

Oct. 23, 1962

G. M. BAUGHMAN ET AL

3,059,612

VACUUM COATING APPARATUS

Filed Oct. 19, 1959

Fig. 1.

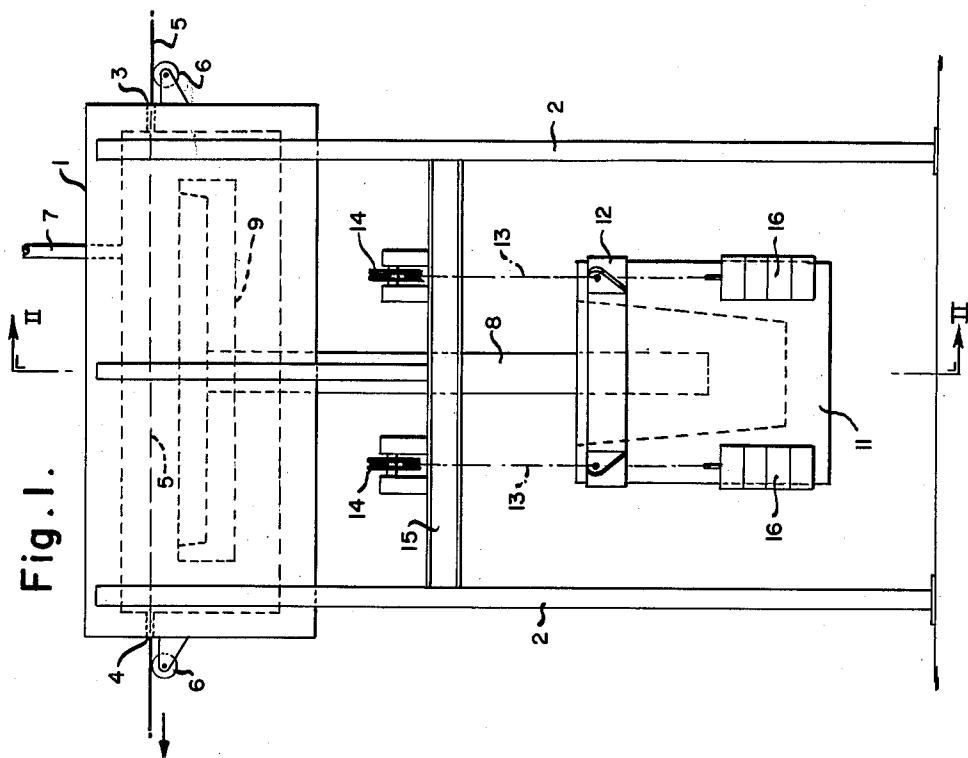
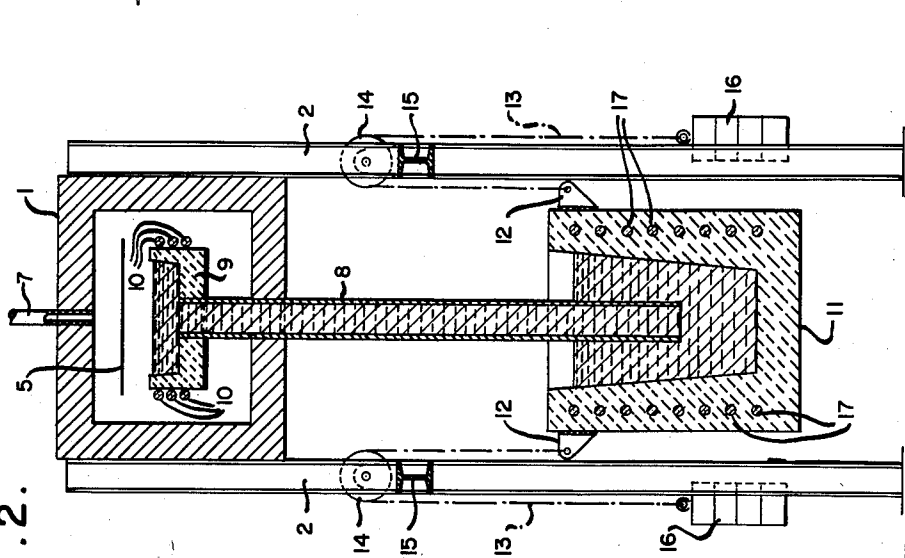


Fig. 2.



INVENTORS

George M. Baughman and
John E. Erhardt, Jr.

