Precoated aluminum stock material for use in forming a drawn and ironed aluminum container and method of forming such container. The aluminum stock material initially has a thin layer of lubricant applied to one or both surfaces thereof. The lubricant is peanut oil and/or certain oleic acid esters of aliphatic polyhydric alcohols. The method contemplates applying the thin layer of said lubricant to an aluminum stock, cutting a disc and forming a drawn and ironed container utilizing said lubricated disc without additional lubricant being applied to the tooling.
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PRECOATED STOCK MATERIAL FOR CONTAINERS
AND METHOD OF FORMING SEAMLESS CONTAINER

DESCRIPTION

Reference to Related Application
This application is a continuation-in-part of U.S. Serial No. 149,850, filed May 14, 1980.

Technical Field
Our present invention relates to an improved stock material for making aluminum containers and to a method for forming seamless drawn and ironed aluminum containers from the improved stock material.

Background Prior Art
The use of a two-piece container for packaging products such as beer and/or carbonated beverages has become very popular in recent years. The two-piece container generally is a container sidewall or body with a unitary end wall at one end thereof. The second piece of the container comprises an end seamed to the open end of the container in a fluid-tight manner.

Typically, a two-piece aluminum container may be produced by initially cutting a disc from a sheet or coil of stock aluminum, and substantially simultaneously transforming the disc into a shallow cup in a conventional cupping machine forming a part of a can manufacturing line. The shallow cup is then converted into
a drawn and ironed container of desired dimensions
in a body maker by ramming the cup through a plurality of forming die rings on a punch in a known manner
to progressively decrease the wall thickness of the
reformed cup and produce a seamless container as
described in detail in an article appearing in the
November, 1973 AEROSOL AGE magazine entitled "The
Drawn and Ironed Can - Understanding the Technology".

In general, conventional commercial machinery which form the cups for conversion to drawn and
ironed aluminum containers utilizes a lubricant-coolant in the cup making device or cupper to provide
the necessary lubricity between the surface of the stock material and the tooling. The can body making
machinery also incorporates a mechanism for flowing a lubricant-coolant onto the surface of the container
and to the ironing dies utilized in cooperation with the punch. Typically, the lubricant-coolant is a
mixture of water and an emulsified oil-blend lubricant, such as a commercially available Texaco brand 591
product. Criteria which such lubricants must meet to be commercially acceptable include the following
qualities: good lubricity at high pressure and temperature, good emulsion stability, easily washable from
the can surface, good availability and inexpensiveness.

Considerable effort has gone into finding and developing lubricants which meet the exacting
requirements for optimal use in the manufacture and production of two-piece aluminum containers, and
illustrative of such efforts are numbers of patents. Thus, as shown in U.S. Patents Nos. 3,298,954;
3,478,554 and 3,873,458, various resin coatings containing lubricants have been suggested for use.
Mixtures of polymers, mineral oil and fatty acids
are disclosed in U.S. Patent No. 4,027,070. Others have taught the application of a pretreatment procedure wherein a phosphate coating is applied prior to the application of a fatty acid as is disclosed in U.S. Patents Nos. 3,313,728 and 3,525,651. The special requirements for lubricating aluminum sheet are discussed in U.S. Patents Nos. 3,783,644 and 3,832,962, where an oil-water emulsion and a thermosetting resin are used respectively. U.S. Patent No. 3,826,675 lists some of the more important characteristics of an entirely satisfactory lubricant for metallic container stocks such as tinplate, blackplate and aluminum, and then discloses numbers of lubricants which were previously proposed for such use. Among the latter have been naturally occurring vegetable oils and synthetic esters of carboxylic acids, stated examples of which are cottonseed oil, palm oil, and synthetic esters of sebacic acid such as dioctyl sebacate. The aforesaid vegetable oils are stated to have the objection that they have a tendency to oxidize to a solid film which is no longer a good lubricant after a relatively short period of storage. The disadvantages or deficiencies of synthetic ester lubricants, even the stated best of them, dioctyl sebacate are described in said U.S. Patent No. 3,826,675, and it is stated therein that an entirely satisfactory lubricant was not available prior to the invention of the said patent. The invention of U.S. Patent No. 3,826,675 resides in the use of a lubricant in the form of a citric acid ester of an alcohol containing from 1 to 10 carbon atoms in an amount of about 0.05 to 1 gram for each 67,720 square inches of lubricated surface area, illustrative examples of said citric acid ester lubricant being triethyl citrate, acetyl triethyl citrate and tributyl citrate.
Summary of the Invention

