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METHOD OF ELECTROFORMING VESSELS

Filed May 31, 1968

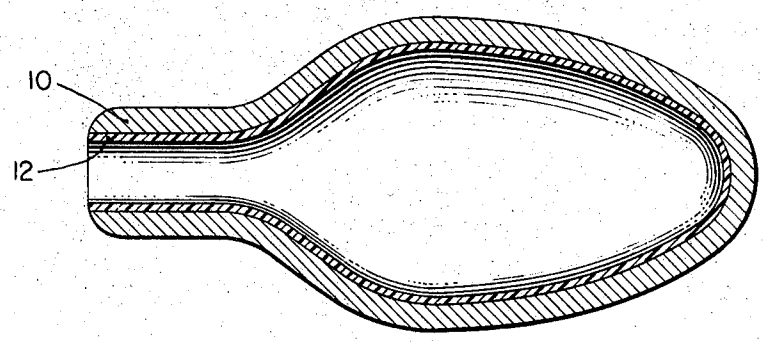


Fig. 1

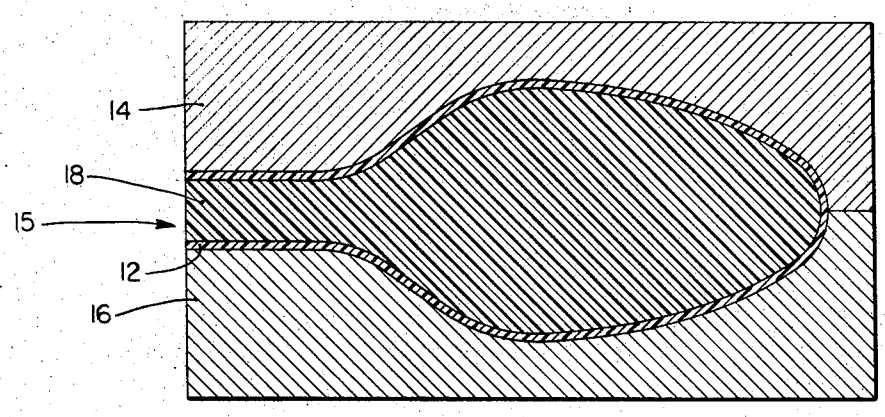


Fig. 2

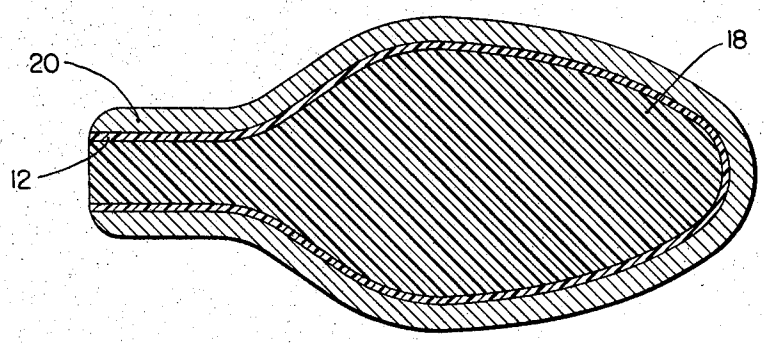


Fig. 3

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METHOD OF ELECTROFORMING VESSELS

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ABSTRACT OF THE DISCLOSURE

A method of electroforming a vessel includes first casting a hollow flexible body inside a mold. The flexible body is then collapsed, taken out of the mold and inserted inside a two-piece mold. The flexible body is then filled with a castable material to form a mandrel and the two-piece mold is then removed. Metal is then electrodeposited on the mandrel which includes the flexible body and castable material. The castable material is then removed after which the flexible material is removed leaving the electroformed vessel.

In many cases it is necessary to have vessels which have extremely smooth interior surfaces. Many such vessels are formed by the electroplating process. When electrodeposition is used to form a vessel, the mandrel that is used is subjected to much machining and polishing operations to achieve the proper dimensions. Even when this is done, however, problems often arise regarding the removal of the casting material within the vessel with a solvent after the vessel is formed.

While it is conceivable that this problem may be overcome by the use of two-piece molds, such an arrangement does not always produce the desired finish and requires polishing to remove the flash line produced by the mold.

In addition to the aforementioned problems relating to the electroforming of a vessel, a convenient and easy means for checking for the surface smoothness of the interior of the vessel after it is formed often presents additional problems.

An example of the importance of having a very smooth surface in the interior of a vessel may be seen in the case of a blood bottle to be used to store blood. Such bottles may be used in hospitals and emergency stations in vessels where the blood is maintained under relatively high pressure. In such a blood bottle, it is essential that the interior of the container be absolutely smooth. Even a slight roughness within the interior tends to affect the blood within the container making it unusable. Because of the importance of interior smoothness of this item, it is necessary not only that the interior of the vessel be smooth but also that the interior of every vessel which is manufactured is examined to assure such smoothness.

It is an object of this invention to provide an improved method for electroforming vessels having interior surfaces relatively free of irregularities.

It is a further object of this invention to provide an improved method for examining the surface smoothness of the interior of a vessel.

