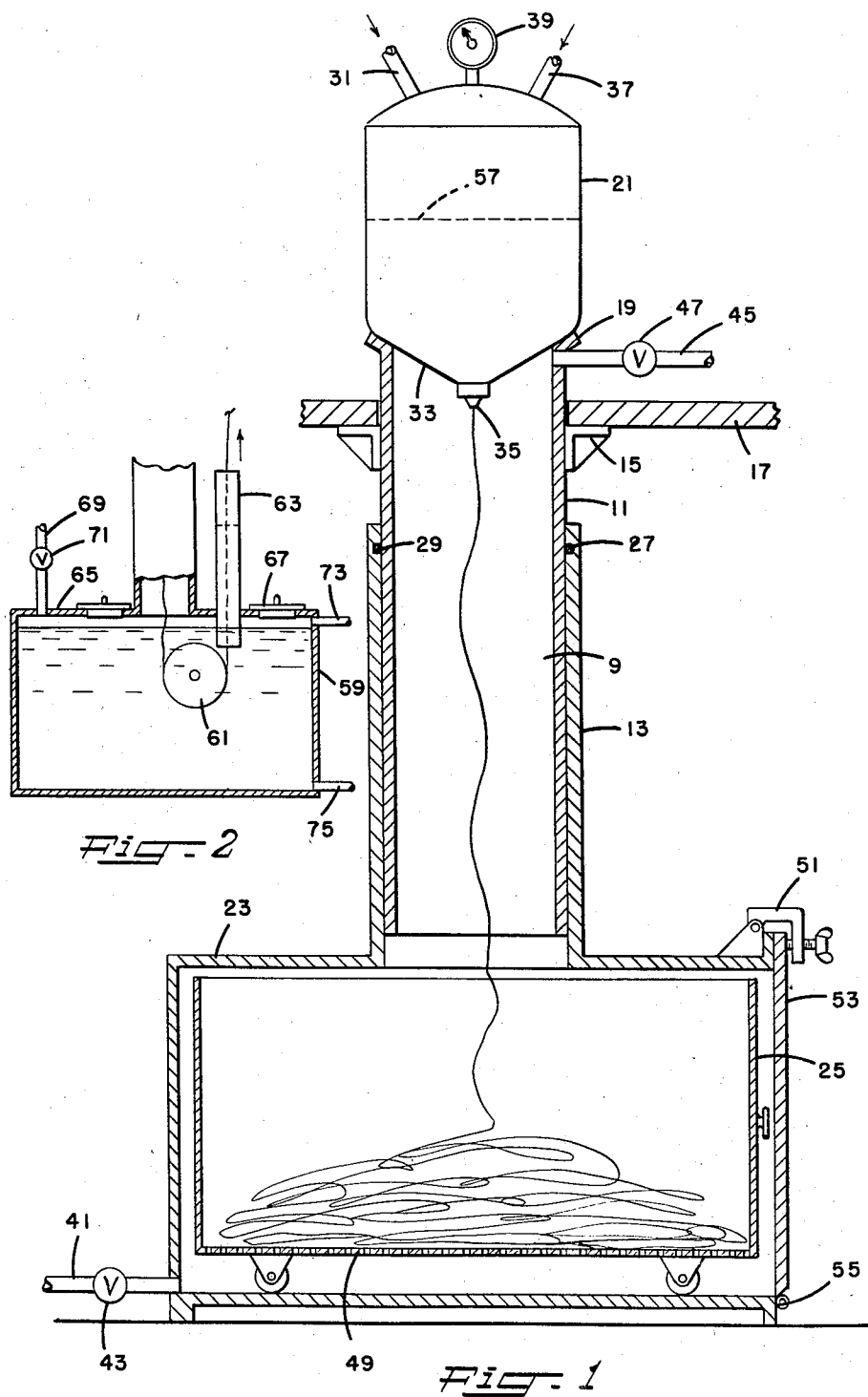


Oct. 6, 1959

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PRODUCTION OF CONTINUOUS FILAMENTS
OF HIGH VAPOR PRESSURE METALS
Filed Feb. 6, 1956

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PRODUCTION OF CONTINUOUS FILAMENTS OF HIGH VAPOR PRESSURE METALS

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Application February 6, 1956, Serial No. 563,541

5 Claims. (Cl. 22—57.2)

The invention relates to the manufacture of filaments, by an extrusion process and particularly to continuous filaments formed of metals having high vapor pressures.