We have discovered, surprisingly, that, when forming seamless, drawn and ironed containers from aluminum stock, which containers have a bottom wall and an integral sidewall, all lubricants in the cooling fluid can be eliminated by applying a thin layer or coating of peanut oil to the stock material before the cupping operation is initiated. We have also discovered that peanut oil does not solidify on the can forming machine, thus avoiding the necessity for frequent or constant cleaning. Peanut oil also cleans off the can surface readily using mild detergents, and it is readily available and relatively inexpensive. It is particularly surprising that peanut oil is so satisfactory since, as noted above, U.S. Patent No. 3,826,675 states that a number of naturally occurring vegetable oils, such as cottonseed oil and palm oil, tend to oxidize to a solid film which is no longer a good lubricant after a relatively short period of storage.

Peanut oil is a triglyceride of a mixture of fatty acids or aliphatic carboxylic acids, the contents of said acids being somewhat variable. An illustrative example of the mixture of acids and the proportions thereof in the triglycerides which comprise peanut oil is primarily oleic acid, approximately 55 to 60%; linoleic acid, approximately 22 to 26%; palmitic acid, approximately 6 to 8%; stearic acid, approximately 3 to 5%; behenic acid, approximately 3%; and arachidic acid, approximately 2 to 2.5%. In place of peanut oil, one can utilize what may be characterized as a synthetic peanut oil which would result from esterifying a mixture of the foregoing fatty or aliphatic carboxylic acids, or their acyl
chlorides or bromides or their methyl esters, in the approximately above stated ratios with an amount of glycerol to produce the triglycerides, although this approach would be uneconomical. The term "peanut oil" will be understood to include such synthetically produced peanut oils and which would possess a low solidification temperature, similar to that of peanut oil, which is around 0°C or slightly below.

While, as stated, peanut oil has been discovered to be exceptionally satisfactory as a lubricant in the forming of seamless, drawn and ironed containers from aluminum stock, which containers have a bottom wall and an integral sidewall, and its use represents the best and most important embodiment of our invention, it has, further, been discovered that certain synthetically produced oleic acid esters of aliphatic polyhydric alcohols containing at least three hydroxyl groups are also very satisfactory as lubricants for the same purposes which have described above in regard to the use of peanut oil as the lubricant. Such synthetically produced oleic acid esters which are useful as lubricants in accordance with the present invention are, particularly, the predominately trioleic acid esters of said aliphatic polyhydric alcohols; but, where the aliphatic polyhydric alcohol contains four or more hydroxyl groups, as in penterythritol and in aliphatic hexahydric alcohols such as sorbitol, mannitol and dulcitol, the tetra- and hexa-oleic acid esters can be used. It is, however, especially desirable, in regard to the synthetically produced oleic acid esters of said polyhydric alcohols, that the trioleic acid esters be utilized or said esters which contain predominately trioleic acid esters of the said aliphatic polyhydric alcohols. Commercial
sources of oleic acid can be used in preparing the aforesaid esters such as Red Oil and so-called White Oleic Acid; but crude oleic acid containing unduly high contents of acids with two or more double bonds, such as are prepared from tall oil, should generally not be used if optimal results are to be obtained.

The aliphatic polyhydric alcohols of which said synthetically produced oleic acid esters are useful in the practice of our present invention include, by way of examples, glycerol, pentaerythritol, and aliphatic hexahydric alcohols of which sorbitol, mannitol and dulcitol are illustrative and of which aliphatic hexahydric alcohols sorbitol is preferred. Illustrative examples of the synthetically produced oleic acid esters of the polyhydric alcohols which are useful as lubricants in the practice of our present invention are glycerol trioleate, pentaerythritol tetraoleate, sorbitol trioleate, mannitol trioleate, sorbitol tetraoleate and mannitol tetraoleate, particularly glycerol trioleate and sorbitol trioleate.

