from JETEC release #2320, Nov. 17, 1958

7110, 7111, 7112

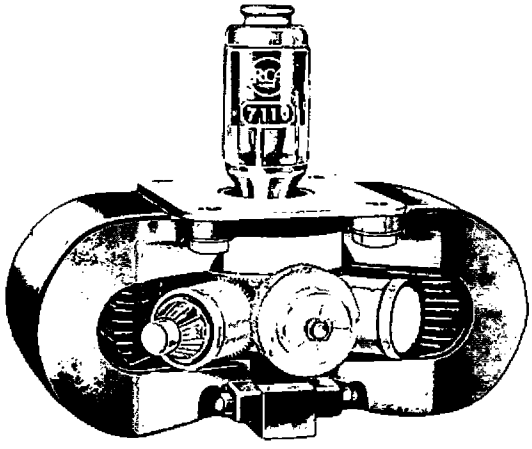
TUNABLE MAGNETRONS

Integral Magnet
Forced-Air Cooled

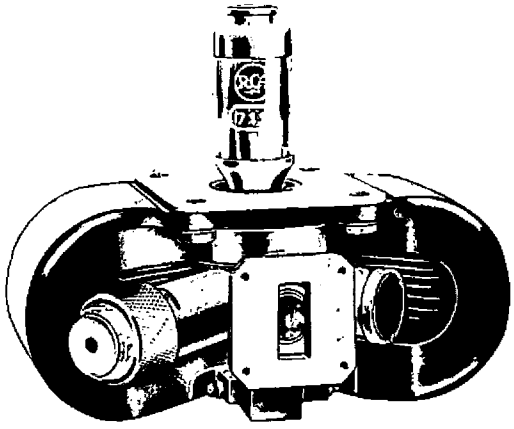
8500 - 9600 Mc
For Pulsed-Oscillator Service
TENTATIVE DATA

230 Kw Peak
Power Output

RCA-7110, -7111, and -7112 are tunable magnetrons intended for pulsed oscillator service at frequencies between 8500 and 9600 megacycles per second. They offer the advantage of providing



an adjustable frequency for radar equipment without requiring appreciably more space than that occupied by a fixed-frequency magnetron having comparable power output.



These three magnetron types differ only mechanically in the location of the tuning controls and the micrometer-type indicator provided to facilitate frequency calibration of each tube.

Type 7110 utilizes a knurled tuning knob equipped with a locking nut. On type 7111, the tuning knob must be pushed in to engage the tuning mechanism. Type 7112 (not illustrated) features a tuning shaft which permits the use of a remote control for adjustment.

Each of these types operates with high efficiency and with full power ratings at pulse durations up to 2.6 microseconds. Each type has a maximum peak input power rating of 630 kilowatts, a maximum peak anode voltage rating of 23 kilovolts, and a maximum peak anode current rating of 27.5 amperes. When operated at a peak anode current of 27.5 amperes, corresponding to a peak anode voltage of about 22 kilovolts. Each type is capable of giving a peak power output of approximately 230 kilowatts.

The design of the 7110, 7111, and 7112 features excellent stability at a high rate of rise of anode voltage and provides good spectrum shape, low pushing figure, good frequency stabilization, low thermal drift during warm-up and after tuning, and a relatively uniform power output over the operating frequency range.

RCA-7110, -7111, and -7112 are ruggedly constructed. Samples of their design have withstood a shock impulse of 30 g for a period of 11 milliseconds. Furthermore, these types exhibit a negligible amount of frequency modulation under vibration accelerations of 2 g from 50 to 500 cps.

Employed in these types are: an axial cathode having good structural rigidity; a getter to maintain a high vacuum and minimize any tendency toward arcing after a period of storage; a double-helical heater to minimize mechanical resonance of the heater and to reduce hum modulation at the power-line frequency; and an output waveguide which can be coupled to a standard JAN RG-51/U waveguide by means of a modified JAN UG-52A/U choke flange. The output waveguide flange and the mounting flange are designed to

ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

7110, 7111, 7112 10-58
Printed in U.S.A.

permit use of pressure seals. The heater-cathode stem will operate without electrical breakdown at atmospheric pressures as low as 600 mm of mercury.

Types 7110, 7111, and 7112 are electrically similar to the servo-tunable type 7008, as well as to the fixed-frequency type 4J50. All of these types have a similar mounting arrangement.

GENERAL DATA

Electrical:

Heater, for Unipotential Cathode:		
Voltage (AC or DC)	13.75 ± 10%	volts
Current at 13.75 volts	3.15	amperes
Starting Current	Must never exceed 12 amperes even momentarily	
Minimum Cathode Heating Time	2.5	minutes
Frequency	8500 - 9600	Mc
Maximum Frequency Pulling at VSWR of 1.5	15	Mc

Mechanical:

Operating Position . . . . . Any

Dimensions . . . . See *Dimensional Outline* for Each Type

Air Flow:

To Pins--An air stream should be directed along the cooling fins toward the body of the tube. Adequate flow should be provided so that the temperature of the anode block does not exceed 150° C. Typical air-flow requirements are shown in Fig.1.

