May 2, 1950 R. L. ADAMS 2,506,326

ARTICLE OF TUNGSTEN AND WROUGHT COPPER JOINED BY CAST COPPER

Filed Jan. 18, 1947

Fig. 1.

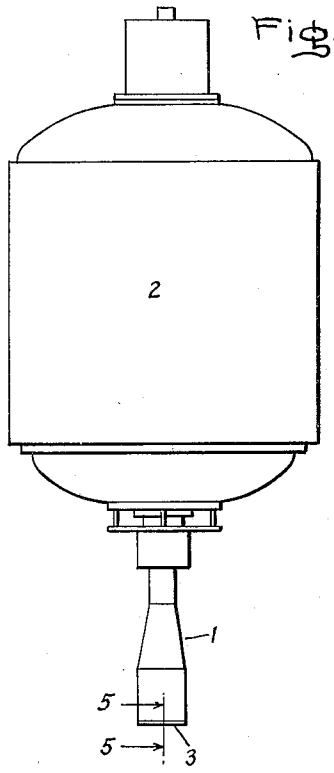


Fig. 5.

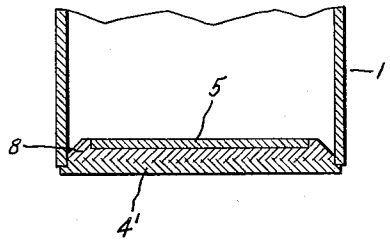


Fig. 3.

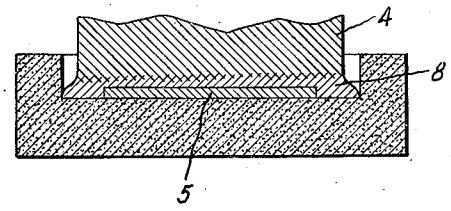


Fig. 2.

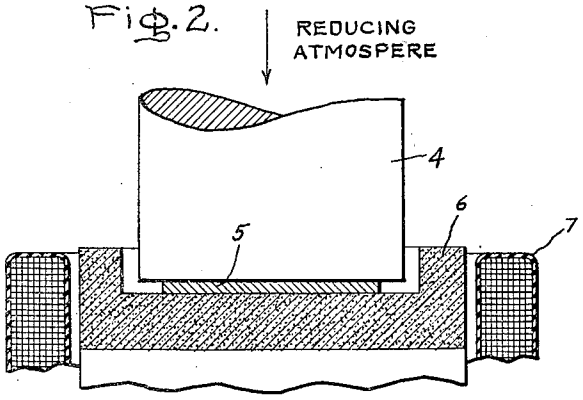
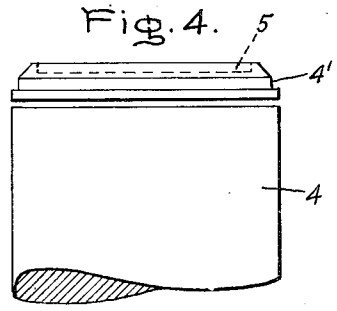


Fig. 4.



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2,506,326

ARTICLE OF TUNGSTEN AND WROUGHT COPPER JOINED BY CAST COPPER

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Application January 18, 1947, Serial No. 722,795

1 Claim. (Cl. 250—149)

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The present invention comprises composite metal bodies consisting of tungsten and copper parts joined in good heat-conducting relation and thereby being adapted for use as targets in X-ray devices.

Target electrodes or targets as heretofore fabricated have consisted of a charge-receiving plate of tungsten imbedded in a backing plate of copper which functioned as a means for carrying away the heat which was generated by the impingement of high velocity electrons on the tungsten plate during the functioning of an X-ray tube containing such target electrode.

In some forms of high-powered X-ray devices a plate of tungsten backed with copper has constituted both a discharge-receiving electrode and a wall-member in the evacuated envelope in which the electron discharge for producing X-rays was caused to operate. It was found that leakage of gas occurred from the exterior into the evacuated interior of such devices, which interfered with their proper functioning and in many cases caused complete failure.

In these devices the copper backing for the X-ray target consisted of copper solidified from fusion in the process of fabrication by casting copper against the target metal. The entry of gas into the evacuated space appears to be due to slow molecular diffusion of gas (e. g. components of air) along the very slightly open grain boundaries characteristic of interdendritic shrinkage which occurs in some degree in all forms of cast or resolidified fused metal, the gas thereupon diffusing around the tungsten target into the evacuated space.

As a consequence of my present invention I have provided an improved composite body of tungsten and copper through which such diffusion of gas can not occur. In accordance with my invention composite metal articles are constructed of tungsten joined to a body of wrought copper by an intermediate layer of fused copper (that is, copper resolidified from fusion) which functions as a cementing layer uniting the tungsten or other target metal and wrought copper in good heat-conducting relation.

My invention is illustrated by the accompanying drawing in which Fig. 1 is a side elevation of a high voltage X-ray outfit embodying my invention; Figs. 2, 3 and 4 are sectional views of different stages of target fabrication and Fig. 5 is a sectional view of a complete target.

Leakage of gas into the evacuated space within an X-ray apparatus has been found to be particularly troublesome in high voltage, high powered X-ray devices, such as shown for example in Fig. 1, and described in detail in Charlton and Westendorp, U. S. Patent 2,144,524, patented January 17, 1939. In such apparatus an extension tube 1 is provided leading from the main X-ray chamber 2. A source of cathode rays (electrons) as for example, an incandescent filament (not shown in the drawing) is provided in the main chamber. A beam of electrons which may be suitably focussed by well understood means, is directed upon the end wall 3 of the X-ray apparatus. The impact of the electrons on the target generates X-rays which pass through the target and are radiated to the exterior. It is important, therefore, that the target and backing plate should be as thin as practicable.

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When copper is joined to a plate of tungsten, or other refractory metal, by casting fused copper against the plate of refractory metal, the crystallization shrinkage of the solidified copper causes the trouble heretofore noted. Wrought copper on the other hand is non-pervious to gas.

In carrying out my invention an elongated mass of wrought copper 4, which is dense and impervious to molecular diffusion of gas, is placed as shown in Fig. 2 into end-abutting relation to a plate 5 of tungsten, tantalum or other chosen refractory metal in a shallow graphite holder 6. Encircling the mold is the primary winding 7 of an induction heater. This winding when supplied with alternating current of suitable frequency (e. g. about 1,000 to 2,000 cyc./sec.) induces sufficient energy into the graphite holder and its contents to cause fusion of a thin layer 8 (Fig. 3) of the copper mass 4 which is immediately adjacent the tungsten disk. Preferably the heating apparatus and its contents are surrounded during the fusion step with a reducing gas, such as hydrogen or a mixture of hydrogen and nitrogen. Under these conditions the molten copper wets the tungsten and becomes intimately united therewith upon cooling. The fusion, however, does not extend an appreciable distance away from the tungsten disk, due to the good heat conductivity of the mass of copper 4 extending away from the heating zone. The mass of copper with its attached plate of tungsten is removed from the induction heater and allowed to cool.

As indicated in Fig. 4, the plate of refractory metal and a desired portion 4' of the mass of copper to which the refractory metal has become joined is cut off from the main mass 4 by any convenient mechanical means. The final

product is a plate of refractory metal backed by a plate 4' of wrought copper, which is joined to the refractory metal by a thin layer 8 of copper which has been fused and thereupon resolidified. As shown in Fig. 5 it is applied by welding or otherwise to the end of extension tube 1 which ordinarily consists of copper.

When a composite plate thus constructed is used as a target member in an evacuated X-ray device as shown in Fig. 1, slow entry of gas from the atmosphere into the evacuated interior of the X-ray tube through the composite target does not occur.

What I claim as new and desire to secure by Letters Patent of the United States is:

An X-ray device comprising an evacuated envelope and an X-ray target, said target consisting of a plate of tungsten, a plate of wrought copper, and an intermediate layer of fused copper uniting said plates in good heat-conducting relation, said plate of wrought copper forming a gas impervious wall portion of said envelope.

ROY L. ADAMS.

REFERENCES CITED

The following references are of record in the file of this patent:

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