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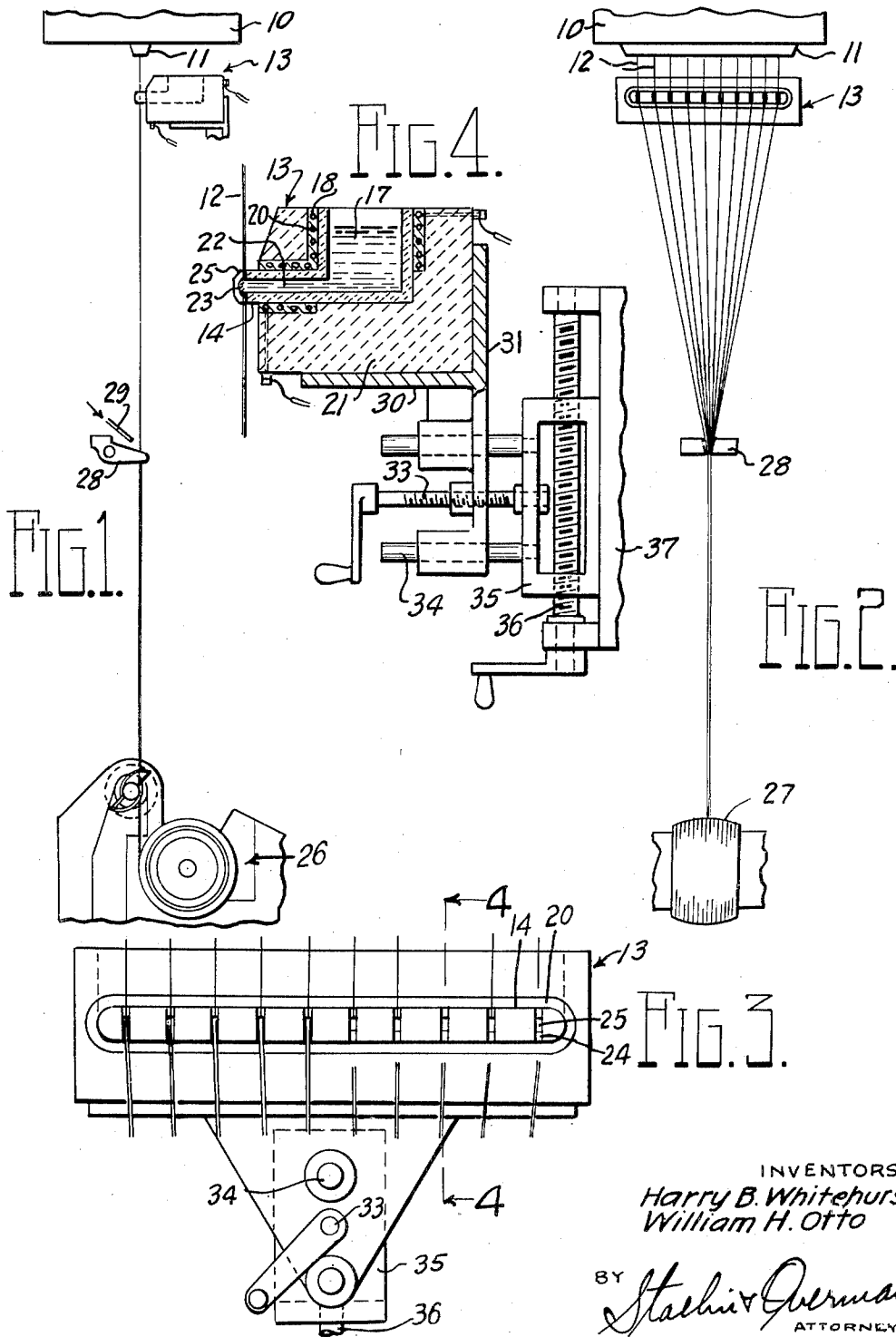
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2,772,518

METHOD OF COATING GLASS FILAMENTS WITH METAL

Filed Nov. 10, 1952

2 Sheets-Sheet 1



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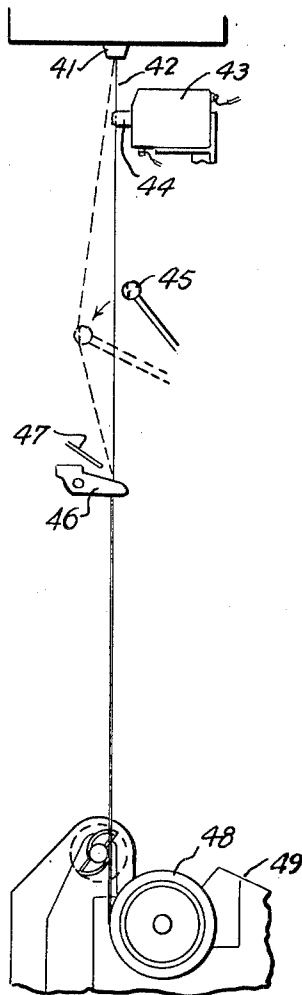


FIG. 5.

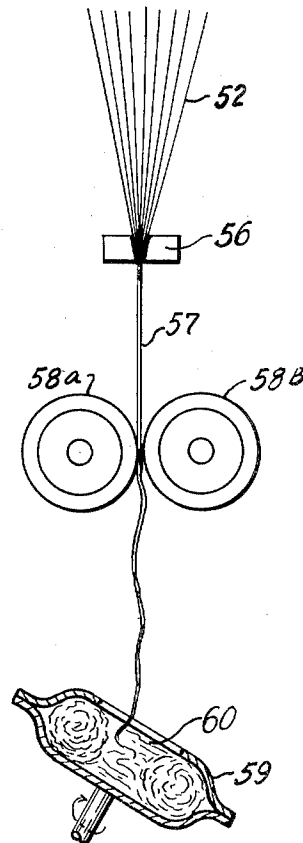


FIG. 6.

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METHOD OF COATING GLASS FILAMENTS WITH METAL

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10 Claims. (Cl. 49—77)

This invention relates to metal coating of filaments or fibers, and more particularly to methods and means for applying metal coatings to continuous glass filaments.

It is well known that glass filaments have extremely high strength characteristics as well as highly desirable flexing characteristics which make them of particular advantage for many uses and applications as reinforcing agents. Such fibers, however, have a weakness to surface abrasion which reduces their ability to withstand wear to the extent that it eliminates the possibility of their application for many uses in which the strength and flexibility of the filaments would be highly desirable. The coating of glass filaments with metals, such as copper, zinc, aluminum, silver, or alloys thereof, it has been found, is highly successful in providing protection against abrasion, but difficulty has been experienced in applying the metal to such filaments at a high rate of speed and with uniformity so as to make of economically feasible to produce them in mass production.

It is therefore a principal object of the present invention to provide a new method and means for applying metal to glass filaments which permits economical production of coated filaments at a high rate of speed and at the same time providing coating uniformity which assures positive securement of the metal to the filaments and the desired degree of coating of the individual filaments by the metal along their length.

Another object of the present invention is to provide a novel method and means for applying metal on glass filaments without disrupting or deleteriously affecting the desired physical characteristics of the filaments.

Still another object of the present invention is to provide an efficient and economical means for applying metal to glass filaments which is adapted to functional association with conventional filament-forming means to provide a continuous and direct metal-coated fiber-forming process.

Still another object of the invention is to provide means for applying metal to glass filaments adapted to continuous processes and requiring little care and attention to effect the desired degree of coating.

A further object of the invention is to provide means for applying metal to glass filaments on a continuous basis controllable to provide a predetermined linear and peripheral uniform coating.

A feature of the invention is that it permits the application of metal coatings to glass fibers at a very rapid rate.

Another feature lies in the fact that this invention is readily adapted to permitting application of metal coatings to glass filaments during the process of forming them.

The application of metal to glass filaments in accordance with the above objects and features is accomplished in the present instance by pulling or drawing the filaments through an accumulation of molten metal such as

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a globule or bead of such metal. In particular, the apparatus is arranged so as to permit drawing of filaments through such metal in vertical paths which facilitates adapting such coating operations to conventional filament-forming means.