To Heater Cathode Terminal--Adequate flow should be provided to maintain the temperature of the heater-cathode terminal below 165° C.

Waveguide Output Flange. . . . . .Mates with Modified JAN UG-52A/U Flange

Heater & Heater-Cathode Connector with built-in capacitor. . . . . Jettron No. 9000-C* or Ucinite No. 11536#**

Tuning Shaft with Associated Calibrated Indicator:

Revolutions (Approx.) to cover full range of 8500 to 9600 Mc—	
Type 7110	12
Type 7111	8-1/2
Type 7112	25
Maximum Torque (Absolute) at tuning-range stops	200 oz-in.
Typical Torque between -55° and +150° C (Approx.)	50 oz-in.
Weight (Approx.)	12 lbs

PULSED OSCILLATOR SERVICE

Maximum and Minimum Ratings, *Absolute Values:*

For Duty Cycle up to 0.0011 max.

PEAK ANODE VOLTAGE	23 max.	kv
PEAK ANODE CURRENT	27.5 max.	amp
PEAK POWER INPUT●	630 max.	kw
AVERAGE POWER INPUT	0.630 max.	kw
PULSE DURATION	2.6 max.	μsec
RATE OF RISE OF VOLTAGE PULSE	200 max.	kv/μsec
	70 min.	kv/μsec
ANODE-BLOCK TEMPERATURE	150 max.	°C
HEATER-CATHODE TERMINAL TEMPERATURE	165 max.	°C
LOAD VOLTAGE STANDING WAVE RATIO	1.5 max.	

Typical Operation# with Load Voltage Standing Wave Ratio Equal to or Less than 1.05, except as noted:

With Duty Cycle of 0.001

Heater Voltage			See Text
Peak Anode Voltage	22	22	kv
Peak Anode Current	27.5	27.5	amp
Pulse Repetition Rate	400	4000	pps
Pulse Duration	2.5	0.25	μsec
RF Bandwidth with worst phasing of 1.5 VSWR	0.5	5	Mc
Side Lobes with worst phasing of 1.5 VSWR	8	10	db
Pulling Figure at VSWR of 1.5	10	10	Mc
Pushing Figure	0.2	0.2	Mc/amp
Thermal Factor for any 30° range of anode-block temperature between -55° C and 150° C	0.2	0.2	Mc/°C
Frequency Deviation due to Tuning Backlash	8	8	Mc
Peak Power Output (Approx.)	230	230	kw

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	Note	*Min.*	*Max.*	
Heater Current	1	2.9	3.3	amp
Peak Anode Voltage	2	20	23	kv
Peak Power Output	3	200	—	kw
Pulses Missing from Total	4,5	—	0.25	%

Note 1: With 13.75 volts ac or dc on heater.

Note 2: With peak anode current of 27.5 amperes. For heater voltage value, see page 5.

Note 3: With peak anode current of 27.5 amperes corresponding to a peak anode voltage in the order of 22 kv, anode-block temperature of 115° C approx., pulse duration of 2.5 microseconds, and maximum load voltage standing wave ratio equal to or less than 1.05. For heater voltage value, see page 5.

Note 4: Pulses are considered to be missing if the energy level at the operating frequency is less than 70% of the normal value.

Note 5: With peak anode current of 27.5 amperes corresponding to a peak anode voltage in the order of 22 kv, anode-block temperature of 115° C approx., pulse duration of 0.25 microsecond, load voltage standing wave ratio of 1.5 adjusted in phase to produce maximum instability. For heater voltage value, see page 5.

● For atmospheric pressure greater than 600 millimeters of mercury in the vicinity of the heater-cathode stem. Operation at pressures lower than 600 millimeters of mercury may result in arc-over across the stem with consequent damage to the tube. The waveguide must always be pressurized to a minimum of 15 psi absolute to prevent arcing, especially when there is a mismatched load. Arcing in the waveguide due to lack of pressure can damage the tube.

\# It is essential that the input circuit be designed so that if arcing occurs the energy per pulse delivered to the tube cannot greatly exceed the normal energy per pulse. To satisfy this requirement, it is recommended that pulsers of the discharging-network type be used.

* Manufactured by Jettron Products, Hanover, N. J.

