# 8 F 7 6 R

## FORCED-AIR-COOLED TETRODE

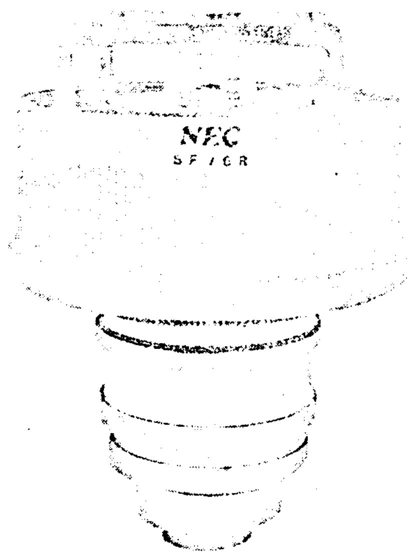
The NEC 8F76R is a forced-air cooled tetrode designed specifically for use as an amplifier in VHF TV and FM equipment. The tube is also suitable in SSB linear amplifier application.

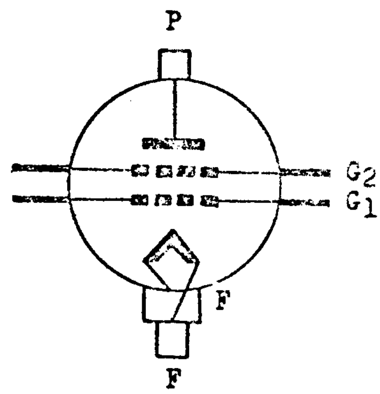
It features rugged coaxial ceramic-to-metal sealed construction suitable for cavity operation.

The cathode consists of a mesh type thoriated tungsten filament. The novel techniques, including electro-spark machining processes, are used throughout the fabrication of grid.

With these modern construction and new techniques being employed, the tube has high transconductance essential for high gain and high efficient operation and assures long life and highly reliable operation. The anode with its integral radiator can dissipate 15 kilowatts with moderate rate of air flow.

Maximum ratings apply at frequency up to 250 MHz.




P : Plate
$G_2$ : Grid No.2
$G_1$ : Grid No.1
F : Filament

TERMINAL CONNECTIONS

ELECTRICAL DATA

GENERAL DATA:

Filament: Thoriated Tungsten

| | | |
|---|---|---|
| Voltage | 7.5 | volts |
| Current | 120 | amps |
| Maximum Starting Current | 300 | amps |
| Minimum Heating Time | 10 | sec. |

| | | |
|---|---|---|
| Transconductance (Ib=2.5 amps) | 60 | millimhos |
| Amplification Factor, Grid No.2 to Grid No.1 | 8.75 | |

Interelectrode Capacitances:

| | | |
|---|---|---|
| Grid No.1 to Filament | 56 | μμF |
| Grid No.1 to Grid No.2 | 91 | μμF |
| Grid No.2 to Plate | 20 | μμF |
| Grid No. 1 to Plate (Note 1) | 0.6 | μμF |
| Plate to Filament (Note 1) | 0.075 | μμF |

Note 1. Values measured with metal shield, 305 mm diameter having a central hole of 106 mm diameter, placed on the grid No.2 terminal plain and connected to it.

MECHANICAL DATA:

Dimensions:

| | | |
|---|---|---|
| Maximum Diameter | 188.6 | mm |
| Maximum Overall Length | 257 | mm |

Net Weight (approx.) ........ 9.4 kg

Mounting Position: Vertical, anode up or down

Cooling:

To plate: Forced air cooling required (Note 2)

| | | | | |
|---|---|---|---|---|
| Plate dissipation | 10 | 12 | 15 | kW |
| Minimum air flow | 18 | 20 | 23 | $m^3$/min |
| Minimum static pressure | 110 | 140 | 180 | 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 the maximum rating (Note 2).

| | | |
|---|---|---|
| Maximum incoming air temperature ......... | 45 | °C |
| Maximum radiator temperature (Note 3) .... | 250 | °C |
| Maximum filament and grid seal temperature ......... | 250 | °C |

Note 2. Start forced-air-flow to each portion of the tube prior to application of filament voltage. Continue air flow for about five minutes after removal of all voltages.

Note 3. Indicates the value measured at the point indicated by * sign in the outline drawing.

RF POWER AMPLIFIER-CLASS B TELEVISION

(Synchronizing peak level conditions per tube)

MAXIMUM RATINGS: Absolute Values

| | | |
|---|---|---|
| DC Plate Voltage .................................. | 8000 | volts |
| DC Grid No.2 Voltage .............................. | 1500 | volts |
| DC Grid No.1 Voltage .............................. | -1000 | volts |
| DC Plate Current .................................. | 5.5 | amps |
| DC Grid No.2 Current .............................. | 250 | mA |
| DC Grid No.1 Current .............................. | 250 | mA |
| Plate Input ....................................... | 30 | kW |
| Plate Dissipation ................................. | 15 | kW |
| Grid No.2 Dissipation ............................. | 300 | watts |
| Grid No.1 Dissipation ............................. | 180 | watts |

