June 30, 1964 H. J. KIRSCHNING 3,139,505

METHOD AND APPARATUS FOR COATING BASE METAL WITH FACING METAL

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Fig. 1

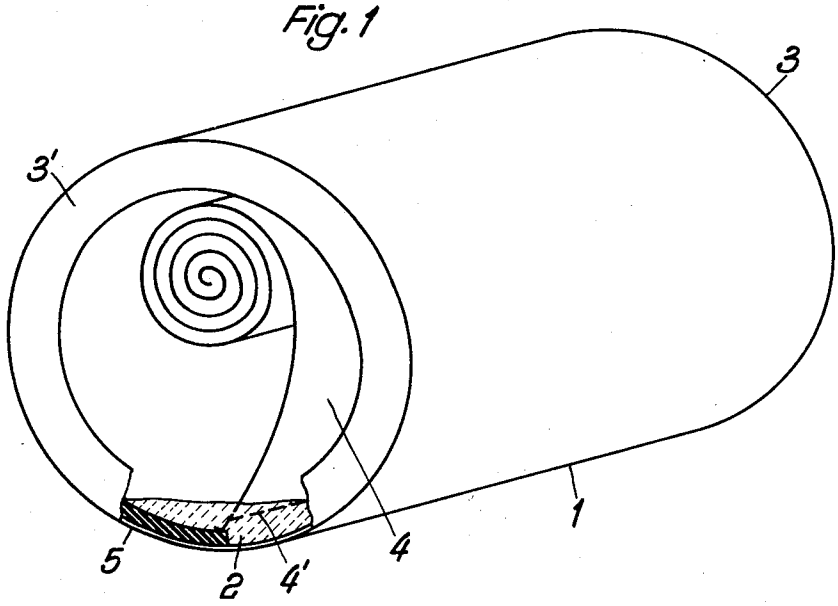
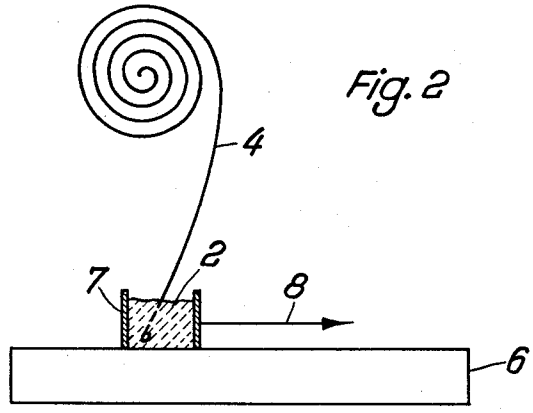


Fig. 2



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Fig. 3

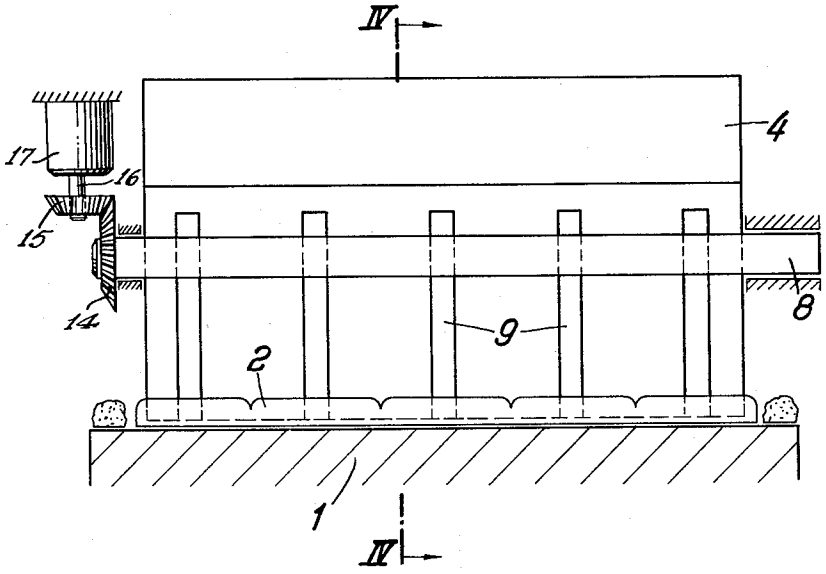
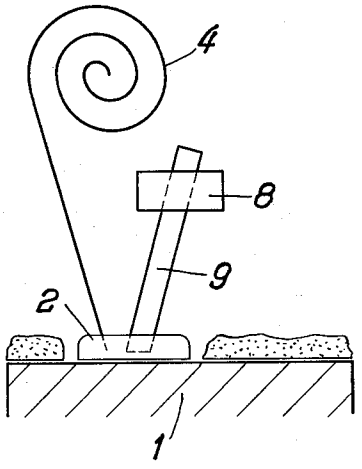


