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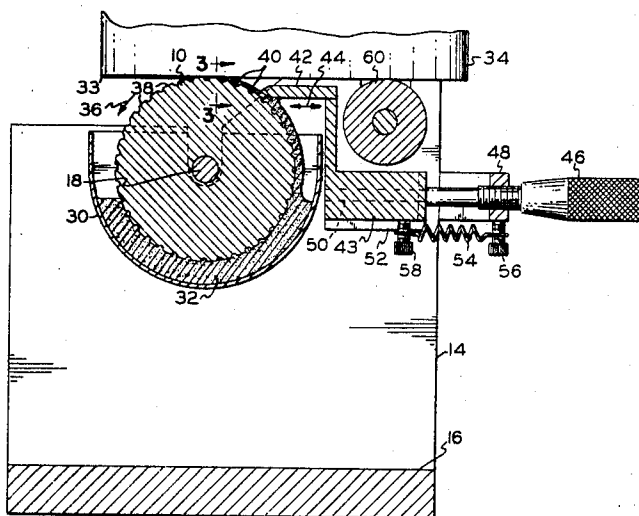
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[54] **BONDING WITH A GLASS FRIT COATING
APPLIED BY A KNURLED ROLLER**
10 Claims, 4 Drawing Figs.

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117/129
[51] Int. Cl. **C03c 23/00,**
C03c 27/00
[50] Field of Search **65/43, 59,**
60, 33; 117/124, 125, 111, 23, 129; 156/546, 547,
60

[56] **References Cited**
UNITED STATES PATENTS
Re. 25,791 6/1965 Claypoole **65/60 X**

ABSTRACT: A coating apparatus and method are described in which a knurled applicator roller is employed to apply a slurry of suspended particles to the surfaces of articles of different shape. The applicator roller is motor driven and partially immersed in the slurry solution so that it agitates such slurry as it is rotated to prevent settling of the particles. The articles are fed onto the applicator roller from an idler roller. An adjustable scraper blade is supported adjacent the applicator roller to control the thickness of the slurry layer provided on such roller. The present apparatus and method is employed to apply a coating of a slurry of glass frit particles suspended in a solution of organic binder and solvent, to the end of the funnel portion of a cathode-ray tube envelope in order to enable such glass frit to form a seal between such funnel portion and the faceplate of such envelope.



