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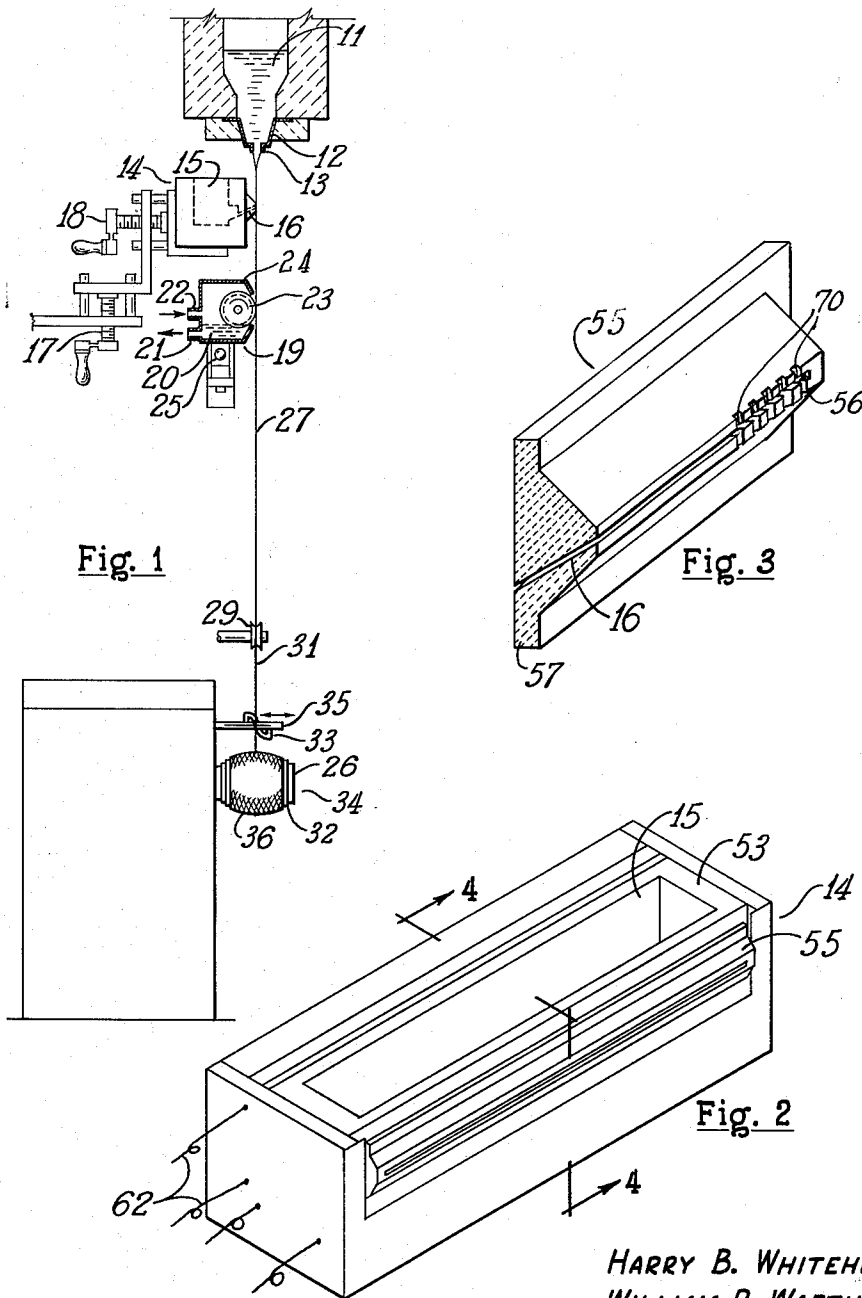
H. B. WHITEHURST ET AL

