APPLYING VITREOUS ENAMEL

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Continuation-in-part of application Ser. No. 865,997, July 18, 1966. This application Apr. 9, 1968, Ser. No. 719,914

Int. Cl. B44d 1/94; C23d 5/04

U.S. Cl. 72—46

7 Claims

ABSTRACT OF THE DISCLOSURE

The invention relates to a process and apparatus for applying vitreous enamel by preheating metal sheet while wound in a coil, uncoiling the preheated sheet and progressing it forward while preferably stabilizing the temperature so that the sheet is at vitreous enameling temperature, applying dry powder vitreous enamel frit or slip to one or both sides of the heated sheet, melting the frit in contact with the sheet to form a molten vitreous enamel coating on the sheet and cooling the sheet and coating. The sheet is then in the preferred embodiment cooled to a temperature at which the enamel remains plastic and then deformed while the sheet and enamel are at that temperature. The temperature for deforming is desirably attained by cooling and then reheating slightly.

Further purposes appear in the specification and in the claims.

In the drawing I have chosen to illustrate a few only of the numerous embodiments in which the invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

FIG. 1 is a diagrammatic plan view of an enameling and corrugating mechanism according to the invention.

FIG. 1a is a view similar to FIG. 1 showing a variation in the corrugating mechanism.

FIG. 2 is a diagrammatic fragmentary end elevation of the corrugating mechanism at an early stage, showing a single upper corrugating roll and a pair of lower corrugating rolls.

FIG. 3 is a diagrammatic fragmentary end elevation at a more advanced point along the corrugating mechanism showing additional corrugating rolls in the upper and lower groups.

FIG. 4 is a side elevation of a modified form of corrugating rolls for use in the invention.

Describing in illustration but not in limitation and referring to the drawings:

An extensive industry has developed relating to the production of vitreous enameled metal sheet, applied for example on plain carbon steel, stainless steel, aluminum, or other metal base. The metal base may be an alloy composition especially intended for vitreous enameling as well known in the art.

The operation of vitreous enameling especially when applied on relatively large areas, has in the past been quite slow. This has been due to two factors. One reason for the slowness of the prior art vitreous enameling is that they have depended on taking a sheet or strip and heating it as it is progressed longitudinally. Heating under these conditions using desirable rates of heat input is necessarily a slow operation.

A further purpose for the slowness of the prior art enameling is that they have relied upon bringing the powder frit or slip, which is really a powder glass, into a coatable form by adding a liquid medium such as water, and in the actual enameling this must be eliminated with corresponding delay in the operation. Calton U.S. Pat. 2,428,307, granted Sept. 30, 1947 for Method of an Apparatus for Porcelain Enameling Sheet Metal.

By the present invention the metallic sheet in coil form is preheated to a temperature at least as great as 1000°F. In the case of steel sheet, and preferably just below the temperature of fusion of the frit, then the preheated coil is uncoiled and advanced while its temperature is regulated to the correct temperature for fusion of the frit, and then the dry powder frit is applied to one or both sides of the sheet while it is at the elevated temperature so that the frit will fuse on the metal surface as vitreous enameled coating.

The closer the temperature of preheating can be regulated to the temperature for fusing the frit, the less heat will have to be added as the sheet is progressing to the point of enameling and therefore the faster the overall operation.

If the sheet is desired in flat form, it is not necessary to corrugate or otherwise deform it. The invention, however, lends itself to corrugating or otherwise deforming the sheet after enameling. For this purpose the temperature of the sheet and the enamel is lowered to a temperature at which the enamel is soft or plastic but not liquid, for example a temperature of 1150°F to 1250°F, or approximately 200°F to 300°F below the fusion temperature of a commercial porcelain enamel, which is around 1450°F. The achieving of this plastic tempera-
ture is best done by cooling the enamel and the sheet after enameling as by an air blanket, and then adding a slight amount of additional heat in order to properly regulate the temperature to the enamel plastic temperature. The sheet can then be corrugated or otherwise deformed, for example deep drawn, at the plastic temperature of the enamel without cracking the enamel. Finally the sheet is cut to suitable size, as by a flying shear, either before or after the metal working operation.

As shown in FIG. 1, coils 20 of sheet 21 are mounted on reels in a manner which will permit unrolling of the sheet, the reels being supported on cars or dolleys 22 running on a railway track 23. The cars are run in the direction of the arrow 24 into a tunnel furnace 25 whose roof has been omitted in FIG. 1 to permit better illustration. The tunnel furnace has suitable incremental heating chambers 26 and 27 separated by swinging doors 28, it being understood that as many different increments or chambers will be used as desired. The fully heated or fully preheated coil 20 is positioned in a final chamber 30 in which the sheet is uncoiled and threaded through suitably driven pinch rolls 31 and then fed through a temperature adjusting or final heating furnace 32 suitably heated as by electric resistors 33. The intention is to add only a minor increment of heat to adjust to the actual enameling temperature in furnace 32.

From the furnace 32 the sheet passes continuously through enamel spray booth 34, suitably as a long stretch of sheet free from guiding rollers, and there it has deposited thereon, preferably on both sides, dry powder frit or slip, desirably from an electrostatic spraying mechanism 35 as well known in the art. While electrostatic spraying is preferred, it will be understood that the dry powder frit can be applied by mechanically propelling it or propelling it in a stream of air or by any other well recognized means of spraying dry powder.

The spray booth 34 is provided with a suitable stack 36 to eliminate dust.

As soon as the dry frit or slip contacts the metallic sheet heated to a temperature which will fuse the enamel, it adheres to the sheet and fuses thereon, making a layer of enamel on one or both sides of the sheet as desired.

Beyond the spray booth 34 and suitably separated therefrom, is a cooling chamber 37 which has on the top and bottom opposite the sheet downwardly and upwardly directed ports 38 through which a cool air blanket or stream is applied, sufficient to cool the enamel and the sheet to a temperature at which the enamel is no longer molten. Then the sheet continues through a heat control furnace or tunnel 40 suitably heated by electric heating elements 41 and capable of adjusting the temperature of the enamel and the sheet by adding a relatively slight amount of heat to make the enamel plastic but not molten.

Then the sheet with a plastic enamelled layer thereon is subjected to deformation, for example, to corrugation. In FIG. 1 the sheet passes through a corrugator 42, as well known in the art, bringing the sheet into contact with progressive top and bottom corrugating rolls. Thus as shown in FIG. 2, the sheet may first be contacted near the middle in the longitudinal direction by an upper corrugating roll 43 and lower spaced cooperating corrugating rolls 44 and 45.

At a more forward position as shown in FIG. 3 the sheet may be contacted with a set of spaced upper corrugating rolls 46, 47 and 48, and a transverse set of lower corrugating rolls 50 and 51, and so on progressively until the corrugation is complete.

Then the sheet is severed transversely by a flying shear 52, after which the severed sheets are taken off by a transfer mechanism not shown.

Other techniques for corrugating may be used as desired.

In FIG. 1a, after leaving the heat control furnace 40, the sheet may be severed by a flying shear 52 and then received on a transfer table 53 to be transferred by a transfer mechanism 54 and then to pass through a corrugator 55 having top and bottom cooperating corrugating rolls 56 and 57 as shown in FIG. 4. Finally the corrugated sheet is discharged at 58.

It will be evident that in the operation according to the invention most of the time taken up formerly in heating the sheet for preheat will be saved by preheating the steel as a coil, and also the time taken to drive off moisture will be saved since the frit is being applied as a dry powder. Thus speeds of the order of 100 feet per minute or more for advancement of the sheet can be obtained.

It will also be evident that various colors of enamel may be produced, for example by providing alternatively used spray booths for different colors in the production system.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art to obtain all or part of the benefits of my invention without copying the process and apparatus shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. A process of applying vitreous enamel to metal sheet, which comprises preheating the metal sheet wound in a coil, uncoiling the preheated metal sheet and progressing it forward, regulating the temperature of the sheet as it is progressed forward to vitreous enameling temperature prior to applying a dry powder vitreous enamel frit, applying dry powder vitreous enamel frit to at least one side of the heated sheet, melting the frit in contact with the sheet to form a molten vitreous enameling coating on the sheet, and cooling the sheet and coating.

2. A process of claim 1, which comprises electrostatically applying the dry powder frit to the sheet.

3. A process of claim 1, which comprises blowing the dry powder frit against the sheet by heated air to apply the frit.

4. A process of claim 1, which comprises applying the frit to both sides of the sheet.

5. A process of claim 1, which comprises cooling the sheet and frit by a stream of relatively cool air.

6. A process of claim 1, which comprises cooling the sheet and cooling to a temperature at which the enamel remains plastic and deforming the sheet and enamel while at that temperature.

7. A process of claim 1, which comprises after cooling further heating the sheet and enamel to a temperature at which the enamel is plastic, and deforming the sheet and enamel while at that temperature.

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U.S. Cl. X.R.

117—10, 17, 23