Aug. 16, 1938. A. L. PUGH, JR 2,126,810

INKING APPARATUS AND METHOD OF SUPPLYING INK TO A DIELECTRIC BODY

Filed Dec. 31, 1935 2 Sheets-Sheet 1

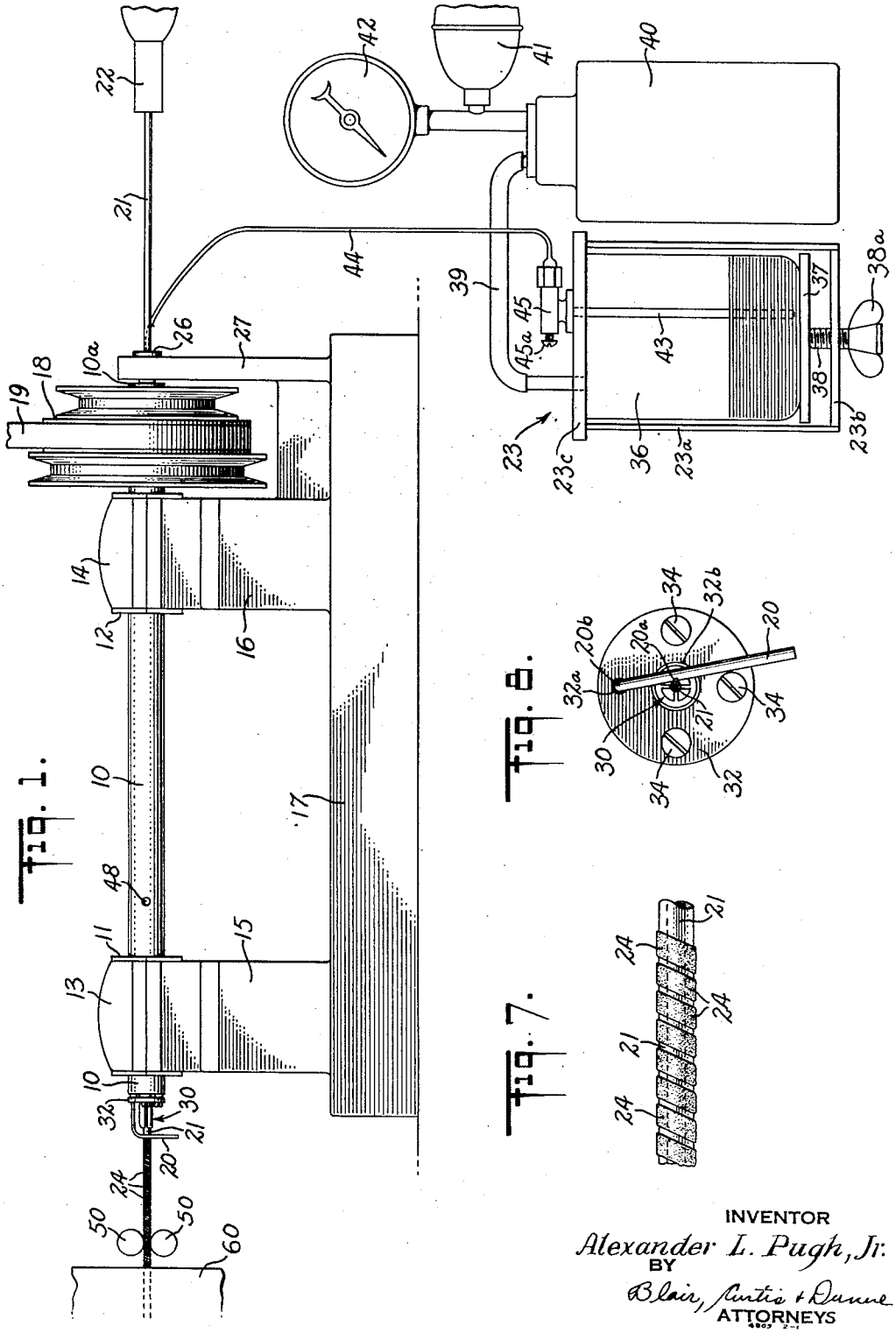


Fig. 1.

Fig. 6.

Fig. 7.