2,977,929

METAL APPLICATOR FOR FILAMENTARY MATERIAL

Filed Jan. 3, 1955

3 Sheets-Sheet 1



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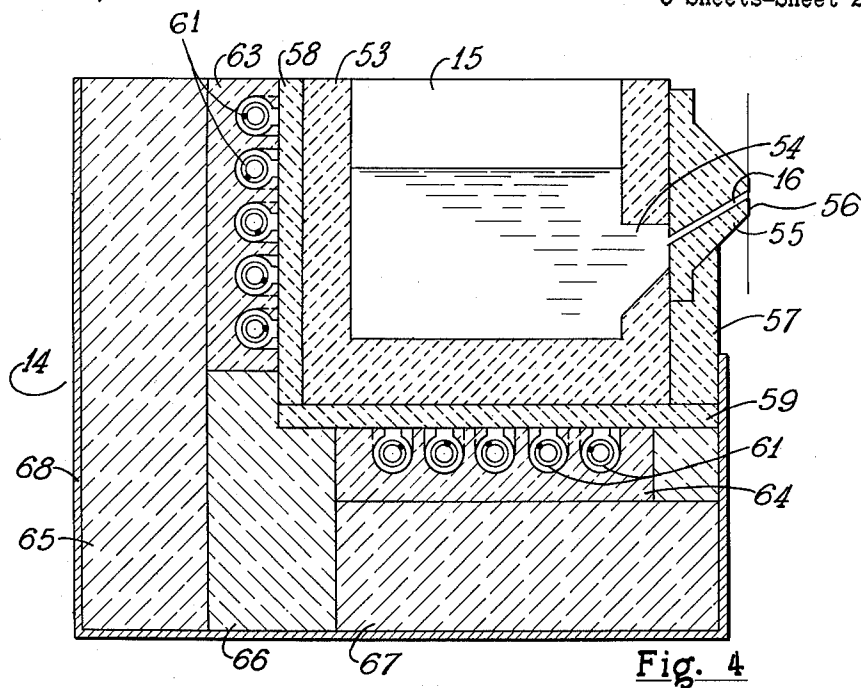
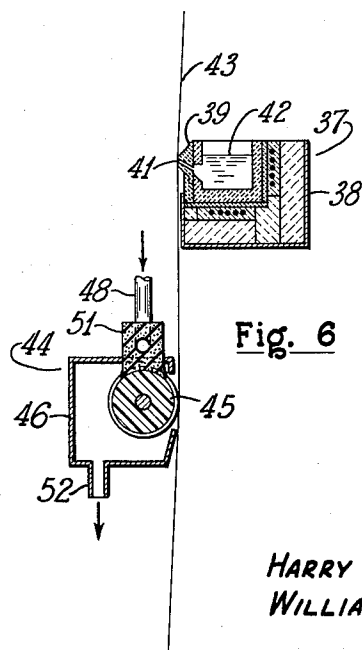
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3 Sheets-Sheet 2



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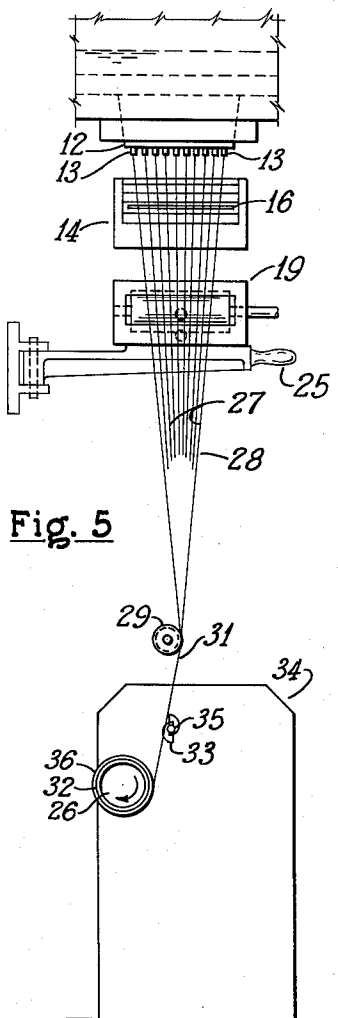
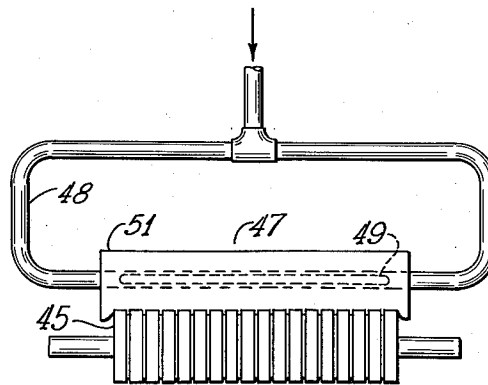
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METAL APPLICATOR FOR FILAMENTARY MATERIAL

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3 Sheets-Sheet 3



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2,977,929

METAL APPLICATOR FOR FILAMENTARY MATERIAL

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5 Claims. (Cl. 118—401)

This invention relates to coating of filamentary or fibrous material, and more specifically to apparatus and method for applying metal to fibers.

