March 14, 1944. F. E. DRUMMOND 2,344,138

COATING METHOD

Original Filed May 20, 1940

Fig. 1.

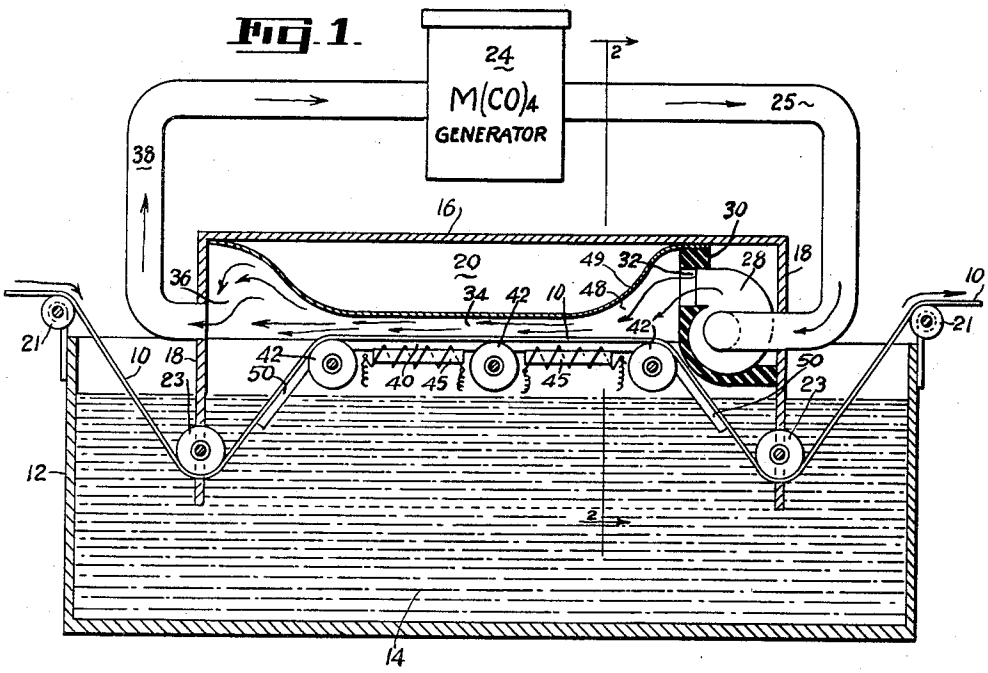


Fig. 2.

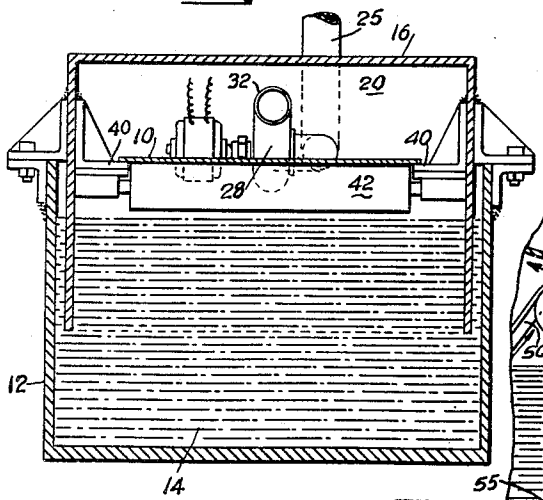
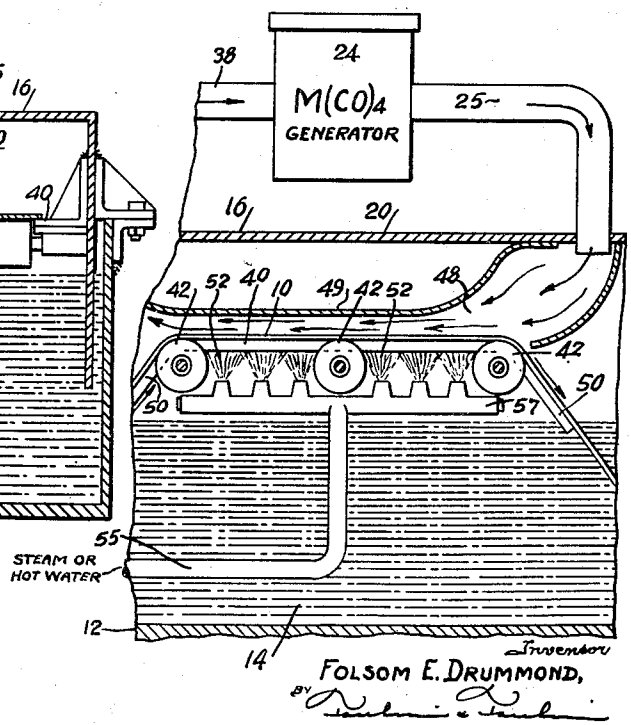


Fig. 3.



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2,344,138

COATING METHOD

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Original application May 20, 1940, Serial No. 336,191. Divided and this application January 16, 1941, Serial No. 374,657

2 Claims. (Cl. 117—107)

This invention relates to the deposition of metals, and more particularly comprises a method and apparatus for plating metal strip by utilizing gaseous metal carbonyl substances.

Heretofore it has been the common practice to deposit metal coatings by the use of electroplating solutions. Further, the plating of steel strip and the like has been effected by thermo-mechanical methods involving the use of relatively high temperatures and complicated, expensive equipment. My invention provides a simple and inexpensive method of plating metal strip, or ribbons. The strip or ribbon of metal is adapted to be moved continuously through the apparatus and receive a coating of the metal desired to be deposited on the surface. Thereafter the coating may be burnished, or otherwise treated, as desired, to produce a surface having the luster required.

It is the principal object of this invention to devise a method and apparatus for utilizing the volatile metal carbonyl compounds for metal coating articles in sheet or strip form.

Another object is to provide an apparatus and method of applying a coating of metal to a surface without the use of electroplating solutions and wherein continuous deposition of the metal is effected from a gaseous medium.

Another object is to provide an apparatus and method of utilizing gaseous metal compounds for plating articles wherein the metal is deposited from a volatile metal compound by continuously decomposing the compound and conducting the gaseous product resultant from the de-composition back to a source to regenerate the gaseous metal compound.

Another object is to provide a simplified method and apparatus for depositing metal by the use of volatile metal compounds and thereafter buffing and polishing the coated article to provide a bright, smooth coating.

These and other objects and advantages will be apparent from the following description taken in connection with the drawing, wherein,

Figure 1 illustrates one embodiment of my invention showing diagrammatically an apparatus, partly in section, for treating continuous metal strips, or ribbons, with a gaseous metal carbonyl compound;

Figure 2 is a vertical sectional view, taken substantially on the line 2—2 of Figure 1 and looking in the direction of the arrow;

Figure 3 is a fragmentary sectional view of a modification of the apparatus shown in Figure 1.

In general, it has been proposed heretofore to utilize non-volatile carbonyls of iron in the production of very finely divided pure iron, but the use of the volatile metal carbonyls, which are poisonous compounds, have not been employed in processing treatments.

My invention makes it possible to use the volatile carbonyls of nickel, iron, chromium and the like for depositing metal coatings on the surfaces of articles. The method of preparing the metal carbonyls is well-known in the art and forms no part of this invention.

The principal step of coating metal strip by my process comprises bringing about the separation of the metal from the volatile compound by its decomposition in the presence of the metal strip or article to be coated, which strip has been previously thoroughly chemically cleaned, so as to provide for ready adhesion of the metal particles onto the metal surface.

The cleaning of the metal strip, or ribbon, prior to the plating may be effected by employing the conventional methods used in the art comprising electrochemically cleaning the strip by moving the same through a bath of alkali or acid electrolyte, wherein the strip is made the cathode or anode. Pickling of the metal strip with hydrochloric, sulphuric, or nitric acid, or a combination of these acids, may be also made as a part of the cleaning process and the strip thoroughly rinsed, or washed, prior to advancing the same through the gaseous carbonyl plating apparatus of this invention.

This application is a division of my copending application, Serial No. 336,191, filed May 20, 1040, now Patent No. 2,332,309, granted October 19, 1943.

Referring to the drawing in detail wherein there is illustrated an apparatus for carrying out the process of this invention, a continuous metal strip 10 is arranged to be drawn through a tank 12, which is filled with liquid 14, such as water or other liquid, which will form a liquid seal for the strip as it passes though the tank. In the tank 12 there is provided a chamber 16 which comprises an inverted closed container having the depending side wall portions 18 which are immersed in the liquid 14 so as to provide a liquid seal chamber 20 through which the strip 10 is moved. This arrangement prevents the escape of the poisonous metal carbonyl gas into the surrounding atmosphere during the operation of the device. Suitable guide rolls 21 are positioned on the ends of the tank 12 over which the strip is moved and similar immersed guide roll members 23 are suitably mounted in the end walls 18 forming the gaseous chamber for conducting this strip into the chamber 20.

In the apparatus shown in Figures 1 and 2, the gaseous metal carbonyl compound $M(CO)_4$, wherein the M may be nickel (Ni), for example, is generated in a generator 24 and the gaseous metal carbonyl compound is circulated through the conduit 25 into the chamber 20 by means of the suction fan 28. This fan is preferably arranged at one end within the chamber 20 and is

partially surrounded by a heat insulating wall portion 30, as shown in Figure 1. It is arranged to move the gaseous metal carbonyl from the generator through the pipe 25 and discharge conduit 32 and into the confining chamber 34 arranged adjacent the surface of the strip 10. After the gaseous metal compound is moved over the surface of the metal and decomposed under the action of heat, the products of decomposition pass out at the other end of the confining chamber 34, as at 36, and are discharged through the conduit 38 and returned to the generator 24, as shown in Figure 1.

In order to present the largest amount of the metal strip surface which is to be coated to the volatile metal carbonyl gas, the strip is moved over a table means 40, which is provided with rollers 42 over which the strip is passed along. A heating element 45 is arranged beneath the table surface so as to heat the metal strip to the temperature at which the metal carbonyl gas will be decomposed. The temperature of the metal strip, in the case of $Ni(CO)_4$, for depositing nickel would be above 180 degrees centigrade, or that sufficient to bring amout a temperature in the auxiliary chamber 48 whereby the carbonyl compound is decomposed and the metal deposited onto the surface of the strip 10 forming a coherent coating thereon.

For guiding the metal carbonyl gas in a thin layer over the surface of the metal strip 10 an inwardly extended partitioning wall 49 is arranged in the chamber 20, as shown in Figure 1. Guide wall 49 is preferably made of non-metal heat insulating material to inhibit the deposition of metal thereon. All exposed parts preferably are covered with heat insulating coatings or fabrication so as to resist deposition of metal thereon. Glass, ceramic, or synthetic resinous products may be used for the purpose.

In using nickel carbonyl, the regeneration of the carbonyl may be brought about with the use of NiO_2 which is reduced with water gas ($CO+H_2$). This mixture of nickel oxide and water gas is heated to 45 degrees to 90 degrees centigrade in a current of producer gas (CO, H_2 and CH_4). This reaction forms gaseous $Ni(CO)_4$. $Ni(CO)_4$ heated to 180 degrees centigrade causes deposition of pure nickel and liberation of CO which is returned to the generator and used again to form more $Ni(CO)_4$.

In order to prevent the coating of the metal onto the underside of the strip, when this is not desired, a resilient pad 50 is provided which extends over the table 40 and having its ends immersed in the liquid of the tank, as illustrated in Figure 1.

As explained, the temperature in the zone 48 is controlled by suitable means so as to bring about the decomposition of the metal carbonyl and the carbon monoxide (CO) which is freed during the process is returned to the generator and used again to generate more of the metal carbonyl compound. It will be observed that the apparatus provides a fluid-sealed apparatus for continuously treating metal strips of long lengths which are moved therethrough and whereby the regeneration of the metal carbonyl and its decomposition is carried on continuously during the operation of the apparatus. The apparatus provides a hermetically sealed device for carrying out the method of this invention without the danger of poisonous gas coming in contact with the operator.

In the modification shown in Figure 3, the blower for moving the gaseous metal carbonyl compound from the generator into the restricted chamber 48 of the compartment 20 is omitted and suitable means, not shown, is provided in the generator 24 for moving the gas through the conduit 25 and into one end of the chamber 48 which confines the carbonyl gas adjacent the surface of the strip 10 as it is moved over the table 40. In this modification means is also provided for heating the metal strip as it passes over the table 40 by means of a fluid spray 52, which is directed on the underside of the strip, as shown in Figure 3. Suitable means, comprising conduit means 55 and spraying means 57, is provided for conducting the heated fluid into the chamber 20 beneath the table 40 over which the strip passes. Heated water, or steam may be employed for this purpose, or other suitable heat exchange means may be utilized which will not hinder the decomposition and deposition of the metal onto the surface of the strip.

After the coating of the metal strip is completed, it will be understood that where it is desired, the coating may be further treated as by heating, burnishing, buffing, or polishing the same to provide the desired luster or brightness of the coating.

It will be understood from the foregoing description that the method and apparatus disclosed herein are susceptible to various changes and modifications without departing from the principle and spirit of this invention and such modifications as are required to adapt the invention to different conditions and uses are contemplated as within the scope of this invention.

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

1. A method of coating long continuous lengths of metal stripping on only one side thereof comprising continuously moving and guiding the stripping through a liquid sealed chamber, circulating gaseous metal carbonyl over the upper surface only of said stripping and in a direction opposite to the movement of said stripping while protecting the underside of said stripping from contact with said gaseous metal carbonyl throughout its movement in said chamber, and heating said strip on its underside as it passes through said chamber to decompose said gaseous metal carbonyl and thereby precipitate and deposit the pure metal onto the upper surface only of said stripping as it is moved therealong.

2. A method of coating long continuous lengths of metal stripping on only one side thereof comprising continuously moving and guiding the stripping through a liquid sealed chamber, circulating gaseous nickel carbonyl over the upper surface only of said stripping and in a direction opposite to the movement of said stripping while protecting the underside of said stripping from contact with said gaseous nickel carbonyl throughout its movement in said chamber, and heating said strip on its underside as it passes through said chamber to decompose said gaseous nickel carbonyl and thereby precipitate and deposit the pure nickel onto the upper surface only of said stripping as it is moved therealong.

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