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METHOD OF PRODUCING HIGHLY EMISSIVE CATHODES ACCORDING TO THE METALLIC VAPOR PROCESS

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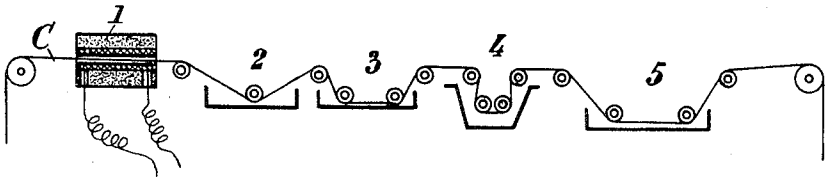


Fig. 1.

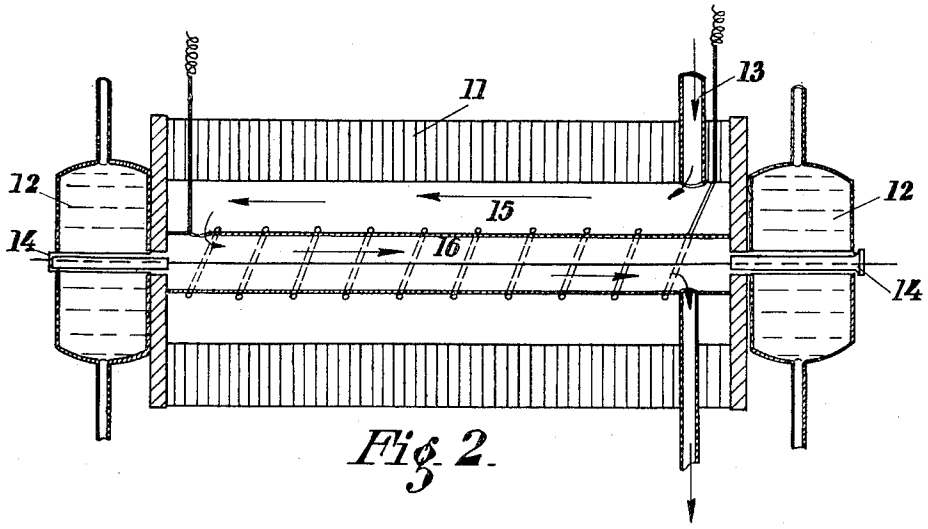


Fig. 2.

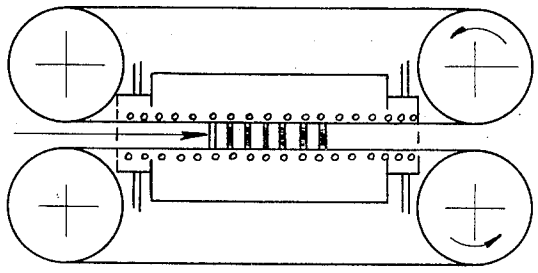


Fig. 3.

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METHOD OF PRODUCING HIGHLY EMISSIVE CATHODES ACCORDING TO THE METALLIC VAPOR PROCESS

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6 Claims. (Cl. 250—27.5)

In the production of highly emissive cathodes special methods have been developed, in which an electron-active layer is produced on the filament, more particularly on tungsten filaments. It is important that the layer is completely even and adheres quite firmly. The layer is required to be sufficiently resistant to temperature.

Practically all tungsten filaments available on the market are contaminated on their surface by layers of undefined composition. Mechanical cleaning processes do not cause their removal, as recesses are not touched thereby. Chemical agents either fail to remove all of the impurities concerned or attack the material of the filament.

The method according to the invention, by means of which all of these disadvantages are overcome, will now be described in a possible form of embodiment with the assistance of Figs. 1–3.

The filament 6 (Fig. 1) is passed through a furnace 1, in which the same is coated with a thin film of oxide at a temperature of 400–500°. At the same time impurities of an organic nature, such as fat, are burnt in part. This weakly oxidized filament is passed through a molten alkaline mass 4, such for example as pure NaOH or a hydrate thereof, which however, should not contain any additional oxidizing constituents. In this bath at a temperature of approximately 300–400° the film of oxide is removed together with the remnant impurities adhering thereto, without the tungsten itself being noticeably attacked.

In the case of numerous filaments it was also found desirable to conduct the filament through a bath of chromium-sulphuric acid 2. This rendered certain impurities of an organic nature, such for example as aromatic oils, soluble in water. Upon using chromium-sulphuric acid the filament was accordingly conducted, following thereon, through a water bath 3. This gradually acquires a content of sulphuric acid by reason of the acid residues. The water, therefore, is continuously renewed by feeding action. The water discharged is conducted into a second water bath 5, which is traversed by the filament after the same has been passed through the fused alkaline mass. The residual alkali adhering thereto is in this manner washed off in a continuously weak acid bath.

