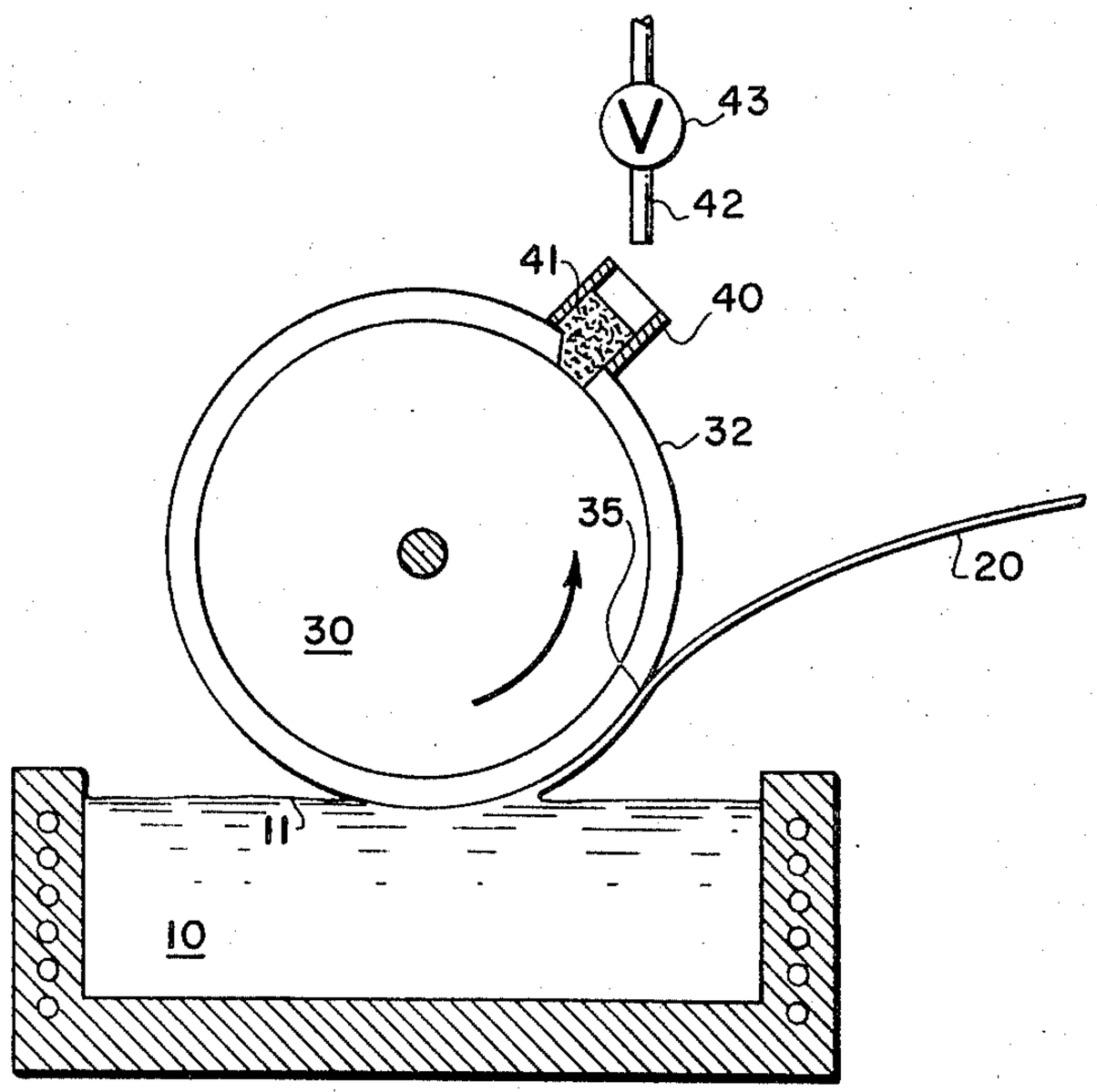

Fig. 1

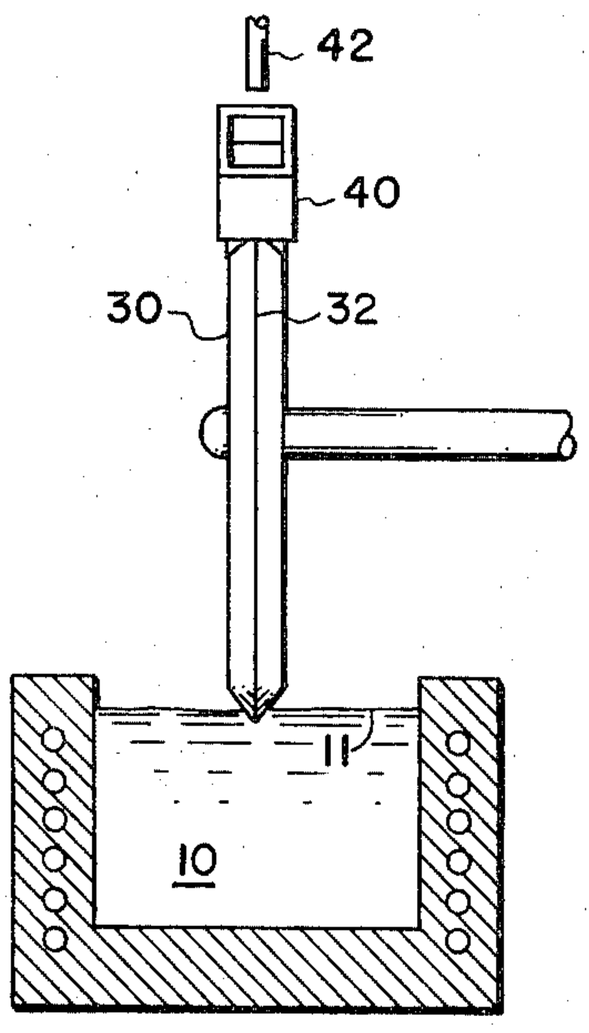

Fig. 2

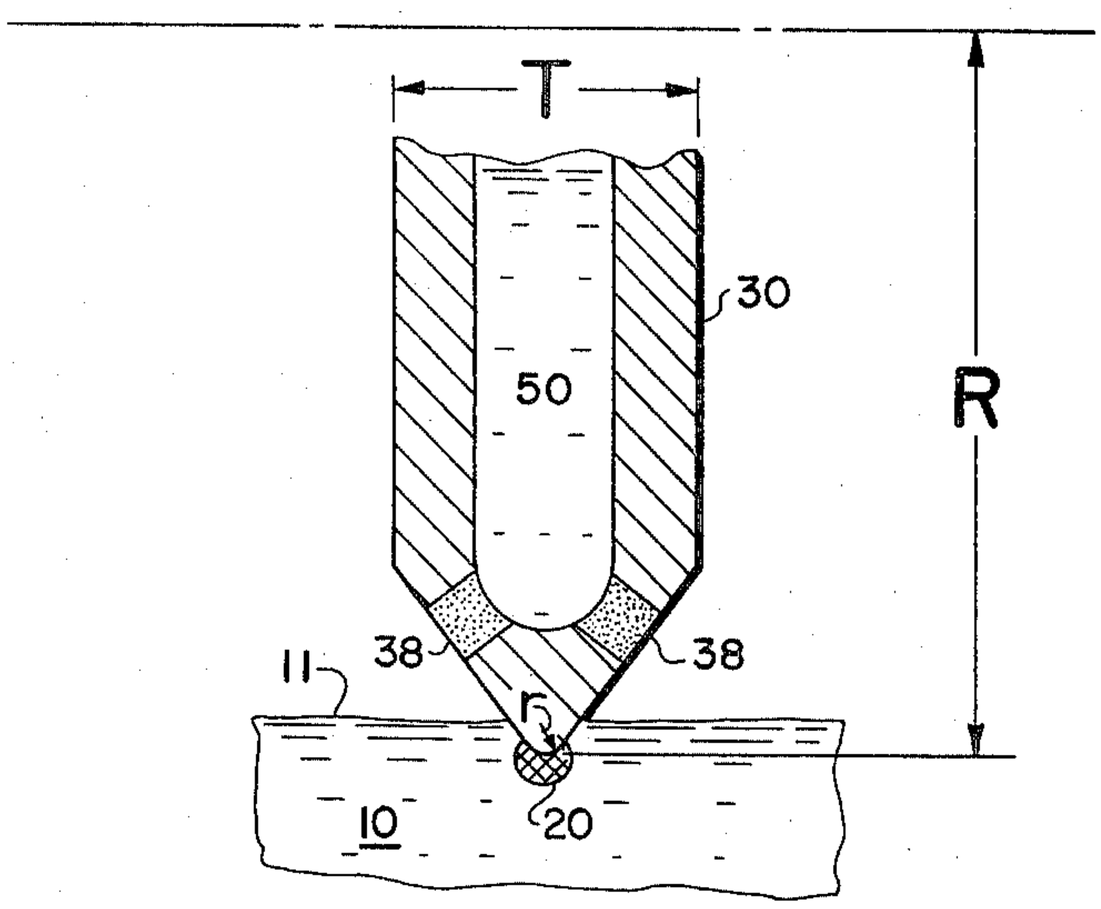

Fig. 3

United States Patent [19]

Sleigh

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[54] **METHOD OF MAKING FILAMENT**

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[52] **U.S. Cl.** ..... **264/213,** 264/8, 264/215, 164/87, 164/283 M

[51] **Int. Cl.** **B22d 13/00,** D01d 5/00

[58] **Field of Search** ..... 164/87, 276, 283 R, 283 M; 264/8, 165, 212, 213, 215

[56] **References Cited**

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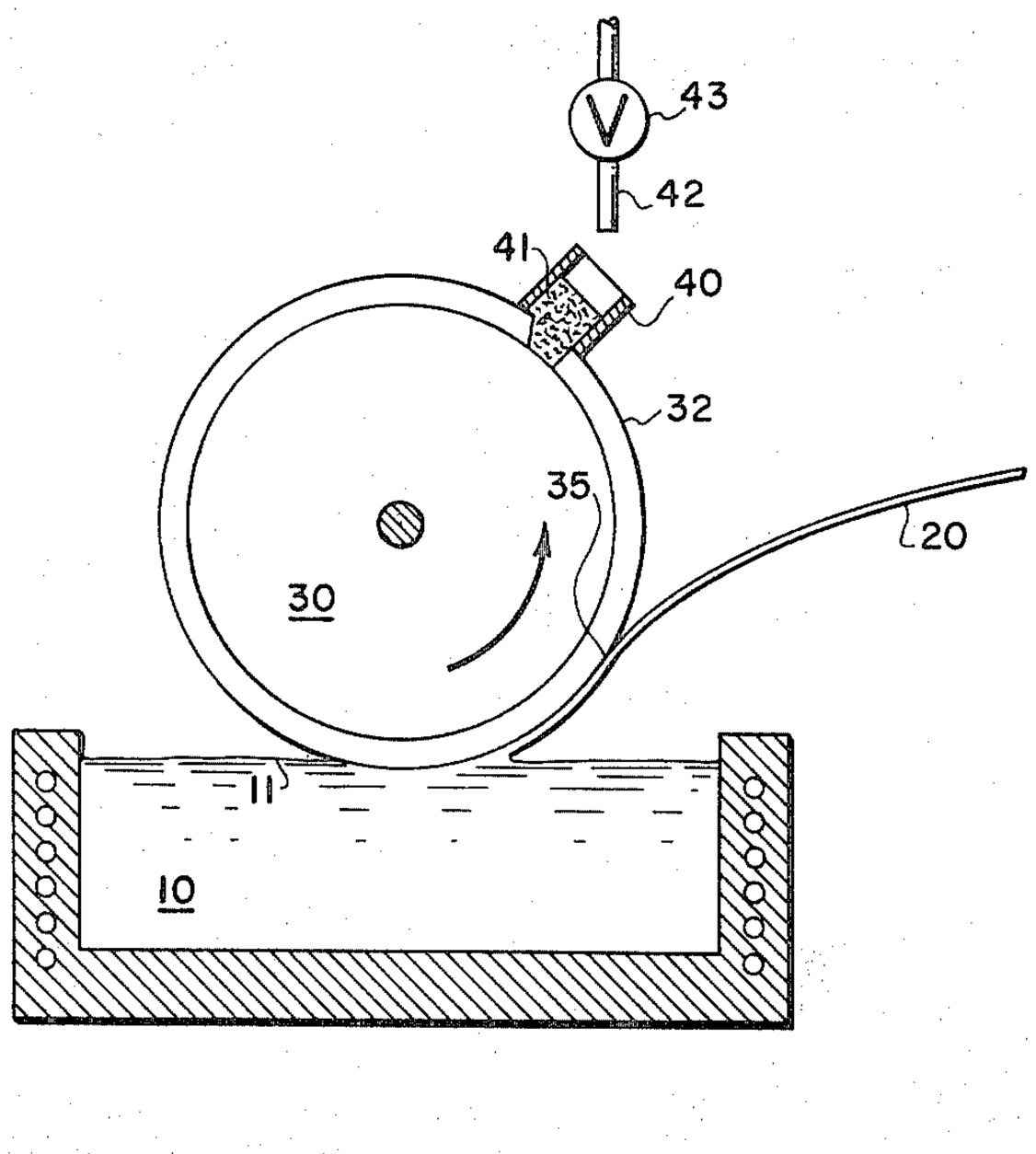
Primary Examiner—R. Spencer Annear

Attorney, Agent, or Firm—Stephen L. Peterson

[57] **ABSTRACT**

A method of insuring the spontaneous release of a filament formed by contacting the surface of a molten material with the circumferential edge of a rotating heat-extracting member by applying a film of cooling liquid to the external surface of the circumferential edge.

6 Claims, 3 Drawing Figures



METHOD OF MAKING FILAMENT

BACKGROUND OF THE INVENTION

The present invention relates to the art of making elongated filamentary articles by rotating a heat-extracting member in contact with a source of molten material and solidifying a portion of the molten material as a filamentary product on the surface of the rotating member where it spontaneously releases and is subsequently collected.

Prior art methods of producing filamentary articles conventionally comprise casting and repeated mechanical deformation techniques disposed to sequentially reduce the cross-sectional area of the elongated member. The complexity and cost of such operations have created a long standing demand for a method of forming filamentary material directly from the material in the molten state.

One proposed method involves the use of a rotating heat-extracting member in contact with the surface of a source of molten material. The member is shaped so as to limit the area introduced to the molten material and thereby solidify a filamentary article adherent thereto. The adherent filament is subsequently released from the forming member and is then collected. The spontaneous release of the previously adherent filamentary article is most important since the speed of operation and the size of the filament preclude the use of any scraping means to insure filament release. Furthermore, where the edge of the heat-extracting member is in contact with molten materials having high melting points (e.g., over 1,000° C) the resultant erosion and oxidation of the forming edge inhibits spontaneous release of the filament. While the use of internal circulation of cooling fluids within the member can reduce this effect the present invention substantially reduces the oxidation and erosion of the circumferential edge by applying an external film of cooling liquid to the edge.

SUMMARY OF THE INVENTION

The present invention comprises the application of a liquid film to the external edge of a disk-like heat-extracting member forming filamentary material by contacting the surface of a supply of molten material and solidifying a portion of that material on the circumferential edge of the heat-extracting member. Prior art techniques are hindered by the erosion or oxidation of this edge which effects the spontaneous release of the filaments formed thereon. In improving the cooling of the edge the present invention insures spontaneous release of the filament by preventing excessive heat buildup at the edge and thereby preventing oxidation or erosion of the circumferential edge of the heat-extracting member.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partial cross section showing one embodiment of the present invention in side view.

FIG. **2** illustrates the embodiment of FIG. **1** rotated 90°.

FIG. **3** is a cross-sectional view of the heat-extracting member showing the operation of the present invention including the use of the internal coolant as the supply for the external cooling film.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is an improvement of a filament forming method operable with materials that, in their molten state, have properties similar to those of molten metals. Specifically the molten materials operable with the present invention must have (at a temperature within 25 percent of their equilibrium melting point in degrees Kelvin): a surface tension in the range of from 10 to 2,500 dynes/cm, a viscosity in the range of from 10^{-3} to 1 poise and a reasonably discrete melting point (i.e., a discontinuous viscosity versus temperature curve). Such molten materials are contacted on their surface by a rotating heat-extracting member generally in the manner shown in FIG. **1.**

The molten material **10** is contacted at the surface **11** by the circumferential edge **32** of the rotating heat-extracting member **30.** In the embodiment shown the circumferential edge **32** is V-shaped with the apex of the V in contact with the melt surface **11.** By removing heat from the molten material **10** a filamentary product **20** is formed on the edge **32.** The rotation of the member **30** causes the edge **32** to be continuously advanced through the melt surface **11** as well as promoting the spontaneous release of the filament **20** from the edge at the release point **35.**

The improvement of the process resides in the application of a cooling film to the circumferential edge of the heat-extracting member and the means shown in FIGS. **1** and **2** include a supporting member **40** containing a porous member **41** exposed to the application of a cooling liquid shown here simply as a tube **42** and a flow regulating valve **43.** The porous member **41** is in contact with the circumferential edge **32** of the rotating member **30.**

The embodiment shown in FIGS. **1** and **2** is in no way the only operable means of applying the cooling film. Other means would include the use of liquid sprays or aerosols, the direct application of the liquid to the edge etc. The inventive concept of the present invention is not the means used to apply the cooling film and one having ordinary skill in the art can readily devise means of dispensing and applying liquid to the edge using means not specifically described herein.

FIG. **3** illustrates an embodiment of the invention where the source of the cooling film is the liquid coolant **50** circulating within the heat-extracting member. The member **30** is formed so as to allow a liquid coolant **50** to circulate internally so as to increase the capacity of the member **30** to remove heat from the molten material **10.** The member **30** in this embodiment includes a porous section **38** that allows a portion of the internal coolant **50** to pass from the internal cavity onto the surface of the member **30** in the form of a cooling film. Furthermore, if the porosity of member were controlled to yield an appropriate flow rate of coolant to the surface the entire heat-extracting member may be porous.

The centrifugal force generated by the rotation of the heat-extracting member induces the flow of the film toward the circumferential edge **32** thereby placing the cooling film at the most critical location irrespective of the means used to place the film on the external surface of member **30.** In this manner the edge **32** of the heat-extracting member is further cooled and oxidation and erosion at that location are significantly inhibited. With the condition of the edge stabilized by the inhibition of

oxidation and erosion the spontaneous release of the filament is insured.

The present invention may be used solely or in conjunction with internal disk cooling and such a combination has been used successfully in preventing oxidation or erosion of a metal disk used to produce continuous filament from a source of molten steel. While continuous filament is specifically disclosed and illustrated in the figures the present invention is also applicable to a heat-extracting member having indentations on its circumferential edge of a depth greater than the diameter of the filament formed disposed to attenuate the solidified filament into discontinuous filament having a length approximating the distance between indentations.

FIG. **3** also illustrates the configuration of the preferred embodiment of the circumferential edge **32.** The member **30** has a thickness indicated as T and it preferably is in the range of from 0.10 to 2.0 inches. The radius R of the disk preferably is in the range of from 2 to 15 inches and the radius of curvature *r* of the edge **32** is preferably in the range of from 0.0005 to 0.10 inch. The edge **32** is passed through the surface of the melt at a linear rate in excess of 3 ft/sec.

The liquid used as the coolant may be water or any liquid that does not chemically attach the molten material or the material comprising the disk. The coolant should be chemically unreactive with the atmosphere surrounding the process at the operating temperature and preferably be non-flammable.

I claim:

1. In a method of forming filamentary material from a source of molten material having properties in the molten state substantially similar to molten metals by rotating the circumferential edge of a disk-like heat-extracting member in contact with the surface of said molten material while limiting the area of contact of said edge with said surface, solidifying said material in solid filamentary form on said edge and spontaneously releasing the filament from said edge the improvement comprising:

applying a film of cooling liquid externally to said edge at a point between the location of spontaneous filament release and the point where said edge enters the surface of said molten material.

2. The method of claim **1** where said disk-like heat-extracting member is internally cooled by circulation of liquid therethrough with a portion of the internal cooling liquid passing through said member so as to form an external film of cooling liquid.

3. The method of claim **1** where said film is produced by directly applying said cooling liquid to said circumferential edge.

4. The method of claim **3** where said cooling liquid is applied to a porous medium in contact with said circumferential edge.

5. The method of claim **3** where said cooling liquid is applied to said circumferential edge in the form of a liquid spray.

6. The method of claim **1** including the step of providing notches on said circumferential edge disposed to attenuate the filament into discontinuous lengths.

* * * * *