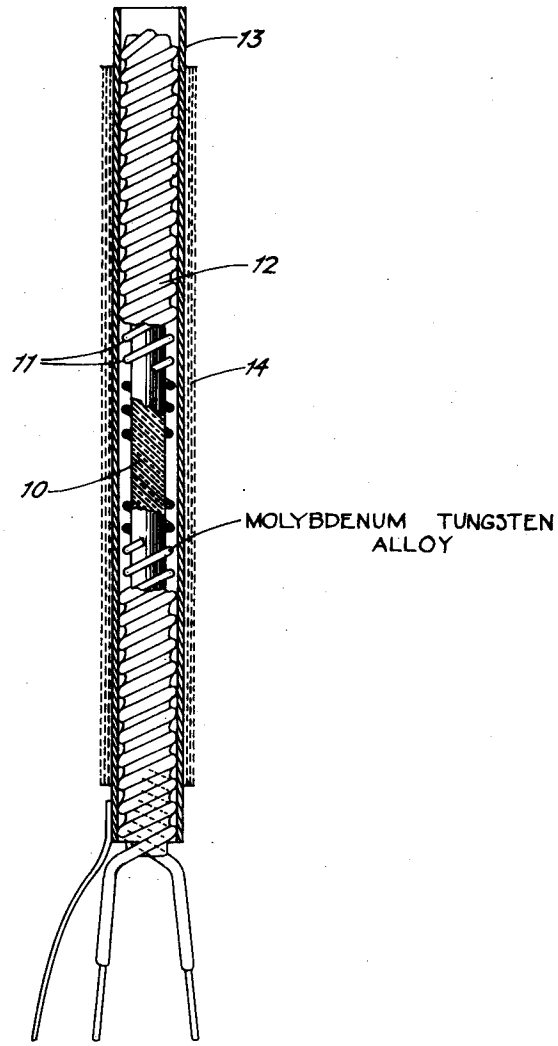
Oct. 4, 1938. S. UMBREIT 2,131,909

ALLOY

Filed Nov. 30, 1934



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Patented Oct. 4, 1938 2,131,909

UNITED STATES PATENT OFFICE

2,131,909

ALLOY

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Application November 30, 1934, Serial No. 755,373

2 Claims. (Cl. 250—27.5)

My invention relates to alloys of metals having a high melting point, and particularly to alloys of high melting point which are suitable for heaters, and to cathode heaters for electron discharge devices.

In the conventional indirectly heated cathode having a heater surrounded by a tubular cathode sleeve the heater wire is preferably wound into a double helical coil, and may be mounted on an insulating core, usually of alumina. This core and heater wire are sprayed with a suspension of an insulating material, such as finely powdered alumina, and then baked at comparatively high temperatures, for example around 1600° C. or higher to harden and consolidate the alumina into a coherent coating and to fix the heater on the core, producing a cathode heater which may be mounted within the cathode sleeve.

The ductile tungsten wire often used for cathode heaters is expensive, and is so resilient that the turns of a double helical coil of tungsten wire spring out considerably when the winding mandrel is removed, hence the wire must be wound on the core with a closer pitch than the final pitch desired. Because of this resiliency and the fact that it may vary with different pieces of wire, the winding pitch may have to be varied from piece to piece to get the proper pitch so that the coils are not easily made to accurate dimensions. The tungsten wire often shows considerable brittleness during winding, and regularly shows brittleness after the heater has been fired at high temperatures to bake the insulation on the heaters, which brittleness seems to be due to the recrystallization of the tungsten. Since the tendency in commercial practice is toward higher and higher firing temperatures to rid the alumina core and insulation of impurities, the brittleness of the tungsten wire after high temperature firing has become a serious difficulty. It has been found that the heater wire of pure tungsten becomes so extremely brittle after about one thousand hours of life that severe jars will often cause the wire to break, opening the cathode heater circuit and sometimes causing shorts between the cathode heater and the cathode sleeve. Other common metals have high melting points, such as molybdenum, which has electrical characteristics somewhat similar to tungsten. However, the melting point of molybdenum is so much lower than tungsten that satisfactory cathode heaters cannot be made of molybdenum wire.