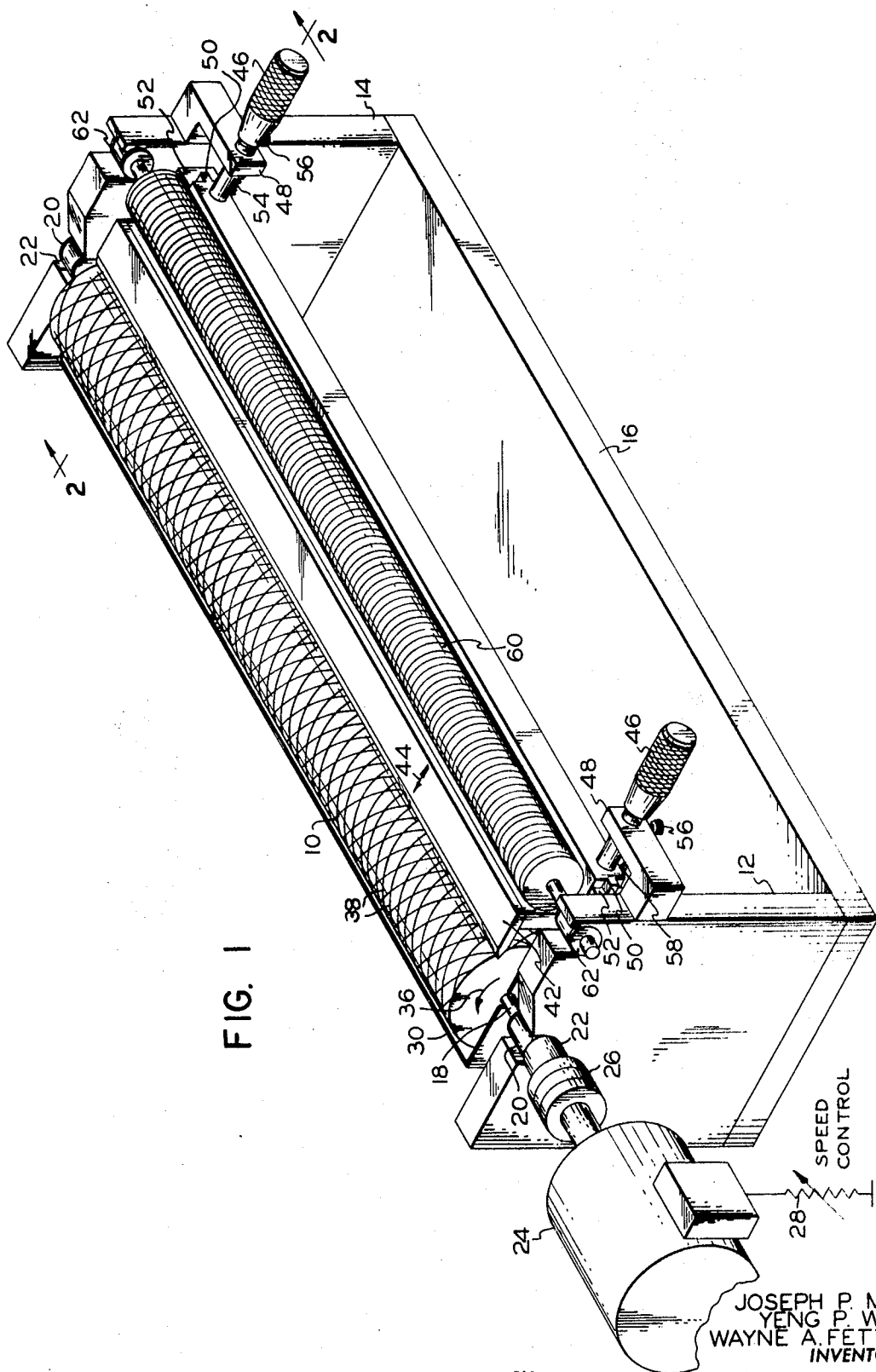


FIG. 1

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FIG. 4

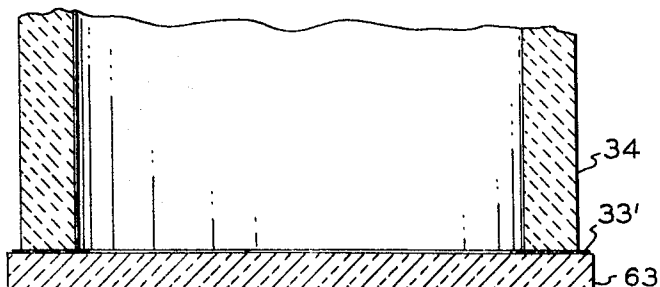


FIG. 3

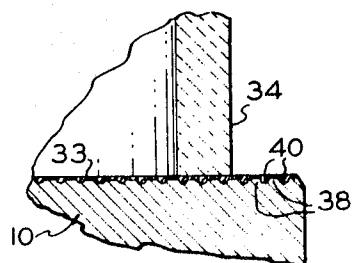
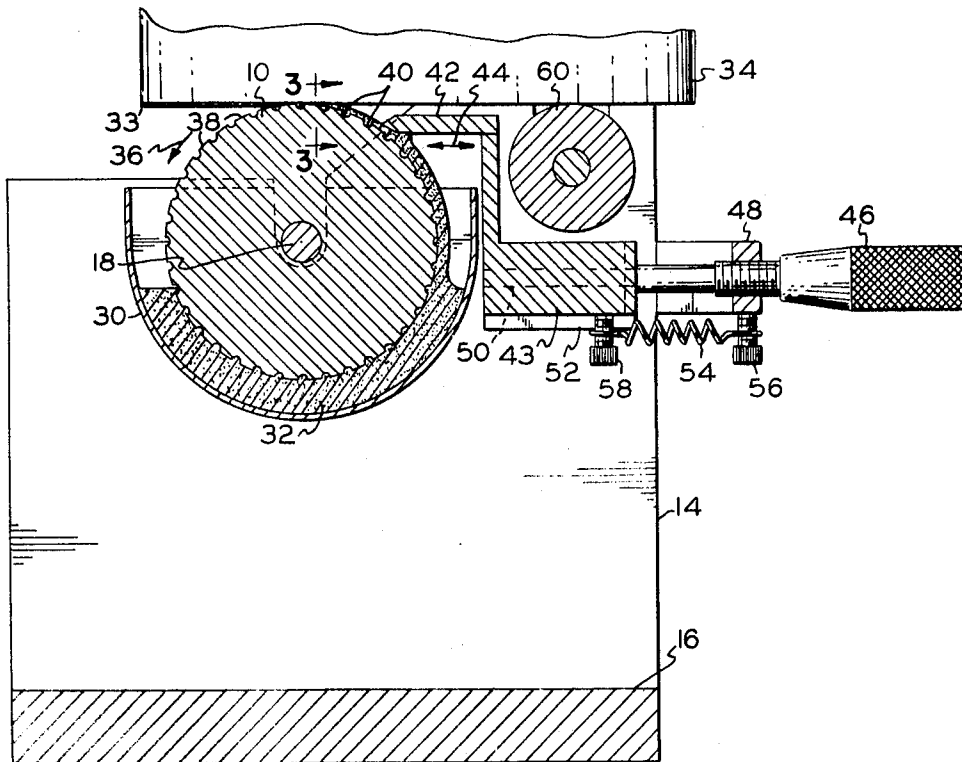