** Manufactured by Ucinite Div. of United-Carr Fastener Corp., Newtonville 60, Mass.

OPERATING CONSIDERATIONS

The 7110, 7111, and 7112 are rated in accordance with the following definition of the Absolute-Maximum Rating System for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the de-

vice, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

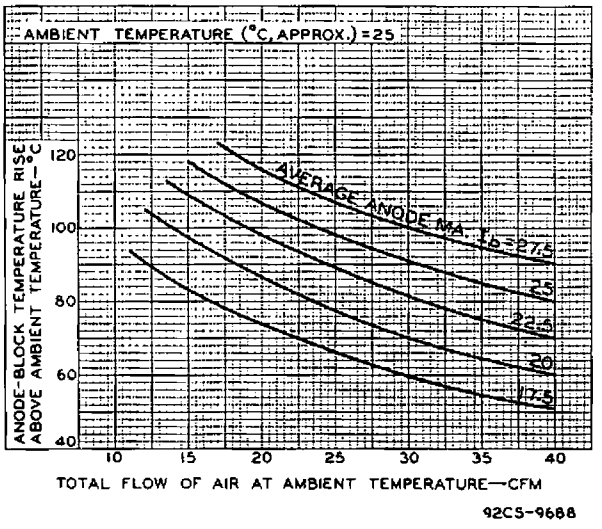


Fig. 1 – Typical Cooling Requirements for Anode Block of Types 7110, 7111, and 7112 with Cooling Arrangement Described in Text.

The equipment manufacturer should design so that initially and throughout life no absolute maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

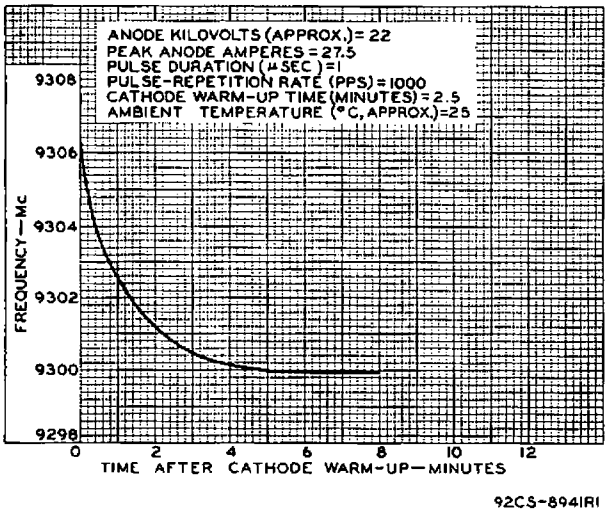


Fig. 2 – Typical Stabilization Characteristic of Types 7110, 7111, and 7112.

The *high voltage at which the 7110, 7111, and 7112 is operated is very dangerous.* Great care should be taken in the design of apparatus to prevent the operator from coming in contact with the high voltage. Precautions include the enclosing of high-potential terminals and the use of interlocking switches to break the primary circuit of the power supply when access to the equipment is required.

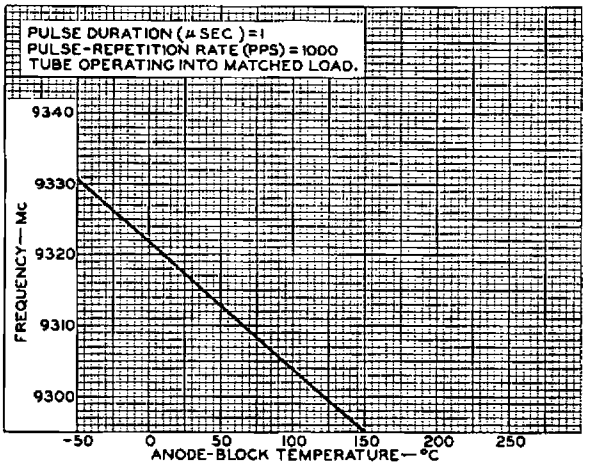


Fig. 3 – Typical Thermal-Factor Characteristics of Types 7110, 7111, and 7112.

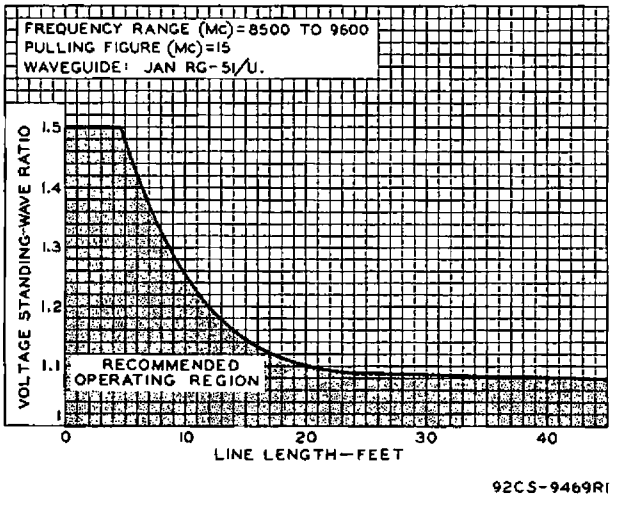


Fig. 4 – Effect of Length of Transmission Line between Output Flange and Load on Allowable Voltage Standing Wave Ratio.

