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PROCESS FOR THE MANUFACTURE OF A SUPRACONDUCTIVE WIRE

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This invention relates to a process for the manufacture of a supraconductive wire, particularly of a wire of intermetallic compounds.

As is known, supraconductivity of metallic materials, i.e. the sudden drop in electric resistance in the range of low temperatures, particularly near absolute zero, is not limited to specific pure metals or to alloys of two supraconductors. Alloys of a normal conductive material and a supraconductive material and alloys of two normal conductive materials show supraconductivity as well.

Intermetallic compounds gained particular importance as supraconductors since their transition temperatures markedly exceed those of the pure components. Known intermetallic compounds having supraconductivity are chiefly those of the metals niobium, vanadium and tantalum, e.g. the compounds Nb_3Sn, Nb_3Al, Nb_3In and Nb_3Ga, V_3Si, V_3Ga and V_3Sn as well as Ta_3Sn. In particular, these supraconductors are widely used for production of strong magnetic fields with both direct current and alternating current.

The present invention is based on the problem to simplify the manufacture of supraconductive wires of intermetallic compounds, which manufacture is faced with great difficulties due to the brittleness of these compounds, while simultaneously bringing about the "filament structure" which is essential for the use of supraconductors.

It is already known to manufacture wires of the intermetallic compound Nb_3Sn by filling a tube of niobium either with a mixture of powdered Nb_3Sn and an excess of tin powder or with a still reactive mixture of tin and niobium powders, sealing the tube with a niobium plug and reducing it to the wire diameter desired by mechanical working. Following this, the wire is annealed at temperatures of between 970° and 1400° C. While a certain number of "filaments" is developed in this prior art process, it has been found that a substantial increase in view of the properties of the supraconductive wire is desirable.

A surprising solution to the problem on which the invention is based is the manufacture of a supraconductive wire, particularly of intermetallic compounds, by density filling a tube made of one of the components of the intermetallic phase with a wire bundle of the same material, filling the voids with the second component of the intermetallic phase in fused state, drawing down the shaped body while cold to the diameter desired using preferably several steps, winding it, e.g. into a coil, for final shaping and finally annealing it. This will give the wire the supraconductive characteristics.

The particular advantage of this process consists in that the wire bundle consisting of the one component of the intermetallic phase is already in a state which favors the formation of the filament structure and that the dense packing of the tube with wires of the same material substantially increases the number of filaments as compared with the prior art process where their formation was left to chance.

The process of the invention is illustrated hereafter in

connection with the manufacture of a supraconductive wire consisting of the intermetallic phase Nb_3Sn with the ratio of tube and wire to the amount of tin filling the voids being chosen in accordance with the resultant compound Nb_3Sn. Wires of other intermetallic compounds may be manufactured in an analogous manner so that this example does not constitute a limitation of the subject matter of this application. For example, the material for the tube and the wire bundle may be vanadium and the second component of the intermetallic phase may be gallium. Moreover, it is to be understood that the manufacture of a wire of an intermetallic compound or alloy consisting of more than two components is also possible by the process of the invention.

A niobium tube of 50 cm. in length and 10 mm. in outside diameter and being pickled in its interior is electroplated in its interior with a tin layer of 15 microns thickness. Niobium wires each having a diameter of 0.5 mm. are tin-plated by the dipping process, combined into a bundle and drawn through a wire die thereby adapting the diameter of the total bundle to the inside diameter of the niobium tube. After the wire bundle has been drawn into the niobium tube, the latter is purged with inert gas, dipped into fused pure tin and the molten tin is sucked into the tube with the use of vacuum. Desirably the tube is then left for some time in the molten tin and thereafter the tube is cold-drawn in several steps to the wire diameter desired of, for example, 0.1 mm. The wire is then wound into a coil and annealed for several hours at temperatures of between about 900 and 1200° C.

The wires of intermetallic compounds manufactured by the process of the invention have considerably improved properties as compared with wire of Nb_3Sn manufactured by the prior art process and result in substantial advantages when used for the production of high magnetic fields, particularly for the control of electron and ionic currents.

What is claimed is:

1. A process for the manufacture of a supraconductive wire, particularly of a wire consisting of intermetallic compounds, which comprises densely filling a tube made of the one component of the supraconductive intermetallic phase with a wire bundle preferably consisting of the same material, filling the voids with the second component of the intermetallic phase in molten state, drawing down the shaped body to the diameter desired and annealing it after final shaping.

2. The process of claim **1**, wherein said filling of the voids with said second component of the intermetallic phase is effected with the application of vacuum.

3. The process of claim **1**, wherein said drawing-down to the final diameter is effected cold in several steps.

4. The process of claim **1**, wherein said wire is wound into a coil before annealing.

5. The process of claim **1**, wherein the material of the tube and wire bundle is niobium.

6. The process of claim **1**, wherein said second component of the intermetallic phase is tin.

7. The process of claim **1**, wherein said annealing is effected for several hours at a temperature between about 900 and 1200° C.

References Cited by the Examiner

UNITED STATES PATENTS

3,124,455	3/1964	Buehler et al.	75—174 X
3,162,943	12/1964	Wong	75—528 X

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