Sept. 5, 1944. C. E. McMANUS, JR., ET AL. 2,357,415

CONTAINER AND METHOD OF MAKING SAME

Filed July 18, 1940

Fig. 1.

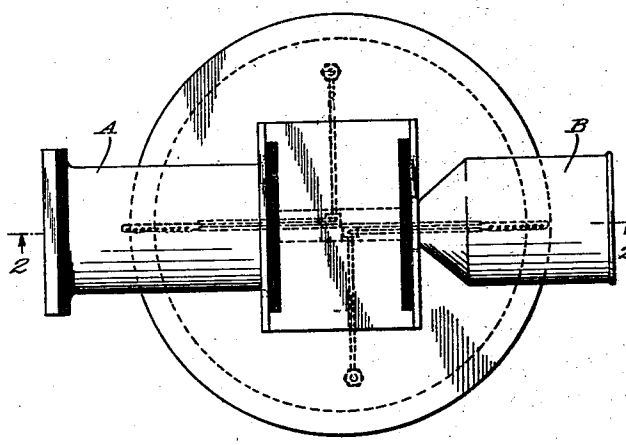


Fig. 3.

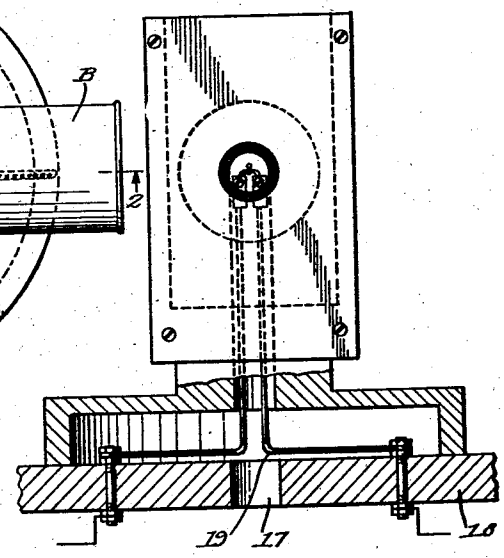


Fig. 2.

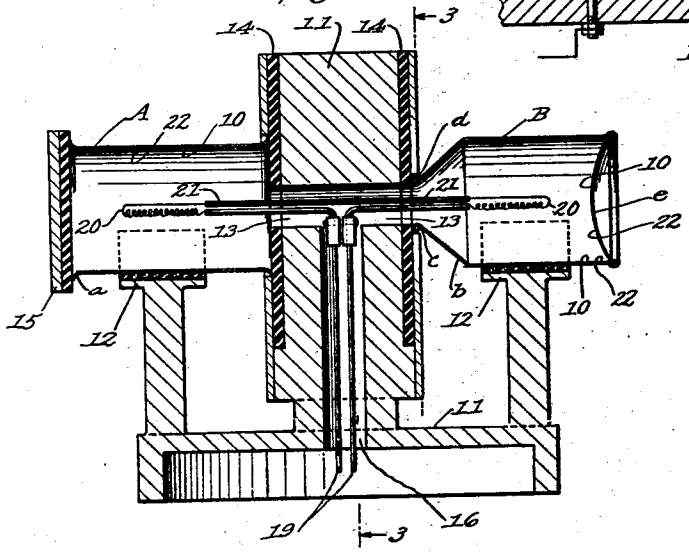
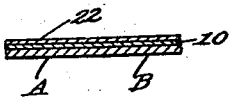


Fig. 4.



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CONTAINER AND METHOD OF MAKING SAME

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Application July 18, 1940, Serial No. 346,238

1 Claim. (Cl. 220—64)

The present invention relates to containers having a novel protective liner of silver and includes a new articles and method of making the same.