Magnetic-Field Precautions. In general, magnetrons with integral magnets should be stored so as to maintain a minimum distance of 6 inches between tubes. If this precaution is not

followed, excessive interaction may occur with consequent decrease in the strength of the magnetic fields. In addition, it is important to maintain a minimum distance of 2 inches between the magnet and any magnetic materials and to use non-ferrous tools during installation. Failure to observe this latter precaution may subject the magnet to sharp mechanical shocks which may result in demagnetization of the magnet. Furthermore, precautions should be observed to insure that the magnetic field of the 7110, 7111, and 7112 does not affect nearby instruments and tubes.

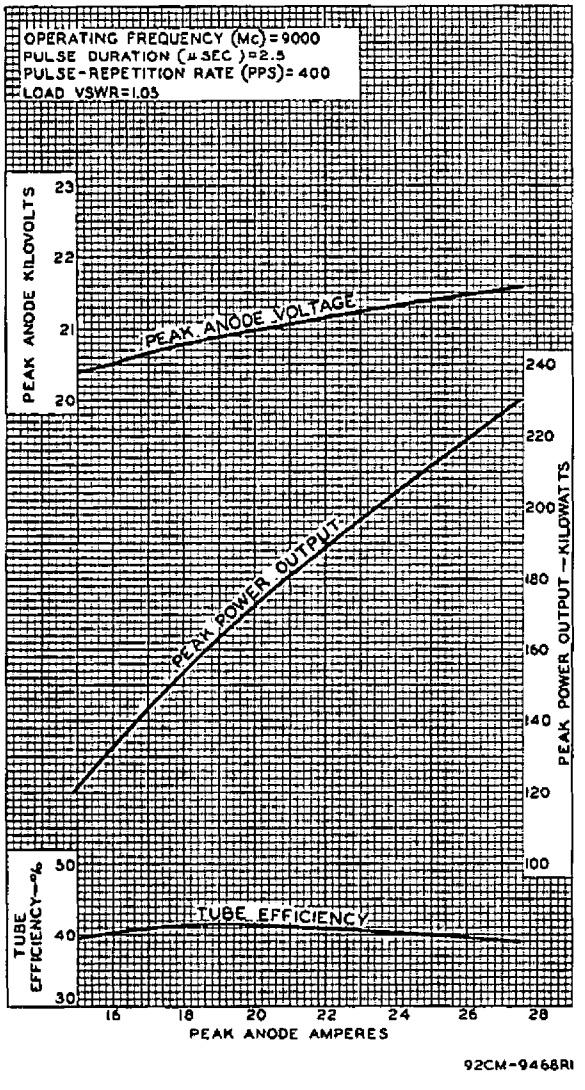


Fig. 5 - Typical Performance Curves for Types 7110, 7111, and 7112.

In the *handling* of the 7110, 7111, and 7112, exercise care to prevent rough treatment which might distort the metal structure and cooling fins. Any such distortion may result in loss of vacuum or impairment of the electrical characteristics. *The tube should never be held by the heater-cathode stem* because undue strain on the cathode assembly will weaken the structure and will result in permanent damage to the tube.

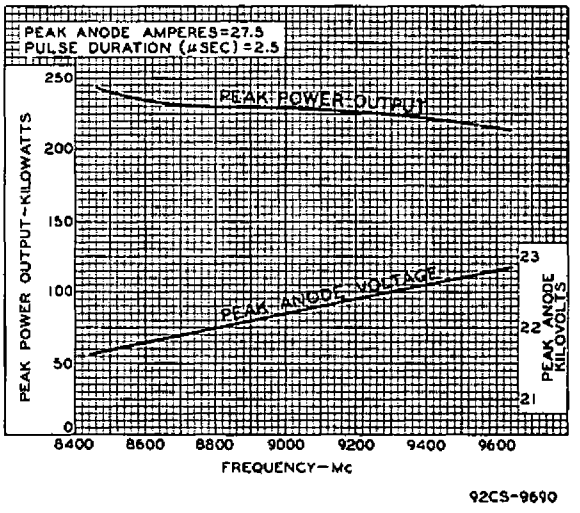


Fig. 6 - Typical Performance Curves for Types 7110, 7111 and 7112.

