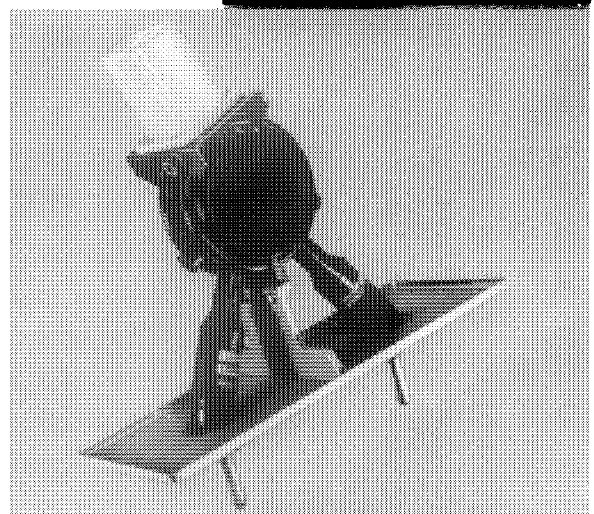
TYPE QK630

GENERAL DESCRIPTION

The QK630 is a self-excited oscillator capable of producing a minimum of 550 kilowatts peak power output. Used with a tunable, external cavity the combination is an oscillator frequency stabilized to a high degree and tunable from 1270 to 1350 Mc.

The information contained herein is representative of a small number of prototypes and is not necessarily representative of the final tube. Detailed information on specific applications may be obtained by contacting the Applications Engineering Department, Microwave and Power Tube Division, Raytheon Company, Waltham 54, Massachusetts.



PULSED-TYPE STABILOTRON OSCILLATOR

GENERAL CHARACTERISTICS

ELECTRICAL

Heater Characteristics

Heater current preheat	2.4 A
Heater current operate	2.4 A
Heater voltage @ 2.4 A	27-33 V
Minimum preheat time	3 Minutes
Cold heater resistance	2.0 ohms (Approx.)

Typical Operation

Pulse duration	3.0 usec
Duty cycle	.0024
Peak anode voltage	35 kv
Peak anode current	37 A
Average anode current	89 mAdc
Peak power output	550 kw
Average power output	1320 W
VSWR	1.1/1
Frequency region	1270-1350 Mc
RF bandwidth	0.67 Mc

MECHANICAL

Overall dimensions	19.625" x 18.3" x 8.125"
Net weight: tube	16 lbs.
magnet, typically	40 lbs.
Mounting	Any
Output coupling	Round flange, 3 5/8" diameter
Input coupling	Round flange, 3 5/8" diameter

Printed in U.S.A.

TENTATIVE DATA

Output Pressure	35 psia
Input Pressure	35 psia
Cooling	Forced Water
Cathode bushing	Glass @ atmos. Press.
Vibration	50 cps @ 2.5G
Shock	15G
Magnet Protection	12"

DETAILED ELECTRICAL INFORMATION

HEATER-CATHODE

The cathode must be preheated at 2.4 amperes for at least three minutes prior to the application of the high voltage pulse. Heater current surges in excess of five amperes may cause damage to the tube. When the average anode current is greater than 50 milliamperes, the heater current should be reduced to zero. The application of heater power without forced liquid cooling may cause permanent damage to the tube.

TYPICAL OPERATION

As illustrated in Figure 1 the Stabilotron circuit consists of a Stabilotron tube, a high Q tunable stabilizing system and a feedback mismatch in the output circuit of the tube. The circuit will oscillate when the following conditions are satisfied.

1. $|\Gamma_1|\ |\Gamma_2|$ Gain $\geqq$ 1
2. Total loop phase shift from plane $l\ l^1$ to plane $r\ r^1$ is an integral multiple of 360 degrees.

