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METHOD OF AND APPARATUS FOR ENAMELING

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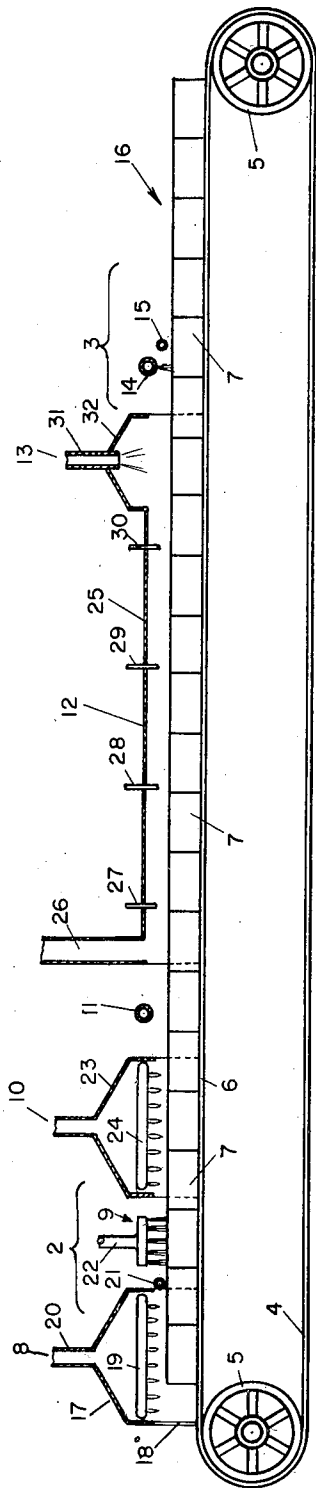


FIG. 1

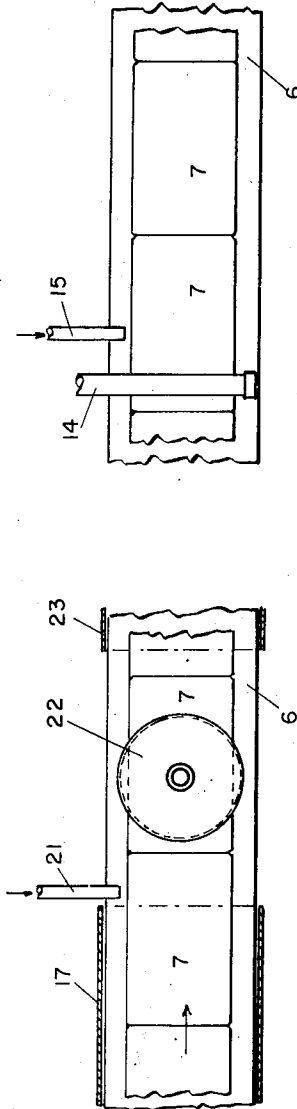


FIG. 2

FIG. 3

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METHOD OF AND APPARATUS FOR
ENAMELING

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12 Claims. (Cl. 91—55)

This invention relates as indicated to a method of and apparatus for enameling and more particularly to the enameling of non-metallic articles which may, on account of the nature of the material from which they are made, not be fired in a conventional muffle in accordance with the customary process of porcelain enameling.

In the enameling of non-metallic objects, the nature of the material from which the same are made introduces other difficulties not encountered in the enameling of metallic articles. In other words, it is of exceedingly greater difficulty to secure a continuous and uniform enameled finish coat on a non-metallic article, which is many times full of pores and gas occlusions and subject to deterioration under the influence of the heat employed in fusing the enamel, than in the enameling of a metallic object which can be safely heated to the fusion temperature of the enamel and even higher without undergoing any substantial change.

It is a principal object of my invention, therefore, to provide a method of and apparatus for the enameling of non-metallic objects, and by which a fused enamel finish coat may be secured which favorably compares with that which can at present be secured by conventional process on metallic objects.

Other objects of my invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, said invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative however of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

Fig. 1 is a side elevational view showing somewhat diagrammatic an apparatus embodying the process of my invention;

Fig. 2 is a fragmentary plan view partially in section of that portion of the apparatus illustrated in Fig. 1 indicated by the bracket 2; and

Fig. 3 is a fragmentary plan view of that portion of the apparatus illustrated in Fig. 1 embraced by the bracket 3.