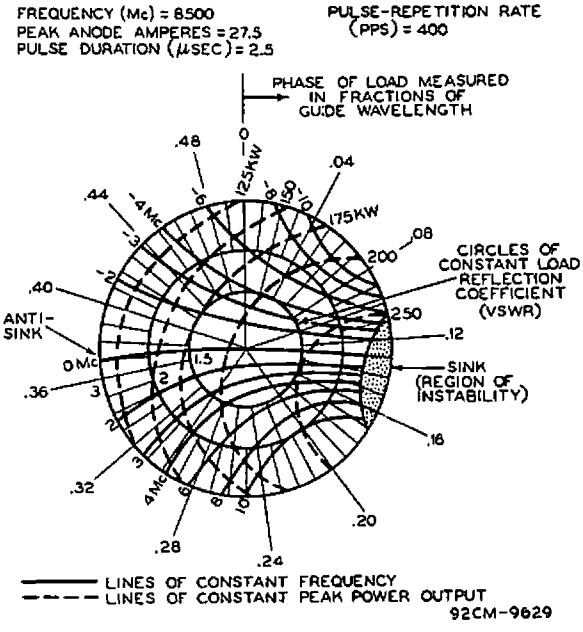


Fig. 7 - Rieke Diagram for Types 7110, 7111, and 7112.

Mounting of each of these three magnetron types should be accomplished by means of its mounting flange which may be positioned to operate the tube in any orientation. This flange is made to permit use of each type in applications

requiring a pressure seal. Care should be taken by the equipment designer to insure that the tube is mounted on a surface having adequate flatness so as to avoid possible distortion of the mounting flange when it is bolted to the mounting surface.

Fastening the JAN RG-51/U waveguide to the waveguide output flange of the tube is accomplished in the following manner. A JAN UG-52A/U choke flange or equivalent should be modified by drilling out the screw threads from the four mounting holes in the choke flange using a No.15 drill. This operation will permit four size 8-32

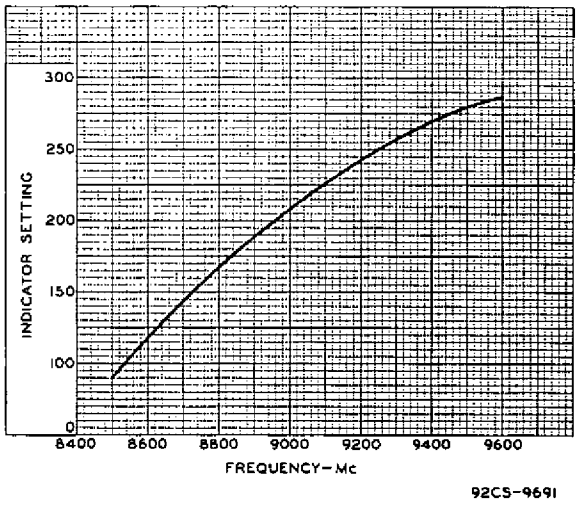


Fig.8 - Representative Tuning Characteristic of Types 7110, 7111, and 7112.

bolts inserted through the flange mounting holes, to engage the threaded waveguide output flange of the tube.

Cooling of the anode block is accomplished by directing a separate stream of clean air through each set of cooling fins toward the anode block. The two streams are provided from two 3/4-inch-diameter ducts placed 1/2" to 3/4" from the fins.

After the *heater voltage* is raised gradually to its rated value of 13.75 volts, allow the cathode to warm up for at least 2-1/2 minutes to make sure that the cathode reaches operating temperature. When the cathode has reached full operating temperature, high-voltage pulses, negative with respect to anode (ground), can be applied to the heater-cathode terminal. As soon as the high-voltage pulses are applied, the heater voltage (E_f) should preferably be reduced in accordance with the following formula, depending on the average power input (P_i) to the tube:

P_i up to 450 watts: $E_f = 13.75\left(1-\frac{P_i}{450}\right)$ volts

P_i greater than 450 watts: $E_f = 0$ volts

In those cases where these types are used as replacements for the fixed-frequency type 4J50, it is permissible to apply the following formula which is specified for reducing the heater voltage on the 4J50.

P_i up to 100 watts: $E_f = 13.75$ volts

P_i greater than 100 watts: $E_f = 14\left(1-\frac{P_i}{1120}\right)$ volts

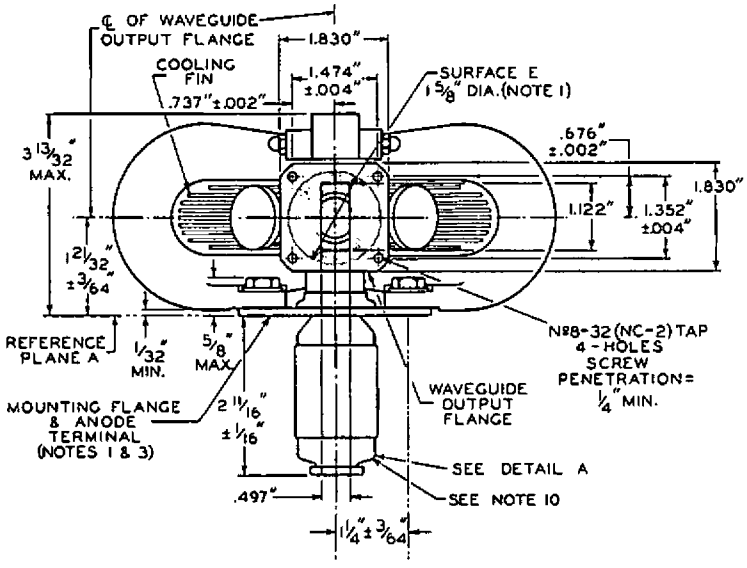
For *standby operation*, during which the high-voltage pulses are not applied to the tube, the heater voltage should be restored to 13.75 volts.

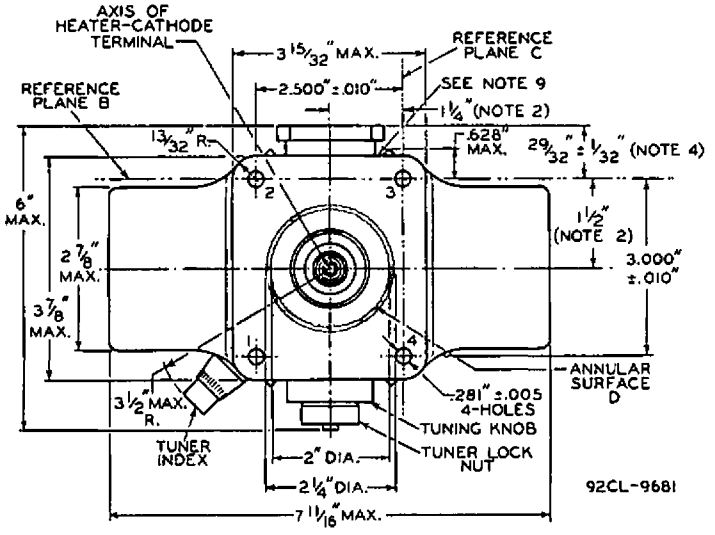
Tuning of the 7110 is accomplished by turning the tuning knob until the setting of the micrometer-type indicator is reached which corresponds to the desired frequency, as determined from the calibration chart prepared for each tube. Then lock the tuning knob by tightening the locking nut. Type 7111 is tuned by pushing in on the knurled tuning knob and turning it until the desired setting of the calibrated indicator is reached. Releasing the knob allows a spring to disengage it from the tuning mechanism. The 7112 can be tuned in the same manner as the 7110 except that a screw-driver slot is provided in the tuning shaft. If desired, a flexible coupling may be attached to this shaft and the tube tuned remotely. The designs of the 7111 and 7112 provide an essentially constant operating frequency without requiring a positive mechanical lock even though the tube is subjected to vibration.

For precise tuning adjustment, the final indicator setting should be approached using the same direction of rotation of the tuning shaft. There is little frequency drift after changing tuner setting.

Our engineers are ready to assist you in circuit applications of the 7110, 7111, and 7112. For further information, write to Commercial Engineering, RCA, Harrison, New Jersey, giving complete details as to the proposed service.

DIMENSIONAL OUTLINE
for Type 7110





REFERENCE PLANE A IS DEFINED AS THE PLANE THROUGH THAT PORTION OF THE MOUNTING FLANGE DESIGNATED AS ANNULAR SURFACE D.

REFERENCE PLANE B IS DEFINED AS THE PLANE WHICH IS PERPENDICULAR TO PLANE A AND PASSES THROUGH THE EXACT CENTERS OF MOUNTING-FLANGE HOLES NO.2 & NO.3.

REFERENCE PLANE C IS DEFINED AS THE PLANE WHICH IS PERPENDICULAR TO PLANE A & PLANE B AND PASSES THROUGH THE EXACT CENTERS OF MOUNTING-FLANGE HOLES NO.3 & NO.4.

NOTE 1: SURFACE E OF THE WAVEGUIDE OUTPUT FLANGE, AND THE ENTIRE SURFACE OF THE MOUNTING FLANGE ARE MADE SO THAT THEY MAY BE USED TO PROVIDE A HERMETIC SEAL.

NOTE 2: THE AXIS OF THE HEATER-CATHODE TERMINAL WILL BE WITHIN THE CONFINES OF A CYLINDER WHOSE RADIUS IS 3/64" AND WHOSE AXIS IS PERPENDICULAR TO REFERENCE PLANE A AT THE SPECIFIED LOCATION.

NOTE 3: ALL POINTS ON THE MOUNTING FLANGE WILL LIE WITHIN 0.015" ABOVE OR BELOW REFERENCE PLANE A.

