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A DEMOUNTABLE WAVEGUIDE ASSEMBLY METHOD

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The CSF Company in France has built an electron linac using a process whereby they actually hold together subsections of the cavity mechanically to produce a complete iris-loaded structure, as shown in this sketch.

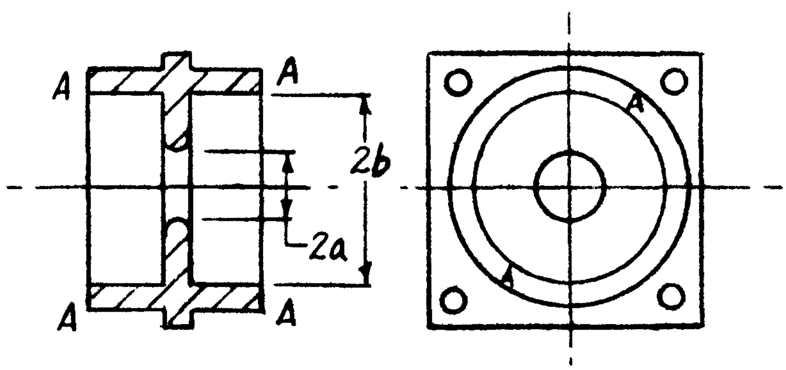

Figure 1

This is a section of an iris-loaded waveguide, and it is repetitive, since in the electron case they would all be exactly the same. In plan, it's a square structure with a hole at each corner. These were precision manufactured, and joined together on tube steel, which is also used as the water cooling tubes for the linac. This is then all squeezed together by means of screw clamps at the end of the water cooling tubes. This, of itself, made a guide whose Q was above 90% of what it theoretically should have been. However, they found that, at high power, they sometimes had some sparking at the joints. So the next step was to put a very thin electroplate of indium on the surfaces of the copper marked "A", and this has cured the trouble. This machine has been in use at Orsay for 3 years. The sections have been taken apart and put together again, obtaining the same resonant frequencies, the same position of operation. As far as CSF is concerned, they would do it again in exactly this way. This process does not produce a vacuum-tight waveguide, so that it must be placed inside a vacuum container.

There are obviously other ways of making a guide. It is interesting to note that Stanford is still trying to find the best way. In the 13 or 14 years I've been connected with the linac business they have tried just about every way that you might think of and are still looking.

I think for those of us who are interested in protons, the CSF way may be especially good because we have to cut each one of our cavities, (or perhaps small groups of cavities) to different phase velocities. I would think that if this technique could be worked out it would be very useful because we could check each group of cavities electrically before assembly and then expect them to be dimensionally the same after assembly. Merle Hoover's scheme would probably not change dimensions, either. I hope to see if there is some way you could make a vacuum seal in this guide at the same time you make the electrical seal.

Hopefully, you could make an indium ring seal which would be vacuum tight.

HOOVER: My recollection is that indium has a horrible vapor pressure at almost any temperature.

POLK: I think it's very good at room temperature.

HOOVER: But, how is it at higher temperatures?

POLK: This may not be so good, but we are using indium in our linac, internally, as a low temperature solder.

HOOVER: Yes, if you keep it cool it's probably alright. The above scheme doesn't really involve diffusion and furnacing. One might put the system that I suggested together by shrink fitting the cylinders to the iris, and then shrink fitting a belly band over the outside to hold the entire assembly in compression at each one of the joints. We feel that this would probably be vacuum tight, because we've been making disk seals for klystron windows this way, and I understand that the klystron seems to work very well.

POLK: Yes, but your alumina is a lot tougher in compression than copper is.

HOOVER: The disk seal of copper should have pretty fair strength in compression.

POLK: Stanford at one time made a guide just that way, except that they didn't use any external pressure. They shrunk copper tubes onto the disks with gold plating between.

HOOVER: Well, which piece was giving? Was the inside piece giving, or was the cylinder moving out? If the cylinder was moving out, then you're in trouble.

POLK: I don't know, but the pressures that are usually sustained on alumina, could not be sustained by copper.

GRAND: When we looked into the shrinking method, with which Stanford has had experience, I calculated the stresses you would induce in copper, and got worried. I wrote and received the reply from Stanford that they found a cold flow of copper inside their waveguides. After several years, things just got loose.

HOOVER: It depends on what is making them loose. You see there is a bit of difference between having copper in tension and copper in the compression. Unless they looked at this very carefully, I don't see how they could be sure which one moved. I still have the feeling that the radial disk of copper, in compression, is going to take quite a bit of abuse, whereas copper in tension is not. If they were not putting a belly band of steel on the outside of each one of those joints, I would suggest that the cylinder failed. So this last discussion here was about a different approach, in that copper would always be in compression.