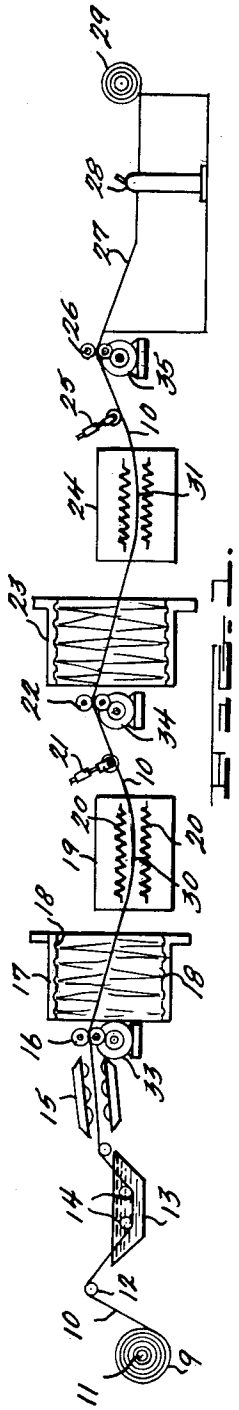
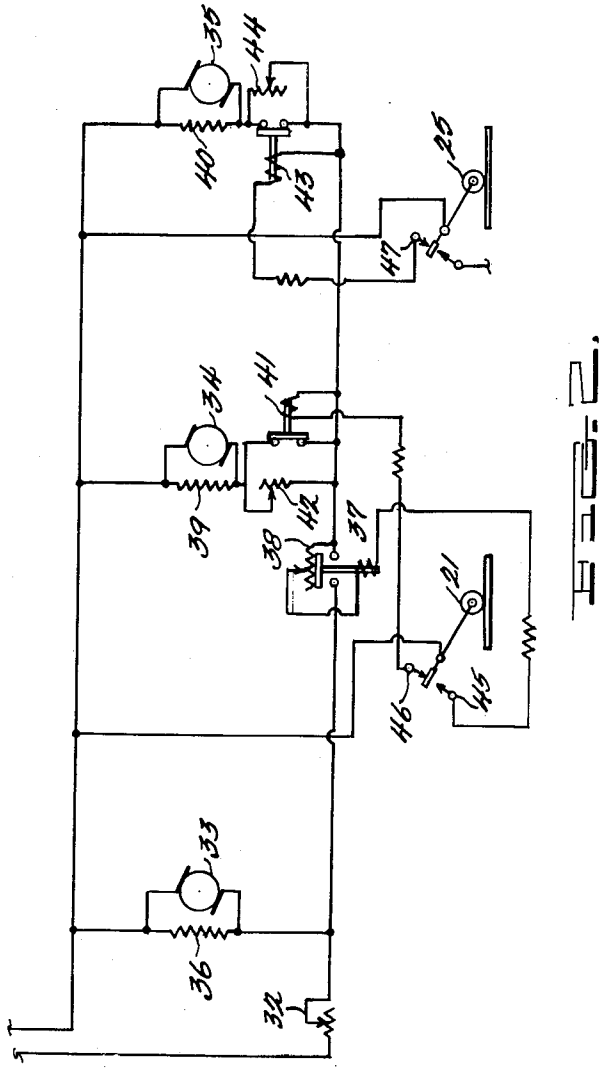
Jan. 1, 1952 R. G. CALTON 2,580,406

APPARATUS FOR PORCELAIN ENAMELING SHEET METAL

Filed Nov. 2, 1949





INVENTOR
ROBERT G. CALTON

BY Adams + Birch

ATTORNEYS

Patented Jan. 1, 1952

2,580,406

UNITED STATES PATENT OFFICE

2,580,406

APPARATUS FOR PORCELAIN ENAMELING SHEET METAL

Robert G. Calton, Nashville, Tenn.

Application November 2, 1949, Serial No. 125,087
In Canada October 28, 1949

3 Claims. (Cl. 91—13)

1

This invention relates to methods of and apparatus for porcelain enameling sheet metal and has more particular reference to a method and apparatus for continuously applying porcelain enamel to thin sheet steel or thin sheet iron.

In the firing of porcelain enameled sheet iron of 20 gauge or lighter, it has been the practice to either support the article in a horizontal plane on spaced pins or the like, or to hang the article from hooks on a chain which carries the articles through a firing zone. It has never been possible heretofore to fire large flat pieces thinner than 20 gauge by either of these procedures. If the workpiece was rested on the conventional firing pins in a horizontal position, the base metal was softened during the firing operation to an extent sufficient to cause sagging in the areas between the pins and noticeable deformation in the supported areas. A sheet thus fired with the base metal deformed will always show the presence of such deformed area because of the reflective nature of the poreclain enamel coating. Furthermore the cooled sheet was severely warped and did not present an adequate flat surface. When the sheets have been hung from hooks and fired by being carried through a furnace, the sheets usually warped, due not only to the weight of the sheet itself, but also the inherent stresses which are present in the sheet. Thin sheets, that is, thinner than 20 gauge, when fired in this way also tend to exhibit an overall "crinkled" effect due to the unequal softening of the sheet in local areas and the internal stresses in the sheet as aforesaid.

It is therefore a principal object of this invention to provide a new and novel method of and apparatus for continuously porcelain enameling sheet metal ranging from 20 to 40 gauge, without the enameled sheet metal warping or showing areas of deformation.

Another object of this invention is to provide a method of and apparatus for continuously porcelain enameling sheet metal ranging from 20 to 40 gauge, whereby the fired finished surface thereof is a dense continuous and non-porous glassy surface which will not become soiled by dirt and other foreign material becoming embedded therein.

A further object of this invention is to provide means for maintaining a predetermined amount of sag in the metal sheet during its travel through the processing apparatus.

Other objects and advantages of the invention will appear in the specification when considered

2

in connection with the accompanying drawing, wherein;

Fig. 1 is a diagrammatic elevational view of the apparatus of the invention, with parts broken away to show the interior of certain of the elements; and

Fig. 2 is a diagrammatic elevation view of the device for automatic control of sag in the steel strip.

This application is a continuation-in-part of my copending application, Serial No. 735,617, filed March 19, 1947, now abandoned, and entitled, "Method of and Apparatus for Porcelain Enameling Sheet Metal."

Broadly stated this invention provides a method for continuously poreclain enameling an elongated strip of sheet iron from 20 to 40 gauge free of surface blemishes and local deformed areas which comprises applying and firing the porcelain enamel coating onto said elongated metal strip while the same is freely suspended under tension between spaced supports.

Referring now to the drawing and more specifically to Fig. 1 there is shown a coil or roll 9 of sheet metal 10, ranging from 20 to 40 gauge mounted on a horizontal spindle 11. The sheet passes over idle roller 12 through a vat 13 filled with a nickel sulfate solution of approximately 12 oz./gallon, the sheet being held below the surface of the solution by means of idle rollers 14. From the nickel sulfate solution the sheet passes through a drying chamber 15 which may comprise heat lamps or other suitable heating elements, where the sheet is dried. From the drying chamber 15 the sheet passes through driven rollers 16 into a spraying chamber 17 indicated as having a series of spray heads 18 for applying the porcelain enamel slip on one or both sides of the sheet. From the spray chamber, the sheet passes through a firing chamber 19 shown diagrammatically as being heated electrically by resistors 20. It is to be understood that the heat may be applied in any other suitable manner.

From the furnace the fired sheet passes under sag control device 21, through driven rollers 22 into a second spray chamber 23 identical with spray chamber 17. From the second spray chamber 23 the sheet passes through a second firing chamber 24 identical with firing chamber 19. The sheet emerges from the second firing chamber 24 as the finished product. As the finished sheet emerges from the second firing chamber 24 it passes under a second sag control device 25 and then through driven rollers 26. The sheet

emerging from driven rollers 26 passes onto shearing bench 27 where it is sheared into proper lengths by automatic shears 28 and rolled into a coil 29. If it is desired the sheared sheets may be left flat instead of being rolled into a coil.

As shown in Fig. 1, the driven rollers 16, 22, and 26 are positioned sufficiently above the entrance and exit openings of the spraying and firing chambers so as to permit the formation of sag in the sheet as it passes through these chambers. The motors which drive rollers 16, 22 and 26 are shunt wound adjustable speed D. C. motors. It is one of the essential features of this process that the sag be predetermined and maintained constant. The amount of sag being such that the slack provides sufficient tension to prevent buckling and warping due to the extreme heat (1500–1600° F.) of the firing chambers. Due to the thinness and flexibility of the sheet, the sag will be substantially in the form of catenaries as indicated at 30 and 31.

In the area between spaced suports 16 and 22 and 22 and 26 the sheet has the enamel applied thereto in the form of a paste or slip. The first or ground coat is applied on the order of two-thousandths inch thickness. The enamel is dried and then by passing through the first firing chamber the enamel is fired onto the sheet at about 1560° F. while the latter is under longitudinal tension. Thus by this process all "crinkling" of the sheet is avoided and likewise the sheet, because it is not in contact with any supports during its softened state, does not have any deformed areas imparted thereto as has been the case of the practice heretofore employed. The fired sheet thus emerging from the first firing chamber free of "crinkling" and deformed areas is now ready for its second or cover coat. The cover coat is usually applied on the order of four-thousandths inch in thickness and is fired at about 1560° F. It is to be noted that here again the predetermined sag is maintained for the reasons previously mentioned. A finished sheet thus produced is different from the sheets produced by previous practices not only from the standpoint of being smooth flat plane as compared wth the uneven products previously made but also the hardened porcelain enamel coating is affixed to the sheet in a much more uniform physical state. Since it is imperative that the porcelain enamel once fused onto the iron surface does not chip or spall off it is necessary for the porcelain enamel to have a coefficient of thermal expansion such that when the enamel has solidified on the surface of the iron it is in a state of compression. By having the sheet under tension during the firing step and thereby preventing "crinkling" of the sheet, the final cooled product appears to have the enamel under a more uniform state of compression than the sheets made according to the previous practices. This factor of having the enamel present in a uniform state of compression makes possible the production of a sheet which may be readily coiled even to relatively small diameters on the order of 8"–12" without damage to the enamel coating.

Thus having the sheet under tension, one may use almost any conventional sheet iron enamel of which there are many published compositions.

Since it has been shown to be so necessary to control the depth of the sag of the iron sheet and to maintain constant tension of the sheet the apparatus of this invenion has been equipped with an automatic device for controlling the depth of the sag.

Rererring now more specifically to Fig. 2: resistor 32 is manually adjustable and is set at a predetermined point and controls motors 33, 34 and 35 which drive rolls 16, 22 and 26 respectively. The motors 33, 34 and 35 are thus set at a predetermined R. P. M. and are substantially synchronized. The speed of motor 33 is manually adjustable by speed control winding 36. Motors 34 and 35 are automatically adjustable as a group through control device 21, control relay 37, resistor 38 and motor control windings 39 and 40. Speed of motor 34 only is varied with change of tension of sheet 10 through the control device 21, control relay 41 and resistor 42. Speed of motor 35 only is automatically adjusted to changing tension of sheet 10 leaving furnace 24 through control device 25, relay control 43 and resistor 44. As previously stated the sheet 10 is threaded through the apparatus with a predetermined amount of sag so that catenaries are formed at 30 and 31. If the sheet rises above the proper line of travel it comes in contact with controlling device 21 which is a limit switch and may be of the mechanical or electric eye type. The controlling device 21 upon being pushed up by the sheet 10 touches contact 45 and energizes contact coil and relay 37. Contact coil 37 which is normally open, closes and short circuits resistor 38. Thus motors 34 and 35 which drive rolls 22 and 26 respectively are slowed down allowing sheet 10 to sag. If sheet 10 drops below the proper line of travel control device 21 touches contact 46, and energizes contact coil and relay 41. Contact coil 41 which is normally closed, opens and resistor 42 functions which causes motor 34 to speed up thus retruning the sag to the predetermined line of travel. The control device 25 controls the sag of sheet 10 just exactly in the same manner as discussed for control device 21. If the sheet 10 drops below the proper line of travel, control device 25 touches contact 47, and energizes contact coil and relay 43. Contact coil 43, which is normally closed, opens and resistor 44 functions which cause motor 37 to speed up thus returning the sag to the predetermined line of travel.

Although the control scheme indicated here is based on the use of mechanical limit switches adjustable speed D. C. motors and constant voltage supply and control similar results can be obtained by the use of photoelectric limit switches, variable voltage source of power and control. All are arranged to automatically control the speed of the drive motors so as to maintain a substantially constant predetermined sag and rate of travel on the sheet metal going through the apparatus of this invention.

From the foregoing discussion, it will be readily seen that there has been provided a method of and apparatus for continuously porcelain enameling thin sheet iron. The method completely eliminates warping and deformed areas which would appear if prior practices were used and the apparatus is relatively simple in its construction. The finished product may be cut to any desirable length without the use of power shears or may be formed into coils for convenience without the enamel chipping or spalling off.

What is claimed is:

1. Apparatus for the progressive porcelain enameling of a continuous, very thin metal sheet comprising, in combination, a horizontal spindle for carrying a coil of sheet stock; laterally

spaced pairs of substantially horizontally disposed gripping and feeding rollers; a spraying chamber and a firing chamber located between each pair of said spaced pairs of rollers, the entrances and exits of said chambers positioned below said rollers so that the sheet is suspended in the form of a catenary during its passage through said chambers; and independent electric motor connected to drive each of said pairs of rollers; and speed control means, including a variable resistance in the circuit of at least one of said motors and a switch connected to control said resistance, said switch being actuated by an element positioned adjacent to the path of the suspended portion of the sheet and responsive to changes in the sag of the moving sheet to vary the speed of the controlled motor and thereby maintain the sag substantially constant.

2. Apparatus for porcelain enameling very thin sheet metal comprising, in combination, a horizontal spindle for carrying a coil of sheet stock; two laterally spaced pairs of horizontally disposed gripping and feeding rollers; a spraying chamber and a firing chamber located between said spaced pairs of rollers, the entrances and exits of said chambers positioned below said rollers, whereby the sheet is suspended in the form of a catenary and is tensioned by its own weight during its passage through said chambers; an independent electric motor connected to drive each of said pairs of rollers; and speed control means including a variable resistance in the circuit of one of said motors and a switch connected to control said resistance, said switch being actuated by an operating element positioned in the path of the sheet to engage the sagging sheet between said pairs of rollers and responsive to changes in the sag of the sheet to vary the speed of the controlled motor and thereby maintain the sag substantially constant.

3. Apparatus for porcelain enameling very thin sheet metal comprising, in combination, a horizontal spindle for carrying a coil of sheet stock; three laterally spaced pairs of horizontally disposed gripping and feeding rollers; a spraying chamber and a firing chamber located between each of said spaced pairs of rollers, the entrances and exits of said chambers positioned below the rollers to cause sag to be formed in said sheet during its passage through said chambers between said spaced pairs of rollers; a separate electric motor connected to drive each pair of rollers; speed control means, including a variable resistance in the circuit of the motors which drive the second and third pairs of rollers, and a switch connected to control said resistance, said switch being actuated by an element positioned adjacent to the path of the sagging sheet between the first and second pairs of rollers and responsive to changes in the sag of said sheet between the first and second pairs of rollers to control the speed of the motors driving said second and third pairs of rollers to maintain the sag of the moving sheet between the first and second pairs of rollers at a predetermined level; and a second speed control means, including a second variable resistance in the circuit of the motor which drives the third pair of rollers and a second switch connected to control said second resistance, said second switch being actuated by an element positioned adjacent to the path of the sagging sheet between the second and third pairs of rollers and responsive to changes in the sag of said sheet between the second and third pairs of rollers to control the speed of the motor driving the third pair of rollers and thereby maintain the sag of the moving sheet between the second and third pairs of rollers at a predetermined level.

ROBERT G. CALTON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,801,374	Stock	Apr. 21, 1931
2,109,487	Kreidl	Mar. 1, 1938
2,428,307	Calton	Sept. 30, 1947
2,469,123	Martin	May 3, 1949