FIG. 2



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BONDING WITH A GLASS FRIT COATING APPLIED BY A KNURLED ROLLER

BACKGROUND OF THE INVENTION

The subject matter of the present invention relates generally to a coating apparatus and method, and in particular those employing an applicator roller for applying a slurry of suspended particles as a coating on the surfaces of articles of different shape. The apparatus and method uses a knurled roller to apply a coating of a slurry of glass frit or other particles suspended in a solution of organic binder and solvent.

The coating apparatus and method of the present invention is especially useful as an intermediate step in the manufacture of cathode-ray tube envelopes having a ceramic funnel portion and a glass face plate portion, and is employed to apply a suspension of devitrifiable glass frit to the funnel to enable the face plate to be sealed thereto, as shown in U.S. Pat. No. 3,207,936 of W. H. Wilbanks et al. However, the apparatus and method of the present invention is also useful for applying slurries of other particulate materials to different articles, including slurries containing particles of conventional vitreous glass frit, particles of phosphor material or particles of other insulating materials or metals. Also the invention can be used to form other seals including glass to metal, glass to glass, and metal to ceramic.

Previously the glass frit was applied to the funnel portions of cathode-ray tube envelopes by an extrusion process in which a cam follower roller senses the exterior surface of the funnel to maintain the edge of such funnel beneath the extrusion outlet, as shown in U.S. Pat. No. 2,880,697 of W. S. Blanding et al. This apparatus has several disadvantages including a need for different mounting jigs to hold cathode-ray tube funnels of different diameters. Also a complicated and expensive extrusion control mechanism is necessary in order to provide the proper amount of frit for the coated layer. The glass frit slurry employed previously included an organic binder or vehicle of nitrocellulose dissolved in a solvent of amyl acetate, together with glass frit particles of the devitrifiable glass, as disclosed in U.S. Pat. No. 2,889,952 of S. A. Claypoole. Since the usable shelf life of this prior slurry in air is only about 5 minutes it must be held within a closed airtight container such as used in the extrusion apparatus. It is difficult to apply a coating of uniform thickness with the extrusion apparatus which is confined to the narrow edge on the end of the ceramic funnel of the cathode-ray tube envelope. Also the extrusion apparatus requires a much longer time to coat the end of the funnel since the extrusion outlet must travel along the entire circumference of the funnel.