As set forth in my copending application Production of Continuous Metallic Filaments, filed on February 6, 1956, Serial No. 563,615, the conventional extrusion procedures utilized in forming metallic fibers or flakes or powders are not readily adapted for use in the manufacture of continuous metallic filaments of indefinite length and uniform cross-section. Further, the known extrusion methods are not suited for use with certain metals which possess highly desirable qualities and which, in a filament form, would be readily accepted by industry in general for varied and numerous applications. Special difficulty has been encountered when attempting to form filaments of wires of materials having a high vapor pressure since the metal, in molten form, tends to disintegrate or vaporize before any appreciable solidification takes place, thus providing a mass of particles or an irregular filament. It is therefore a general object of this invention to provide a generally improved and more satisfactory procedure for manufacturing continuous filaments from metals having high vapor pressures.

Another object is the manufacture of improved continuous metallic filaments and the method of forming the same in which the filament is shaped into the desired configuration concomitantly with its extrusion and solidification.

Still another object is to provide a filament-making process in which a continuous streamline flow of fluid metal is extruded into a substantially quiescent and inert gaseous cooling and protective medium, which is under pressure, to effect solidification thereof.

A further object is the provision of a process for producing continuous metallic filaments which are free from crystalline deformation or reorientation, and is adapted for use with various materials, particularly metals having high vapor pressures, heretofore found to be unsuitable with known methods.

A still further object is to provide both a more satisfactory method and apparatus for easily and economically producing continuous metallic filaments without the use of any special skills or complex equipment.

These and other objects and advantages of this invention will be apparent from the following description and accompanying drawing in which:

Figure 1 illustrates one form of apparatus, partly in vertical section, for practicing the method of the present invention, particularly on a batch process scale; and

Figure 2 is a fragmentary side view showing a modified form of apparatus especially adapted for the production of filaments of indefinite length.

In general, the invention relates to the manufacture of continuous metallic filaments by extruding a streamline flow of molten metal into a pressurized gaseous medium through which it travels, in suspended relationship and under the force of gravity, for a distance suf-

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ficient to effect solidification by the cooling gaseous medium. While the present invention has particular utility with metals having a high vapor pressure when in a molten condition, it will be understood that the teachings are equally well adapted for use with metals other than those set forth above without departing from the spirit or scope of the following invention disclosure. Various factors determine the distance of travel necessary before complete solidification of the molten stream results, such as the metal employed, the ejection velocity or the pressure under which the molten metal is extruded, and the rate of cooling. On the other hand, the orifice configuration dictates the resulting cross-sectional shape of the completed filament, while both the pressure applied to molten metal and the pressure of the cooling medium have an important effect on the continuity and quality of the finished product. The pressurized gaseous medium, besides serving to cool and prevent disintegration of the molten stream, shields the same with a protective fluid envelope.

With reference to Figure 1 of the drawing, there is disclosed in elongated cooling chamber 9 formed of a pair of snugly telescoped tubular members 11 and 13 which are adapted to move relative to each other as described hereinafter. The inner tubular member 11 is connected, adjacent its upper end, by brackets 15 to a movable framework 17, shown in part, which is adapted to be elevated by any convenient and suitable structure not shown. The uppermost end of the member 11 is flared to provide an annular flange 19 to which the tank 21 is fixed, preferably in a removable manner to facilitate cleansing and repair or replacement. The outer member 13 is formed integrally with and projects upwardly from the housing 23 within which the bin 25 is adapted to be positioned for collecting the filament as it solidifies. The telescoping members 11 and 13 may be of any desired cross-section with a circular configuration being desired to enable the members to fit snugly and thereby prevent the escape of gases. To further insure a leak-proof fit between the telescoping members 11 and 13, the internal periphery of the outer member is grooved at 27 and is provided with an annular sealing gasket 29 which is adapted to snugly engage the external periphery of the inner member 11.