A portion of the output power is reflected from the reference plane $l\ l^1$. This reflected power travels back through the Stabilotron network with little or no attenuation or reflection and out to the reference plane $r\ r^1$. The energy at the resonant frequency of the cavity is again reflected, amplified by the backward wave principle and arrives at the reference plane $l\ l^1$ at full power level. The energy not at the resonant frequency of the cavity is absorbed by the damping resistor. A line stretcher provides phase adjustment for optimum system performance.

Figure 2 shows a QK630 Stabilotron tube used with a QK629 Stabilizing System. The input of the QK630 is connected to a 1⅝" coax line stretcher which in turn is connected to a cylindrical, tunable cavity. A damping resistor for the purpose of absorbing off resonant energy is connected through a fixed length of 1⅝" coax line to the other side of the cavity. As the cavity is tuned it moves physically toward or away from the tube, changing the line length between the cavity and tube and thus maintaining proper loop phase shift.

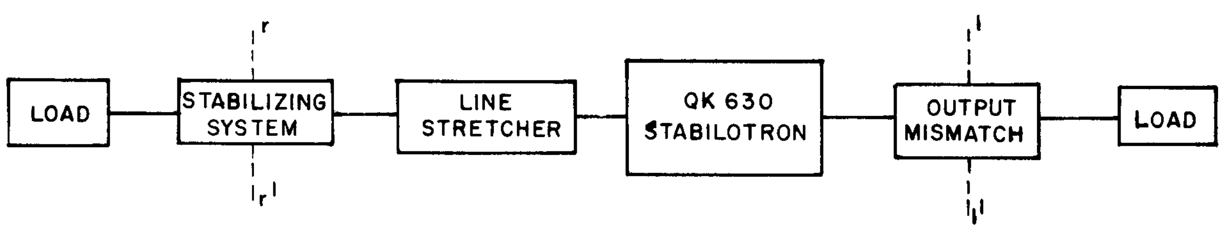


Figure 1

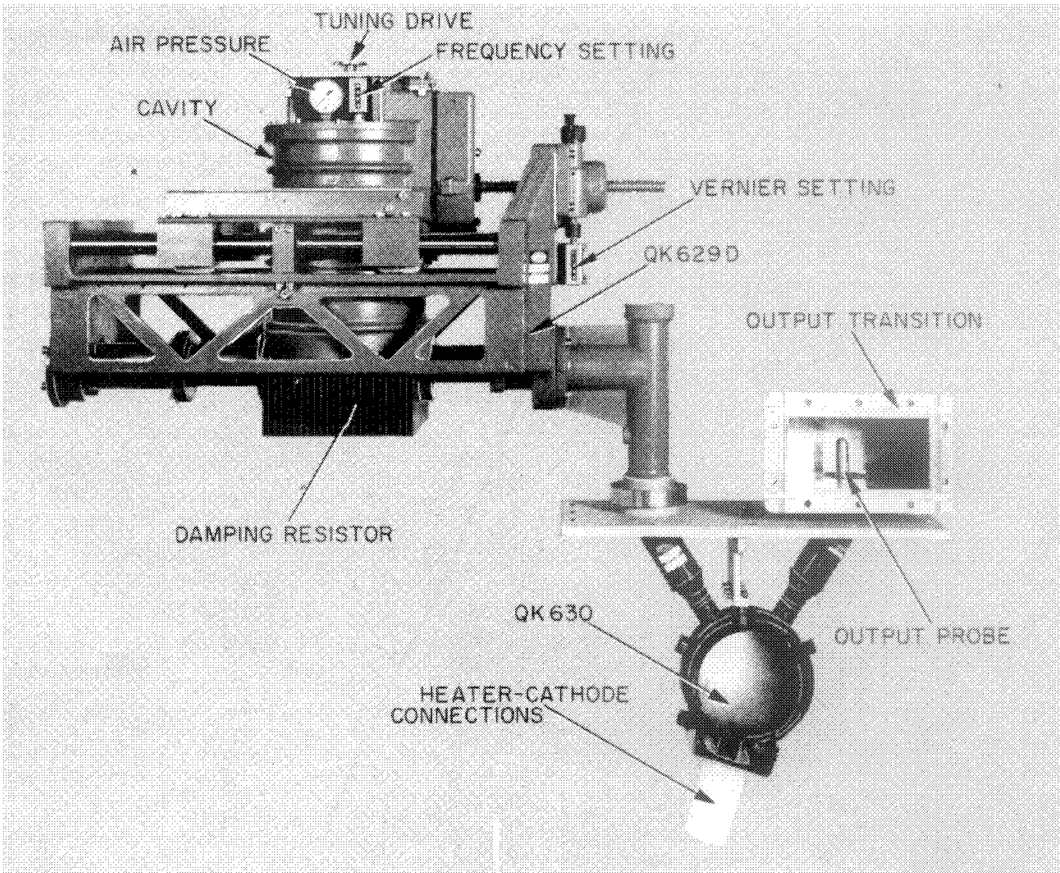


Figure 2

FREQUENCY STABILITY

