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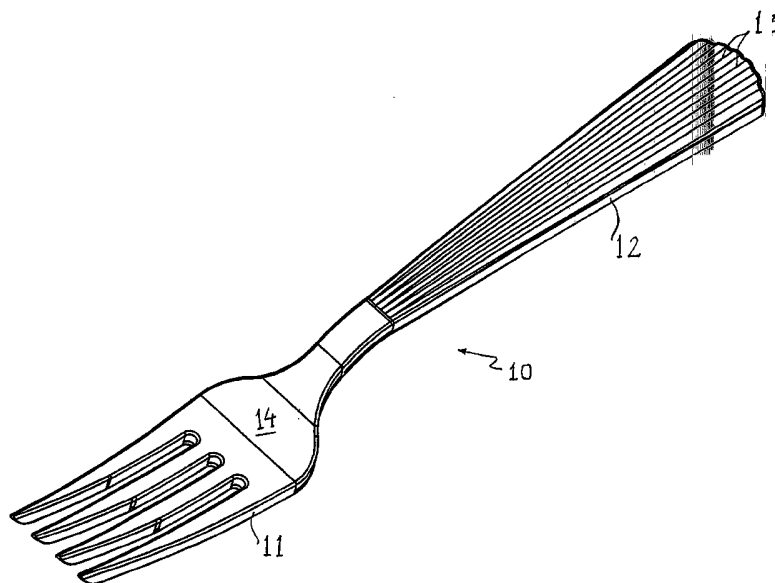
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- (71) Applicant (for all designated States except US): **WNA COMET EAST, INC.** [US/US]; 6 Stuart Drive, Chelmsford, MA 01824 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **MITHAL, Ashish, K.** [US/US]; 8 Hatikva Way, North Chelmsford, MA 01863 (US). **GORDON, David** [US/US]; 45 Overlook Drive, Groton, MA 01450 (US). **CHAN, Raymond** [US/US]; 9 Jay Drive, Framingham, MA 01701 (US). **ELLSWORTH, Thomas, E.** [US/US]; 380 Main Street,
- #1R, Wilmington, MA 01887 (US). **GALLOP, William, A.** [US/US]; 6 Carpenter Lane, Westminster, MA 01473 (US).
- (74) Agents: **MAINE, Vernon** et al.; Maine & Asmus, PO Box 3445, Nashua, NH 03061-3445 (US).
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[Continued on next page]

(54) Title: METALLIZED CUTLERY AND TABLEWARE



(57) Abstract: A plastic cutlery item (10, 20, 30), fabricated primarily from a plastic material, such as polystyrene, having a metallic coating (14, 24, 34) that imparts to the cutlery item the appearance of metal cutlery or silverware. The plastic cutlery or tableware items are molded using traditional injection molding techniques, and subjected to a vacuum metallizing process in an individualized non-contiguous manner, where a thin metallic layer is deposited on at least one of their surfaces. In the most preferred embodiment of the invention the plastic cutlery or items are molded from a light-transmitting grade of Polystyrene resin and are coated with a thin stainless steel layer through vacuum sputtering deposition on only one of the surfaces.



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METALLIZED CUTLERY AND TABLEWARE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. 119(e) from a U.S. Provisional
5 Patent Application Serial No. 60/314,677, filed August 24, 2001, which is incorporated
herein by reference for all purposes.

FIELD OF THE INVENTION

10 This invention relates generally to the production of food-service articles for
household, catering and restaurant use including commercial and institutional tableware.
More particularly, this invention relates to plastic cutlery having a metallic appearance.

BACKGROUND OF THE INVENTION

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Disposable plastic food-service items are in increasingly widespread use for
storing, serving and consuming food, due to their reasonably low-cost and the convenience
they provide. Disposable food containers and articles range from non-returnable containers
such as yogurt cups and dinner entrée packaging, to microwavable storage containers and
20 general tableware items such as plastic plates, cups and cutlery. The increasing popularity
of fast-food restaurant chains further fuels the demand for plastic tableware. In addition to
the fast food restaurants, caterers also prefer disposable food service items for the
associated convenience, hygiene and competitive-costs. In this regard it is important to
note that replacement costs for disposable items such as cutlery are offset by the clean-up
25 costs (labor, materials and equipment) associated with metal cutlery.

The presence of non-disposable metal cutlery along with other disposable food-
service articles such as plates, cups and the like presents unusual problems for restaurants
and caterers. The problems stem from the loss of valuable metal cutlery into trash or refuse
30 containers along with disposable tableware and food remnants. The problem can be further
accentuated during peak business hours where time-pressures can further cause leftover

food on a plate together with one or more items of cutlery to be scrapped. Previous attempts to circumvent this problem are known. US Patent No. 4,632,253 describes apparatus for separating cutlery from restaurant waste, including a chute for the waste and an inductive type probe with associated evaluation logic for sending an electric switching
5 signal when an item of cutlery passes along the chute.

Another problem that food caterers encounter is the ability to clean metal flatware utensils at certain locations and outdoor catering events. In preparation for such circumstances caterers tend to carry a large inventory of expensive metal cutlery. The use
10 of disposable plastic cutlery for such catering events would eliminate the limitations with cleaning metal flatware, handling heavy metal cutlery or keeping a large inventory thereof. In addition, it is noteworthy that disposable cutlery offers significant handling advantages compared to its metal-counterparts. For example, a typical cutlery combination containing a fork, a knife, a tablespoon, and a teaspoon would weigh about 200 grams for metal
15 flatware versus about 30 grams for premium plastic cutlery. Applying these weights to a hypothetical 250-person event would yield an overall weight for metal cutlery of about 110 lbs., as compared to only 16 lbs. for plastic cutlery.

Due to the history of terrorist attacks in airplanes and the potential threat resulting
20 from misuse of stainless steel flatware as weapons, there has been an increased tendency for major airline organizations to utilize disposable plastic cutlery while serving meals during flights. However, the use of disposable plastic cutlery affects the image of the airline, especially in premium seating and higher priced flights.

25 A significant number of upscale catering establishments utilize disposable plastic cups, plates, and bowls etc. for catering functions. However, there is a general preference for continued use of traditional metal cutlery. The primary reason is the less-than-classic appearance, perception and image of plastic cutlery compared to stainless steel flatware. Although stainless steel cutlery is stronger than plastic cutlery, heavy weight plastic cutlery
30 is functionally adequate for most occasions. Thus, a primary obstacle for use of disposable

cutlery in such catering events is perception and the image associated with disposable cutlery rather than its performance.

From the foregoing, it can be readily appreciated, that there is a need for cutlery implements that offer the disposability of plastic cutlery and the upscale perception of real stainless steel flatware. Thus, imparting a metallic appearance to disposable plastic cutlery would enhance the perceived value and quality of the cutlery items. A metallic appearance would also lead to greater acceptance of disposable cutlery, as worthy replacements for metal flatware, for use at various events and occasions by caterers and other food-service establishments.

The same is true for the additional tableware items such as cups and plates, although to a lesser extent. Employing a metallic appearance such as gold or silver to the plates and cups to coordinate with the cutlery enhances the aesthetics and provides a more regal presence. The state of the art generally does not introduce metallized cups and plates due to the difficulties discussed herein. Thus while the present description focuses on cutlery, the information is also relevant to other tableware items.

