

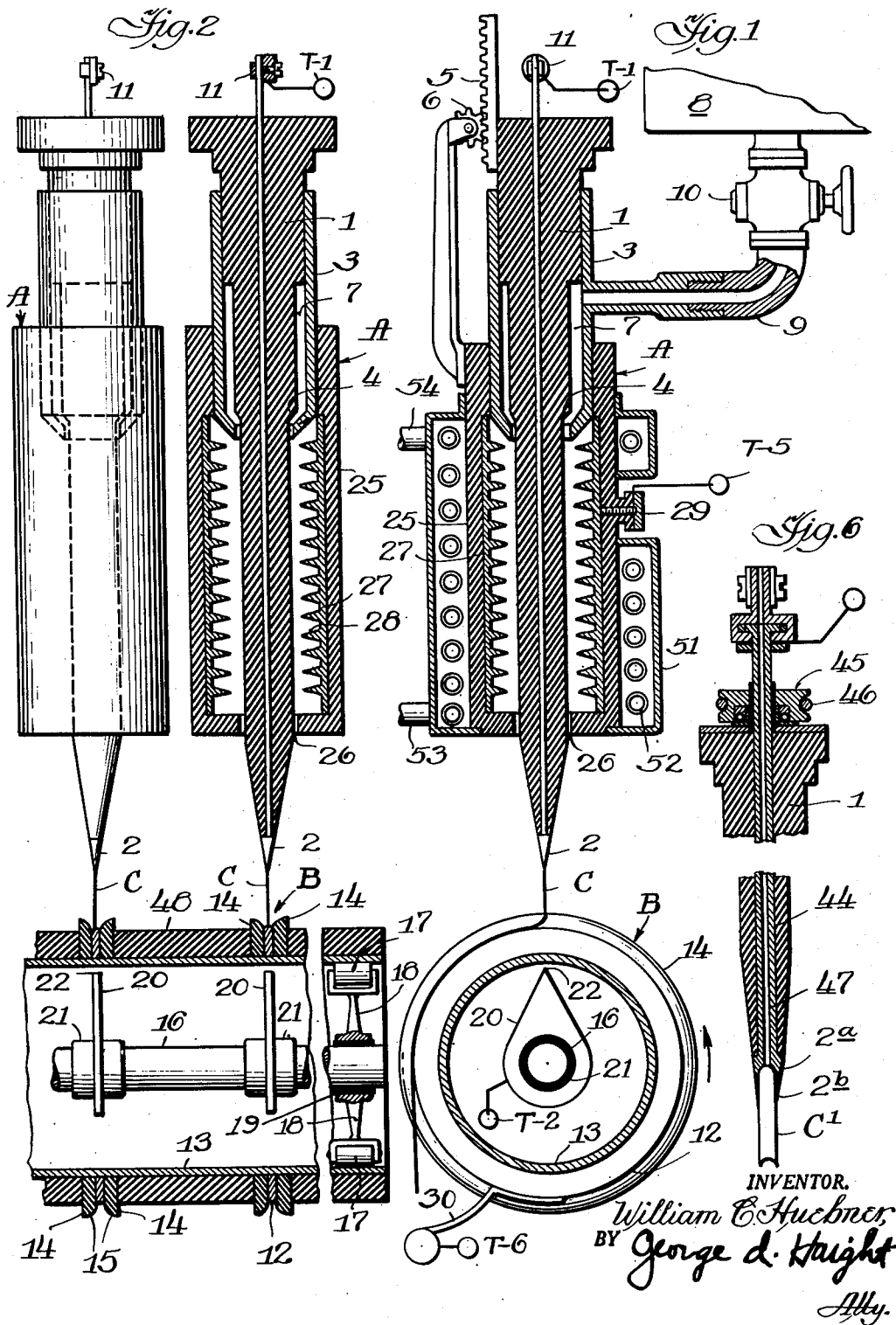
April 28, 1953

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METHOD AND MEANS OF PRODUCING THREADS
OR FILAMENTS ELECTRICALLY

2,636,216

Filed Oct. 23, 1948

2 SHEETS—SHEET 1



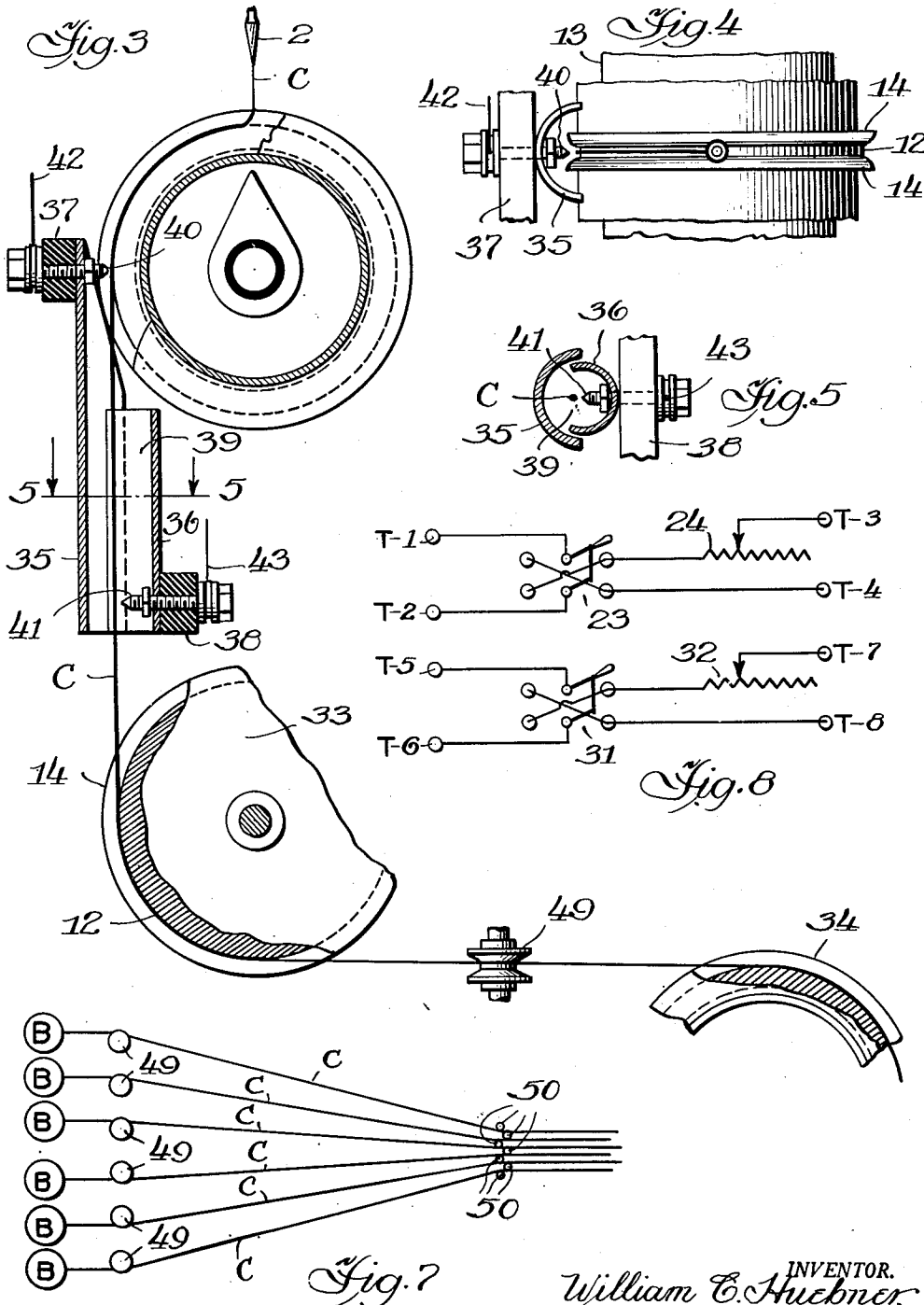
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2 SHEETS—SHEET 2



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METHOD AND MEANS OF PRODUCING
THREADS OR FILAMENTS ELECTRICALLY

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2 Claims. (Cl. 18-8)

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This invention relates to a method and means for the production of continuous threads or threadlike filaments from electrically chargeable material in a fluid or flowing state.