The invention particularly is concerned with metal containers of black iron or steel of the sizes and shapes of the conventional "tin can." It is equally useful as regards larger metal cans, drums or barrels as well as small cans and boxes. The metal containers may be of the seamless drawn type, as described in the application of Calleson et al., Serial No. 334,876, and the application of McManus et al., Serial No. 217,274, and of the welded side seam or conventional lock-seam side seam types or of any other construction. Such containers when provided with our silver lining are useful for a wide variety of products among which may be mentioned foods, beverages including carbonated beverages, chemicals, oils, pharmaceuticals, milk and syrups, and the containers having readily removable closures such as screw, lug or crown caps may be opened, portions of the contents removed and the containers resealed as often as necessary without injury to the contents or the liner.

The invention includes a metal container having its entire interior surface lined with a continuous highly reflective and permanently adherent film of pure silver of commercially satisfactory thinness. That is to say, the thickness of the film (*a*) is sufficient for it to act as a protective liner in association with an extremely wide variety of contents and (*b*) requires an amount of silver so markedly small that containers, for example those of the usual "tin can" shapes and sizes may be manufactured and sold at popular prices. We produce in accordance with this invention containers having a silver liner coating of a thickness in the neighborhood of five millionths of an inch. Films as thin as from substantially two millionths of an inch to ten millionths of an inch may be applied and usefully employed.

Lacquers, varnishes and enamels are at present generally employed for lining metal containers, but it is recognized that such coatings possess a limited life, a restricted field of application and in general have a resistance and durability substantially less than silver. Silver has a wide field of application and substantially unlimited durability and resistance, but cannot be applied directly to the metal wall of a container of the popular type in a thinness to be economically feasible because galvanic action will take place between the iron and such necessarily thin silver film.

We have discovered that the durability and resistant properties of silver are made available for liner purposes by depositing the thin silver film upon a non-conductive surface of lacquer, enamel or varnish which has been previously applied to the container wall surface. With this construction (1) galvanic action is precluded, (2) there is obtained a smooth continuous permanently adherent and satisfactory protective liner film having a thinness of the order above described, (3) a wide selection of materials for forming the intermediate film is afforded and (4) the life of the intermediate film is materially extended by the protective influence of the silver surface film.

In other words, we produce a container having a composite liner consisting of a non-conducting under coat and a silver surface film which is smooth and attractive and has a durability and resistance of a much higher order than tin coated containers or containers provided with lacquer, varnish or enamel liners. This composite liner possesses none of the disadvantages mentioned above in respect to organic coatings or to silver coatings directly applied to container walls of steel. At the same time, we provide a silver liner of a thinness not heretofore obtained for containers and which makes commercially available the highly desirable protective properties of silver at a modest price.

It will be appreciated that the production of such a widely used container of the general character of the usual "tin can" having a reliable over-all silver liner, at a popular price, is a particularly important improvement of the present invention.

The presence of the intermediate film of varnish, lacquer or enamel has the advantages that it protects the metal base and seals any irregularities in the surface thereof, thereby forming a smooth continuous coat for receiving the thin silver film. This intermediate film appears to promote better adherency and in addition reinforces and supports the thin silver film and assures a bright and lustrous mirror-like appearance for the liner.

In preparing the cans for the intermediate coating operating we find it important that the can wall surface first be freed as far as possible from surface irregularities and thoroughly cleaned. Thereafter the coating solution is applied so as to form a continuous adherent coating on the steel base i. e., the container body, bottom

or ends, and is baked at such a temperature as to remove all volatile matter and produce a continuous, adherent, glossy and preferably flexible surface film on the metal base.

In connection with the intermediate coating, we employ coating compositions which are baked at a high temperature to produce a flexible film free of volatiles and particularly advantageous for foods and beverages. Also we use various types of compositions which may be baked at lower temperatures according to the specific use of the container and produce films of desired flexibility with complete or substantially complete freedom from volatiles. In addition to organic intermediate films, we produce satisfactory enamel films of vitreous nature which generally are not flexible. The intermediate coating in any case is one upon which the silver will deposit and adhere satisfactorily and which is inert to the silver, the metal container wall and to the contents where this property is important as with foods, beverages and medicines.