TYPICAL OPERATION: (in cathode drive circuit)

| | | |
|---|---|---|
| DC Plate Voltage .................................. | 6200 | volts |
| DC Grid No.2 Voltage .............................. | 880 | volts |

| | | |
|---|---|---|
| DC Grid No.1 Voltage | -120 | volts |
| Peak RF Grid No.1 to Cathode Voltage | | |
| Synchronizing peak level | 155 | volts |
| Pedestal level | 128 | volts |
| DC Plate Current | | |
| Synchronizing peak level | 3.5 | amps |
| Pedestal level | 2.6 | amps |
| DC Grid No.2 Current | | |
| Synchronizing peak level | 27 | mA |
| Pedestal level | 0 | mA |
| DC Grid No.1 Current | | |
| Synchronizing peak level | 46 | mA |
| Pedestal level | 0 | mA |
| Driving Power (approx.) (Note 4) | | |
| Synchronizing peak level | 455 | watts |
| Pedestal level | 270 | watts |
| Plate Power Output (approx.) | | |
| Synchronizing peak level | 13.4 | kW |
| Pedestal level | 7.55 | kW |

## RF LINEAR AMPLIFIER-CLASS A $B_1$

(SSB suppressed - carrier operation, single tone modulation conditions per tube)

MAXIMUM RATING: Absolute Values

| | | |
|---|---|---|
| DC Plate Voltage | 8000 | volts |
| DC Grid No.2 Voltage | 1500 | volts |
| Max. Signal DC Plate Current | 5.5 | amps |

| | | |
|---|---|---|
| Plate Dissipation | 15 | kW |
| Grid No.2 Dissipation | 300 | watts |

TYPICAL OPERATION: (in grid drive circuit)

| | | |
|---|---|---|
| DC Plate Voltage | 8000 | volts |
| DC Grid No.2 Voltage | 1000 | volts |
| DC Grid No.1 Voltage | -130 | volts |
| Peak RF Grid No.1 Voltage | 120 | volts |
| Max. Signal DC Plate Current | 2.16 | amps |
| Zero-Signal DC Plate Current | 250 | mA |
| Max. Signal DC Grid No.2 Current | 30 | mA |
| Max. Signal Driving Power (approx.) (Note 4) | 0 | watts |
| Max. Signal Power Output (approx.) | 11.4 | 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 | 8000 | volts |
| DC Grid No.2 Voltage | 1500 | volts |
| DC Grid No.1 Voltage | -1000 | volts |
| DC Plate Current | 4.5 | amps |
| DC Grid No.2 Current | 250 | mA |
| DC Grid No.1 Current | 250 | mA |
| Plate Input | 30 | kW |
| Plate Dissipation | 15 | kW |
| Grid No.2 Dissipation | 300 | watts |
| Grid No.1 Dissipation | 180 | watts |

TYPICAL OPERATION: (in grid drive circuit)

| | | |
|---|---|---|
| DC Plate Voltage .................................... | 7000 | volts |
| DC Grid No.2 Voltage ................................ | 1000 | volts |
| DC Grid No.1 Voltage ................................ | -260 | volts |
| Peak RF Grid No.1 Voltage ........................... | 312 | volts |
| DC Plate Current .................................... | 3 | amps |
| DC Grid No.2 Current ................................ | 63 | mA |
| DC Grid No.1 Current ................................ | 67 | mA |
| Driving Power (approx.) (Note 4) .................... | 20 | watts |
| Plate Power Output (approx.) ........................ | 15.4 | kW |

Note 4. These values do not include circuit losses.

## APPLICATION INSTRUCTIONS

1. INITIAL INSPECTION

When NEC 8F76R is received, it should be unpacked and inspected as soon as possible. In handling the 8F76R, extreme care should be taken to protect the tube from undue shock and vibration since the thoriated-tungsten filament, the ceramic-to-metal seals or other intricate tube parts may easily be damaged. It is to be noted that the tube should be carried only by the handles provided at the top of radiator.

A careful inspection should be made for any visible damage, such as cracked ceramic or deformed metal parts which may have occurred during the transit. The tube should then be checked with an ohmmeter to determine if interelectrode short-circuit or open-filament has occurred.

If no failure is assured by the above-mentioned inspection, the tube should be installed in the equipment and all electrical connections made. Rated filament voltage should be applied and the filament current checked to see if it agrees with the value indicated on the data sheet attached to the tube. When the filament voltage and current measurements are performed, measurement should be made a few minutes after the application of filament voltage and the values have been stabilized. Care should be taken to calibrate the voltmeter and ammeter accurately, and to connect the voltmeter directly across the filament terminal so as to prevent the error caused by the voltage drop of filament leads and socket 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 top surface of anode.

2. OPERATION

When the tube is being fixed to the cavity, the ceramic envelope and other external portions of the 8F76R should be kept free from accumulated dust to minimize surface leakage and the possibility of arc-over. It is recommended that dust be wiped with clean soft cloth.

The ceramic surface should never come in contact with metallic pieces such as metal tools, because the contact will leave some metallic traces which may impair the insulating property of the ceramic surface. For the same reason, writing on the surface with lead pencil is prohibited.

