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J. S. HILL ET AL

3,091,026

METHOD OF MAKING WIRE

Filed Nov. 13, 1958

FIG. 1

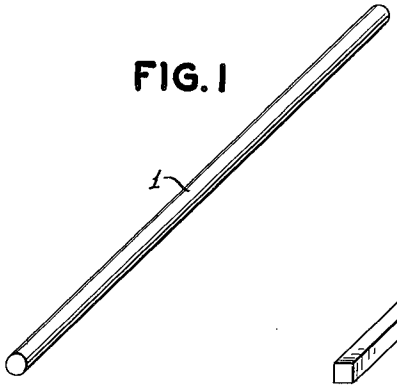


FIG. 2

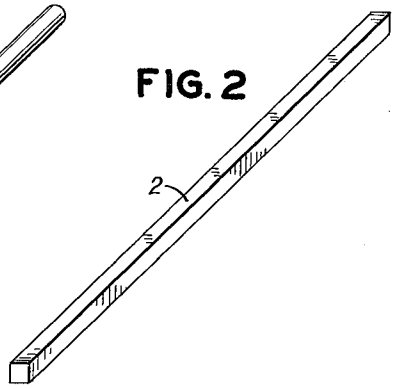
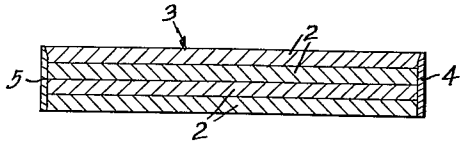


FIG. 4



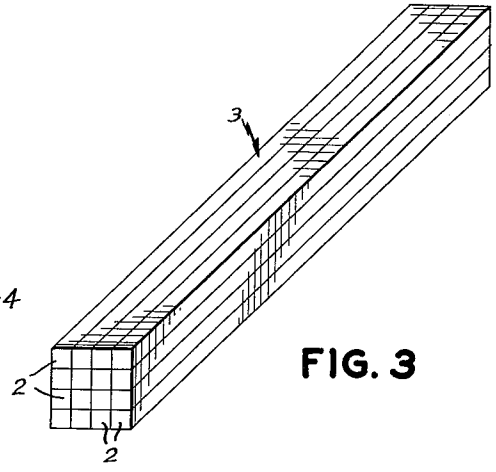
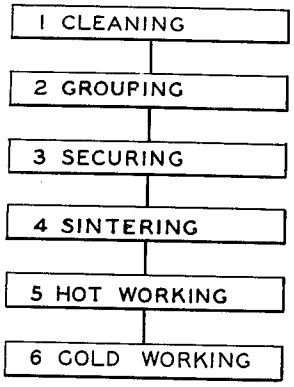


FIG. 3

FIG. 5



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METHOD OF MAKING WIRE

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3 Claims. (Cl. 29—419)

The present invention deals with a method of making wire and more particularly with a method of making wire for high temperature applications and especially for use as thermocouple wire and furnace windings.

Certain metals, such as metals of the platinum group, e.g. platinum, palladium, rhodium, in substantially pure state are used as high temperature electrical conductors in view of the ability of such metals to withstand high temperatures. The pure metals are, nevertheless, subject to grain growth and brittleness under prolonged use under high temperatures. The grain growth progresses with prolonged use until continuous grain boundaries completely traverse the diameter of the wire and some slippage occurs along the grain boundary resulting in a change in electrical characteristics or breakage of the wire at the grain boundary.

It is an object of the present invention to provide a method of making wire of substantially pure metal, whereby grain growth is retarded and mechanical strength is maintained under conditions which would otherwise deleteriously affect the wire. It is another object of the invention to provide a method making wire of pure metal, whereby desirable electrical characteristics thereof are maintained under prolonged use at high temperatures. Other objects and advantages of the invention will become apparent from the description hereinafter following and the drawings forming a part hereof, in which:

FIGURE 1 illustrates a perspective view of a wire,

FIGURE 2 illustrates a perspective view of a modified form of wire,

FIGURE 3 illustrates a perspective view of a compact bundle of longitudinally aligned wires,

FIGURE 4 illustrates a longitudinal sectional view of FIGURE 3, but with the ends of the bundled wire fused into a solid mass, and

FIGURE 5 illustrates a diagrammatic illustration of the method steps employed in the making of a wire according to the invention.

