TECHNICAL INFORMATION

WESTERN ELECTRIC 721A VACUUM TUBE

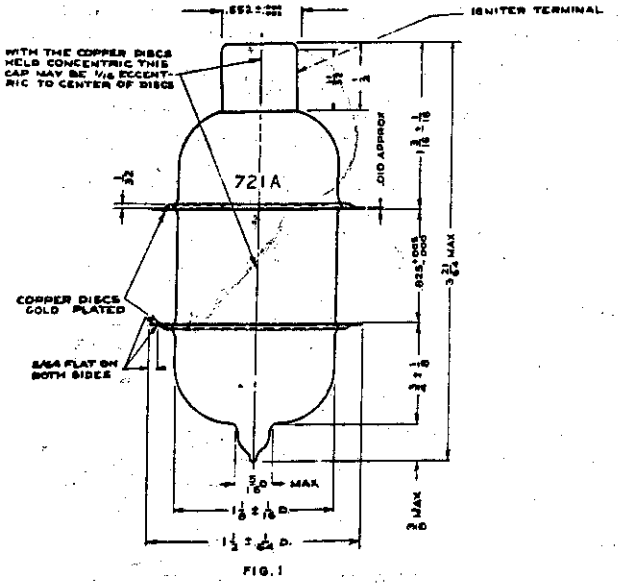

FIG. 1

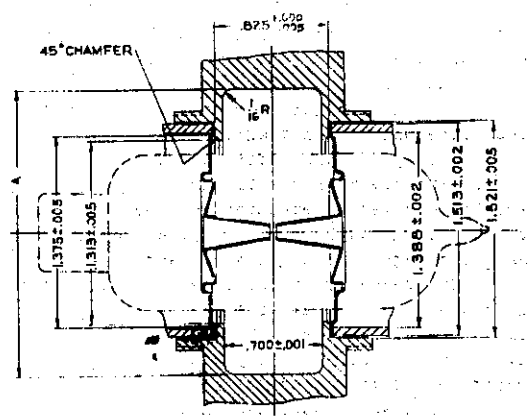

FIG. 2

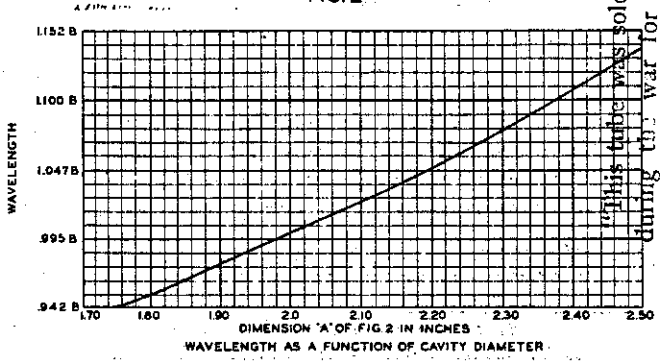

FIG. 3

CLASSIFICATION

The 721A is a double-gap gas-filled tube for use in pulsed systems employing a common antenna, particularly those operating over the range shown in Figure 3. The ultra-high frequency gap is formed by two disc electrodes; the auxiliary gap is provided by an igniter electrode and the adjacent disc.

MOUNTING AND CONNECTIONS

The 721A tube may be mounted in any position. It should be supported only through the electrical connections to the discs. These discs must be clamped between machined surfaces and rings conforming to the dimensions shown in figure 2. For easy insertion, the tube is supplied with a larger spacing between discs than that specified for the circuit. When the tube is installed in the circuit, the clamping mechanism must deform the discs to meet the machined surfaces on a continuous circle of contact with sufficient pressure to provide a low resistance high-frequency connection. The mounting must be constructed so as to clamp the tube without introducing excessive stresses into the tube seals either as a result of initial deformation or as a result of differential thermal expansion over the expected range in operating temperatures. The appearance of strain patterns in the tube envelope, when viewed in polarized light, is a qualitative indication of excessive stresses.

Contact to the cap terminal of the igniter electrode may be made by a quick release clip.

AMBIENT TEMPERATURE

The 721A tube is intended for operation over the temperature range from -40°C to +100°C. Temperatures outside this range may cause mechanical failures. As noted below, under "operation" the electrical behavior of the tube is also temperature dependent.

PRETUNING

The 721A tube is pretuned to operate at predetermined wave lengths to within ± 1% in fixed dimension cavities over the range shown in Figure 3. The mean value of these wave lengths as a function of the cavity size is shown in figure 3. These data apply to tubes mounted in cavities of the type shown in figure 2. The correct dimensions for cavities used in service will depart from those shown because of the effects of the input and output coupling devices and because of the need for tuning adjustments. The total range of the provided tuning adjustment should exceed the desired tuning range of the system by 2% of the mean wave length in order to compensate for the permitted variation between the individual 721A vacuum tubes.

OPERATION

The 721A tube may be used either as a receiver disconnect switch or as a transmitter disconnect switch.

When used as a receiver disconnect switch the tube and its associated circuit effectively disconnects the receiver from the system during the transmitting period. The isolation is not complete; the amount of leakage power, i.e. transmitter power reaching the receiver, depends upon the adjustment of the circuit and to a less extent upon power of the transmitter. Changes in the circuit adjustment to decrease the leakage power (other than those necessary to match the impedances at the input to the 721A tube circuit)

will result in an increase in the low level loss which is introduced in the received signal path. The approximate relationship between the leakage power and the ultimate low level loss for matched input conditions is given by the expression: $P_r = K \frac{T}{1-T}$ watts. Where K is a constant depending upon the tube and its cavity design and to a slight extent upon the transmitter power level and T is the fraction of the received signal power which gets through the circuit. The low level loss expressed in db $(10 \log_{10} \frac{1}{T})$ is normally adjusted to approximately 1 db. The value of K increases gradually with temperature over the recommended operating range. Excessive values may be obtained at temperatures both above and below this range.

Additional leakage power reaches the receiver as a result of direct coupling between the transmitter and the receiver. Some direct coupling occurs within the tube cavity itself through higher order transmission modes which do not excite the tube. The amount of this directly coupled leakage power depends upon the size and shape of the cavity and the type and relative positioning of the input and output devices. It varies directly with the transmitter power level and normally is important only in high power systems. The directly coupled attenuation is usually of the order of 60 db unless special precautions are taken to increase it. A rough check on direct coupling may be made by dropping the transmitter power level and observing the change in the leakage power.

The recovery of the tube after the transmitting period is not instantaneous. The additional loss at the end of the transmitting period varies with the ambient temperature from a few db at temperatures of 20 degrees centigrade or higher to approximately 50 db at a temperature of -40 degrees. At normal temperatures this loss decreases rapidly with time, returning to within 3 db of the ultimate low level loss value in approximately 2 microseconds.

The power dissipated in the tube during the transmitting period varies with the transmitter power with the effectiveness of the circuit and with the circuit adjustment. The approximate relationship is given by the expression: $P_g = \left(\frac{PK}{1-T}\right)^{1/2}$, watts, where P is the transmitter output, and K and T have the same meaning as above. The life of the tube may be materially increased by maintaining P_g at a low value.

When used as a transmitter disconnect switch, the tube and its associated circuit effectively disconnect the transmitter from the system during the receiving period. Some low level loss is introduced so that of the received power only a definite fraction F of this will be directed toward the receiver. The power dissipated in the tube during the transmitting period varies with the circuit adjustment, being given by the expression: $P_g = \left(\frac{PK\,F}{1-F}\right)^{1/2}$, watts, where the symbols have their previous meanings.

The resonant frequency of the 721A tube and its associated cavity is temperature dependent, shifting 0 to 0.05 megacycle per degree centigrade over the range from -40°C to +100°C.

CIRCUIT REQUIREMENTS

Since the constant K is a function of both the tube and of the cavity design, satisfactory operation can be obtained only with properly designed cavities. A measure of the goodness of the cavity design can be obtained by measuring Q_o, the unloaded cavity Q. For cavities designed to operate at the same wave length the values of K will vary directly as the respective values of Q_o. In general, a cavity with a Q_o value less than 2,000 will be unsatisfactory.

LIFE

The life expectancy of the 721A tube will vary greatly with the power dissipation requirements which the system places on the tube.

STARTING DISCHARGE

When the 721A tube is used to protect receivers which may be damaged by a temporary overload, a continuous low current discharge must be maintained between the igniter and the adjacent copper disc. The igniter should be negative. An 800 volt d-c source with a current limiting resistance of sufficient value to limit the discharge current to approximately 0.2 ma. is satisfactory. When the starting discharge is not required no connection need be provided to the igniter.

RATING

For the 721A tube mounted in cavity shown in figure 2 with dimension A of 2.000 inches.

Operating Wavelength (B) ± 1%	As specified for the type
Minimum unloaded Q (Q_o)	2500
Maximum instantaneous dissipation	100 Watts
Maximum average dissipation	1 Watt
Maximum value of K when operated within the ratings (in cavity shown in figure 2)	10 Milliwatts
Maximum starting electrode strike voltage	800 Volts
Maximum starting electrode sustain voltage	500 Volts
Minimum starting electrode sustain voltage	400 volts
Maximum starting electrode current (to be limited by a series resistance)	0.2 Milliampere
Operating temperature range	-40°C to +100°C

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