This application is a continuation-in-part of our pending application, Serial Number 440,372, filed on June 30, 1954.

In order to utilize the great tensile strength inherent in fibers and especially in fibrous glass, it is necessary to provide improved surface characteristics for the fibers. Surface treatments to improve abrasion resistance, physical appearance, compatibility with other materials, and adaptability for combination with laminating and reinforcing materials must be used.

It is an object of this invention to provide protective films in coatings upon fibrous glass products.

It is an object to provide an improved method and apparatus for producing metal coated fibrous glass products.

It is also an object to provide a continuous and stabilized process for coating fibrous glass with metal.

It is a further object to provide apparatus for melting metal and continuously applying uniform coatings of metal to fibers.

It is a further object to provide such apparatus adapted for use with fiber forming apparatus in carrying out a continuous metallized fiber forming process.

It is an object to provide metal coating apparatus of simplified construction having replaceable parts.

Other objects will be apparent from the description which follows.

The objects are attained by use of a metal applicator comprising a receptacle having a replaceable, slotted graphite insert, which applicator is used in conjunction with fiber forming apparatus including a size applicator, winding apparatus, and the like.

The various forms of the apparatus used in carrying out this invention are shown in the drawings, wherein:

Figure 1 is a side elevational view showing fiber forming apparatus and a metal applicator;

Figure 2 is a perspective view of the metal applicator;

Figure 3 is a perspective view of the replaceable slotted member of the metal applicator, one end being in section;

Figure 4 is an enlarged, cross-sectional view on line 4—4 of Figure 2;

Figure 5 is a front elevational view of the apparatus shown in Figure 1;

Figure 6 is a side elevational view of equipment used in making metal coated fibers, the size applicator being substantially opposite the metal applicator; and

Figure 7 is a view of a roll applicator and a means of applying a liquid thereto.

In Figures 1 and 5, apparatus is shown for applying metal to fibers and then applying a treating liquid to the metal coated fibers before they are gathered into the form of a strand. A source of molten glass 11 is provided with a feeder 12 in which are disposed a plurality of orifices 13, 13 from which small streams of molten

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glass emit. A metal applicator 14 is disposed below the feeder 12 and comprises a molten metal reservoir 15, and a slot 16. The metal applicator is provided with a vertical adjusting means 17 and a horizontal adjusting means 18 for placing the metal applicator into operating position below feeder 12.

Disposed below metal applicator 14 is a roll applicator 19 which is adapted for applying liquids including solutions, dispersions and hot melts to the fibers passing thereover. The roll applicator comprises a reservoir 20, an outlet port 21, an inlet port 22, a grooved roll 23, and an upper housing 24 which may be mounted by hinges, if desired, to facilitate cleaning of the reservoir. The roll applicator 19 is provided with means for moving the applicator into and out of operating position, this means comprising a pivotable arm 25 upon which the roll applicator is mounted. The roll of the applicator may be rotated either clockwise or counterclockwise, but it has been found generally preferred to rotate the roll so that its fiber contacting surface is travelling in the same direction as the fiber which is being formed although not necessarily at such great speeds as the fiber travels. The roll may be free turning, if desired.

The streams of molten glass emitting from orifices 13, 13 are pulled downwardly by the action of tube 32 on the expanding shaft 26 of collet winder 34, which tube and shaft rotate rapidly and cause the streams of molten glass to be attenuated into fibers 27, 27 which form a fan 28 as shown in Figure 5. The individual fibers 27, 27 are gathered upon gathering wheel 29 which is constructed of graphite, Teflon or any other suitable material which presents a smooth, non-abrasive surface. Gathering wheel 29 forms a strand 31 of individual fibers 27, 27 and this strand is wound upon tube 32 in successive layers of helixes formed by the action of traverse device 33.