The phase shift vs frequency characteristics of the stabilizing cavity in the region of cavity resonance has a slope many times greater than that of any other element in the circuit. A slight change in frequency will result when the cavity is subjected to a substantial shift in phase which might be introduced by the antenna load, frequency pushing, etc. Figure 3 demonstrates the frequency shift which occurs for the same phase shift increment in a stabilized and unstabilized system. It is seen that in the stabilized case the resulting frequency change, Δfs, caused by the $\Delta\theta$ increment of phase is much less than the frequency change, Δ fu, in the unstabilized case.

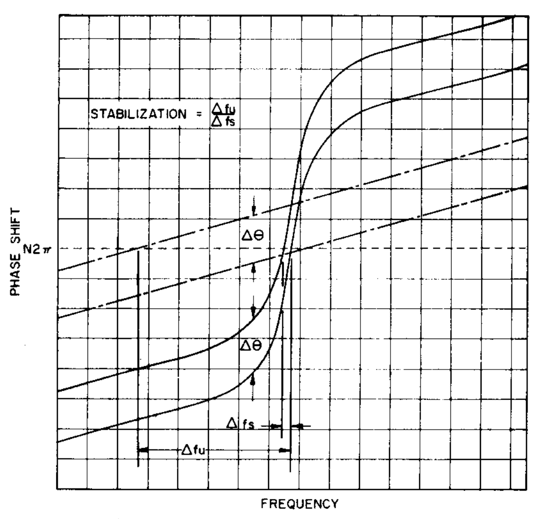


Figure 3

TENTATIVE DATA

OPERATING CHARACTERISTICS

Figure 4 is a plot of peak power output, peak anode voltage, efficiency, and bandwidth variation with respect to frequency.

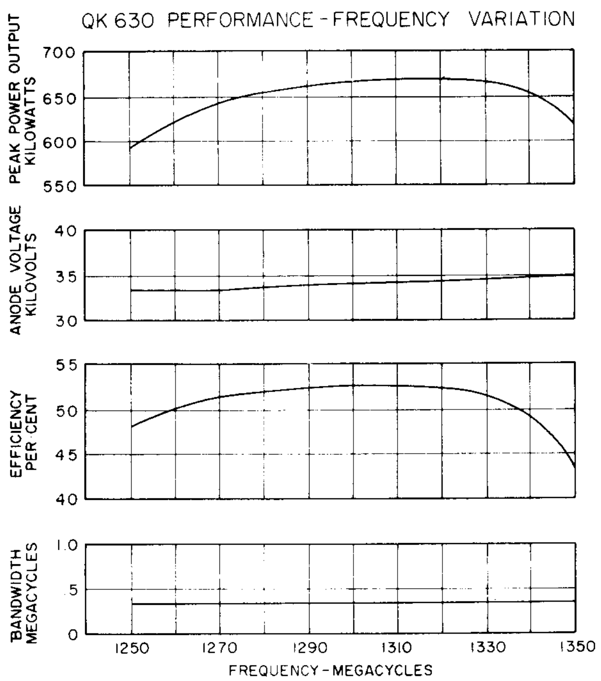


Figure 4

COOLING

The QK630 Stabilotron is a forced liquid cooled tube. The input temperature of the coolant will dictate the flow rate necessary to maintain the anode temperature below the specified maximum of 125°C. Figure 5 shows cooling water flow versus the total input power plotted for different values of anode temperature rise, Δt, above the inlet temperature of the coolant. The relationship of back pressure and water flow is also shown.