The aforesaid synthetically produced oleic acid esters of the polyhydric alcohols can be produced by reacting the polyhydric alcohols with oleic acid in the requisite proportions to produce said esters, or with oleyl chloride or bromide, or with the methyl ester of oleic acid, in the presence or absence of catalysts, in accordance with esterification procedures which are well known to the art. When reference is made herein and in the claims to oleic acid esters of aliphatic polyhydric alcohols containing at least three hydroxyl groups and wherein three or more of said hydroxyl groups of said aliphatic polyhydric alcohols are esterified with
oleic acid, or, for example, to glycerol trioleate or to sorbitol trioleate, it will be understood that it is intended to cover such esters which are produced synthetically and by the procedures generally described above.

It will also be understood that mixtures of peanut oil and one or more of said oleic acid esters, in various proportions in relation to each other, can also effectively be used; and, further, that mixtures of two or more of said oleic acid esters, in various proportions in relation to each other, can also be utilized, it being understood that, where the foregoing mixtures are used, they are in the form of homogeneous compositions or solutions.

Except as otherwise indicated hereafter, the invention will, for convenience as well as because the use of peanut oil represents the best embodiment of the present invention of which we are presently aware, be described in terms of the use of peanut oil as the lubricant.

In accordance with the best manner of the practice of our invention, aluminum stock material that is to be used for forming a drawn and ironed seamless container first has a thin layer of peanut oil applied to at least one surface, and preferably both surfaces. A disc is cut from the metal blank and formed into a shallow cup without the use of any additional lubricant or coolant. The shallow cup is then further drawn and ironed, as described above, to produce a seamless container which again is done without the use of any additional lubricant in the drawing and ironing machine.

More specifically, according to one embodiment of our invention, the thin layer of peanut oil has a generally uniform distribution or thickness
on the aluminum stock surface, desirably 0.5-3 mg./in.². The peanut oil films can, however, be used in amounts significantly less than 0.5 mg./in.² with even distribution, e.g. down to about 0.2 mg./in.². Coatings of greater than 3.0 mg./in.² also produce acceptable commercial cans, but the cost-benefit ratio of such thicker films makes it economically unattractive. The scope of the subject invention, therefore, is intended to cover such lower and higher weight distributions.

While the manner of applying the peanut oil to the aluminum stock material is not critical in carrying out our present invention, the peanut oil is most desirably applied to the aluminum stock material prior to the point when it is fed to the blanking and/or cupping machine. The peanut oil can, however, be applied in other ways. For example, it can be applied to blank discs before they are formed into cups in the cupping machine. Preferably the peanut oil coating is applied to each side of the aluminum stock, although it can be applied as a coating to only one side of the sheet, sufficient transfer of the peanut oil to the uncoated side occurring during the normal coiling or stacking of the aluminum stock. It is, however, more advantageous initially to apply the peanut oil to both sides of the blank discs.

It has been determined that cans can be formed very effectively from an aluminum stock material having a layer of peanut oil applied to one or both surfaces of the stock material in a layer or coating weight of approximately 0.5 mg./in.² or somewhat more on each surface, and such pretreated stock material is then utilized in forming a seamless drawn and ironed container that has a bottom wall and an integral sidewall in the general manner set forth above. By applying the peanut oil to the aluminum stock material before forming
such stock material into a can, we have found that all additional lubricants in the drawing and ironing process can be eliminated and it is only necessary to provide the body maker with a water coolant that has a small amount of a conventional rust inhibitor and a conventional sequestering agent therein to maintain the tooling below a predetermined temperature. No additional lubricant is needed because a sufficient amount of the peanut oil remains on the cups after the cupping operation. Furthermore, since peanut oil is water-insoluble, it is not washed off in the body maker by the water coolant of the bodymaker, and thereby remains on the can surface for lubrication during the ironing process.