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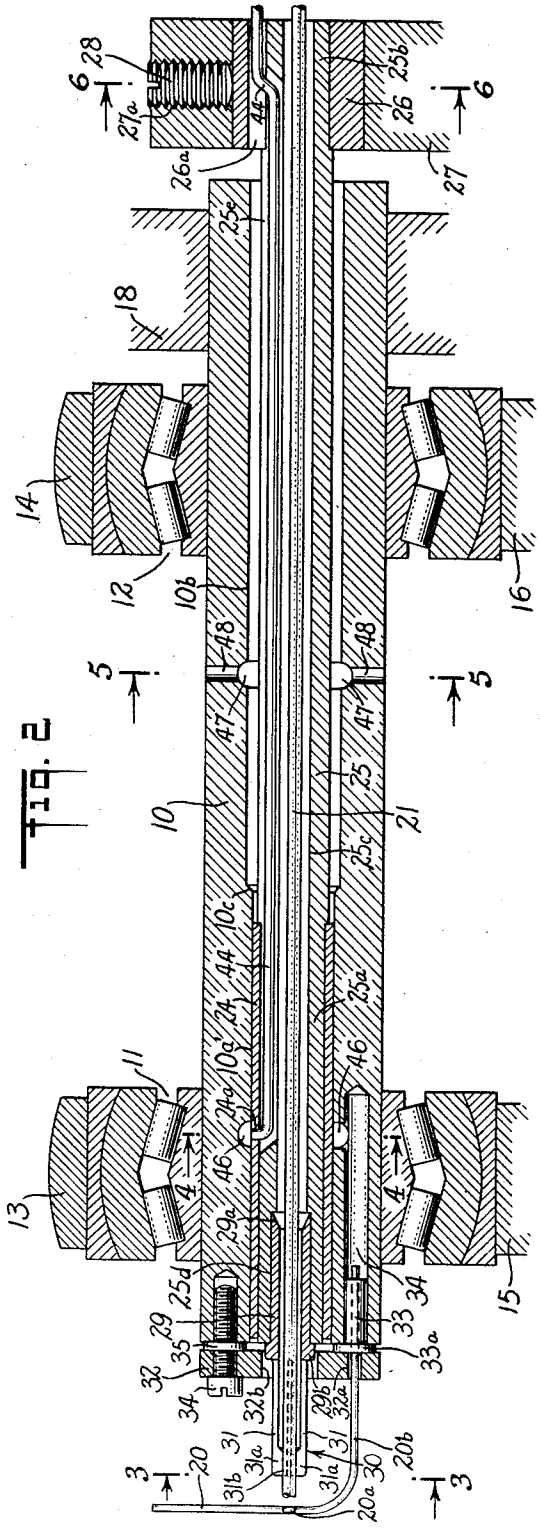


Fig. 2.

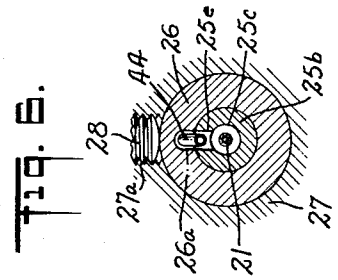


Fig. 6.

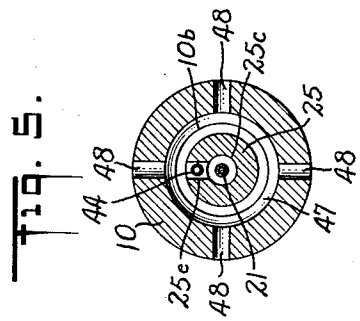


Fig. 5.

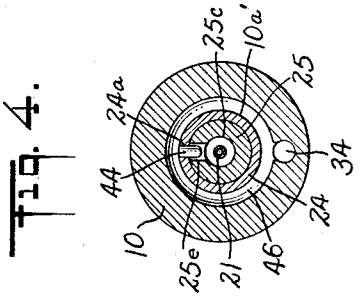


Fig. 4.

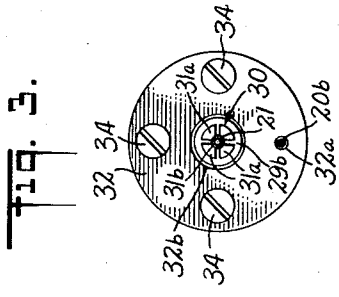


Fig. 3.