The containers provided with the intermediate coating adjacent to the container wall are delivered to an automatic machine for carrying out the silver coating operation. We preferably deposit the film of pure silver upon the wall of the container from an atmosphere of vaporized silver created by distillation under reduced pressure. That is, we have discovered that efficient results are obtained by using the container or container body as the vacuum or reduced pressure chamber during deposition. In this manner the container may be coated with or without the bottoms or ends assembled. In the automatic machine, the cans are continuously evacuated, subjected to an atmosphere of vaporized silver and then as silver coated containers, delivered from the apparatus. Other methods of silver coating such as chemical reduction and cathode sputtering may be employed. The coating employed may be determined as being produced by a particular method by metallographic examination and X-ray diffraction studies.

Before describing in detail the present invention, it is to be understood that the invention is not limited in its application to the details of construction and arrangements of parts illustrated in the accompanying drawing, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

In the drawing,

Figure 1 is a top plan view of one type of apparatus for carrying out the invention;

Figure 2 is a side elevation partly in section;

Figure 3 is an end view partly in section; and

Figure 4 is a fragmentary section of a container having a composite coating in accordance with this invention.

Referring to the drawing we will, for purposes of illustration, describe the invention in connection with containers having drawn seamless bodies as disclosed in the aforementioned applications. The container A at the left of Figures 1 and 2 has a cylindrical seamless body and end flanges *a* and is shown without its bottom or ends assembled. The container B shown at the right of Figures 1 and 2 likewise has a seamless drawn body with integral conical top *b*, neck *c* and sealing lip *d* to receive a removable closure such as a crown, screw, or lug cap, and has the bottom *e* united.

Each of the containers is provided on its entire inner wall, including the bottom where the same is attached, with a continuous thin flexible coating or film **10** of a suitable non-conducting lacquer, varnish or enamel. This intermediate film **10** may be composed of a single layer produced as by spraying the container wall or may be built up to have the desired thickness and resistance by means of several spray coats. The coating should have a thickness in the neighborhood of from 0.0001 to 0.002 inch.

Examples of suitable coatings are solutions of chlorinated rubber, polyvinyl acetal resin, varnishes of the drying oil type and phenol formaldehyde varnishes and enamels which may be termed inorganic because of their predominant vitreous nature. In fact, in view of the protective action of the silver film, practically any of the usual liner materials which may be suitably baked or dried to form an adherent smooth surface film to which silver will adhere may be utilized. Preferably, those coatings which upon drying or baking will form a glossy, flexible surface film and under the silver coating conditions will not evolve objectionable vapors or disintegrate are employed. There are a large variety of coating compositions commercially available for this purpose, and as will be appreciated, the protective film of silver permits a considerable range of selection in the varnish, lacquer, or enamel which is to be used, namely, according to cost, availability and suitability. Such coatings, moreover, may in some cases initially have resistant qualities substantially equal to the properties of the silver, but as stated above, even the best quality coating compositions disclose a lack of durability far short of that possessed by a silver lining. The important functions of the varnish or other intermediate nonconducting film are to preclude galvanic action between the silver film and the metal wall and to assure the deposition of a smooth continuous adherent silver film. The properties of compatibility or receptivity to a deposited silver film and the preventing of galvanic action are equally important because the silver film will provide a protective layer for the varnish or intermediate coating against the action of air, moisture, organic acids and other deteriorating influences.

The following are examples of coating compositions suitable for receiving the deposited silver film:

1. *Black varnish*

Linseed oil (bodied)	pounds	110
China-wood oil (raw)	do	24
Amberol F-7	do	34
Cumar	do	34
Manganese acetate	ounces	13
Cobalt acetate	do	3
High flash naphtha	gallons	4
Fine oil	do	4
Kerosene	do	4
Xylol	do	100

This coating is applied by spraying and baked at 600° F. in clean, dry circulating air for fifteen minutes.

