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METAL APPLICATORS FOR GLASS FILAMENTS

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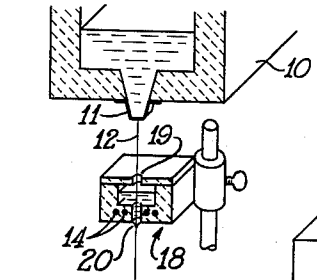


Fig. 1

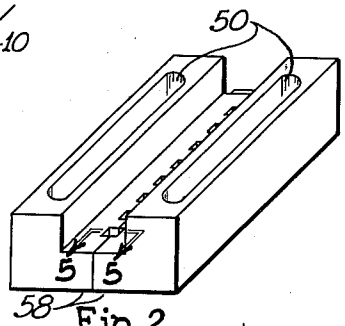


Fig. 2

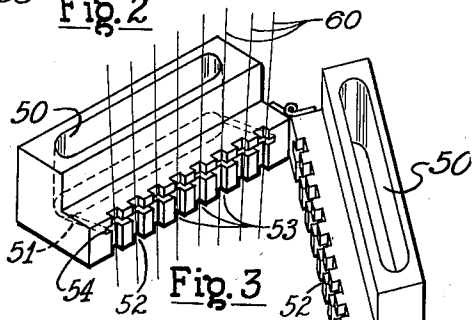


Fig. 3

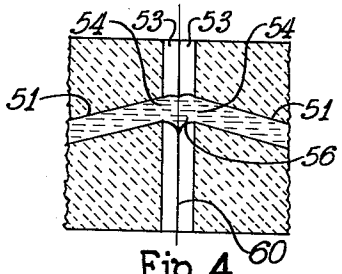


Fig. 4

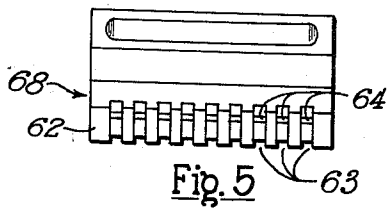


Fig. 5

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METAL APPLICATORS FOR GLASS FILAMENTS

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2 Claims. (Cl. 18—8)

This invention relates to apparatus for the production of metal-coated glass fibers and more particularly to novel applicators for applying metal coatings to glass fibers in high speed fiber-forming operations.

The coating of glass fibers with metal such as zinc, aluminum, tin, lead and alloys of such metals such as zinc aluminum alloys, has been found highly advantageous in offering protection to the wear sensitive surfaces of the glass fibers and in facilitating their adaptability to a working use for strength purposes such as in strands, yarns, cords, ropes, fabrics and other textile products as well as products such as fibrous mat, wool, and structural boards. It has also been found in the practical aspects of manufacturing metal-coated glass fibers that economy of production is greatly enhanced when the metal is applied to the fibers directly in the fiber-forming process, thereby eliminating the need for extra handling of fibers for the coating operation. A method and apparatus adapted to application of metal to glass fibers in this manner has been described in a copending application, Serial Number 322,598, filed on November 26, 1952, entitled "Metal Applicators for Glass Filaments."

In each of the various embodiments described in the above application, the accumulation of molten metal through which the fibers are drawn is suspended under its own surface tension upon emission from an orifice of a supply source located to one side of the filaments. As higher and higher speeds are resorted to in the production of metal-coated fibers in this manner, however, vibration of the fibers or filaments by reason of winding operations or extraneous motions and forces often creates an instability at the point of application of molten metal to the fibers, causing non-uniform distribution of metal in the coating and resulting in inconsistencies in the desirable characteristics of fibers so coated.

Accordingly, it is an object of the present invention to provide a method and means for continuously applying metal to glass fibers during fiber-formation which permit stable high speed production with a minimization of non-uniformities in the final product and discontinuities in fiber-forming operations.

Another object of the invention is to provide an improved method and means for applying metal to glass fibers without deleteriously affecting the desired physical properties obtainable in such fibers.

Still another object of the present invention is to provide an improved method of applying metal to glass filaments during fiber-forming operations with the assurance that a thoroughness of coating will be provided with a minimum of manual control or supervision of operations.

A further object of the invention is to provide a method and means for producing metal-coated glass fibers adaptable to existing glass fiber-forming operations and equipment with a wide sensitivity tolerance to minimize the need for regulation of coating operations.

In the various embodiments herein disclosed, the application of metal to fibers is geared to application of metal at extremely high speeds corresponding to rates at which fibers may be formed in conventional processes such as when streams of molten glass supplied from feeder orifices in a source of molten glass are attenuated into fibers of small diameter.

According to the principles of this invention, the glass fibers or filaments are coated with molten metal by engulfing each individual fiber with molten metal forming globules or accumulations through which the fibers are drawn.

