

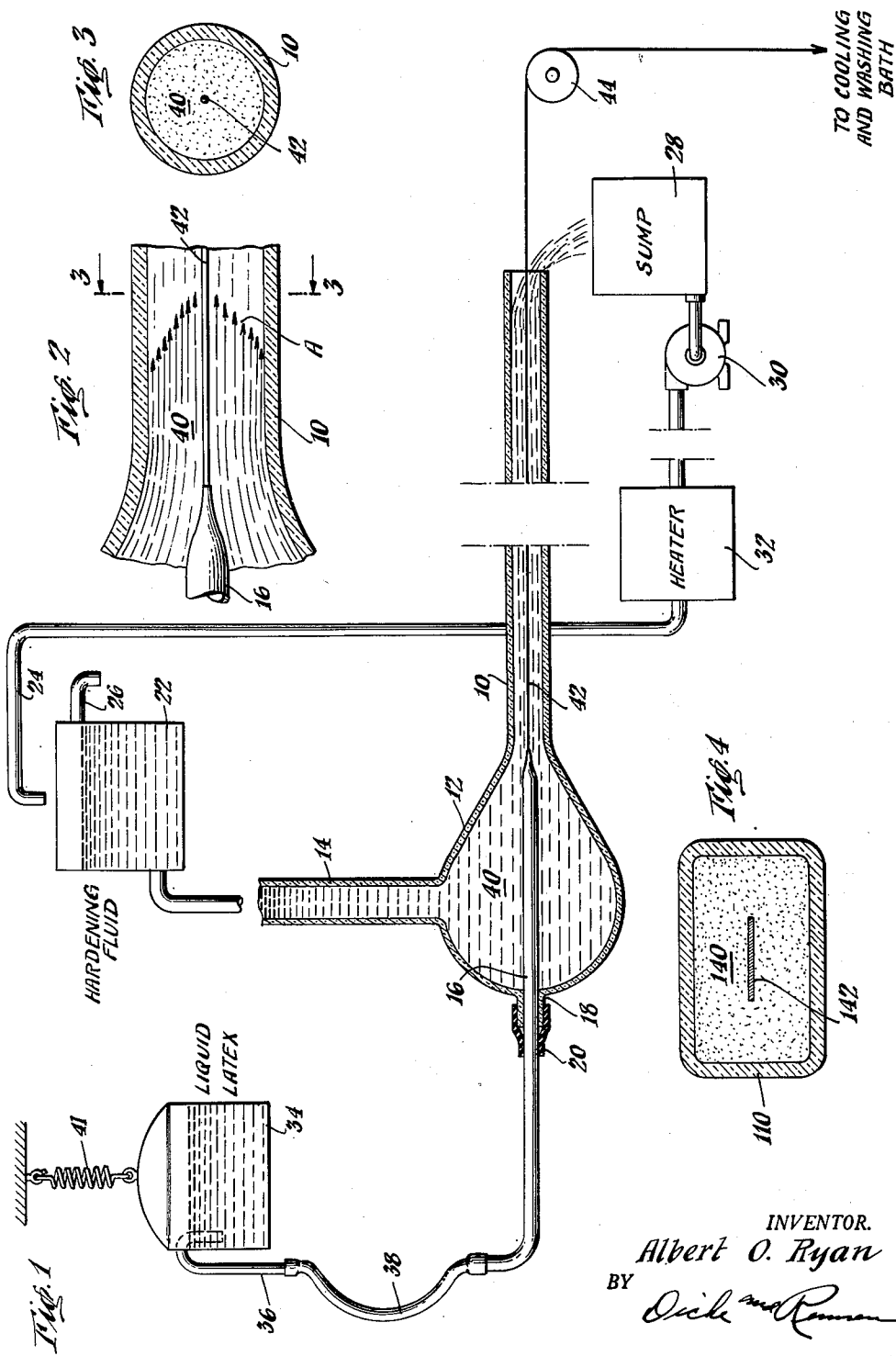
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METHOD OF AND MEANS FOR FORMING FILAMENTARY ARTICLES

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METHOD OF AND MEANS FOR FORMING
FILAMENTARY ARTICLES

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This invention relates to methods of and means for forming filamentary articles, and more particularly to the continuous formation of thread-like structures from liquids which may be hardened by a change in temperature or by chemical reaction.

An object of this invention is to provide a novel method and means for forming filamentary articles.

Another object of this invention is to continuously form threads from liquid temperature-hardenable materials discharged within a moving stream of heated material.

A further object of this invention is to continuously form threads or filaments by discharging a fluid, heat-hardenable material within a moving stream of heated material flowing at the same speed as the speed of the heat-hardenable material.

An additional object of this invention is to form continuous threads by discharging a fluid material within a moving stream of another fluid material flowing at the same speed as the discharged material and hardening the latter in this stream by chemical reaction.

A specific object of this invention is directed to a novel method and means for producing latex thread.

These and other objects and advantages of the present invention will become apparent from the following description of a preferred example thereof, illustrated in the accompanying drawing wherein:

Fig. 1 is a schematic view, with certain portions in enlarged cross-section, illustrating a preferred form of apparatus according to the present invention;

Fig. 2 is an enlarged, partial cross-sectional view of part of the apparatus illustrated in Fig. 1;

Fig. 3 is a transverse cross-sectional view taken along the line of III—III of Fig. 2; and

Fig. 4 is a transverse cross-sectional view showing a modified form of the apparatus illustrated in Fig. 2.

In the example illustrated in Fig. 1, there is shown a long tube 10 which may be formed of glass or other material suitable for the liquid to be contained therein. The inner diameter of the tube 10 will depend upon the size of the thread to be formed, but in any event will preferably be relatively small compared to its length, which may be from twenty to forty feet and depends upon the time required to coagulate the inner fluid. In a preferred form, one end of the tube 10 is formed with an enlarged section form-

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ing a chamber 12 to which is connected an inlet pipe 14. Inside of the chamber 12 and preferably projecting partially into the pipe 10 is a nozzle 16 which may also be made of glass. The nozzle 16 is preferably slidably mounted in an extension 18 formed integrally with the walls of the chamber 12, while a rubber sleeve 20 grips the outside of the projection 18 and about the nozzle 16 to hold the latter in place in the position desired, and at the same time prevents leakage of fluid from the chamber 12.

In the example given for the formation of latex thread, the chamber 12 and the pipe 10 are filled with hardening fluid such as glycerine under constant pressure from a container 22 supplied from the conduit 24. In order to maintain a constant head within the container 22, the latter may be formed with an overflow pipe 26 which may discharge any excess fluid back into a sump 28 (through suitable connecting pipes not shown). The glycerine is pumped into the container 22 through the conduit 24 by means of a pump 30 supplied from the sump 28, and is heated in passage by means of any suitable apparatus indicated at 32.

The liquid latex is supplied from a suitable container 34 through a siphon 36 and an intermediate connecting hose 38. In order that the flow of the liquid latex may be accurately controlled, the container 34 may be suspended by a spring 40 which is so designed that as the latex leaves the container 34 the spring 40 will contract such an amount as to keep the head of the latex supply constant. Likewise, as more latex is added to the container 34 from time to time the spring 40 will expand so as to maintain the head in this container constant relatively to the position of the nozzle 16.

In accordance with the present invention, it will accordingly be seen that heated glycerine flowing from the container 22 fills the chamber 12 and then flows outwardly through the tube 10 to the sump 28. The diameter of the tube 10 is such that under the pressure contemplated this tube will remain substantially completely full of the glycerine until just near the far end thereof. At the same time, liquid latex from the container 34 flows through the nozzle 16 where it is first pre-heated by the glycerine 40 surrounding the portion of the nozzle in the chamber 12, and is then discharged from the end of the nozzle into the moving stream of glycerine. Since, in accordance with the present invention, it is contemplated that the relative pressures of latex and glycerine in the containers 34 and 22 are

such that in the pipe 10 the two will flow at the same speed, the latex discharged into the stream of glycerine will be carried along in the center of the glycerine as a continuous enclosed semi-liquid thread which, under the combined action of heat and the dehydrating action of glycerine, gradually coagulates into a solid continuous filament 42. This solid thread or filament is then drawn out from the far end of the tube by means of pulling rollers 44, and is then passed to a suitable cooling and washing bath (not shown). The heating device 32 will remove any water from the sump 28, and the recovered glycerine may be re-used as described.