Various methods of imparting a metallic look have been utilized in the prior art. One of the most common and inexpensive methods of imparting a metallic look to plastic parts is the incorporation of a metallic pigment, in the plastic resin, during the molding process. The metallic pigments, typically, have a high metal-content loading. Metallic pigment additives and colorants are manufactured and sold by a variety of pigment and master-batch colorant manufacturers such as Clariant, Engelhard and EM Industries. Other methods commonly employed for enhancing the visual impact of a plastic part and enhancing its commercial appeal consist of applying a finish or graphic to some portion or the entire article. A variety of methods for decorating plastic articles, including printing, hot stamping, heat transfers, in-mold decorating, spray painting, and electroplating are known. Printing techniques have been further classified as silk screen printing, gravure or offset printing, and pad transfer printing (see Hilestad, K., *Decorating and Printing, Modern Plastics Encyclopedia* 1999, F-7).

It has been the experience of the inventors of the present invention and those skilled in the art that traditional decorating and plastic pigmentation techniques do not impart a commercially acceptable metallic look to plastic cutlery due to a variety of reasons.

5

First, it is the general experience of those skilled in the art that these metallic pigments do provide a level of sheen to the plastic surface, but do not approach the polished metal look of fine cutlery. In addition, some of the formulations for metallic pigments have an odor which is less-than-desirable for a food-service item.

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Second, metallic inks do not approach the genuine look of polished stainless steel flatware.

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Third, environmental and food contact issues associated with cutlery further limit the use of metallic inks and carrier solvents that can be used for imparting a metallic look.

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Fourth, fine stainless steel flatware is often characterized by an intricate design particularly on the handle of the cutlery items. Consistent with the objective of this invention, namely, to render fine plastic cutlery that is practically indistinguishable from fine metal cutlery requires that design trends be in general agreement with traditional flatware for commercial acceptance. This poses a particular problem with in-mold labeling, wherein a label is strategically placed inside the mold, prior to molding, and hot plastic is introduced into the mold to affect label adhesion on the molded part. The fine and intricate design provided on the surface of the plastic cutlery interferes with label adhesion and results in wrinkling of the label in the areas containing the fine design details.

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Fifth, hot stamping, particularly metal foil stamping can provide an authentic metallic-look when strategically placed on a plastic surface. However, hot foil stamping poses the same challenges previously described with in-mold labeling, where foil wrinkling and inconsistent adhesion in the intricate detail areas limit the utility of the foil stamping process for obtaining metallic-look cutlery.

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Sixth, electroplating methods are undesirable due to the environmental impact associated with electroplating chemicals as is known in the art.

5 Various metallizing methods are known, including U.S. Patent No. 5,022,554 that describes metallized tableware, such as plates, cups, etc., made of a paper substrate, a metallized plastic film joined to the substrate, and an FDA approved top coating over the plastic film. This method of obtaining a metallic-look food service items by laminating a metallized film is not readily applicable to cutlery due to the fact that most plastic cutlery is generally produced by the injection-molding process wherein the feedstock is thermoplastic resin pellets and not laminated film. The shortcomings of incorporating a
10 metallic foil or label during injection molding plastic cutlery have been discussed herein above. Similar shortcomings would apply to the use of a laminated metallic film.

Other approaches to metallization such as those used by Quest et al. (U.S. Patent
15 No.'s 5,177,124 and 5,280,052) describe a utilitarian and/or decorative object and a method for forming plastic parts having a metallic outer face, appearance and hand. In this technique, a mixture of a liquid monomer, curing agent, a dispersion of metal particles and floatable particles are poured into a mold. The mold is then centrifuged to cause the metal particles to migrate towards the surface of the piece before the monomer polymerizes and
20 hardens to bind the particles. After removal from the mold, the outer face of the piece is polished and buffed to remove the plastic skin from the metal surface, whereby the resultant plastic piece simulates the appearance of a solid metal piece. This method is too cumbersome for application to plastic cutlery as most plastic cutlery is either made of polystyrene and/or polypropylene which are thermoplastic polymeric materials and not
25 monomeric as the above prior art teaching suggests. In addition, the typical process for producing cutlery is injection molding and it is difficult and cost-prohibitive, if not impossible, to rotate a heavy injection mold. And, finally the secondary step of cleaning and buffing the plastic piece is expensive and unacceptable for food-service use.

30 Various references are available on plating of plastic materials by chemical deposition techniques, electro-deposition techniques and/or a combination thereof. Some

plating methods are described in U.S. Patents 3,607,350; 3,629,922; 3,896,252; 3,962,494;
4, 4,610,895; 3,445,350; 4,039,714; 4,073,743; 4,195,117; 4,810,333 and numerous others.
These techniques are essentially wet processes and require that parts be brought into
contact with solutions containing metal ions, which must then be washed off to remove any
5 residual chemicals and for general hygiene reasons for a food service article. These
processes are relatively unattractive for metallizing cutlery because of the high process and
environmental costs.

Thus, it can be readily established that there is a need for fine plastic cutlery that
10 has an enhanced visual and commercial appeal. The improved plastic cutlery should be
inexpensive, permitting simple disposal and not requiring separation from food refuse.
Such an invention should be manufactured without environmental shortcomings generally
associated with metal-plating wet processes. An improved plastic cutlery article should be
fabricated primarily from plastic materials, yet have the appearance of genuine metal on
15 the outer surface such that it is practically visually indistinguishable from fine metal
cutlery.

SUMMARY OF THE INVENTION:

The present invention is devised in the light of the problems of the prior art described herein. Accordingly it is a general object of the present invention to provide
5 cutlery items that can solve the problems described herein. One of the objects of the invention is to provide premium disposable cutlery item(s) fabricated mainly from plastic materials and having a metallic surface appearance that simulates genuine metal flatware.

Yet another object of the present invention is to provide a method, which lends
10 itself to mass production of plastic cutlery having an authentic metallic appearance at a reasonable cost for disposable use.

Still another object of the present invention is to provide a method for metallization
of injection-molded plastic cutlery at a reasonable incremental cost.

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A further object of the present invention is to provide disposable cutlery that has the appearance of fine metal cutlery.

A further object of the present invention is to obtain a plastic object, such as a
20 cutlery item, which is molded from a light transmitting thermoplastic material and is subsequently metallized.

Still another object of the present invention is to provide a plastic article such as a
cutlery item, molded from a light transmitting thermoplastic material, which is metallized
25 on one side only.

A further object of the present invention is to provide cutlery items having a surface geometry, which enhances the reflective appearance of the metallized plastic cutlery. Surface geometry of the cutlery items prepared according this invention is
30 characterized by a plurality of surface features including concave and convex areas, ribs, flutes and other artistic features that enhance the reflective appearance of the article.

Still another object of the present invention is to provide metallized plastic cutlery items wherein the metal layer has enhanced adhesion and abrasion resistance. For example, applying an over coating to the thin metallic layer further enhances the abrasion resistance characteristics of the metallic layer. FDA approved versions of over coating compositions can be readily obtained from a variety of vendors.

In addition, another object of the present invention is to provide metallized cutlery items having enhanced optical density by incorporating a color tint, such as a gray tint, in the base material.

An object of the invention is a metallized plastic food service item, comprising a plastic tableware article with a thin metallic coating deposited on the plastic tableware item, wherein the thin metallic coating is deposited by a vacuum deposition process. The tableware items include cutlery such as forks, spoons, knives, as well as other tableware items such as plates, bowls, and cups.

Yet a further object is the metallized plastic food service item, wherein the thin metallic coating is comprised of a metal selected from the group consisting of silver, steel, stainless steel, chromium, aluminum, copper and gold. The thin metallic coating is generally less than 1000 nm. In addition, the article can further comprise a thin overcoat of a curable clear coating on the thin metallic coating. In addition, the plastic tableware article can have the metallic coating disposed on a single surface of the plastic tableware article.

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An additional object is the metallized plastic food service item, wherein the plastic tableware article is composed of polystyrene and is produced by injection molding. The article can also be composed of a similar light transmitting plastic material. And, wherein the metallized plastic food service item has an optical density of less than 2.0.

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An object of the invention is a metallized plastic food service article produced by the process comprising the steps of forming a plastic tableware body by injection molding, placing the plastic body into a vacuum metallizing unit, and depositing on the plastic body a thin metallic coating by a vacuum deposition process. In one embodiment the vacuum
5 deposition process is physical vapor deposition, and in particular sputtering vapor deposition, with the sputtering deposition process utilizing plasma generated by mixtures of Argon and Nitrogen.

Still other objects and advantages of the present invention will become readily
10 apparent to those skilled in this art from the following detailed description, wherein we have shown and described only a preferred embodiment of the invention, simply by way of illustration of the best mode contemplated by us on carrying out our invention. As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various respects, all without departing from the
15 spirit of the invention.

DESCRIPTION OF THE DRAWINGS

The present invention will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

FIG. 1A shows an isometric view of a fork with metallic coating that has been constructed in accordance with the invention.

FIG. 1B is a side profile view of a fork with metallic coating in accordance with the invention.

FIG. 2A is an isometric view of a spoon with metallic coating in accordance with the invention.

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FIG. 2B is a side profile view of a spoon with metallic coating in accordance with the invention.

FIG. 3A is an isometric view of a knife with metallic coating in accordance with the invention.

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FIG. 3B is a side profile view of a knife with metallic coating in accordance with the invention.

Fig. 4 is a cross-sectional view of a typical cutlery item exhibiting a metallic coating in accordance with the invention.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The terms cutlery or cutlery items or utensils or eating implements or food-
implements or food-handling implements or food service tools as used in this description
5 or in any of the appended claims are used in a generic and broad sense. These terms
encompass disposable plastic cutlery items molded into standard food-handling
implements such as forks, spoons, knives, serving utensils and/or combinations thereof
including spatulas, sporks, ladles, seafood forks, seafood picks, soup spoons, and the like.
Accompanying items such as napkin rings, candle holders, and centerpiece receptacles are
10 sometimes designed to match the cutlery items. Finally, the various assortments of goblets,
glasses, soup bowls, dishes, trays, champagne flutes, lids, and the like are also sometimes
matched to the rest of the serving items and are all within the scope of the present
invention. The preferred embodiments are merely illustrations of the techniques, and there
are many other variations and applications all within the scope of the invention.

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Disposable cutlery items, which are currently sold in the marketplace, are typically
constructed of either polystyrene and/or polypropylene. However, it would be clear to
those skilled in the art that a variety of thermoplastic polymer types and/or resin grades can
be employed for the purpose of making the cutlery items of the present invention. Material
20 choices for such applications are more often than not governed by a variety of factors
including consumer preferences, cost, engineering requirements, availability and other
economic and market factors. The primary selection criteria for the present invention for a
base material are: High-end attractive appearance of the cutlery item; Superior optical
properties with respect to light transmission characteristics; High rigidity; and High surface
25 energy or adhesion characteristics for metallization.

Several thermoplastic resins having desired optical and functional characteristics
including polystyrene (PS), polymethyl methacrylate (PMMA), acrylonitrile-butadiene-
styrene (ABS), styrene-acrylonitrile (SAN) and polycarbonate (PC) can be employed for
30 achieving the objects of this invention. Polystyrene (PS) was the material of choice for the
preferred embodiment of the invention on several accounts. Polystyrene resin has a lower

cost compared to ABS, PC and SAN. It is the general experience of those skilled in the art that polystyrene cutlery is perceived as the higher end disposable cutlery in the marketplace. One criterion for selecting crystal polystyrene as the material of choice for this application is the relatively high flexural modulus of polystyrene compared to other resin materials in an equivalent price range. More specifically, the flexural modulus of polystyrene is superior to that of polypropylene. Crystal polystyrene has excellent light transmission characteristics due to its amorphous polymeric structure as opposed to polypropylene, which is highly crystalline in nature. In addition, variable cooling rates such as are encountered in the injection molding process have little effect on the light transmission characteristics of the molded article due to the amorphous polymeric structure of polystyrene. In other words, crystal polystyrene has a large processing window with respect to its optical characteristics. And, Polystyrene exhibits a higher surface energy compared to polypropylene and other polyolefins and is a better substrate for adhesion to other materials.

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Thus, in the most preferred embodiment of the present invention, the cutlery items are molded from a suitable crystal polystyrene resin grade having good physical properties and desirable flow, melt viscosity and molding characteristics from a production and manufacturing standpoint.

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Referring now to **FIGS. 1A, 1B, 2A, 2B, 3A and 3B** there are shown typical cutlery items, which have been constructed in accordance with the present invention wherein like parts are designated by like reference numerals.

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FIG. 1A shows an isometric perspective view of a fork represented by reference numeral **10** having its general construction in accordance with the present invention. Fork **10** has a tines portion **11** and a handle portion **12**. Fork **10** also contains surface features in the form of flutes or other geometrical artistic contours generally denoted by reference numeral **13**. A surface-coating layer of metal is deposited on at least one of the surfaces of the plastic fork to impart the appearance of a metallic cutlery piece. In the most preferred embodiment of the invention the metallic coating is applied to the side that is facing-up in

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a typical place setting for a food-event. The metallic coating on the plastic surface of the fork is denoted by reference numeral 14.

5 **FIG. 1B** shows a side view of Fork 10 wherein the various fork portions are identified with the corresponding reference numeral designations of **FIG. 1A**. The metallic coating is imparted on only the upper surface of the plastic fork and is represented by reference numeral 14.

10 Referring now to **FIG. 2A**, there is shown an isometric perspective view of a spoon represented by reference numeral 20 having its general construction in accordance with the present invention. Similarly, **FIG. 2B** shows a side view of spoon 20 wherein like reference numerals represent like parts or features. Spoon 20 has a bowl portion 21 and a handle portion 22. Spoon 20 also contains surface features in the form of flutes or other geometrical artistic contours generally denoted by reference numeral 23. A surface-coating layer of metal is deposited on at least one of the surfaces of the plastic spoon to impart the appearance of a metallic cutlery piece. In the most preferred embodiment of the invention the metallic coating is applied to the side that is facing-up in a typical place setting for a food-event. The metallic coating on the plastic surface of the spoon is denoted by reference numeral 24.

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FIG. 3A and **3B** respectively show isometric and side views of a knife represented by reference numeral 30 having its general construction in accordance with the present invention. Knife 30 has a blade portion 31 and a handle portion 32. Knife 30 also contains surface features in the form of flutes or other artistic contours generally denoted by reference numeral 33. A surface-coating layer of metal is deposited on at least one of the surfaces of the plastic knife to impart the appearance of a metallic cutlery piece. In the most preferred embodiment of the invention the metallic coating is applied to only one of the sides of the knife. The metallic coating on the plastic surface of the knife is denoted by reference numeral 34.