The various embodiments, among other novel aspects, are characterized by the manner in which the molten metal supplied to the filaments is supported by its own surface tension coacting with filament-surrounding support structure of the applicator units without need for immediate under support. The invention is further characterized by the fact that the support structure coacts with the fibers in their motion through the molten metal to promote stabilization of the coating operation and resulting uniformity of coatings.

A feature of the invention lies in the fact that metal may be applied to fibers in conventional fiber-forming processes without need for alteration of the forming apparatus and without changing the characteristic operation of the forming process.

Still another feature of the invention lies in the fact that the applicators disclosed feed molten metal in a manner which assures a thorough envelopment of the fibers and is so associated with the metal-supply structure that the accumulation through which the fibers are drawn, remain stably disposed without need for under support which would otherwise entail alteration in the method of forming glass fibers.

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 diagrammatic perspective view, broken away in part to show interior construction, of apparatus for producing a single continuous metal-coated glass fiber in accordance with the present invention;

Figure 2 is a perspective view of a two part metal-coating unit comprising another embodiment of the present invention;

Figure 3 is another perspective view of the unit shown in Figure 2 with the two halves in an open position;

Figure 4 is a partial cross sectional view taken on line 5, 5 of the unit of Figure 2 showing the disposition of a glob of molten metal within the groove as a glass fiber is drawn therethrough for a coating;

Figure 5 is an inclined front view of a grooved-face applicator for coating glass fibers with molten metal, each groove having an individual outlet for the molten metal.

Turning to the drawings in detail:

Figure 1 shows a general layout of fiber-forming and metal-coating apparatus including a suitable glass-melting tank 10 having an associated feeder 11 with an outlet in its bottom from which flows a stream 12 of molten glass. As this stream flows from the outlet it is drawn out into a continuous filament or fiber 13 by suitable means such as a rotating drum or collet-supported collection tube 16 which winds the fiber while exerting a pulling force thereon to draw out the stream from which it is attenuated. A size-applicator shoe 15 which also acts as a guide member for the fiber in its movement to the collecting means

is provided in a position intermediate the source of the stream of molten glass and the collection tube 16. Sizing fluid is fed to the shoe by an associated supply tube connected to a reservoir not shown. A traverse device such as a spiral-wire traverse 17 associated with the winder is arranged to effect a traversal of the fiber back and forth over the collection tube 16 according to the form of package desired.

Metal is applied to the fiber 13 at a point intermediate the size-applicator shoe 15 and the source 11 of the glass stream. The metal is contained in a molten state within a container or tank 18 having an opening 19 above the molten metal and an outlet orifice 20 aligned therewith in its bottom to permit the fiber to be drawn in a straight line through the molten metal. The tank 18 is lined with suitable refractory material of high-temperature character to withstand the heat of the molten metal to be contained therein. The opening 19 is made sufficiently large that metal may be introduced to the tank 18 therethrough, and is also made sufficiently large that the fiber may be readily threaded therethrough without making the maneuver too difficult. Suitable heating means such as electrical heater elements 14 are embedded within the tank walls to permit melting of the metal and provision of heat for maintaining it at desired temperature. The outlet orifice 20 is formed in suitable heat resistant material such as graphite or a suitable refractory and is of such size that the fiber 13 may be readily drawn therethrough without restriction. The orifice, however, is made sufficiently small that when a fiber is not passing therethrough, the molten metal will not freely flow therefrom by reason of establishment of a resistance to flow in the surface of the metal due to its surface tension. The surface tension of the metal, it has been found, is appreciable in magnitude and can be advantageously utilized in its own support without need for immediate under support when it is bridged across a small gap. In the present instance, the small gap is embodied in the orifice 20 fully surrounding the fiber 13. When a fiber is drawn through the orifice as illustrated, metal tends to flow therewith by reason of the motion and tendency of molten metal to cling to the surface of the glass fiber. The metal coating on the fiber, on exposure to the atmosphere after leaving the orifice 20, is cooled and solidifies to form an integral part of the fiber.

Since during the winding operation, the fiber 13 is constantly oscillated back and forth to form a package, and since the traverse mechanism 17 cyclically exerts directional forces thereon, the fiber has vibratory tendencies which are especially accentuated at high speeds in the order of 10,000 to 15,000 feet or more per minute at which the fiber may be drawn through the molten metal. The size applicator or guide member 15 plays a part in dampening some of the vibratory effects, but as higher and higher speeds of formation of the metal-coated fiber are resorted to, it has been found desirable to incorporate additional motion stabilizing means directly at the point of application of metal to the fiber. Thus, in the present instance, the orifice 20 which fully surrounds the fiber 13, acts in this regard, both to stabilize motion of the fiber at the point of application and to support the metal to promote the uniformity of coating desired.