The coating method and apparatus of the present invention overcomes these disadvantages by employing a roller applicator which is simple, inexpensive, and easy to operate. The applicator roller applies the coating faster because such roller merely traverses the diameter of the envelope funnel and is more versatile since it can coat envelope funnels of different size without need for special support fixtures or other adapters. In addition, by employing ethylene glycol monobutyl ether as a solvent for the nitrocellulose organic binder in the glass frit slurry, a much longer useful shelf life on the order of 5 hours is obtained for such slurry. As a result the container holding the glass frit slurry may be open to the atmosphere, which enables the use of a roller to apply such slurry. Furthermore, by immersing the applicator roller in the slurry, such roller also acts to stir such slurry and prevent settling so that no circulating pump or separate stir apparatus is needed. In addition, the present coating apparatus is more versatile, since the speed of rotation of the applicator roller may be varied, and the spacing between a scraper blade and such roller changed to control the thickness of the slurry thereon. These may be adjusted to compensate for slurries of different viscosity in order to maintain a coating of constant thickness or to provide a plurality of coatings of different thickness.

It is therefore one object of the present invention to provide an improved coating apparatus and method employing a roller

for applying a slurry of particles as a coating and which is simple and inexpensive in construction.

Another object of the present invention is to provide an improved coating apparatus and method employing an applicator roller partially immersed in a particle slurry coating solution so that such roller stirs the slurry and prevents settling of the particles to provide an efficient maintenance free operation.

A further object of the present invention is to provide an improved coating apparatus and method which is versatile in that it can be used to coat articles of different size or shape and is capable of providing coatings of different thickness or compensating for liquids of different viscosity to maintain coatings of uniform thickness.

An additional object of the present invention is to provide an improved coating apparatus and method for applying a slurry of glass frit particles as a coating on the end of the funnel portion of a cathode-ray tube, in which a slurry of long useful shelf life is provided in an open container, and an applicator roller is mounted partially immersed in such slurry in order to provide a simple, trouble-free coating operation which is fast and accurate.

BRIEF DESCRIPTION OF DRAWINGS

Other objects and advantages of the present invention will be apparent from the following detailed description of a preferred embodiment thereof and from the attached drawings of which:

FIG. 1 is a plan view of one embodiment of the coating apparatus of the present invention;

FIG. 2 is a section view taken along the line 2—2 of FIG. 1 and also showing the apparatus in operation coating the funnel portion of a cathode-ray tube envelope;

FIG. 3 is a partial vertical section view taken along the line 3—3 of FIG. 2 showing on an enlarged scale the region of contact between the applicator roller and the article being coated; and

FIG. 4 is a section view of a portion of a cathode-ray tube envelope made in accordance with the method of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

As shown in FIG. 1, the present coating apparatus includes an applicator roller 10 rotatably mounted between a pair of end plates 12 and 14, which are secured to a bottom plate 16 to form the frame of the apparatus. The opposite ends of the roller shaft 18 are provided with bearings 20 mounted within U-shaped notches 22 provided in the tops of the end plates 12 and 14. The roller shaft 18 is connected to the drive shaft of an electrical motor 24 by means of a suitable gear coupling 26. The motor 24 is provided with a speed control shown as a variable resistor 28, in order to change the speed of rotation of the applicator roller 10 in the range of about 8 to 80 r.p.m. The applicator roller 10 is supported with its lower portion within a container 30 which may be in the form of a semicylindrical trough having a slightly greater radius than the radius of the applicator roller to provide the proper clearance between such roller and such container to enable the applicator roller to stir a slurry 32 of suspended particles provided within such container, as shown in FIG. 2.

The slurry 32 includes particles of glass frit suspended in a solution of organic binder and solvent. The glass frit particles may be made of devitrifiable glass of the type shown in U.S. Pat. No. 2,889,952 of S. A. Claypoole, and are suspended in a solution of nitrocellulose vehicle or binder and a solvent of ethylene glycol monobutyl ether. In a preferred example, the glass frit particles have a particle size less than 20 mesh and are suspended in a solution of 1 to 3 percent nitrocellulose in ethylene glycol monobutyl ether. This frit slurry has been found to be very suitable since it has a shelf life of more than 5 hours in air and therefore can be used in the open container 30. This is considerably better than the slurry solution recited

in the above-mentioned Claypoole patent which employs a solvent of amyl acetate and has a shelf life of only about 5 minutes in air so that it cannot be used in the present apparatus. Other organic binders and solvents can be employed as long as they are capable of being completely burned out at well below the sealing temperature of the glass frit and do not leave any appreciable residue which will affect the devitrifying or crystallization process described in the Claypoole patent.