If dusts are adhered to the cavity, it should be removed and check if deformation, loss or wear of contact finger, which will be a cause of imperfect contact, exists in the socket. When the tube is inserted into the socket, it should be pushed carefully with its axis being right on the axis of the socket. If it is felt tight, never force it. Check the concentricity of all contact surface of the socket.

After filament and grid No.1 voltage supplies have been on for two to three minutes, apply minimum plate and grid No.2 voltages or if plate and grid No.2 voltage cannot be reduced, reduce driving power and operate the tube at approximately half the normal plate input level for half an hour. All tuning adjustment should be made during this period.

Normal plate and grid No.2 voltages and plate input may then be applied and final tune-up performed. The tube should be run at normal voltages and driving power for at least additional half an hour.

3. TUBE PROTECTION

All protective circuits and interlocks such as over-current relay, air interlocks etc. to remove power in fault condition should be checked regularly in order to assure their proper functioning.

Fault over-load, due to circuit or tube instability may result in the following conditions.

1 liberation of gas in the tube

2 gross damage to internal element, e.g. burn-out of grid wires

3 external arcing-over between electrode terminals with damage to seals

A tube which became gassy can often be cleaned up successfully by the patient reaging process 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 portions of the 8F76R should be kept free from accumulated dust to minimize surface leakage and the possibility of arc-over. All tube terminals and connectors must be kept bright and clean to provide good electrical contact. The tube should be stored in its shipping container and should be protected from moisture, extreme temperature variation and undue shock and vibration. In handling, transit and storage the tube should always be held vertically with its anode down.

When packing the NEC 8F76R for reshipment, it should be packed as in the initial shipment. The tube Return Authorization Sheet supplied with each tube should be filled out and forward, whenever the tube is to be returned to the factory.

## EQUIPMENT DESIGN CONSIDERATION

1. MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Maximum ratings given either for electrical or for mechanical items in the tabulated data are limiting 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 circuitry, therefore, it is necessary to insure that the maximum ratings will never be exceed under any conditions, even momentarily.

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

2. COOLING SYSTEM

The cooling system is required to provide sufficient clean air flow through the radiator and to the filament terminals. A suitable air-filter should be provided in the air supply system. Care should be given for cleaning or replacing 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 the radiator of the NEC 8F76R is shown in the attached figure. Allowance for pressure drops in an air filter, ducts and louvers etc., should be made in selecting a blower. It is also necessary to provide enough margin in air flow to take care of the increase of friction loss in the duct and the decrease of blower efficiency after prolonged operation.
Since the cooler operation of the tube prolongs tube life markedly, adequate margin in air flow should be provided. Without air flow, the tube is easily damaged by the application of filament power alone.

Therefore, the cooling system should be electrically interlocked with the filament and other power supplies. The arrangement is necessary to make sure that the tube is supplied with air before any voltage is applied. The filament, grid No.2, plate power supplies and air flow may be shut down simultaneously but as a good practice it is recommended to supply air flow for about three minutes after removal of all voltages.

The temperature of the radiator and each electrode seal must not exceed their maximum ratings of 250 °C, like other electrical maximum ratings. Temperature at various parts of the tube may be measured by using thermosensitive paint like "tempilaq".

## 3. ELECTRICAL CONSIDERATION

### Filament Voltage

The cathode of the NEC 8F76R is of the mesh type thoriated-tungsten filament. Since the life of the tube can be prolonged markedly by operating it at the lowest voltage which will enable the tube to give satisfactory performance, it is range of 10 percent down from nominal value. The filament should never be operated, under any circumstancés, 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.
Active material evaporates from the filament even when the filament voltage alone is applied.
Therefore tube life should be counted by total hours of filament operation.

### GRID NO.1 BIAS

In class-A B and B RF linear amplifier service, the 8F76R should be operated with grid No.1 bias obtained from 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 separated bias

adjustment to balance the grid and plate current. The zero-signal plate current has a critical influence on the linearity and usually it is chosen for the best compromise between zero signal plate dissipation and distortion. Therefore the grid circuit should be designed with a fine bias adjustment. In class-C RF telegraphy service, the grid No.1 bias may be obtained either from a grid resistor, combination of grid resistor and a fixed supply or combination of grid and cathode resistor.
The latter two methods have an advantage of protecting of the tube from damage through loss of driving power.

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 current. Light load increases grid No.2 current while decreasing plate current and results in excessive grid No.2 dissipation.
Heavy load tend 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 grid No.2 and cathode, 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-A B 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.

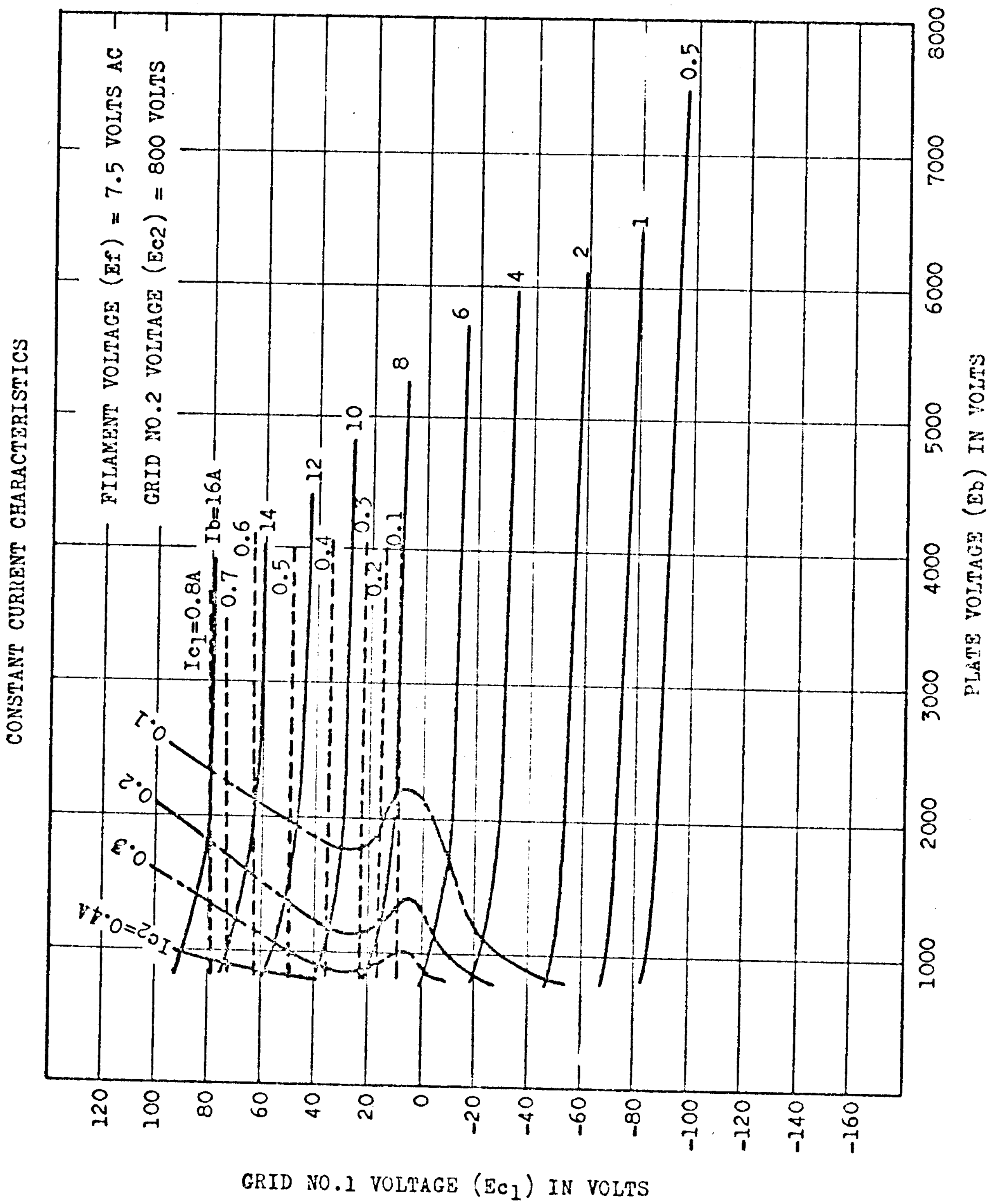
4. FAULT PROTECTION

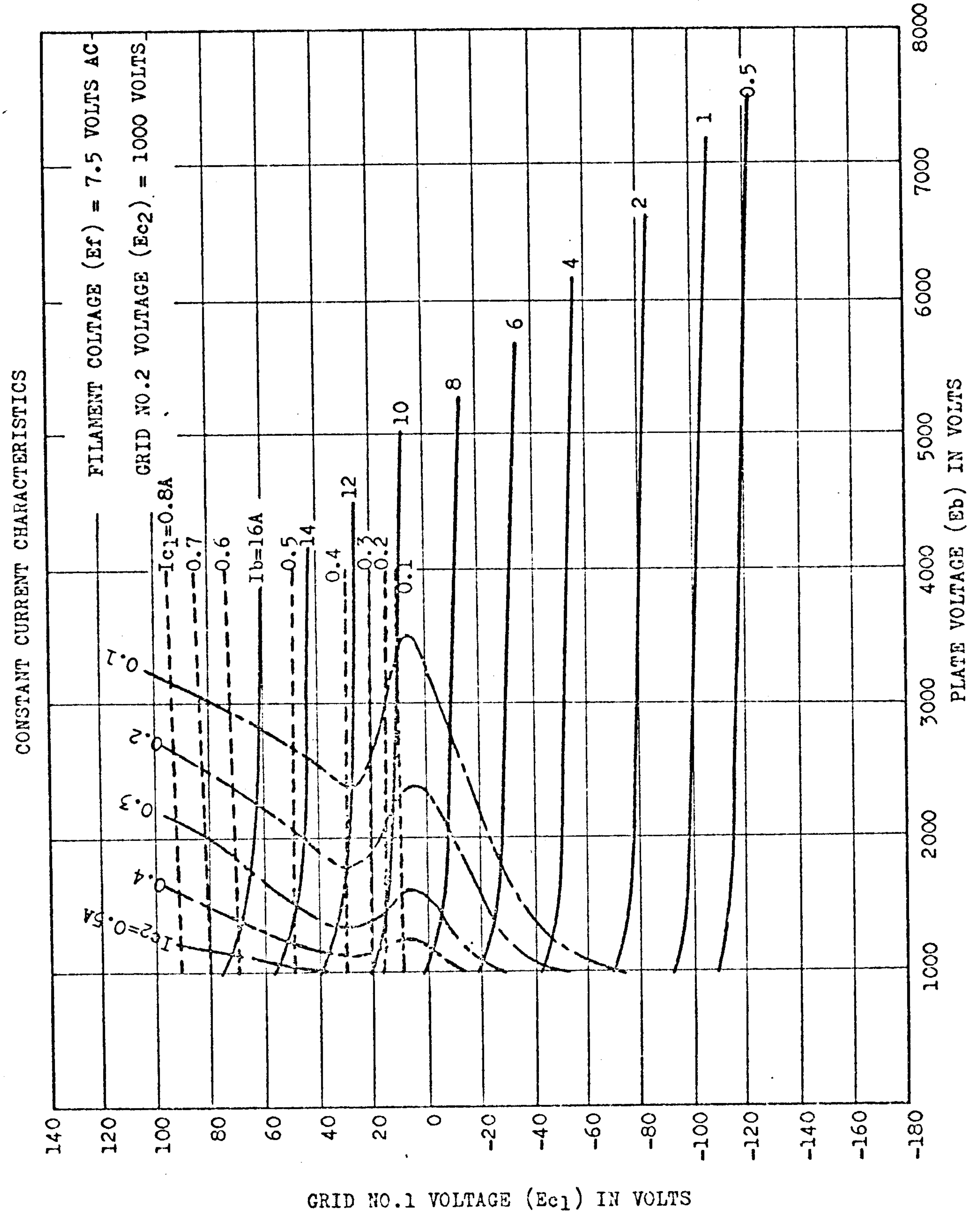
The handling of high power requires particular attention to the removal of power under fault conditions, since the large amount of energy involved can cause severe damage to the tube or to the equipment, if not properly controlled.