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INKING APPARATUS AND METHOD OF SUPPLYING INK TO A DIELECTRIC BODY

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Application December 31, 1935, Serial No. 57,067

19 Claims. (Cl. 91—12)

This invention relates to inking apparatus designed for use in connection with the application of a liquid conductor to an elongated body or the like and to a method of applying conducting material to such a body in a spiral path.

One of the objects of this invention is to provide inking apparatus simple in design and sturdy in construction. Another object is to provide apparatus of the above character which may be made from inexpensive materials and whose assembly is free from complicated detail. Another object is to provide apparatus of the above character which may be easily operated and whose operation is practically automatic after starting. Another object is to provide apparatus of the above character wherein liquid suspensions of solids, various solutions, or conducting liquids may be deposited upon a moving elongated body evenly and continuously without effecting the movement of the body. Another object is to provide inking apparatus of the above character which will apply a resistance path on a continuous dielectric body while allowing for the free passage of that body therethrough without damage. Another object is to provide apparatus of the above character which will apply ink or like conducting liquid on a moving dielectric tube or rod in a continuous spiral path. Another object is to provide a method of applying liquid conducting material to the surface of a dielectric body in a spiral path which may be practiced with efficiency and economy. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which is shown one of the various possible embodiments of my invention,

Figure 1 is a side elevation of my apparatus as installed and ready for use;

Figure 2 is a longitudinal sectional view of a portion of the apparatus shown in Fig. 1 on an enlarged scale;

Figure 3 is a vertical sectional view taken along the line 3—3 of Fig. 2;

Figure 4 is a vertical sectional view taken along the line 4—4 of Fig. 2;

Figure 5 is a vertical sectional view taken along the line 5—5 of Fig. 2;

Figure 6 is a vertical sectional view taken along the line 6—6 of Fig. 2;

Figure 7 is a side elevation of a portion of the resistance element produced by my apparatus; and

Figure 8 is an end elevation of a portion of the apparatus shown in Figure 1.

Similar reference characters refer to similar parts throughout the several views of the drawings.

To provide a clearer understanding of certain features of my invention, it might here be pointed out that many difficulties are encountered in the manufacture of small resistance elements, particularly when they are in the form of a dielectric, such as glass tubing, or rod, for example, coated with resistance material which is usually graphitic or carbonaceous in nature. The resistance value of such elements depends largely upon the thickness and consistency of the resistance material and the length of the path of the resistance material along which the electricity flows. Under certain circumstances it is desirable that the path be of considerable length although the length of the element itself is substantially shorter (this being effected by applying a spiral coat) and in all cases it is highly important that the thickness and consistency of the resistance material be uniform throughout the length of the path. It is accordingly evident that the length, thickness and consistency of the resistance material are variables which must be controllable within narrow limits if elements of the desired resistance value are to be obtained under high production requirements, and it is the control of these variables which constitute many of the difficulties mentioned above. Further difficulties arise in handling glass tubing of substantial length during the coating thereof because of its fragility.

The above-noted difficulties, in addition to others, result from the desirability, for practical purposes, of very small resistance units for radio instruments or the like, such a unit being described in detail in my copending application, Serial No. 29,433 filed July 2, 1935.

It is a further object of this invention to provide apparatus which successfully and practically obviates such difficulties.

Referring now to the drawings and to Figure 1 in particular, my apparatus comprises in general a rotating sleeve 10 journaled in self-aligning ball bearings 11 and 12 (Figure 2) mounted re-

spectively in split pillow blocks 13 and 14 (Figure 1). Blocks 13 and 14 are respectively secured to uprights 15 and 16 extending from a mounting base 17 which is preferably a solid metal casting to lend stability to the apparatus. Secured to one end 10a of shaft 10 is a multi-speed pulley 18 which may be driven by a belt 19 connected to any suitable source of power (not shown). An inking needle 20 is secured to and rotates with sleeve 10 and applies resistance material 24 in a spiral path to a glass capillary filament 21 which is fed at a constant rate through sleeve 10 from a glass pulling furnace 22; the resistance material is supplied to needle 20 from an ink container generally indicated at 23 by means of instrumentalities to be described hereinafter. Filament 21 may be moved by a pair of driving wheels 50 having a frictional surface, preferably rubber, in contact with the filament. After tube 21 is painted with resistance material by needle 20 it passes into and through a baking furnace 60 where the spiral path of resistance material is cured and hardened.