An object of my invention is to provide an alloy which has for practical purposes the advantages of tungsten, is ductile and malleable, can be easily formed to desired dimensions, and which will not become brittle when heated to comparatively high temperatures or during use as a cathode heater.

Another object is to provide an improved cathode heater.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing, which shows a cathode assembly in elevation having a heater coil of wire made in accordance with my invention and with parts broken away to show details of construction.

Referring to the drawing the insulating core 10, preferably of alumina, carries a heater coil 11 of alloy wire made in accordance with my invention and wound into a double helical coil. The turns of the coil are insulated by a coating of refractory insulation 12, preferably alumina, which is sprayed on the coil and core in the form of finely powdered alumina in suspension. The sprayed assembly is fired in hydrogen to a temperature sufficiently high to bake the insulation on the coil and core and to drive out the impurities from the insulation and core. The cathode heater is then positioned within the cathode sleeve 13 having an emitting coating 14. During operation of an electron discharge device in which the cathode assembly may be incorporated, heat is conducted and radiated from the heater to the cathode sleeve to raise it to operating temperature.

In accordance with my invention the heater coil is made of wire consisting of an alloy of tungsten and molybdenum, in which the molybdenum predominates and for best results the molybdenum should comprise approximately 80% of the entire content of the alloy. While 90% of molybdenum and only 10% of tungsten have been used, an alloy of this composition has a melting point dangerously close to the temperature which the heater attains when the cathode is aged, that is when it is heated for definite periods of time at high temperature to develop emission from the electron emitting coating on the cathode. If the alloy contains too much tungsten, for example over 50%, the objectionable characteristics of tungsten appear, and the working of the alloy becomes difficult. The molybdenum should constitute at least 50% of the alloy. An alloy having 50% tungsten and 50% molybdenum may be desired when a very stiff

and strong wire is desired as for example where no core is used, in which case the double helical coil must be self supporting. When no core is used at least 30% tungsten should be used to prevent deformation of the double helical core, especially while being sprayed with insulating material.

The alloy may be made in the conventional manner by mixing powdered molybdenum and powdered tungsten such as is used in making non-sag tungsten wire, such for example as described in the patent to Pacz 1,410,499, by tumbling these powders for from eighteen to twenty-four hours. The mixture is then worked into wire by methods suitable for making ductile tungsten and described, for example in Coolidge Patent 1,082,933. In general it is pressed into molds and sintered at from 1000 to 1300° C., preferably in a hydrogen furnace, to provide sufficient strength to the molded material so that it can be easily handled. This molded bar is then treated in hydrogen with a current having a value of approximately 90–95% of the current necessary to fuse the material. This results in a metallic bar which may be swaged and drawn to the desired shape and diameter, after which it can be wound into a double helical coil wire with ease.

An alloy made in accordance with my invention is ductile and malleable and when drawn into a wire maintains its shape when once formed into a coil and does not have the excessive resiliency of ductile tungsten. The difficulties due to brittleness of ductile tungsten in winding and firing are eliminated. Although recrystallization of the alloy may take place when it is fired with the alumina insulation, brittleness is not introduced by this firing. The electrical resistance between the heater and cathode is consistently higher than when the heaters are made of pure tungsten wire. It is found that in cathodes having heaters made in accordance with my invention the hum that is sometimes present in indirectly heated cathodes is considerably reduced, and that a heater wire of molybdenum-tungsten alloy made in accordance with my invention does not become brittle after several thousand hours of burning. It has also been found that very satisfactory grid wires for transmitting tubes can be made from an alloy made in accordance with my invention.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is—

1. An indirectly heated cathode having a cathode sleeve, a heater within said sleeve including a core of insulating material, a heater wire of an alloy of tungsten and molybdenum mounted on said core and comprising substantially 80% molybdenum and 20% tungsten said core and wire having a coating of refractory insulating material.

2. An indirectly heated cathode having a cathode sleeve, a heater within said sleeve including a heater wire of an alloy of tungsten and molybdenum, said molybdenum comprising substantially 80% of the alloy, and a coating of refractory insulating material on said wire.

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