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[54] METHOD OF MANUFACTURING METALLIC SHORT FIBERS

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[51] **Int. Cl.** **B22d 11/12**

[58] **Field of Search** ..... 164/69, 81, 82, 283; 264/176 F

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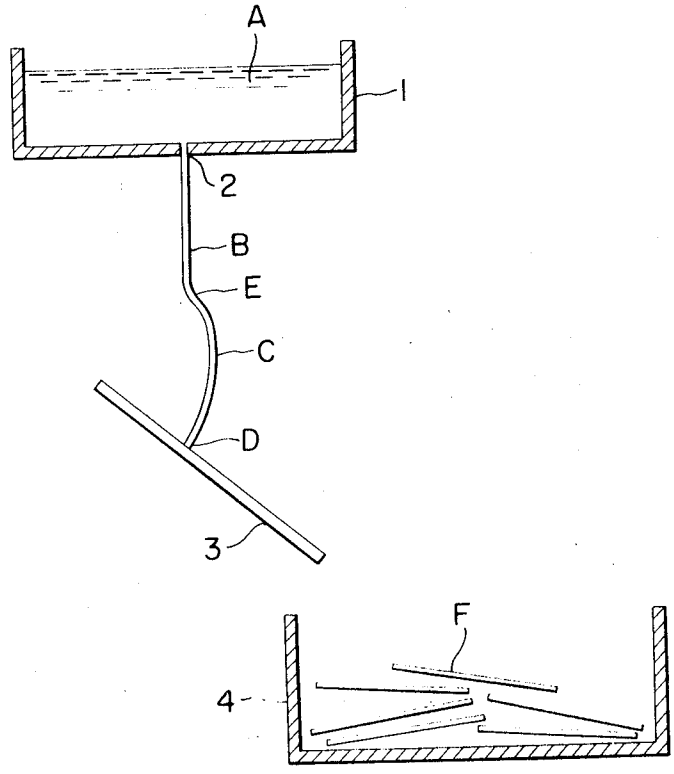
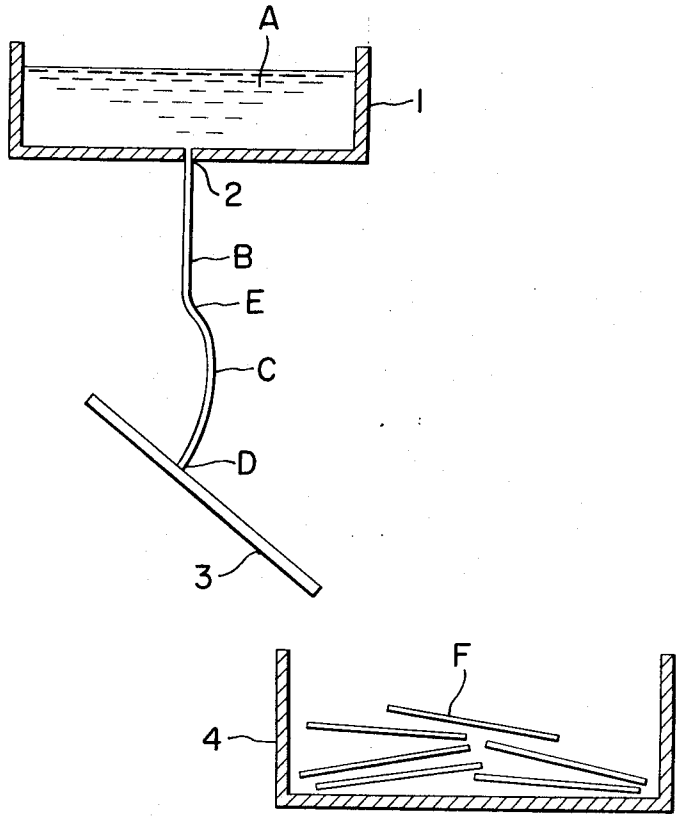
[57] **ABSTRACT**

A method of manufacturing metallic short fibers comprising the steps: making the melt flow out through a small orifice under elevated pressure; and making the resulting solidified endless metallic fiber run against a slant cooling device to thereby break it into pieces of fixed length.

5 Claims, 1 Drawing Figure





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METHOD OF MANUFACTURING METALLIC SHORT FIBERS

BACKGROUND OF THE INVENTION

a. Field of the Invention

The present invention relates to an improvement in the method of manufacturing metallic short fibers by flowing molten metal through a small orifice under elevated pressure and then solidifying same.

b. Description of the Prior Art

The conventional methods of manufacturing various metallic fibers through mechanical processes such as the extrusion process, wire-drawing process, etc. are exclusively intended for obtaining an endless fiber, while, as to the manufacturing of metallic short fibers of uniform length, no pertinent method has ever been developed. As a result, in case where metallic short fibers are required, such as for preparing a composite material by means of mixing metallic short fibers, for the purpose of reinforcement, with another substance or producing porous pressure-moldings by the use of metallic short fibers, it has been usual to employ the method in which conventional endless fibers are cut into pieces of a fixed length to serve for said purpose by means of a cutter. However, this method of cutting endless fibers has been defective in that it is poor in productivity due to the complicated process and apparatus, that the quality of the metallic short fibers thus obtained is such that the surface of the fiber gets stained or distorted caused by working or a multiplicity of short fibers are caused to adhere to each other by the cut ends under pressure even after cutting, thereby forming a bunch inconvenient for handling, etc.

On the other hand, in case of the melt spinning process which comprises the steps that a melt obtained by fusing a metal is made to flow out through a small orifice at the bottom of a receptacle by applying mechanical force, pneumatic pressure or the like and the melt thus flowing out is solidified by means of an appropriate cooling atmosphere, thereby producing a metallic fiber, though it is admittedly possessed of improved productivity as compared with the mechanical process such as the extrusion process, wire-drawing process, etc. mentioned above and the metallic fiber obtained thereby is also superior in quality, the product resulting from this conventional method has also been confined to endless fibers.

SUMMARY OF THE INVENTION

The present inventors have conducted a series of researches on the properties and behaviors of the melt for use in the foregoing melt spinning process and confirmed the fact that a metallic fiber immediately after solidification of the melt flowed out from a small orifice is so poor in intercrystal bonding strength that application of just a slight force readily brings about separation of crystals and breakdown of the fiber. This phenomenon is called the state of hot shortness. They also noticed the fact that a metallic fiber descending in such a state as above can be made into metallic short fibers of uniform length by means of applying thereto a regular breaking force, and, based on this observation, they have successfully achieved their object by means of making the metallic fiber collide with a slant metallic plate as a means of giving rise to regular breaking force and taking advantage of the bending stress arising from said collision.

In other words, the present invention relates to a method of manufacturing metallic fibers by means of making a melt flow out through a small orifice under elevated pressure, which comprises the step that an endless metallic fiber being made of the melt thus flowing out and in the state of hot shortness immediately after solidification thereof is made to collide with a slant cooling device to be broken into pieces of uniform length.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the appended drawing which is a schematic representation of apparatus to be utilized in practicing one embodiment of the present invention, **1** denotes the receptacle, **2** denotes the small orifice provided in the bottom of said receptacle, **3** denotes the cooling device and **4** denotes the collecting box. The melt A in the receptacle **1** is subjected to elevated pressure applied thereon by an appropriate means, so that it flows out through the small orifice **2** at a regular speed and gets solidified completely at the point marked B. On this occasion, if there no cooling device **3** is provided, the melt thus flowing out will be collected in the form of an endless fiber. According to the present invention, however, by virtue of the provision of the slant cooling device **3**, the descent of the solidified metallic fiber C is obstructed as the tip D thereof collides with the cooling device **3**, and, as a result, the metallic fiber C bends as shown in the drawing, is subjected to a bending stress, and finally gives way under this bending stress to break at the point marked E. The metallic short fibers F resulting from such breaking slip down along the cooling device **3** to be collected in the collecting box **4**. The length of the metallic short fibers F to be obtained in this way can be controlled at will by means of modifying the distance between the point marked E and the point marked D: the closer the point D is to the point B, the shorter is the length of the broken fibers, and vice versa. The position of the point D where the descending metallic fiber C comes in contact with the cooling device **3** varies with the temperature of the melt, the flowing rate of the melt, the condition of cooling and the thickness of the metallic fibers to be obtained, etc., and it can be usually regulated in the range of 5–300 cm in terms of the distance from the small orifice **2**. As for the cooling device **3**, it suffices to be a metallic plate or a hollow metalwork having a slant smooth surface so that the short fibers resulting from the breaking can be cooled thereby while retaining a sufficient strength and slide down smoothly into the collecting box **4**. As to the means of cooling, either of the air-cooling and water-cooling will do.

In the present invention, the manufacturing process is simple, the producing speed is high, and, by means of vertically or horizontally shifting the position of the cooling device, metallic short fibers of a desired length can be readily manufactured. The short fibers obtained by the method of the present invention are quite clean and absolutely free from stains ascribable to oil, water, etc. inasmuch as they are not made by the conventional mechanical cutting process. Besides, inasmuch as the present short fibers are of uniform length and separated from each other without being intertwined, they are convenient for use in pressure-molding by filling them in a metal pattern, and, therefore, they constitute a

quite suitable material for use in manufacturing porous board-type mold goods. Moreover, since the present short fibers are absolutely free from any permanent set inasmuch as they have been subjected to cooling subsequent to the breaking in the state of hot shortness and are possessed of a uniform texture, the function of the manufactures made by utilizing them is improved.

