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METHOD OF GROWING SEMICONDUCTOR CRYSTALS

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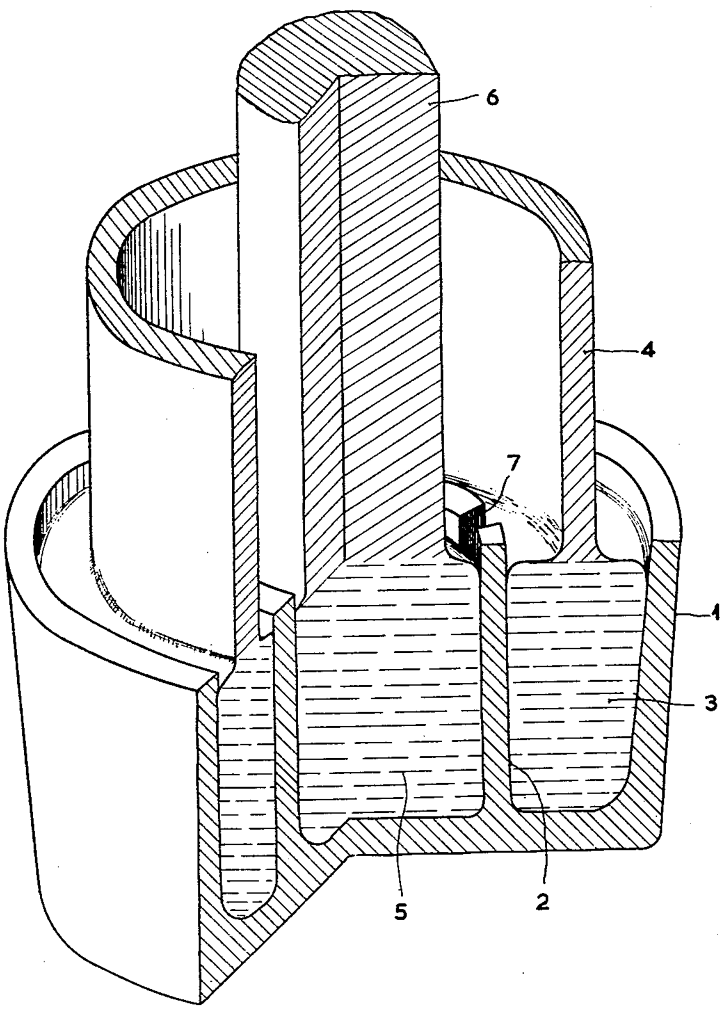

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METHOD OF GROWING SEMICONDUCTOR CRYSTALS

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The present invention relates to methods of making bodies, more particularly monocrystalline bodies, from semi-conductive material by drawing them upwards from a melt. Such a method has been described by Czochralsky in "Zeitschrift für Physikalische Chemie," 92 (1917), pages 219 to 221.

It is known that, for obtaining rod-shaped bodies of regular shape, it is advantageous to rotate them about their longitudinal axis in drawing them upwards. Furthermore, it is known that the number of dislocations in the crystals produced is smaller as the liquid-solid interface approaches to a plane at right angles to said longitudinal axis. In order to obtain such an interface special forms of heating elements have been proposed, while it has also been suggested to surround the liquid-solid interface by heat radiators and/or reflectors.

The present invention has inter alia for its object to permit such bodies to be made with very few dislocations, and this more particularly by preventing as much as possible the occurrence of marginal effects.

According to the invention, such bodies are drawn upwards from a melt while being surrounded by a tubular member consisting of the same material and being also immersed in the melt.

Viewed in a vertical direction or axial direction, the temperature distribution inside the tubular body will be approximately the same as that in the body surrounded by it. This applies in particular to the inner faces and outer faces adjacent each other. This uniformity will be a maximum if the tubular body is drawn upwards simultaneously but, unless imposing the highest requirements, it is alternatively possible for this body to be stationary or even to make it melt slowly.

It is known per se that such tubular bodies can be made in a simple manner by drawing them upwards, namely by immersing a tubular seed of the relevant material in the melt and by subsequently letting it grow in the same manner as was usual for solid rod-shaped bodies.

The material of the tubular member having more lattice defects than that of the rod-shaped body, may be employed for uses imposing less stringent requirements or it may be melted up and worked up again.

In order that the invention may be readily carried into effect, an example will now be described in detail with reference to the accompanying drawing, which shows schematically in a simplified manner a device for carrying out the invention and in which this device comprises a round crucible **1** in which provision is made of a partition **2** which is spaced from the outer wall, between which walls an annular space **3** is formed. In this space, the semi-conductive material, for example germanium, is melted, subsequently to which a semi-conductive, tubular member **4** is drawn upwards therefrom. For this purpose, a tubular seed is immersed in the molten mass and subsequently slowly drawn upwards, while rotating it about its axis. The mechanical equipment required therefor is not shown in the drawing.

Inside the crucible, a central vessel **5** is formed, from which a second semi-conductive body **6** is drawn upwards. The partition **2** is preferably as thin as structurally possible and the process is controlled so that the inside diameter of the tube **4** and the outside diameter of the rod **6** approach to each other as much as possible. The partition **2** should only slightly overtop the surface of the melt. The partition **2** prevents the tubular member **4** from growing in the direction of its axis and uniting with the rod **6**.

By now making provision that any part of the rod **6** is located opposite a part of the inner wall of the tube **4**, cooling will be low in a radial direction. This cooling will mainly occur in an axial direction, which results in the interface between the melt and the solidified mass being as planar as possible.

The level of the melt can be maintained constant by replenishment through an aperture in the wall. It may then be desirable locally to interrupt the partition **2**, for example by providing one or more slots **7** in order that the level may remain the same at both sides. Alternatively, the spaces at both sides of the wall **2** may be filled up each separately, while the material in the space **5** may be purer than that in the space **3**. In this connection, the prescription that the bodies **4** and **6** should consist of the same material is not to be understood to mean that there should be no difference in purity or in content of donors or acceptors, provided that their melting points and heat conductivity do not differ noticeably due to such differences.

What is claimed is:

1. A method of growing high-quality semiconductor crystals, comprising the steps of providing a melt of semiconductor material, drawing a first growing tubular crystal upwards from the melt, and, simultaneously with the last step, drawing a second growing single crystal upwards from the melt within the first crystal and separate from the latter and such that it never extends beyond the first crystal.

2. A method of growing high-quality semiconductor crystals, comprising the steps of providing a melt of semiconductor material, drawing a growing hollow cylindrical crystal upwards from the melt, and, simultaneously with the last step, drawing a growing crystal upwards from the melt and within the hollow cylindrical crystal.

3. A method as set forth in claim 2, wherein the growing conditions are controlled such that the outer surface of the inner crystal is close to the inner surface of the hollow crystal.

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