

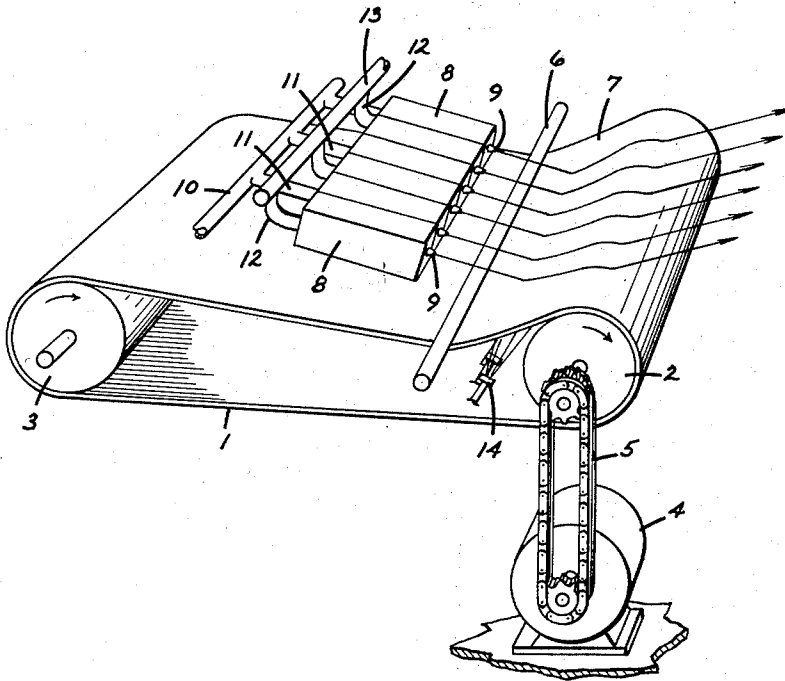
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APPARATUS AND METHOD FOR PRODUCING METAL FIBERS AND FILAMENTS

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APPARATUS AND METHOD FOR PRODUCING METAL FIBERS AND FILAMENTS

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5 Claims. (Cl. 22—57.4)

This invention relates to the production of metal filaments and, more particularly, to an improved method and apparatus for forming continuous metal filaments.

In the copending application of Robert B. Pond, Serial No. 387,187, filed October 20, 1953, 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. This form or type of apparatus has limited capacity since but a single filament is formed.

The principal purpose of the present invention is to provide a method and apparatus for forming a plurality of continuous filaments simultaneously.

Another purpose of this invention is to provide a method and apparatus for forming simultaneously continuous filaments of different metals.

Another purpose of this invention is to provide a method and apparatus for forming simultaneously a plurality of continuous filaments all of the same cross-sectional dimensions.

A further purpose of this invention is to provide a method and apparatus for forming simultaneously a plurality of continuous filaments of different physical sizes.

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

The drawing is a diagrammatic perspective view of the apparatus of this invention.

This invention provides a method of extruding a plurality of continuous streams of molten metal, directing the streams onto a rapidly moving continuous metallic band or belt and solidifying the metal on the belt, that portion of the belt upon which the streams of molten metal impinge and upon which the molten streams are transformed into solid filaments being concave. After a short period of contact, the solidified filaments are discharged and may be collected in any desired manner. The apparatus contemplated by this invention includes at least two ejector tubes or chambers each provided with means for extruding a continuous stream of molten metal, a rapidly moving continuous metal belt or band and means for depressing a portion of the band so as to provide the required concavity on which the streams of the molten metal impinge.

In the embodiment of the apparatus of this invention as illustrated in the drawing, there is provided a continuous metal band or belt 1 supported by suitable drums or rollers 2 and 3. It is preferred that the metal band or belt be provided with a smooth polished surface. The drum 2 may be driven by suitable means

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such as motor 4 and belt 5, and drum 3 may be an idler drum. It is well known that in high speed belts, unless means is provided to compensate for the slack, the belt will assume substantially straight planes between the supporting drums and the slack portion will extend beyond the idler drum. For the purposes of the present invention, the streams of molten metal should be impinged upon the belt at a point where the belt is concave. It is therefore necessary to provide means such as a depresser bar 6 so as to deflect the belt from a normally plane surface which it would assume at high velocities. The depresser bar is preferably rotatably supported above the belt. The depresser bar thereby alters the path of the belt so that the belt presents a concave surface as at 7.