By *Hoopes Leonard & Buell*
their attorneys

1

3,059,612

VACUUM COATING APPARATUS

George M. Baughman, Warren, Ohio, and John E. Erhardt, Jr., Baltimore, Md., assignors to The Wean Engineering Company, Inc., Warren, Ohio, a corporation of Ohio

Filed Oct. 19, 1959, Ser. No. 847,395
6 Claims. (Cl. 118—49.1)

This invention relates to the plating of a metallic substrate by coating it with a metal which is vaporized and deposited on the substrate while it is in a vacuum.

We provide a vacuum coating chamber, a coating metal container placed within the chamber, a coating metal reservoir for retention of molten coating metal at a lower level than said container, and a coating metal supply means extending upwardly from the coating metal reservoir to the coating metal container. We preferably maintain the coating metal reservoir at atmospheric pressure and provide means to extract air from the coating chamber to form a vacuum therein. We further preferably provide means to guide the substrate into and from the vacuum chamber for continuous passage of the substrate there-through. We further preferably provide means to raise and lower the elevation of the coating metal reservoir to adjustably position the reservoir vertically. We also preferably provide induction heating means adjacent the coating metal reservoir to maintain coating metal therein in molten condition.

Other details, objects, and advantages of our invention will become apparent as the following description of a preferred embodiment thereof proceeds.

In the accompanying drawings we have illustrated a certain present preferred embodiment of our invention in which

FIGURE 1 is a side elevational view of vacuum plating apparatus embodying our invention; and

FIGURE 2 is a sectional view taken along line II—II of FIGURE 1.

The coating chamber is defined by and lies within walls 1 which are supported on structural steel upright members 2. The walls have oppositely positioned openings, an entrance 3 and an exit 4, through which a steel strip substrate 5 enters and leaves the vacuum chamber. Sealing members are preferably fitted in the openings 3 and 4 to prevent the passage of outside air into the chamber. Guide rolls 6 are mounted outside openings 3 and 4 to support and guide the strip 5 as it enters and leaves the coating chamber, passing through the openings 3 and 4. A vacuum pipe 7 extends through one wall of the chamber and is connected to an external vacuum pump of conventional design for evacuation of the coating chamber.

A molten metal supply pipe 8 is fixed in the lower wall of the coating chamber and extends upwardly into the chamber and downwardly below it. A shallow elongated molten metal container 9 is mounted on the upper end of supply pipe 8 within the chamber. It is placed below and generally parallel to strip 5 and extends for substantially the width of the strip and along the major portion of the length of the chamber. It provides a surface area of coating metal which is relatively large compared with the size of the chamber. Several turns of induction heating coils 10 are wound about container 9 to supply heat thereto and to aid in maintaining metal therein in a molten condition and aid in vaporizing it.

A molten metal reservoir 11 is suspended beneath the vacuum chamber. A cradle 12 is attached to and supports the reservoir and is in turn suspended from cables 13 passing over pulleys 14 which are journaled on cross bars 15 extending between structural members 2. Counterweights 16 are attached to the opposite ends of cables

2

13 from ring 12. Locks may be provided on the pulleys to prevent their rotation and lock the pulleys in any desired position. A plurality of turns of induction heating coils 17 are placed within the walls of reservoir 11 to maintain metal therein in molten condition. Reservoir 11 is of substantial depth and is placed to receive the lower end of supply pipe 8. It is arranged for substantial vertical movement.

When the apparatus is placed into operation, strip 5 is placed in position extending through the vacuum plating chamber passing in at entrance 3 and leaving at exit 4. The strip is handled by equipment of a conventional type external to the chamber which pulls the strip through the chamber under tension. The width of the strip may vary from time to time as required by the need for coated strip. The strip may be only a few inches in width and may, for example, be 48 inches, or wider, in width. It may be drawn through the chamber at speeds of up to perhaps 1,000 feet per minute.

When molten metal is placed within reservoir 11, it is maintained in molten condition by the induced current from induction coil 17. Before running a length of strip through the apparatus, the vacuum pump connected to pipe 7 is started producing a vacuum in the coating chamber. As a vacuum is produced in the chamber, molten metal rises through supply pipe 8 and fills container 9. The elevation of reservoir 11 may readily be adjusted up and down to maintain a proper level of molten metal in container 9, having due regard for the degree of vacuum produced in the vacuum chamber and the weight of coating metal which is being used. When a less dense coating metal is being employed, it is obvious that reservoir 11 must be lowered to maintain the proper level of coating metal in container 9 for a given vacuum. The molten metal in container 9 will vaporize in the presence of the vacuum and disperse throughout the coating chamber, condensing on the relatively cool strip material passing through the chamber. As coating metal is vaporized from container 9, additional metal will rise from reservoir 11 through supply pipe 8. From time to time, additional coating metal is added to reservoir 11 as necessary to replenish the system.