It should be noted that the level at which the metal applicator or container 18 is located may be determined by the temperature of the fiber 13 at different distances from the outlet in feeder 11. The glass on exposure to the atmosphere gradually diminishes in temperature from approximately 2300° F. until it reaches atmospheric temperature a considerable distance from the outlet 20. The position of the container 18 can be modified for the different metals to be applied, the level being selected which offers the predeterminable properties desired in the metal-coated fiber. To facilitate selection of the point of application of metal, the container 18 is mounted on a rod and arranged for vertical positioning by means of an adjusting screw.

In order to start the metal-coating operation, all that is required to be done is that a longitudinal member, such as a wire member made of heat-resistant material such as carbon, be inserted up through the orifice 20, through the molten metal in the container 18 to a point where the glass fiber may be engaged and pulled down through the metal and the orifice. The end of the fiber is then started on the winding apparatus to initiate continuous coating of the fiber as it is being formed.

Figure 2 shows another embodiment of the present invention in which a multiplicity of metal-coated glass fibers may be produced simultaneously to permit direct production of a strand of metal coated fibers. The fibers 33 are drawn from streams 32 supplied from outlets in a platinum feeder 31 associated with source of molten glass such as melting tank 30. The fibers are drawn over a roll-type size applicator 35 at which sizing material such as petroleum oil, vegetable oil, gelatine, and starch or the like may be applied before the fibers are gathered into strand form at a freely rotatable spinner-type gathering member 41 made of material such as graphite or Teflon. A strand 42 is formed of gathered glass fibers 33 which is wound on a collection tube 36 traversed by a traversing mechanism such as a spiral-wire traverse 37 to produce a package of desired form.

Metal is applied to the glass fibers 33 by a metal applicator unit 38 located intermediate the feeder 31 and the size-applicating roll 35 and is positioned at a level determined by the type of metal to be applied to the glass and a level at which the glass fibers are of a temperature which will produce the desired properties in the metal-coated fibers. The applicator unit 38 is in general a container for molten metal and is made of suitable high-temperature materials to withstand the heat of the metal to be melted and maintained in molten condition therein by the electrical heater elements 34 associated therewith.

Figures 2, 3 and 4 illustrate another embodiment of the present invention which is more flexibly adaptable to continuous production operations by reason of the ease with which the glass filaments may be first aligned in proper position to start coating operations.

The applicator unit of Figures 2, 3 and 4 includes two metal-containing portions 58, identical in construction and arranged for abutting mated relationship at their metal-coating faces 52. Each of the container portions is provided with a cavity 50 wherein metal may be melted and maintained in molten condition by suitable associated heating means. The cavity 50 is connected to the face 52 by an inclined channel 51 which assumes the shape of a slot at the face 52. The channel 51 is inclined upwardly to prevent extraneous particles of matter in the cavity 50 from readily passing up through the channel 51 toward the slot 54 where they might clog the channel and prevent application of metal to the fibers. The applicator face is made of, or coated with, a material such as graphite which offers low resistance to fiber passage thereover.

The inclination of the channel 51 is also such that a level of metal may be maintained in the cavity 50 of substantial depth. The head of metal in the cavity 50 may be somewhat higher than the slot opening 53 in the face 52 by reason of the surface tension of the metal when accumulated at the slot. The slot in this respect is made sufficiently narrow that the accumulation of metal thereat is small enough that the surface tension is appreciable in comparison to its weight, thereby offering the restraint to flow desired. The surface tension causes the metal accumulated at an open slot to assume the form of a longitudinal glob or strip of metal overhanging the gaps in the face produced by the grooves immediately under the slot 54. Grooves 53 are provided in the face 52 and extend perpendicularly to the slot and

completely across the face to accommodate glass fibers for passage over the slot. With such a face arrangement, fibers may be drawn over the slot through the grooves to apply a coating of metal thereto, but as already mentioned, as the fiber speeds are increased to higher and higher values, it becomes increasingly difficult to maintain a stabilized metal-applicating operation.

By combining the two separate container portions into a single applicator by abutting their faces as shown in Figure 2, individual coating channels are provided for each of the fibers. The metal from the two container portions are fed to the abutting faces through their respective slots to form globules of metal through which the fibers may be drawn in the manner shown in Figure 4. The grooves in the face are of such depth and width that when mated with a corresponding groove in the opposite container portion, the resulting channel is sufficiently large to permit free passage of a fiber therethrough, but yet is small enough that the bead or glob **56** of metal will be supported by the surface tension of the metal between the two lower edges of the slots **54**. Thus, the glob of metal **56** is supported from more than one side of the fiber to provide greater stability than would otherwise be possible in a coating process utilizing but one side support of the globule.

