Feb. 22, 1938. A. FORMHALS 2,109,333

ARTIFICIAL FIBER CONSTRUCTION

Filed Aug. 15, 1936

FIG. 1.

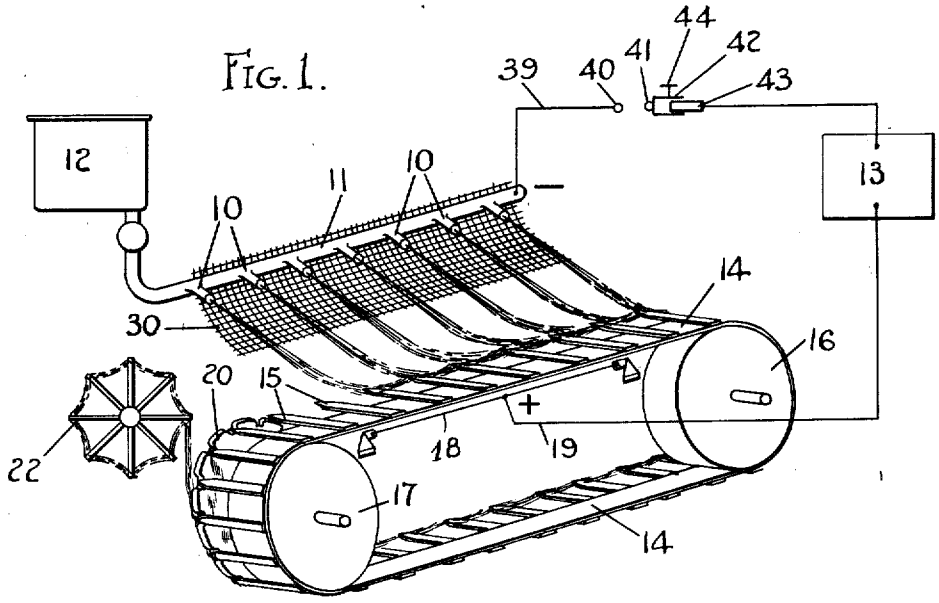
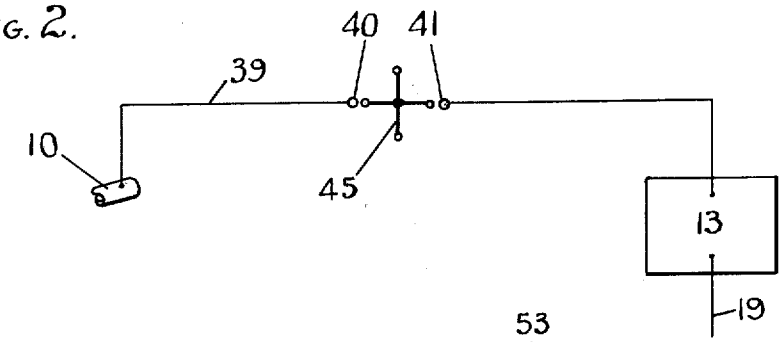


FIG. 2.



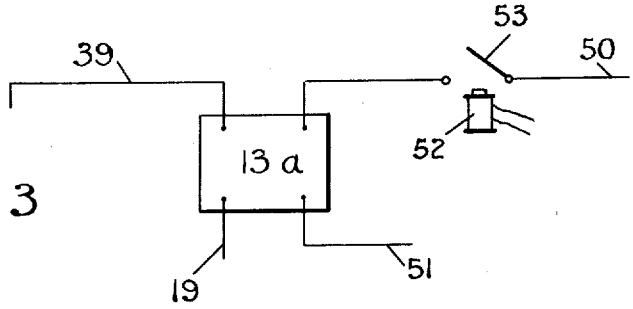


FIG. 3

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ARTIFICIAL FIBER CONSTRUCTION

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Application August 15, 1936, Serial No. 96,225
In Germany March 4, 1936

9 Claims. (Cl. 18—8)

This invention relates to the production of artificial fibers, and more particularly it relates to a process and apparatus for regulating and controlling the length of artificial fibers during their production in a process comprising the electrical dispersion or shattering of a stream of a spinning solution by means of a high electrical potential. The dispersion or shattering of a stream of spinning solution into fibers by means of a high electrical potential shall hereinafter, for convenience, be referred to as the "electrical spinning" of fibers.

In the electrical spinning of fibers, for example, by the method and apparatus disclosed in the U. S. Patent to Formhals, No. 1,975,504, or in the copending application for Letters Patent of Anton Formhals, Serial No. 88,429, filed July 1, 1936, it is extremely difficult, if not impossible to control the length of the fibers. Although a considerable change in the potential difference between the solution feeding device and the fiber collecting device of previously known processes, had a direct influence on the average length of the fibers, it was impossible thereby to produce fibers of approximately uniform length, that is, when comparatively short fibers were spun a considerable number of long fibers were present and when long fibers were spun, they were accompanied by a considerable number of short fibers. Furthermore, when the potential difference is increased to such a degree as to produce relatively short fibers, there is an increased tendency of these fibers to fly back towards the spinning nozzle, which seriously interferes with the continuous operation of the process.

It is therefore an object of this invention to provide a process for the electrical spinning of fibers which comprises a decided improvement in regulating and controlling the average length of the resulting fibers.

It is another object of this invention to provide means in an apparatus for the electrical spinning of fibers, whereby the average length of fibers may be more closely regulated and controlled.

It is a further object of this invention to provide a method and apparatus for the electrical spinning of fibers in comparatively short average fiber lengths in which there will be comparatively little tendency of the fibers to fly back towards the spinning nozzle.

Other objects of the invention will appear hereinafter.

The objects of this invention may be accomplished, in general, by periodically interrupting or periodically materially lowering the normal intensity of the high electrical potential difference between the spinning nozzle and the fiber collecting means.

In order to more clearly set forth the invention, reference is made to the following detailed description taken in connection with the accompanying illustration, in which:

Figure 1 is a diagrammatic perspective view of a device for the electrical spinning of fibers constructed in accordance with the present invention.

Figure 2 is a diagrammatic view of a portion of the invention showing a rotary spark gap in a lead wire.

Figure 3 is a diagrammatic view of a portion of the invention showing a current interrupting means positioned in the primary circuit of a transformer.

Referring to the drawing, a plurality of metal nozzles 10 are connected with a pipe 11 which may or may not be metal, and are supplied with spinning solution from the storage tank 12. The nozzles and pipe are electrically connected in circuit with a device 13 for producing high electrical potential. Device 13 may, for example, be a transformer and rotary convertor for changing ordinary line current such as 115 volts, 60 cycle alternating electric current into a high voltage pulsating direct current or 13 may be any suitable device for producing a high potential direct current. Spaced from the nozzles is a long, endless belt 14, preferably comprising rubber or any suitable non-conductive material although an electrically conducting material such as a metal may be used. The belt is provided with spaced metal prongs or lugs 15 which are fastened to the belt so as to project from at least one side thereof. The lugs 15 are disposed substantially within the plane of the belt with the projecting ends extending perpendicularly from the side of the said belt. The projecting portions or ends of the lugs are preferably pointed as shown. These lugs constitute the individual electrodes to which the fibers are attracted and which serve to support the fiber band at spaced sections thereof. It is to be understood, however, that the individual prongs may be electrically connected with each other, in which case an electric charge will nevertheless be accumulated on the individual prongs. The belt is driven by pulleys 16 and 17 which are preferably composed of wood or some other suitably electrically non-conducting material. Positioned parallel to the under surface of the belt is shown

a long conductor wire 18 attached by means of a conductor 19 to the circuit which includes the high potential source 13. Conductor 18 is preferably spaced from the belt, the electrodes 15 receiving a charge from the wire 18 through the air gap therebetween. The potential between the nozzles and the electrodes 15 is maintained between 10,000 up to 100,000 volts and preferably at least at 30,000 volts.

The high potential electric charge on the electrodes 15 is of opposite polarity to that imparted to the spinning solution and is preferably lower in potential than that imparted to the said solution so as to prevent undesirable flying about of fibers due to a repelling action of said electrodes.

A potential stabilizing and directing means 30 such as a concave plate, screen or other wire network is preferably positioned in back of the nozzles 10 and is connected to a charge of high potential electricity of the same polarity as the potential imparted to the spinning solution. The directing means serves primarily to direct the fibers towards the prongs and in addition serves to repel any fibers towards the belt from which occasional fibers sometimes tend to fly back to the spinning nozzle.

The fibers, during the spinning operation, are attracted to and electrostatically adhere to and are supported by the electrode prongs 15 and travel with the belt. The fibers form a sliver which is preferably removed continuously at one end of the belt collector by means of a stripping device 20 mounted on a shaft 21, the axis of which is inclined towards the axis of the shaft or pulley 17, so that the lobes of the disc 20 move with the prongs 15 as the disc revolves, thereby scraping off the sliver from the collector, the sliver being continuously wound upon a suitable reel 22 or other collecting device.

In order to regulate and control the length of the fibers produced during the spinning operation, the lead wire 39 is provided with a spark gap between terminals 40 and 41. The length of the spark gap is made adjustable in any desired manner such as, for example, by means of telescoping sleeves 42 and 43 and set screw 44. The length of the spark gap is adjusted so that there will be periodic passing of sparks across the same, thus periodicaly interrupting the high potential maintained between the nozzles and the fiber collecting device. By varying the distance between the terminals 40 and 41, it is possible to vary the frequency at which sparks are passed and therefore vary the length of the resulting fibers.

Referring to Figure 2 of the drawing, the lead wire 39 is provided with spaced terminals 40 and 41 between which is positioned a rotary spark gap producing element 45. The distance between the projecting ends of the element 45 and the terminals 40 and 41 is such that when the ends of element 45 are in direct alignment with the terminals, the spark will immediately pass across the gap. In this case, the frequency of the spark may be regulated and controlled by the speed of the rotation of the element 45. One or both of the terminals may be provided, if desired, with adjustable means 42, 43, and 44 as described above with reference to Figure 1.

