METHOD OF AND APPARATUS FOR PRODUCING FIBROUS OR FILAMENTARY MATERIAL

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This invention relates to the formation of filaments or fibers from viscous material capable of relatively rapid solidification from a liquid condition, by expelling them from a container in which the material is held in liquid form either as the result of fusion or in solution in a volatile liquid. This is preferably done by an air blast in conjunction with an electrostatic attraction toward an adjacent target, as well as by the repulsion between the charged surface portions of the liquid and other adjacent parts of the mass. It is well known that small particles when electrified by charges of like sign repel one another, whereas particles or masses of opposite sign are attracted.

The process may be applied to materials such as gums, pitches or synthetic resins, either molten or held in solution, and also to other viscous materials such as glass in a fused condition. The container in which the liquid is held may be of metal or, if high temperatures are required, of porcelain or refractory clay, and the liquid therein is electrically connected with one terminal or pole of a static machine or other source of high electric potential. The other terminal of the potential source is electrically connected with a target or screen, which may be in the shape of a flat plate or of a cylinder, and which, while spaced from the container, is sufficiently near the latter to permit of a considerable electrostatic attraction between the target and the fibers as they emerge from the container. In carrying out the invention I have used a multiple plate static machine capable of giving voltages of the order of one hundred thousand volts or more. I have used containers of metal, porcelain or refractory clay and have used targets of galvanized iron maintained at a distance from one to six feet from the container. With some low melting point materials, such as resins, the targets can be placed at a distance of twenty feet or more. The filaments or fibers are formed by the blast of air and the electrostatic repulsion from the surface of the liquid and fly through the air toward the target. They are all electrified in the same sign and are repelled by both the mass of liquid in the container and by each other. Said fibers, as they leave the liquid mass, solidify progressively and are drawn out in continuous lengths, sometimes of a great many feet, as they proceed from the surface of the liquid mass. Those which are expelled from solution in alcohol, for instance, offer a very great surface because of their fineness, so that evaporation is very rapid, and the fibers become solid almost immediately after their expulsion from the surface of the liquid.

In this manner, under the influence of the electrostatic expulsion, in combination with the air blast, or with the attracting target, or both, fibers of extreme fineness can be made, which fibers are mutually so repelled that they are rarely straight and may therefore be used to produce a fibrous mass well suited for packing, insulation, or similar purposes. They may be made of a still more irregular or kinked contour by subjecting them, after their expulsion from the liquid mass and before their complete solidification, to an intermittent force acting transversely to their direction of travel. This may be accomplished by arranging at opposite sides of the path of travel of the fibers two electrodes in the form of auxiliary targets upon which are superimposed an alternating electromotive force, for instance, 60 cycles at 2200 volts, so that the fibers, while emerging from the liquid and before their complete solidification, receive sidewise impulses alternating in opposite directions, as they proceed toward the main target, causing them to become still more crooked and irregular. The same type of irregularity may be given to the fibers by subjecting them to the influence of a pulsating air blast acting transversely to their direction of travel.

The electrostatic repulsion of the fibers from the liquid mass and from each other may be utilized either in conjunction with the electrostatic attraction of said fibers for an oppositely charged target, or in conjunction with the ordinary process of blowing glass or slag wool by a blast of steam or air under pressure, or both. I have succeeded in producing fibers of great fineness and length and of knickly or irregular contour by blowing viscous liquids over the edge of a container and at the same time making the latter one terminal of a static machine whose other terminal is electrically connected with a large metallic target or even with the floor and side walls of the room.

The point at which the liquid escapes from the container can be controlled and the efficiency of the apparatus increased by providing the container with a spout or lip and tilting it in the ordinary manner so that, as material is supplied to it, said material tends to flow out over the lip. At this point electrification seems to be more intense, and the material, as it escapes from said lip, instead of falling or blowing out in the form of drops or coarse fibers, is scattered about and shredded into fine threads which fly toward the target and often adhere for a time to it.
Preferably the melting of the material, where fusion is employed, is done by means of electric heaters, since the presence of hot gases from heaters of the combustion type tends to cause excessive leakage of the electrostatic charge from the liquid, although excellent glass wool has been made by this method employing a gas and air furnace.

The invention will best be understood by the following description of certain forms of apparatus, illustrated in the accompanying drawing, by which it may be practiced. It will be appreciated, however, that the particular apparatus and operations shown and described have been chosen for purposes of exemplification merely, and that the invention, as defined by the claims hereto appended, may be otherwise embodied and practiced without departure from the spirit and scope thereof.

In said drawing:

Figs. 1 and 2 are diagrammatic views illustrating two forms of apparatus suitable for practicing the invention.

Referring to Fig. 1, 10 denotes a container for the material which may be supplied thereto by a suitable feed chute or spout 11. Said container, which may be heated by any suitable means, such as an electric heating unit or units 12 of any usual or well known type, is provided with a discharge lip or spout 13 from which the liquid is blown by means of compressed air delivered from a suitable source to a nozzle 14 supported to deliver a blast in a direction away from the container 10 toward a galvanized iron or other target 15. In other words, the blast is delivered in the general direction of the target 15 or of the field. At 16 is shown a static machine having one pole 17 connected with the target 15 and the other electrically connected with the liquid in the container 10, the connections being made in any usual or suitable manner. As shown, the positive terminal is connected with the target and the negative pole with the container, although the polarity direction is relatively unimportant. Disposed at opposite sides of the path from the lip 13 to the target 15 are electrodes in the form of auxiliary targets 17 connected respectively with the terminals of an alternating current generator 18.

In operation, due to the combined action of the air blast from the nozzle 14 and the electrostatic repulsion above described, the liquid emerges from the lip 13 in the form of fibers which are immediately attracted to the target 15. The air blast, used in conjunction with the electrostatic repulsion, serves not only to draw out and remove the fibers as fast as they are formed by giving them a mechanical impulse in addition to the electrostatic pull, but also to carry away the ionized air which results from the brush discharge of the container and tends to maintain a zone of conducting medium around the latter. Consequently the electrostatic leakage from the container is diminished and the production of fibers greatly increased. Due to their mutual electrostatic repulsion, said fibers tend to assume an irregular or kinky form which is intensified by the intermittent transverse force to which they are subjected by the alternating electromotive force supplied to the electrodes 17. Upon striking the target 15, the static charges carried by said fibers are usually discharged, permitting said fibers to fall into a receiving container 10. If, as may occur in some instances, the fibers tend to adhere to the target, they may be removed therefrom and delivered into said container in any convenient manner.

The apparatus illustrated in Fig. 2 is substantially similar in principle to that shown in Fig. 1 with the following differences in construction. In lieu of the electric heating means 12, there is employed a suitable gas and air mixing burner 20 for heating the container 10, said burner discharging its flame into a suitable fire pit 21 below said container. The target 22 is in the form of a rotating cylinder provided with a doctor 23 for continuously removing therefrom any fibers which may tend to adhere thereto. In lieu of the auxiliary targets 17 and alternating current generator 18, there is provided, for the purpose of subjecting the fibers to a transverse intermittent force, a nozzle 24 directed crosswise of the path of travel of the fibers and supplied with compressed air from any suitable source under the control of a rotary or other pulsating valve 25. The operation of this apparatus is substantially the same as that of the form first described and requires no further explanation.

Referring to both forms, it will be observed that there is employed an electrical field suitable regulating as to extent and intensity in conjunction with a mechanical impulse predetermined or controlled as to direction, location and force, whereby substantially solidified fibers are formed within the field.

I claim:

1. The method of forming fibers from viscous liquid capable of rapid solidification which comprises expelling said liquid from a suitable container while subjecting the fibers so formed, after their expulsion and before their complete solidification, to an alternating electromotive force acting transversely to their direction of travel.

2. The method of forming fibers from viscous liquid capable of rapid solidification which comprises expelling said liquid from a suitable container under joint electrostatic and mechanical impulse while subjecting the fibers so formed, after their expulsion and before their complete solidification, to an intermittent force acting transversely to the direction of their expulsion.

3. An apparatus for forming fibers from viscous liquid capable of rapid solidification comprising, in combination, a container for the liquid, means for expelling said liquid from said container in the form of fibers, and means for subjecting said fibers as they leave said container to an intermittent force acting transversely to the direction of their expulsion.

4. An apparatus for forming fibers from viscous liquid capable of rapid solidification comprising, in combination, a container for the liquid, a target spaced from said container, a source of static electricity having one pole electrically connected with said liquid and the opposite pole electrically connected with said target, a pair of electrodes located respectively at opposite sides of the path from said container to said target, and means for superimposing upon said electrodes an alternating electromotive force.

5. The method of forming fibers which comprises expelling a viscous liquid capable of rapid solidification from a body of such liquid while controlling the shape of the fibers so formed by subjecting them, after their expulsion and before their complete solidification, to an intermittent force acting transversely to their direction of travel.
6. The method of forming fibers from a viscous liquid capable of rapid solidification from a body of such liquid which consists in creating an electrical field between two poles and electrically propelling from one pole of the field toward the other, portions from the liquid body while subjecting such portions to mechanical impulse, regulating the extent and intensity of said field and controlling the location, direction, and force of said mechanical impulse in such manner as to form substantially solidified fibers in the field.

7. The method of forming fibers from a molten viscous liquid capable of rapid solidification from a body of such liquid which consists in creating an electrical field between two poles and electrically propelling from one pole of the field toward the other, portions from the liquid body while subjecting such portions to mechanical impulse, regulating the extent and intensity of said field and controlling the location, direction, and force of said mechanical impulse in such manner as to form substantially solidified fibers in the field.

8. The method of forming fibers from a viscous liquid capable of rapid solidification from a body of such liquid which consists in creating an electrical field between two poles and electrically propelling from one pole of the field toward the other, portions from the liquid body while subjecting such portions to mechanical impulse in the form of a blast, regulating the extent and intensity of said field and controlling the location, direction, and force of said mechanical impulse in such manner as to form substantially solidified fibers in the field.

9. The method of forming fibers from a molten viscous liquid capable of rapid solidification from a body of such liquid which consists in creating an electrical field between two poles and electrically propelling from one pole of the field toward the other, portions from the liquid body while subjecting such portions to mechanical impulse in the form of a blast, regulating the extent and intensity of said field and controlling the location, direction, and force of said mechanical impulse in such manner as to form substantially solidified fibers in the field.

10. The method of forming fibers from a viscous liquid capable of rapid solidification from a body of such liquid which consists in creating an electrical field between two poles and electrically propelling from one pole of the field toward the other, portions from the liquid body while subsequently subjecting such portions to mechanical impulse, regulating the extent and intensity of said field and controlling the location, direction, and force of said mechanical impulse in such manner as to form substantially solidified fibers in the field.

11. The method of forming fibers from a viscous liquid capable of rapid solidification from a body of such liquid which consists in creating an electrical field between two poles and electrically propelling from one pole of the field toward the other, portions from the liquid body while subjecting such portions to mechanical impulse acting in the general direction of the field, regulating the extent and intensity of said field and controlling the location, direction, and force of said mechanical impulse in such manner as to form substantially solidified fibers in the field.

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