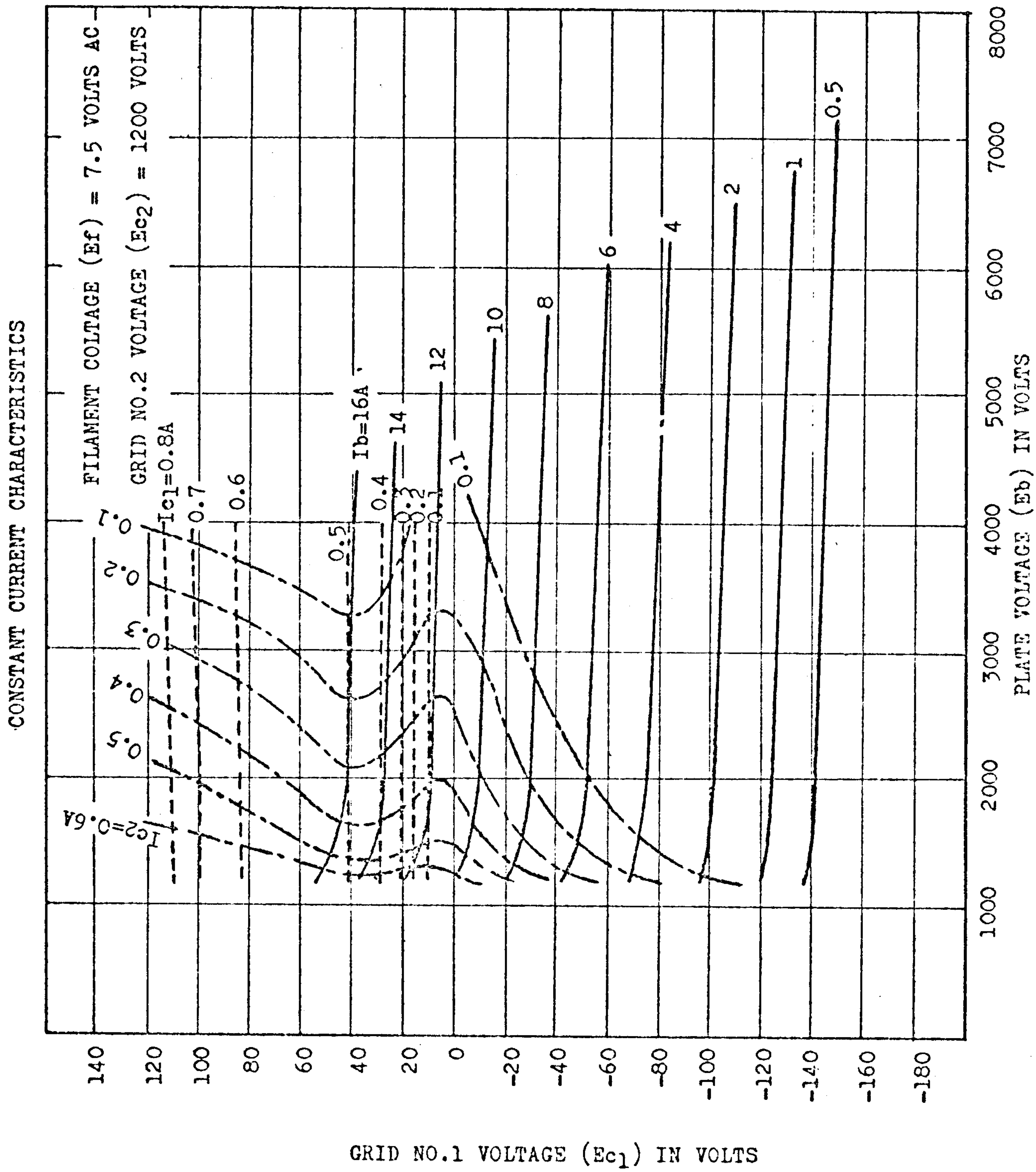
The ground lead of the plate circuit of each tube should be connected in series with the coil of quick acting over-load relay, adjusted to open the circuit breakers in primary of rectifier transformer at slightly higher than normal operating plate current. The total response time required for the operation of relay and circuit breakers should be 1/10 of a second or less.

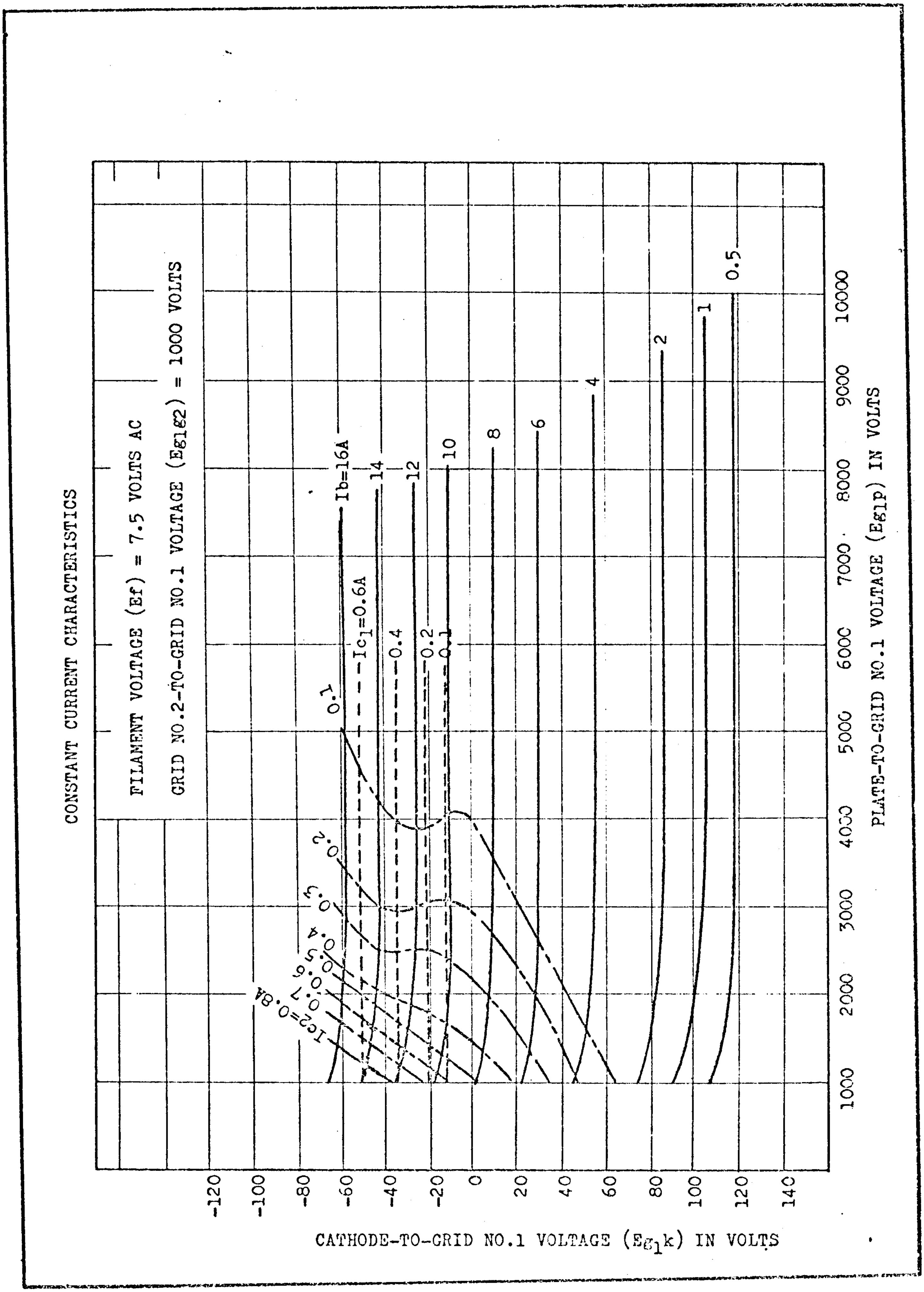
As mentioned before, the grid No.2 circuit should also be equipped with similar over-load relay.

The above mentioned discussion presents information necessary to obtain satisfactory and economical performance of the NEC 8F76R under normal operating conditions. For information concerning specific tube problem or application not covered here, consult the Engineering Department, Electron Device Division, Nippon Electric Company Ltd., 1753 Shimo-numabe, Kawasaki City, Japan.

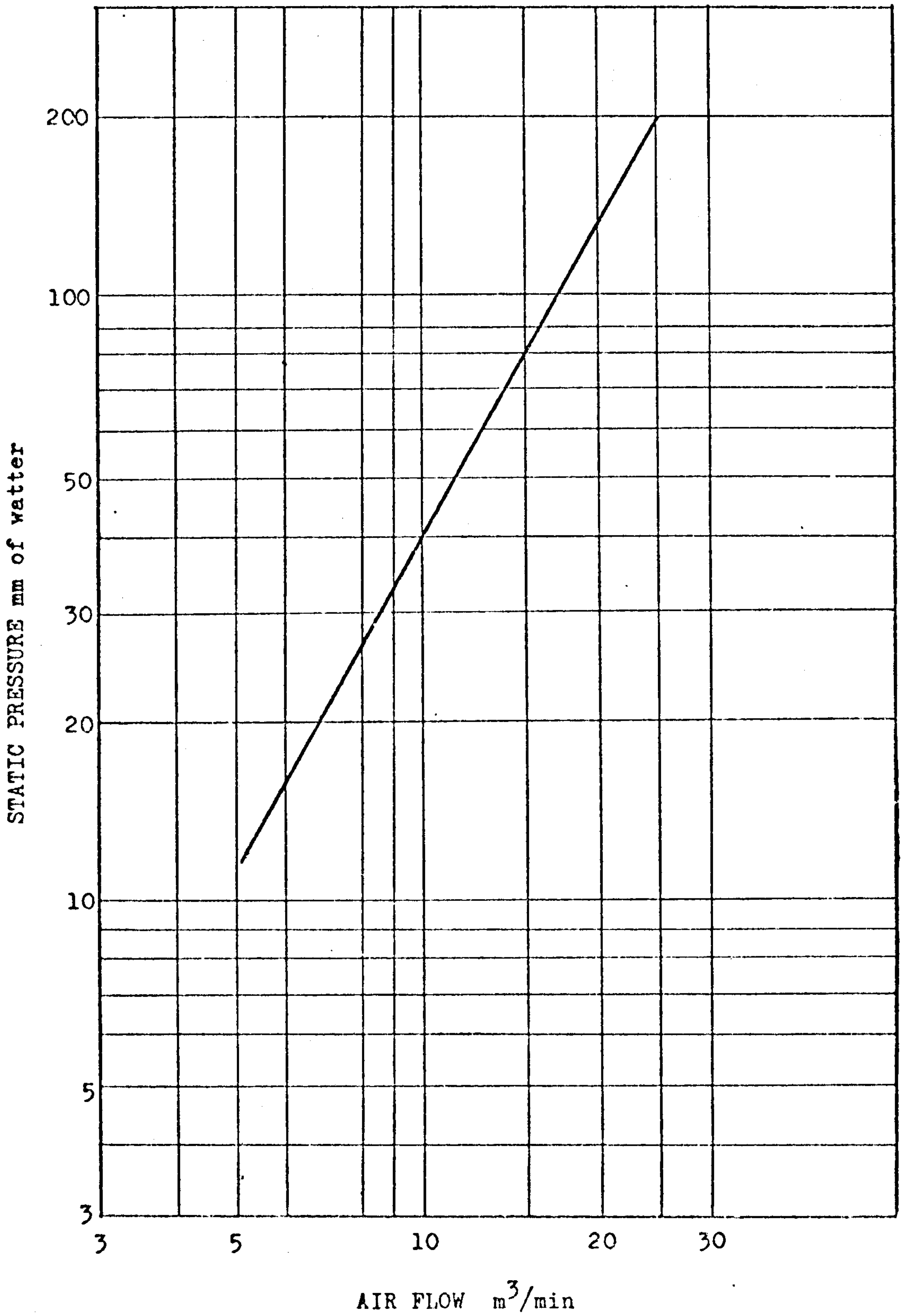

CONSTANT CURRENT CHARACTERISTICS
FILAMENT VOLTAGE (Ef) = 7.5 VOLTS AC
GRID NO.2 VOLTAGE (Ec2) = 800 VOLTS
Ib=16A
14
12
10
8
6
4
2
1
0.5
Ic1=0.8A
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Ic2=0.4A
0.3
0.2
0.1
PLATE VOLTAGE (Eb) IN VOLTS
1000
2000
3000
4000
5000
6000
7000
8000
GRID NO.1 VOLTAGE (Ec1) IN VOLTS
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160


CONSTANT CURRENT CHARACTERISTICS
FILAMENT COLTAGE (Ef) = 7.5 VOLTS AC
GRID NO.2 VOLTAGE (Ec2) = 1000 VOLTS
Ib=16A
14
12
10
8
6
4
2
1
0.5
Ic1=0.8A
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Ic2=0.5A
0.4
0.3
0.2
0.1
PLATE VOLTAGE (Eb) IN VOLTS
1000
2000
3000
4000
5000
6000
7000
8000
GRID NO.1 VOLTAGE (Ec1) IN VOLTS
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180