2. *Chlorinated rubber*

Chlorinated rubber	pounds	80.00
Hydrogenated rosin ester	do	10.00
Diamyl phthalate	do	1.25
Wax	ounces	2.00
Salvesso #2	gallons	45.00

This is a spray coating and is baked at 230° F. for thirty minutes in clean, dry circulating air.

In connection with Example 1 we have found that coatings which are baked at a high temperature and produce flexible adherent films which are inert, odorless, tasteless and free of volatiles, are highly satisfactory for a wide variety of food products and beverages. The solution of Example 1 is representative of a number of coating compositions of this character which maintain their properties when subjected to high temperatures and therefore have a broad field of application.

In connection with the solution of Example 2, it is to be noted that this is baked at a somewhat lower temperature to form a film having similar properties to Example 1 and is representative likewise of a large number of coating compositions which may be employed for special purposes as where temperatures much above 230° F. will not be encountered.

Either of the above-mentioned compositions is preferably sprayed upon the interior wall of the container body before the end or bottom is united thereto. In some cases this coating may take place after the end or bottom has been united. Preferably the coating compositions are applied by spraying, as a continuous operation in which the container walls are smoothed, if necessary, cleaned, then coated while traveling on a suitable conveyor, and then transported by the conveyor through a suitable drying or baking oven. The ends or bottoms are similarly coated and dried or baked.

After the baking or drying operation, it will be found that each of the aforesaid coatings forms a smooth continuous glossy and preferably flexible surface film free from volatiles. The coatings are odorless and tasteless and sufficiently inert so that should there possibly be some pinholes in the silver film, no deleterious action in respect to the contents, the intermediate lining 10 or to the wall of the container will result.

The coated containers may have the bottoms or ends united thereto and then be continuously delivered to the automatic silver coating apparatus, or the bodies and ends or bottoms may be separately provided with the thin silver film. It is preferred to conduct the silver coating operation with the bottom applied to the container B and with one end applied to the container A but this is not necessary.

In some cases, the containers are transported directly and continuously from the baking oven to the silver coating apparatus and in such cases the containers may or may not have the ends or bottoms attached thereto. Where it is not desired to have such a continuous and direct delivery from the oven to the silver coating apparatus, the containers and ends may be stored under conditions where they will be maintained clean.

Referring to Figures 1, 2 and 3, the coating apparatus comprises a fixed head 11, of which a plurality may be mounted upon a rotary turret set up either vertically or horizontally, or arranged in a straight line. Each container having the intermediate film 10 adjacent its inner wall surface, is continuously and automatically fed to each head and positioned on a saddle 12. In each case the container or container body will act as the vacuum or reduced pressure chamber during the deposition of the vaporized silver, and in the case of the container B at the right of Figures 1 and 2, the lip *d* of the container is held fixed in communication with the opening 13 in the head and against a suitable gasket 14 with the body supported upon the saddle 12. The container A at the left of Figures 1 and 2 has one of its end flanges *a* likewise held fixed in communication with the opening 13 being supported in a similar saddle 12, with its opposite end closed by a clamping plate 15 of suitable resilient sealing material.

The openings 13 intercommunicate within the head and are in communication with the opening 16 through the head which in turn is connected with a suitable vacuum pump or other evacuating apparatus not shown through the port 17 in the base 18 upon which the heads are carried. When this apparatus is operating, the interior of the container or container body will be exhausted and we prefer to operate at a pressure of between substantially 0.1 and 20 microns. Extending up through the opening 16 and supported therein in fixed position are lead-in wires 19. These lead-in wires are connected to heating units or filaments 20 which project from without the openings 13 so as to be received within the interior of the container or container body. It will be noted that protective connector sleeves 21 are provided to insure against overheating at the constricted part of the cone top can B, such sleeves not being necessary where container bodies A are employed.

The filaments 20 are preferably formed of tungsten or molybdenum and are platinized or aluminized, if desired, to promote adhesion of the small globule or pellicle of molten silver to each filament. The filaments are composed of wire of 0.015 to 0.040 inch in diameter, wire of 0.025 inch in diameter being preferable.