The applicator roller 10 is provided with a roughened outer surface having raised portions and recessed portions and which may be grooved to provide a threaded or gear tooth surface. However it has been found that in most cases best performance is provided by a knurled applicator surface which may be formed with a 45° helix angle. The grooves of the knurl were cut approximately 0.05 inch deep with a 60° angle milling cutter. As shown in FIG. 2, this provides a deep knurled design which picks up the frit slurry 32 from the container 30 and applies it as a coating 33 to the end of the funnel portion 34 of a cathode-ray tube or other article being coated when the applicator roller 10 is rotated in the direction of arrow 36. As shown in FIG. 3, the raised surface portions of the roller provided by the tops of the knurl projections 38 contact the end of the article being coated, such as the cathode ray tube funnel 34, and a slurry layer 40 carried on the roller applicator 10 is held in the spaces between the knurl projections for applying the coating 33. Thus the thickness of the slurry coating 33 applied onto the funnel 34 is dependent upon the depth and shape of the knurl pattern.

As shown in FIGS. 1 and 2, a scraper blade 42 is provided adjacent the front of the applicator roller 10 in order to make substantially uniform the thickness of the frit slurry layer 40 carried by the roller. The scraper blade 42 is supported on an L-shaped support member 43 which is secured between the end plates 12 and 14 of the frame for longitudinal sliding movement to move the scraper blade toward and away from the roller applicator as indicated by arrows 44. This sliding adjustment of the scraper blade 42 is accomplished by a pair of micrometer-type adjusting screws 46 extending through threaded holes in brackets 48 attached to frame end plates 12 and 14. The opposite ends of the scraper blade support 43 are each provided with a guide projection 50 which slides within a guide slot provided within a guide member 52 attached to each of the frame end plates. A pair of coil springs 54 are connected between screws 56 provided on the bracket arms 48 and screws 58 provided on the scraper blade support 43 which urge such support outwardly toward the brackets 48. The end of the adjustment screws 46 engage the blade support 43 to space such support from the brackets 48 a distance which varies with the setting of such adjustment screws and thereby changes the spacing between the scraper blade 42 and the applicator roller 10.

An article feeder means including an idler roller 60 is provided for feeding the cathode-ray tube funnel or other article onto the applicator roller 10. The idler roller 60 is mounted between the frame end plates 12 and 14 in front of the scraper blade 42, with the upper surface of such idler roller positioned slightly above the scraper blade so that the funnels 34 are supported solely on such idler roller and the applicator roller during the coating process. Bearings 62 are provided at the opposite ends of the idler roller shaft and supported within notches in the top of the frame end plates in a similar manner to the applicator roller bearings 20. The idler roller 60 may have its outer support surface threaded to increase friction between it and the article being coated. It should be noted that the cathode-ray tube funnel 34 may be hung on an overhead support as it is moved over the applicator roller, so that such funnel is similarly supported after it leaves the applicator roller. Alternatively the funnel can be removed by hand from the applicator roller when the coating is finished.

As shown in fig. 4, a glass faceplate 63 is positioned in contact with the frit coating 33 on the funnel 34 and the assembly heated to seal the faceplate to such funnel. The funnel 34 and faceplate are pressed together during the heating step which

fuses the frit particles and produces the devitrified glass frit seal 33' between such members. This devitrification process is described in the above mentioned U.S. Pat. No. 2,889,952 and will not be further described except to note that the organic binder or vehicle and solvent are both burned out or vaporized before the sealing temperature of the glass is reached. After the glass sealing temperature is reached it is maintained at that temperature until the glass frit has fused and crystallized to provide the permanent seal. It should be noted that the funnel 34 may be made of a ceramic material so that the composite envelope employs a ceramic-to-glass seal in the frit region 33'. The resulting envelope structure is described in U.S. Pat. No. 3,207,936 of Wilbanks et al. which also disclosed the use of another ceramic-to-glass seal between a glass neck portion of the envelope and the other end of the ceramic funnel which may be made in a similar manner to seal 33'.

In one example the ceramic funnel 34 is made of Forsterite ceramic material having a composition by weight of approximately 28 percent magnesium oxide, 60 percent talc and 12 percent kaolin, while the faceplate 63 may be made of a soda lime glass having a composition by weight of approximately 73.6% SiO₂, 16.0% Na₂O, 0.6% K₂O, 5.2% CaO, 3.6% MgO, 1.0% Al₂O₃. The devitrifiable glass frit may be of a lead-zinc-borate type glass set forth in the table on column 3 of the above mentioned U.S. Pat. No. 2,889,952.

The coating apparatus and method of the present invention may be employed with slurries of different particles, such as phosphor particles, conventional glass frits, metal particles and other insulating particles, as well as the devitrifying glass frit slurry given by way of specific example. Thus the present apparatus and method can be employed with any particle slurries having viscosities in the range of approximately 2,000 to 30,000 centipoise. Also virtually any shape article can be coated with the coating apparatus of the present apparatus. By varying the speed of the applicator roller 10, the distance of the knife blade 42 from roller 10, and by varying the knurled surface on roller 10, coatings of many different thicknesses can be achieved and coatings of uniform thickness for slurries of different viscosity may also be produced.

It will be obvious to those having ordinary skill in the art that many changes may be made in the details of the above described preferred embodiment of the present invention without departing from the spirit of the invention. Therefore the scope of the invention should only be determined by the following claims.

1. A method of producing an envelope for a cathode-ray tube from separate faceplate and funnel portions, comprising the steps of:

- forming a slurry containing particles of glass frit;
- applying a layer of said slurry to the surface of a roller including a raised surface portions and recessed surface portions;
- moving an end surface on the funnel portion of the envelope across said roller as it rotates so that the raised portions of the roller surface contact said end surface while said recessed portions are spaced from the end surface to apply a coating of said slurry to said end surface;
- assembling the faceplate portion of the envelope on the coated end of said funnel portion with said coating therebetween; and
- heating the assembly to fuse the glass frit and form a seal between said faceplate portion and said funnel portion.

2. A method in accordance with claim 1 in which the glass frit is made of a devitrifiable glass and the seal is heated during sealing for sufficient time to cause at least part of the glass to crystallize.

3. A method in accordance with claim 2 in which the slurry also includes a solution of organic binder and a solvent and the heating removes said binder at a lower temperature than the sealing temperature of the glass so that the seal is free of said binder and said solvent.

4. A method in accordance with claim 3 in which the binder is nitrocellulose and the solvent is ethylene glycol monobutyl ether.

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5. A method in accordance with claim 1 in which the funnel portion is made of a crystalline ceramic material and the faceplate portion is made of a glass.

6. A method in accordance with claim 5 in which another seal is made in a similar manner between a glass neck portion of the envelope and the other end of the ceramic funnel portion.

7. A method in accordance with claim 1 in which the slurry is held in a container and stirred by rotating the roller in said slurry.

8. A method in accordance with claim 1 in which the thickness of the slurry layer on the roller is varied by moving a scraper member to change its spacing relative to the applicator surface of such roller to compensate for different conditions.

9. A method in accordance with claim 1 in which the slurry layer is held on the roller by a knurled surface and the tips of the knurl projections contact the surface of the funnel portion.

10. A method of joining two preformed bodies at least one of which is of ceramic material having a random configuration

along the surfaces to be joined, comprising the steps of:
 depositing a coating material including glass frit in a container to provide a pool of coating material;
 immersing a roller having an applicator surface with raised and recessed surface portions in said pool of coating material;
 rotating said roller in position in said container so that said coating material is carried by said applicator surface from said pool to a coating position;
 moving a random surface of one of the preformed bodies along said applicator surface at said coating position to apply a layer of said glass frit coating material on said random surface;
 heating the coated body to melt the glass frit layer;
 assembling said bodies so that the random surfaces are together with said layer of coating material therebetween; and
 maintaining said random surface together until they are joined.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,607,180 Dated September 21, 1971
Inventor(s) Joseph P. Merz, Yeng P. Wong and
Wayne A. Feters

It is certified that error appears in the above-identified patent
and that said Letters Patent are hereby corrected as shown below:

Column 2, line 70, "20" should be --200--;

Column 3, line 38, "accomplishment" should
be --accomplished--;

Column 4, line 13, "disclosed" should be --discloses--;

Column 4, claim 1, line 52, after "including"
delete "a"

Signed and sealed this 21st day of March 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents