June 2, 1970 F. J. SCHMIDT 3,515,662

ELECTROFORMING ASSEMBLY FOR PRODUCING COMPLEXLY SHAPED ARTICLES

Filed Dec. 27, 1966

Fig. 1.

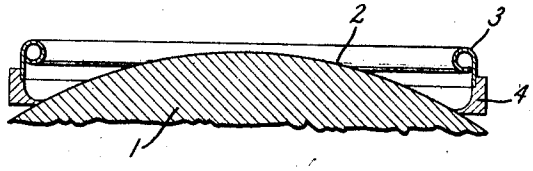


Fig. 2.

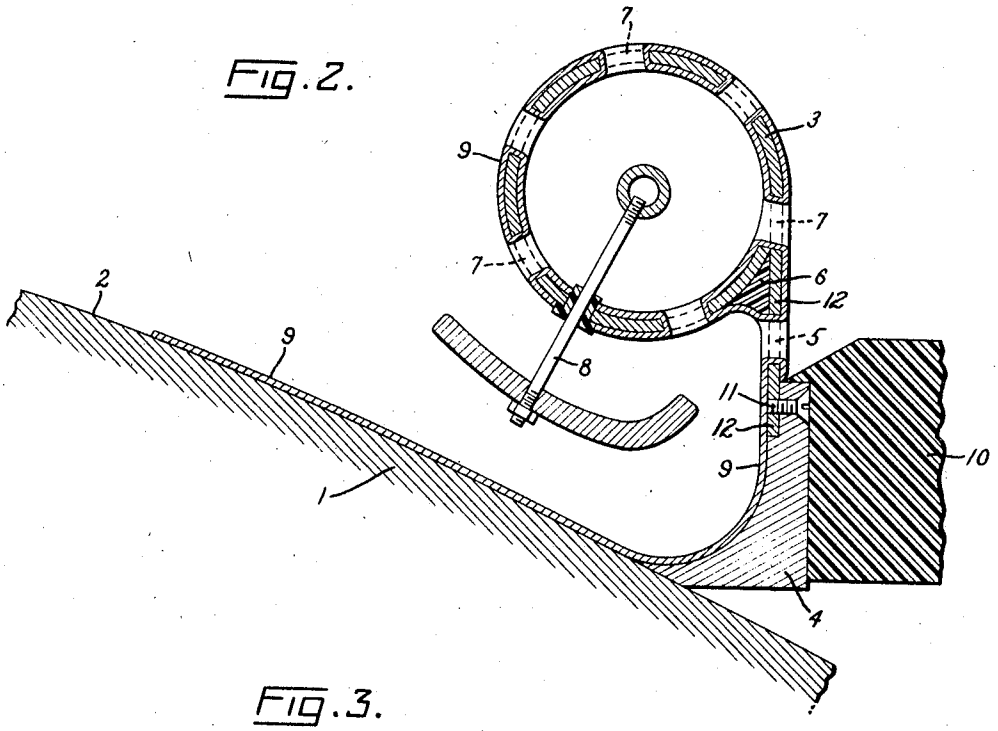
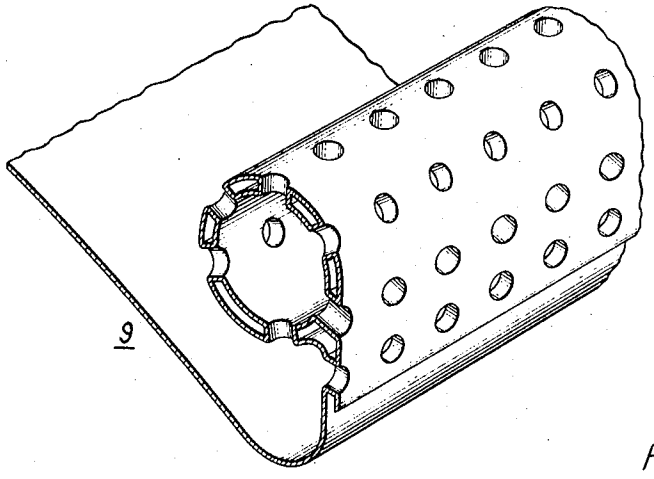


Fig. 3.



INVENTOR:
FERENC JOSEPH SCHMIDT,
BY Paul F. Prentice
AGENT

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ELECTROFORMING ASSEMBLY FOR PRODUCING COMPLEXLY SHAPED ARTICLES

Ferenc J. Schmidt, Ardmore, Pa., assignor to General Electric Company, a corporation of New York

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ABSTRACT OF THE DISCLOSURE

Perforations in the recessed area of a surface mold are provided to produce smooth, even, relatively stress-free deposition on the recessed area. Fusible fillets may also be used to form rigid bridges over parts of the recessed area. A specific product is an integrally formed, rigidly supported, relatively stress-free, electroplated mirror.

INTRODUCTION

This invention relates to surface molds for electroforming complexly shaped articles by deposition processes and to means for facilitating deposition in recessed areas of these molds. In particular, this invention relates to molds for producing electroplated, optically smooth, mirror surfaces with integral toroidal supports therefor and to the stress-free, integrally-supported mirrors thus produced.

Formation of articles by deposition onto a form or surface mold is quite common. If the mold includes small depressions, indentations, etc., generally referred to herein as recessed areas, it is often difficult to achieve uniform deposition in these recessed areas. There are a number of possible causes for this. One example is premature deposition across the recessed area which closes off the recessed area from further deposition and results in little or no deposition taking place in the recessed area itself. The bridge of deposition material thus formed, since it is formed randomly and without a support surface, is generally not strong enough to contribute to the strength of the article formed. A second problem is that if the deposition process involves the evolution of a gas, the evolved gas collects in the recessed areas of the mold without being able to escape. This inhibits further deposition in these areas by interfering with the availability of the depositing material to the recessed areas. Fluid stagnation may also occur in that part of the depositing material which is trapped in the recessed areas of the mold. Deposition in these areas may therefore also be limited by depletion of the depositing material in the recessed areas. Finally, if the recessed area is located at the juncture of two distinct parts of the mold or article to be formed, where these two parts, when formed, are ultimately of different thicknesses or rigidity, the article formed includes a substantial amount of inherent stress at this juncture. Such stress is a particular problem where a high degree of precision is required in the article formed, such as large electroplated mirrors.

OBJECTS OF INVENTION

With a view to these problems, it is a primary object of the present invention to provide a mold surface having a recessed area with a means for facilitating deposition in the recessed area.

Another object of this invention is to provide a means whereby stress-free sheet-like articles may be formed with integral and rigidly attached supporting members therefor.

Still another object of this invention is to provide means for forming complexly shaped articles by deposition processes.

One other object of this invention is to provide an electroplated relatively stress-free, mirror and a rigidly attached, circumferentially disposed, integrally formed, toroidal support therefor.

BRIEF SUMMARY OF THE INVENTION

These and other objects are met, in accordance with one embodiment of the present invention, by a surface mold, with recessed areas therein, having perforations in these recessed areas, and also having a fusible fillet occupying portions of the space surrounded by the recessed areas. In the prefered form of the present invention, integrally formed, toroidally supported, electroplated mirrors are provided, using as the mold surface, an optically smooth mandrel connected to a perforated, fusible, toroidal member, circumferentially disposed near the other edge of the mandrel, through a perforated mold surface which provides a continuous curved surface from the optically smooth mandrel to the toroidal member. In addition, a fusible fillet is disposed in portions of the recession at the juncture of the flat connecting surface and the toroidal member.

DETAILED DESCRIPTION OF THE INVENTION

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter of the present invention, this invention may be better undersood from the following description, taken in conjunction with the following drawings, in which:

FIG. 1 depicts, in cross-section, an electroform for producing relatively stress-free electroplated mirrors with integrally formed, toroidal supports;

FIG. 2 is a detailed cross-sectional view of a part of the electroform shown in FIG. 1; and

FIG. 3 is cut-away view of a part of the electroplated mirror and integrally formed support therefor formed using the device shown in FIGS. 1 and 2.