In the operation of the apparatus, a small quantity of silver such as a predetermined length of wire, is automatically positioned within the convolutions of each filament, whereupon the container bodies are positioned automatically as above described and connection automatically made to the exhausting apparatus. When a sufficient vacuum has been created within the container bodies, the current is automatically supplied to the wires 19 and causes the filaments 20 to heat and vaporize the silver. Under the reduced pressure the silver deposits from the metal atmosphere upon the intermediate non-conducting film 10 on the inner wall of a container body to form the thin film 22 of pure or elemental silver. We employ a current of from about ten to thirty amperes and five to ten volts for periods ranging from four seconds to two minutes. The deposition of a thin continuous film of pure silver is caused by the fact that the wall of the container body is of lower temperature than that of the metal vapor and this promotes condensation. The thickness of the coating is controlled by feeding a predetermined amount of silver to each filament, this charge of silver being completely volatilized at each energization of the filament. The entire operation consumes less than one minute, actual operating times having been frequently about 26 seconds. In connection with the operating time, one consideration is the necessity for permitting the filaments 20 to cool before breaking the vacuum and allowing the air to enter, so that the silver coated containers may be removed from the head.

We have not found it necessary to preheat the can to secure adherency, but there are certain types of lacquers, enamels, or varnishes in which the adherency is enhanced by heating to a tem-

perature of about 220° F. for up to thirty minutes, usually less, after the silver coating has been applied.

While we have illustrated the invention by a method employing a vaporized atmosphere of silver in which the container body or container forms the vacuum chamber, it is possible to utilize other methods, such as induction, using crucibles in which a predetermined amount of silver is automatically placed and vaporized in timed relation with the operation of the apparatus. Such crucibles replace the filaments 20 and the wires 19 serve to carry the high frequency current to a suitable coil disposed around each crucible, the crucible and coil being located approximately at the center of the container.

The silver coating may also be applied by cathode sputtering, by chemical reduction as well as by heat vaporization using the exploding wire method. This latter involves the discharge of a relatively large amount of electrical energy in an exceedingly small period of time, the energy being liberated between silver electrodes and volatilizing portions thereof. Alternatively a predetermined current of very high amperage is passed through a fine silver wire, thus instantaneously vaporizing the silver wire.

In some cases, multiple silver coatings are provided as for example in the case of relatively large drums and barrels where increased thickness is advantageous or in other instances where the relatively uneven surface of the container wall makes the provision of two or more films particularly desirable.

Also, while we have described the provision of a lining, it is to be understood that the exterior of the container may also be given a silver coating, the same being formed upon an intermediate non-conducting film as herein described. For the production of the external coating, a suitable bell jar type of vacuum chamber may be utilized in which the containers are placed, filaments being positioned so as to coat both the inside and outside simultaneously or simply the outside, as desired. In the case of containers having walls of a thickness or design which does not permit the use of the container body as its vacuum chamber, the bell jar apparatus may be utilized as the chamber for forming the vacuum.

While we have described the preferred embodiment of the invention, namely the coating of containers made of black iron or steel, we have found that containers of tin plate coated or not with an intermediate non-conducting coating 10 as required, containers of Bakelite or other molded resin, galvanized iron containers to which an intermediate coating is first applied, paper and glass containers and, in fact, receptacles formed of a wide variety of materials may be lined with a thin silver film in accordance with this invention. Glass bottles may be provided with a thin silver film by direct deposition upon the cleaned glass.

We claim:

A metal food and beverage container having a lining comprising a base coating of a substance which is galvanically inactive to silver, and an additional continuous protective coating of silver thereon and of a thickness between substantially 2 millionths of an inch and 10 millionths of an inch deposited on said first coating by condensation thereon from an atmosphere of silver vapor, said first coating rendering the metal can wall and the silver lining chemically inactive relative to one another.

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