NOTE 4: THE LIMITS INCLUDE ANGULAR AS WELL AS LATERAL DEVIATIONS.

NOTE 5: THESE DIMENSIONS DEFINE EXTREMITIES OF THE 0.169" INTERNAL DIAMETER OF THE CYLINDRICAL HEATER TERMINAL.

NOTE 6: THESE DIMENSIONS DEFINE EXTREMITIES OF THE 0.540" INTERNAL DIAMETER OF THE CYLINDRICAL HEATER-CATHODE TERMINAL.

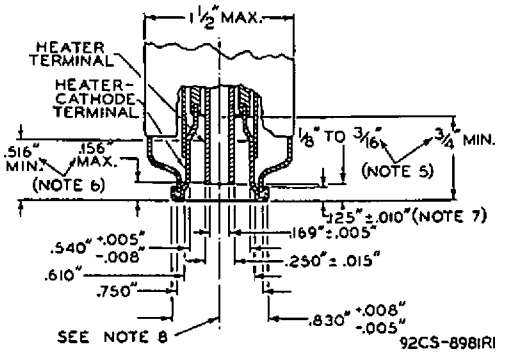
NOTE 7: NO PART OF THE CONNECTOR DEVICE FOR THE HEATER AND HEATER-CATHODE TERMINALS SHOULD BEAR AGAINST THE UNDERSIDE OF THIS LIP.

NOTE 8: THE HEATER TERMINAL AND THE HEATER-CATHODE TERMINAL ARE CONCENTRIC WITHIN 0.010".

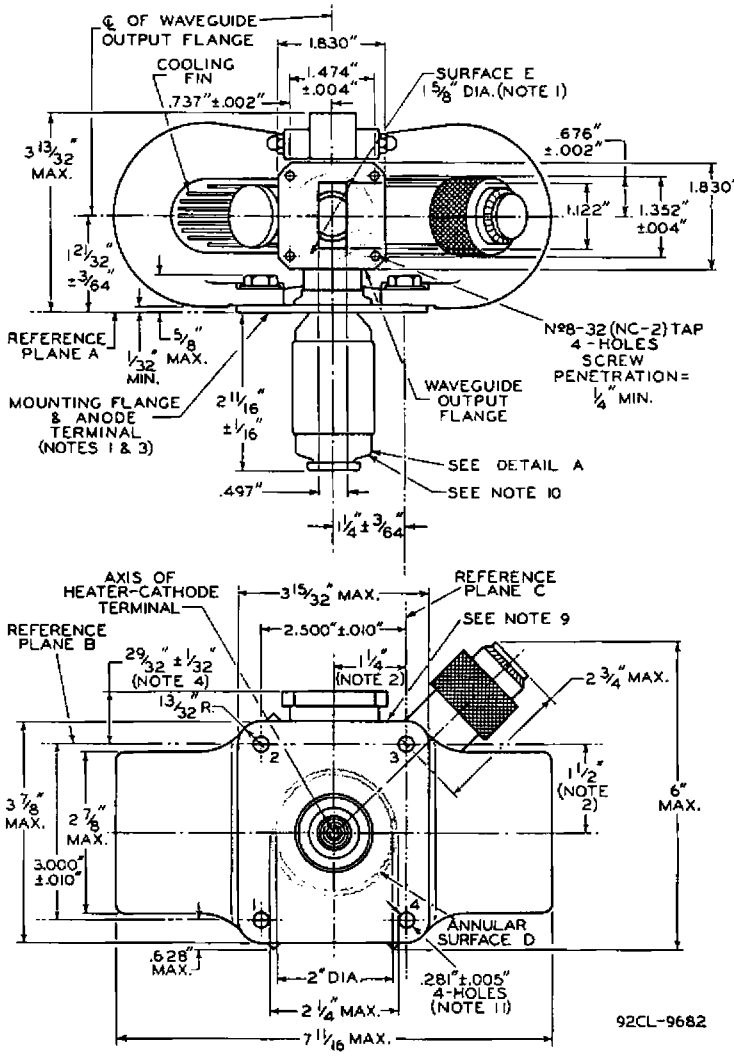
NOTE 9: ANODE TEMPERATURE MEASURED AT JUNCTION OF WAVEGUIDE AND ANODE BLOCK.

NOTE 10: CATHODE TEMPERATURE MEASURED HERE.