Refering more specificaly to FIG. 1, there is shown a metallic mandrel **1** having an optically smooth surface **2** for electroplating large, concave mirror surfaces. In order to provide rigid, stress-free support for a mirror electroplated an metallic mandrel **1**, a fusible perforated, toroidal member 3 circumferentially disposed around the edge of the mandrel **1** is provided along with a gutter member **4** which abuts both the metallic mandrel **1** and toroidal member **3** and on which a connecting surface between the deposit on the mandrel **1** and toroidal member **3** is formed. These elements are seen in more detail in FIG. 2.

In order to provide an even, smooth, rigid, deposit in the recessed area formed by the metallic mandrel **1**, the toroidal member **3** and the gutter member **4**, perforations **5** are provided at intervals in the recessed area. These are shown in FIG. 2, as is a fusible fillet **6** located at the very tip of the recessed area. Other features include additional perforations **7** in the toroidal member **3**, and an electrode extension **8** for providing relatively well distributed electrical stress in the enclosed and recessed areas of the electroform. The electroplate **9** formed on this mold is also shown in FIG. 2, as is a shield **10** over the outer surface of the gutter member **4** and a bolt **11**, which secures the gutter member **4** to the toroidal member **3**. Since the member **3** is toroidal, the electroplate **9** is a double-walled hollow structure, with the plating inside the perforations **5** forming tubular connections between the two walls which form the double wall. The extension **12** of form **3**, which joins tangently the circular cross section of form **3**, provides continuity with the gutter member **4**.

In FIG. 3, the electroplate is shown after it has been removed from the electroform shown in FIGS. 1 and 2, and

after the fusible, perforated, toroidal member and the fusible fillet have been melted out.

While it has been found, in accordance with the present invention, that the perforations **5** are necessary to permit escape of evolved gases and circulation of electrolyte material through the recessed area, the remaining perforations **7** in the toroidal member **3** serve a useful function also. In particular, these additional perforations reduce the weight of the overall structure. Notwithstanding this, the structure is supported by the optimum shape, namely a torus. Further, the support is rigid but the structure is free of stresses caused by the mating of separate members, and particularly those induced by mating of separate members formed of dissimilar materials. Finally, and most importantly, stress induced by uneven plating on a complex shape is avoided.

While it is clear that this concept may be used to form, in a single step, a stress-free toroidally supported electroplated mirror, using for example nickel or aluminum electroplating baths, it is equally clear that the concept may be useful in a variety of other applications in which articles having complex shapes are formed by deposition processes onto a mold surface, particularly one having recessed areas. Good deposition within the recessed areas is facilitated by the present invention and rigid bridge supports across the recess area may be provided to enhance the quality of the final article.

While the present invention has been described with reference to particular embodiments thereof for purposes of clarity and convenience, it should be understood that numerous modifications may be made by those skilled in the art without departing from the invention's true spirit and scope. Therefore the appended claims are intended to cover all such equivalent variations as come within the true spirit and scope of the present invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electroforming assembly for producing by electrodeposition thereon from a solution a double-walled hollow structure **9** of first metal having tubular connections between the two walls which are the double wall, including a form which

is constructed of a second metal fusible at a relatively low temperature below the softening temperature of the first metal;

is hollow, and substantially of the shape of the article to be formed;

is provided with apertures **7** in its wall for enery of solution into its hollow interior;

is provided with an electrode extension **8** in its hollow interior which electrode has a portion thereof extending through said wall to the outside of the form.

2. An assembly as claimed in claim **1** in which said form is substantially circular in cross section and has an addition an external extension **12**, of the said second metal, which is joined tangently to the part of circular cross section.

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JOHN H. MACK, Primary Examiner

T. TUFARIELLO, Assistant Examiner

U.S. Cl. X.R.

204—231

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,515,662 Dated June 2, 1970

Inventor(s) Ference J. Schmidt

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 11, change "enery" to -- entry --
line 17, change "an" to -- in --

SIGNED AND
SEALED
SEP 1 - 1970

SEPT. 1, 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents