RF NOTE #12

8/12/77
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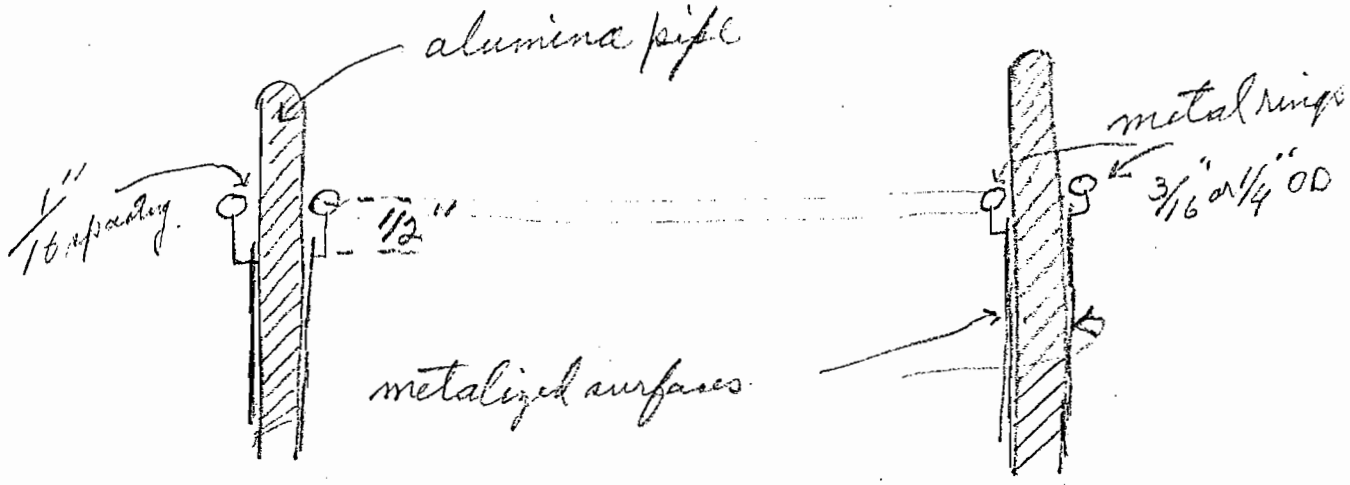
Corona Shield for Plate Blocker

The metalized 7" diameter by 10" long Alumina insulator presently being used on the final amplifier of the cyclotron r.f. system gives trouble due to corona from the sharp edge of the metalizing. It is obvious that this will occur and eventually lead to destruction of these goodies which cost $500 each in 1968 and probably would cost in excess of $1000 to replace now. Ages ago it was learned that place where there is a discontinuity between ceramic, copper and air or vacuum is likely to corona and simple solutions exist. The reason for the problem is that the ceramic has a dielectric constant of 10 so that the electric field in air or vacuum is 10 times greater than in the ceramic. Due to the sharp discontinuity of the metalizing the electric field even in the ceramic is already enhanced by the 1/r factor associated with the radius of curvature of the edge (usually 1 mil). If the average field is 40 KV/cm then at the discontinuity it can easily be 1 MV/cm. Air breaks down at 36 KV/cm.

The problem is divided into two orthogonal parts: dc and rf. The destruction occurs because of arcing along the surface of the insulator when charges from the ionized gas accumulate on the surface of the insulator until the electric field is brought down below the ionizing value. For the d.c. situation there is no way of reducing the field below the ionizing value! The trick then is to fix things so that there is no path along the insulator for charges to wish to travel. For the r.f. case the problem is not due to the potential across the insulator, but from the outer edge to a ground surface.

Both mechanisms for possible failure will become nonexistent with the fix recommended below.



Each time the B^+ is turned on or off the air will still break down and deposit or remove charges from the insulator -- but no arcing along the insulator surface will occur. The r.f. field due to the 10 KV to ground terminates on the shield and causes no problem at the discontinuity. It is averred without proof that the problem was due to the rf field and thus the above solution will clobber the problem.

It is left as an exercise for the ingenious to figure out how to hold the rings. They should be simply spring clamped onto the silver surfaces -- for example brass rings which act as springs.