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Referring now to **FIG. 4** there is shown a rear cross-section of a typical cutlery item **40**. The stem portion of the cutlery item **40** is denoted by reference numeral **42**. In the described embodiment the stem **42** has various curved and flute-like features on its surface denoted by reference numeral **43**. The cutlery item has a metallic coating applied on one of its surfaces shown in the cross-sectional view by reference numeral **44**. The metallic coating **44** is very thin in relation to the bulk of the article (not shown to scale) and follows the contours on the surface of the part. The thickness of the metallic coating can vary depending upon the particular application, but for weight, cost and manufacturing time, a thin layer is preferred. For example, in a preferred embodiment, the thickness is approximately 200 nanometers or less. Various patterns and ornamental characteristics can adorn the stem, that are known to those in the art, and the present invention is applicable to any such designs.

The cutlery items in **FIG. 1A** through **FIG. 3A** have been shown as having particular configurations and specific design feature ratios, e.g. fork-tine length to overall fork length, spoon bowl length to overall spoon length, and knife blade length to overall knife length. It will be readily understood by those skilled in the art that these cutlery items are manufactured and marketed in a variety of geometrical configurations, feature ratios and sizes. The physical configurations and design features and aspect ratios exhibited here are done for the purpose of illustration and not by way of limitation.

Also, it should be readily apparent that depositing the metal layer on only one side of the article offers several economic advantages in comparison to coating the entire article. Firstly, there is a metallic material savings, as approximately only one-half of the surface area of the parts is metallized. Secondly, there is only one pass through the metallizer, and the parts are not subjected to the deposition mechanism twice to accommodate both sides. Thirdly, metallizing cycle-time is halved as it takes approximately half as long to deposit the metal on only one side of the parts. Finally, the process provides a simpler part handling, as the complex part handling mechanisms for turning/flipping the parts for metallizing both sides are avoided.

From an aesthetic standpoint the metallized coating is applied to the side which typically faces up in a traditional table-setting for placing cutlery implements. A traditional place setting typically includes a fork with tine facing upwards, a spoon with the concave bowl facing upwards and a knife with the serrated edge placed pointing left and away from the user; handle portions of all eating implements are towards the user.

Metal coating on the cutlery items can be applied by any of the known vacuum deposition procedures. Vacuum metallization or deposition is the deposition of a film or coating in a vacuum or low-pressure plasma environment. The term plasma generally refers to an ion- or electron- rich gaseous environment for providing appreciable electrical conductivity. Vacuum deposition is a term that is applied to processes that deposit atoms or molecules one at a time, such as in physical vapor deposition (PVD) or low-pressure chemical vapor deposition (LPCVD).

Typical PVD techniques can be used for accomplishing the objectives of the current invention. In Physical vapor deposition or (PVD) processes metallic particles are vaporized from a solid or liquid source and transported as vapor through vacuum or low-pressure gaseous or plasma environment. The vaporized material can be an element, alloy or compound. The condensation of the particles produces a thin-metallic coating or film on the substrate surface and imparts a metallic look to the substrate. Film thickness ranges from few nanometers to thousands of nanometers. However, PVD processes can be used to form thick deposits through multilayer coatings. Various variants of the PVD processes have been described in the prior art including Vacuum Evaporation, Sputter Deposition or Sputtering, Arc Vapor Deposition and Ion Plating. Additional Evaporation techniques include Filament Evaporation, Flash Evaporation, and Electron-beam Evaporation.

In order to ensure that durable metal coatings are deposited on the surface of the cutlery article the resin used must be of high quality and free of volatiles. Processing aids that are routinely added to commercial resins such as mineral oil and surface waxes are exuded to the surface of the part and interfere with obtaining adequate adhesion between the deposited metal and the part surface.

In the preferred embodiment of the present invention:

- (a) The cutlery items are made of a light-transmitting grade of a thermoplastic polymeric material. The resin is substantially free of mineral oil and other volatile additives.
- 5 (b) The metallic coating is of the same composition as the stainless steel alloy used in real tableware cutlery.
- (c) The metallic coating thickness is less than 200 nanometers.
- (d) The metallic coating is applied on one side only of the cutlery articles.
- (e) The metallic coating is applied by physical vapor deposition techniques.

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In the most preferred embodiment of the present invention the metallic coating is applied to the plastic cutlery items by sputtering vacuum deposition (also referred to as sputter deposition or sputtering).

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Sputtering is a PVD coating process which, is conducted in an evacuable coating or sputtering chamber. The source of the coating material, the target, is mounted opposite to the substrate items in the sputtering chamber which is then evacuated, generally in the range of 1 to 100 milliTorr (1 Torr = 1mm Hg) in the presence of an inert gas such as Argon. A negative DC or RF voltage is applied to the metal sputtering target (metal source), which is positioned inside the sputtering or coating chamber. A gas plasma or glow discharge is created between the metal target and the item or substrate to be coated. Positively charged gas ions generated in the plasma region are propelled at high velocities towards the target (negative potential), resulting in the ejection of neutral atomic size particles of the metal target. Thus, Sputtering is a non-thermal vaporization process where surface atoms are physically ejected from the metal source or target by momentum transfer or exchange from an energetic bombarding particle or gaseous ion accelerated from plasma. A particular advantage of the sputtering technique is the ability for depositing metals as well as metal alloys and is well suited for depositing stainless steel alloy compositions used in traditional metal cutlery.

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A useful method of manufacture of metallized plastic cutlery and other tableware according to the present invention is as follows:

5 Step1: Molding plastic cutlery using traditional injection molding techniques well known in the art.

Step 2: Taking out the plastic cutlery from the mold using a part take-out device such as a side-entry or top-entry robot, again, well known in the art and in current use at the current assignee's facility.

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Step 3: Placing the individual pieces of cutlery in a non-contiguous manner on transferring or conveying means wherefrom cutlery parts are transferred to a vacuum depositing station. Cutlery pieces are maintained in an individualized or non-contiguous manner to prevent surface masking by adjacent cutlery pieces during metallizing or coating.

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Step 4: Subjecting plastic cutlery to a vacuum deposition process.

Step 5: Collecting plastic cutlery that has been metallized and packing them into suitable packaging containers for shipping.

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In testing of the preferred embodiment, plastic cutlery pieces in the form of a fork, spoon and knife were introduced into a lab-size sputtering chamber. The sputtering equipment was provided by Soleras, Inc. A stainless steel target was mounted in the sputtering chamber. The particular composition of stainless steel was 304. The chamber was then pumped down until a vacuum was reached in the range around 10^{-3} mm Hg. Argon was supplied to the chamber to generate the plasma. When the vacuum was reached a negative voltage in the range of 5 to 10kW was applied to the cathode. The coating operation at this setting was continued for about 1 to 5 seconds. Following coating, the power was turned off and vacuum was then released allowing the chamber to rise to atmospheric pressure. Thereafter parts were removed from the chamber and examined.

25
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Various tests were conducted on the plastic cutlery items for peel-off adhesion. In some trials, coating was applied to both sides of a part. In other iterations it was applied to only one side of the part.

5 It was found that polystyrene cutlery exhibits much better coating adhesion compared to polypropylene cutlery. A power setting of 7.5 kW and a 3-second sputtering time, were deemed to be the optimum conditions for good adhesion, surface appearance and uniformity of coating. The most remarkable finding from this experimental work was that the coating could be applied to one side of the clear polystyrene part to obtain the
10 desired metallic look or effect. This unexpected result reduces manufacturing time and the complexity of manufacturing while at the same time providing twice the utilization of the metal target.

 For a given hardware and power setting configuration, the metal deposition or the
15 thickness of the metal layer is proportional to the duration of sputtering. An increase in the duration of sputtering (sputter time) results in a corresponding increase in the metal-layer thickness. Increase in metal layer thickness is directly proportional to the optical density; hence optical density measurements can be used to define the thickness of the metal deposited on the surface. Optical density values of around 1.5 are considered acceptable
20 for the purpose of metallized cutlery. At optical density values of 1 and under the metal layer tends to be very thin and lacking adequate opacity for imparting an attractive metallic appearance on the part surface. Increase in optical density can be attained by increased metal deposition or longer sputter time. Another method of enhancing optical density without increasing sputter time is to incorporate a light transmitting dye or tint in the base
25 material. Typically gray tints work well but tints in a variety of colors can be utilized for enhancing the opacity of the cutlery item and imparting other appearance effects.

 Tape peel tests are normally used for testing the adhesion between the cutlery item surface and the metal layer deposited thereon. Adhesion is also related to abrasion
30 resistance or durability of the coating. Adhesion and abrasion resistance of the deposited metal layer to the substrate surface can be enhanced by a variety of methods.

One method of improving abrasion resistance involves coating the cutlery item with a light transmitting heat- or UV- curable coating, which serves to seal-off the deposited metal layer. Such coating compositions are well known in the art and are used to provide a barrier overcoat over a variety of articles including Compact disks and DVDs. FDA approved compositions of hardenable clear coatings, which can be applied by spraying, are also readily available for covering food service articles.

Another way to improve resistance to abrasion is subjecting the cutlery item to a flame or Corona treatment for increasing the surface energy of the cutlery item. Surface treatments for enhancing the surface energy of plastic parts are also well known in the art. A typical corona treatment can enhance the surface energy of a polystyrene part from 35 dynes to about 46 dynes.

The adhesion between the substrate or the plastic article and the deposited metal layer can be enhanced by utilizing a volatiles free resin completely free of mineral oil and similar lubricants.

Another technique to improve adhesion of the metallic coating to the article is by utilizing a mixture of Argon and Nitrogen for plasma generation in the sputtering chamber during metal deposition. The typical concentration of Nitrogen in the Nitrogen and Argon mixture is between 10 % and 40%. Sputter deposition conducted with a mixture of Nitrogen and Argon yields a metal layer with enhanced durability compared to Argon plasma alone.

To determine that the coated cutlery could be used against various foods, which could affect the coating or cause it to peel-off, the cutlery was subjected to confirmatory tests in a variety of food environments. Tests included subjecting cutlery to boiling water, boiling tomato sauce, boiling water-vinegar mixture, lemon juice, coffee, ice, thermal cycles with alternate exposure to boiling water and ice-cold water, shipping bulk cutlery

across the country etc. It must be noted that the coated cutlery is susceptible to scratches due to abrasion as any ordinary metal cutlery.

5 Although, this invention has been described particularly in relation to metallizing plastic cutlery, it will be recognized that it is applicable to general food service items, tableware and other industries wherein it is desired to impart metallic coating onto plastic and non-plastic parts. Also, it would be realized by those skilled in the art that various modifications, alterations and adaptations can be made to this invention without departing from the spirit and scope of this invention.

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Numerous characteristics and advantages have been set forth in the foregoing description, together with details of structures and functions of the present invention, and some of the novel features thereof are pointed out in appended claims. The disclosure, however, is illustrative only, and changes may be made in arrangement and details, within 15 the principle of the invention, to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

The objects and advantages of the invention may be further realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended 20 claims. Accordingly, the drawing and description are to be regarded as illustrative in nature, and not as restrictive.

What is claimed is:

1. A metallized plastic food service item, comprising:
 - 5 a plastic tableware article having a display surface and an underside, said plastic tableware article being adapted for placement on a table surface in a traditional table-setting presentation with said underside facing down towards said table surface and said display surface facing upwards; and
 - 10 a thin metallic coating deposited on said plastic tableware article, wherein said thin metallic coating is of a sufficient thickness to impart a reflective metal-like appearance to the plastic tableware article, and wherein said thin metallic coating is deposited by a vacuum deposition process.
2. The metallized plastic food service item according to claim 1, wherein said thin metallic coating is comprised of a metal selected from the group consisting of:
 - 15 silver, steel, stainless steel, chromium, aluminum, copper and gold.
3. The metallized plastic food service item according to claim 1, wherein said thin metallic coating is less than 1000 nanometers in thickness.
- 20 4. The metallized plastic food service item according to claim 1, further comprising a thin overcoat of a curable clear coating on said thin metallic coating.
5. The metallized plastic food service item according to claim 1, wherein said plastic tableware article is an implement for handling and consuming food, selected from a group consisting of fork, knife, and spoon.
 - 25
6. The metallized plastic food service item according to claim 1, wherein said plastic tableware article is composed of a light transmitting plastic material.
- 30 7. The metallized plastic food service item according to claim 1, wherein said plastic tableware article is composed of polystyrene.

8. The metallized plastic food service item according to claim 1, wherein said plastic tableware article is obtained from a plastic resin composition which is substantially free of mineral oil and wax.
- 5
9. The metallized plastic food service item according to claim 1, wherein said metallized plastic food service item has an optical density of less than 2.0.
10. The metallized plastic food service item according to claim 1, wherein said plastic tableware article is produced by injection molding.
- 10
11. The metallized plastic food service item according to claim 1, further comprising cosmetic surface features for enhancing the reflective metal-like appearance of said plastic tableware article.
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12. The metallized plastic food service item according to claim 1, wherein said vacuum deposition process is a sputtering deposition process.
13. A metallized plastic food service item, comprising:
- 20 a plastic tableware article having a display surface and an underside, said plastic tableware article being adapted for placement on a table surface in a traditional table-setting presentation with said underside facing down towards said table surface and said display surface facing upwards; and
- a thin metallic coating deposited on the display surface of said plastic tableware article, wherein said thin metallic coating is of a sufficient thickness to impart a reflective metal-like appearance to the plastic tableware article, and wherein said thin metallic coating is deposited by a vacuum deposition process.
- 25
14. The metallized plastic food service item according to claim 13, wherein said thin metallic coating is comprised of a metal selected from the group consisting of:
- 30 silver, steel, stainless steel, chromium, aluminum, copper and gold.

15. The metallized plastic food service item according to claim 13, wherein said thin metallic coating is less than 1000 nanometers in thickness.
- 5 16. The metallized plastic food service item according to claim 13, further comprising a thin overcoat of a curable clear coating on said thin metallic coating.
17. The metallized plastic food service item according to claim 13, wherein said plastic tableware article is an implement for handling and consuming food, selected from a group consisting of fork, knife and spoon.
- 10
18. The metallized plastic food service item according to claim 13, wherein said plastic tableware article is composed of a light transmitting plastic material.
- 15 19. The metallized plastic food service item according to claim 13, wherein said plastic tableware article is composed of polystyrene.
20. The metallized plastic food service item according to claim 13, wherein said metallized plastic food service item has an optical density of less than 2.0.
- 20
21. The metallized plastic food service item according to claim 13, wherein said plastic tableware article is produced by injection molding.
22. The metallized plastic food service item according to claim 13, wherein said plastic tableware article is obtained from a plastic resin composition which is substantially free of mineral oil and wax.
- 25
23. The metallized plastic food service item according to claim 13, further comprising cosmetic surface features for enhancing the reflective metal-like appearance of said plastic tableware article.
- 30

24. The metallized plastic food service item according to claim 13, wherein said vacuum deposition process is a sputtering deposition process.
25. A tableware article for handling and consuming food, composed primarily of a light transmitting plastic material and having a plurality of surfaces, wherein at least one surface amongst said plurality of surface is cosmetically accentuated by a thin metal layer; said thin metal layer being deposited by a sputter deposition process, whereby a reflective metal-like appearance is imparted to at least a portion of said tableware article.
26. A metallized plastic food service article produced by the process comprising the steps of:
molding a plastic tableware article by the process of injection molding, wherein said plastic tableware article has a first surface and a second surface;
placing said plastic tableware article into a vacuum metallizing unit with said first surface facing said vacuum metallizing unit;
depositing onto said first surface of the plastic tableware article, a thin metallic coating, by a vacuum deposition process, of sufficient thickness to impart a reflective metal-like appearance to the plastic tableware article.
27. The metallized plastic food service article produced by the process according to claim 26, further comprising the steps of spraying a clear coating and curing said clear coating.
28. The metallized plastic food service article produced by the process according to claim 26, wherein said vacuum deposition process is a physical vapor deposition.
29. The metallized plastic food service article produced by the process according to claim 26, wherein said physical vapor deposition is a sputtering vapor deposition.

