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METHOD OF FORMING ROUND METAL FILAMENTS

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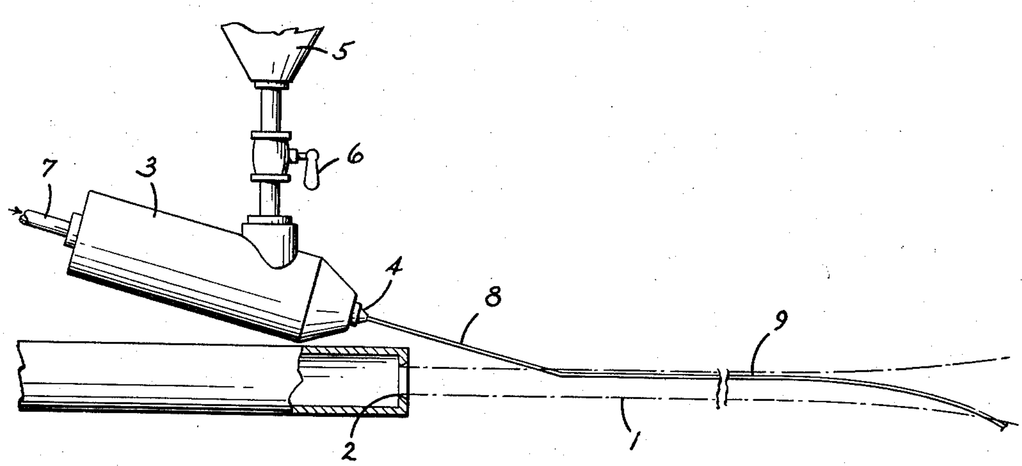

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METHOD OF FORMING ROUND METAL FILAMENTS

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14 Claims. (Cl. 22—200.1)

This invention relates to a method of producing metal fibers and filaments.

Numerous methods have been employed in forming metal fibers and filaments such as drawing a wire rod or extruding metal through suitable forming dies. Certain types of metals have been cast into grooves in forming wire of various types. In my copending application Serial No. 387,187, now Patent No. 2,825,108, there is disclosed a method of forming metal filaments by extruding a continuous stream of molten metal and impinging the stream on the concave surface of a rapidly rotating chill plate or block. The chill block is formed of a metal of high heat conductivity and possesses sufficient mass or is provided with cooling means so as to dissipate the superheat and the heat of fusion of the metal as it impinges on the chill block. The molten stream of metal is transformed into a solid during a brief contact with the chill plate and a continuous filament is cast off by the centrifugal force resulting from the rapid rotary motion.

The principal purpose of the present invention is to provide a simple and novel method for the production of round filaments and fibers.

Other objects and advantages will be apparent from the drawing and the description thereof hereinafter.

The accompanying drawing illustrates the essential apparatus employed in forming filaments and fibers in accordance with the present method.

This method involves extruding a continuous stream of molten metal and directing the stream into contact with a jet air or gas stream.

It is known that an unconfined high velocity or jet gas stream may function as a solid body. It has been discovered that an unconfined high speed column of gas or jet gas stream may be utilized to support a continuous stream of molten metal until the molten metal has solidified.

As shown in the drawing, the jet stream of gas **1**, such as air, may be created by a sharp orifice **2** to which the gas is supplied by a suitable blower (not shown). The velocity of the gas at the point of discharge from the orifice may be as low as about 85 feet per second. The velocity utilized in any particular instance will be dependent more or less upon the density of the metal being converted into fibers or filaments and the degree of attenuation which it is desired to impart to the extruded metal, as will be explained hereinafter.

The continuous stream of molten metal may be provided by various means, such as an ejector tube **3** mounted in close proximity to the nozzle and provided with a nozzle **4** having an extrusion orifice of the desired size. The ejector tube **3** communicates with a source of supply of the molten metal such as a reservoir **5** from which the flow of molten metal into the ejector tube may be regulated by valve **6**. Pressure is applied to the molten metal so that it may be extruded from the ejector tube in the form of a continuous stream of molten metal **8** as by supplying gas under pressure through con-

duit **7** which communicates with a source of the gas. The orifice size, extrusion temperature, velocity and pressure of the molten metal are all factors affecting the size and shape of the filament. In one example of the process disclosed in application Serial Number 387,187 filed October 20, 1953 the orifice was made of glass with an aperture of 30 μ. The metal was heated to a temperature of 100° above the melting point and was ejected at 75 feet per second with 8 pounds of pressure. Satisfactory filaments can be produced according to the present invention under these conditions. The metal may be extruded at a velocity of from about 10 feet per second to 100 feet per second depending upon the specific metal, the temperature of the molten metal and the type or nature of product being produced. The specific angle of contact between the molten metal stream and the jet gas stream is not particularly critical although it is preferred to extrude the molten metal at an acute angle with respect to the direction of movement of the air stream.

For example, if the velocity of the air stream and the velocity of extrusion of the molten metal are substantially the same, for example, 100 feet per second, the air stream merely supports the molten metal while it solidifies, and carries the solidified metal **9** a short distance before the pull of gravity on the metal overcomes the supporting force of the jet air stream. The filament **9** then begins to fall. However, the high velocity stream of air creates air currents in the ambient atmosphere and the filament will be carried by an air current although the filament is gradually settling. The filaments formed in accordance with this invention are substantially round.

Although the stream of molten metal comes into contact with the high speed jet stream of gas, the molten metal is not disintegrated or atomized. The metal in some instances appears to be supported by the jet air stream and in other cases it appears that the metal just enters the top side of the air stream and is carried in this portion of the air stream without penetrating more than about one-fourth of the jet air stream. By decreasing the rate of extrusion of the molten metal or by increasing the velocity of the jet air stream, the solidified portion of the filament and that portion which, because of the pull of gravity, has penetrated the jet air stream exerts a tension on the extruded molten metal and thereby attenuates the molten stream before the metal has set or solidified. It is possible, therefore, to form a filament of appreciably smaller diameter than the diameter of the extruded metal. A further decrease in the velocity of extrusion or an increase in the velocity of the air stream may be utilized to form fibers of desired lengths.

In order to solidify the molten metal and form filaments or fibers, it is necessary to regulate the extrusion velocity and the velocity of the jet air stream to limit the penetration of the metal in the air stream before solidification of the metal. Thus, the velocity of the air stream must be increased with an increase in the density of the metal. As pointed out hereinbefore, where the molten metal is continuously extruded, the particular angle of extrusion with respect to the direction of the jet air stream is not critical and satisfactory filaments have been formed by extruding the molten metal stream at 90° with respect to the jet air stream flow. As the angle is increased, it is noted, however, that the stream of metal immediately adjacent the jet air stream assumes an arcuate path as it contacts and just breaks through the surface of the jet air stream. In most instances, the metal stream and filament are carried on or in the upper portion of the jet air stream for a distance of not over about three inches before the filament appears to deviate from a straight line.

Fibers of a substantially circular cross-section may be prepared from non-refractory metals which do not oxidize readily in air at the temperatures required for extrusion. Satisfactory filaments and fibers of this type, for example, may be prepared from such metals as tin, lead, zinc and the like by extruding the molten metal at temperatures of from about 1° C. to about 50° C. above their melting points and at pressures sufficient to extrude the metal continuously at the rate of from about 50 feet per second to about 100 feet per second into a jet air stream having a velocity at the outlet of the jet of from about 85 feet per second to about 100 feet per second. Although as illustrated in the drawings and the description, the metal has been shown as being extruded at the top of the jet air stream, it has been discovered that substantially identical results may be obtained by extruding in any other direction, such as in a horizontal direction toward the jet air stream or even in a vertical direction from beneath the jet air stream.

In view of the fact that the metal is either carried on the surface of the jet air stream or just in the jet air stream beneath the surface while it is being transformed from a liquid to a solid condition, it is possible to employ more than one extrusion chamber and space the extrusion chambers angularly around the nozzle **2**. The metal of each stream, while it is molten and immediately after it is solidified, remains at its respective position in or on the jet air stream and will not come into contact with other molten metal streams or solidified filaments until after the filaments leave the jet air stream and are cooled to a point below that at which the metal or metals weld together.

Although reference is made hereinbefore to tin, lead and zinc, this invention is not limited to the production of filamentary bodies (fibers and filaments) of these metals but is applicable to other non-refractory metals such as, for example, iron and other ferrous metals, copper, aluminum, cadimum, bismuth, indium, magnesium and their alloys as well as other metals and alloys which do not readily oxidize in their molten conditions.

I claim:

1. The method of producing fibers and filaments which comprises establishing an unconfined jet gas stream, extruding a continuous stream of molten metal and directing the stream of molten metal into at least partial contact with the jet gas stream, the metal stream in a molten state penetrating not more than about one-fourth of the jet stream.

2. The method as defined in claim 1 wherein the stream of molten metal is directed into contact with the jet gas stream at an acute angle with respect to the direction of gas flow.

3. The method as defined in claim 1 wherein the stream of molten metal is directed into contact with the jet gas stream at an angle not greater than 90° with respect to the direction of gas flow.

4. The method as defined in claim 1 wherein the velocity of the jet gas stream is at least about 85 feet per second.

5. The method as defined in claim 1 wherein the velocity of extrusion of the molten metal is at least about 10 feet per second.

6. The method as defined in claim 1 wherein the velocity of extrusion of the molten metal is between about 10 feet per second and about 100 feet per second.

7. The method as defined in claim 1 wherein the velocity of the jet gas stream is at least about 85 feet per second and the velocity of extrusion of the molten metal is between about 10 feet per second and about 100 feet per second.

8. The method as defined in claim 1 wherein the velocity of the jet gas stream is at least about 85 feet per second, the molten metal is molten tin and the velocity of extrusion of the molten tin is between about 50 feet per second and about 100 feet per second.

9. The method as defined in claim 1 wherein the velocity of the jet gas stream is at least about 85 feet per second, the molten metal is molten lead and the velocity of extrusion of the molten lead is between about 50 feet per second and about 100 feet per second.

10. The method as defined in claim 1 wherein the velocity of the jet gas stream is at least about 85 feet per second, the molten metal is molten zinc and the velocity of extrusion of the molten zinc is between about 50 feet per second and about 100 feet per second.

11. The method of producing fibers and filaments which comprises establishing an unconfined jet gas stream, extruding a continuous stream of molten metal, directing the stream of molten metal into at least partial contact with the jet gas stream at such an angle that the metal stream in a molten state does not penetrate more than about one-fourth of the jet stream and carrying the stream of molten metal with the gas stream until the molten metal has been solidified.

12. The method as defined in claim 11 wherein the velocity of the jet gas stream is at least about 85 feet per second.

13. The method as defined in claim 11 wherein the velocity of extrusion of the molten metal is at least about 10 feet per second.

14. The method as defined in claim 11 wherein the velocity of the jet gas stream is at least about 85 feet per second and the velocity of extrusion of the molten metal is between about 10 feet per second and about 100 feet per second.

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