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METHOD OF MANUFACTURING A COATED METAL CONTAINER

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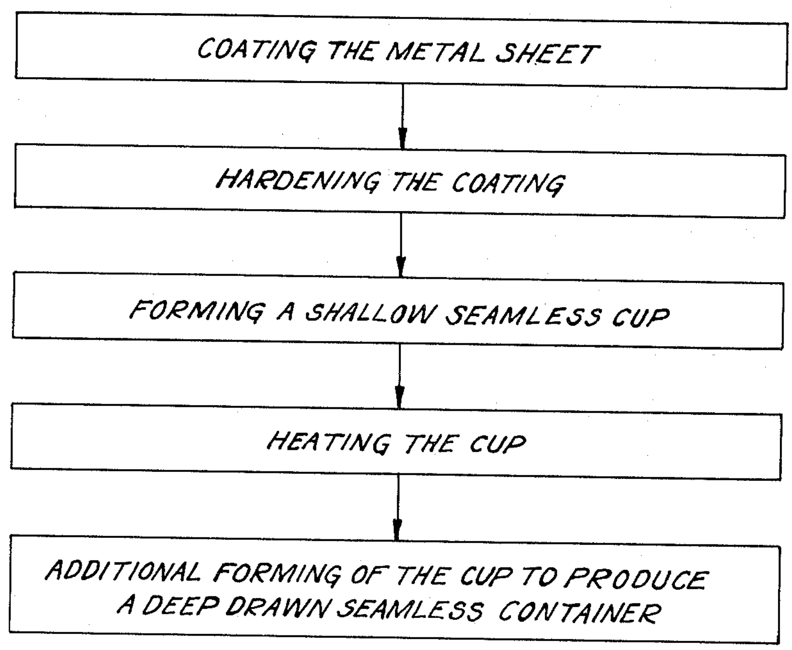

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METHOD OF MANUFACTURING A COATED METAL CONTAINER

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This invention relates to the manufacture of coated metal containers and more particularly to the manufacture of metal containers where an organic coating is applied to metal sheet prior to forming the container.

Lining the interior of metal cans to prevent the contents of the containers from coming into contact with the metal is well known in the art. Such coatings not only prevent imparting a metallic taste to food products contained therein, but also retard the corrosive action of the product upon the metal container. In order to fulfill these requirements the coating must be continuous and free from perforations. For this reason coatings are generally applied to the containers after they have been completely formed. This is especially true for seamless cans. It is apparent that coating, subsequent to fabrication, entails considerable handling of the can, since each can must be coated individually.

U.S. Patent 2,145,252 discloses early attempts to coat metal sheet prior to manufacturing can bodies. In this patent, lubricants were applied to the sheet to prevent breakage of the coating during shaping of the can. Such lubrication does, of course, retard coating perforation, but also introduces the additional problem of covering the dies and shaping machinery with the lubricant. This necessitates periodic curtailment of operation while the manufacturing facilities are being cleaned. Also, variations of the coating itself may lead to difficulties which the lubricant cannot overcome.

It is therefore an object of the present invention to provide a method for forming an article from coated metal sheet.

Another object is to provide a method for shaping a seamless container from a metal sheet having a coating applied thereto prior to shaping.

A further object is to provide a method for drawing a seamless container from a resin coated metal sheet.

An additional object is to provide a method whereby an organic coating, upon a metal sheet, is maintained in a ductile condition while the sheet is being shaped.

Another object is to provide a method of shaping a resin coated metal sheet into a container without exfoliation of the coating.

Yet another object is to provide a method of forming a coated seamless container from a precoated flat sheet without fracturing the coating.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawing, discloses a preferred embodiment thereof.

The above objects are achieved by applying an organic coating to the surface of a sheet of metal, hardening the coating, and then shaping a shallow seamless cup from the sheet. After the shallow cup is formed, it is heated to and maintained at a suitable temperature whereby the coating again becomes ductile. Thereafter the cup

is additionally formed until a deeper, seamless container is produced. The formed container is thus covered with a coating free from fractures, with exfoliation of the coating from the container wall eliminated.

