Jan. 13, 1942. J. H. RAMAGE 2,269,860

THIMBLE SEAL FOR VACUUM TUBES

Filed June 11, 1940

Fig. 1.

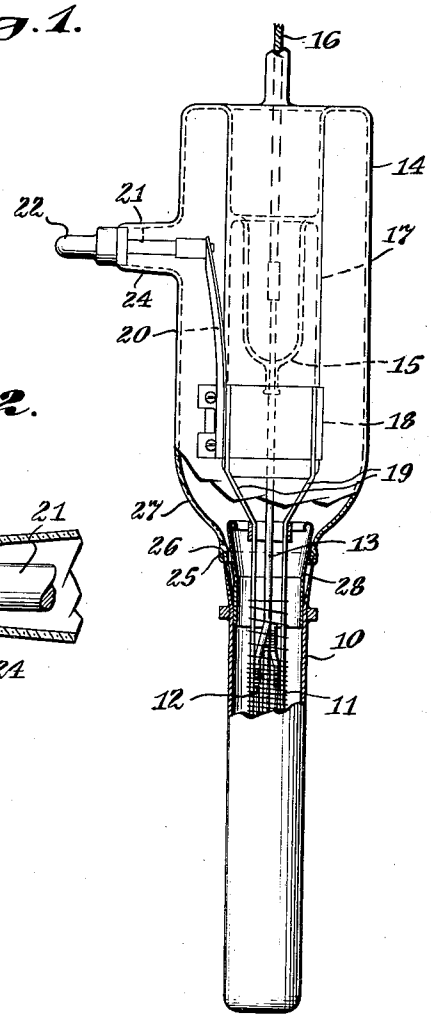


Fig. 2.

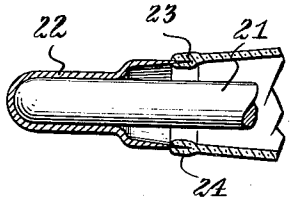


Fig. 3.

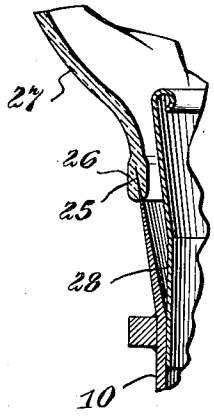


Fig. 4.

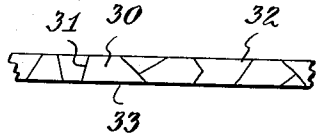
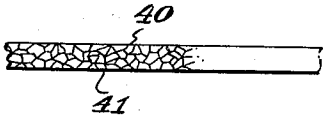


Fig. 5.



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THIMBLE SEAL FOR VACUUM TUBES

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Application June 11, 1940, Serial No. 339,850

4 Claims. (Cl. 250—27.5)

My invention relates to seals between copper and glass, and especially to such seals in electronic discharge devices.

An object of the invention is to retard grain growth in copper that is sealed to glass.

Another object of the invention is to prevent leaks through the feather edge of a glass-to-copper seal.

Other objects and advantages will be apparent from the description and drawing in which:

Fig. 1 is a view, partly in cross section and partly in elevation of a discharge device illustrating the application of the invention.

Fig. 2 is an enlarged cross sectional view of the thimble seal of Fig. 1.

Fig. 3 is an enlarged cross sectional view of a portion of the anode seal of Fig. 1.

Fig. 4 is a micro-photograph of copper of the prior art.

Fig. 5 is a micro-photograph of copper prepared according to the invention.

Considerable difficulty has been experienced with large discharge tubes embodying copper-to-glass seals, in that after heat treatment of the device, leaks and cracks have developed at the seals. These tubes are frequently heat-treated from two to six hours. These tubes represent a large investment in both time and careful assembly and a leak at one of the seals ruins the tube.

My invention concerns preventing the development of leaks in the seal between the copper and glass in vacuum containers, and especially in the electronic discharge devices. In its specific embodiment, my invention is to retard the grain growth in the copper by the addition of an alloying element, especially manganese, in a minimum of .2% to 2%.

In Fig. 1 is disclosed a typical form of electronic discharge tube which must be highly evacuated. This discharge device comprises a copper anode 10 in the form of a closed end cylinder enclosing a grid 11 and cathode 12. The cathode 12 preferably comprises wires of tungsten supported by standards 13 extending into the other end of the tube which is comprised of a cylinder of glass 14 having preferably a reentrant press 15, through which extend the conductors 13 to an exterior cable 16. The press preferably has a cylinder extension 17 around which is secured a band 18 supporting the conducting standards 19 around which the grid wires 11 are wound inside of the anode.