By this method of cleaning there is also obtained an additional important result. If the purified filament is to be subjected to chemical reactions of any kind, such for example as oxidation, the nature of the surface should always be the same in the interest of a uniform final product. This, however, would not appear capable of being attained in the case of the present methods of production. Oxidation layers of a thin or thick kind are obtained, dependent on the use of a smooth, polished filament or a rough and dull one. On the other hand, by reason of the method of cleaning described above, the surface is made to an appreciable extent uniform, the same receiving a medium surface layer.

The tungsten filament thus preliminarily treated is furnished with a coating of oxide by being passed at certain furnace temperatures, for example 700° C., and at a certain rate of passage amounting, for example, to 30 mm. per sec., through a furnace of, say, 50 cm. in length, through which there is conducted a defined current of air. A mixture of several oxides is thus produced on the filament. As regards the subsequent treatment, it has been found that the lowest oxide, tungsten-dioxide, is the most suitable on account of its constancy of temperature. To obtain the same in pure form commencement is made with tungsten-trioxide, and reduction performed in a mixture of steam and hydrogen.

This method is not readily capable of use for continuous treatment of the filament, as the latter, when passing through a furnace which is fed with a mixture of steam and hydrogen, preferably consisting of 50–60% hydrogen and 50–40% steam, traverses zones, which differ from the reducing atmosphere both as regards the temperature and on account of condensation of the steam, as well as regards the concentration conditions. These requirements are fulfilled by the fact that at the inlet and the outlet of the furnace 11 (Fig. 2) there is provided a cooling device 12 operated preferably by boiling water, so that the filament passes immediately, without a transition zone, from the cold condition into surroundings in which the temperature of the brown tungsten-dioxide is constant, and then from these surroundings suddenly into a zone in which, owing to the low temperature, variation of the tungsten-dioxide is no longer possible. In order to maintain the concentration of the gas in the furnace constant, a current of gas is introduced at 13 possessing the requisite concentration. To prevent the penetration of air, and on the other hand to avoid the consumption of particularly large amounts of hydrogen, which might give rise to oxyhydrogen explosions, the filament is allowed to enter and emerge through narrow passages 14. These possess a resistance to flow

which is so great that practically no gas is able to emerge at these points.

In order to bring the gas in good tempered condition into contact with the filament, the same is previously heated. The gas enters a chamber 15, in which there is located a second chamber 16 bearing the heating coil and communicating with the first chamber.

Indirectly heated cathodes are furnished with a coating of tungsten-dioxide after the same have been fitted in position. For this purpose they are passed on two conveyor belts (Fig. 3) through a furnace, which is also furnished with cooling bushes. In this case, however, trap doors are provided in place of the passages.

I claim:

1. A method of producing highly emissive cathodes comprising the steps of producing on a tungsten wire a coating of tungsten-trioxide and tungsten pentoxide, reducing the said coating to pure tungsten dioxide and vaporizing an earth alkaline metal on the said coating of pure tungsten dioxide.

2. A method of producing highly emissive cathodes comprising the steps of cleaning a tungsten wire, producing a coating of the higher tungsten-oxides on the surface of said wire, reducing the said coating to pure tungsten dioxide and vaporizing an earth alkaline metal on the said coating of pure tungsten dioxide.

3. A method of producing highly emissive cathodes comprising the steps of superficially oxidizing a tungsten wire, then reducing the oxidized surface to produce a clean tungsten surface, producing a coating of the higher tungsten oxides, reducing the said coating to pure tungsten dioxide and vaporizing an earth alkaline metal on the said coating of pure tungsten dioxide.

4. A method of producing highly emissive cathodes comprising the steps of superficially oxidizing a tungsten wire by means of heating it in an oxidizing atmosphere and then removing the oxide coating by passing the wire through a fused earth alkaline mass, producing a coating of the higher tungsten oxides as trioxide and pentoxide, reducing the said coating to pure tungsten dioxide and vaporizing an earth alkaline metal on the said coating of pure tungsten dioxide.

5. A method of producing highly emissive cathodes comprising the steps of superficially oxidizing a tungsten wire by means of heating it in an oxidizing atmosphere, conducting the wire through an acid bath, then through a water bath and then removing the oxide coating by passing the wire through a fused earth alkaline mass, producing a coating of the higher tungsten oxides, reducing the said coating to pure tungsten dioxide and vaporizing an earth alkaline metal on the said coating of pure tungsten dioxide.

6. A method of producing highly emissive cathodes comprising the steps of purifying the surface of a tungsten wire, heating it in an oxidizing atmosphere to produce a coating comprising the higher tungsten oxides and reducing said coating in a reducing atmosphere comprising water-steam and hydrogen to pure tungsten dioxide, vaporizing an alkaline metal on the said coating of pure tungsten dioxide.

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