

# UNITED STATES PATENT OFFICE.

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## MANUFACTURE OF ENAMELED WARE.

SPECIFICATION forming part of Letters Patent No. 564,217, dated July 21, 1896.

Application filed March 16, 1896. Serial No. 583,439. (No specimens.)

*To all whom it may concern:*

Be it known that I, ALEXANDER NIEDRINGHAUS, a citizen of the United States, residing at the city of St. Louis, State of Missouri, have  
5 invented a certain new and useful Improvement in the Manufacture of Enameled Ware, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which the invention ap-  
10 pertains to make and use the same.

This invention relates to a new and useful improvement in the manufacture of enameled ware; and it consists, essentially, in the method of treating the base, or the part which  
15 is to be enameled.

Heretofore, in the manufacture of enameled ware, iron has generally been used as a base. Steel has been used to a greater or less extent for some wares, but with the result, generally,  
20 that pin-holes, flecks, and chips occur to such an extent as to constitute a serious objection to its use, destroying the beauty and impairing the usefulness of the enameled ware. "Pin-holes," as they are called, appear irregu-  
25 larly over the enameled surface, and are the result of the development of a gas or gases beneath the enamel coating during the fusion of the glaze, forming bubbles, which, bursting, expose the black metal beneath. "Flecks,"  
30 as they are called, also appear irregularly over the enameled surface, but are apparently produced by different or modified causes from that ascribed to pin-holes. These flecks, or scale-like chips, differ in depth and size. Some  
35 of them extend down to and expose the surface of the base, while others are more shallow and show the dark color of the glaze near the base. In many instances the enamel is not entirely flecked off, but is loosely attached,  
40 appearing white where the rupture of the fleck extends beneath the surface of the enamel. Moreover, it is known that these fleckings occur after the ware has been removed from the muffle, and it may be some time before  
45 they appear. "Chips," or "chippings," as they are called, are generally found at corners of the ware, and expose the surface of the base to a considerable extent. This is supposed to be the result of insufficient attach-  
50 ment of the enamel to the base, aggravated by the strain of gases in some cases, causing

it to flake or chip off in large pieces and expose the base.

I am aware that colored enamel, consisting of two or more coats, has been applied to steel. 55 This is accomplished by burning the first coat, which is usually colored with cobalt or manganese, into the steel under excessive heat. If any of the defects to which I have heretofore referred are present in this first coat, they  
60 do not constitute a serious objection, because they are cured or covered by the second coat of soft and easy-fusing glaze, which is generally opaque, so as to hide the first coat.

I will now describe my invention, and, in 65 the beginning, desire to be understood as not limiting myself to the exact ingredients herein named, the proportion of such ingredients as I have found by experiment desirable to use, nor the particular manner herein described of  
70 using the ingredients, as it is obvious that there are many equivalents which could be employed with more or less success.

To begin with, in the manufacture of mottled enameled ware having steel for its base 75 the same general steps are employed to convert the raw material into a finished article, with such exceptions as I will note, as are employed in making mottled enameled ware with iron for its base. The base, either steel or  
80 iron, having been rolled into sheets, is stamped or seamed into form and enameled.

This invention is based upon the discovery that sulfur, incorporated into the base either during the manufacture of the metal base or 85 while the base is being annealed, causes the metal to be particularly well adapted to the reception of a perfect glaze of mottled or variegated enamel, or, in fact, of any well-known or suitable enamel. It has been found by ex- 90 periment that from .12 to .20 per cent. of sulfur in the steel or homogeneous iron gives excellent results, but of course it is understood that this percentage could be changed to suit different conditions. 95

In carrying my invention into effect I may either anneal the steel in the presence of sulfur, or I may incorporate the sulfur into the steel or homogeneous iron at the time of its manufacture, as above stated. 100

In annealing the steel or homogeneous-iron base in the presence of sulfur, I introduce the



sulfur into the annealing-pot, preferably in the "first annealing," as it is known in the art, and in about the proportion of two pounds of sulfur to one hundred pounds of steel, and sub-  
 5 ject the same to a proper annealing heat, which generally takes from three to six hours. It has been found that this sulfur treatment of the base has the peculiar effect of preventing the production of bubbles, pin-holes,  
 10 flecks, and scale-like chips, above described, which treatment also enables the base to receive a coat of enamel which firmly and uniformly adheres thereto, thus producing a superior article of enameled ware. By this  
 15 sulfur treatment the steel is also rendered more sensitive to receive the enamel by being more thoroughly etched.

Instead of adding the sulfur in the first annealing, as hereinabove described, it may  
 20 be introduced into the annealing-pot after the metal has been shaped into form of ware, that is to say, the ware having been stamped out, or shaped, is put into the annealing-pot and the sulfur introduced in about the pro-  
 25 portions above set forth. The annealing-pot is then closed and heat applied for from three to six hours until the sulfurous fumes shall have become thoroughly incorporated with the metal base, after which the metal base  
 30 thus treated can be subjected to the enameling process with the beneficial results hereinabove indicated.

It has been found that if chlorid of calcium, in the proportion of about three-fourths of a  
 35 pound of said chlorid of calcium to one hundred pounds of steel, be added to the sulfur in the annealing-pot the satisfactory results hereinabove indicated will also follow, and that if, instead of chlorid of calcium, other  
 40 chlorids, a salt of ammonia, or niter be used in conjunction with the sulfur, like results will be produced. Hence this invention, which, broadly considered, consists in the incorporation of the sulfur, in about the proportions

indicated, with the metal base, will not be 45 avoided by adding to the sulfur either the chlorid of calcium or analogous substance.

Having thus described the invention, what I claim, and desire to secure by Letters Patent, is—

1. The process herein described of preparing steel for enameling, which consists in combining it, in the presence of heat, with sulfur; substantially as described. 50

2. The process herein-described of preparing steel for enameling, which consists in subjecting the steel to the action of sulfur before it is coated with the enamel; substantially as described. 55

3. The herein-described process of preparing steel for enameling, which consists in annealing the same in the presence of a chlorid and sulfur; substantially as described. 60

4. The herein-described process of making enameled ware, which consists in first charging the steel with sulfur and in then applying the enamel thereto and fusing the same thereon; substantially as described. 65

5. The herein-described process of preparing steel for enameling, consisting in impregnating the same with elements which destroy the effect of gases injurious to the enamel; substantially as described. 70

6. The herein-described process of preparing steel for enameling, which consists in rendering the steel insensible to gases injurious to the enamel, which treatment also has a physical effect upon the steel, rendering its surface capable of effecting an intimate adhesion of the enamel; substantially as described. 75 80

In testimony whereof I hereunto affix my signature, in presence of two witnesses, this 14th day of March, 1896.

ALEXANDER NIEDRINGHAUS.

Witnesses:

HUGH K. WAGNER,  
 F. R. CORNWALL.