The invention relates to the method of making a wire from a bundle of individual wires of substantially pure metal, the bundle being compacted and sintered at a temperature above the recrystallization temperature of the wire metal and subsequently hot worked to a solid wire mass. Thereafter, the wire is worked to desirable dimensions by the usual alternating hot and cold working.

More specifically, and according to the illustrations, a plurality of wires 1, for example wires of circular cross-section, or wires 2 of rectangular cross-section are first cleaned by usual cleaning methods to remove foreign or undesirable material on the surfaces thereof, and such wires are grouped into a bundle 3 as illustrated by FIGURE 3. The wires are cleaned, e.g. by etching with an acid prior to grouping into a compact bundle and secured or maintained in the form of a bundle by mechanical clamping or, preferably, by fusing the ends of the wires as at 4 and 5 into a solid mass. The compact bundle is then sintered at a temperature above the recrystallization temperature of the metal until the individual wires are bonded together into a rod. The sintered or frittered bundle 3 is worked by hot rolling until it is in the form of a hot metal rod as one solid mass. Thereafter, the metal rod is cold worked to desired dimensions or alternately cold worked and hot worked until the desired dimensions are attained.

Example

Wires of chemically pure platinum having a square cross-section of 0.110″ were etched with aqua regia until the surfaces thereof were chemically clean. Ninety-nine of the wires were grouped and compacted into a bundle 1″ square. Both ends of the bundle were heat-treated with a helium electric arc until the individual wire ends were fused into a solid mass. The fusion of the ends of the bundle secured the bundle as a compact group. The secured bundle was placed in a furnace and heat-treated at a temperature of 1400° C. (which is above the recrystallization temperature and below the melting temperature of the platinum) for 16 hours until the individual wires were bonded into the form of a solid rod. The bonded rod was then hot worked at 1000° C. by rolling between a pair of shaped reducing rolls and hot rolled to a square cross-section of 0.625″. At this reduction the individual wires were not distinguishable and the rod was in the form of a solid metal mass. The rod was further reduced by cold rolling to a 0.110″ square cross-section, and still further reduced by drawing to finished size, i.e. 0.020″. A four foot length of the wire was connected between a pair of electrodes and electric power was passed through the wire for eight hours continuously at 287 watts. After 8 hours, a micrographic cross-section showed no crystals large enough to traverse the wire cross-section and with the metal crystals being highly irregular and interlocked.

A four foot length of conventional platinum wire was tested under identical conditions and showed grains developed across the entire cross-section of the wire.

Stress rupture tests showed that the wire of the invention showed a life test of one hundred times that of the convenional platinum wire, both wires consisting of chemically pure platinum.

The stress rupture tests were conducted at a temperature of 1400° C. under a load of 230 lbs./sq. in.

It has been determined that the method of manufacturing wire according to the invention creates a migration of various occlusions in the metal to the grain boundaries where the occlusions become fixed and act to retard grain growth. In conventional wire, there is a minimum of occlusions, but in the wire of the invention, an increase of occlusions is created by the method of manufacture, whereby the metal is still in the pure state and of desirable electrical characteristics together with increased mechanical strength, which are maintained under use of the wire at high temperatures.

While the example is specific to platinum, other substantially pure metals can be formed into wire by the method of the invention within the scope of the appended claims.

What is claimed is:

1. The method of making electrically conductive grain-growth controlled wire for use in high temperature operating devices comprising chemically cleaning numerous wires of substantially the same size and of the same substantially pure metal selected from the class consisting of platinum, palladium and rhodium, grouping and securing the wires into a compact bundle, heat treating the bundle at a temperature above the recrystallization temperature and below the melting temperature of the metal until the wires are bonded into a rod reducing the cross-section of the rod by hot working until the rod is a solid metal mass of substantially pure metal, and cold working the rod into wire.

2. The method according to claim 1, wherein the hot working comprises reducing the cross-section thereof by hot rolling.

3. The method according to claim 1, wherein the cold working comprises drawing the rod into wire.

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