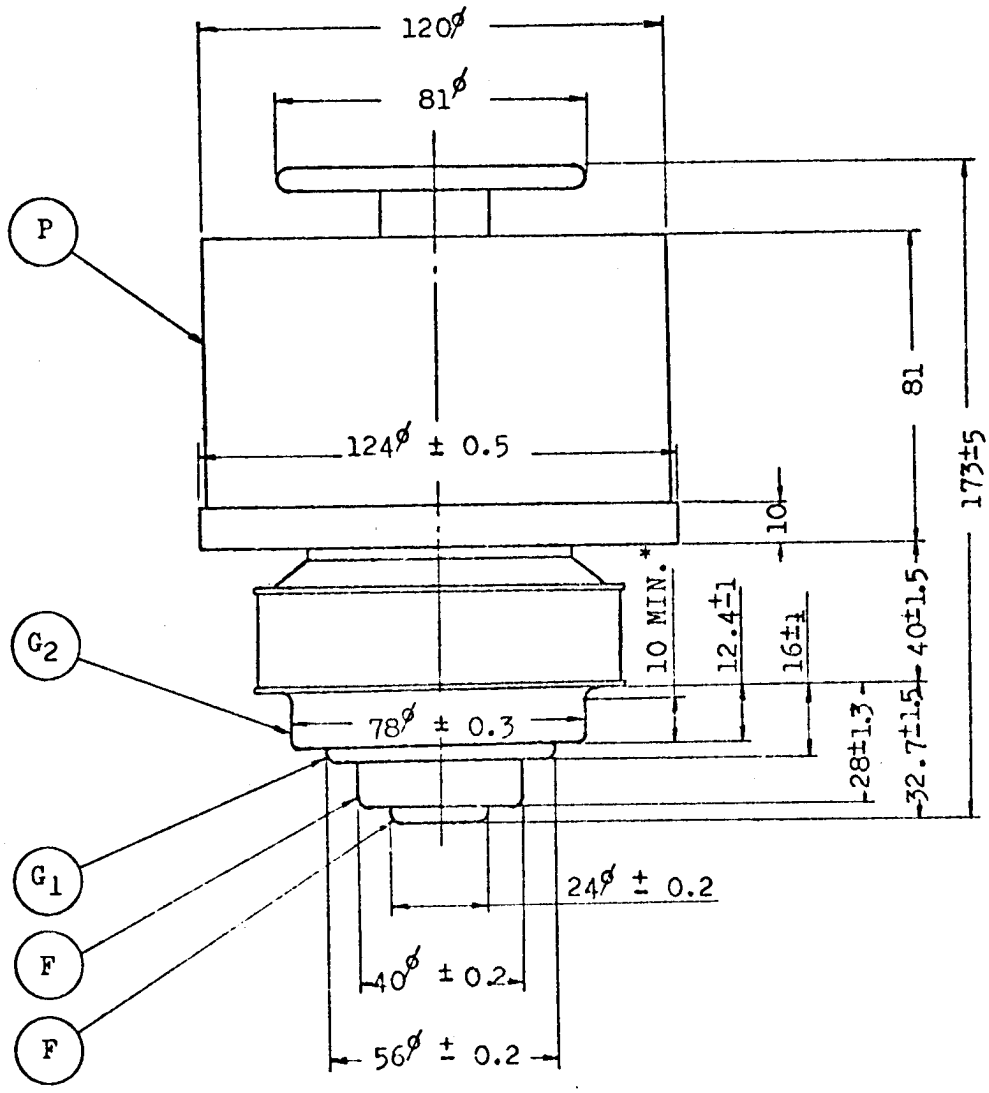


Fig 4 CONSTANT CURRENT CHARACTERISTICS



(Unit in mm)

Fig 5 OUTLINE DRAWING



* 78ø ± 0.3 TOLERANCE APPLIES