The peanut oil can be successfully applied to one or both surfaces of aluminum stock by commercially available lubricators to produce a thin layer or weight distribution thereof as indicated above. To produce the desired thickness of the layer, it may, in certain instances, be necessary either to thin the lubricant mixture by adding an organic solvent before it is applied to the surface of the stock material or by simply heating the aluminum stock before being contacted by the lubricator. A further alternative form of heating is to heat the rollers that form part of the lubricator.

A series of experiments was performed using three sets of sheets of aluminum stock material. The peanut oil was applied to one set of sheets to provide a lubricating layer of approximately 1.25 mg./in.² weight distribution on each side. On the second set of sheets, glycerol trioleate was applied to provide a layer thickness or weight distribution of 2.5 mg./in.² for each side. On the third set of sheets, sorbitol trioleate was applied as the lubricant to a layer thickness of 1.25 mg./in.² per side. The sheets in each case
were then converted into cups and subsequently into cans, utilizing a commercially available cupper and body maker in the manner previously discussed. The cups were converted to finished containers in the body maker without using any additional lubricant and utilizing only tap water as a coolant. Approximately a thousand of such cups and containers were produced with each lubricant. Inspection of the finished containers showed that they had a shiny outside surface and a scratch-free inside surface in each case. The containers were then cleaned using standard cleaning solutions with less than the present standard recommended concentration, yet commercially acceptable cleaning of the can surfaces was achieved.

The elimination of the water-emulsion oils from the process and substitution of the peanut oil results in appreciable cost savings in the lubricant alone and also provides additional savings in the use of milder cleaners and lower cleaning temperatures since less cleaning agent is required. Furthermore, peanut oil provides better lubrication for the tooling than water-lubricant mixtures as currently used. This is believed to result from the fact that the peanut oil is initially located directly between the tooling and the container surface interface and also from the fact that the peanut oil permits ironing of the metal body without deterioration. Also, the presence of the peanut oil on the surface which becomes the inner surface of the container tends to aid in stripping the ironed container from the punch.

While the above description deals with the application of the peanut oil to the aluminum stock material before the cupping operation, it should be understood that the peanut oil can be applied after
the cupping operation by spraying or otherwise applying it as the cup goes to the body maker. Alternatively, the peanut oil can be sprayed or otherwise applied on to the cup as it goes through the body maker.

It will be clear to those skilled in the art in light of the above teachings of the present invention that various modifications can be made in the details of carrying out the invention, but without departing from the principles disclosed and the scope thereof which is more clearly set forth in the appended claims.

The low rate of oxidation of peanut oil allows it to be applied to the stock material at the mill and stored for extended periods of time. It can also be applied at any point between the mill and the cupper. The peanut oil eliminates the necessity of adding any lubricant in the water coolant which is necessary to operate at commercial rates. However, it will be appreciated that it is usually necessary to add a rust inhibitor into the coolant for the tooling.
CLAIMS

1. A method of forming a seamless drawn and ironed container of aluminum stock, said container having a bottom wall and an integral sidewall, comprising the steps of
   a) applying a thin layer of a lubricant to at least one of the two surfaces of said aluminum stock, said lubricant being (i) peanut oil or (ii) at least one oleic acid ester of an aliphatic polyhydric alcohol containing at least three hydroxyl groups and wherein three or more of said hydroxyl groups of said aliphatic polyhydric alcohol are esterified with oleic acid, or mixtures of (i) and (ii); and
   b) converting said aluminum stock into a drawn and ironed container from said stock material.

2. A method of forming a seamless drawn and ironed container of aluminum stock, said container having a bottom wall and an integral sidewall, comprising the steps of
   a) applying a thin layer of peanut oil to at least one of the two surfaces of said aluminum stock; and
   b) converting said aluminum stock into a drawn and ironed container from said stock material.

3. The method of Claim 1 wherein, in the carrying out of step b), no additional lubricant is applied thereto.

4. The method of Claim 1 wherein the layer of said lubricant is about 0.5-3 mg./in.² film weight.

5. The method of Claim 1 wherein the layer of the lubricant is applied to the two surfaces of said aluminum stock.
6. The method of Claim 1 wherein said lubricant is sorbitol trioleate.

7. The method of Claim 1 wherein said lubricant is glycerol trioleate.

8. A method of forming a seamless drawn and ironed container of aluminum sheet, said container having a bottom wall and an integral sidewall, comprising the steps of
   a) applying a thin layer of a lubricant in the range of about 0.5-3 mg./in.² film weight to at least one of the two surfaces of said aluminum sheet, said lubricant being (i) peanut oil or (ii) at least one oleic acid ester of an aliphatic polyhydric alcohol containing at least three hydroxyl groups and wherein three or more of said hydroxyl groups of said aliphatic polyhydric alcohol are esterified with oleic acid, or mixtures of (i) and (ii);
   b) converting said aluminum sheet into a cup; and
   c) forming a drawn and ironed container therefrom without applying additional lubricant thereto.

9. A method of forming a seamless aluminum container having integral bottom and sidewalls from an aluminum material, including the steps of
   a) applying a thin layer of a lubricant to a surface of said aluminum material, said lubricant being (i) peanut oil or (ii) at least one oleic acid ester of an aliphatic polyhydric alcohol containing at least three hydroxyl groups and wherein three or more of said hydroxyl groups of said aliphatic polyhydric alcohol are esterified with oleic acid, or mixtures of (i) and (ii); and
b) converting said aluminum material into said seamless container without applying additional lubricant thereto.

10. The method of Claim 9 wherein said converting step includes first forming said aluminum material into a cup and subsequently ironing said cup into an elongated seamless container, and further characterized by said step of applying said lubricant being performed after said cup is formed.

11. The method of Claim 9 further characterized by said step of applying the lubricant being performed before ironing said cup.

12. The method of Claim 9 wherein said converting step includes first forming said aluminum material into a cup and then forcing said cup through a plurality of forming dies to elongate said sidewalls to produce a seamless container and further characterized by said step of applying said lubricant being performed during said converting step.

13. The method of Claim 12 further characterized by said step of applying said lubricant being performed just prior to the forcing of said cup through at least one of said forming dies.

14. A stock material for use in forming a drawn and ironed container comprising an aluminum base having a thin layer of lubricant on a surface thereof, said lubricant being (i) peanut oil or (ii) at least one oleic acid ester of an aliphatic polyhydric alcohol containing at least three hydroxyl groups and wherein
three or more of said hydroxyl groups of said aliphatic polyhydric alcohol are esterified with oleic acid, or mixtures of (i) and (ii).

15. A stock material according to Claim 14 wherein the lubricant is peanut oil, and wherein said layer of peanut oil is about 0.5-3 mg./in.$^2$ film weight.

16. A stock material according to Claim 15 wherein the lubricant is applied to the two surfaces of the aluminum base.
### I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC

- Int. Cl. (3) B21b 45/02; B32b 7/02, 9/2, 9/0, 29/04, 15/04, 15/08
- U.S. Cl 72/42,46; 428/219, 341, 461, 463, 467, 497

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Documentation Searched other than Minimum Documentation to the extent that such Documents are Included in the Fields Searched

### III. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US, A, 3,832,962 Published 03 SEPTEMBER 1974, ROLLES</td>
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* Special categories of cited documents:
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  - "L": document cited for special reason other than those referred to in the other categories
  - "O": document referring to an oral disclosure, use, exhibition or other means
  - "P": document published prior to the international filing date but on or after the priority date claimed
  - "T": later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention
  - "X": document of particular relevance

### IV. CERTIFICATION

- Date of the Actual Completion of the International Search: 05 AUGUST 1981
- Date of Mailing of this International Search Report: 18 AUG 1981
- Signature of Authorized Officer: WILLIAM R. DIXON
- Primary Examiner: ART UNIT 164

Form PCT/ISA/210 (second sheet) (October 1977)