PULSE LENGTH AND DUTY CYCLE

The QK630 Stabilotron has been designed and tested at the following pulse conditions. See Figure 6.

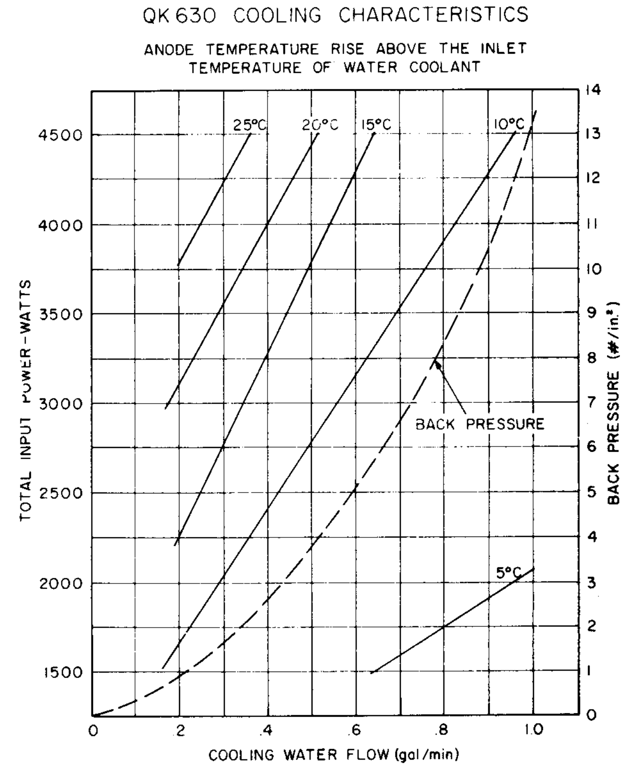


Figure 5

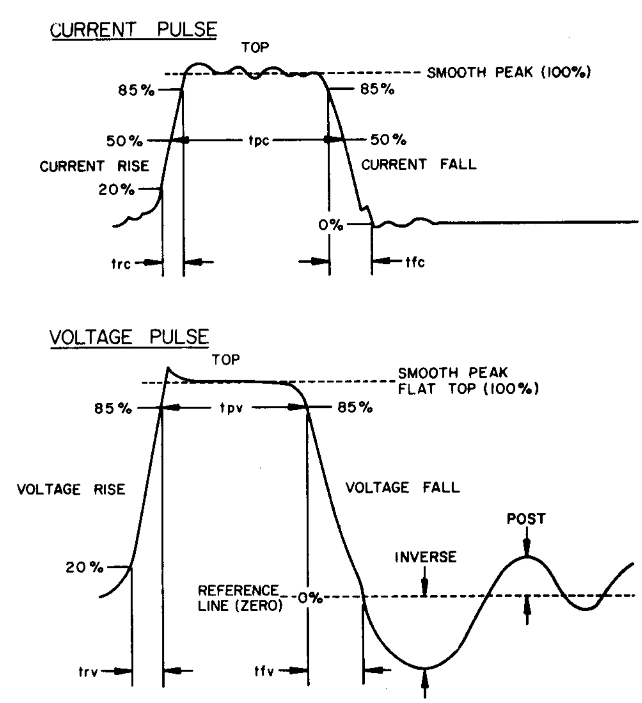


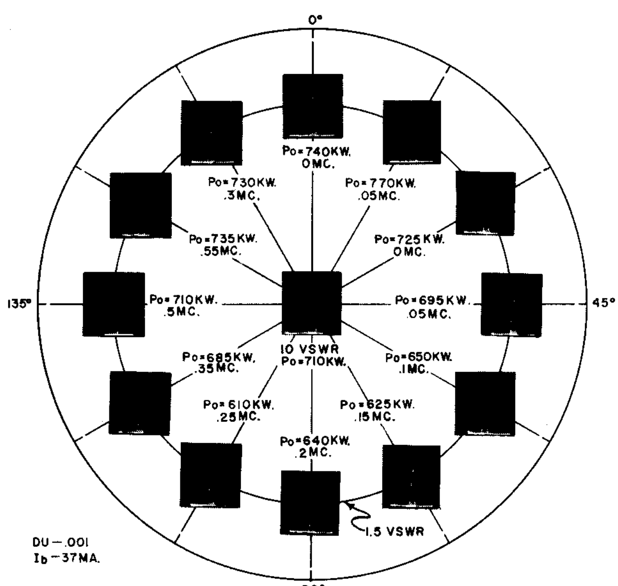
Figure 6

t_{pc} = 3.0 usec (measured at 50%)
t_{rc} = 0.20 usec (measured 20 to 85%)
t_{fc} = 1.30 usec (measured 0 to 85%)
t_{rv} = 0.45 usec (measured 20 to 85%)
t_{fv} = 2.0 usec (measured 0 to 85%)

No spike or ripple should exceed ±2.5% of the average peak value of current or voltage. Inverse voltage should not exceed 25% of the forward voltage. Post voltages should be held to a minimum to avoid post pulse noise or oscillations. If operation at pulse conditions different from those given above is anticipated, the manufacturer should be consulted for further information.

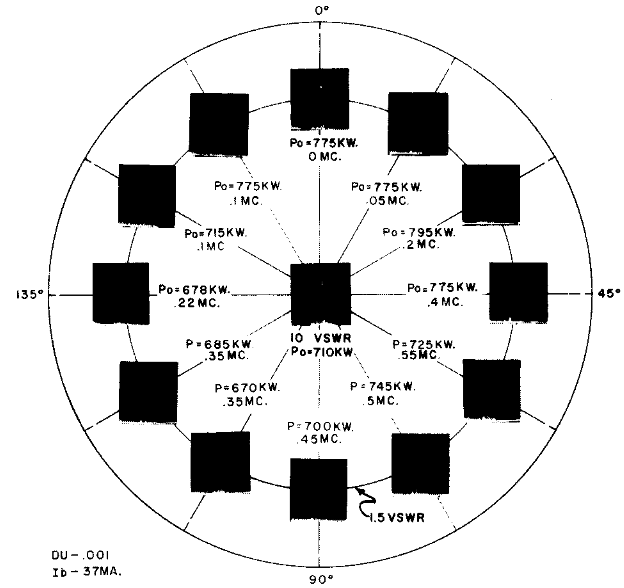
LOAD DIAGRAMS

Figures 7, 8, and 9 are load diagrams of the QK630 Stabilotron at 1270 Mc, 1300 Mc, and 1350 Mc. The output spectrum, peak power output and frequency deviation are shown at a matched load position and several phase positions with a load VSWR of 1.5/1.