Referring to the drawing:

The figure shows a schematic flow sheet of the process of the instant invention.

As a preferred or exemplary embodiment of the instant invention, a sheet of metal, such as aluminum, steel, or metal coated steel is first cleaned by a suitable immersion or electrolytic cleaner and then rinsed. Subsequently it is pickled, using any of the common pickling acids, such as sulfuric acid for ferrous metals and nitric acid for aluminum and its alloys.

Once the metal sheet's surface is chemically cleaned and dried, it is covered with a liquid coating containing a synthetic resin. The coating may be applied by spraying, dipping, or roller coating, or by other means well known in the art.

A number of resins, both thermoplastic and thermosetting, have been found to be acceptable for this process. Among the thermoplastic resins that have been used are vinyl organosols and solution vinyls. Epoxy phenolics are among the thermosetting resins that have been found to be useful. However, any organic coating which accepts a strain, yet remains integral, can be utilized.

Once the coating has been applied to the metal sheet, it is necessary to harden the liquid coating to a solid. This may be done either by allowing those resins which are thermoplastic to evaporate their organic solvents in air or, evaporation may be accelerated by subjecting the coating to a higher temperature baking operation. On the other hand, thermosetting resin coatings cannot harden in air, but must be heated in order for the curing reaction to take place.

The following are the preferred times and temperatures used for hardening the coatings. It is understood, however, that other time and temperature relationships may be used, the values hereinafter listed being only for the purpose of clarity in describing this invention.

Coating	Temperature, ° F.	Time, min.
Epoxy phenolic	380-400	8
Vinyl organosol	380	8
Vinyl phenolic	360	8
Solution vinyl	350	8

Any suitable method may be used to heat the coated sheet to the desired temperature. Both hot air ovens and infra-red radiation have been used with success. Upon hardening, the coating thickness is approximately 0.25 mil for thermosetting and 0.5 mil for thermoplastic resins.

Although some variations are necessary in the coating procedure, depending upon the type of metal being used, the method will not vary to any great extent. On the other hand, the container forming parameters will vary considerably according to the metal utilized. For the purposes of this specification the process parameters for aluminum sheet will be described. Once the coating has been hardened the coated sheet is ready for the forming operation. An aluminum 5052 alloy in the H36 temper has been found to be the most compatible with the forming technique. From the sheet having a thickness of 9 mils, a disc having a diameter of 5⅝ inches is punched.

The circular blank is then placed in a holder, over an annular die, within a hydraulic press, and coated with a suitable drawing lubricant, such as mineral oil. A punch then forces the blank through the die at a speed of approximately 15 feet per minute, thereby forming a shallow cup having a diameter of approximately three inches and a depth of somewhat less than two inches. Drawing flat metal sheet into seamless cups is, of course, old in the art, the parameters herein described being only for purposes of clarity.

After the shallow seamless cup is formed by the initial drawing operation, it is removed from the press and cleaned of any surface contamination. The cup is then heated, by suitable means such as mentioned hereinbefore, and maintained at a temperature between 10° and 30° F. below the initial hardening temperature of the liquid coating for a suitable time period depending upon the particular organic coating used. Obviously the time-temperature relationship must be such that the coating is not thermally degraded. Usually, a time interval of beteen one and twenty minutes is operable; but it is preferred to use an interval of from two to five minutes. If air drying is used for hardening the coating, baking subsequent to the initial drawing operation is between 275° and 380° F.

It is believed that this baking operation has the effect of relieving the stresses in the coating and thus reducing the susceptibility of the coating to fracture upon additional shaping of the article. Although the physical phenomena that results in relieving the stresses in the organic coating is not known, it is thought that it is somewhat analogous to the softening of metal.

In metal, which has been cold-worked, hardening of the metal occurs due to straining. This is due to an increase in the internal energy of the metal. In order to decrease the internal energy in a cold-worked metal, one common method is to heat the metal to its recrystallization temperature. At this temperature the internal energy of the metal decreases, stresses are relieved, and grain growth begins.