The filament-forming material, in a molten condition, is introduced into the tank 21 through a conduit 31, which is connected at its opposite end to a conventional melting pot or other similar structure, not shown. The tank 21 may be thermally insulated and, in addition, may be provided with conventional heating elements along the tank wall or immersed within the molten metal itself to maintain the molten metal at the desired extrusion temperature. The bottom wall 33 of the tank 21 is inclined or conical in shape to prevent the occurrence of stagnant flow areas and to direct the molten metal to the extrusion nozzle 35, which is preferably removably mounted centrally of the tank bottom wall. As mentioned in my above-noted copending application more than one extrusion nozzle may be employed, with the cross-sectional configuration of the finished filament depending upon the shape of the nozzle orifice. Thus, a circular orifice provides a round wire, while a complex orifice, as for example one resembling a cloverleaf, providing a filament other than round, such as rectangular in form. To insure that a continuous filament results, the molten metal is extruded through the nozzle orifice in a streamline flow by means of pressure supplied by a gas introduced into the tank 21 through a separate conduit 37 leading from a supply source, not shown. The pressure required will vary with the orifice design and thus it is merely necessary to adjust the

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pressure until the desired flow is obtained. Any suitable and conventional means may be employed for indicating the pressure imposed upon the molten metal within the tank 21, as for example a gauge 39 as shown on the drawing.

As indicated above, the invention is particularly directed to forming continuous filaments from metals having a high vapor pressure when in a molten condition, that is metals which, in a molten state under atmospheric pressure, rapidly vaporize. Thus, it is necessary to fill both the cooling chamber 9 and the bin housing 23 with an inert cooling gas which is maintained under pressure to prevent disintegration or vaporization of the stream of molten metal. Accordingly, a conduit 41, having a regulating valve 43, is provided for introducing under pressure chilled air or carbon dioxide or an inert gas, such as helium or argon, from a suitable gas and pressure source, not shown. The gas, upon entering the housing 23, flows through the housing 23 and chamber 9 and is exhausted therefrom by means of the conduit 45 also having a control or regulating valve 47, and thus it is seen that at all times the gas is circulated in a manner as to present a fresh cool supply along the path of the molten metal stream as it is extruded through the nozzle 35. While the cooling gas is continuously circulated, its movement is non-turbulent and is not sufficient to break the filament continuity. For sake of economy, the gases exhausted through the conduit 45 are passed through a convenient chilling chamber, not shown, for recirculation through the conduit 41.

As the molten metal is extruded through the nozzle orifice, it descends downwardly through the pressurized gas-filled chamber 9 where it is ultimately solidified and collected within the wheeled bin 25. The bottom or floor of the bin is preferably perforated at 49 to enable the compressed gases to circulate more readily. During production, the housing 23 is closed in an air-tight manner, with access into the housing 23 being made possible by releasing the clamp 51 and rotating the housing door 53 clockwise about its hinge 55. It is of course obvious that the door 53 in its lowermost position serves also as a ramp upon which the wheeled bin 25 is adapted to ride.

In practicing the method of the present invention, molten metal, as indicated by the broken line 57, is delivered into the tank 21 through the conduit 31 while gas under pressure is introduced through the conduit 37 until the desired pressure is obtained as indicated by the gauge 39. As heretofore mentioned, the amount of pressure imposed over the liquid metal will depend both upon the particular orifice design, and must be such that a streamline flow of fluid metal is obtained through the orifice. Prior to commencing extrusion, the cooling chamber 9 and the bin housing 23 are flushed with the cooling gas to insure that the proper atmosphere and the required gas pressure is provided within the chamber 9 and housing 23 once the extrusion process is underway. Simultaneously as the molten metal is extruded through the nozzle 35, the conduit 41 provides a continuous supply of cooling gas under pressure which is circulated upwardly through the housing 23 and chamber 9 and exhausted through the conduit 45. The pressure of the cooling gas within the chamber 9 and housing 23 must at all times be equal to or greater than the vapor pressure of the particular metal at its extrusion temperature to prevent the extruded stream from vaporizing once it enters into the chamber 9. Further, it is obvious that the pressure of the gas within the chamber 9 and housing 23 must be at all times less than the pressure applied to the molten metal within the tank 21 to insure that continuous extrusion will occur. As the stream of molten metal descends through the cooling chamber 9, the surface tension forces of the molten metal alter the shape of the stream into the desired configuration. In addition, the ejection of the metal in a downward direc-

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tion enables the force of gravity to assist in maintaining the streamline flow of the molten metal.

The distance of travel of the stream of molten metal through the chamber 9 must be such as to insure that the metal has solidified into a filament before entering into the bin 25 and therefore depends upon such factors as the metal extruded, the temperature and position of the cooling medium relative to the extruded molten stream, the temperature of the molten metal, and the extrusion pressure. Once the necessary height through which the molten metal stream must pass has been determined, as for example by simple trials of the extrusion nozzle at different heights, the inner tubular member 11 may be extended or retracted relative to the outer member 13 by moving the frame work 17 to the required degree.

Throughout the extrusion process, the cooling gases are withdrawn from the chamber 9 through the conduit 45, chilled, and ultimately recirculated under pressure through the inlet conduit 41. The production of filaments as described above remains continuous until the bin 25 is filled and so long as the molten metal is supplied to the tank 21 and the cooling gases are circulated and maintained under the required pressure and thus is highly satisfactory for batch scale production.

To utilize the inventive teachings described above in the manufacture of continuous filaments of indefinite length, the apparatus is modified as shown in Figure 2 by merely altering the structural arrangement at the lower end of the chamber 9. In the case, the tubular member 13 is formed integrally with a tank 59 within which fluid, such as water, is adapted to be contained. A roller or godet 61 rotatably is mounted between opposite sidewalls of the tank 59, or other supporting structure, for reversing the direction of travel of the continuous filament as it leaves the lower end of the member 13, and to direct the same to the lower end of the standpipe 63 passing through the upper wall 65 of the tank 59. Access into the tank 59 and lacing of the filament about the roller 61 is facilitated by openings provided in the tank wall 65 which are normally closed during operation by covers 67 locked in place. An inlet conduit 69, having a regulating valve 71, supplies the cooling gas under pressure to the chamber 9 in the same manner as the corresponding structure 41 and 43 shown in Figure 1, while conduits 73 and 75 respectively permit fluid to be added or drained from the tank 59, as desired.

In operating this modified apparatus, fluid is first introduced into the tank 59 to a level sufficient to maintain, at all times, the lower end of the standpipe 63 submerged, and thus prevent the escape of the pressurized cooling gas. As in the process heretofore described, the chamber 9 is preferably flushed with the cooling gas to insure that the required pressure and atmosphere exists before the extrusion is commenced. After these preliminary steps, the extrusion of the molten stream into the chamber 9 is started to form a filament as described above. The completed filament merely collects within the tank 59, and after a short period of extrusion the operator is free, through the tank access openings, to lace the filament about the roller 61 and up through the standpipe 63. When a high gas pressure is required within the chamber 9, the pressure is temporarily reduced to safe limits before the operator commences lacing. The loss in pressure occasioned by such a pressure reduction and the loss of pressure due to the opening of the tank access openings is only temporary and will have only a slight damaging effect on the filament produced during this short period but will not normally break the filament continuity. Once the lacing is completed and the proper atmosphere and pressure within the chamber 9 is resumed, the production continues in the same manner as described in relation to the structure shown in Figure 1. Lacing of the filament about

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the roller 61 and through the standpipe 63 can be also accomplished by merely passing a hooked rod through the standpipe and into the tank 59 where the filaments collected therein can be retrieved and then pulled upwardly through the standpipe. With this last described method of filament lacing, there is of course no need to open the access openings. The filament leaving the standpipe 63 may be collected in any suitable manner and it is evident that production is continuous so long as the molten metal is supplied and the proper pressurized atmosphere is maintained in the chamber 9.

The invention described above is adapted for use with most all metals and alloys, but has particular utility when metals of high vapor pressure are being extruded. For example, highly satisfactory results have been obtained by extruding brass in a manner as described above. At a temperature of approximately 1700° F., the brass material employed is in a molten condition, and at this temperature the zinc component has a vapor pressure equal to about 500 millimeters of mercury. Without the use of a pressurized cooling chamber, the extruded stream of molten metal would rapidly vaporize producing a mass of particles or a highly pitted filament. By employing air or an inert cooling gas under a pressure of about ten pounds per square inch within the chamber 9, the zinc is prevented from vaporizing and a continuous smooth filament is obtained. Of course, it will be understood that pressure required will vary also with the particular material to be extruded. Thus, in the case of unkill steels wherein carbon monoxide is formed by the reaction of the carbon and iron oxide, the pressure required will depend upon and vary directly with the carbon and iron oxide content in the material. In this latter case, a pressure ranging up to a maximum of one thousand pounds per square inch may be necessary. Other metals with which this invention has particular utility are cadmium, lead, magnesium, antimony, calcium, selenium, sodium, potassium and mercury, where they are alloyed with other metals which melt at a temperature higher than the boiling temperature of these metals. For example, in alpha and alpha plus beta cadmium silver alloys, the cadmium boils at a temperature lower than the melting temperature of silver and thus, without the teachings of the present invention, the formation of filaments from an alloy of these metals is not possible.

As mentioned in my copending application, noted above, the filaments produced in accordance with the extrusion process described above are free from crystalline deformation or reorientation. Furthermore, the filaments can be formed in various cross-sectional shapes and sizes, some having a diameter in a vicinity of 4 to 8 ten-thousandths of an inch, as well as larger diameters such as 1/8 of an inch.

It is seen from the above description that the objects of the invention are well fulfilled by the method and structure described. The description is intended to be illustrative only and it is to be understood that changes and variations may be made without departing from the spirit

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and scope of the invention as defined by the appended claims.

I claim:

1. A method of forming continuous metallic filaments from materials having a high vapor pressure when in a molten state comprising the steps of extruding molten metal, passing the extruded molten metal through a chamber filled with a gaseous cooling medium to solidify the metal, maintaining the cooling medium under a pressure greater than the vaporization pressure of the molten material, and collecting the solidified filament at that end of the chamber opposite to the end through which the molten metal is extruded.

2. A method according to claim 1, wherein said gaseous cooling medium is an inert gas.

3. A method according to claim 1, wherein the molten metal is extruded in a vertically downward direction and falls through the cooling medium for a distance sufficient to effect solidification of the molten metal.

4. Apparatus for forming continuous metallic filaments, including an elongated tubular cooling chamber, a tank at one end of said chamber from which molten metal is adapted to be extruded, a container at the lower end of said cooling chamber, said container adapted to be closed in a fluid tight manner, means supplying to said container and said chamber a cooling medium under pressure and a wheeled collection bin positioned within said container, said collection bin having a perforated bottom floor to allow circulation of said cooling medium.

5. Apparatus for forming continuous metallic filaments, including an elongated tubular cooling chamber, a tank at one end of said chamber from which molten metal is adapted to be extruded, a container at the lower end of said cooling chamber, said container adapted to be closed in a fluid tight manner, means supplying to said container and said chamber a cooling medium under pressure, a stand pipe extending upwardly from said container with its lower end disposed therein, means for supplying fluid within said container to a level above the lower end of said stand pipe, and a roller carried by and within said container and below the lower end of said cooling chamber whereby said solidified filament is adapted to be laced about said roller and passed upwardly through said stand pipe for continuous collection.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,907,082

October 6, 1959

Robert Barrett Pond

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, lines 2 and 12, and in the heading to the printed specification, lines 4 and 5, name of assignee, for "Marvaland, Incorporated" read -- Marvalaud, Incorporated --.

Signed and sealed this 12th day of April 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents