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[54] **MOUNTING DEVICE FOR CRYSTALLINE RODS**

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[51] **Int. Cl.** **B25b 1/10**

[58] **Field of Search** ..... 23/273 SP, 301 SP; 279/83; 269/155, 156, 285, 286, 287, 321 W, 321 WE

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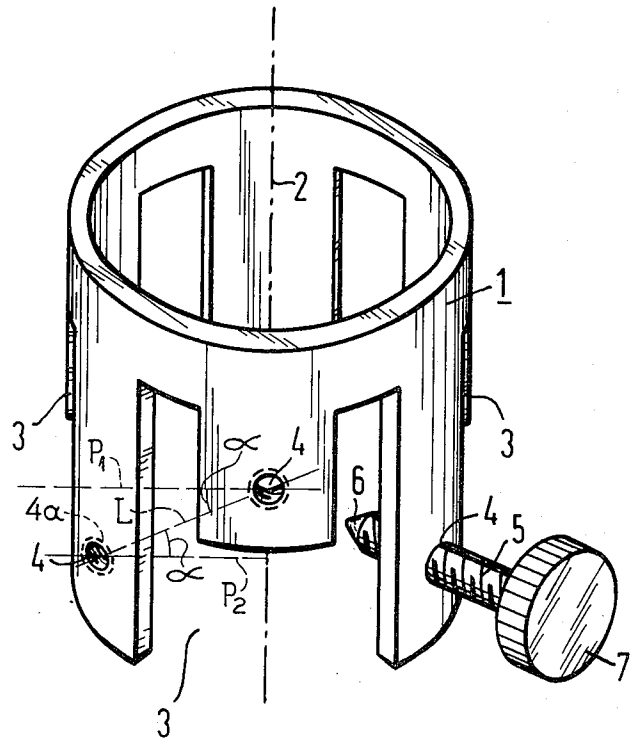
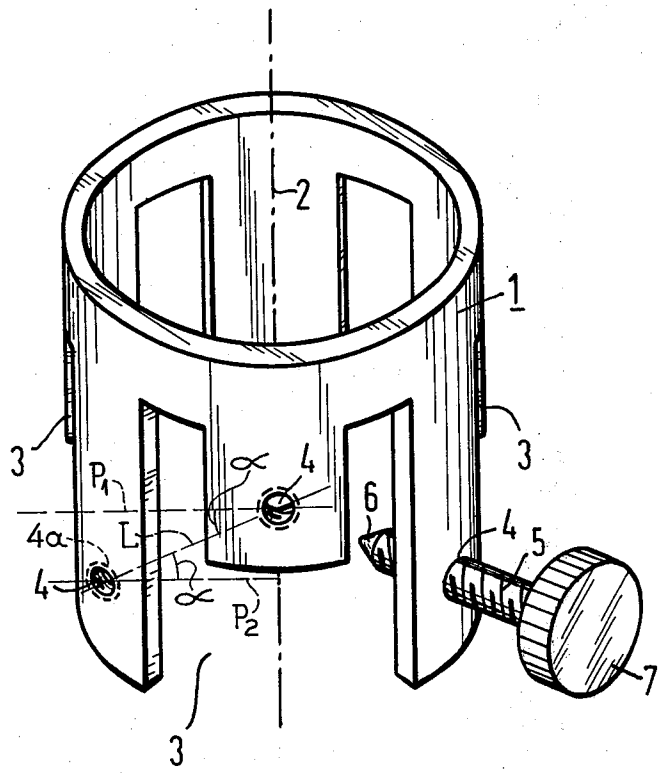
[57] **ABSTRACT**

A device for mounting crystalline rods, such as semiconductor rods which are undergoing a floating zone melt treatment, comprised of a frame for supporting a rod and and having a plurality of axially extending open spaces in the peripheral boundary thereof, along with adjustable screws for mating with bores in the frame periphery for anchoring and centering a rod end within the frame.

8 Claims, 1 Drawing Figure

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MOUNTING DEVICE FOR CRYSTALLINE RODS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to mounting devices and somewhat more particularly to mounting devices for supporting ends of a crystalline rod while the rod is being processed by a floating zone melt process.

2. Background of the Invention

In a typical floating zone melt process, a crystalline rod, such as composed of a semiconductor material, for example, silicon, is mounted within a reaction chamber so that an induction heating coil within the chamber encompasses an axial portion of the rod and upon energization of the coil, a zone of melt is generated on the rod. Relative movement between the coil and the rod is effected so that the zone of melt "floats" along the length of the rod from one end to the other. This type of process is used to treat, for example a semiconductor rod, in order to either concentrate impurities within the rod at one end of the rod or to transform a polycrystalline semiconductor rod into a monocrystalline rod. Generally, a seed or core crystal is attached to a stock rod and the initial zone of melt is generated in the core crystal and then moved back and forth along the length of the rod until a desired degree of treatment has been achieved. The rod (including core crystal) member is generally mounted vertically at its opposite ends by a pair of mounting devices during such a floating zone melt process.

German Pat. No. **1,114,171** describes mounting devices for rod-shaped semiconductor materials undergoing a floating zone melt process. Generally, these prior art mounting devices comprise a hollow frame member having three rotatable and resilient clamping means located in two different planes, both of which are essentially perpendicular to the vertical axis of the frame and the axis of a rod mounted within the frame. The clamping means are actuatable by screws or studs mounted in the frame member which have their ends in contact with the clamping means. Such devices have a relatively complicated construction and are difficult to adjust to attain a proper centering of a rod mounted therein. Further, the various components of such mounting devices, particularly the molybdenum studs, heat-up during a floating melt zone process when the induction heating coil approaches a rod end since the components extend into the field of the HF coil. The results in a loosening of the semiconductor rod since the mounting devices expand and allow the semiconductor rod mounted therein to fall out of the frame members and become damaged and/or unsuited for further processing.

SUMMARY OF THE INVENTION

The invention provides a rod mounting device which substantially eliminates the aforesaid prior art drawbacks and comprises a hollow frame member for mounting a rod end and having at least one open space extending in the axial direction of the frame member along with an adjustable screw matable with a bore within the frame for anchoring and centering a rod end within the frame.

It is a novel feature of the invention to provide a rod mounting device comprised of a hollow cylindrical frame member having three somewhat M-shaped wall portions or U-shaped open spaces or recesses symmetrically spaced about the periphery of the frame member, with a threaded bore adjacent to each leg portion of the M-shaped wall portions and a screw for mating with each bore and having a tip for holding and centering a rod end mounted within the frame member.

It is another novel feature of the invention to provide a rod mounting device as described hereinabove, wherein the somewhat U-shaped open spaces have alternating solid wall areas between the leg portions of the open areas and each solid area is of a different length than an adjacent solid area. This arrangement prevents the high frequency field of an induction heating coil from inducing any substantial heat or heating current into such a mounting device.

It is yet another novel feature of the invention to provide a rod mounting device as described hereinabove wherein alternate threaded bores are located in adjacent parallel planes perpendicular to a rod axis. In a presently preferred exemplory embodiment, adjacent threaded bores are located at points in one of the two parallel planes so that a line joining the respective bore center points defines an angle of about **60°** with one of the parallel planes. This arrangement provides an extremely good centering and anchoring of a rod mounted within the frame.

Other and further objects of the invention will be apparent from the following description and claims and are illustrated in the accompanying drawing which, by way of illustration, shows a preferred embodiment of the present invention and the principle thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be used as structural changes may be made as desired by those skilled in the art without departing from the present invention and the purview of the appendant claims.

BRIEF DESCRIPTION OF DRAWINGS

The single FIGURE is a perspective illustration of a rod mounting device constructed in accordance with the principles of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

The invention provides a rod mounting device comprised of a hollow frame member having at least one open space in the peripheral boundary thereof which extends in the axial direction of the frame member, along with an adjustable screw for mating with a bore within the frame member and centering and anchoring a rod end mounted within the frame member.

In preferred embodiments, the frame member comprises a hollow cylindrically shaped member which includes three spaced somewhat M-shaped wall portions or U-shaped open spaces or recesses extending in the axial direction of the frame member. Preferably, the U-shaped open spaces are symmetrically spaced about the periphery of the frame member. In other words, the open spaces in the frame member are preferably spaced about **120°** apart about a rod axis within the frame member. The high frequency field of a coil can induce considerably less heating current into the frame member or mounting device through the open spaces, which extend in the axial direction of the frame member. Further, the remaining solid areas of the frame between the open areas are resilient in respect to other solid areas so that even if some slight heating of the frame member occurs during a zone melting process, the resiliency of wall portions of the frame member will

maintain a semiconductor rod in its preset position. These advantages are available in embodiments wherein only one open space or isolated wall portion is present in a frame member.

The preferred embodiment of the invention also include a plurality of threaded bores in the frame member which are spaced about the frame periphery so as to be substantially symmetrically spaced about a rod axis and mating screws or bolts which, in cooperation with the bores, anchor and center a rod end within the frame member. Preferably, alternate bores are disposed in one of two parallel planes which extend perpendicularly to the vertical axis of the frame member, which is, of course, parallel to a rod axis.