Although there is no recrystallization temperature for an organic coating, it is thought that the hereinbefore mentioned baking operation on the coated drawn seamless cup has the effect of reducing the internal energy which was built up in the coating during deformation. After being baked, the coating apparently becomes more ductile and less apt to fracture and exfoliate from the metal upon subsequent deformation.

Following the baking operation the cup is cooled, since coatings generally soften and are more easily marred as their temperature is increased above 150° F. Then the shallow cup is once again placed in the hydraulic press over another annular drawing die having a diameter less than the first. A mating punch forces the coated metal cup through the die at a speed of approximately 100 feet per minute. This second drawing operation forms a seamless container having a diameter of about 2½ inches and a depth of 2¼ inches. It may be readily understood that the drawing speed is greatly dependent upon the hydraulic press equipment. Faster or slower speeds may be used without departing from the spirit or scope of this invention.

It is also obvious that additional drawing operations may be made with baking steps between each of the draws. Should such additional draws be desired, the following average reductions in diameter for each draw is suggested:

Circular blank—D (diameter)	Reduction in diameter
First draw—D_1	40%D
Second draw—D_2	20%D_1
Third draw—D_3	15%D_2
Fourth draw—D_4	15%D_3

In order to determine the effectiveness of baking between drawing operations, sample aluminum containers

having different organic coating thereon were packed with applesauce and stored at 98°. After a nineteen month storage period the containers were opened and the coatings evaluated. The following table shows the results with epoxy phenolic thermosetting resin and vinyl phenolic thermoplastic resin coatings:

Coating	No rebake	Failures	
		2 minute bake after 1st draw	5 minute bake after 1st draw
Epoxy phenolic	7 of 8	0 of 8	0 of 8.
Vinyl phenolic	6 of 8	0 of 8	0 of 8.

From this data it is apparent that baking the coating between drawing operations greatly increases the ability of the coating to undergo additional deformation without fracture or exfoliation.

Although the deformation steps in this invention have been described in terms of drawing the coated metal sheet, other methods may also be used. Among such other methods are drawing and ironing, bending, flanging, beading, curling, crimping, and stamping. This invention may thus be used in producing various coated metal articles that require multiple shaping operations during their manufacture.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the steps of the method described and their order of accomplishement without departing from the spirit and scope of the invention, or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. The method of manufacturing a coated metal container comprising the steps of: applying a thin liquid organic coating to the surface of a sheet of metal; hardening said organic coating; shaping a shallow seamless cup from said coated sheet; heating said coated cup to an elevated temperature; maintaining said temperature until said coating becomes ductile; and additionally shaping said cup until a deep drawn seamless container is formed without exfoliation of said organic coating.

2. The method in claim 1 wherein said liquid coating comprises a thermosetting resin.

3. The method as claimed in 1 wherein said liquid coating comprises a thermoplastic resin.

4. The method as claimed in claim 1 wherein said liquid coating is hardened by the application of heat.

5. The method as claimed in claim 1 wherein said temperature is maintained between 275° and 400° F.

6. The method as claimed in claim 1 wherein said shallow cup is maintained at said temperature for a duration of at least one minute.

7. The method as claimed in claim 1 wherein said cup and container are shaped by drawing.

8. The method of manufacturing a coated metal container comprising the steps of: applying a thin liquid organic coating to the surface of a sheet of metal; hardening said organic coating; drawing said coated sheet into a shallow seamless cup; heating said coated cup to a temperature whereby said coating becomes ductile; redrawing said cup until a seamless container is formed without exfoliation of the coating.

9. The method as claimed in claim 8 wherein heating is used to harden said coating.

10. In a method of manufacturing a coated metal article wherein a liquid organic coating is applied to the surface of a metal sheet, the organic coating is hardened, and said article is shaped from said sheet, the improvement comprising the steps of: partially deforming said coated sheet after said coating is hardened; heating said partially formed sheet at a temperature whereby said

organic coating becomes ductile; and thereafter deforming said partially deformed sheet to its final shape.

11. The method as described in claim **10** wherein the coated sheet is deformed by drawing.

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