As the strip material passes through the coating chamber, it receives a coating of metal which is deposited thereon by condensation. The strip material is drawn out of the chamber and is coiled in the usual manner. When a run of strip material has been completed, the vacuum pump is stopped or disconnected, allowing the plating chamber to return to atmospheric pressure. All of the coating metal then drains back to reservoir 11 where it is held in molten condition by the induction coils awaiting further operation of the plating apparatus.

While we have illustrated and described a present preferred embodiment of our invention, it is to be understood that we do not limit ourselves thereto and that our invention may be otherwise variously practiced within the scope of the following claims.

We claim:

1. Vacuum plating apparatus for coating a substrate with a metal by deposition thereon comprising a vacuum chamber, a coating metal container placed therein, a coating metal reservoir in connection with the atmosphere for retention of molten coating metal placed at a lower level than said container, vertically movable, and external to said chamber means supporting said reservoir for vertical movement, coating metal supply conduit means extending upwardly from within said reservoir and terminating in said container whereby molten metal maintained in said reservoir is forced upwardly to the container by atmospheric pressure when a vacuum is produced in the chamber.

3

2. Apparatus for coating a substrate with a metal by deposition thereon comprising a coating chamber having an inlet and an outlet for said substrate, a coating metal container within said chamber, means to produce a vacuum in said chamber a coating metal reservoir open to the atmosphere below said container and vertically movable, means supporting said reservoir for vertical movement, metal heating means adjacent said reservoir whereby coating metal in the reservoir is maintained in molten condition, and coating metal supply conduit means extending between said reservoir and said container.

3. Apparatus for coating a substrate with a metal by deposition comprising a coating chamber having an inlet for said substrate and an outlet for said substrate, a coating metal container placed in the chamber beneath the line of passage of the substrate, gas removal means from the chamber, a coating metal reservoir in connection with the atmosphere at a level below the level of said container, coating metal supply conduit means extending between said reservoir and said container, metal heating means adjacent said reservoir whereby metal in the reservoir is maintained in molten condition, and means adjustably supporting said reservoir at a desired elevation whereby a substantially constant metal level may be maintained in said container independently of variations in the pressure in the coating chamber and the composition of coating metal by adjustment of the elevation of said reservoir.

4. Apparatus for continuously coating a substrate of extended length with a coating metal by deposition thereon comprising a coating chamber having an inlet for entrance of uncoated substrate and an outlet for exit of coated substrate, a coating metal container placed in said chamber beneath the line of passage of the substrate, vacuum producing gas removal means connected to said chamber, a coating metal reservoir in connection with the atmosphere, coating metal supply means opening

4

into said container and extending downwardly therefrom terminating within said reservoir, and means adjustably supporting said reservoir for selective vertical positioning of the reservoir.

5. Apparatus for coating a substrate with metal by condensation of coating metal thereon, comprising a coating chamber having an inlet for entrance of uncoated substrate and an outlet for exit of coated substrate, a coating metal container placed in said chamber, gas removal means connected to said chamber for production of a vacuum therein, a coating metal reservoir placed at an elevation below said container and external to said chamber, coating metal conduit means extending from said reservoir to said container, means to vary the elevation of said reservoir, heating means adjacent said reservoir whereby coating metal therein is maintained in molten condition, and heating means adjacent said container whereby metal in said container is further heated and vaporized.

6. Apparatus for coating a substrate with metal by condensation of a coating metal thereon comprising a coating chamber having an inlet for uncoated substrate and an outlet for coated substrate, a coating metal container placed therein and forming a relatively large liquid surface for vaporization of coating metal, a coating metal reservoir external to said chamber at a lower level than the container, supporting means for said reservoir, adjustable for variation of the elevation of said reservoir, coating metal supply means for transfer of molten coating metal between said reservoir and said container, and heating means for application of heat to said coating metal.

References Cited in the file of this patent

UNITED STATES PATENTS

2,508,500	De Lange et al. -----	May 23, 1950
2,664,852	Chadsey -----	Jan. 5, 1954

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,059,612

October 23, 1962

George M. Baughman et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 5, after "chamber" insert a comma.

Signed and sealed this 23rd day of April 1963.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents