

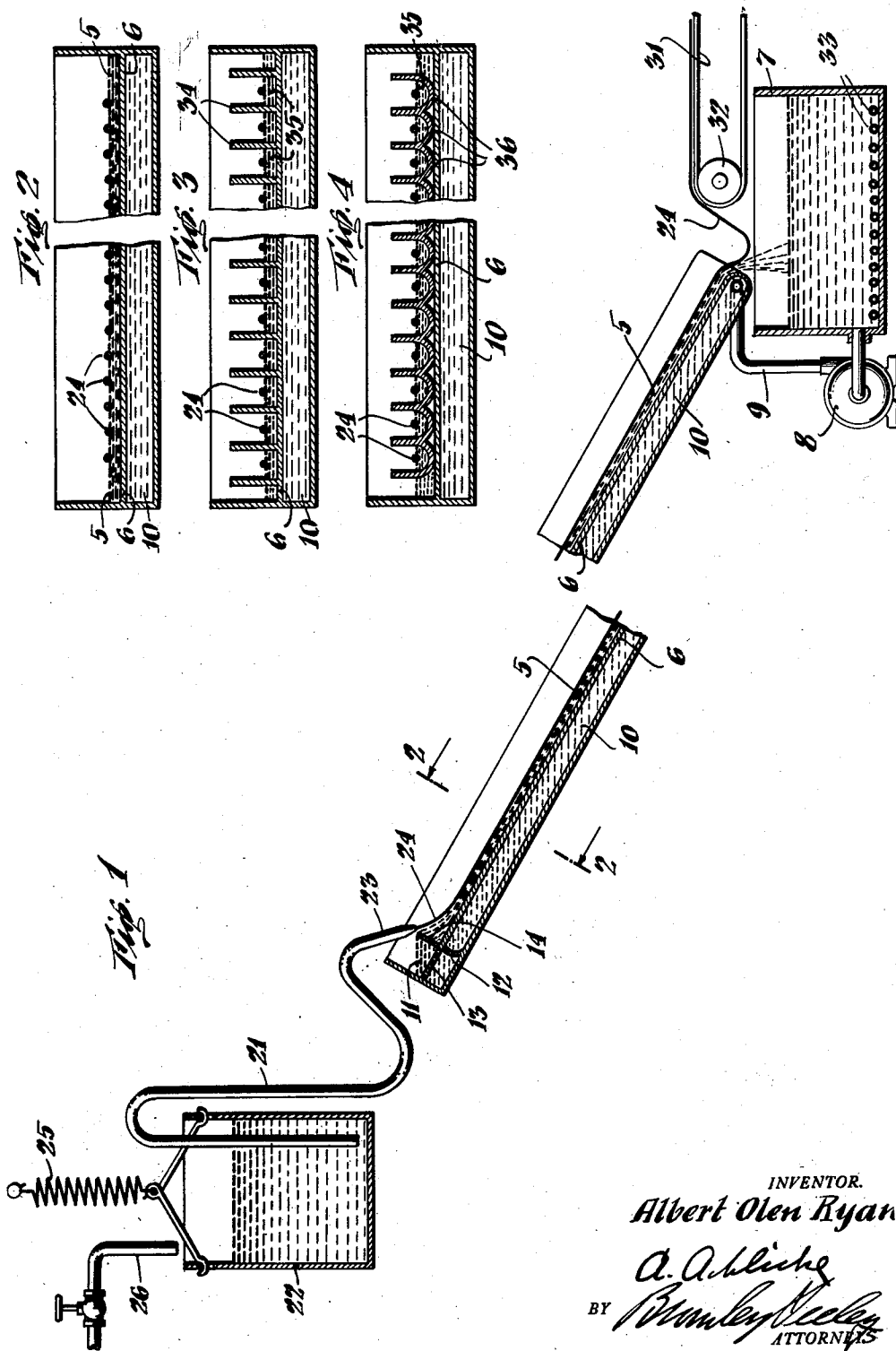
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MANUFACTURE OF FILAMENTS, THREADS OR THE LIKE FROM LIQUID MATERIAL

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MANUFACTURE OF FILAMENTS, THREADS
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This invention relates to the manufacture of filaments, threads or the like from liquid material capable of being hardened by physical or chemical action, and an object is to provide an improved method and apparatus for such manufacture.