In accordance with the present invention, a method of electroforming a vessel comprises the steps of first casting a flexible hollow body inside of a mold by rotational casting or other methods. The flexible hollow body acquires the same shape as the interior surface of the mold. After the flexible body has been removed from the mold, it is inserted into a two-piece mold and filled with a suitable casting material to form a mandrel which is later used to form the vessel. After removal from the two-piece mold, the electrodepositing method is carried out about the mandrel to form the vessel. The castable material is then

removed from the flexible liner. The liner is then collapsed and removed from the vessel. The method involving the casting of the flexible liner and then removing it provides a convenient way to indirectly inspect the interior of a vessel.

Other objects and advantages of the present invention are apparent and suggest themselves to those skilled in the art, from a reading of the following specification and claim, in conjunction with the accompanying drawing, in which:

FIGS. 1 to 3 illustrate the steps in electroforming a vessel in accordance with the present invention.

Referring particularly to FIG. 1, a one-piece mold **10** is provided. The interior of the mold **10** is the shape of the interior of the vessel which is to be ultimately formed. A flexible liner **12** is then slush cast in the mold. This may be done by a conventional rotational casting method or any other method known in the art. In one such method of casting, a liquid material is put into the mold. The mold is then rotated while subjected to heat. The liner is then permitted to harden and then cooled.

The liner **12** may then be removed by collapsing with vacuum and pulling the liner out of the mold. The flexible liner **12** is then put into a two-piece mold **15** including the pieces **14** and **16**. The interior of the two-piece mold represents the interior of the vessel to be ultimately formed. The interior of the two-piece mold **15** is extremely smooth.

The flexible liner **12** is then filled with a castable material such as a low melting alloy **18** to form a mandrel which is subsequently used to form the vessel. The low melting alloy causes the liner to seat against the two-piece mold, which as mentioned, is the exact shape of the vessel to be formed. The finished mandrel including the liner with the castable material is then removed from the two-piece mold **15** for electroplating.

As is well known, electroplating is the process of coating an article with a thin layer of a metal through electrolytic deposition. The article to be plated is generally immersed in an electrolytic bath and becomes the cathode in the electrolytic system. Also immersed in the bath is an anode composed of the plating metal. A voltage is applied between the cathode and the anode causing a current to pass through the electrolytic solution, which electrolizes and plates the cathode with the anode material to the desired thickness. In this way articles may be plated with silver, copper, iron, cadmium, nickel, and a variety of other metals.

The use of electroforming to make articles such as dies and molds has a number of advantages. In many cases, dies and molds made by conventional methods are very costly. Lower cost and shorter delivery schedules are possible when electroforming techniques are used in place of conventional machining methods. This is especially true if the shape of the mold or die is of an unusual shape. Electroforming of the vessels in connection with the subject application is not shown or described in detail because the technique is well known to those skilled in the art.

Metal **20** is electrodeposited on the mandrel in a conventional manner. Following the electroforming process, the mandrel is removed by melting or otherwise removing the castable material **18**, collapsing the flexible liner **12** with vacuum and removing the liner from the electroformed vessel **20**.

It is noted that the step involved in FIG. 1 makes it possible to easily inspect the interior surface of a mold. For example, after the flexible liner **12** is removed, it may be visually examined for any rough areas. Since these rough areas represent the interior of the vessel, they will indicate the relative roughness or smoothness of the vessel being inspected.

Because the flexible liner is removable after the final step of electroplating, there is no plastic or other material on the interior of the formed vessel. Consequently, solvents are not necessary to clean the interior of the vessel. Because of the smooth flexible liner, it is seen that the final vessel formed has a very smooth interior and is suitable for such items as blood bottles.

The metals electrodeposited may be nickel, silver, copper, iron, cadmium or any one of a variety of metals. The casting material **18** may be a product sold under the trademark Cerrobend, which comprises an alloy of tin, bismuth and lead, synthetic waxes or break-away gypsum cement.

What is claimed is:

1. A method of electroforming a vessel having a seamless interior and a relatively small opening therein with respect to the cross-sectional area of said interior, comprising the steps of providing a mold having an interior shaped to the interior of the vessel to be formed, forming an integral hollow flexible body by rotationally casting liquid material under heat and pressure inside of said mold and then permitting said material to cool and harden so that the exterior surface of said flexible body is the same shape as the interior surface of said mold, collapsing and removing said flexible body from said mold,

inserting said flexible body in a two piece mold having an interior shaped to the interior of the vessel to be formed, filling said flexible body with a low melting alloy castable material to cause said flexible liner to seat against the interior of said two piece mold, removing said two piece mold, electrodepositing metal on said flexible body to form said vessel, melting and removing said castable material from said flexible body, collapsing said flexible body, and removing said flexible body from the electroformed vessel.

References Cited

UNITED STATES PATENTS

1,958,072	5/1934	Sebrell	204—4
2,275,582	3/1942	Bull	204—6
2,282,022	5/1942	Bishop et al.	204—9
2,327,762	8/1943	Bull	204—4
2,949,410	8/1960	Bingham, Jr.	204—9

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