30. The metallized plastic food service article produced by the process according to claim 29, wherein said sputtering deposition process utilizes plasma generated by mixtures of Argon and Nitrogen.
- 5 31. The metallized plastic food service article produced by the process according to claim 26, wherein said thin metallic coating is comprised of a metal chosen from the group of metals consisting of silver, steel, stainless steel, chromium, aluminum, copper and gold.
- 10 32. The metallized plastic food service article produced by the process according to claim 26, wherein said plastic tableware article is molded from a light transmitting plastic material with a color tint.
- 15 33. The metallized plastic food service article produced by the process according to claim 26, wherein said thin metallic coating is less than 1000 nanometers in thickness.

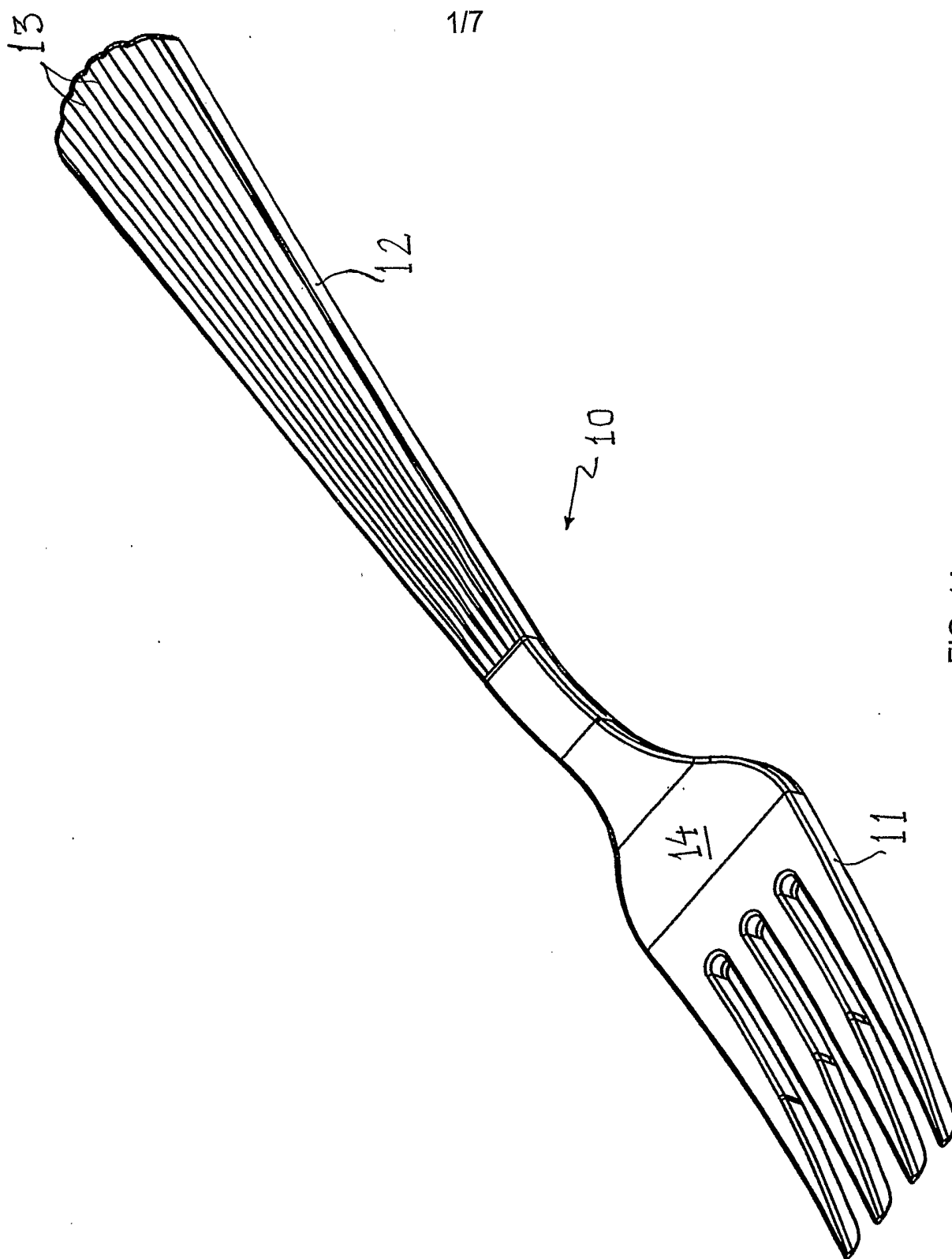


FIG. 1A

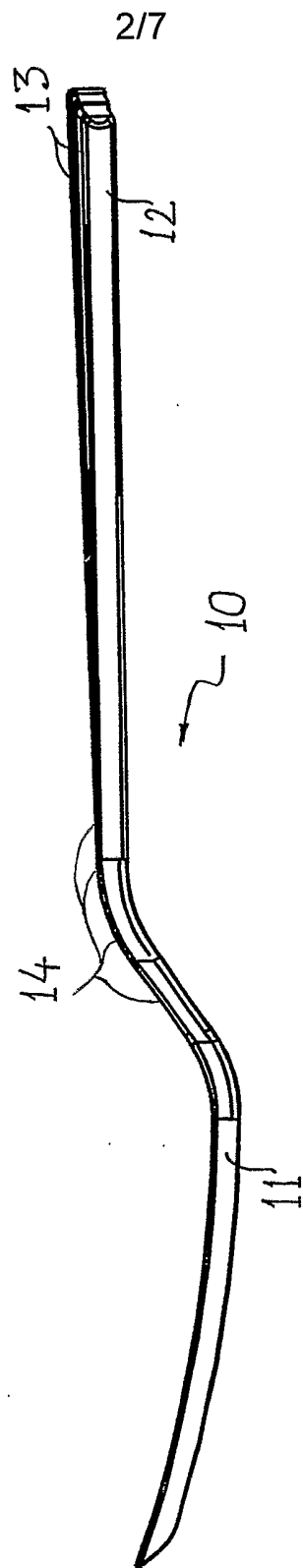


FIG. 1B

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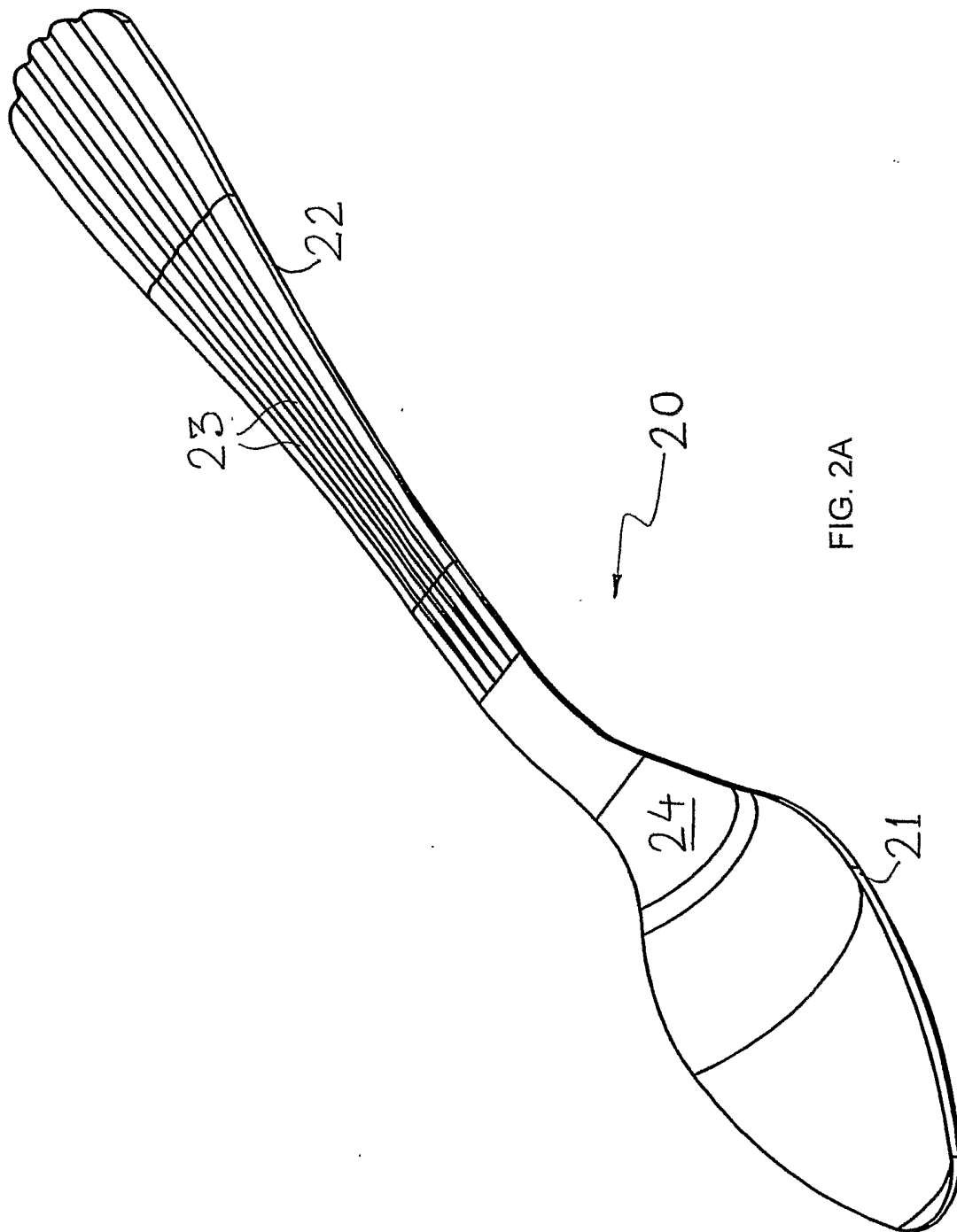


FIG. 2A

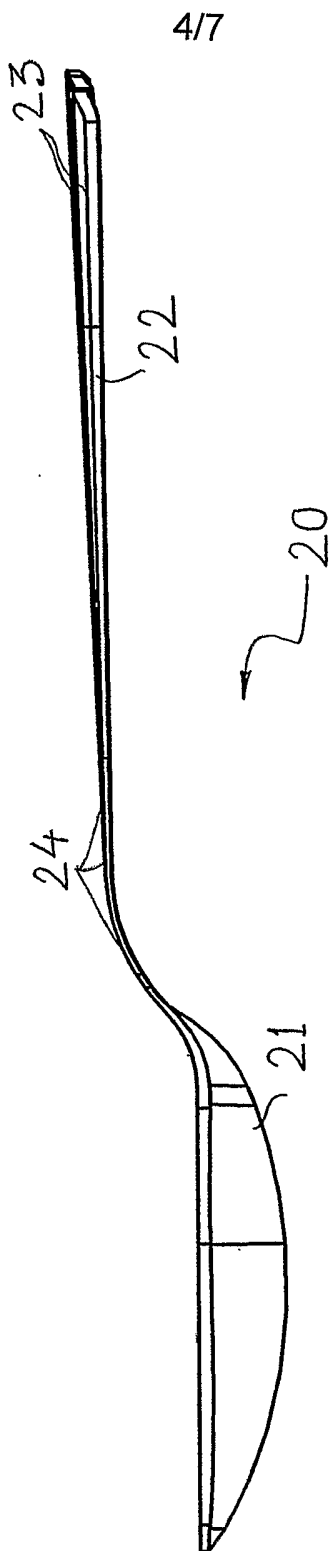


FIG. 2B

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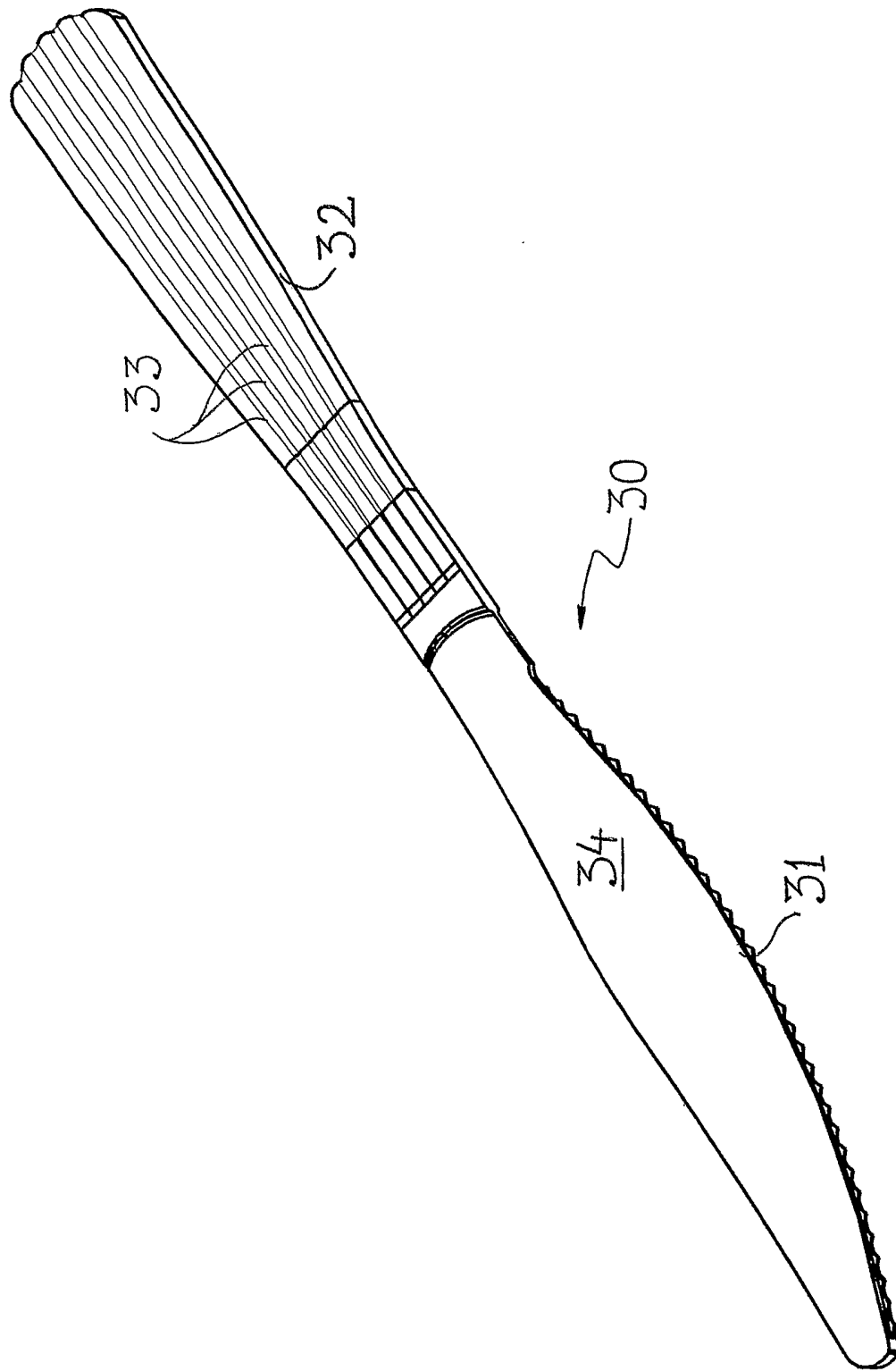


FIG. 3A

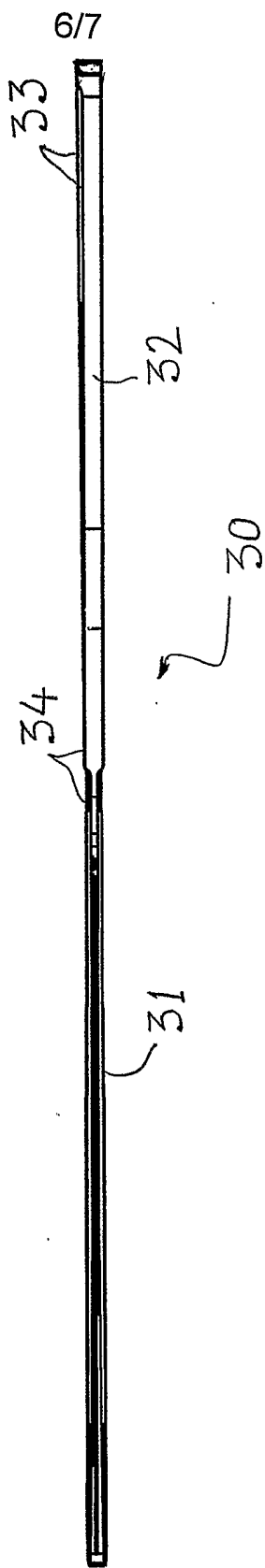


FIG. 3B

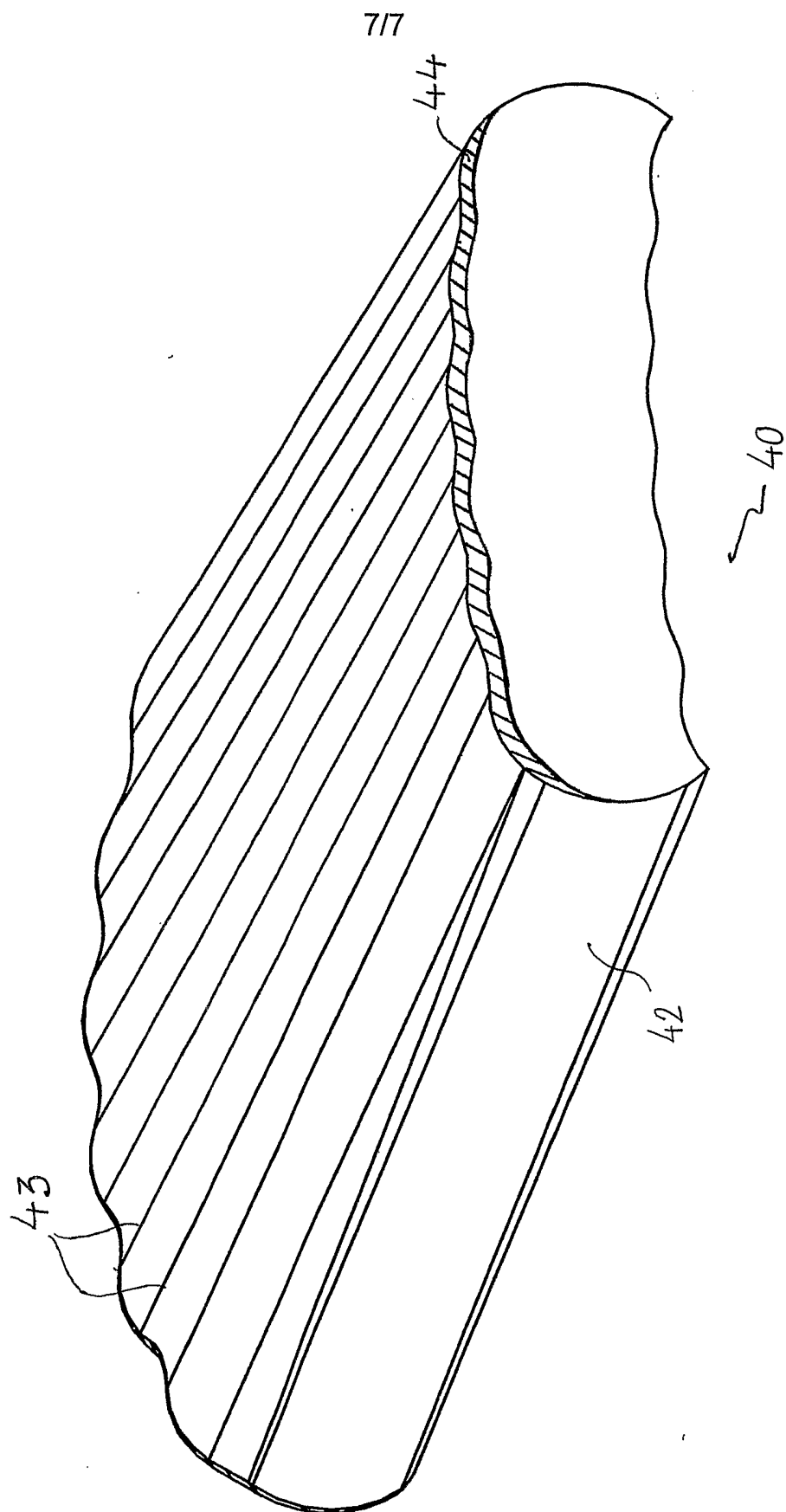


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/27232

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B25G 1/10
 US CL : 30/322, 340

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 U.S. : 30/322, 340

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,782,346 A (GRAY et al.) 21 July 1998 (21.07.1998) see entire document	1-33
A	US 6,145,204 A (CASH) 14 November 2000 (14.11.2000) see entire document	1-33

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:	"T"	later document published 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
"A" document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

02 November 2002 (02.11.2002)

Date of mailing of the international search report

19 DEC 2002

Name and mailing address of the ISA/US
 Commissioner of Patents and Trademarks
 Box PCT
 Washington, D.C. 20231
 Facsimile No. (703)305-3230

Authorized officer
 Douglas D Watts

Telephone No. (703) 308-1078