In the modification illustrated in Figure 3, the lead wires 39 and 19 are connected to the secondary or high potential circuit of a transformer 13A. The primary or low potential circuit of the transformer is supplied with electrical current from a rotary convertor or the like (not shown) by means of lead wires 50 and 51. Lead wire 50 is provided with a switch 53 and a cooperating, periodically energized magnet 52 whereby to periodically operate the switch 53. The periodicity of the magnet and switch may be regulated in any desired manner such as is well known in the art. In this manner the primary circuit, and therefore also the secondary circuit is periodically broken so as to cause the potential difference between the spinning nozzle and the fiber collecting device to periodically collapse and rise to its maximum value and thus control a length of the electrically spun fiber. By means of the above described device it is possible to spin relatively short fibers without resorting to an extremely high electrical potential which may cause the fibers to fly back towards the nozzle and thereby seriously impair the operation of the device.

It will be obvious that the current interrupting means employed may be positioned in either or both lead wires connecting the various elements of the spinning apparatus. Furthermore, many other modifications of the specific devices illustrated will be apparent to those skilled in the art. It is possible, for example, to control the length of the fiber by greatly reducing the intensity of the high electrical potential between the spinning nozzles and the fiber collecting device by interposing suitable periodically operative high resistances in the high potential circuit, such as will be apparent to anyone skilled in the electrical art. Such resistances must be sufficiently high to reduce the potential to at least 35% and preferably to at least 20% of its normal intensity. Another modification of the spark gap type of switch may be obtained by positioning a suitable condenser across the terminals of the spark gap so as to modify the rate and intensity of the discharge.

Other high voltage switching devices may likewise be used in carrying out this invention. For example, a vacuum tube may be used as a high voltage switch in which there are positioned two contacts, one movable relative to the other. One of these contacts may be oscillated by coils surrounding the switch tube and energized by an alternating current of the correct frequency.

The present invention for controlling the length of staple fibers may be used to particularly great advantage in connection with the electric field stabilizing, directing and shaping device 30 above described, which device is the subject of the copending application of Anton Formhals, Serial No. 88,430, filed July 1, 1936.

As above described, the potential stabilizing and directing or field shaping means 30 is connected to a high electrical potential of the same polarity as the potential imparted to the spinning solution. A current interrupting means, such as, for example, a spark gap may be placed in series with the high tension lead wire attached to the spinning nozzle, or in series with the high tension lead wire attached to the stabilizing or directing means, or in series with both of these leads.

Obviously, many changes and modifications may be made in the processes and apparatus above described without departing from the nature and spirit of the above invention. It is therefore to be understood that the invention is not to be limited thereto except as set forth in the appended claims.

I claim:

1. In a method for the electrical spinning of

fibers, the step comprising electrically dispersing a stream of spinning solution into fibers by means of a high electrical potential, and controlling the length of said fibers by periodically reducing the intensity of said potential during said spinning operation.

2. In a method for the electrical spinning of fibers, the step comprising electrically dispersing a stream of spinning solution into fibers by means of a high electrical potential, and controlling the length of said fibers by periodically reducing the intensity of said potential to at least 35% of its normal intensity during said spinning operation.

3. In a method for the electrical spinning of fibers, the step comprising electrically dispersing a stream of spinning solution into fibers by means of a high electrical potential created between said stream of spinning solution and a fiber collecting means, and controlling the length of said fibers by periodically reducing said potential during said spinning operation, the periodicity of said reduction of potential being adjusted to correspond to the average length of fiber desired.

4. In a method for the electrical spinning of fibers, the step comprising electrically dispersing a stream of spinning solution into fibers by means of a high electrical potential of predetermined value created between said stream of spinning solution and a fiber collecting means, and controlling the length of said fibers by periodically reducing the said potential and causing the same to be re-established to said predetermined value during said spinning operation.

5. In an apparatus for the electrical spinning of fibers, a spinning nozzle, a fiber collecting device, means for creating a high electrical potential between said nozzle and said device, and means connected in series with said means for creating said high electrical potential for periodically reducing said potential at substantially regular intervals of such periodicity as to control the length of said fibers.

6. In an apparatus for the electrical spinning of fibers, a spinning nozzle, a fiber collecting device, means for creating a high electrical potential between said nozzle and said device, and switch means for periodically reducing said potential at substantially regular intervals of such periodicity as to control the length of said fibers.

7. In an apparatus for the electrical spinning of fibers, a spinning nozzle, a fiber collecting device, means for creating a high electrical potential between said nozzle and said device, and spark gap means for periodically reducing said potential at substantially regular intervals of such periodicity as to control the length of said fibers.

8. In an apparatus for the electrical spinning of fibers, a spinning nozzle, a fiber collecting device, means for creating a high electrical potential between said nozzle and said device, and rotary spark gap means for periodically reducing said potential at substantially regular intervals of such periodicity as to control the length of said fibers.

9. In an apparatus for the electrical spinning of fibers, a spinning nozzle, a fiber collecting device, means for creating a high electrical potential between said nozzle and said device, and adjustable spark gap means for periodically reducing said potential at substantially regular intervals of such periodicity as to control the length of said fibers.

ANTON FORMHALS.