

June 21, 1949.

P. L. SPENCER
DIRECTLY-HEATED CATHODE
Filed Aug. 19, 1947

2,473,550

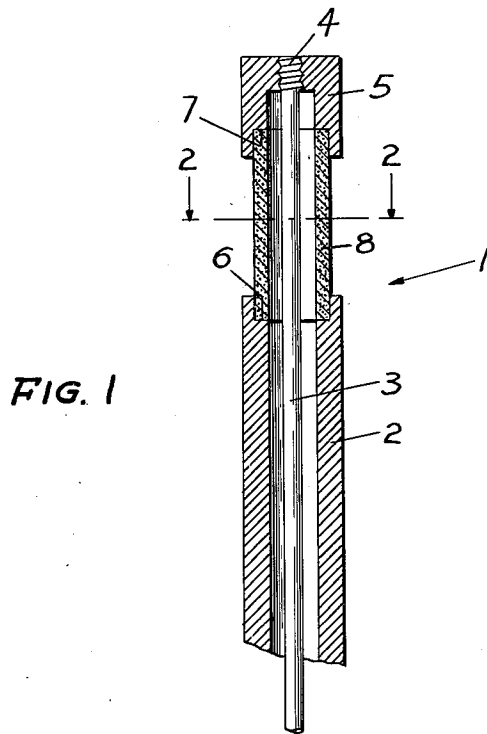
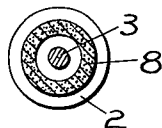


FIG. 2



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2,473,550

DIRECTLY HEATED CATHODE

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Application August 19, 1947, Serial No. 769,348

9 Claims. (Cl. 250—27.5)

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This invention relates to cathodes for electron discharge devices, and more particularly to cathodes for electron discharge devices of the magnetron type.

This invention constitutes an improvement over the device claimed in the copending application of John F. Hanson, Serial No. 753,864, filed June 11, 1947, and assigned to the same assignee as the present application.

The principal object of the present invention is to provide a directly-heated cathode for electron discharge tubes which has a tensile strength substantially greater than the cathode of the Hanson application, making for greater ease of manufacture and longer tube life.

Another object is to devise a cathode which is more compact and dense than that claimed in the aforesaid Hanson application.

The foregoing and other objects of the invention will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawing, wherein:

Fig. 1 is a fragmentary, longitudinal sectional view of a cathode made in accordance with the present invention; and

Fig. 2 is a transverse sectional view of the same taken along line 2—2 of Fig. 1.

Referring now to the drawing, the numeral 1 generally designates a cathode which includes an outer tubular conductor 2 and an inner conducting rod 3 coaxial with said outer conductor.

The rod 3 extends beyond the conductor 2 and is attached at its outer end, as at 4, to a conducting cap 5 which is thereby held in spaced relationship to the end of conductor 2.

The opposed edges of the conductor 2 and the cap 5 are shouldered, as at 6 and 7, respectively, to support therebetween an electron-emissive body 8 in the form of a cylindrical sleeve.

The body 8 preferably consists of compressed, compacted, intimately admixed powdered thorium (thorium oxide) and a finely divided or powdered mixture of metals, preferably in the proportions of 27 per cent by weight of metal mixture and 73 per cent by weight of thorium. The metal mixture itself preferably consists of a refractory metal, such as tungsten or molybdenum, and a small amount of cobalt. Considering the metal mixture only on the percentage basis, the cobalt should constitute from about $\frac{1}{2}$ to about $2\frac{1}{2}$ per cent, by weight, of the metal mixture.

When a suitable voltage is applied between the conductors 2 and 3, the current passing through the body 8 heats said body to the temperature

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of thermionic emission, the structure thereby constituting a directly-heated cathode which has been found particularly suitable for use in electron discharge devices of the magnetron type.

The body 8 is preferably fabricated by a pressure molding process, as described in the aforesaid Hanson application.