This application is a continuation in part of my co-pending application, Serial No. 591,740, filed May 3, 1945, now abandoned, for a method and means of producing threads or filaments electrically.

One of the objects of my invention is to electrically form a thread or threadlike filament from synthetic or other suitable electrically chargeable material in a liquid or flowing state, and to harden or set and otherwise prepare the formed thread for use for any of the purposes for which threads or threadlike filament are used.

A further object is to provide a method and means which produces thread or threadlike filament from liquid material, of relatively great strength, and of uniform size and diameter and having the properties and characteristics required for the purpose for which the thread is used.

My invention involves the discharge or projection through space or across a gap, of electrically chargeable liquid material in a continuous stream or threadlike filament by the forces set up by an electric potential difference established across said gap.

My invention further involves the pre-charging and ionization of the electrically chargeable liquid material to facilitate and control the discharge and formation of the thread by subjecting the material to the action of an electric potential of suitable characteristics.

The invention further involves the provision of mechanism for carrying out the methods and treatment of the material hereinbefore referred to and described more fully in the following specification in conjunction with the accompanying drawings in which

Fig. 1 is a view principally in vertical section showing the thread-forming unit mechanism, including the material-discharging and thread-forming parts, the pickup device and the connections to a container for the supply of material from which the filament or thread is produced;

Fig. 2 is a vertical section of the mechanism substantially at right angles to that of Fig. 1, illustrating a plurality of unit mechanisms positioned side by side, with the pickup devices on a common mounting for the simultaneous production of a plurality of individual threads;

Fig. 3 is a vertical section in the same plane as that of Fig. 1, of heating means for hardening

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or setting the thread as it leaves the pickup device, the view including the lower idler and a reel or spool upon which the finished thread is wound;

Fig. 4 is a top plan of the pickup device and the associated heating means shown in Fig. 3;

Fig. 5 is a detail section on the line 5-5 of Fig. 3;

Fig. 6 is a vertical section of a modified discharge device for forming hollow tubular thread or filament;

Fig. 7 is a diagrammatic view illustrating the manner of converging a plurality of threads from the forming units into close proximity for incorporation in a web of material in which the threads are used as reinforcement; and

Fig. 8 is a schematic illustration of a portion of the electric circuit for the thread forming mechanism.

The structure of the unit thread-forming mechanism comprises a discharging device A (Figs. 1 and 2) positioned vertically and spaced above a pickup or receiving member B, and upon which the material is deposited in a continuous stream C forming the thread or filament.

The discharging device A comprises a pencil-like member 1 of insulating material, tapered to a discharge point 2 at its lower end and mounted in a tubular member 3 at its upper end. The lower end of the tubular member 3 is contracted to form a valve seat which cooperates with a shoulder 4 on the pencil to regulate the flow of material along the outer surface or exterior of the pencil. The pencil is adjustable in the tubular member for this purpose by means of a suitable rack 5 and pinion 6. The portion of the pencil above the valve is less in diameter than the tubular member 3 which provides an annular chamber 7 for the material from which the thread is formed.

The material in a liquid or flowable state is supplied to the discharge device from a container 8 which is connected to the upper end of chamber 7 by means of a pipe 9. A suitable valve 10 is provided in this connection for controlling the flow of material. The material may be permitted to flow from the container by gravity, or slight pressure may be applied thereto as desired, depending upon the fluidity of the fluid.

The material when it reaches the discharge end of the discharge electrode is in the form of a film which remains on said end by the surface tension of the film.

The discharge point 2 is formed as a metal

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electrode connected to a conductor 11 which extends centrally through the pencil member to the upper end thereof. The conductor 11 is connected to a terminal T-1 of an electric circuit later to be described whereby the terminal is connected to a source of suitable electric potential for establishing a field of force. The field is operable to project the thread or filament C from the discharging device A to the pickup or receiving member B. The circuit establishing the field is described later in this description.

The pickup device B is positioned below the point 2 to receive the thread C and carry it away as fast as it is deposited thereon. The pickup device comprises a metal disc or ring 12 which functions as a receiving member, and on the periphery of which the thread is deposited. The ring 12 is mounted on a copper or other metal cylinder or drum 13 which is rotated on a horizontal axis by any suitable means and at the proper speed relatively to the speed of flow of the thread from the discharge point. The ring 12 is flanked on both sides by discs 14 of insulating material which are greater in diameter than the ring 12 and are beveled on their inner marginal faces 15 to converge toward the ring 12 to form a narrow groove which confines the formed thread therein as the thread is carried around by the rotation of the pickup device.

A fixed rod or shaft 16 extends axially of the cylinder 13 and forms a support for rotatably carrying the cylinder or drum 13. For example the cylinder may be carried by rollers 17 mounted in brackets 18. The brackets 18 are mounted on the shaft 16, but are insulated therefrom by an insulating bushing 19.

The shaft 16 also carries an electrical attraction member 20. This attraction member is in the form of a triangular metal plate which is mounted on the shaft 16 but insulated from the shaft 16 and the drum 13 by a bushing 21. The apex 22 of the plate is spaced from the interior surface of the cylinder 13 and is positioned in vertical alignment with the longitudinal axis of the positive electrode discharge point 2. The attraction member 20 is connected to a terminal T-2 of an electric circuit later to be described.

An electric potential is applied across terminals T-1 and T-2. This creates an electric field, its circuit comprising the terminal T-1, the conductor 11, the discharge point 2, the gap between the discharge point 2 and the disc 12, a portion of the disc 12 and the drum 13, the gap between the interior of the drum 13 and the apex 22, and the terminal T-2. This electric field is centered upon a direct axial line from the discharge point 2 to the apex 22 and the thread of filament migrating from the discharge point is physically removed from this direct axial line through rotation of the disc 12 in a counterclockwise direction, viewing Fig. 1.

A circuit which may be used to supply a desired potential to the terminals includes a reversing switch 23 (Fig. 8) and a rheostat 24 connected to terminals T-3 and T-4. T-3 and T-4 are connected to a suitable electrical source supplying any desired potential. The reversing switch 23 may be used to reverse the relative potential of the discharge point 2 and the apex 22 and the rheostat 24 may be used to vary the potential available across the discharge point 2 and the apex 22. Thus, the operating conditions are under a wide range of control by the operator by varying the distance between the discharge point 2 and the apex 22 by reversing the potential of

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the discharge point 2 and the apex 22, and by varying the potential.

In addition to the formation of a thread by electrically transferring or discharging the liquid material from a discharge electrode to a receiving element, there is provided means for establishing a second circuit in which electric potential from a suitable source is utilized to precharge and ionize the material during the flow or movement of the film thereof to the discharging point of the thread-forming unit. As shown more clearly in Figs. 1 and 2, the portion of the pencil below the shoulder 4 is enclosed and in an insulating member 25 in the form of a tube, the upper end portion of which is telescoped over the tubular member 3 and the lower end of which is provided with an opening 26 large enough in diameter to permit the flow of liquid material down the exterior surface of the pencil 1. This insulating member 25 has a tubular lining of copper or other suitable metal 27 which forms an electrode and which has upon its interior a plurality of fine pointed projections 28 directed toward but spaced from the film of material which flows down the exterior of the pencil 1. This shell has a binding post 29 extending to the exterior of the insulating tube 25 for connection to one terminal, T-5 of an electric circuit having a source of suitable electric potential of suitable characteristics and of proper polarity to effect the precharging or ionization of the liquid thread-forming material. The other terminal for the precharging or ionizing circuit is the receiving element or pickup B. A brush rides on the surface of the disc 12 and is connected to a terminal T-3 of the electric ionizing or precharging circuit. Because of drawing limitations the brush 30 is shown located 60° clockwise from the position intended to be depicted. Thus the precharging of the material as it flows down the discharge electrode will be effected prior to the discharge of the film of material from the end of the electrode and will facilitate the migration or transfer of the film from the end of the electrode toward the attraction electrode by the electrostatic field of force.

A precharging or ionizing circuit which may be used to supply a desired potential to the terminals T-5 and T-6 includes a reversing switch 31 (Fig. 8) and rheostat 32 connected to terminals T-7 and T-8. T-7 and T-8 are connected to a suitable electrical source supplying any desired potential. Certain fluids take a positive charge while others take a negative charge. The polarity of the discharge and attraction elements is changed in accordance with the polarity of precharge given to the fluid, i. e., the discharge polarity is always the same as the fluid polarity. The reversing switch 31 may be used to reverse the relative potential of the lining 27 and the disc 12 and the rheostat 32 may be used to vary the potential available between the lining 27 and the disc 12. Thus, the operating conditions are under a wide range of control by the operator and by varying polarity and the potential.

After the thread has been deposited upon the receiving pickup, means are provided to condition it. For example, it is shown carried by the receiving pickup a quarter of a revolution of the pickup device, from whence it is led vertically downwardly through the heating zone of a dielectric heater (Figs. 3, 4 and 5) to an idler 33 which is spaced below the pickup device a sufficient distance for the purpose. The idler is preferably in the form of a peripherally grooved disc or wheel

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of the same diameter as the pickup device and may be driven in unison with the pickup device, or it may serve as an idler around which the thread is led to a suitable winding spool or reel 34. During its travel from the pickup device to this idler 33, the thread is subjected to dielectric heat for the purpose of hardening and setting the material of which the thread is formed.

The dielectric heater comprises the induction members 35 and 36 which are semi-circular in section and which are mounted in opposed relation to each other on the supporting bars 37 and 38 of insulating material. These induction plates are electrically spaced from each other but provide between them a tube-like chamber or zone 39 through which the thread passes. These induction plates have electrodes 40, 41 to which are connected the conductors 42, 43 from a suitable source of high potential current of suitable characteristics for developing heat in the dielectric between the induction plates 35 and 36 and in the stretch of thread traveling through this zone.

Fig. 6 illustrates a modification of the discharge electrode used to form a hollow or tubular thread or filament C¹. In this construction the electrode 2^a at the lower end of the pencil member 1 is formed as a ring tapered to a fine edge 2^b and of a diameter corresponding to the desired diameter of tube C¹ so that the material discharged therefrom will form a hollow tubular filament. To facilitate uniformity of wall thickness, the ring-shaped electrode is made rotatable on its axis. To this end, the electrode is carried on a stem 44 extending through the upper end of the pencil member and provided with a pulley 45 which may be driven by a belt 46 or any suitable means for the purpose. It is understood, of course, that the formed tube may be deposited on a receiving pickup similar to that hereinbefore described and then passed through the zone of the dielectric heater in the same manner as the solid thread or filament C. In order to maintain the tube circular in cross section, while it is being formed and carried to the heater by the pickup device, the stem 44 is provided with a passage 47 which communicates with the ring electrode and through which compressed air or gas may be supplied to the interior of the tube at the proper pressure to prevent the collapse of the tube until the material has been set in the heater. When no compressed air is supplied, the tube will be deposited on the pickup device as a flat ribbon.

Pickup devices for a plurality of units may be mounted upon a common cylinder or drum and properly spaced apart by insulating sleeves 48 (Fig. 2). In like manner, the shaft or rod 16 is extended axially of the cylinder and the attraction plates or members 20 and the apexes 22 mounted thereon in proper spaced relation. Thus the pickup devices are all arranged in axial alignment and operated in unison. This is important where a plurality of threads are to be simultaneously formed and brought together in close relation for incorporation in a web or fabric. A plurality of units may be arranged side by side in a row (diagrammatically illustrated in Fig. 7) and the threads simultaneously produced thereby can be converged into close relation for incorporation in a web or band of material in which the thread provides reinforcement. The threads C from the units can be passed around idlers 49 and then led to suitable guides 50 into the web-forming machines.

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The thread material may be cooled or heated if desired prior to being discharged from the discharging device A by means of a temperature control device consisting of a jacket 51 surrounding the insulating member 25 (Fig. 1). A helical heat transfer coil 52, mounted within the jacket 51, is provided with inlet and outlet pipes 53, 54 through which coolant or heater fluid may be passed as desired.

The following materials have the characteristics and properties for effective utilization of my improved method and apparatus:

	A	C
	B	D
15	Water Silicate of Soda	Water Dextrine Soap
20	Water Liquid Glue Oleic Acid Castor Oil Turpentine	Water Lime Soda Fibers Clay

A solution made of these materials has the properties of susceptibility to ionization and responsiveness to the fields of force established to form and control the filament or thread. These materials are prepared as a solution or mixture or composition of suitable liquid consistency for the purpose.

It is understood that the electric current supplied to the several circuits for the ionization and transfer of the thread material may be produced electronically or otherwise and varied characteristics such as potential, frequency, direction, and polarity determined to be suitable for the purpose.

The herein before described method may be practiced and the mechanism may be used, for example, by bringing the discharge point 2 to between $\frac{1}{8}$ of an inch and $\frac{1}{4}$ of an inch from the periphery of the disc 12. The potential across the transfer circuit, which comprises T-1 and T-2, may be 8000 volts D. C., T-1 being negative and T-2 being positive. Optimum potentials are between 3,000 and 12,000 volts D. C. The potential across the pre-charging circuit, which comprises T-5 and T-6 may be 7000 volts D. C., T-5 being negative and T-6 being positive. If the thread material has a tendency to spray, then the distance between elements 2 and 12 should be reduced. With higher voltages, the distance between elements 2 and 12 may be greater.

I claim:

1. The method of producing a continuous tube from a solidifiable composition in flowable condition and containing electrically chargeable material which comprises establishing an electrostatic field of force across an atmospheric gap between the reduced circular discharge end of a pencil-like discharge electrode and a predeterminedly spaced attraction electrode by arranging both electrodes in a high potential direct current electric circuit to have opposite polarities and substantially equal potentials, continuously supplying a film of the composition while in flowable condition to the circular discharge end of the discharge electrode causing said film while on said circular end of the discharge electrode to have a rotative movement about the longitudinal axis of the discharge electrode, migrating said film as a tube under the impetus of said field of force from the circular discharge end of the discharge electrode

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through said atmospheric gap toward said attraction element, simultaneously with the migration of said film as a tube from the circular discharge end of the discharge electrode introducing pressure fluid into the tube to maintain the same in tube-like form, and intercepting said migrating tube and continuously transporting the same away from said field of force for final solidification into a unitary self-sustained tube.

2. An apparatus for producing a unitary and individual thread-like continuous filament from a solidifiable composition in flowable condition and containing electrically chargeable material which comprises a single pencil-like discharge electrode having a reduced narrow discharge end, an attraction electrode spaced a predetermined distance from said end of the discharge electrode to provide an atmospheric gap therebetween, a high potential direct current electric circuit including said electrode to produce an electrostatic field of force across said gap, a housing surrounding a portion of said discharge electrode, precharging means mounted in said housing in close proximity to said discharge electrode but spaced therefrom, an electrical precharging circuit independent of said high potential direct current electric circuit, means electrically connecting one side of said pre-

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charging circuit to said precharging means, a supply container adapted to have the composition in flowable condition arranged therein, means interconnecting said container and said discharge electrode to conduct the flowable composition from the container to said discharge electrode and supply the same as a filament to the discharge end thereof, a continuously moving receiving member insulated from said electrodes and passing through said atmospheric gap and intercepting the filament which migrates from the end of the discharge electrode under the influence of the electrostatic lines of force of said field of force, and means electrically connecting the other side of said precharging circuit to said receiving member.

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