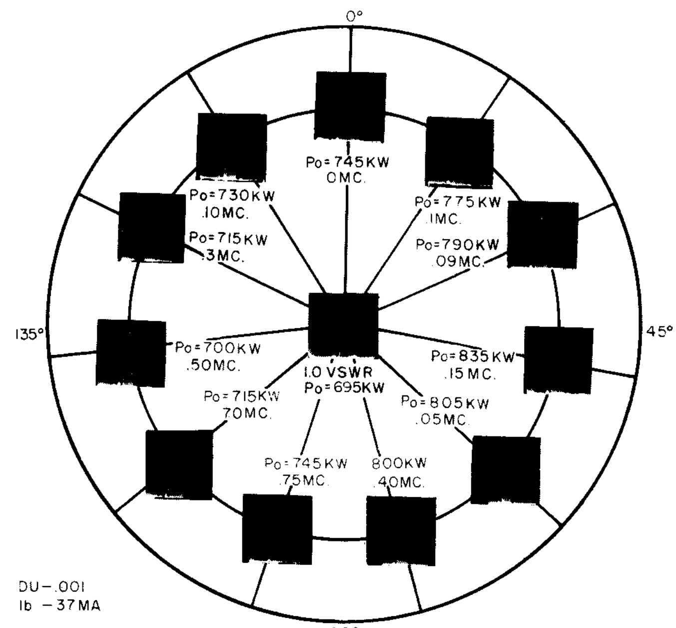
QK 630-LOAD DIAGRAM
FREQUENCY-1270MC/S

Figure 7



QK 630-LOAD DIAGRAM
FREQUENCY-1300MC/S.

Figure 8



QK630-LOAD DIAGRAM
FREQUENCY-1350MC/S

Figure 9

ELECTRICAL CONNECTIONS

Electrical connections are made to the frame of the tube and to the two terminals located on the high voltage cathode bushing. The positive high voltage should be grounded on the mounting surface. Heater connections should be designed to minimize contact resistance and lateral forces on the heater terminals. The common heater-cathode terminal is marked with the letter "C". Drawings of suitable heater-cathode connecting devices are available on request.

MOUNTING

The tube is mounted within the equipment by twelve bolts passed through clearance holes in the rectangular mounting plate. The relative position of the tube is unimportant. Details of the mounting plate are shown in the outline drawing.

COUPLING AND PRESSURIZATION

The input pipe of the tube has been designed to mate with the connection of the QK629 Stabilizing System. The output pipe, identical to the input pipe, is intended to couple into a standard 3" x 6" waveguide (RG-69/U) through the mounting flange shown in the outline drawing. Pressurization of the input and output RF transmission system to 35 psia is required to prevent arcing in the system.

REFERENCES

Final Engineering Report, Volume I on the Design and Development of the Platinotron, Amplitron and Stabilotron: W. C. Brown, Signal Corps Contract No. DA-36-039-sc-56644, December, 1955.

Description and Operating Characteristics of the Platinotron — A New Microwave Tube Device: W. C. Brown, Proceedings of the IRE, September 1957.

Raytheon Technical Information Bulletin — Eng. I: June 1958.

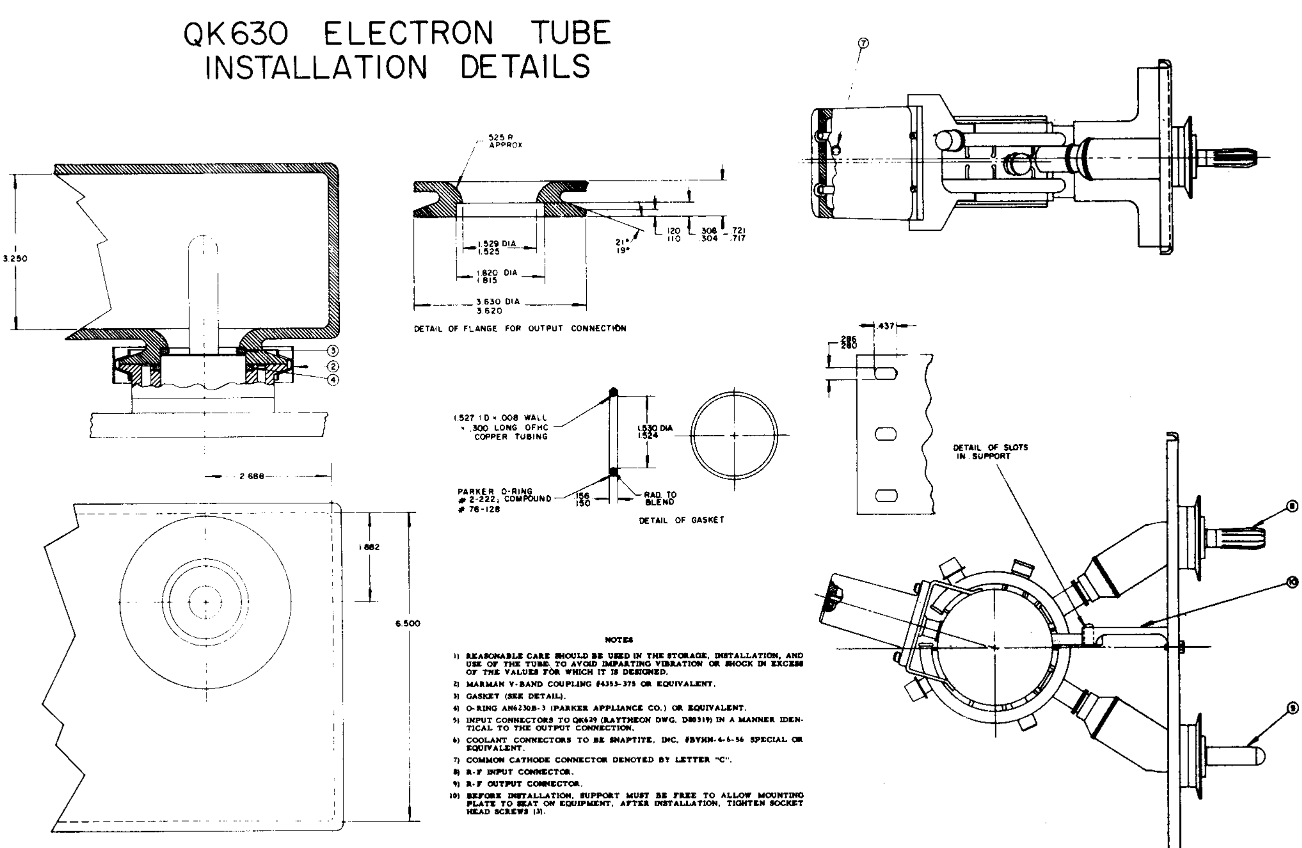