A plurality of ejector tubes or cylinders 8 are positioned above the moving belt. Each of the ejector tubes is provided with an extrusion nozzle 9 which is preferably removably mounted in the end of the chamber. The extrusion or ejector nozzle is provided with any desired size of orifice. The molten metal is supplied to the extrusion chamber under sufficient pressure so as to provide a continuous stream of the molten metal. Where it is desired to form metal filaments of a single material, all of the ejector tubes may be connected through a suitable header or manifold to a source of the molten metal. If, for example, filaments are to be formed of two different metals, alternate ejector tubes may be connected by means of conduits 11 to header 10 which communicates with a source of supply of one of the molten metals. The remaining alternate ejector tubes may be connected by conduits 12 to header 13 which communicates with a source of the second molten metal.

Where it is desired to form filaments of different thickness and width, nozzles having different size extrusion orifices may be employed in the different ejector tubes. Alternatively, as pointed out in the patent of Robert B. Pond, the thickness and width of the filaments may also be varied by varying the temperature of the molten metal as it is extruded and impinged on the belt 1 and by varying the velocity of extrusion of the molten metal from the different ejector tubes. In general, for a single metal, the higher the extrusion temperature and the lower the extrusion velocity with a given orifice size and speed of the belt, the thinner the filaments.

The metal belt must serve as a chill plate so as to remove the superheat and the heat of fusion of the molten metal to transform the molten metal into a solid. Where the mass of the belt is not sufficient to remove this heat during the short period of contact of the metal with the belt, additional cooling means such as water sprays 14 may be positioned beneath the belt to remove the additional heat. In order to rapidly remove the superheat and heat of fusion, it is necessary that the molten stream be in close contact with the metal belt. This close contact is obtained by ejecting or extruding the molten metal at a velocity that forces the metal into contact with the belt and by the force created by the rapid change in direction of the molten metal as it travels with the belt through the convex path. The forces acting on the molten stream are sufficient to overcome the surface tension of the molten metal causing the surface of the metal to rupture at the point of contact with the belt and results in a transverse spreading of the molten metal. This spreading or thinning out of the molten stream provides a relatively large area of contact between the metal and the belt whereby both the superheat and the latent heat of fusion are removed rapidly to effect an almost instantaneous solidification.

Neither the molten metal nor the solidified metal adheres to the metal band. As the molten metal impinges on the band, it is almost instantaneously solidified and is

carried on the band. The band is concave at the point of impingement and the force of impingement and the rapid movement, as pointed out above, causes the metal to exert a force on the band. As the metal band is rising in its travel to the driving drum 2, the solidified metal will also have a component of force in an upward direction. As the belt begins its travel around the drum 2, the resulting inertia of the solidified metal will cause the solidified metal to be thrown from the band or belt. The path of the metal filament will not be strictly tangential to the drum because of the forces and the air resistance to the movement of the solidified filament. For any given metal and speed of the belt, the angle at which the filament leaves the belt will be relatively fixed and permits the filaments to be collected in any desired manner.

The filaments as formed by this method have a more or less rectilinear shape or cross-section imparted as the stream of molten metal is converted into solid form and have crystal or grain structures corresponding to a cast structure in contradistinction to the elongated grain structure normally found in filaments due to drawing or rolling operations. The filaments have distinctly different and identifiable surfaces. The bottom surface because of its formation in contact with the mold surface (the belt surface) conforms to the finish of the belt. The upper surface is somewhat rough and is characterized by shrinkage marks, relief dendrites and line striae or mam-miforms.

The filaments may be formed by the herein described method wherein the speed of the belt may be up to about two hundred or more feet per second. The velocity or speed of the belt is dictated by certain economic conditions. The life of the belt will be in direct proportion to the fatigue resistance of the metal belt because of the flexing of the belt as it travels around the drums and beneath the depresser bar. The mass of solidified metal filament discharged from the belt will be at approximately the same rate as the mass of molten metal which impinges upon the surface of the belt. The length of filament in contact with the surface of the belt at any one time will be dependent upon the relative position of the point of impingement with respect to the point of discharge of the solidified metal. The minimum amount of contact necessary may be determined by impinging the molten metal onto the belt at a point close to the point of discharge. At such close relative positions, the metal discharged is molten. The point of impingement is then moved back from the point of discharge until such point is reached at which the metal filament is solid as it leaves the belt. This minimum contact must be maintained for any given metal and any given set of operating conditions. Preferably, in practice, an additional amount of contact is provided to insure the solidification of the metal while on the moving belt. The speed of solidification and formation of the filament may be calculated by determining the minimum contact necessary to solidify the metal on the belt and by the speed of the belt.

As is obvious from the foregoing description, the size of the filaments may be varied as desired by varying the conditions of formation. Where all of the filaments are to be of the same size, the extrusion orifices must be of the same size. The velocity of extrusion and temperature of the molten metal must be identical in all extrusion or ejection chambers. For the production of thinner filaments, the temperature of the molten metal may be increased and the ejection velocity decreased for a given orifice and belt speed. Where all conditions are maintained constant, wider filaments may be formed by employing orifices of greater diameter. Where filaments of greater thickness are desired, the ejection velocity of the molten metal may be increased. In such instance, because of the almost instantaneous solidification of the metal, the larger amount of molten metal impinged upon the belt tends to pile up and form the filaments of greater thickness. It is obvious, therefore, that the filaments

formed may be all of the same size or different sizes may be formed by utilizing different size orifices in the individual ejection chambers or increasing the temperature or velocity of extrusion of the molten metal in the different individual ejection chambers.

This method and apparatus is satisfactory for forming filaments from non-refractory metals and alloys which do not have a high vapor pressure at the temperatures required for extruding or ejecting them to form the continuous stream of metal. Where the metal is subject to rapid oxidation, a protective blanket of an inert gas such as argon, helium, nitrogen and the like may be provided. The method is entirely satisfactory with such metals as iron and various ferrous alloys, tin, lead, cadmium, indium, zinc, bismuth, aluminum, copper and their alloys, for example, copper-nickel alloys, tin-lead alloys, aluminum-zinc alloys and the like and alloys of the metals with other metals. The metal belt is formed of a metal of high heat-conductivity and preferably has inherently or may be readily provided with a film which is passive to avoid any tendency toward alloying of the molten metal with the metal of the belt. The belts may be formed of alloys commonly employed as spring metals or materials such as aluminum alloys, copper alloys, for example, beryllium copper, steel and the like.

While preferred embodiments of the invention have been shown and described, it is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. A method of casting solid metal filaments from molten metal which comprises moving a metallic belt at a high velocity along a path having an upwardly concave portion which merges with an upwardly convex portion, impinging a stream of molten metal on the moving belt as it travels along the upwardly concave portion of its path, the direction of impingement being coincident with the direction of movement of the belt, solidifying the molten metal while on the belt and discharging the same in its solidified form as the belt travels along the convex portion of its path.

2. The method as defined in claim 1 wherein the metallic belt is moved at a velocity of at least about twenty feet per second.

3. The method as defined in claim 1 wherein the metallic belt has a smooth polished surface.

4. Apparatus for continuously casting solid metal filaments which comprise a metallic belt forming a chill surface, means for rapidly moving the belt, means for deflecting the belt along a path having an upwardly concave portion which merges with an upwardly convex portion, and means for impinging a stream of molten metal against the belt as it travels along the upwardly concave portion of its path, the direction of impingement being coincident with the direction of movement of the belt whereby the molten metal is solidified while on the belt and is discharged from the same in its solidified form as the belt travels along the convex portion of its path.

5. Apparatus as defined in claim 4 wherein the metallic belt has a smooth polished surface.

References Cited in the file of this patent

UNITED STATES PATENTS

467,041	Morris	Jan. 12, 1892
745,786	Cole	Dec. 1, 1903
1,098,944	Fisher et al.	June 2, 1914
2,450,428	Hazelett	Oct. 5, 1948
2,598,344	Brennan	May 27, 1952
2,737,436	Le Boeuf	Mar. 6, 1956
2,825,108	Pond	Mar. 4, 1958

FOREIGN PATENTS

4,391	Great Britain	Sept. 15, 1882
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