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METHOD AND APPARATUS FOR TRANSFORMING CRYSTALLINE STRUCTURES OF DRAWN TUNGSTEN WIRES

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Fig. 1.

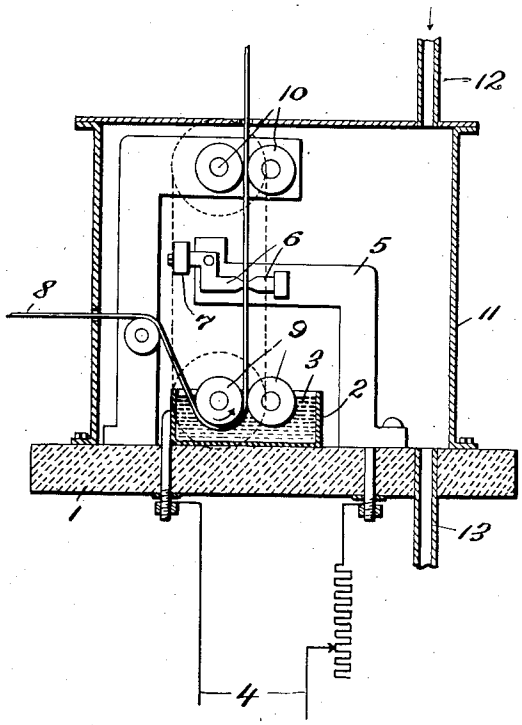
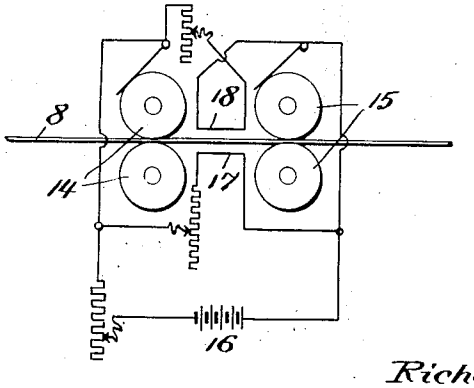


Fig. 2.



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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR TRANSFORMING CRYSTALLINE STRUCTURES OF DRAWN TUNGSTEN WIRES.

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To all whom it may concern:

Be it known that I, RICHARD JACOBY, a citizen of the German Republic, residing at Berlin, Germany, have invented certain new and useful Improvements in Methods and Apparatus for Transforming Crystalline Structures of Drawn Tungsten Wires, of which the following is a specification.

Although tungsten filaments, which are made by squirting amorphous or finely crystalline tungsten with a binding medium, can be transformed into filaments consisting of crystals, each filling the entire cross-section and a considerable length of the filament, according to a process now known, by passing the filaments through a zone of high temperature, no process is known which makes it possible to transform drawn tungsten wire into a wire of the same or like structure.

Now it has been demonstrated that at the highest temperatures, only slightly below the melting point of tungsten, it is possible to convert into long-crystal wires drawn wires which at somewhat lower temperatures show no such tendency. It was however with difficulty that it was found possible to keep these temperatures uniform for a wire which was passed in a continuous operation through a zone of incandescence. The reason for this lies in the fact that at the highest temperatures the tensile strength of the tungsten wires is extraordinarily small, so that the wires, by friction on the contacts even when the latter are as small as possible, will be broken very easily, and particularly at places which may be somewhat weaker than the rest. It is a circumstance particularly favorable for reaching very high temperatures to have the heating done wholly or partly by the passage of electric current through the wire. In this case a somewhat thinner part of the wire, or even a part having a little greater electrical resistance by reason of excessive heat at that point, will become still thinner under the pull exerted, and thus will melt or break sooner than a part which has not been weakened. Therefore a wire will melt at a point which is somewhat weaker or is a poorer conductor, without the remaining portions of the wire approaching sufficiently near the melting temperature. The disadvantages above described appear more strongly in proportion to the thinness of the wire which is to be brought to incandescence, and in proportion to the speed at which it is drawn through the zone of incandescence.

In accordance with the invention, as hereinafter described, the pull on the wire in the zone of highest temperature is neutralized to as great an extent as desired, or is even replaced by a light pressure. In this way it becomes possible to bring the whole wire to temperatures which are only slightly below the melting point of tungsten without any melting of the thinner parts. It has been demonstrated that the comparatively slight increase in temperature to just below the melting point of the tungsten which is obtained by means of this invention favors the transformation of the short crystals into long crystals, and indeed this is the only thing that makes it possible at all, or that increases the speed of the process of crystallization; these points are of the greatest importance as regards the technical application of the process.

In accordance with this new process the wire, instead of being drawn through the zone of incandescence, as would seem obvious at first with a slender wire, is pressed through it. This is best done by rollers which push the wire into the zone of incandescence. Beyond this zone of incandescence the wire may be caught and passed on, or it may be received by a sliding contact or a layer of liquid metal, provided only the friction is kept so small that the wire is not bent and cracked in the zone of incandescence. Passing the wire through the zone of incandescence under pressure is facilitated if the incandescent section of the wire is made as short as possible.

The rollers which push the wire through the zone of incandescence may themselves form the contacts for the electric current to be sent through the wire, or they may be mounted in mercury which causes the contact, or they may form the termination of a mercury contact. Other combinations of the rollers with the contacts are also conceivable.

To facilitate understanding of my invention, reference may be had to the accom-

panying drawing in which I have illustrated apparatus by means of which my invention may be practiced and in which Figure 1 is a longitudinal section through a form of apparatus in which the wire is moved vertically, and Figure 2 is a diagram of the electrical connections of an apparatus in which the wire is moved horizontally.

In the particular arrangement shown in Figure 1 a base 1 carries a metal trough 2 containing a body of mercury 3. The metal trough 2 is electrically connected to one of the leads of a supply circuit 4, the other lead of which is connected to a metal yoke 5 which carries cooperating knife edged contacts 6 made of tungsten or similar high fusing metal and normally pressed toward each other by a weight 7 or similar device.

The wire or similar material 8 of which the crystalline structure is to be transformed is fed vertically upward by any suitable feeding mechanism which will push the wire instead of pulling it, as, for example, a pair of feed rolls 9 mounted in contact with the mercury 3 and driven in such a direction that they push the wire 8 toward the contacts 6. The wire 8 between the rolls 9 and the contacts 6 may be heated to very high incandescence by properly regulating the amount of current through it. I prefer to provide another pair of feed rolls 10 which take hold of the wire as it leaves the hot zone between the rolls 9 and the contacts 6, and to drive these rolls 10 at the same speed and in the same direction as the feed rolls 9. The entire operation is carried out in a chamber 11 through which inert gas, such as forming gas which is a mixture of nitrogen and hydrogen, flows through the inlet 12 and outlet 13. By this apparatus the wire may be pushed through the hot zone and a slight pressure exerted upon it longitudinally due to the frictional resistance offered by the contacts 6.

In Figure 2 I have illustrated an arrangement of circuits by which the effect of gravity on the wire in the hot zone may be neutralized. In this particular arrangement the wire 8 is fed by two pairs of feed rolls 14 and 15 driven at such relative speeds that a slight end pressure is exerted on the wire in the hot zone between them. A source of direct current 16 is connected to the feed rolls so that a current flows through that portion of the wire in the hot zone in the direction indicated by the arrow. To neutralize the effect of gravity I mount a conductor 17 parallel to and immediately beneath the hot portion of the wire 8 and connect it as shown in the drawing so that current from the source 16 flows through it in the same direction as the current in the wire 8. The mutual repulsion thus set up neutralizes the effect of gravity on the wire 8.

This effect may be further supplemented if desired by another neutralizing conductor 18 which, as indicated in Figure 2, is mounted immediately above the hot zone and is so connected to the source 16 that the flow of current through it in that portion immediately adjacent to the hot zone is in the opposite direction to the direction of flow in the hot wire 8 and the mutual attraction thus produced also tends to neutralize the effect of gravity.

Under specially favorable conditions the process is also capable of exerting an equalizing effect on the wire, the more slender portions of the wire which become hotter than the rest being pushed together.

In carrying out the process it may be desirable to carry the wire through the hot section in such a manner that even its own weight does not exert any pull. This is possible, for example, by passing the wire horizontally through the zone of highest temperature and thereby neutralizing the effect of gravity on the wire by means of electrical forces. To this end wires having oppositely or like-directed currents may be arranged parallel over or under the wire, so that by repulsion or attraction the equalization of weight takes place; but the wire may also be guided perpendicularly, it being forced upward or downward or being allowed to fall from above against a rubbing contact, mercury for example, or metal which is kept in a liquid state at quite a temperature.

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

1. The process of converting a wire of small crystals of high fusing metal such as tungsten into a wire composed of longer crystals which consists in pushing the wire to be converted through a zone of high temperature in which it is heated to a point only slightly below its melting point.

2. The process of converting a tungsten wire composed of small crystals into a wire composed of longer crystals which consists in passing the wire to be converted through a hot zone in which it is heated to a point only slightly below its melting point and exerting on the wire in said zone a light pressure lengthwise of the wire.

3. In an apparatus for converting a wire composed of small crystals into wire composed of longer crystals, the combination of means for maintaining a hot zone in which the wire to be converted is heated to a point only slightly below its melting point, and feed rolls for pushing the wire to be converted through said zone of high temperature at a speed favorable to the growth of crystals longitudinally of the wire.

4. In an apparatus for passing a wire through a zone of high temperature to convert small crystals into longer crystals, the combination of means for maintaining a hot

zone, and feed rolls on opposite sides of said zone, rollers on one side for pushing the wire through said zone and the rollers on the opposite side for receiving it as it leaves said zone.

5. In an apparatus for passing a tungsten wire composed of small crystals through a zone of high temperature to produce longer crystals, the combination of means for maintaining a hot zone, feeding means for pushing said wire through said zone, an electrical contact for engaging said wire with some frictional resistance as said wire leaves said zone, and means for establishing an electrical circuit through said contact and said wire.

6. In an apparatus for passing wire through a heated zone to alter its crystal structure, the combination with means for maintaining a heated zone, of feed rolls mounted on one side of the heated zone to engage the wire and push it through said heated zone, a body of liquid metal forming a contact which engages the wire on the other side of said heated zone, and means connected to said rolls and to said contact to pass current through the wire in said heated zone.

7. In an apparatus for passing wire through a heated zone to alter its crystal structure, the combination with means for maintaining a heated zone, feeding means for passing a wire horizontally through said zone, and means for neutralizing the effect of gravity by electrical attraction or repulsion of the wire in the heated zone.

8. In an apparatus for passing wire through a heated zone to alter its crystal structure, the combination of means for maintaining a hot zone, feeding means for pas g the wire through said zone horizontally and for maintaining current of electricity through the wire in said zone, current carrying conductors mounted parallel to the wire in said zone and so disposed that the electrical forces between said conductors and said wire will neutralize the effect of gravity on the wire in said zone.

In witness whereof, I have hereunto set my hand this sixteenth day of June, 1922.

RICHARD JACOBY.