DETAIL A



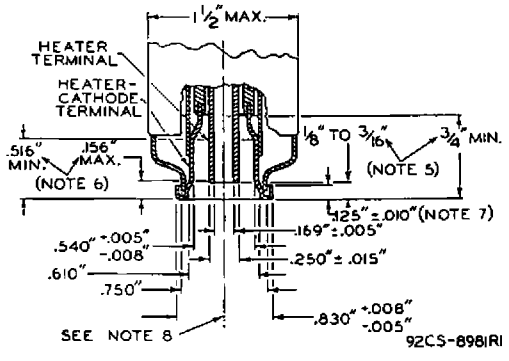
DIMENSIONAL OUTLINE
for Type 7111



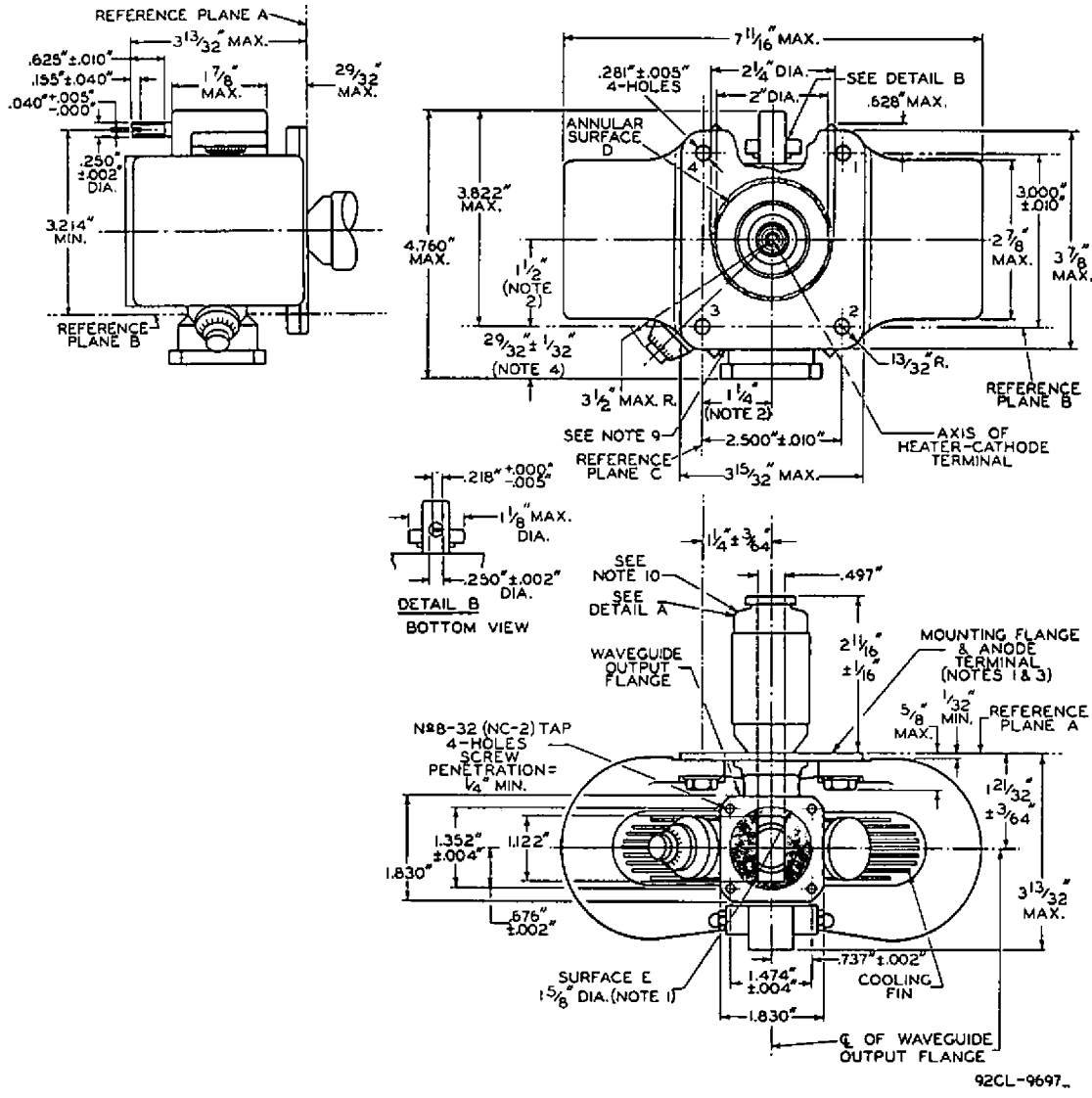
For Reference-Plane Definitions and Notes 1 - 10, See Page 6.

NOTE 11: THE ENDS OF THE MOUNTING STUDS MUST NOT PENETRATE THROUGH THE MOUNTING HOLES MORE THAN 1-3/32" FROM THE MOUNTING FLANGE SURFACE.

DETAIL A



DIMENSIONAL OUTLINE
for Type 7112



For Reference-Plane Definitions and Notes 1-10, See Page 6.

DETAIL A