The unit can be mounted on a vertically adjustable platform to permit selection of the point of application of metal to the fibers. To start the coating operation, the two container portions **58** are opened as shown in Figure 3 and the fibers **60** are aligned in the grooves of one, whereupon the two halves are closed as in Figure 2 and the fibers are drawn through the channels formed by the grooves and through the molten globules of metal formed therein as shown in Figure 4. If desired, two different types of metal may be fed to the fibers simultaneously from the two container portions **58** to be alloyed in the accumulation **56** as coating of the fiber occurs.

Figure 5 shows a container portion **68** of an applicator unit of this invention similar to that of the previous embodiment except that each of the fiber grooves **63** in the face **62** is fed by a separate metal-feeding channel ending in an outlet **64** within the groove. The grooves **63** when mated with corresponding grooves in the face of another container portion **68**, not shown, form fiber channels for holding metal as in the previous embodiment and through which fibers may be freely drawn for coatings of metal.

Metal coated glass in the massive form or in the form of fibers, strands, yarns and like textile products produced by the apparatus and methods of the invention may be used in many products including the following: mirrors; reflecting surfaces; decorative materials, decorative fabric; tapes; fishing lines; awnings; upholstery material; roofs; reinforced resins; movie screens; clothing; clutch facings; reinforcing cords for rubber products, including tires, garden hose, fire hose, conveyor belts, blankets, fan belts, motor belts, erasers, rug paddings, gloves, oxidizable material in flash bulbs, conductors in electrical circuits, radio, television and electronic equipment, radiation shields, protective wrappings in the form of foil or fabric, laminated products comprising thin foils of glass and metal, heating elements and resinous table tops and the like, and many more.

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 which fall within the true spirit and scope of our invention.

We claim:

1. Apparatus for producing metal-coated glass fibers comprising in combination a container for supply of molten glass, said container having outlet openings through which the glass from the container flows in streams, means for attenuating said streams downwardly into fibers, and a metal-applicating unit located intermediate said outlet openings and attenuating means, said metal-applicating unit comprising a pair of metal-containing portions, said container portions having similar applicator faces for abutting matched relationship, each container portion having a slot extending through to its respective face for supply of molten metal therethrough, each said face having grooves therein extending generally perpendicularly to their respective slots, each such slot being arranged for matched relationship with a corresponding groove of the other face for accommodation of a fiber drawn therethrough for a coating of metal, said slots in the applicator faces each being sufficiently narrow that metal will not freely flow therefrom when open by reason of the surface tension of the metal, said grooves in the faces each being of such depth that when mated by its matching groove in the other face, a fiber may be freely drawn through the channel formed by the two grooves for a coating of metal, said grooves being sufficiently small however to prevent free flow of metal from the mated grooves when a fiber is not being drawn therethrough.

2. Apparatus for coating a glass filament with metal comprising a pair of opposed metal-containing applicators, said applicators having similar applicator faces arranged for establishment of a confronting matched relationship, each applicator having a metal containing portion connected by a horizontal slot to its respective face for supply of molten metal to its face, each said face having grooves therein extending generally perpendicularly to its respective horizontal slot, the slot in each face being sufficiently narrow that the metal will not flow therefrom when said applicator portions are in unmatched open relation, said grooves in each face being oriented for matched relationship with grooves in the other face to form channels through each of which a fiber can be freely drawn when said faces are in confronting matched relation, said grooves being sufficiently small in width however to permit a widthwise bridging therein of metal supplied from said applicators and also to prevent free flow of metal from the channel when a fiber is being drawn therethrough.

References Cited in the file of this patent

UNITED STATES PATENTS

1,033,912	Lendi	July 30, 1912
1,986,533	Ronci et al.	Jan. 1, 1935
2,077,492	Ritzert	Apr. 20, 1937
2,225,667	Staelin	Dec. 24, 1940
2,272,588	Simison	Feb. 10, 1942
2,392,805	Biefeld	Jan. 15, 1946
2,394,066	Kauth	Feb. 5, 1946
2,616,165	Brennan	Nov. 4, 1952
2,679,823	Denham	June 1, 1954
2,699,415	Nachtman	Jan. 11, 1955
2,772,518	Whitehurst et al.	Dec. 4, 1956
2,782,563	Russell	Feb. 26, 1957
2,909,151	Kahn	Oct. 20, 1959

FOREIGN PATENTS

849,842	France	Aug. 28, 1939
849,843	France	Aug. 28, 1939
743,607	Germany	Dec. 1, 1944