Fig. 4



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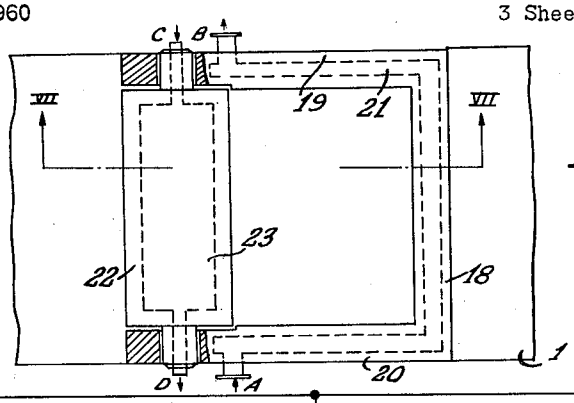


FIG. 6.

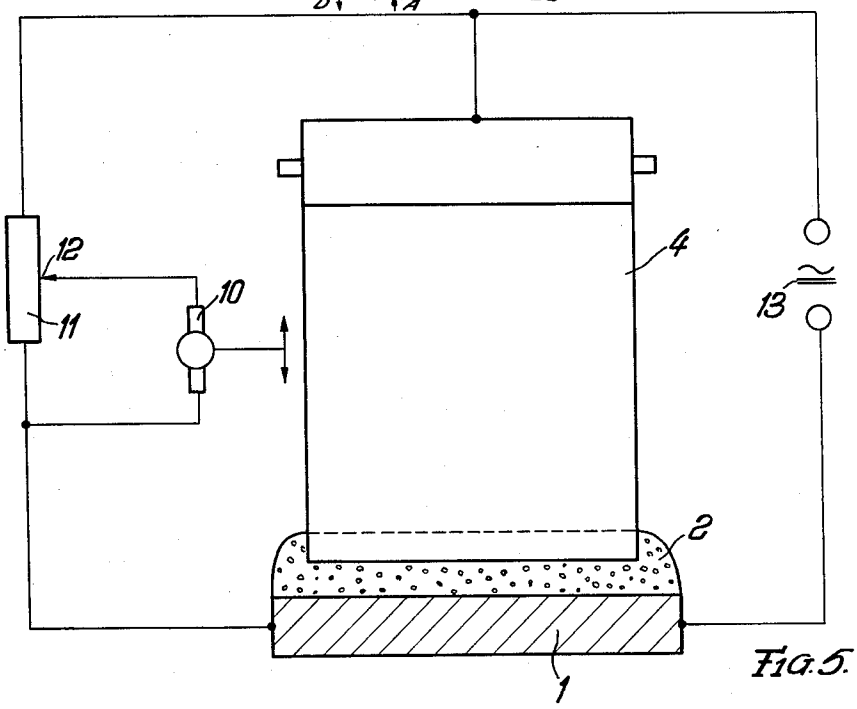
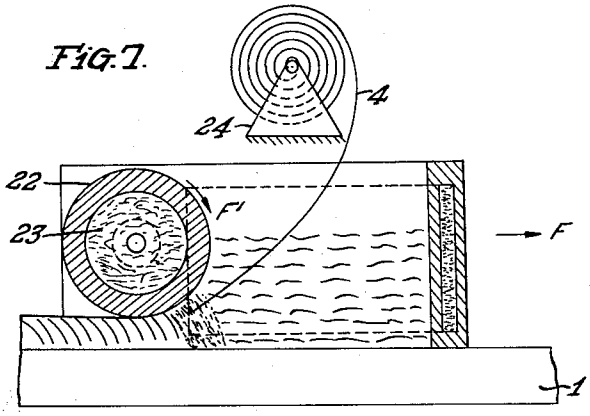


FIG. 5.

FIG. 7.



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METHOD AND APPARATUS FOR COATING BASE METAL WITH FACING METAL

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16 Claims. (Cl. 219—73)

This invention relates to a method for the coating of metal facings onto a base metal. A familiar process is that of coating larger pieces of stock, such as cylinders, by plating or surfacing. Plating is a highly cumbersome and costly process, which calls for the availability of special furnaces and rollers.

In the manufacture of heavy containers, the weights of the individual units are so heavy that special roller installations to perform the given function are required so as to meet the demands of the plating process. With a view to simplifying this coating process, surfacing (or beading) has been proposed and executed, in lieu of plating. The latter method entails the facing of the entire inner surface of the container to be coated, by successive steps, employing welding electrodes, whereby the entire welding process is performed under the usual conditions, that is, under an arc temperature, or 3000° C. The surfacing process is not feasible for the fusing-on of steel with the admixture of alloys, owing to the fact that the high arc temperature eliminates or unduly reduces by vaporization the admixtures which are frequently critical from the standpoint of quality. Both processes are time-consuming and call for extensive experience in this specific art.

The object of the present invention is to provide an improved method and apparatus for coating a base metal with a facing metal.

The present invention is characterized by the fact that an electrode is provided, extending from one edge of a piece of stock, to another edge running parallel to the former, said electrode consisting of the surfacing metal, which electrode is introduced into a limiting or masking frame which surrounds it on all sides. The latter frame holds the liquid, electrically conductive slag, and the said frame, along with the electrode, is capable of shifting position with respect to the piece of stock.

The electrode preferably consists of a length of sheet-metal coiled in the form of a scroll which uncoils at the dipping edge in accordance with the rate of the flash-welding process. In such a case, the current is supplied to the electrode in a manner that is most simple to devise, inasmuch as a contact bar may be employed for the purpose of supplying a uniform current distribution. The present invention is particularly suited to the coating of the inner surfaces of cylindrical shapes. All that is required for its accomplishment is for a horizontally lodged cylinder to be masked at the ends thereof for the purpose of stemming or damming the slag which tends to drain. The cylinder is made to rotate slowly, and the latter rotation is coupled with the rotation of the length of sheet-metal which is caused to unwind, say, by means of an appropriate gear.

In those cases where the base material exhibits a level surface, the masking frame may consist of a trough-shaped container, open at the bottom, while being hollow on the inside and traversed by a cooling agent.

It has been found that the electrode is required throughout the length of the dipping edge for the purpose of carrying out the flashing off process which takes place in the liquid slag, if it is to be adaptable to large-scale engineering, since it is a function of the full-length arrangement of the electrode to maintain the slag in a liquid state.

Furthermore, it becomes feasible to surface a piece of stock uniformly with the coating material throughout its complete surface only where the edge of the dipping electrode extends uninterruptedly from one edge of the stock to the other. Owing to the high energy which is thus capable of being supplied, it becomes feasible to bring about a heavy flow of slag, so that the surfaces to be coated are preheated even before the slag flows underneath the electrode, and thereby a condition is created permitting a high-quality welding together of the flashed off material with the supporting material.

From a technological standpoint, the apparatus as described in the foregoing affords particularly favorable conditions as regards the thermal stresses prevalent in the stock, by virtue of the fact that the parallel progress of the surfacing in a sequence embracing stepwise the base material, induces a heating and cooling process extending from one edge to the other, and bringing with it a reduction of thermal stresses. Particularly where the surfacing of high-alloy steels is concerned with high-carbon ingot steel as a base, this process produces a favorable transitional area which prevents the concentration of carbon in the bearing material.