My Patent No. 2,402,846, granted June 25, 1946, describes the manufacture of a single continuous thread or filament by discharging liquid thread-forming material into the center of a stream of hardening liquid flowing with viscous flow through a closed tube. In such an arrangement substantially all operating parts, such as nozzles, fluid streams, etc., are enclosed and inaccessible during operation, and a separate, complete apparatus is required for each thread being formed.

A further object of this invention is to provide a method and apparatus for making threads, filaments, tapes and the like in quantity by producing a plurality of separate threads with a single stream of hardening liquid.

A further object is to provide a finished product of substantially any shape from a hardenable material which is introduced at a plurality of points into a viscously flowing stream of hardening liquid.

A still further object is to provide an apparatus for this purpose constructed and arranged to give access to the operating parts, as well as to the material being hardened during the hardening operation.

Other objects will appear from the following description of an illustrative embodiment of the invention taken together with the attached drawings wherein Fig. 1 is a diagrammatic view, with parts in section, illustrating one arrangement of apparatus capable of being used in carrying out the present method, and Figs. 2, 3 and 4 are transverse sectional views on the line 2—2 of Fig. 1 showing modified arrangements for controlling the viscous flow of the hardening liquid.

As in my said patent, the present invention makes use of the characteristic of viscous flow of the hardening liquid. Viscous flow, or streamline flow, as it is sometimes designated, is obtained by a proper proportioning of the density, the cross sectional area, the flow velocity and the viscosity of the hardening liquid. In the present invention the hardening liquid is caused to flow by gravity with viscous flow down an inclined surface. The material to be hardened is discharged in the form of a plurality of parallel liquid streams onto the surface of the hardening liquid and at the same rate of flow as the

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surface of such liquid so as to move along therewith and be supported on the surface thereof. The hardening operation may be accomplished by physical or chemical action, the hardening liquid being selected or treated to accomplish the desired purpose. For example, if the material to be hardened is subject to hardening by thermal action, the supporting and hardening liquid stream is heated or cooled to the proper degree to effect hardening of the material while supported thereon and moving along therewith. If, on the other hand, the material is adapted to be hardened by chemical action, then the hardening liquid is properly selected to have the desired chemical hardening effect on the material. The stream of hardening liquid is of sufficient length for the material to be sufficiently hardened while in contact therewith, after which the hardened material is removed from contact with the hardening liquid and may, for example, be passed through conditioning and washing operations.

Although the invention will hereinafter be described in connection with the hardening of latex for the purpose of manufacturing latex threads or filaments, it will be apparent that it is equally well adapted to hardening other suitable materials to produce other forms of product. The term "thread" and its derivatives as used herein is intended to cover products having various cross-sectional configurations.

For example, in the hardening of latex threads by heat, the present invention employs glycerine heated to substantially 210° F. as the hardening liquid. The glycerine is caused to flow in the form of a substantially flat sheet downwardly through an inclined trough, the bottom of which is formed by a substantially flat supporting pan 6. Preferably the glycerine is drawn from a sump 7 by a circulating pump 8 and forced through a connecting line 9 to the lower end of a closed chamber 10 formed in the trough beneath the inclined pan 6. The glycerine is forced upwardly through the space 10 and through a screened outlet 11, having screens 12 and 13 through which the glycerine passes. A dam 14 extends across the trough and upper edge of the pan 6 on the lower side of the outlet 11, the glycerine flowing over the edge of the dam and downwardly by gravity along the pan 6, from which it returns to the sump 7.

As illustrated, viscous flow of the glycerine is obtained by adjusting the trough to the proper inclination with relation to the viscosity of the glycerine, and the flow velocity and the cross sec-

tional area of the flowing sheet. In viscous flow the liquid in contact with the confining surface is substantially stationary, the velocity of flow increasing up to a certain point with the distance of the fluid from such surface. Under such conditions, the glycerine sheet 5, or the like, flows without turbulence.

The liquid thread-forming material to be hardened, for example hardenable latex, is discharged in the form of a plurality of thin, spaced streams onto the surface of the hardening liquid such as glycerine, on which they are supported and with which they move, as indicated in the drawing. Each stream of the liquid latex is siphoned through a conventional siphon 21 from a supply reservoir 22 and delivered under suitable pressure through a nozzle 23 which is so positioned above the dam 14 as to deposit a filament or thread 24 of liquid latex onto the face of the sheet of glycerine and at the same speed as the glycerine. As shown in Fig. 2, for example, the number of threads which can be formed is dependent only upon the width of the apparatus, that is to say the width of the stream of hardening liquid, and the necessity of spacing the filaments of thread-forming material sufficiently to prevent any interference or contact between the different filaments.

In order to maintain the discharge of latex by the nozzles 23 at a constant rate, the fluid pressure of the latex at the nozzles must be maintained constant, for example by keeping the surface level of the latex in the reservoir 22 at a substantially fixed height above the discharge nozzles 23. This may, for example, be done in the manner illustrated in Fig. 1 in which the latex reservoir 22 is yieldingly supported on a spring 25 or the like so that as the level of the liquid in the reservoir is lowered, the reservoir itself is lifted by the spring 25 to maintain a constant head of liquid. In the same way increasing the amount of liquid in the reservoir increases the weight thereof and lowers the reservoir in proportion. Latex, or other liquid to be hardened, can be delivered to the reservoir through a valve-controlled supply line 26 or the like. It will be apparent that a single reservoir can be employed for any number of associated nozzles 23. A single reservoir can supply all nozzles or a plurality of reservoirs can be used for supplying any selected number of nozzles.

The trough is so designed and the speed of of flow is such that the filaments or threads 24 are substantially hardened by the time the lower end of the trough is reached, permitting their removal to any suitable drying and washing apparatus or other conditioning apparatus (not shown). As illustrated a conveyor belt 31, operating over a roller 32, is employed for removing the hardened threads 24.

When the thread-forming material is hardenable by heat the hardening liquid in the sump 7 is brought to the desired temperature by any heating means such, for example, as heating coils 33 in the bottom of the sump, a suitable heating medium being circulated through the coils. In making threads from latex by the combined action of heat and dehydration, the coagulating or hardening liquid can be glycerine. It will normally be heated in the sump to approximately 210° F. with the result that it has a temperature of approximately 200° F. at the head of the viscous stream as it passes over the dam 14, where the thread-forming material is deposited on it. The streamline or viscous flow of

the glycerine prevents the mutual diffusion of miscible liquids or the mixing of non-miscible liquids of low viscosities. Hence, when the discharge speed of the latex from the nozzles 23 is the same as the surface speed of the moving sheet of glycerine, the glycerine will carry the latex filaments along without breaking or stretching them. The dehydrating and heating effect of the glycerine upon the latex coagulates or hardens the liquid filaments to form the desired threads which can be removed from the bottom of the trough on the conveyor belt as described.

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 onto the surface of a sheet of aqueous fluid having a low pH value. Such coagulating or hardening fluid could be a solution containing buffer salts such as magnesium sulphate, zinc ammonia sulphate, and the like, or 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 streamline viscous flow and aided by surface and interfacial tension.

The velocity of flow of the hardening liquid will usually vary from approximately 20 feet per minute to approximately 100 feet per minute, depending for the most part upon the viscosity of the material.

In the modification shown in Fig. 3, the flat stream of hardening liquid is divided by a plurality of partitions 34 into a plurality of narrow, parallel streams 35. The partitions are spaced equi-distantly across the width of the trough and pan 6, and the filaments 24 of thread-forming material are deposited on the surface of each stream midway between the adjacent partitions so as to take advantage of the viscous flow characteristics of the associated stream.

In the modification illustrated in Fig. 4 the trough is provided with a plurality of U-shaped channels 35 supported on the pan 6 and serving to divide the sheet of hardening fluid into a plurality of streams 35 similar to the streams in Fig. 3. Here also each filament 24 of thread-forming material is deposited on the surface of each stream 35 midway between the sides of the U-shaped channels.

It will be recognized that the density of the hardening liquid must usually be greater than that of the latex or other material being hardened, in order to cause the latter material to float upon the hardening liquid. However, while the relative densities of the materials are important, and although the viscosity of the hardening liquid may vary within a relatively wide range, it is essential to have viscous or streamline flow of the hardening liquid to insure the proper support of the material being hardened.

It will be apparent, as previously pointed out, that threads can be made by the present invention from other materials than latex. For example, artificial resins or plastics may be discharged onto the surface of a moving stream of suitable hardening material and then condensed, polymerized or chemically interacted, as the case may be. Likewise, with suitable apparatus, molten metal may be discharged onto the surface of a stream of cooling material and carried therealong until it becomes sufficiently hardened for withdrawal. In accordance with the invention, substantially any physically or chemically hardenable material may be used provided it is

supported upon a suitable surface medium flowing with viscous flow and that the density of the hardenable material is less than that of the hardening liquid. A "temperature hardenable" material may be defined as any substance, liquid solution or colloid, which is in a normally liquid state or capable of being easily liquefied but which becomes hardened or coagulated upon a suitable temperature change, that is to say any liquid which can be changed to a substantially permanently hardened condition by a temperature change.

Therefore, while I have, for the purposes of illustration, described an illustrative embodiment of the invention, it will be apparent that the invention is not limited to the specific example given but may be variously modified and adapted within the scope of the appended claims.

I claim:

1. The method of forming continuous threads, which comprises the steps of flowing liquid onto a substantially flat inclined surface at such a speed that the liquid flows across said surface with viscous flow in the form of a substantially flat sheet returning said liquid as an underlayer at a relatively higher temperature to its point of beginning of downward flow on the inclined surface delivering a continuous liquid stream of temperature hardenable thread-forming material onto the surface of said stream of viscously flowing liquid at substantially the same speed and direction of flow as said liquid, whereby said stream of viscously flowing liquid supports said thread-forming material on its surface, creating a temperature difference between the thread-forming material and the liquid while the former is supported on the latter sufficient to harden said material, and then withdrawing the hardened material from the liquid in the form of a thread.

2. The method of forming continuous threads or the like which comprises causing a latex hardening liquid to flow at an incline in the form of a substantially flat sheet with the characteristics of viscous flow and acting as a carrying layer, delivering a stream of liquid latex onto the surface of said viscously flowing liquid sheet in the form of a thread at substantially the same speed and in the same direction as said liquid sheet whereby said liquid supports said latex on its surface and permits the liquid latex to harden on the surface of said liquid while moving therewith, and then removing the resultant hardened thread from the liquid, heating and then recycling the hardening liquid in a plane below that of the carrying layer so as to maintain the temperature of the carrying layer relatively constant.

3. Apparatus for the production of continuous threads comprising a substantially flat smooth surface, means for flowing a hardening liquid across said smooth surface, the thickness of the liquid sheet and the viscosity and speed of flow thereof being such as to produce viscous flow of said liquid on said surface, means for delivering a filament of thread-forming hardenable liquid on the surface of said liquid at a speed substantially equal to the surface speed thereof, whereby said thread-forming liquid is hardened as it moves in contact with said liquid, means for withdrawing the hardened thread from said

liquid and means for carrying the hardening liquid back to the point of flow on said surface.

4. A combination according to claim 3 in combination with heat transfer means for said hardening liquid to produce hardening of the thread-forming material by a difference in temperature.

5. A combination according to claim 3 in which said hardening liquid is chemically reactive with the thread-forming material to harden the same.

6. A combination according to claim 3 in which the thread-forming material is alkaline liquid latex and the hardening liquid is a buffer solution having a pH value sufficient to agglomerate the latex.

7. Apparatus for the production of continuous threads comprising a substantially flat, smooth, inclined surface, means for flowing a hardening liquid across said surface in a substantially flat sheet, the thickness of the liquid sheet and the viscosity and speed of flow thereof on said surface being such as to produce a viscous flow of said liquid across said surface, a pan beneath said surface for carrying back the hardening liquid to the point of beginning of said surface, means for simultaneously delivering a plurality of filaments of thread-forming hardenable material on the surface of said sheet at a speed substantially equal to the surface speed thereof whereby said material is hardened as it is supported by and moves in contact with said liquid, and means for withdrawing the hardened threads from the surface of said hardening liquid.

8. Apparatus for producing continuous threads, comprising an inclined chamber for a hardening liquid, a trough above said chamber and inclined in the same direction as said chamber, said trough having a flat surface down which the liquid flows, the thickness of the liquid and the viscosity and speed thereof being such as to produce viscous flow of said liquid across said surface, a dam extending across the upper end of the trough and the chamber, screening means in the upper end of the chamber and above the dam for establishing communication between the chamber and the trough into the trough at its upper end, means for delivering a filament of thread forming hardenable liquid onto the surface of said viscous liquid in the upper end of said trough at a speed substantially equal to the surface speed of said viscous liquid so as to harden said hardenable liquid into thread form during movement with and on said viscous liquid, and means for withdrawing the hardened filament from said hardening liquid.

9. Apparatus according to claim 8 in which there are provided a plurality of longitudinal extending partitions on the trough, said partitions being formed by a plurality of parallel substantially U-shaped channels.

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