Other objects and features which we believe to be characteristic of our invention are set forth with particularity in the appended claims. Our invention, however, both in organization and manner of construction together with further objects and advantages thereof may be best understood by reference to the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a somewhat schematic side elevational view of apparatus of the present invention for forming metal-coated glass filaments;

Figure 2 is a partially broken away front elevational view of the apparatus shown in Figure 1;

Figure 3 is a front elevational view in part of the applicator of Figures 1 and 2;

Figure 4 is a side elevational view in cross-section as taken on the line 4—4 of Figure 3;

Figure 5 is a schematic side elevational view of apparatus incorporating modifications over the apparatus of Figures 1 and 2 for adjustably associating the applicator and filaments with each other; and

Figure 6 is a front elevational view in part of apparatus similar to that of Figures 1 and 2 showing another manner in which collected filaments may be pulled to effect rapid production of coated filaments.

Turning to the drawings in detail, Figures 1 and 2 show a suitable glass-melting tank 10 having a multiple-orifice feeder or bushing 11 from which a plurality of glass filaments 12 are drawn downward to a metal-coating portion 14 of the metal-applicating unit 13. The feeder orifices are preferably arranged in one or two rows so that the streams of glass drawn from the feeder are all substantially in the same plane.

As shown in Figures 3 and 4, the applicator 13 has a container portion which is lined with a high-temperature resistant material 19, such as graphite, which will withstand the temperatures of molten metal 17 held therein without appreciable deterioration. The lining is surrounded by a heating means, such as an electrical resistance heater or an induction coil, the conductors 18 of which are embedded within an electrical-insulation layer 20, such as refractory cement or silica fibers. The entire lining and heater element are encased in a refractory material 21 which promotes the retention of heat within the container portion to maintain the metal 17 in molten condition. The heater unit is provided with external terminals for connection to a power source and may be of a type which will melt down the metal introduced into the container portion or may be of a type which merely provides heat to retain the metal in its molten condition after being melted down and introduced in molten form from an outside source.

A channel 22 is provided within the container portion providing a path between the main body of the molten metal 17 and the face of the metal-coating portion 14 for supply of molten metal to the coating face. The metal flows from orifices 25 at the face to form separate beads or globules of metal 23 for individually coating each of the filaments 12. To assure that the filaments 12 are properly directed through their respective globules 23, each of the orifices 25 are arranged to be disposed at the base of a groove 24 in which a globule 23 is at least partially disposed upon emission from its orifice 25. The sides of each groove 24 guide the associated filament through the globule and also act in part to suspend the globule in proper position for full envelop-

ment of the filament. The width of the groove may also be made of such dimensions as to wipe excesses of metal from the coated filament.

As shown in the drawings, the grooves 24 are vertically aligned in registry with the filaments 12. If desired, however, each groove may be arranged in alignment with the straight line path between the orifice of its associated filament and the gathering member 28. In most instances, however, the gathering of filaments extends over such an appreciable distance after leaving the grooves and is a gathering together from so relatively small a dimensional distribution of filaments that the grooves when so aligned with the filament paths, for all practical purposes, also correspond to the vertical.

Each of the orifices 25 is made sufficiently small that the globule of metal 23 emitted therefrom has a surface tension developed therein which provides sufficient retaining force to prevent free flow of the molten metal from the container portion and to suspend the globule in the space of its groove without external support. In this respect, the surface tension in the globule 23 permits the applicator to be made operable substantially independently of the head of the molten metal 17 over the range operating heads determined by its size. Thus, one of the variables involved in filament-coating operations is eliminated to reduce the care and attention required to coat filaments on a mass production basis. The fact that the globules 23, because of their surface tension, can be suspended without external support permits unobstructed passage of filaments through them in vertical paths. This feature is particularly of advantage in that it lends itself to locating the globules anywhere along the length of the filaments upon emission from the feeder.

As an example of relative dimensions of the metal-feeding parts of the applicator portion 14, the channel 22 which supplies the metal for the globules 23, has a vertical dimension in the order of $\frac{3}{16}$ inch while the orifices 25 have dimensions approximating .010" diameter. The grooves 24 have a width dimension also about .010" for filaments in the range of .0005" in diameter or smaller.

The force of drawing the filaments 12 from the feeder 11 and through their respective globules of metal 23 is provided by a drive motor 26 which also draws the filaments through a filament-gathering member 28 and winds the filaments in strand form on a collet-supported forming tube 27. The gathering member 28 is grooved to direct sizing fluid introduced through a tube 29 from an outside source to the metal-coated filaments. The size may be any of a number of size materials such as those set out in U. S. Patent No. 2,234,986, issued March 18, 1941, or a material such as molybdenum disulfide which provides metal surfaces with a film of low frictional character when subjected to high pressures. It should be noted that sizing materials on strands serve to provide an adhering property between filaments to promote their integral association in strand form and also act to lubricate the filaments and promote their being used without detrimental wearing effect on metal coatings which have occasion to rub against each other.

It has been found that passing a glass filament through a given metal applies a coating thereto of thickness depending to a great extent upon the temperature of the metal. In general, the higher the temperature of the given metal, the lower is its surface tension and the greater its ability to flow about the filament it is to coat. The lower the viscosity and surface tension of the metal, however, the less is its natural tendency to build up thickly on the filament passing therethrough. Thus, it can be generally stated that the lower temperatures of application of metal effect greater coating thicknesses. It has also been found that an excess of metal at any given temperature causes the formation of beads on the coating surface, which for most applications would be

undesirable. In view of these operating variables, it becomes apparent that it is highly desirable that the applicator be adjustably movable in a vertical direction along the lengths of the filaments where their temperatures gradually decrease from the point of emission from the feeder, and a temperature can be selected for most effective coating with metal to the thickness desired.

To facilitate alignment of the applicator 13 with the filaments 12, the entire applicator is mounted on a platform 30 pivotally supported on a horizontally movable member 31. The platform 30 is pivoted on a pin 32 which is axially aligned with the center of the row of orifices 25, thereby permitting ready leveling of the orifices with the horizontal.

To permit movement of the applicator for engagement with the filaments and removal therefrom, the member 31 is made adjustably movable in a horizontal direction by adapting an adjusting screw 33 and a pair of slidable guide rods 34 thereto. The screw and guide rods are associated with a vertically adjustable support member 35. By reason of the applicator portion 14 projecting outward from the front of its casing, the entire applicator can be readily moved vertically into close proximity with the feeder 11 with an accurate degree of adjustment by means of a horizontal adjusting screw 36 associated with a main support member 37 which is adapted to being mounted in a position generally close to that desired. Thus, by proper proportioning of the casing, the applicator can be adjustably positioned even up to a point immediately under the feeder where filaments are at their highest temperature and lowest viscosity.

Adjustment of the applicator with respect to the filaments may also be accomplished by moving the filaments rather than the applicator. This is illustrated in Figure 5 wherein an adjusting bar 45 is used to move the filaments. In this illustration, filaments 42 are drawn from a bushing or feeder 41 over a coating portion 44 of the applicator 43 and through a gathering member 46 by a forming tube 48 driven by a winder 49. Sizing material is introduced to the coated filaments in a conventional manner such as from a tube 47 directed to the gathering member 46.

When it is desired to move the filaments from their respective applicator grooves, they are merely pushed away therefrom by moving the bar 45 into contact therewith and exerting a force thereon until the filaments become disengaged from the grooves and are moved to the position shown in dotted lines. If desired, the bar 45 may also be provided with spaced grooves for the filaments, thus facilitating alignment of the filaments outside of the applicator grooves and also facilitating ease of reinsertion of the filaments in the applicator grooves in which they are to be coated.

Figure 6 illustrates an alternate manner in which filaments gathered in strand form may be drawn and collected. A pair of pulling wheels 53a and 53b of the type disclosed and described in Drummond et al. application, Ser. No. 300,748, filed on July 24, 1952, may be used in place of the driven forming tube shown in the foregoing figures. The wheel-type pullers have the advantage that they can pull strands at the extremely high rates of speed to which the present invention is adapted. As shown in Figure 6 a multiplicity of coated filaments 52 are drawn through a gathering member 56 where sizing is applied and strand is formed. The pulling force is provided by the pulling wheels 53a and 53b which are driven by a suitable common drive through gear means or a pair of individual drives such as motors synchronized by connection with each other through the pulling wheels themselves.

The strand moving at a high rate of speed is collected into a bundle 60 in the container 59 which has an opening conveniently disposed to receive the strand as it is emitted from the pulling wheels. The container 59 is

made rotatable to facilitate forming the bundle 60 into a doughnut shape under the forces of rotation.

Although the apparatus in each of the illustrations herein shown and described, gather and collect coated filaments in strand form, it will be readily recognized that the nature of the invention is such that the filaments may also be collected individually for applications where conditions dictate the need for single metal-coated filaments.

While we have shown certain particular forms of our invention, it will be understood that we do not wish to be limited thereto since many modifications may be made within the concepts of the invention, and we therefore contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of our invention.

We claim:

1. The method of producing continuous metal-coated glass fibers which comprises attenuating continuous glass fibers from molten streams of glass, heating metal to be coated thereon to a temperature above its melting point but below a temperature damaging to the glass fibers, feeding the molten metal to globules thereof suspended in horizontal projecting relation from a supply source, maintaining said globule in size equilibrium and drawing the glass fibers while hot due to their residual heat of formation through the molten metal globules to apply a coat of metal to the fibers.

2. The method of coating a glass filament with metal comprising suspending a globule of molten metal in a given position under its own surface tension, passing a continuous filament through said globule at a temperature compatible to receive a coating of said metal, and supplying molten metal for said globule to maintain it in size equilibrium by replenishing molten metal removed from said globule in coating said filament.

3. The method of coating glass filaments with metal comprising supplying molten metal to an orifice at a temperature such that a quantity of the metal is suspended therefrom and is prevented from freely flowing due to its own surface tension, guiding a continuous glass filament through said suspended metal at a temperature compatible to cause said filament to receive a coating thereof, and replenishing the molten metal removed from said suspended quantity of metal to maintain it in equilibrium for continuous coating of filaments drawn therethrough.

4. The method of coating continuous glass filaments with metal comprising forming globules of molten metal suspended and blocked from freely flowing by the surface tension of the metal at orifices connected to a common supply of said metal, guiding continuous glass filaments in vertical paths past each of said orifices respectively, feeding a sufficient amount of said metal from the common supply through said orifices to maintain said globules sufficiently large while suspended by their own surface tension about said filaments to apply a metal coating thereto.

5. The method of coating a continuous glass filament with metal comprising supporting a molten globule of metal in a given position under its own surface tension, passing a continuous filament through said globule in a generally vertical path through said globule to receive a

coating of said metal, and replenishing the metal removed from said globule to maintain it in equilibrium for continuous coating of filaments.

6. The method of coating glass filaments with metal comprising moving a continuous filament axially through a generally vertical path between guide surfaces, supplying molten metal to a position in the path of movement of said filament between said surfaces and suspending said metal by its own surface tension between said surfaces, passing said fiber through said suspended metal for a coating of said metal, and replenishing the molten metal removed from said suspended metal to maintain it in equilibrium for continuous coating of filaments drawn therethrough.

7. The method of coating glass filaments with metal comprising suspending a quantity of molten metal by its own surface tension from a source of the molten metal, passing a continuous filament in a generally vertical path through said suspended metal to receive a coating of said metal, and replenishing the molten metal removed from said suspended metal to maintain it in equilibrium for continuous coating of filaments drawn therethrough.

8. The method of producing a metal-coated glass fiber which comprises flowing a stream of glass from a source of molten glass, attenuating a continuous glass fiber from said stream, suspending a globule of molten metal in the path of said fiber by its own surface tension, moving said fiber through said suspended globule for a coating thereof, and replenishing the molten metal removed from said globule to maintain it in size equilibrium for continuous coating of said fiber.

9. The method of producing a strand of metal-coated glass fibers which comprises flowing streams of glass from a source of molten glass, attenuating continuous glass fibers from said streams, forming globules of molten metal at orifices connected to a common supply of said metal, said globules of metal being formed to such size that the metal of each is suspended and blocked from freely flowing by its own surface tension at their respective orifices, guiding a separate glass fiber in a generally vertical path through each of said globules for a coating of said metal, gathering said fibers into a strand after being coated, and replenishing the molten metal removed from said globules to maintain them in size equilibrium for continuous coating of said fibers.

10. A method as in claim 8 wherein a plurality of glass fibers are formed and a plurality of globules of molten metal are formed, and wherein each of said fibers are passed through an individual globule to provide a coating thereon, and then gathering the fibers to form a strand.

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