When the electron-emissive sleeve 8 is removed from the mold, it is "green" and must be fired or sintered to give it mechanical strength and electrical conductance. For this purpose, it is heated to a temperature of from about 1300° to about 2200° C. for from about 5 min. to about 3 hrs., depending upon the characteristics desired.

I have found that, if the aforesaid rather small percentage of cobalt is added to the powdered mixture of thorium and a refractory metal, the tensile strength of the sleeve cathode is greatly increased as compared to what it is if no cobalt is present in the mixture. I have found, furthermore, that this increase in tensile strength is effectuated during the firing or sintering process, and that a decrease of volume of the sleeve, and therefore an increase in density thereof, takes place during the step of sintering.

It is not known, nor is it necessary to know, exactly how or why this increase of tensile strength takes place, but my present understanding of the theory of operation is as follows. The melting point of cobalt is on the order of 1500° C., a temperature which is much lower than the melting points of thorium, tungsten, or molybdenum, and one which is preferably and ordinarily achieved and maintained during the sintering process. Therefore, during the sintering process the cobalt melts. When the cobalt melts and resolidifies, it effectuates a compacting of the mixture, or a reduction in the volume thereof. This reduction in volume results in an increase in tensile strength of the cathode sleeve because of the more intimate engagement of the individual particles with each other. In effect, the cobalt, in melting and resolidifying, produces a cementing together of the individual particles of the powdery mixture, greatly increasing the tensile strength of the cathode sleeve 8.

This completes the description of the aforesaid exemplification of the present invention. It will be noted that there has been provided a directly-heated cathode for electron discharge devices, which cathode is inexpensive, has high electron emissivity, has very high tensile strength, and is compact and dense.

Of course, it is to be understood that this invention is not limited to the particular details

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as described above, as many equivalents will suggest themselves to those skilled in the art. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of this invention within the art.

What is claimed is:

1. A directly-heated electron-emitting cathode comprising a bare compressed body of thoria, a refractory metal, and cobalt.
2. A directly-heated electron-emitting cathode comprising a bare molded sleeve of powdered thoria, a refractory metal, and cobalt.
3. A directly-heated electron-emitting cathode comprising a bare molded sleeve of powdered thoria, molybdenum, and cobalt.
4. A directly-heated electron-emitting cathode comprising a bare compressed body of powdered thoria and a powdered mixture of a refractory metal and cobalt.
5. A directly-heated electron-emitting cathode comprising a bare cylindrical sleeve of powdered thoria, molybdenum, and cobalt.
6. A directly-heated cathode comprising a compressed body of powdered thoria and a powdered mixture of a refractory metal and cobalt, said cobalt constituting from about $\frac{1}{2}$ to about $2\frac{1}{2}$ per cent, by weight, of said mixture.
7. A directly-heated cathode comprising a

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compressed body of powdered thoria and a powdered mixture of molybdenum and cobalt, said cobalt constituting from about $\frac{1}{2}$ to about $2\frac{1}{2}$ per cent, by weight, of said mixture.

8. A directly-heated cathode comprising a mixture of powdered thoria and a metal mixture compressed to form a cylindrical sleeve, said metal mixture consisting of a refractory metal and cobalt, said cobalt constituting from about $\frac{1}{2}$ to about $2\frac{1}{2}$ per cent, by weight, of said metal mixture.

9. A directly-heated cathode comprising a mixture of powdered thoria and a metal mixture compressed to form a cylindrical sleeve, said metal mixture consisting of molybdenum and cobalt, said cobalt constituting from about $\frac{1}{2}$ to about $2\frac{1}{2}$ per cent, by weight, of said metal mixture.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,948,445	Lederer	Feb. 20, 1934
2,428,042	Schmidt	Sept. 30, 1947

Certificate of Correction

June 21, 1949.

Patent No. 2,473,550.

PERCY L. SPENCER

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 3, lines 7, 10, 13, 16, and 20, before the word "directly-heated" insert *bare*; lines 8, 11, 14, 17, and 21, strike out "bare";

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of November, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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