In certain and presently preferred embodiments of the invention, the threaded bores are located adjacent the peripheral edges of the open spaces or recesses within the frame member and alternate bores are disposed at a point in one of two parallel planes which extend perpendicularly to a rod axis so that a line joining the respective center points of two adjacent bores defines an angle of about **60°** with one of the parallel planes. This type of arrangement provides very good centering and anchoring of a semiconductor rod mounted within the frame member.

The screws or bolts utilized in the rod mounting devices of the invention are preferably composed of steel and are provided with a tungsten carbide (Widia metal) tips. Such screws provide a very good attachment of a semiconductor rod since the screw tips tend to slightly work into the surface of a rod and securely anchor the rod in place. Also, the preferred screws are provided with a milled screw head so that better centering is achieved and centering tools or the like are rendered superfluous. Further, milled screw heads give an operator a better feel of pressure during attachment of a semiconductor rod.

In certain preferred exemplory embodiments of the invention, the frame member and screws are composed of a high grade steel, for example a steel having approximately a **19** percent chromium and approximately a **9** percent nickel content therein (V2A-steel). Such frame members and screws expand uniformly during a zone melt process and this type of steel does not give off any detrimental oxidation impurities.

The rod mounting device of the invention allows one to mount and center various rod-shaped members having differnt diameters. In particular, very small diameter rods, for example core or seed crystal rods, are readily mounted and centered with the mounting device of the invention. With frame members designated for mounting relatively thin rods, the wall thickness (or strength) of the frame member is matched to the diameter of the rod so as to achieve a good resilient effect. Thus, frame members adapted for small diameter rods have a reduced strength wall in relation to a normal frame member. If necessary, nuts may be placed onto the bores in order to attain better guidance of a milled screw.

The rod mounting devices of the invention are especially useful in a vacuum environment, such as sometimes present within a reaction chamber of a floating zone melt process, since lubricating means are not required.

Referring now to the exemplory embodiment of the invention illustrated, a hollow cylindrically shaped steel frame **1** is shown having three somewhat U-shaped open spaces or recesses **3** milled into the peripheral wall of frame **1**. The recesses **3** extend parallel to a rod axis **2** and are symetrically spaced about axis **2**. A plurality of bores **4** having internal threads**4***a* are spaced about the peripheral wall of frame **1**. In the embodiment shown, six bores **4** are provided adjacent each leg portion of the U-shaped openings or recesses **3**. Alternate bores **3** are disposed in one of two parallel planes P_1 and P_2 which are perpendicular to the rod axis **2** and are located at a point in one of the planes so that a line L joining their respective center points defines an angle α with one of the planes P_1 or P_2 of about **60°**. A steel screw **5** is provided for mating with each of the bores **3** so that the screws tip **6**, which is composed of tungsten carbide (Widia metal) extends into the interior of frame **1** and contacts a semiconductor rod end (not shown) mounted within frame **1**. The screw tip **6** works itself slightly into the surface of a semiconductor rod and provides a good attachment between the frame and a rod end. The screws **5** also has a milled head **7** which simplifies centering of a rod within the frame, since screw adjustment can easily be carried out by hand.

The drawings and specification presents a detailed disclosure of the preferred embodiments mentioned and it will be appreciated that the invention is not limited to the specific forms disclosed. Accordingly, modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the invention.

I claim as my invention:

1. A device for mounting opposing ends of a semiconductor rod undergoing a floating zone melting treatment, with each rod end being supported by one such device, said device comprising a hollow cylindrically shaped frame member for encompassing a rod end, said frame member having a peripheral wall with three U-shaped recesses symmetrically spaced 120° apart about said wall, said peripheral wall having a plurality of threaded bores symmetrically spaced about said peripheral wall and screws mating with said bores and securing the rod end within said frame.

2. A device as defined in claim **1** wherein alternate bores of said plurality of bores are disposed in one of two parallel planes extending perpendicularly to the axial direction of a rod mounted within said frame.

3. A device as defined in claim **2** wherein said alternate bores are located at a point on said parallel plane so that a line joining the center points of said alternate bores defines an angle of about **60°** with one of said parallel planes.

4. A device as defined in claim **1** wherein screws are provided with tungsten carbide tips.

5. A device as defined in claim **4** wherein said screws are provided with milled heads.

6. A device as defined in claim **1** wherein said frame member and said screws are composed of a high-grade steel.

7. A device as defined in claim **6** wherein said high-grade steel includes about **19** percent chromium and about **9** percent nickel.

8. A device for mounting an end of a semiconductor crystalline rod undergoing a floating zone melt treatment, comprising:

a hollow cylindrically shaped frame member for mounting an end of the rod;

said frame member having a peripheral wall with three U-shaped recesses therein extending in the axial direction of the rod;

said peripheral wall having threaded bores adjacent spaced peripheral edges of said recesses; and

screws for mating with said bores for anchoring and centering the rod end within said frame member.

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