CONSTANT CURRENT CHARACTERISTICS
FILAMENT COLTAGE (Ef) = 7.5 VOLTS AC
GRID NO.2 VOLTAGE (Ec2) = 1200 VOLTS
Ic1=0.8A
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Ic2=0.6A
0.5
0.4
0.3
0.2
0.1
Ib=16A
14
12
10
8
6
4
2
1
0.5
0.1
PLATE VOLTAGE (Eb) IN VOLTS
1000
2000
3000
4000
5000
6000
7000
8000
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
GRID NO.1 VOLTAGE (Ec1) IN VOLTS

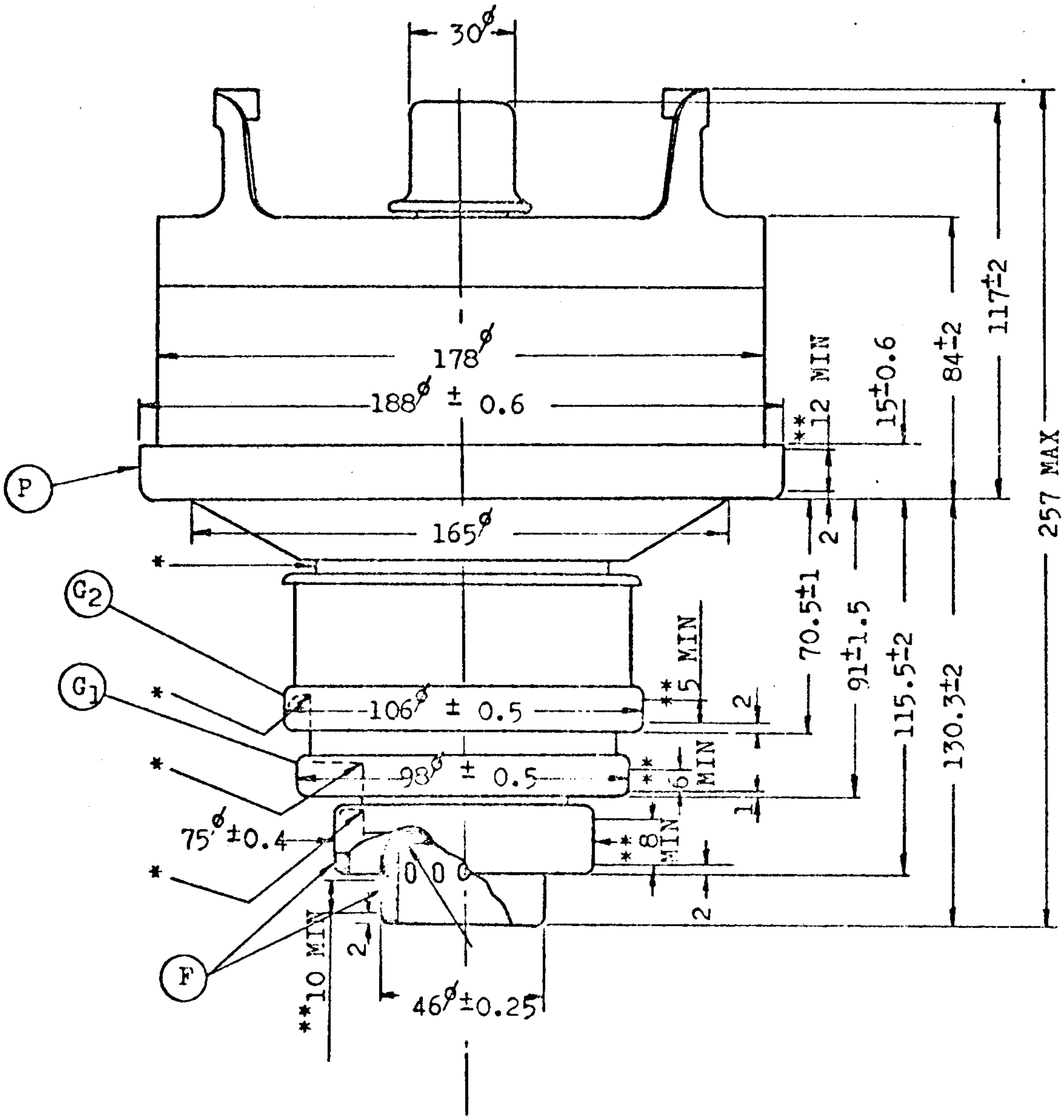

CONSTANT CURRENT CHARACTERISTICS
FILAMENT VOLTAGE (Ef) = 7.5 VOLTS AC
GRID NO.2-TO-GRID NO.1 VOLTAGE (Eg1g2) = 1000 VOLTS
Ib=16A
14
12
10
8
6
4
2
1
0.5
Ic1=0.6A
0.4
0.2
0.1
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Ic2=0.8A
PLATE-TO-GRID NO.1 VOLTAGE (Eg1p) IN VOLTS
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
120
140
CATHODE-TO-GRID NO.1 VOLTAGE (Eg1k) IN VOLTS

AIR COOLING CHARACTERISTICS



OUTLINE DRAWING

(Unit in mm)




** CONTACT SURFACE