As noted above needle 20 applies resistance material 24, hereinafter referred to as ink, to a glass capillary filament or tube 21 in a spiral path (see Figure 7) and this ink is preferably a graphite or carbon suspension (both good conductors) in a binder as, for example, varnish. It is noted that the ink may be, in addition to a liquid resistance or conducting material, a liquid suspension of any solid or any desirable solution. Thus it appears that by controlling the feed rate of tube 21, the feed rate of ink 24, the consistency of ink 24, the rate of rotation of sleeve 10 and the width of the ink path, a resistance element of substantially any desired resistance value within reasonable limits may be made, all as will be more clearly pointed out hereinafter.

Referring now to Figure 2, it will be seen that sleeve 10 has a bore 10a' which connects preferably with a larger bore 10b at any convenient point as, for example, point 10c. A bushing 24 preferably of bearing bronze, is disposed in bore 10a' of sleeve 10, the bushing preferably having a close sliding fit with sleeve 10. One end 25a of a stationary hollow shaft 25 is disposed within and secured to bushing 24 preferably by a force fit. Shaft 25 extends through bores 10a' and 10b of sleeve 10 and its other end 25b is received in a bushing 26 mounted in an outboard support 27 which is secured to and extends upwardly from base 17 (Fig. 1). A set screw 28 (Fig. 2) is threaded into a hole 27a in support 27 to prevent rotation or axial displacement of bushing 26. Preferably a soft solder joint is provided between bushing 26 and shaft 25 to hold shaft 25 stationary in sleeve 10 during rotation of the sleeve.

Still referring to Fig. 2, glass tube 21 lies within bore 25c of shaft 25, bore 25c being sufficiently large to accommodate the tube. Bore 25c is preferably enlarged at portion 25d thereof so as to receive a guide bushing 29 which may be secured in the end of tube 25 by a force fit. Bushing 29 preferably has a bevel 29a at one end and a collar 29b at the other, the bevel permitting ready entrance of tube 21 and the collar limiting the insertion of the bushing into shaft 25. The inner diameter of bushing 29, while preferably smaller than that of bore 25c of shaft 25, is larger than the diameter of tube 21 thus to avoid impeding the travel of the tube from right to left as viewed in Fig. 2.

Although tube 21 leaves the glass pulling furnace 22 (Fig. 1) at a substantially constant diameter, small variations in diameter due to imperfections in the glass occasionally occur. Accordingly, it is preferable to provide a guide or support for the tube which will expand or contract as the tube diameter varies and thus prevent the tube from jamming in the guide during the course of its travel therethrough. To this end I have provided, as is best shown in Figs. 2 and 3, a split collet filament guide, generally indicated at 30 (Fig. 2) secured to collar 29b of bushing 29 and comprising resilient arms 31 (Fig. 3) on the ends of which are formed heads 31a. The inner surfaces of heads 31a (Fig. 3) form a bore 31b which, due to the resiliency of arms 31, varies in diameter of tube 21, expanding or contracting in accordance with the size of the tube, thus to maintain a firm but unrestraining grip on the tube as it passes therethrough.

After tube 21 leaves collet 30, it is engaged by needle 20 (see Figs. 1 and 8) which is preferably quite close to collet heads 31a (Fig. 1) to prevent the tube from whipping as needle 20 revolves thereabout. Needle 20 is provided with an orifice 20a (Fig. 2) located at the point where it engages tube 21 (Fig. 8). Accordingly, ink may pass through the needle and out onto tube 21 through orifice 20a. Needle 20 has a very small interior for reasons to be pointed out hereinafter.

Preferably needle 20, (Fig. 2) extends a substantial distance beyond orifice 20a and has a closed end. The needle curves inwardly on the other side of orifice 20a so that portion 20b thereof extends through a hole 32a in a retainer plate 32 and is received in and passes through a plug 33 tightly fitting a hole or reservoir 34 drilled in the end of sleeve 10. Plug 33 preferably has a head 33a which acts both as a gasket and a spacer between retainer plate 32 and the end of sleeve 10, the retainer plate being secured to the sleeve by screws 34 (Fig. 8) each of which is provided with a spacing washer 35. Retainer plate 32 is also provided with a bore 32b through which collet 30 and collar 29b of bushing 29 extend. It may now be seen that the retainer plate is secured in spaced relationship to the end of sleeve 10 and that needle 20 is also secured to sleeve 10. Thus rotation of the sleeve causes rotation of the needle about capillary tube 21. It is also manifest that as the needle revolves about the tube during the movement of the tube past the needle, a spiral path of ink is painted on the tube, the pitch of the spiral being determined by the ratio of the speed of linear travel of the tube and the speed of rotation of sleeve 10.

In order to provide needle 20 with a steady supply of ink at a constant feed rate and even consistency, I have provided ink container generally indicated at 23 (Figure 1) comprising a casing 23a in which is disposed a tank 36 supported on a platform 37 movable vertically upon manipulation of a screw 38 threaded through the bottom 23b of container 23. Screw 38 is preferably provided with a handle 38a which when turned one way or the other causes platform 37 and tank 36 to rise or fall. During operation of the apparatus the rim of tank 36 is forced firmly against top 23c of the container to seal the tank hermetically.

An air inlet pipe 39 (Figure 1) may be connected with any suitable apparatus for maintaining a substantially constant pressure within tank 36. For example, pipe 39 may connect container 23 to a compression tank 40 in which air

is maintained at a constant predetermined pressure above atmospheric by way of a hand bulb 41, a gauge 42 indicating the air pressure in compression tank 40. Ink tank 36 being directly connected with air tank 40, the pressure in the ink tank will then be at the desired value to force ink 24 upwardly through supply line 43 into ink pipe 44 through connection 45. Preferably the flow orifice (not shown) in connection 45 is variable by means of a screw 45a so as to control at will the ink pressure in pipe 44.

As is more clearly shown in Fig. 2, ink pipe 44 enters bushing 26 through a slot 26a milled therein, thence enters a slot 25e of substantial length milled in shaft 25 and finally terminates in a hole 24a drilled in bushing 24; pipe 44 is preferably secured to bushing 24. Pipe 44 through hole 24a communicates with an annular groove 46 extending about bore 10a of sleeve 10, and groove 46 communicates with reservoir 34 in the end of the sleeve. It is to be noted that groove 46 and reservoir 34 are very close to the axis of rotation of sleeve 10 and this for a purpose to be discussed hereinafter.

It may now be seen that a flow of ink at constant pressure may be supplied to orifice 20a in needle 20 from ink tank 36 (Fig. 1) by way of supply line 43, connection 45, ink pipe 44, hole 24a, groove 46, reservoir 34, and needle 20. Furthermore, ink pipe 44 is stationary while sleeve 10 is rotating. While the ink is in groove 46, reservoir 34 and needle 20, it rotates with these parts. However, it will be noted that the portion of the course of travel of the ink which is revolving is comparatively short.

Although bushing 24 (Figure 2) fits bore 10a' of sleeve 10 closely, sufficient clearance must be provided to prevent binding of these parts during the rotation of sleeve 10. There will consequently be a certain amount of ink seepage or overflow from groove 46 between the bushing and sleeve. Accordingly, I have provided another groove 47 (Figures 2 and 5) in sleeve 10 suitably spaced from point 10c (Figure 2) of the sleeve connected to ink outlets 48 (Figure 5) extending through sleeve 10. If desired, a suitable guard (not shown) may surround outlets 48 to prevent spattering of the ink. As the ink seeps into sleeve bores 10a' and 10b (Figure 2) it will flow along the walls of the bores, collect in groove 47 and be thrown out of the sleeve through outlets 48 by centrifugal force.

