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METHOD AND APPARATUS FOR PORCELAIN ENAMELING

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3 Sheets-Sheet 1

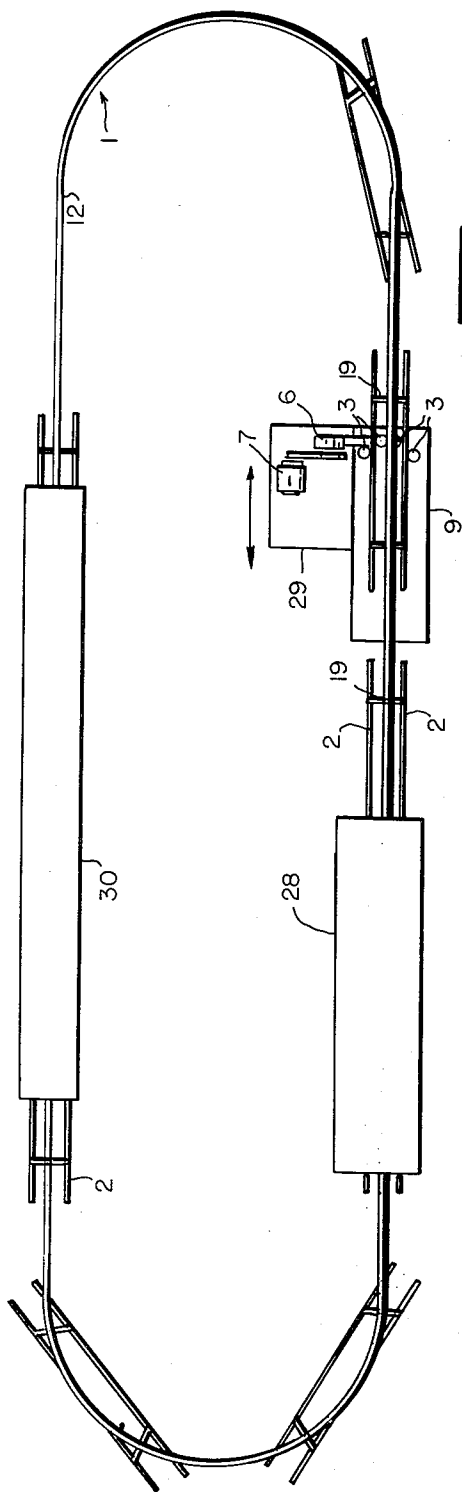


Fig. I

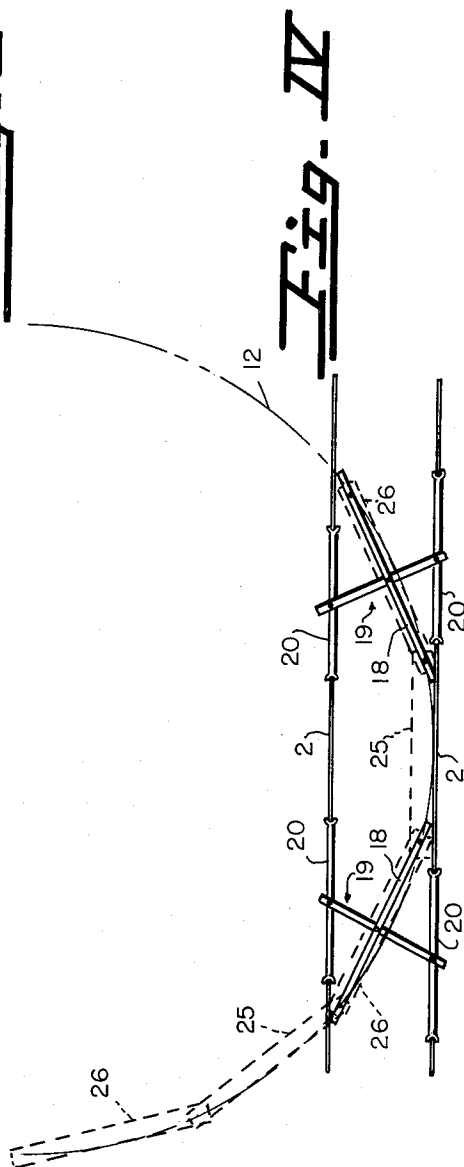


Fig. IV

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3 Sheets-Sheet 2

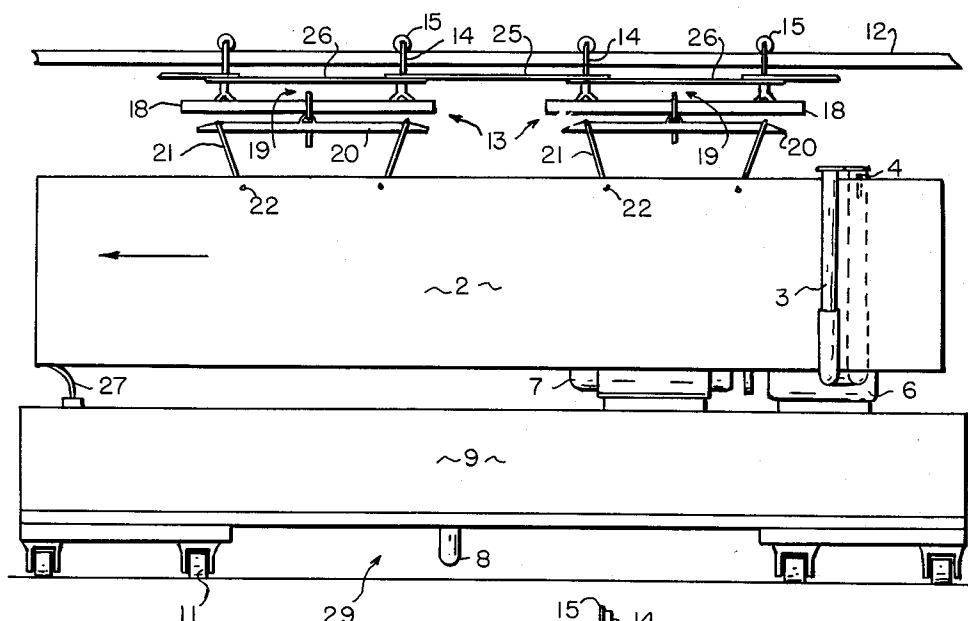


Fig. II

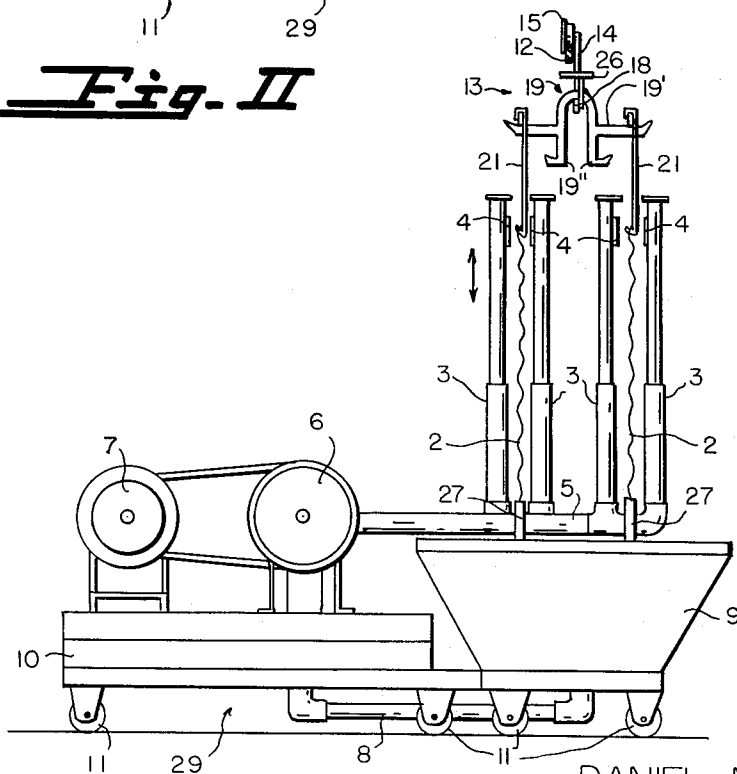


Fig. III

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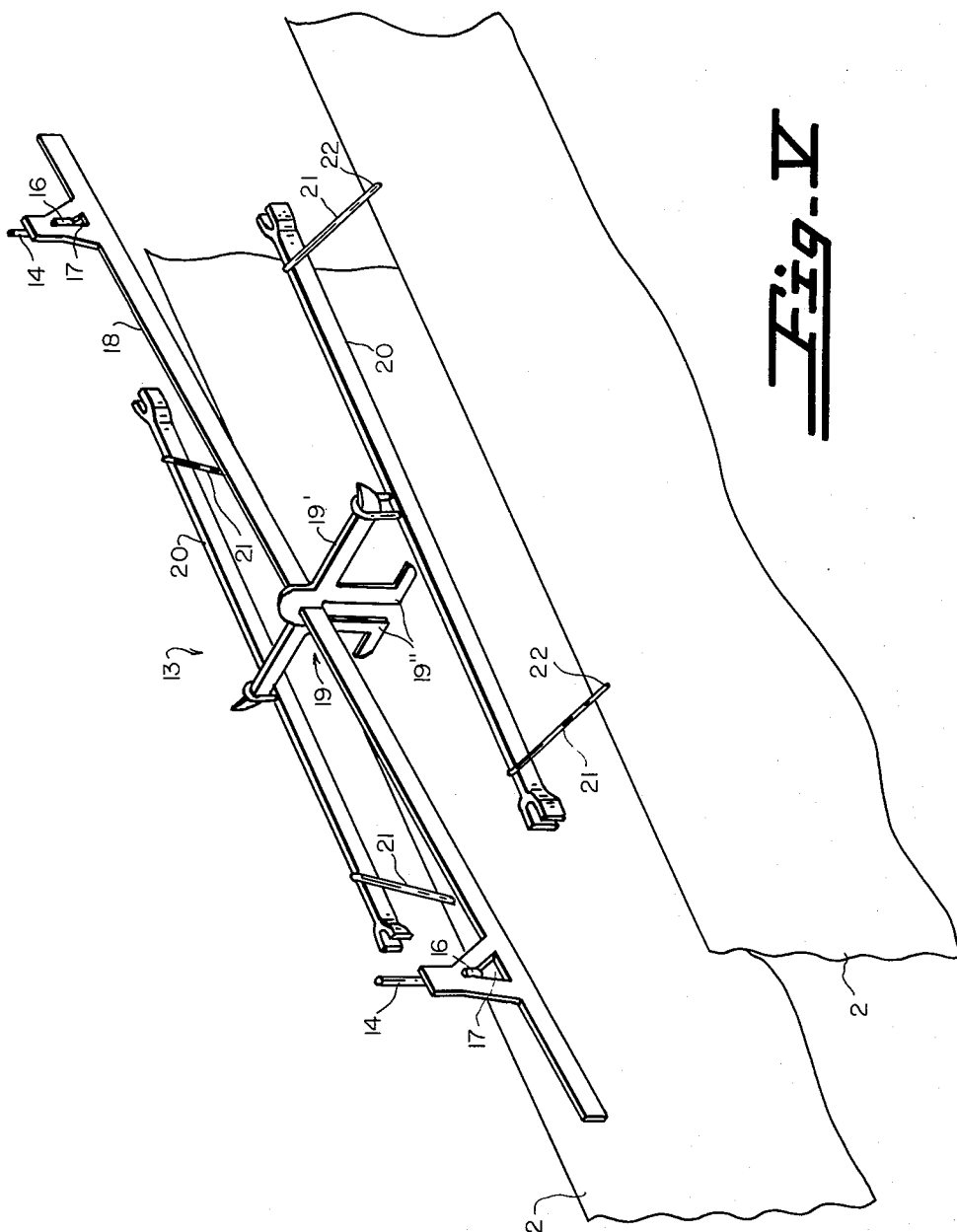


Fig. 1

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2,996,407

METHOD AND APPARATUS FOR PORCELAIN ENAMELING

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12 Claims. (Cl. 117-66)

This invention relates to the art of porcelain enameling. Porcelain enameling consists of depositing upon a prepared surface of metal, e.g. iron or steel, a coating of pulverulent glass composition, known in the art as "frit," which when applied is suspended in water to make a slurry; drying the coating to leave a chalky layer of frit adhering to the surface and then fusing the frit into a tightly adherent vitreous glaze. The coating of slurry is sometimes applied by "dipping" i.e. by immersing the article to be coated bodily into a vat of slurry, lifting the body and permitting the excess slurry to drain off. In recent years, however, the coating has been usually applied by atomizing, i.e. air blast spraying.

Both dipping and spraying have disadvantages. Dipping involves handling, either manually or by machine, of the articles and if the excess slurry is not drained directly back into the vat in which the articles were immersed the excess slurry must either be wasted or be re-conditioned and rebled with fresh slurry. The dipping process thus is elaborate and slow and liable to produce products which are imperfect because of the formation of stalactites during drainage or because of marring during handling. Atomizing is wasteful of frit much of which is blown away by the air blast or taken away by exhaust ventilation to be disposed of as a dirty nuisance. Moreover, the coating applied by atomizing may be non-uniform, thick in some areas and thin in others, with edges and prominences left partially or completely bare, and it may contain pores which are the remains of minute bubbles of atomizing air that have formed upon surfaces being coated.

It is an object of this invention to provide a method and apparatus for expeditiously porcelain enameling articles, particularly metal sheets.

It is another object of the invention to provide a method and apparatus for porcelain enameling articles with a vitreous glaze of uniform thickness.

A further object is to provide a method and apparatus for porcelain enameling articles with vitreous glaze which covers edges and prominences as well as even surfaces.

It is a further object to provide a method and apparatus for porcelain enameling articles with a vitreous glaze which is free or substantially free of pores.

Another object is to provide a method and apparatus for porcelain enameling which involves a minimum of waste of glazing material.

Another object is to provide porcelain enameling apparatus in which glazing materials can be readily replenished as they are consumed and articles can be readily supplied to be porcelain enameled and removed after being porcelain enameled all without halting the operation of the apparatus.

Another object is to provide porcelain enameling apparatus having the characteristics indicated above which occupies minimum space and is not liable to get out of order.

Other objects and numerous advantages of the invention will be apparent upon perusal of the following description as illustrated by the accompanying drawings, in which:

FIG. I is a small scale schematic general layout in

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plan of one form of apparatus embodying the instant invention;

FIG. II is a side elevational view on a larger scale of the portion of the apparatus utilized in a step of applying a coating of slurry to articles being processed;

FIG. III is an end elevational view of the portion of the apparatus illustrated in FIG. II;

FIG. IV is a view in plan showing on an intermediate scale a portion of the apparatus illustrated in FIG. I with articles being carried around a turn in their path through the apparatus, and

FIG. V is an isometric view on a further enlarged scale showing parts of articles hung from a carriage as it rounds the turn.

These drawings and the description that follows illustrate and describe a preferred form of the invention but they are not intended to limit its scope.

In the form illustrated and described herein an oblong conveyor 1 conveys previously cleaned and prepared sheets 2 (which may be of corrugated steel and the dimensions of which may be e.g. 2' x 10') between upright pipes 3 the tops of which are closed and which have vertical slits 4 adjacent their tops. The lower ends of the pipes 3 are connected to a manifold 5 which in turn is connected to a pump 6, the pump 6 being operated by a motor 7. A conduit 8 leads from the pump 6 to the bottom of a tank 9 which is positioned directly below the pipes 3 and the manifold 5. The walls of the tank 9 are flared, the top is open and the tank is relatively shallow as compared to dipping vats heretofore used.

With the tank 9 containing an adequate supply of slurry, and corrugated sheets 2 moving between pairs of the pipes 3, slurry pumped from the tank 9 through the conduit 8 by the pump 6 is forced through the manifold 5 and the vertical pipes 3 and emerges from the slits 4 in flat streams which flow upon the upper edges and margins of the sheets 2 and thence downwardly over the sides of the sheets and from their lower edges into the tank 9 to blend with slurry in the tank and to recirculate therewith through the conduit 8, the pump 6, the manifold 5, the pipes 3 and over other sheets 2 that are in position to receive the flat streams emerging from the vertical slits 4. This circulation and recirculation ordinarily keeps the frit in suspension but in some installations ancillary stirring may be advisable.

The apparatus so far described, with the exception of the conveyor 1 and the sheets 2, is mounted on a framework 10 having casters 11, so that the framework 10 and the mechanism mounted thereon may be conveniently rolled about and may be exactly positioned relatively to the paths of the sheets 2. The pipes 3 are telescopic so that the heights of the slits 4 may be adjusted to discharge slurry most efficaciously.

The conveyor 1 in the form shown in the drawings comprises a track 12 under which carriages 13 are slung by means of hanger rods 14 which have rollers 15 that are journaled at the upper ends of the hanger rods and roll upon the track 12, there being a pair of hanger rods 14 and rollers 15 for each carriage 13. The lower ends of the hanger rods 14 are formed with hooks 16 which are engaged in openings 17 in a main hanger bar 18 in such manner as to permit slight swiveling and articulation at the joints between the hanger rods 14 and the main hanger bar 18.

Straddling the main hanger bar 18 at its center and pivotally and swivelly supported thereby is a yoke 19 having laterally extending equal arms 19'. (The yoke 19 may also have downwardly extending legs 19'' that can be utilized in carrying articles having shapes not adapted to being carried by the laterally extending arms.) Pivotal and swivelly supported at their centers upon the

outer ends of the laterally extending arms of the yoke 19 are beams 20, and hung, for limited pivotal and swivel movement, from the ends of the beams 20 are short lengths of wire 21 with hooks formed at their lower ends. The lower ends of the short lengths of wire 21 are hooked into eyelets or holes 22 in the upper margins of the sheets 2.

The carriages 13 are coupled into an endless train by means of links 25 and 26 which reach from each hanger rod 14 to the following hanger rod 14, the dimensions of the links 25 and 26 being such as to accommodate sheets 2 of the particular size to be porcelain enameled. Two carriages 13 linked in tandem carry a pair of sheets 2 suspended side by side. The ends of the pair of sheets carried by each tandem of carriages 13 are spaced sufficiently from the ends of the pair of sheets carried by the following tandem to avoid interference between the ends of the sheets whether they are being carried along a straight stretch of track 12 or around a curve in the track.

The train of carriages 13 is pulled at appropriate slow speed around the track 12 by any preferred type of traction mechanism, many types of which are commercially available. Since traction mechanism per se is not a feature of this invention it is not shown or described herein.

Each tandem of carriages 13 is loaded by hooking the lower ends of the short lengths 21 of wire into the holes 22 in the upper margins of the sheets 2 while the train is in continuous motion and before that tandem of carriages reaches the space above the tank 9.

As the sheets 2 pass between the vertical pipes 3 the flat streams of slurry flowing in nearly vertical planes from the slits 4 encounter the upper edges and upper margins of the sheets 2 and the continuous horizontal movement of the sheets 2 spreads the streams into thin liquid layers which slip rapidly down both sides of the sheets and off of the lower edges thereof. As the layers slip down the sides of the sheets 2 uniform alluvial coatings of wet frit stick to the sides and edges. The effect of thus applying the coating by flushing flat streams in vertical planes against the upper edges and margins and down the sides of the sheets is different from and superior to the effect of applying coatings by dipping or atomizing or even of applying slurry from nozzles which do not form it into streams that are flat. The flat streams are solid yet light, their vertical dimensions are great enough to cover the upper edges of the sheets with little overshoot even though the heights of the upper edges may vary somewhat from sheet to sheet.

The spread of the streams is great enough to obviate the liability of occurrence of uncoated islands by-passed by the streams, and the momentum of the downward flushing flow is great enough to carry away non-adhering residues. Other methods and apparatus leave muddy residues to creep slowly down the sheets. These residues are liable to lose water and form pasty irregularities, particularly on surfaces which are not vertical. The flushing action gives especially good performance on corrugated sheets. When corrugated sheets are processed while hanging from or standing on their longer edges, the surface area varies in steepness over each corrugation. The downwardly flushing slurry sweeps over the corrugations with no perceptible lag at the less steep areas and no perceptible thickening of the coating on the less steep areas, whereas the sluggish drainage that occurs when a sheet is lifted from a dip is liable to leave coatings that are undesirably thick on the less steep areas and undesirably thin on the more steep areas of the corrugated surface.

The mobility and momentum of the downwardly flushing layer causes rapid drainage as well as uniform coating. The only place where residues are liable to form welts or stalactites on the sheets coated by flushing according to the instant invention is along the lower edges of the sheets.

In order to forestall the formation of welts or stalactites along the lower edges of the sheets and to smooth

the coating over the lower edges, resilient wipers 27 are so mounted upon the tank 9 as to engage lightly the lower edges of the sheets 2 as the sheets move out of the space about the tank 9. Where the wipers 27 engage the lower edges of the sheets 2 drainage has been completed except for droplets which if they were to remain would form nodules or welts. The action of the wipers, however, removes the droplets and "batters" the alluvial frit smoothly along the edges. All of the slurry that returns to the tank 9 is reusable.

The conveyor 1 extends through a drying oven 28 preferably located on the same straight stretch as that on which the slurry applying mechanism is positioned. The casters 11 with the framework 10 constitute a cart 29 which enables the pipes 3 and the tank 9 to be positioned at such distances from the drying oven 28 that the coating, though damp, will not be too wet when the sheets enter the drying oven. The drying oven may be of any preferred type. Since the drying oven per se is not a feature of this invention it is not illustrated or described in detail herein.

After the coating on the sheets has been dehydrated the sheets travel from the drying oven around a curve in the track 12 and enter a fusing furnace 30 the particular form of which is not a feature of this invention and which therefore is not illustrated or described in detail herein.

The chalky coating on the sheets after drying is very fragile and liable to damage by scratching or scraping if the sheets should touch each other or anything else as they travel around the curved portion of the track 12 which leads from the drying oven 28 to the fusing furnace 30. The path of one of the sheets carried by each tandem of carriages 13 is shorter than the path of the other sheet but the construction and articulation of the carriages 13 as hereinbefore described permits the carriages to yield and go askew in a manner that results in the avoidance of damage and at the same time completes the preparation of the dried coating for fusing. It will be noted by the examination of FIG. II that the short lengths 21 of wire are not vertical when the sheets 2 are loaded on the carriage 13 but are so pulled out of plumb that they prevent the sheets 2 from swinging endwise or getting out of level to any important degree, though they hold the sheets against vagrant movements without imparting significant strains thereto. The yieldability of the carriage assemblies allows such relative movement of the sheets as occurs when they move along their shorter and longer inside and outside paths around the curved portion of the track 12 without setting up strains or bending in the carriage and without bending or otherwise deforming the sheets.

When slurry is flushed over the upper margins of the sheets residues sometimes form films over the eyelets or holes 22. These films when dried become crusts that after being fused into miniature glass panes would be broken in removing the hooked ends of the short lengths of wire 21 from the eyelets or holes 22. The breakage might extend into and damage the glazing around the holes. With the carriage designed according to this invention such crusts as may have been formed in the holes 22 are crumbled away by the rocking of the hooked ends of the wires 21 in the holes 22 as the carriages travel around the curved portion of the track before entering the fusing furnace.

As the sheets 2 are carried through the fusing furnace 30 the particles of pulverulent frit are fused together and fused to the metal of the sheets so that when the sheets cool below fusing temperature they are glazed uniformly with an imperforate, smooth, fire polished covering of porcelain enamel of superior quality.

After leaving the fusing furnace 30 the sheets are carried around a second curve of the conveyor 1 where the carriages 13 function in the same way that they functioned while carrying the sheets from the drying oven

around the first mentioned curve to the fusing furnace. After rounding the second curve, the porcelain enameled sheets having cooled to temperatures at which they can be handled by persons wearing asbestos mittens or gloves, are manually removed from the carriages 13 and replaced by precleaned and prepared sheets to be porcelain enameled.

The steps of the method hereinabove described, of flushing articles with slurry while they are traveling along oval paths carrying the articles in proper sequence with suitable timing through flushing, drying, fusing and replacement stages, produce superior porcelain enameled products with great economy of space, of time and of materials.

The flushing mechanism comprises a combination of features which enable articles to be coated with alluvial frit quickly and uniformly and with important economy of material.

The carriages of special design, proportioning and articulation are new and useful in themselves and in combination with the flushing mechanism and with the conveyor. The products, i.e. the corrugated sheets porcelain enameled by means of the process and apparatus hereinabove described, has outstanding characteristics of appearance, durability and low cost which are very valuable in a highly competitive market. Although these valuable characteristics of the product may be looked upon as matters of degree rather than matters of kind, the fact that they exist in the product enhances the attributes of patentability possessed by the method and apparatus by which the product is produced.

The embodiments of the invention hereinabove described and illustrated by the accompanying drawings are to be regarded as exemplary only and the invention is to be regarded as encompassing all modifications and variations within the scope of the invention as disclosed.

I claim:

1. A method of porcelain enameling metal articles which comprises the steps of making eyelets in said articles adjacent an edge thereof; hanging said articles from supporting means passing through said eyelets; moving a series of such supporting means to carry a succession of said articles horizontally through a coating stage, a drying stage and a fusing stage; applying vertically flat streams of slurry, consisting of a suspension of pulverulent frit in water, to the upper edges and to the upper margins of both sides of said articles as they move through said coating stage, whereby such slurry is flushed downwardly over both sides of said articles; applying wiping means to the lower edges of said sheets while said sheets are in motion and thereby removing excess slurry from the lower edges only of said articles; moving said supporting means in a straight path from said coating stage through said drying stage and in a curved path from said drying stage toward said fusing stage; rocking said supporting means in said eyelets to crumble dried residues of slurry from said eyelets while said supporting means are moving along said curved path; and moving said supporting means in a straight path through said fusing stage.

2. A method of porcelain enameling a metal article which comprises the steps of supporting said article with the surface to be enameled generally vertical, applying a flat, solid stream of slurry consisting of a suspension of frit in water to the upper edge of said surface of said metal article in a quantity sufficient to flow across said surface whereby an alluvial coating of damp frit is deposited on said surface; and fusing said frit remaining on said surface into an imperforate layer of porcelain.

3. A method of porcelain enameling as described in claim 2 further characterized in that said flat streams of slurry are substantially vertical.

4. A method of porcelain enameling a metal article which comprises the steps of supporting said article with the surface to be enameled generally vertical while mov-

ing it successively through a coating stage, a drying stage, and a fusing stage; applying a flat, solid stream of slurry, consisting of frit in water, to the upper edge of said surface of said article in said coating stage in a quantity sufficient to flow across said surface whereby an alluvial coating of damp frit remains on said surface; drying said surface in said drying stage; and fusing said frit into an imperforate layer on said surface in said fusing stage.

5. A method of porcelain enameling as described in claim 4 further characterized in that said flat stream of slurry is substantially vertical.

6. In apparatus for porcelain enameling metal articles, in combination, a conveyor adapted to position articles with their surface to be enameled in a substantially vertical position and to move said articles through a coating stage and a fusing stage; means including a nozzle having an elongated orifice for applying a flat stream of slurry consisting of a suspension of frit in water to a surface of said articles whereby an alluvial coating of damp frit remains on said surface; and means to position said nozzle orifice to direct said stream of slurry onto the upper margin of said surface to be coated.

7. In apparatus for porcelain enameling metal articles, in combination, a conveyor adapted to position articles so that the surface to be enameled is substantially vertical and to move said articles through a coating stage and a fusing stage; means including a nozzle having a vertically elongated orifice for applying a flat stream of slurry consisting of a suspension of frit in water to a surface of said articles whereby an alluvial coating of damp frit remains on said surface; means to position said nozzle to direct the stream of slurry upon the upper margin of the surface to be coated; and means removing excess slurry from the lower edge of said surface prior to said fusing stage.

8. In apparatus for porcelain enameling metal articles, in combination, a conveyor adapted to position said articles so that their surfaces to be enameled are substantially vertical and to move said articles through a coating stage and a fusing stage; said conveyor supporting said metal articles by means engaging holes formed in the upper portions of said articles; means including a nozzle having a vertically elongated orifice for applying a flat stream of slurry consisting of a suspension of frit in water to a surface of said articles whereby an alluvial coating of damp frit remains on said surface; means to position said nozzle orifice to direct said stream to the upper margin of the surface to be enameled; said conveyor adapted to move said engaging means in said holes formed in said articles after said coating stage to crumble dried residues of said slurry from said holes before said fusing stage.

9. In apparatus for porcelain enameling, in combination, a conveyor comprising a closed oblong track, a series of carriages movable along said track and hung therefrom by hanger rods, each of said carriages having an articulated frame consisting of a horizontal main hanger bar to the ends of which the lower ends of said hanger rods are connected for limited pivoting and swiveling, a member having arms extending laterally, said member being connected at its center to the center of said main hanger bar for limited pivotal and swiveling movement, a pair of beams pivotally and swivelly supported at ends of said laterally extending arms, and short lengths of wire swingingly depending from the opposite ends of said beams, said lengths of wire having hooked lower ends adapted to be hooked into eyelets in metal sheets, said carriages being linked into tandems of two carriages each, and said tandems being linked into endless trains, whereby each tandem is capable of carrying a pair of sheets along straight stretches of said oblong track and around curves thereof; flushing mechanism located in proximity to a straight stretch of said track for applying slurry to metal sheets as they are carried along by said tandems, said flushing mechanism including a tank having an

open top, a manifold above said tank, a pump and conduits for pumping slurry from said tank into said manifold, pipes extending upwardly from said manifold above said tank, said pipes having their upper ends closed and having vertical slits adjacent their upper ends and being adjustable in height, whereby the vertical slits may be positioned to discharge vertically flat streams of slurry upon the upper edges and margins of moving metal sheets so that layers of such slurry are flushed downwardly over both sides of said sheets leaving alluvial coatings of damp frit on the sides of said sheets and returning excess slurry to said tank.

10. In apparatus for porcelain enameling, in combination, flushing mechanism for applying slurry to metal sheets, said flushing mechanism including a tank having an open top, a manifold above said tank, a pump and conduits for pumping slurry from said tank into said manifold, pipes extending upwardly from said manifold above said tank, said pipes having their upper ends closed and having vertical slits adjacent their upper ends and being adjustable in height, whereby the vertical slits may be positioned to discharge vertically flat streams of slurry upon the upper edges and margins of moving metal sheets so that layers of such slurry are flushed downwardly over both sides of said sheets leaving alluvial coatings of damp frit on the sides of said sheets and returning excess slurry to said tank.

11. In apparatus for porcelain enameling, in combination, a conveyor comprising a closed oblong track, a series of carriages movable along said track and hung therefrom by hanger rods, each of said carriages having an articulated frame consisting of a horizontal main hanger bar to the ends of which the lower ends of said hanger rods are connected for limited pivoting and swiveling, a member having arms extending laterally, said member being connected at its center to the center of said main hanger bar for limited pivotal and swiveling movement, a pair of beams pivotally and swivelly supported at ends of said laterally extending arms, and short lengths of wire swingly depending from the opposite ends of said beams, said lengths of wire having hooked lower ends adapted to be hooked into eyelets in metal sheets, said carriages being linked into tandems of two carriages each, and said tandems being linked into endless trains, whereby each tandem is capable of carrying a pair of

sheets along straight stretches of said oblong track and around curves thereof; flushing mechanism located in proximity to a straight stretch of said track for applying slurry to metal sheets as they are carried along by said tandems, said flushing mechanism including a tank having an open top, a pump and conduits for pumping slurry from said tank into pipes extending upwardly above said tank, said pipes having their upper ends closed and having vertical slits adjacent their upper ends and being adjustable in height, whereby the vertical slits may be positioned to discharge vertically flat streams of slurry upon the upper edges and margins of moving metal sheets so that layers of such slurry are flushed downwardly over both sides of said sheets leaving alluvial coatings of damp frit on the sides of said sheets and returning excess slurry to said tank.

12. In apparatus for porcelain enameling metal sheets, in combination, a conveyor passing through a coating stage, a drying stage and a fusing stage, means for supporting such metal sheets from said conveyor with their major surfaces generally vertical, means at said coating stage for applying vertically flat streams of slurry from both sides to the upper edges of said sheets, and means for wiping excess slurry from the lower edges only of said sheets while they are being conveyed.

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