Referring now more specifically to the drawing, and more especially to Fig. 1, the apparatus which is here illustrated as an embodiment of one form of my invention, and by which the process of my invention may be conveniently carried out, includes an endless conveyor belt or

chain 4 trained about spaced sprockets 5 so that on its upper run 6 the conveyor may carry a plurality of work objects 7 past the various treating stages. Any suitable form of conveyor may be employed, the endless belt type being illustrated for purposes of convenience. In the apparatus which has been constructed and operated successfully, the conveyor is driven by means of a variable speed motor so that the speed of travel of the work objects past the several stages may be controlled. Such a variation in the speed of the conveyor is usually not necessary after the apparatus has once been adjusted to handle a particular type of material. It will generally be found that with the treating stages arranged in the manner and for the purpose hereinafter more specifically defined, and when treating a material such as Haydite block for example, the conveyor may be set to operate at a speed of about two feet per minute, and such speed then progressively increased until maximum permissible speed is attained, and the speed then held at that point for continuous operation of the apparatus. The conveyor chain or belt 4 should be made of suitable material such as the conveyors generally employed in enameling furnaces in order that it may withstand high heat without deterioration.

The conveyor chain or belt 4 may be of any desired width so as to accommodate at least one row of the work objects to be enameled. In the commercial installation which has been made of this apparatus, this conveyor chain is several times wider than the width of the individual units being treated, so that depending upon conditions of operation, one or more rows of work objects may be simultaneously passed through the apparatus.

As above indicated, the conveyor is designed to substantially continuously move the work objects at the stated speed past a plurality of stages where various steps in my process are performed. These steps in the process can best be defined by having reference to the individual stages which, for purposes of convenience in identification in the following description, will be designated by the ordinals 8 to 16 inclusive.

The drier stage 8

At this stage, there is provided a hood generally indicated at 17, the same being provided with open ends just sufficient to permit the passage of the work objects 7 therethrough as carried by the conveyor 4. These openings, such as 18, may, if desired, be provided with swinging gates to automatically open when engaged by a

work object, and to close behind the work object as the same passes into the hood 17. It will generally be found more economical, however, especially when treating work objects of uniform size, to place the same in closely abutting relation on the conveyor 4 as illustrated in Fig. 1, and to then conform the opening 18 to the cross-section of the work objects so that they, in passing into the hood 17, act as a seal for such opening.

Positioned in the hood 17 is a burner 19 utilizing conventional fuels, such as hydrocarbon gas or oil, for the purpose of preheating and drying the work objects. The hood 17 is provided with a stack 20 through which the products of combustion and the moisture eliminated from the work objects may pass. The temperature maintained in the drier 8 should be sufficiently high so that in the interval during which the work objects pass therethrough, the surface area thereof to be enameled are thoroughly dried. This is necessary in order that in the succeeding stages of the process, especially during the firing of the finish coat, there will be no liberation of moisture from the work object which, in passing upwardly through the finish coat while the latter is in a molten state, would puncture or otherwise break the same. In the enameling of building units, such as Haydite block, cement block, cinder block and the like, this drying may be effected by maintaining a temperature on the order of 2000° F. in the predrier 8. Such temperature will be satisfactory when the speed of the conveyor is two feet per minute, and when the drying stage 8 is four feet long so that the work objects are in the drier for a period of two minutes. Changes may be made in the temperature and speed correlating the same to arrive at substantially the same results.

Mounted adjacent the discharge opening of the hood 17 is a blow pipe 21 so positioned as illustrated in Figs. 1 and 2 that a stream of air discharged thereby will sweep across the upper surface of the work objects as they are discharged from the hood 17. This air blast is effective to remove foreign articles, such as dust, dirt and the like, which may be lying on the surface of the work object to be enameled. It is, of course, desirable that all loose particles, such as dust, dirt and even small pieces of the work object which may have been loosened in the predrying chamber, be removed before the application of any of the protective coatings to the work.

Grip coat application stage 9

At this stage, a so-called grip coat is applied to the work objects by any conventional means. This grip coat is necessary and essential for certain types of material, and has two primary functions. First, it fills the irregular surface of the rough blocks and makes a smoother finish for the enamel to adhere to, and second, it serves to seal the work surface being enameled so that liberation of occluded gases or moisture in the form of steam from the work surface and through the finish coat will be reduced to a minimum. This grip coat may be any of a wide variety of suitable materials. I have found that in the enameling of Haydite block, for example, that the aggregate used in the manufacture of the block when reduced to a finely divided state, i. e. in the form of a powder, and mixed with sodium silicate sufficient to produce a spreadable mass, gives satisfactory results. The principal constituent of the grip coat should be a material which will fuse at the temperature to which the work sur-

face is later subjected so that a fused bond may be established between the grip coat and the work surface. There are a variety of materials available and well-known to those familiar with the art which have these properties, and any of them may be used with satisfaction. A water solution of sodium silicate is a convenient and relatively inexpensive medium by which the grip coat may be applied to the work.

Any one of a variety of well-known ways may be employed in the application of this grip coat to the work object. A transfer roll may be used, or more conveniently, a brush, such as 22, illustrated in Figs. 1 and 2. The brush 22 is what is commonly termed an end brush in that the body of the brush is circular, supported by a hollow shaft extending axially thereof with the bristles of the brush extending in the opposite direction from the circular head. The grip coat, in a fluid state, is fed to the bristles through the hollow supporting handle or shaft, and the brush simultaneously rotated to spread such grip coat evenly over the work surface. The diameter of the brush should only be slightly greater than the width of the work pieces so that the entire width of the work may be covered without wastage of the grip coat.

The thickness at which this grip coat is applied to the work will vary according to the nature of the work surface, it being kept in mind that one of its functions is to provide a smooth surface for the reception of the ultimate finish coat. Thus, when operating upon building units made of Haydite or cinders or the like, the surface of the block may contain a large number of voids and small openings. In order to secure a smooth finish coat, the grip coat should be applied to the work surface with sufficient thickness so as to fill all of the voids on the work surface.

When using a mixture such as sodium silicate and Haydite dust or the like, some difficulty may be encountered in spreading the grip coat uniformly over the work surface especially since the latter is in a heated state as a result of having just passed through the predrier 8. The heated surface of the work unit has a tendency to very rapidly absorb the moisture content of the grip coat, and thus interfere with its uniform distribution. This difficulty may be overcome by entraining a small amount of water, either in the form of finely divided water or steam, in the air stream of the cleaning jet 21. This moisture will be absorbed only by an extremely thin surface layer of the work pieces, and will subsequently be evaporated in the grip coat drier presently to be described.

Grip coat drying stage 10

At this stage, there is provided a hood 23 generally similar to the hood 17 at the predrying stage 8. A burner 24 or other suitable means may be provided in the hood 23 for the purpose of generating sufficient heat and agitation of the air therein to effect a drying of the grip coat. Here again, that must be observed to insure that the grip coat will be thoroughly dry so that no moisture will be given off by it in the form of steam to rise upwardly through and puncture the finish coat ultimately fused thereover. The size of the hood 23, i. e. its extent in the direction of travel of the conveyor, and accordingly the time during which the work objects are in the hood 23, will determine the temperature to be maintained in such hood. In the commercial

apparatus above referred to, the hood 23 is four feet long so that the work objects are required two minutes to pass therethrough at a conveyor speed of two feet per minute, and the temperature in such hood is maintained at 1400° F. using a Haydite dust-sodium silicate grip coat on Haydite building blocks.

Finish coat spray stage 11

While this stage has, in the drawing, been represented diagrammatically by a spray nozzle for the application of the finish coat to the work objects, nevertheless, it will be found that in actual practice a conventional spray booth such as is employed in enameling plants will be most suitable in that the area where the spraying is performed is laterally enclosed and vented to prevent scattering of the spray over areas other than the surface of the work to be enameled. One or more spray guns properly arranged and directed at the work may be provided so that as a continuous line of work objects are moved past the spray stage they will receive a uniform coating of enamel.

At this point, it may be well to point out that in the enameling of building units of the character to be used in walls and the like, a mottled appearance is generally more pleasing to some people than a solid color, and in the production of such an appearance, an underlying continuous finish coat of one color may be applied by one or more spray guns, and thereafter a so-called splatter coat may be applied by means of a splatter gun in a color contrasting to the underlying coat, and the variegated appearance thus produced.

The enamel slip which is applied to the work at the stage 11 will desirably be formed of an enamel which has two principal characteristics in addition to the other characteristics generally found desirable in enamels. First, the enamel should have a relatively low fusing point, and second, the enamel should have a relatively low coefficient of thermal expansion. These two characteristics are desirable for the reasons that in the enameling of non-metallic objects, such as building units, it is desirable to keep down as low as possible the ultimate temperature to which the work object is subjected during the firing or fusion of the finish coat, and secondly the coefficient of thermal expansion of the non-metallic work objects is usually considerably less than the coefficient of thermal expansion of metallic articles, so that an enamel which might work satisfactorily on a metallic article might have too high a coefficient of thermal expansion, and accordingly tear or crack when applied to a non-metallic work object.

While it is desirable, as indicated above, that the enamel have a relatively low fusion point, nevertheless, enamels or glasses which have a relatively high fusion point may be used depending on the nature of the work being enameled and accordingly the degree to which the same may be raised in temperature. In the enameling of Haydite blocks, such as conventional building blocks, I have secured successful results by the use of an enamel which is fundamentally similar to the glass commercially known as Pyrex. Successful results have also been secured with the use of glazes of the type employed for the surface ornamentation of glass objects. These are representative of the wide limits in so far as melting point is concerned of the glass or enamel which may be used.

After leaving the finish coat spray stage 11, it is especially important in the enameling of non-metallic objects to have the work piece and the grip and finish coats thoroughly dry before an attempt is made to fuse or fire the same.

Finish coat dry and preheating stage 12

In order that the grip coat, finish coat, and the underlying work surface may be thoroughly dry, i. e. free from moisture as well as occluded gases which might pass upwardly through the finish coat during the firing operation to disrupt the same, the work pieces are led through an elongated tunnel in which they are subjected to progressively higher temperatures. This pre-drying or preheating stage may be conveniently provided by leading through a tunnel, such as 25, the flame and other products of combustion from the firing stage 13. By providing a stack such as 25 at the forward end of the tunnel 12, the temperature conditions as above specified may be conveniently obtained. In order to observe the temperature conditions which will be maintained in the tunnel 12, thermo couples, such as 27, 28, 29 and 30 may be provided at convenient uniformly spaced points, and the damper in the stack 26 adjusted so as to maintain the desired temperature at such points. Baffles in the tunnel might also be resorted to if necessary to secure the proper control. The temperatures in the various thermo couple stages which I have found to produce satisfactory results in the commercial installation above referred to will be indicated in connection with a description of the flash fire stage.

In the commercial installation above referred to, satisfactory results have been secured by the use of a tunnel 12 which is approximately fourteen feet long with a conveyor speed of two feet per minute so that the work objects are in the drying and preheating tunnel 12 for a period of approximately seven minutes. By making the lateral walls of the tunnel 12 laterally adjustable, i. e. adjustable on a line transversely of the direction of travel of the conveyor 4, the size of the tunnel may be altered to accommodate various widths of work pieces. This is desirable since the interior space of the drying and preheating tunnel if made to conform rather closely to the cross-section of the work pieces will result in more efficient operation since the stream of gases flowing through the tunnel will be in more intimate contact with the work surface, and a greater turbulence set up in such stream.

Flash fire stage 13

The principal equipment in the flash fire stage 13 is a high temperature burner generally indicated at 31, the same having a hood generally indicated at 32 associated therewith for the purpose of confining the generated heat. One form of such burner is illustrated in my copending application Serial Number 308,842, filed December 12, 1939. The burner 31 utilized at stage 13 should be capable of generating a temperature on the order of about 2800° F. The size of the work surface being treated, the speed at which the work pieces are led past the burner, and other factors have a bearing on the amount of heat required at the flash fire stage. Temperatures on the order of those indicated have been attained in the flash fire stage of the finish coat on Haydite block, for example, in a burner utilizing from about 750 to 1500 cubic feet per hour of a mixture of artificial and natural gas having

about 750 B. t. u. per cubic foot. In the operation of the commercial installation under the condition above specified, the average temperatures at the thermo coupled stations 27, 28, 29 and 30 were 760° F., 1115° F., 1500° F., and 2000° F., respectively.

The enamel used will, of course, fuse at a temperature much less than 2800° F. However, this high temperature is necessary and desirable in order that the finish coat may be thoroughly fused and thus bonded to the work without an excessive heating of the work object. By utilizing a temperature on the order of 2800° F., complete fusion of the vitreous or porcelain enamel finish coat may be secured in periods not substantially in excess of one minute. I have operated the commercial apparatus referred to above under such conditions that a unit area of work surface is subjected to the high temperature flame for a period of thirty seconds, and for as short a time as fifteen seconds and even eight seconds with thorough fusion and satisfactory bond of the finish coat to the work surface.

Shock chilling stage 14

As previously indicated, many porcelain enamels with a fusion range low enough to be satisfactorily employed in the enameling of non-metallic articles have a coefficient of thermal expansion considerably greater than the coefficient of thermal expansion of the work object to which the enamel is applied. This fact, coupled with the fact that the enamel passes through a very much greater temperature than does the less highly heated work surface, has a tendency to cause checking or crazing of the enamel upon cooling. I have found that this can be satisfactorily overcome by shock chilling the enamel in its very highly heated state as it leaves the flash firing stage 13. This is accomplished by provoking a stream of water onto the molten finish coat immediately as it issues from the flash fire stage. Successful results have been secured by regulating the supply of water to such an extent that small pools of water actually rest on the surface of the very highly heated enamel finish coat. This shock chilling is effective to eliminate the crazing of the finish coat which would otherwise occur. This is an important step in my process.

Water quench blow-off 15

In order that the water quench or shock chilling may be stopped with sufficient heat remaining in the work surface being enameled and in the finished coat itself, so that subsequent annealing of the finish coat may take place, it is necessary that the water admitted to the highly heated finish coat be removed before the finish coat has cooled to too great an extent. This is conveniently accomplished by an air jet at stage 15 directed across the enamel face of the work surface to blow all moisture therefrom, and to permit the cooling under atmospheric conditions of the work surface thereafter.

The cooling stage 16

After the shock chilling stage, above referred to, the conveyor 4 carries the work pieces through a cooling zone which may be opened to the atmosphere or in which the temperature may be controlled if desired. It has not been found necessary to regulate the rate of cooling in this cooling stage since exposure of the work surfaces to the atmosphere generally permits cooling

thereof at the proper rate so that annealing of the finish coat in the manner above described may take place, and so that the finish coat does not cool too rapidly in order to produce further checking or crazing.

The process above described may be varied from the precisely stated procedure in order to adjust the same to the requirements of the particular material being enameled. Thus, for example, when a non-metallic article is enameled which has a glazed coating, i. e. a surface for the reception of the enamel, which surface is sufficiently dense and smooth so that the two requirements for a grip coat as above explained are not present, then such grip coat may be omitted. Other changes in the described process may be made in order to adapt the same to variation in properties of the particular material being enameled.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

I therefore particularly point out and distinctly claim as my invention:

1. The method of vitreous enameling non-metallic articles which comprises subjecting the surface thereof to be enameled to the following successive steps; a finish coat of vitreous enamel; a drying and preheating of such finish coat; a flash fire at a temperature on the order of about 2800° F. for a period on the order of about 30 seconds; and a shock chilling of the finish coat while the latter is in highly heated condition.

2. The method of vitreous enameling non-metallic articles which comprises subjecting the surface thereof to be enameled to the following successive steps; a grip coat to seal the work surface; a drying of the grip coat; a finish coat; a drying and preheating of the finish coat; and a flash fire at a temperature high enough to fuse the finish coat in a period not substantially in excess of one minute.

3. The method of vitreous enameling non-metallic articles which comprises subjecting the surface thereof to be enameled to the following successive steps; a grip coat to seal the work surface; a drying of the grip coat; a finish coat; a drying and preheating of the finish coat; a flash fire at a temperature high enough to fuse the finish coat in a period not substantially in excess of thirty seconds; and a shock chilling of the finish coat while the latter is in highly heated condition.

4. The method of vitreous enameling non-metallic articles which comprises subjecting the surface thereof to be enameled to the following successive steps; a predrying; a grip coat to seal the work surface; a drying of the grip coat; a finish coat; a drying and preheating of the finish coat; and a flash fire at a temperature high enough to fuse the finish coat in a period on the order of about thirty seconds.

5. The method of vitreous enameling non-metallic articles which comprises subjecting the surface thereof to be enameled to the following successive steps; a predrying; a grip coat to seal the work surface; a drying of the grip coat; a finish coat; a drying and preheating of the finish coat; a flash fire at a temperature high enough to fuse the finish coat in a period on the order of about thirty seconds; and a shock chilling of the finish coat while the latter is in highly heated condition.

6. The method of vitreous enameling non-metallic articles which comprises subjecting the surface thereof to be enameled to the following successive steps; a predrying at a temperature on the order of about 2000° F. for a period on the order of about two minutes; a cleaning to remove foreign material; a grip coat to seal the work surface; a drying of the grip coat at a temperature on the order of about 1400° F. for a period on the order of about two minutes; a finish coat; a drying and preheating of the finish coat; a flash fire at a temperature on the order of about 2800° F. for a period on the order of about thirty seconds; a shock chilling of the finish coat while the latter is in highly heated condition; and an air blast to remove the shock chilling medium and permit the fused finish coat to cool under atmospheric conditions.

7. In apparatus for the vitreous enameling of non-metallic articles, the combination with conveyor means for carrying the work objects past a plurality of treating means, for the work surface to be enameled, said means being adjacent such conveyor and respectively comprising; means for applying a finish coat to the work surface; means for drying and preheating the finish coat; a flash fire means where the finish coat is fused by being subjected to a temperature on the order of about 2800° F. for a period on the order of about thirty seconds; and a water quenching means where the finish coat while in highly heated condition is subjected to shock chilling.

8. In apparatus for the vitreous enameling of non-metallic articles, the combination with conveyor means for carrying the work objects past a plurality of treating means for the work surface to be enameled, said means being adjacent such conveyor and respectively comprising; means for applying a grip coat where a material effective to seal the work surface and increase the adhesion of the enamel thereto is applied to the work surface; means for drying said grip coat; means for applying a finish coat to the work surface; means for drying and preheating the finish coat; and a flash fire means where the finish coat is fused by being subjected to a temperature high enough to fuse the finish coat in a period not substantially in excess of one minute.

9. In apparatus for the vitreous enameling of non-metallic articles, the combination with conveyor means for carrying the work objects past a plurality of treating means for the work surface to be enameled, said means being adjacent such conveyor and respectively comprising; a predrying means; a grip coat application means where a material effective to seal the work surface and increase the adhesion of the enamel thereto is applied to the work surface; a grip coat drying means; a finish coat station where the finish coat is applied to the work surface; a drying and preheating means where the finish coat is dried and preheated; and a flash fire means where the finish coat is fused by being subjected to a temperature high enough to fuse the finish coat in a period on the order of about thirty seconds.

10. In apparatus for the vitreous enameling of non-metallic articles, the combination with con-

veyor means for carrying the work objects past a plurality of treating means for the work surface to be enameled, said means being adjacent such conveyor and respectively comprising; a grip coat application means where a material effective to seal the work surface and increase the adhesion of the enamel thereto is applied to the work surface; a grip coat drying means; a finish coat station where the finish coat is applied to the work surface; a drying and preheating means where the finish coat is dried and preheated; a flash fire means where the finish coat is fused by being subjected to a temperature high enough to fuse the finish coat in a period not substantially in excess of about thirty seconds; and a water quench means where the finish coat while in highly heated condition is subjected to shock chilling.

11. In apparatus for the vitreous enameling of non-metallic articles, the combination with conveyor means for carrying the work objects past a plurality of treating means for the work surface to be enameled, said means being adjacent such conveyor and respectively comprising; a predrying means; a grip coat application means where a material effective to seal the work surface and increase the adhesion of the enamel thereto is applied to the work surface; a grip coat drying means; a finish coat means where the finish coat is applied to the work surface; a drying and preheating means where the finish coat is dried and preheated; a flash fire means where the finish coat is fused by being subjected to a temperature high enough to fuse the finish coat in a period on the order of about thirty seconds; and a water quench means where the finish coat while in highly heated condition is subjected to shock chilling.

12. In apparatus for the vitreous enameling of non-metallic articles, the combination with conveyor means for carrying the work objects past a plurality of treating means for the work surface to be enameled, said means being adjacent such conveyor and respectively comprising; a predrying means where the work surface is subjected to a temperature on the order of about 2000° F. for a period on the order of about two minutes; a cleaning means where the work surface is freed of foreign material; a grip coat application means where a material effective to seal the work surface and increase the adhesion of the enamel thereto is applied to the work surface; a grip coat drying means where the grip coat is subjected to a temperature on the order of about 1400° F. for a period on the order of about two minutes; a finish coat means where the finish coat is applied to the work surface; a drying and preheating means where the finish coat is dried and preheated; a flash fire means where the finish coat is fused by being subjected to a temperature on the order of about 2800° F. for a period on the order of about thirty seconds; a water quench means where the finish coat while in highly heated condition is subjected to shock chilling; and an air blast means where the water quench is blown off from the work to permit the fused finish coat to cool under atmospheric conditions.

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