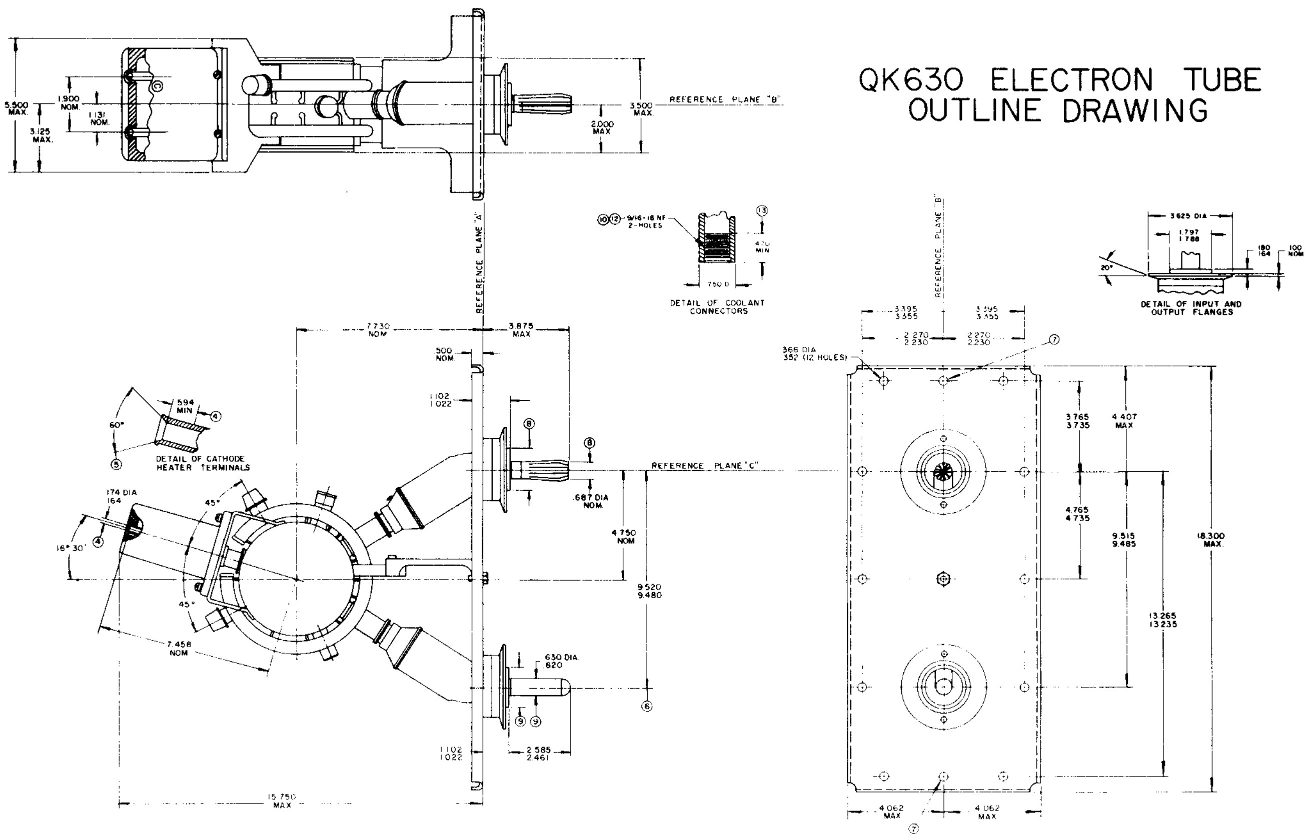