For the purpose of liquefying the slag, which is essential in surfacing, special precautions must be adopted in the case of large area electrodes, that is, electrodes that are not rod-shaped, since it is not possible to produce an arc discharge along the entire length of the edge which is submerged and forms the contact area. Generally, an arc is struck only at one point of the dipping edge of the electrode, so that it is not feasible to have a melting down of the entire slag content of the masking container. Pursuant to a further feature of the invention, this adverse feature can be obviated by having a bank of several electrodes running parallel to a flat linear or laminar electrode, such as a length of sheet-metal, with each individual arc electrode exhibiting either a separate current supply, or coupled by means of its own series resistance to a single common source of electrical energy.

Pursuant to a preferred method of construction, the separate arc electrodes can be fitted along a common transverse strip, running parallel to a laminar electrode, e.g. consisting of a length of sheet-metal, whereby the strip may be fitted in such a manner as to pivot, so that it may be removed once the slag has been liquified. When the slag has been liquified, the sheet-metal elctrode is melted down on those portions thereof that project into the liquid slag.

A further problem occurring on the application of the invention, is that concerned with the correct setting of the depth of immersion of the electrode in the liquid slag. In view of the fact that the depth of immersion is of a highly critical import for the proper functioning of the process, it is essential to provide a reliable and uncomplicated adjusting device.

Pursuant to a further feature of the invention, the electrical resistance of the slag is made use of to the end of regulating the depth of immersion. The motor serving to drive the electrode feed, is coupled with the voltage impressed on the slag resistance, across a voltage divider. Depending on the distance separating the immersion electrode from the base material, and hence, depending on the slag resistance value, a greater or lesser voltage is impressed on the resistance. Thereby the motor is made to feed the electrode supply at a greater or lesser speed. The optimal work spot, and hence the position of the lower flash off point is set on a voltage divider which reduces the voltage impressed on the resistance to a desired value.

The cover or masking frames pursuant to the invention, do not, of course, require any rigid structure. Thus, pursuant to a preferred type of design of the invention, the

rearward portion of the frame can be replaced by a cooled roller, preferably occupying a stationary position in relation to the electrode, the said roller travelling across the deposited coating, on the occurrence of a relative motion as between the piece of stock and electrode. The roller may be composed of a material of high thermal conductivity, such as copper, and it is water-cooled. In addition to the smoothing effect it brings to bear on the surface, the roller also serves the purpose of retaining the liquified slag in the area surrounding the electrode. This prevents the liquified slag which is characterized by a high thermal content, from being lost in the performance of the melting process.

The invention is explained in greater detail, with reference to several embodiments as exemplified in the attached drawings and in which:

FIG. 1 shows the invention as employed in the production of an inner facing on a cylindrically shaped stock.

FIG. 2 shows the invention being employed in working a flat piece of stock.

FIG. 3 exhibits an arrangement which serves to liquify the slag, with the aid of a number of arc discharges along the contact surface of the electrode.

FIG. 4 is a lengthwise section along the line IV—IV of FIG. 3.

FIG. 5 illustrates a wiring diagram for the control of the depth of immersion of the electrode pursuant to the invention.

FIG. 6 is a plan view of a cooled masking frame utilizing the invention, and

FIG. 7 is a cross-sectional view along lines VII—VII of FIG. 6.

As shown in FIG. 1, the cylindrical container **1** exhibits a layer of slag **2** on the ground surface, the said layer being contained against drainage by lateral masking parts **3** and **3'**. The length of sheet-metal **4** which for reasons of the most economic use of the space is coiled into the shape of a scroll, has along its entire length the lower lateral edge **4'** dipped into the slag **2**, the said length of scroll-shaped sheet-metal serving as an electrode for the heating of the slag and the accomplishment of the flash off process. The cylinder **1** is set rotating at a more or less slow rate of speed, in keeping with the thickness of the layer to be surfaced **5**. The liquid metal flashed off onto the base metal drips through the equally liquid slag but of lower specific gravity, onto the base material of the container **1**, where it spreads out, welds on and turns rigid (hardens).

As shown in FIG. 2, the surfacing of the coating material can also be accomplished by employing an oblong, trough-shaped container **7**, capable of being shifted crosswise to its longitudinal direction, with the surfacing metal, in the form of a length of sheet-metal inserted into it. Naturally, the trough-shaped container **7** may also remain at rest, while the plate **6** which lies underneath and is to receive the coating is being withdrawn, e.g. by means of rollers, from underneath the trough. Pressure rollers may well be provided here to assure contact between the traversing piece of metal and the edges of the trough which is open at the bottom **7**. Any greater or lesser loss of slag occurring in the course of the relative movement as between the trough and the metal piece (sheet), can be compensated for by feeding additional slag, into the trough.

According to FIGS. 3 and 4, a mounting strip **8** combined with the arc electrodes **9** is mounted parallel to the lower edge of the sheet electrode **4** which dips into the slag **2**, the said electrodes brought into contact with the powder, and serving to strike the arcs spanning the piece of stock and the electrode. Mounting strip **8**, may be journaled in bearings at each side thereof and rotated by means of a bevel gear **14** on the end of mounting strip **8**, said gear **14** being meshed with bevel gear **15** attached to shaft **16** of electric motor **17**. In this way, the arc electrodes **9** are removed after the slag **2** has been liquified.

Each of the arc electrodes **9** is connected to the pertinent power source through its own resistance, so that arc discharges are able to take place on all the electrodes. Where it is to better advantage to strike the arc by means of a high frequency generator, it is also necessary to shunt the high frequency current by means of a reactance.

The trough-like masking frame may be cooled. As can be seen from FIG. 6, the front part **18** as well as the sides **19,20** represent a box-like structure which has a cooling duct **21** traversing the inside thereof. The cooling agent, which may, for example, be water, enters at point A and moves through the cooling duct **21** to exit at point B. The trailing part of the box-like structure is defined by a cooled roller **22** which has a hollow space or passage **23** through which also flows a cooling agent. The latter cooling agent enters the roller at C and leaves at D. In case of movement of the box-like structure in the direction F (see FIG. 7), the roller **22** will be turned in the direction of the arrow F' and will thereby smooth down the coating agent applied to the workpiece **1**. The wide electrode **4** is arranged on a supporting frame **24** above the box-like structure and may be rotated at a rate corresponding to the fusing speed.

In FIG. 5, the piece of stock subjected to the process is designated by numeral **1**, the liquid slag by **2**, while the sheet-metal is fed with the aid of a motor **10**. The voltage impressed between the piece of stock and the laminar electrode **4** is supplied to the voltage divider **11**, to which the motor is connected. By preference, the voltage divider **11** is designed to be variable, with the aid of a tapper **12**. The depth of immersion of the electrode in the slag is set automatically in keeping with the position of the tapper. The simplicity of the device rests primarily on the fact that both the electrode **4** and the drive motor **10** can be connected to the same source of energy **13**. The current employed may be either A.-C. or D.-C.

What is claimed is:

1. Apparatus for applying a facing metal to a base metal comprising means forming a container for containing an electrically conductive molten liquid slag on the surface of the base metal,

means for supporting and feeding a facing metal electrode in sheet metal form into the molten liquid slag,

means for passing an electric current through the facing electrode, electrically conductive molten liquid slag, and said base metal to effect the heating and melting of the end of said facing metal electrode dipping into the molten slag,

and means for effecting relative movement between said supporting and feeding means and said means forming a container and the base metal.

2. Apparatus as defined in claim 1 including means for controlling the feed of said sheet-metal electrode so that the rate of feed thereof is proportional to the relative speed between said support and the base metal.

3. Apparatus as defined in claim 1 including means for adjusting the distance between the flash-off edge of said sheet metal electrode and said base metal in accordance with variation in electrical resistance of said electrically conductive slag.

4. Apparatus as defined in claim 1 wherein the last named means includes a contact bar positioned to be in electrical contact with the entire width of the sheet metal electrode.

5. Apparatus as defined in claim 1 including electric arc means for liquifying said slag and maintaining the electrically conductive slag in liquid condition.

6. Apparatus as defined in claim 5 wherein said arc means includes a plurality of closely spaced arc electrodes disposed in a line parallel to said sheet metal electrode and said spaced metal and including a melting strip, means securing each of said electrodes to said mounting strip, said mounting strip being adapted to pivot about a horizontal axis to remove said arc electrodes from the slag after liquification thereof.

7. Apparatus for applying a facing metal to a metal cylinder comprising means for supporting and feeding a facing metal electrode in sheet metal form from above the area of the cylinder being faced, means for rotating said cylinder, means forming a receptacle for containing an electrically conductive slag, said receptacle having as the bottom thereof an area of said cylinder substantially equal in width to the width of said sheet metal electrode, means for liquifying said electrically conductive slag, and means for passing an electric current through said facing electrode, electrically conductive slag and the cylinder.

8. Apparatus for applying a facing metal to a base metal comprising means for supporting and feeding a sheet metal facing electrode from above the base metal, means for causing relative movement between said support and said base metal, a masking frame, said masking frame forming a container with an area of said base, an electrically conductive slag in said container, means for passing an electric current through said slag for liquifying same, and flashing-off the edge of said sheet metal electrode and cooling means including a portion of said masking frame for cooling the facing metal deposited on the base metal.

9. Apparatus as defined in claim 8 wherein said masking frame includes a hollow roller, and means for passing a cooling medium through said hollow roller.

10. Apparatus as defined in claim 8 wherein said supporting and feeding means includes an electric motor adapted to feed said sheet metal electrode into said electrically conductive slag, and means for supplying current to said motor as a function of the electrical resistance of said slag.

11. Apparatus as defined in claim 10 including a voltage divider in the supply circuit to said motor.

12. A method of applying a facing metal to a metal base which comprises moving the base along a path, preheating an area of the base having a long dimension transverse to the path of movement of the base and equal to the width of the surface of the metal base being coated, submerging the preheated area in an electrically conductive liquid slag, feeding a metal facing electrode into the liquid slag, and heating said electrode to its melting point by passing an electric current through the facing electrode, the electrically conductive slag and the metal base.

13. A method of applying a facing metal on a base metal which comprises moving one of said metals relative to the other along a predetermined path, preheating an area of the base metal having a long dimension transverse to said path of movement, submerging said preheated area in an electrically conductive liquid slag having a specific gravity lower than that of the facing material, feeding the metal facing material to the liquid slag, and heating said facing metal to its melting point by passing an electric current through the facing metal, the electrically conductive slag and the base metal.

14. A method of applying a facing metal to a metal base as defined in claim 13, including the further step of cooling the metal deposited on the base metal.

15. A method of applying a metal facing to a base metal having a relatively wide surface dimension comprising:

forming a bath of electrically conductive molten liquid slag extending across said wide surface:

introducing a facing electrode having a width coextensive with the width dimension of said surface into said molten slag to melt off the dipping edge of same;

passing an electrical current through said electrode, said electrically conductive molten liquid slag and said base metal to maintain the heat energy of said slag and melt said electrode, and effecting relative movement between the bath and said base metal.

16. A method of applying a facing metal to a base metal having a relatively wide surface area to be faced comprising the steps of

providing a masking frame substantially equal to the width of the wide surface to be faced,

maintaining a pool of electrically conductive molten liquid slag on the surface to be faced and within the masking frame,

introducing a facing metal electrode in sheet metal form into the pool of electrically conductive liquid slag, said sheet metal electrode having a width coextensive with the width of the wide surface area to be faced,

passing an electrical current through the facing metal electrode, the electrically conductive liquid slag and the base metal so as to maintain the molten condition of the slag uniform and melt the end of said sheet metal facing electrode introduced therein,

effecting relative movement between the masking frame and pool of electrically conductive liquid slag and the base metal so that the pool of electrically conductive liquid slag moves over the surface being coated,

and simultaneously as the pool of slag is moved, effecting relative movement between the pool of electrically conductive liquid slag and said sheet metal electrode.

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