As mentioned above, suitable for this use are generally suspensions of graphitic or carbonaceous or other solid particles in a binder and such suspensions are fairly stable under normal conditions. However, these particles may be forced partially or completely out of suspension. Accordingly it is important that the centrifugal forces, to which the ink is subjected after it leaves stationary pipe 44 (Figure 1), be kept at a minimum. To keep these centrifugal forces at a minimum and reduce the effect thereof, ink reservoir 34 and groove 46 are not only quite small in dimensions as compared with rate of flow of ink therethrough but also are located as close as possible to the axis of rotation of sleeve 10. Portion 20b of needle 20 is similarly located with respect to the axis of sleeve 10 and the inside diameter of the needle is comparatively minute so that the ink remains therein a very short length of time. These factors of size and location coupled with the factors of constant feed and rapid use of ink reduce to insignificance the effects of centrifugal force exerted on the ink in spite of the relatively high speed of rotation of sleeve 10. Such centrifugal force as is exerted on the ink is not of sufficient intensity to displace the particles in suspension. Accordingly a constant feed of ink of unvarying predetermined consistency is assured to deposit a spiral track or path of a liquid having particles suspended therein.

Needle 20 may be replaced with one having a larger or smaller orifice and thus the width of spiral ink path 24 is readily controllable.

Preliminary to operation of the apparatus the resistance value of the resistance element to be made is determined and, in accordance with this determination, the proper speed on pulley 18 (Figure 1) is selected, the proper feed rate of tube 21 is effected, a needle 20 having an orifice 20a of right size is installed, and the air pressure in tank 40 is built up to the desired value. After sleeve 10 has attained its operating speed and glass tube 21 (which, if desired, may be a glass rod) attains its feed rate, the orifice in connection 45 is opened to the correct size by screw 45a to permit the flow of ink to needle 20 through tube 21 as described more fully above. Accordingly ink having the desired resistance value is deposited in the form of a spiral path 24 on tube 10.

Accordingly it will be seen that I have designed apparatus which allows for the passage of a continuous glass rod or tube therethrough while evenly applying to the surface thereof a continuous spiral path of ink or the like. This inking apparatus operates without interfering with the travel of the glass tube therethrough and, furthermore, after it has been set in operation it needs little care or attention in order to continue for appreciable periods of time. Thus it will be seen that I have provided a thoroughly practical and efficient apparatus in which the several objects hereinabove mentioned as well as many others are successfully accomplished.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In apparatus of the character described, in combination, means for imparting longitudinal motion to an elongated dielectric body, and means including a part in point contact with said body adapted to rotate about said body and paint spaced spiral coils thereon.

2. In apparatus of the character described, in combination, a rotatable member having a hole formed in the axis thereof and having an ink supply channel formed thereon, means for drawing a continuous body of dielectric material through said hole, an ink applicator connected to said ink supply channel in said rotatable member at a point spaced from the axis thereof and extending inwardly to engage said body, said applicator having an orifice at its point of engagement with said body, and means for supplying a liquid suspension of solid particles to said applicator.

3. In apparatus of the character described, in combination, a rotatable member having a hole formed about the axis thereof, means including a plurality of spring members extending through

said hole independent of said rotatable member, means adapted to draw an elongated dielectric element through said hole and between said spring members, said spring members being shaped to press inwardly against said element to hold it firmly during its passage, and an ink applicator secured to said rotatable member and shaped to engage said dielectric element.

4. In apparatus of the character described, in combination, a rotatable member having a hole formed about the axis thereof, means including a plurality of spring members extending through said hole independent of said rotatable member, means adapted to draw an elongated dielectric element through said hole and between said spring members, said spring members being shaped to press inwardly against said element to hold it firmly during its passage, and a needle extending through and secured to said rotatable member at a point spaced from the axis thereof thence extending inwardly to engage said dielectric element, said needle having an opening at its point of engagement with said element.

5. The herein described art which consists in moving an elongated dielectric body axially only at a constant rate past an applicator rotating around said body at a constant speed, and forcing ink at a constant pressure through said applicator to apply said ink to said body in spaced spiral coils.

6. In apparatus of the character described, in combination, a stationary cylindrical member, a cylindrical element fitting about said member and adapted to rotate thereabout, means adapted to draw an elongated dielectric body through said member, applicating means secured to said element and shaped to engage said dielectric body as it emerges from the end of said member, the inner surface of said rotating element having an annular groove formed therein, a reservoir formed in said rotating element in communication with said groove and said applicating means, and means for supplying a liquid suspension of solid particles to said groove.

7. In apparatus of the character described, in combination, an elongated stationary cylindrical member, a sleeve fitting over one end portion of said member, a cylindrical element fitting about said sleeve and adapted to rotate with respect to said cylindrical member, said cylindrical element having an annular groove formed on the inner surface thereof adjacent said sleeve, said sleeve having a hole formed therein in communication with said groove, means forming a reservoir in said element, a liquid applicator secured to said element and in communication with said reservoir, said applicator being shaped to engage an elongated body passing through said cylindrical member, and means for supplying a liquid suspension of solid particles to said groove through said hole in said sleeve.

8. In apparatus of the character described, in combination, means for imparting longitudinal motion to an elongated body, means adapted to rotate about said body and paint a spiral path of liquid thereon, means forming a reservoir in said last-mentioned means, a supply of conducting material comprising a liquid having solid particles suspended therein, means connecting said supply to said reservoir, the size of said reservoir with respect to the speed of passage of said liquid therethrough being such that said liquid does not remain therein a sufficient length of time for any appreciable displacement of said particles due to the centrifugal forces created by said rotating means.

9. In apparatus of the character described, in combination, a rotating member, means adapted to draw an elongated body through said member along the axis thereof, and a needle secured to said member at a point spaced from the axis thereof and extending toward said axis to engage said body, said needle having an opening therein at its point of engagement with said body, said point of engagement being close to said member to prevent whipping of said body near the point at which it is engaged by said needle.

10. In apparatus of the character described, in combination, means for imparting longitudinal motion to an elongated dielectric body, a part rotatably associated with said body, said part having a reservoir formed therein adapted to receive a liquid suspension of solid materials, and an element connected to said rotating part and in communication with said reservoir adapted to apply said liquid suspension on said body as said body moves, said reservoir being closely adjacent to the rotational axis of said part to prevent the particles of said suspension being forced out of suspension by the centrifugal force set up during the rotation of said part.

11. In apparatus of the character described, in combination, means continuously forming a dielectric body, means imparting uninterrupted axial movement to said dielectric body during its formation, means for applying a helical stripe of a liquid suspension of solid particles on said body during its movement, and means for hardening said suspension during the movement of said dielectric body.

12. In apparatus of the character described, in combination, means for imparting uninterrupted longitudinal movement only to an elongated dielectric body, means for applying a liquid suspension of solid particles in a helix on said body as it is moving, and means for supplying said liquid suspension to said second-mentioned means at a predetermined, constant pressure above atmospheric.

13. The herein described art which consists in continuously forming a tubular dielectric body, moving said body axially, applying ink at a predetermined constant rate, consistency and depth on said dielectric body in a helical path of constant width and pitch, and drying said helix during the movement of said body.

14. In apparatus of the character described, in combination, means steadily supplying a continuous dielectric body, means for imparting longitudinal motion only to said body, and means rotating around said body for continuously applying resistance material on said body in a helix as it is moving.

15. The herein described art which consists in continuously forming a dielectric member, moving said member axially only as it is formed, and applying ink at a constant rate, consistency and depth on said member in spaced spiral coils of constant width and pitch as the member moves.

16. The herein described art which consists in moving a continuous dielectric body axially only, supporting said body as it moves, and applying conductive material in a helix on said body at a point immediately adjacent the point at which said body is supported.

17. The herein described art which consists in uninterruptedly moving a dielectric body axially past an applicator in engagement with said body,

rotating said applicator about said axially moving body, and supplying said applicator with ink at a predetermined constant pressure above atmospheric to paint a helical path of constant width and pitch on said body.

18. In apparatus of the character described, in combination, means for imparting longitudinal motion to an elongated dielectric body, means for supporting said body as it moves, and means including a part in contact with said body adapted to rotate about said body and paint spaced spiral coils thereon, said part contacting said body at a point adjacent said supporting means.

19. In apparatus of the character described, in combination, means for imparting longitudinal motion to an elongated dielectric body, means including a part in point contact with said body adapted to rotate about said body and paint spaced spiral coils thereon, and means for supplying ink to said rotating means, said rotating means including an ink reservoir closely adjacent to the rotational axis of said rotating means to prevent particles of said ink from being forced out of suspension by the centrifugal force occasioned by rotation of said rotating means.

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