Figure 10



NOTES

1) REFERENCE PLANE "A" IS DEFINED AS A PLANE PASSING ALONG THE FACE OF THE MOUNTING PLATE AS SHOWN
2) REFERENCE PLANE "B" IS DEFINED AS A PLANE PERPENDICULAR TO REFERENCE PLANE "A" AND PASSING THROUGH THE CENTERS OF DIAMETERS "XX" AND "YY" AS SHOWN
3) REFERENCE PLANE "C" IS DEFINED AS A PLANE PERPENDICULAR TO REFERENCE PLANES "A" AND "B" AND PASSING THROUGH THE CENTER OF DIAMETER "XX" AS SHOWN
4) JACK HOLE DIAMETERS APPLY FOR DEPTH SHOWN
5) THIS COUNTERSINK SHALL BE CAPABLE OF ACCEPTING A CONE HAVING A 60° INCLUDED ANGLE AND A BASE DIAMETER OF 0.234 AND SHALL REJECT A SIMILAR CONE HAVING A BASE DIAMETER OF 0.254
6) THIS DIMENSION REFERS TO THE CENTERLINE OF DIAMETER "Y"
7) THESE HOLES TO BE LOCATED ON REFERENCE PLANE "B" WITHIN .015
8) WITH A GAGE HAVING AN 1.820 I.D. AND CONCENTRIC 0.640 I.D. PLACED OVER THESE DIAMETERS, ALL FINGERS OF THE INPUT CONNECTOR MUST CONTACT THE 0.640 DIAMETER
9) A GAGE HAVING A 1.797 I.D. AND CONCENTRIC 0.655 I.D. MUST PASS OVER THESE DIAMETERS
10) PITCH DIAMETER MUST ACCEPT CLASS 2 "GO" GAGE ONLY
11) MINOR DIAMETER MUST NOT BE GREATER THAN 0.513
12) APPLIES TO DEPTH OF FULL THREAD

Figure 11