As the material for the melt in the present invention, lead, zinc, aluminum, lead base alloys, zinc base alloys and aluminum base alloys are all applicable.

The metallic short fibers made by the present invention can be made into porous molded goods through pressure-molding process by taking advantage of the above-mentioned properties to serve as the electrode plate of battery, catalyst, filter, sound-arresting material, etc. and they also can be mixed with synthetic resins as a material for use in preparing a composite having the electric conductivity and thermal conductivity.

EXAMPLE 1

Pure lead was melted at 360°C, and the melt thus prepared was made to flow out under a pressures of 2.0 kg/cm_2 through a nozzle having a sectional area of 0.01 mm^2 at the speed of 5.5 m/sec onto a stainless-steel plate for the purpose of breaking and cooling the descending lead fiber, which plate was disposed **15** cm below the bottom of the nozzle with a gradient of 60°. By means of thus making the lead fiber collide with said stainless-steel plate, there were obtained short fibers of pure lead with a length of 2 mm, which were separated from each other without being intertwined and possessed of a quite clean surface.

EXAMPLE 2

Lead-4 percent antimony alloy was melted at 320°C, and the melt thus prepared was made to flow out under a pressure of 2.0 kg/cm^2 through a nozzle having a sectional area of 0.008 mm^2 onto a stainless-steel plate which was disposed **15** cm below the bottom of the nozzle with a gradient of 60°, whereby the descending lead fiber was broken into pieces and there were obtained short fibers of lead-4 percent antimony alloy with a length of 1.5 mm each at the rate of about 20,000 pieces per minute. Further, by means of disposing said stainless-steel plate at a position 20 cm below the bottom of the nozzle, there were obtained short fibers of said alloy with a length of 7 mm each.

EXAMPLE 3

Pure zinc was melted at 450°C, and the melt thus prepared was made to flow out under a pressure of 1.0 kg/cm^2 through a nozzle having a sectional area of 0.04 mm^2 and to collide with a hollow copperwork of water-cooling type which was disposed 2.0 m below the bottom of the nozzle with a gradient of 45°, whereby there were obtained short fibers of pure zinc with a length of 2 mm each.

EXAMPLE 4

An aluminum alloy containing 11 percent silicon was melted at 620°C, and the melt thus prepared was made to flow out under a pressure of 2.0 kg/cm^2 through a nozzle having a sectional area of 0.09 mm^2 and to collide with a hollow copperwork of water-cooling type which was disposed 2.5 m below the bottom of the nozzle with a gradient of 30°, whereby there were obtained short fibers of said alloy with a length of 3 mm each.

All the short fibers prepared as above displayed fluidity like a metallic powder and could be readily filled in a metal pattern uniformly. A porous board manufactured by the process of pressure-molding upon filling the present fibers in a 2 cm square metal pattern was possessed of an apparent density of 4.0 and displayed uniform density all over the structure including all the edges and corners thereof.

What is claimed is:

1. A method of manufacturing short metal fibers, which comprises:

continuously extruding molten metal substantially vertically downwardly through a small orifice under elevated pressure to form a continuous, downwardly moving filament;

immediately after the filament leaves the orifice, cooling the filament to solidify same without breaking same so that the solidified portion of the filament remains integral with the molten metal issuing from the nozzle, so that there is formed in the solidified portion of the filament a zone of increased brittleness at a position spaced downwardly from said orifice;

continuing to move the filament substantially vertically downwardly and directing the lowermost tip of the solidified portion of the filament against the smooth upper surface of a target member, which surface is inclined with respect to the vertical, to bend the solidified filament and thereby to cause the filament to break substantially at said zone of increased brittleness to form a short fiber;

and continuing to move said filament so that the lowermost tip thereof is repeatedly directed against said surface whereby said filament is repeatedly broken into short fibers.

2. A method according to claim **1**, in which said member is made of metal and is maintained stationary during the method.

3. A method of manufacturing metallic short fibers according to claim **1**, wherein said member is vertically and horizontally adjustable.

4. A method of manufacturing metallic short fibers according to claim **1**, wherein said member is a hollow metalwork of water-cooled type.

5. A method of manufacturing metallic short fibers according to claim **1**, wherein the metal is selected from the group consisting of lead, zinc, aluminum, lead base alloys, zinc base alloys and aluminum base alloys.

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