Collet winder 34 comprises a driving means for expanding shaft 26 and an auxiliary power take off for rotative traverse device 33. Shaft 35 of traverse device 33 is oscillated slowly back and forth across package 36 as shown by the double headed arrow in Figure 1. This motion causes a package 36 of the desired configuration to be formed.

In Figure 6 is shown another arrangement of the metal applicator 37 and a roll applicator 44 for the size. The roll applicator is placed substantially opposite the metal applicator, the metal applicator being disposed just slightly above the roll applicator and on the opposite side of the fibers being treated. Metal applicator 37 comprises a generally rectangular receptacle 38 which is provided with a replaceable graphite insert 39 in which is disposed a slot 41 through which molten metal 42 flows to form a bead of metal which contacts fibers 43. Roll applicator 44 comprises a grooved roll 45, and a cooperating liquid applicator 47 consisting of a tube 48 having a slot 49 over which is disposed a sponge 51, see Figure 7. This sponge 51 is preferably cellulose which does not tend to seize the roll even when the sponge is under slight compression. The liquid to be applied is directed through tube 48 and then passes through slot 49 into sponge 51. Roll applicator 44 has a reservoir 46 which collects excess liquid dripping from grooved roll 45 and the reservoir is provided with an outlet tube 52 which returns the treating liquid to a supply chamber and recycling system, not shown.

Roll applicator 44 of Figure 6 also is used with the metal applicator 14 and other apparatus shown in Figures 1 and 5 with great success, roll applicator 44 with sponge 51 replacing roll applicator 19 shown in Figure 1. Any of the liquid applicators may be placed on the same

side or on the opposing side of the fan of fibers with respect to the metal applicator.

It is advantageous to have the roll applicator grooved so that the individual metal coated fibers are maintained in a spaced apart relationship until the liquid treatment to be applied actually covers the metal surfaces. The individual fibers are gathered together in the form of a strand after the treating liquid is applied. In the preferred embodiment, the roll is provided with enough grooves so that each fiber has at least one groove provided for it or more than enough grooves may be provided in the roll to assure that not more than one fiber will be contained in any one groove. Rolls having two times as many grooves as fibers passing thereover have been operated successfully. It is possible to operate successfully without excess grooves and in some instances more than one fiber may be contained in a single groove. The positioning of the grooved roll adjacent to the metal applicator also stabilizes the fibers as they pass over the metal applicator resulting in improved metal coating and ease of operation. Reduction of the wavering of the fibers and increasing the stability of the operation results in a complete and uniform coating of the fibers with metal.

The metal applicators generally have a horizontal slot disposed in a replaceable graphite facing member through which the molten metal is exuded. The fibers to be coated pass across the horizontal slot of the graphite member and through the elongated molten metal bead at the mouth of the horizontal slot. The replaceable graphite member may also be provided with vertical grooves or slots 70, as shown in Figure 3, which cooperate with the horizontal slot in directing the fibers through the molten metal. The vertical grooves in the metal applicator may be provided to maintain the fibers in a spaced apart position which helps assure uniform coating. These vertical grooves in the metal graphite facing member may be spaced in such a manner that the fibers fall into the individual vertical grooves when the metal applicator is moved into operating position.

Whether or not the metal applicator has vertical grooves, it has been found that the roll applicator with grooves stabilizes fibers as they pass over the metal applicator. Any wavering of the fiber within the fan is reduced by the grooved roll applicator and the resulting stabilization of the fibers results in greatly improved metal coating and makes it possible to operate without one or more fibers breaking out during the forming operation.

The size compositions can be applied at a gathering pad which may replace the gathering wheel 29 shown in Figure 1. If such an expedient is used, it is sometimes desirable to use a graphite stabilizing bar which rubs against the fibers after they are metal coated but before they are gathered together. Such a stabilizing rod or bar helps prevent wavering of the fibers as they are being metal coated. Also the size compositions or other treatments can be applied by use of spray nozzles disposed between the metal applicator and gathering device.

Details of the metal applicator are shown in Figures 2, 3, and 4. The metal applicator 14 comprises a reservoir 15 having graphite walls and bottom plate arranged in a generally rectangular box-like structure 53. The box-like structure 53 is provided with an opening 54 which is aligned with slot 16 of replaceable insert 55 when the insert is installed, see Figure 4. When the metal applicator is being used, a bead of metal forms at the face 56 of the replaceable insert, the bead of metal being elongated and continuous along the length of slot 16. Replaceable insert 55 fits into frontal plate 57.

At the back and under side of the graphite box-like structure 53 are baffle plates 58, 59 of graphite. Disposed next to the baffle plates 58, 59 are a plurality of heating coils 61, 61 having power leads 62, 62, see Figure 2. The heating coils 61, 61 are disposed in porcelain plates 63, 64. The porcelain plates 63, 64 are slotted to provide

ease of installation and removal of the heating coils 61, 61. About the rear and lower sides of the entire structure, as shown in Figure 4, are disposed refractory plates 65, 66, 67 which insulate the melter and metal applicator. A metal shell 68 supports the entire structure.

In operating the apparatus shown in Figures 1 and 5, a 98:2 lead-zinc alloy is melted in reservoir 15 and a size composition is introduced into reservoir 20 of roll applicator 19. The operator pulls the fibers downwardly from feeder 12 by hand and places them in gathering wheel 29 and then pulls downwardly on the strand and wraps it upon expanding shaft 26 which is commenced to rotate. After the strand is being pulled at a uniform rate, roll applicator 19 is pivoted into operating position as shown in Figure 1. The fibers which tend to follow wavering paths before the roll applicator is placed into operating position then become stabilized and proceed in relatively fixed paths toward gathering wheel 29.

Metal applicator 14 is moved into position and the fibers are coated uniformly with the alloy as they contact the molten alloy at the applicator slot 16. It is preferable to position the metal applicator in relation to the feeder so that the fibers change direction slightly as they pass over the metal applicator. The metal coated fibers are then coated with a size composition on roll applicator 19 before the fibers are gathered together into the form of a multifilament strand by gathering wheel 29.

A size comprising the following ingredients by weight is used in treating metal coated fibers:

Example I

Ingredient	Proportion	
Gelatine -----	0.5%	0.25 to 0.5
Polyethylene Glycol (Carbowax 1500) -----	0.25%	0.1 to 0.5
Propylene Glycol -----	0.05%	0.025 to 0.015
Water -----	99.2%	

The propylene glycol may be replaced with other humectants such as glycerine or any suitable glycol. The water is necessary in order to plasticize the gelatine so that the gelatine does not form a hard cake which hinders unwinding of the package 36. The size is circulated through the roll applicator and the size is applied to the fibers as they move past the roll and come in contact therewith.

The gathering wheel is preferably a free turning device; however, it may be driven if desired.

Metal coated fibers which are drawn into the form of a strand and formed into packages are produced with the equipment shown. The metal coated strand so produced is of very high quality and it has been found that the strand may be easily removed from the packages so produced in subsequent textile operations such as twisting and plying. The run out of the strands from packages so produced is exceptionally good, this property being of great value in textile manufacturing. In addition, the strand has very good abrasion resistance and long flex life.

Various size compositions in addition to that of Example I may be used including latex sizes such as that illustrated by a size composition comprising two chlorobutadiene 1,3 latex combined with tetraethylene pentamine stearic acid condensate, starch and water and by a size composition comprising butadiene-acrylonitrile latex, tetraethylene pentamine stearic acid condensate, starch, water and a small amount of a nonionic surface active agent. Various other size compositions, lubricants and the like, including those disclosed in Whitehurst's co-pending application, filed March 30, 1954, having Serial Number 419,920, now U.S. Patent 2,920,981, issued January 12, 1960, are used with the equipment of this invention.

It is preferred generally to position the gathering device a sufficient distance from the feeder so that the fibers

are substantially parallel as they pass over the metal applicator. Strands having 30, 100, 200 or more individual fibers are produced on the apparatus shown in the drawings. Strands of metal coated fibers produced by the method of this invention are easily twisted into yarn, thread or cord and then plied as desired for producing reinforcing materials for molded or laminated articles of rubber, resin, and the like. The cord so produced may be woven into fabric if desired. Woven fabric or weftless fabric of substantially parallel cords are further treated with an adhesive such as those comprising resorcinol-formaldehyde latex, resins, and the like when the cord is to be combined with synthetic or crude rubber in such products as tires, belts and other reinforced rubber products.

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 fabrics, 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 and in 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.

The metal applicator herein disclosed has many advantages. It is easily assembled since it is made up of building blocks that fit together easily and accurately. The replaceable insert which houses the slot through which the molten metal is metered and formed into a bead wears after extended use due to the erosive effects of the flowing molten metal, however, this part is easily replaced without the need for building an entire graphite crucible as would be necessary if the slot and its facing were an integral part of the crucible. The graphite baffles have been found to be advantageous in that they protect the metal contacting walls from the heating coils and if and when they need to be replaced, only small relatively thin blocks of graphite need to be replaced instead of the entire melting crucible.

The graphite pot or receptacle may be replaced with a ceramic reservoir if desired. A ceramic pot is used with a graphite insert so that the fibrous glass contacts a graphite facing. It has been found that a graphite facing operates well with fibrous glass being coated according to the methods of the invention.

Various other constructions can be used. For instance, the lower lip of the graphite facing may be a part of the graphite receptacle itself and the upper lip can be in the form of a baffle which is mounted above the lower lip to act not only as the upper wall of the receptacle but also as one of the lips forming the horizontal slot through which the metal passes during the metal coating process.

In order to stabilize the metal coating process even further, it has been found advantageous to shock mount the metal applicator. The metal applicator is mounted upon any shock-mount material such as rubber, sponge rubber, fibrous glass pads, or air filled rubber spheres such as tennis balls or the like.

Obvious modifications and variations may be made within the spirit and scope of the appended claims.

We claim:

1. An improved melter and applicator for applying molten metal to fibers comprising a graphite reservoir having an opening at the top and in at least one side wall, heating coils disposed in porcelain plates adjacent the outer side of the bottom and at least one side of said reservoir, baffle plates disposed between the walls and floor of said reservoir and said heating coils, a frontal

plate butted against the wall of said reservoir below said opening in said side wall, said frontal plate having a vertical slot therein, a replaceable graphite member having a horizontal metering slot which tends to wear away with flow of molten metal disposed over the opening in said side wall, said member having a tongue that fits into the vertical groove of said frontal plate to secure said member in its proper operating position, said opening in the side wall and said metering orifice being aligned to form a passage for metal flowing out of said reservoir, and blocks of insulating material disposed about said porcelain plates and said heating coils and retained within a steel shell of said applicator.

2. The melter and applicator of claim 1 wherein the replaceable graphite member has vertical slots disposed at substantially right angles to said horizontal metering slot, said vertical slots being of sufficient width to admit individual fibers being coated.

3. In fibrous glass forming equipment, a metal applicator comprising a generally rectangular refractory receptacle for molten metal, said receptacle comprising a bottom wall and multiple vertical walls and having an elongated outlet opening in one of said vertical walls, which opening extends substantially the full length of said receptacle, a frontal plate disposed below said elongated outlet opening and immediately adjacent the vertical wall of said receptacle in a cooperative arrangement to form a groove, a removable insert having an elongated slotted opening for metering molten metal flowing from the receptacle through said elongated outlet opening, said removable insert being disposed in said groove with the elongated slotted opening extending upwardly and outwardly from said receptacle, and disposed at the back and underside of the receptacle, electrical heating coils housed in porcelain plates.

4. A pot for molten metal utilized in coating fibers comprising a refractory receptacle having a bottom and four upstanding walls, one of which walls has an elongated opening for passage of molten metal, a grooved supporting member disposed against the latter upstanding wall and below the elongated opening, a metering device inserted in the grooved supporting member to cover the elongated opening of the wall, said metering device having an elongated slot for metering molten metal to the outermost end of said elongated slot for application to fibers.

5. An applicator for metal coating glass fibers as they are being formed comprising a reservoir having a graphite bottom and upstanding walls for melting and retaining molten metal, one of said upstanding walls having an outlet opening for free flow of molten metal therethrough, a replaceable graphite member having a restricted, slotted opening aligned with said outlet opening to meter the flow of metal from said reservoir to an elongated bead of metal formable at the outer extremity of said graphite member, a grooved frontal plate positioned adjacent to that upstanding wall which includes the outlet opening for supporting said replaceable graphite member in cooperative engagement with said wall, and electrical heating coil means positioned outside of the graphite walls for melting the metal.

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