The manner in which the stream of glycerine 40 enclosed and carries along the latex thread 42 may be more clearly understood from a study of Figs. 2 and 3. The glycerine, being relatively viscous, will tend to drag along the inner surface of the tube and the relative speeds of movement within the tube may be represented by the curve A, which shows that this stream will move relatively slowly near the inner surface of the tube, and more rapidly over a small cross-sectional area at the center, which is the section into which the latex is discharged by the nozzle 16.

This stream-lined flow of the glycerine is known as viscous flow and prevents the mutual diffusion of miscible liquids or the mixing of non-miscible liquids of low viscosities. Thus, so long as the discharge speed of the latex from the nozzle 16 is the same as the speed of the moving stream of glycerine at this center area, the glycerine will carry the latex along without breaking or stretching it. Since the inner diameter of the two ends and the diameter of the discharge nozzle opening 16 can be accurately measured, the desired constant speed can readily be obtained and determined by the relative fluid pressures of the glycerine and of the latex. Such pressures are then maintained constant, as by the devices for producing constant head illustrated, by suitable proportional pumps, or other means known in the art.

The apparatus is applicable for producing threads of any cross-sectional shape, determined by the formation of the discharge nozzle opening 16, provided only that the inner cross-sectional area of the tube 10 is shaped proportionately to the cross-section of the desired thread. In Fig. 4, for example, I have shown on an exaggerated scale, a flat thread 42 in a stream of glycerine 40 contained within a tube 10. The tube 10, in this case, is so proportioned that the speed of the central area of glycerine which surrounds the thread 42 is constant and the same as the discharge speed of the latex from the nozzle 16. As will be seen from a study of Fig. 2, by way of comparison, this constant area or core will be found at a section equally spaced from the inner walls of the container. Thus, if the constant speed core is to have an irregular cross-section, the inner walls of the container must have substantially similar shape. Other forms of thread than that shown in Figs. 2, 3, and 4, are, of course, contemplated, and are possible if the principles of this invention are followed.

While it has been found advantageous in the formation of latex thread to pre-heat the latex by means of a pre-heating chamber 12 surrounding a portion of the nozzle 16, in certain instances and in the case of the formation of threads of other materials, such pre-heating may not be necessary and the chamber can be eliminated. In this case, the nozzle will project into the tube 12

just beyond the point at which the fluid is introduced, and at a point at which flow within the tube has become stream-lined.

As an example of the method of forming latex thread according to the aforesaid invention, it may be mentioned that thread one-hundredth of an inch in diameter has been formed within a tube having an internal diameter of one-quarter of an inch, with the glycerine heated to 160° to 212° F., which will cause a pre-heating of the latex to about 150° F. within the nozzle 16 before its discharge. This causes a slight de-stabilization of the latex which, when it comes into contact with the hot glycerine, soon forms a continuous latex thread.

Instead of using glycerine to harden the latex by the combined action of heat and dehydration, the latex may be hardened chemically by discharging a stream of alkaline-stabilized latex into a stream of an aqueous external fluid of low pH. The external stream could be a solution containing buffer salts such as magnesium sulphate, zinc-ammonia sulphate, and the like, or an acid solution such as acetic acid, formic acid, and the like. In all cases, however, the shape of the thread to be formed is maintained by the equilibrium forces of the stream-lined viscous flow.

Variations in the details of the apparatus which will occur to those skilled in this art are contemplated and are included as part of the present invention provided, however, that in all cases the liquid thread-forming material is discharged into a stream-lined flowing fluid flowing at the same core speed as the discharged thread-forming material. Instead of heating the glycerine before it is pumped into the container 22, it is, for example, possible to heat the glycerine directly either when it is in the chamber 12 or when it is in the tube 10, as the case may be. The tube 10 may be vertical, as well as horizontal.

As previously stated, the materials from which the apparatus are made will depend upon the characteristics of the material forming the thread and of the confining coagulating or otherwise hardening material. It is accordingly contemplated that, in accordance with the principles of the present invention, other threads than latex threads can be formed. For example, artificial thread-forming resins or plastics may be discharged into a moving stream of material and there condensed, polymerized or chemically interacted, as the case may be. Likewise, with similar suitable apparatus, molten metal may be discharged into a stream of cooling material and carried therealong until it becomes suitably hardened for withdrawal. It will thus be apparent that in accordance with the principles of my invention, substantially any temperature-hardenable or chemically-hardenable material may be used, provided it is supported within a suitable medium flowing with viscous flow; a "temperature-hardenable" liquid may be defined as any liquid solution or colloid which is in a normally liquid state but which would become hardened or coagulated at an elevated temperature, or, to put it more simply, any liquid which can be changed to a substantially permanent hardened condition by a temperature elevation. For best results in forming a round thread it is desired that the interfacial tension be as high as possible, but surface tension is not the controlling factor.

Therefore, while I have, for the purposes of illustration, shown and described one particular form of apparatus for carrying out my method in connection with the formation of one type of

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thread or filament, it is to be understood that the invention is not limited to the one specific example given, but only as set forth in the objects and the claims which follow.

I claim:

1. The method of forming continuous threads, which comprises the steps of discharging a relatively viscous liquid into a relatively small tube at such a speed that the liquid flows in the tube with viscous flow, discharging a relatively thin continuous liquid stream of thread-forming material into the center of the stream of relatively viscous liquid and at substantially the same speed and in the same direction as said viscous liquid, whereby said stream of viscous liquid supports said thread-forming material at its center, causing the thread-forming material to solidify while supported in the center of the stream of viscous material, and then withdrawing the solidified material from the viscous liquid in the form of a thread.

2. The method of forming continuous threads, which comprises the steps of discharging relatively viscous liquid into a relatively small tube at such a speed that the liquid flows in the tube with viscous flow, discharging a relatively thin continuous liquid stream of temperature-hardenable thread-forming material into the center of the stream of relatively viscous liquid and at substantially the same speed and in the same direction as said viscous liquid, whereby said stream of viscous liquid supports said thread-forming material at its center, creating a temperature difference between the thread-forming material and the viscous liquid while the former is supported in the center of the stream of the latter sufficient to harden said material, and then withdrawing the hardened material from the viscous liquid in the form of a thread.

3. The method of forming continuous threads, which comprises the steps of discharging a relatively viscous liquid into a relatively small tube at such a speed that the liquid flows in the tube with viscous flow, discharging a relatively thin

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continuous liquid stream of thermo-setting thread-forming material into the center of the stream of relatively viscous liquid and at substantially the same speed and in the same direction as said viscous liquid, heating said liquid to a temperature sufficient to harden said material whereby said stream of viscous liquid supports said thread-forming material at its center, and said thread-forming material is hardened while still supported by the heated viscous liquid, and then withdrawing the hardened material from the viscous liquid in the form of a thread.

4. The method of forming latex threads, which comprises the steps of discharging a stream of glycerine into a relatively small tube at such a speed that the glycerine flows in the tube with viscous flow, discharging a relatively thin continuous liquid stream of latex into the center of the stream of glycerine and at substantially the same speed and in the same direction as the stream of glycerine, heating said glycerine sufficiently high to coagulate said latex whereby said glycerine supports said latex at its center and the latter is coagulated by the heating of the former while so supported, and then withdrawing the heat-coagulated latex from the glycerine in the form of a relatively fine thread.

5. The method of forming latex threads, which comprises the steps of discharging a stream of relatively viscous buffer solution having a pH value sufficiently low to agglomerate latex into a relatively small tube at such a speed that said solution flows in the tube with viscous flow, discharging a relatively thin continuous stream of alkaline liquid latex into the center of the stream of buffer solution and at substantially the same speed and in the same direction of flow as said solution, whereby said stream of buffer solution supports said stream of liquid latex at its center and the latter is agglomerated by the former while so supported, and then withdrawing the agglomerated latex thread from the buffer solution in the form of a relatively fine thread.

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