A ribbon 20 extends to a rod 21 extending laterally through the glass cylinder to a copper thimble 22 illustrated in Fig. 2. This copper thimble 22 has a feather edge 23 sealed within the glass walls 24. The copper anode 10 at its upper edge is tapered to the feather edge 25 which is sealed within the edge 26 of the glass cylinder 14, which is curved or tapered at walls 27 to meet the cylindrical anode at its feather edge.

An electrostatic shield 28 protects the anode seal. Investigations have established that there are cracks and leaks at the feather-edged seal between the copper and the glass. I have taken micro-photographs of the heat-treated very thin edge of the copper where it is sealed to and in the glass, and have found the grain structure to be that illustrated in Fig. 4.

It will be noted that this copper has a grain such as 30 with a boundary 31 extending from one edge 32 of the copper to the other edge 33. Other grains may likewise have a boundary through from one edge to the other. The size of the grains of this heat-treated copper is enlarged over that of copper which has not been heat-treated. The grains in Fig. 4 are of the order of .006" in diameter, which is the thickness of the feather edge where it enters the glass.

It is my theory that the long heat treatment of the copper in order to remove all occluded gasses from the metallic parts inside the tube increases the size of the grain. This heat treatment is at a very high temperature, and it will be noted that the copper of the thimble of Fig. 2 or the anode seal in Fig. 3, is exposed to the outside atmosphere. This outside edge may be represented by the edge 32 of Fig. 4.

The oxidation of the outside atmosphere will oxidize this edge 32 and the oxidation will creep down one of the grain boundaries such as 31 until it may reach the inner edge 33. This oxide layer permits the leakage of gas from the atmosphere into the evacuated enclosure.

This oxidation has another serious effect in that it reduces the ductility of the thin copper. It is well known, of course, that the success of the feather edge seal depends upon the thin copper flexing under the strains of the different expansion of the glass sealed thereto. If, however, the grains have an oxide edge extending through the copper, this oxide edge will hinder the movement of the copper and cracking of either the glass or copper will result.

In its specific embodiment, I incorporate a minimum of .2% to 2% of manganese in the copper of the feather edge. This inclusion of manganese forms an alloying substance whose grains

will not grow at the rate of pure copper and will not attain the size illustrated in Fig. 4. The grains will be in the order of the size illustrated in Fig. 5, which have a size of approximately .002", thus providing several grains from one edge to the other.

It will be noted that there will be no easy path for oxidation from one edge 40 to the other edge 41, as there was in Fig. 4. The oxidation will, accordingly, be limited to a thin film on the edge 40 and the remaining portion will retain its ductility as well as its vacuum tightness. The manganese will not decrease the ductility of the copper and, at the same time, will not reduce the conductivity of the copper below the required limits. While a greater percentage of manganese than that stated may be included in the copper, the excess above 2% has been found to reduce the conductivity of the copper. I accordingly prefer to have my copper at least 98% pure. Nickel, palladium, or platinum and other materials forming solid solution with the copper might also be used, but these are not as desirable as manganese.

It is apparent that the invention may be applied to other vacuum-tight containers than the particular one illustrated on the drawing, and that the invention also has application to where thin copper should be maintained vacuum-tight in spite of oxidation.

Accordingly, only such limitations are intended on the invention as are necessitated by the spirit and scope of the following claims.

I claim:

1. A seal for discharge devices comprising glass and copper sealed therein, said copper being heat treated to remove occluded gas therein and also being at least 98% pure and the remainder a substance selected from the group of manganese, nickel, palladium and platinum producing a solid solution alloy with the copper and in sufficient amount to prevent grain growth in the copper as the result of said heat treatment.

2. A seal for discharge devices comprising glass and copper sealed therein, said copper being heat treated to remove occluded gas therein and also being at least 98% pure and the remainder manganese in sufficient amount to prevent grain growth in the copper as the result of said heat treatment.

3. A seal of glass and metal for discharge devices subject to high temperature heat treatment to remove occluded gas therein, said metal consisting of a minimum of .2% to 2% of manganese producing a solid solution alloy with copper and the remainder practically pure copper.

4. A seal of glass and metal for discharge devices subject to high temperature heat treatment to remove occluded gas therein, said metal consisting of a minimum of .2% to 2% of a substance selected from the group of manganese, nickel, palladium and platinum producing a solid solution alloy with copper and the remainder practically pure copper.

JOHN H. RAMAGE.