May 31, 1949. H. D. TIETZ 2,471,663

METHOD FOR PRODUCING CLADDED METAL COOKING UTENSILS

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Fig. 1.

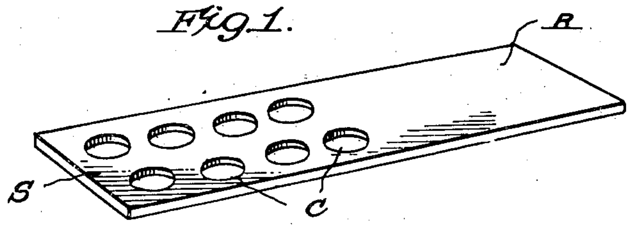


Fig. 2.

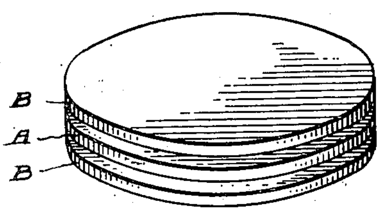


Fig. 5.

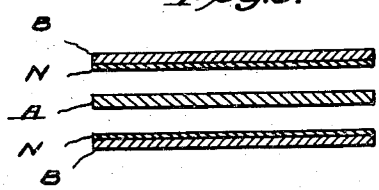


Fig. 7.

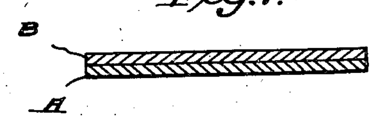


Fig. 3.

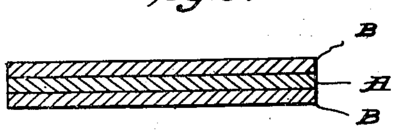


Fig. 6.

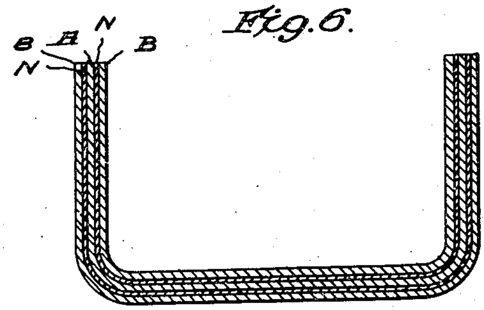
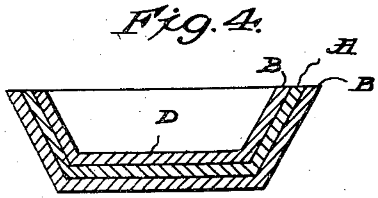


Fig. 4.



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METHOD FOR PRODUCING CLADDED METAL COOKING UTENSILS

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Fig. 8

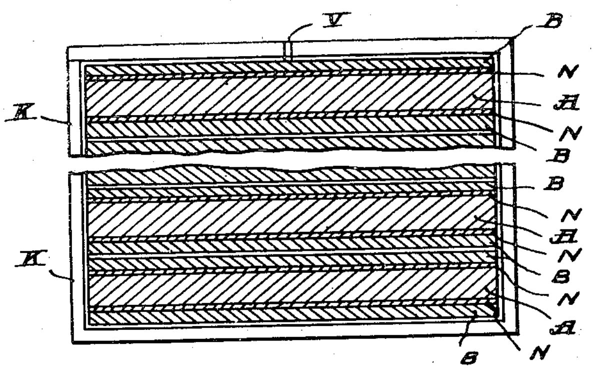
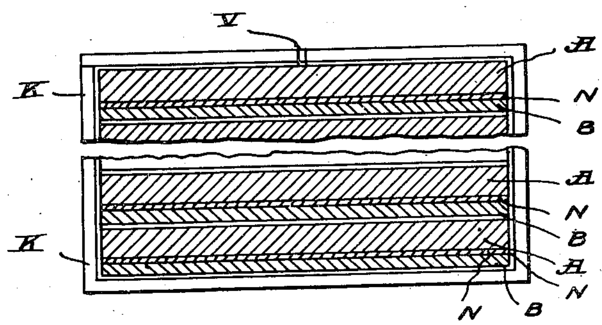


Fig. 9.



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METHOD FOR PRODUCING CLADDED METAL COOKING UTENSILS

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3 Claims. (Cl. 29—148.2)

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The present invention relates to the art of producing shaped blanks suitable for subsequent drawing or other forming operations to form a hollow vessel, and, more particularly, to an efficient and highly economical method for producing such blanks particularly suitable for use in the subsequent production of cooking utensils, and to the product thereof.

Hitherto, a relatively wide variety of metals has been used for the production of cooking utensils, including aluminum, cast iron, enameled steel, tinned steel, copper-plated steel, copper, copper alloys, stainless steel, nickel-plated steel and nickel-chromium alloys. While each of these metals or alloys had specific desirable qualities for use in the production of cooking utensils, such use also was attended with certain disadvantages. The use of copper or an alloy in which copper was predominantly present, for example, was particularly advantageous for its high heat conduction capacity, but such use was disadvantageous because of the very low corrosion resistance of copper and because of its high susceptibility to mechanical damages. Earlier investigators, appreciating the desirability of combining the high heat-conductivity of copper with the desirable qualities of the other metals, resorted to coating steel, for example, with an outer coating of copper, which was applied by such well known methods as spraying, electroplating and the like. The susceptibility of copper to mechanical damage when so used was diminished only to the extent of the support afforded by a steel backing or other backing, such as a nickel chromium alloy or the like. The susceptibility of the copper to oxidation or deterioration was in no way diminished. The combination of desirable qualities was obtained to a certain extent in vessels carrying an exteriorly disposed copper plating, particularly when the copper plating was applied to a nickel chromium alloy as the base metal. The copper plating, however, was relatively thin and apart from mechanical damage and oxidation, was worn away in a relatively short time by the abrasive action of repeated washing and polishing operations after use. Subsequent investigators, with a view of prolonging the life of the copper coating, used copper sheeting which was bonded to a metal sheeting possessing a high degree of corrosion resistance like nickel-chromium alloy. Such composite sheetings or products have been commonly referred to as cladded metals. Such cladded metals, in order to successfully combine the high heat conductivity of the copper with the high corrosion resistance of the

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nickel-chromium alloy, were dependent on obtaining a bond between the two throughout the entire contacting surfaces, with the metals so integrally united that the composite sheet could be subjected to subsequent operations, such as hot or cold rolling and drawing without any tearing apart of the component sheets forming the composite.

A method for producing a composite sheet, with the component sheets, plates or the like integrally and firmly united throughout their entire contacting surfaces is disclosed in U. S. Patent No. 2,147,407. This patented invention stated broadly, contemplates the production of a cladded metal product containing chromium which comprises a base metal or alloy, a cladding or coating metal or alloy containing chromium and a layer of film containing nickel or a nickel alloy, intermediate the base metal and cladding metal, which is adhesively united to the entire face of said chromium-containing cladding metal and the entire face of said base metal to form an integral unit. The base metal was cladded on one face or both. The patent suggested as a theory that the nickel or nickel alloy formed a bond having high physical properties by partial interdiffusion into not only the chromium-containing metal or alloy, but also into the base metal and that the nickel film protected the surface of the chromium-containing alloy before being used or bonded or in any subsequent heat treatments that were required. A cooking utensil, utilizing such a composite sheet as that just previously described, is described in U. S. Patent No. 2,053,096.

The cladded metal sheeting produced according to the methods described in U. S. Patent No. 2,147,407 was found very suitable for use in producing cooking utensils possessing the combination of desirable qualities heretofore specified, but such use has had one very serious disadvantage, namely the coincident production of relatively large amounts of scrap cladded metal in the manufacture of the cooking utensil. The high efficiency of the bonding operation, when considered in connection with the recovery of the scrap metal resulting from the various operations, then became a serious disadvantage since the metals in the scrap cladded metal, like those in the composite blank, were inseparably bonded together and each of the metals was thus contaminated by one or more of the other metals forming the composite sheet. Some of this scrap originated in the milling and bonding operations and a further quantity resulted from operations in the utensil fabricator's plant. Since practically all cooking utensils are round in shape, this latter source of scrap was high. For example, when cutting circular blanks from a rectangular sheet, the resultant scrap is approximately 25%.

It is an object of the present invention to provide a highly economical method for the production of a suitably contoured, cladded metal blank, suitable for subsequent forming into hollow vessels, from a plurality of singular metal blanks.

It is a further object of my invention to provide a cladded metal blank suitable for the production of a hollow vessel which substantially eliminates the production of cladded metal scrap during any of the operations incidental to the formation of a cladded finished hollow vessel such as a cooking utensil.

Other objects and advantages of the method of my invention and the product thereof will become apparent from the following detailed description taken in conjunction with the accompanying drawings, in which—

Fig. 1 depicts a plan view of a metal sheet from which components suitable for use in forming the cladded metal blank according to the method of my invention have been removed;

Fig. 2 illustrates a perspective view of three component metal blanks in arrangement for bonding together, the space between the components being exaggerated for purposes of clarity;

Fig. 3 shows a cross section of a composite bonded blank after the bonding of components such as those shown in Fig. 2;

Fig. 4 is a cross sectional view of a shallow vessel, such as a frying pan in the finished form, the handle being omitted;

Fig. 5 illustrates a sectional view of components similar to the view shown in Fig. 2 and showing the cladding metal with a nickel plating layer on the bonding face of each cladding metal component;

Fig. 6 is a cross sectional view similar to that shown in Fig. 4 of a cooking utensil of different form from that of Fig. 4;

Fig. 7 shows a cross sectional view similar to that shown in Fig. 3, but having only two components instead of three;

Fig. 8 depicts a sectional view of a column of blanks encased in a metal-container for double cladding; and

Fig. 9 is a sectional view of a column or stack of blanks encased in a metal container for single cladding.

The present invention, stated broadly, contemplates producing blanks by cutting, stamping, or otherwise removing or preparing, producing or making of shapes of appropriate peripheral or perimeteral contours from a plurality of singular, dissimilar metal sheetings, plates, or the like, each of which possesses desirable physical qualities and characteristics and subsequently interfacially bonding singular dissimilar metal blanks to each other to form an integrally united, composite metal blank possessing a desirable combination of such physical qualities and characteristics and being suitable for subsequent drawing and/or forming operations.

In the manufacture of the novel blank embodying the present invention, a circle C is cut, stamped, or otherwise removed from a strip or sheet of metal R. As those skilled in the art know, a scrap or skeleton portion S remains after the circles are removed from the strip or sheet. It is a particular feature of the present invention that such component blanks or circles C shall be stamped or otherwise obtained for each of the metals to be used for the subsequent forming of the composite blank and Fig. 1 shows a rectangular skeleton sheet from which the required component blanks have been removed. Thus, the skeleton sheet, like the component blanks which have been removed from it, is a singular metal or alloy and these skeleton sheets, being of known composition, may be recovered with metal of similar composition by any method well known to those skilled in the art. A skeleton sheet of copper, for example, may be immediately reworked with other copper, and scrap loss from this source in cutting the component blanks is thus substantially eliminated. Similarly, when the component blanks produced are of a nickel-chromium alloy, the skeleton sheet can be recovered by reworking with other nickel-chromium alloy of like composition. It is also a particular feature of the present invention that the thickness of the metal sheets, plates or strips, as well as the diameter of the circle C, shall be so chosen in relation to the desired thickness and diameter of the finished cooking utensil that there will be substantially no cladded metal scrap produced in the operations of forming the cooking utensil from the composite metal blank. While the component blanks are shown as being circular in form, it will be apparent that blanks of other contours may be used, such contours being determined by the shapes desired in the finished articles.

An assembly of three circular component blanks with the base metal component blank A having a cladding metal component blank B disposed opposite each of its plane faces is shown in Fig. 2. The space between the components is enlarged or exaggerated in the drawing in order to more clearly show the individual component circles. The base metal may be, for example, copper, while the cladding metal may be a nickel-chromium alloy or other corrosion and tarnish-resisting alloy. The foregoing example is merely an illustration of a specific choice of certain particular metals for the component blanks and it is to be understood that my invention contemplates the novel conception of cutting such circles or component blanks from individual sheets of unlike metals capable of being subsequently inseparably bonded together to form an integral, composite blank adaptable to subsequent forming operations which will produce a hollow vessel such as a cooking utensil or the like.

Component blanks similar to those shown in Fig. 2 are shown as a composite blank in Fig. 3. The base metal component blank A may be made of a metal, such as copper, possessing a high degree of heat conductivity in a direction parallel to its plane surface. As shown, this copper component blank is intermediately disposed between two cladding metal component blanks B. The cladding metal may be any well known corrosion and tarnish resisting metal, such as a nickel-chromium alloy. The diameters of all of the component blanks are the same and are determined by the diameter desired in the finished article, such as a cooking utensil. The thickness of each of the component blanks is also chosen with regard to the thickness desired in the cooking vessel which will ultimately be formed from the composite blank. Thus, while the diameters of all of the component blanks must be the same, the thicknesses of the component blanks may all be different or they may also be the same. For example, the thickness of the cladding metal components may be identical and the base metal component may be of a different thickness. It is an essential feature of the present invention, however, that the diameters of the individual component blanks shall be such that when they are bonded together throughout their area of interfacial contact to form an integral, composite metal blank, such as that shown in Fig. 3, the diameter of the composite metal blank shall be such that the composite metal blank may be formed into a hollow vessel such as a cooking utensil without the coincident production of any substantial amount of composite metal scrap. It is also an essential feature of the present invention that the thicknesses of the individual component blanks shall produce, when integrated in the composite metal blank, substantially the thickness desired in the finished cooking utensil. Although the formation of the composite metal blank has been described as being circular in contour, it will be apparent that component blanks of rectangular or other contour may be used to form an integral, composite metal blank.

A frying pan, formed from a composite blank similar to that of Fig. 3, is illustrated in Fig. 4. Since the handle and the method of attaching it to the pan do not form a part of the present invention, no illustration or description thereof has been included. In the view shown, component blanks or circles B, B, of a corrosion and tarnish-resisting alloy, are bonded to a base metal component or circle A to form a composite blank and the composite blank has been drawn, pressed, or otherwise formed into a hollow vessel D. As stated heretofore, the thickness and diameter of the component blanks or circles A, B, B have been so chosen that the hollow vessel D is formed substantially without any coincident production or formation of cladded metal or composite metal scrap.

When one of the faces of certain of the circles or component blanks is to be pretreated with a nickel film, a stack of component blanks looks like those diagrammatically illustrated in Fig. 5. The cladding metal B is shown as having a nickel plating N applied to the face of the cladding metal which subsequently will be bonded to the adjacent face of the base metal A. This nickel plating, however, does not form a separate component blank, but is preferably electro-deposited or otherwise applied to the bonding face of the cladding metal to protect it. While the nickel plating does not go into the composite blank as a separate component, its presence, as a layer between the cladding metal and base metal, produces, in effect, a five layer composite blank. Stainless metal, such as stainless steel, for example, may be used for the cladding metal and copper for the base metal and when the component blanks are bonded together as shown in Fig. 3, the finished, integral, composite blanks will consist of a middle layer of copper within two outer layers of stainless metal and a layer of nickel plating between the adjacent faces of the stainless metal and copper layers. Thus, the circles B, B, of corrosion and tarnish-resisting metal will each have a layer N of nickel, electrodeposited or otherwise applied to their inwardly disposed faces and firmly adhering to the opposite faces of the base metal circle A. The nickel layer N will have been electrodeposited or otherwise applied to one face of each of the tarnish-resisting alloy circles prior to the bonding operation and preferably by the method described in detail hereinafter. The adherence of the nickel layers N, to the opposite faces of the base metal circle A is obtained in the subsequent bonding operation under preferred conditions of heat, pressure and controlled atmosphere as more completely described hereinafter.

One use of a five layer, integrally united composite blank, similar to the one described in the immediately foregoing description, is described herewith. A five layer, integrally united composite blank, comprising two outwardly disposed tarnish-resistant blanks B, B, an intermediately disposed base metal blank A, and nickel layers N, N, cohesively united to the adjacent faces of the blank A and the blanks B, B, is pressed, drawn, or otherwise formed into a hollow vessel as illustrated in Fig. 6.

While the foregoing description contemplates the formation of a finished, integrally united composite blank having an intermediately disposed layer of a base metal and at least two outwardly disposed layers of corrosion and tarnish-resistant cladding metal, the present invention also contemplates the production of composite blanks having a single layer of cladding metal with a single layer of base metal, and such a composite blank is illustrated in Fig. 7. A suitably contoured cladding metal blank B, for example, is bonded to a similarly contoured base metal blank A to form an integrally united bi-metal blank. It will be apparent that the bonding face of the cladding metal blank may have a coating of nickel applied thereto by electrodeposition, or in any other manner known to those skilled in the art before the bonding operation.

The bonding operation for forming the composite blanks may be carried out in any convenient manner, but is preferably carried out by stacking the component blanks in a particular arrangement and subjecting the stack thus formed to heat and pressure. For example, a stack of component blanks may be arranged as shown in Fig. 8 with a chromium-containing blank B at the bottom. This blank is placed so that the nickel film N faces upwardly. Upon the nickel film a copper blank A is mounted. Both faces of the copper blank will have been previously cleaned by any well known process so that clean copper contacts the nickel film throughout substantially the entire contacting surface. A second chromium-containing blank B with a nickel film N facing downwardly engages the top of copper blank A. This assembly of blanks is herein termed a "set."

As many sets as desired may be superposed one upon the other to form an assembly of sets, referred to hereinafter as a "stack." It is sometimes desirable to use a parting sheet or compound between each set to prevent them from sticking to each other during the bonding operation. When a chromium-containing metal is exposed to the atmosphere, a greenish scale is formed almost immediately and the greenish scale will generally serve to prevent the adjacent faces of chromium-containing metal from sticking to each other in the stack. These faces of chromium-containing metal which will be in interfacial contact in the stack may also be left in an unclean condition and the uncleanliness will also assist in preventing bonding between the adjacent faces. The greenish scale that is formed, the uncleanliness, and the absence of nickel plating in the areas of contact with the sheet metal envelope hereinafter described will also all serve to prevent adhesions of the sets to that sheet metal envelope. A sheet of steel may then be folded around the stack to completely envelop the stack and may be then secured as by welding or the like. In order to completely enclose the stack, the end portions of sheet steel may be welded to the open ends of the folded sheet. For the purpose of permitting the escape of gas and/or vapor from the welded container K, a vent V may be provided, preferably in the top of the container.

The stack of sets in the container is now subjected to heat and pressure sufficiently high to effect bonding of the nickel face to the adjacent face of the copper blank. Due to the fact that the stack is sealed in a container, the heating is practically independent of the atmosphere within the furnace. For the application of pressures the weight of the stack itself may prove sufficient, but it is preferred to press down on the top of the stack for example, by the application of a heavy plate or other weight or a plunger of a mechanical or hydraulic unit. Alternatively, the stack may be placed in an hydraulic press. The stack, while under pressure, is placed within a furnace or is otherwise uniformly heated to a temperature suitable for bonding. The bonding operation is preferably done in a reducing atmosphere, preferably one containing hydrogen and within a temperature range of 1700° F. to 1975° F. Heating is continued at this temperature for at least one-half hour to about 2 hours until the component blanks of each set are inseparably bonded together into a substantially solid composite blank.

In the foregoing operations, it has been found that the top and bottom plates of the sets do not stick or bond to the adjacent walls of the enclosing container or to each other because the contacting surfaces have a skin of non-sticking refractory oxide which has not been nickel plated. However, the contacting surfaces of the chromium-containing component blanks may be coated as pointed out hereinbefore with some refractory material or otherwise separated by an adhesion inhibiting material which will eliminate all possibility of the blanks being stuck together mechanically or otherwise.

When the foregoing treatment has been completed, the enclosing container K may be cut away or otherwise removed. Under the influence of the conditions prevailing within the container during the foregoing treatment, those conditions including heat, pressure and controlled atmosphere, the component blanks of each set will be found to have united throughout their interface into an integral double-cladded composite blank.

In the event that a single cladded composite metal blank is desired instead of a double-cladded blank, such as that just previously described, having, for example, a metal of high corrosion and tarnish resistance forming one of its exposed surfaces and a metal of high heat conductivity forming its other exposed surface, an arrangement such as that illustrated in Fig. 9 may be employed. The corrosion and tarnish resisting metal may be a chromium-containing alloy such as a nickel chromium alloy and the metal of high heat conductivity may be copper, for example.

Within the container K and at the bottom thereof, a chromium-containing component blank B is placed with the surface of the nickel film or layer N facing upwardly. Upon the nickel film or layer N, a component blank of copper plate A is mounted and in this case these two blanks constitute an assembly, hereinafter referred to as a sub-set. A plurality of such sub-sets may be superposed one upon the other as in the double cladding operation, to form an assembly, hereinafter referred to as a sub-stack. The sub-stack is then subjected to preferred conditions of heat, pressure and controlled atmosphere and these conditions may be identical or similar to those used in the double cladding operation. As in the double-cladding operation, a refractory material or other means for inhibiting adhesions between the sub-sets may be interposed between the contacting faces of adjacent sub-sets. On opening or removing the enclosing container, the chromium-containing blank and the upper blank of each sub-set will be found to have united into an integral single cladded composite blank.

In carrying out the bonding operations, it has been noted that the method described in U. S. Patent No. 2,147,407 may be used for the bonding of the component blanks of the present invention and the particular manner for the use of that method has been described hereinbefore with particular reference to Figs. 8 and 9. The particular method which is recited in that patent for the application of a nickel coating to one face of a chromium-containing metal sheet may also be adapted to the preparation of the corrosion and tarnish-resisting component blanks or circles of the present invention in the following manner.

A component blank of nickel-chromium alloy of the desired contour and thickness is cleaned in any appropriate manner, such as by sand blasting, pickling, or the like. In this manner a clean and scale-free surface is produced. To this cleaned surface a film of nickel or nickel alloy is applied by any suitable method, for example, by electroplating or by metal spraying. In practice, it is preferred to apply the film of nickel by electrodeposition. In the use of the term "nickel plating" in the appended claims, it is intended to include any of the methods which are known in the art for applying a film of nickel. Since only one surface of the nickel-chromium component blank will function in bonding relationship to one surface of the component heat-conductive blank referred to hereinafter, it is preferred to place two of the nickel-chromium components back to back and secure them together in that arrangement by means of suitable clamps or the like. The clamped nickel-chromium blanks are immersed in an electrolyte having a suitable composition for the electrodeposition of nickel or of nickel alloy. The electrodeposition is conducted in any appropriate manner to yield a dense, adherent deposit of nickel or nickel alloy.

Alternatively, the nickel-chromium alloy component blanks may be prepared for the nickel plating by treating them as cathodes in an electrolyte alkaline cleaning bath. After this operation, the blanks are rinsed in hot water and are immersed in a solution of muriatic acid containing 5% by weight of hydrochloric acid and heated to a temperature of about 150° F. They are held in the acid solution for several minutes and are then transferred directly to the nickel plating bath where the coating of nickel is electrodeposited. It is preferred to apply a coating of nickel having a thickness of about 0.002 inch to about 0.005 inch although the thickness of the film or coating of nickel may vary considerably and thus thicknesses less than 0.001 inch or more than 0.005 inch may be used.

In conducting the electrodeposition of nickel any suitable nickel plating solution may be used. It is preferred, however, to use the following nickel plating solution and the following operating conditions:

Nickel plating solution and operating conditions

Temperature	130° F. to 150° F.
Agitation	Moderate air agitation
Current density	50 amps. per sq. ft.
Nickel sulphate	44 oz. per gallon
Nickel chloride	2.2 oz. per gallon
Boric acid	4.0 oz. per gallon
Sodium sulphate (anhydrous)	13.8 oz. per gallon

It will be apparent from the foregoing description that the method embodying the present invention, particularly in its application to the production of cladded cooking utensils, is considerably more economical than the methods of the prior art in which the composite blank was stamped or cut from a sheet of composite metal. The scrap metal resulting from the producing of the component blanks in the method of the present invention can be segregated into separate collections free from contamination and can therefore be sold separately or re-used successfully because of the absence of contamination. By careful selection of the size, shape and thickness of the component blank, the production of scrap in the utensil forming operation to which the subsequently formed composite blank is subjected may also be substantially eliminated.

The thickness of the dissimilar metal sheets or plates, for example, from which the individual component blanks or circles are obtained is chosen with a view to the particular thickness which is required for the subsequently formed composite blank and the final thickness which is required in the cooking utensil or other hollow vessel which is ultimately produced from the composite blank. Similarly, the diameter of the individual component blanks, if the vessel ultimately to be produced is to be circular, or the length and breadth, if the vessel ultimately to be produced is to be rectangular, will be determined by the dimensions desired in the finished hollow vessel. This determination of thickness and diameter, or thickness, length and breadth, for the individual component blanks in particular relation to the similar dimensions which are required in the finished hollow vessel is a particularly important feature of the present invention since it is contemplated according to the present invention that the production of cladded metal scrap at any stage, from the production of the singular metal components to the final production of a finished cooking utensil, will be substantially eliminated.

The composite blank of my invention may be bright annealed, for example, by the process described in U. S. Patent No. 1,901,039 to Owens and Frazer, or by the process described in U. S. Patent No. 2,057,518 to Frazer and Owens.

Although the present invention has been described in conjunction with certain preferred embodiments thereof, it is to be understood that variations and modifications may be made as those skilled in the art will readily understand. Thus, base metals, such as iron, aluminum, or the like, may be used instead of copper and the cladding metal may be any corrosion and tarnish-resisting alloy other than the nickel-chromium

alloy and the invention can be applied to the production of many different types of hollow vessels by altering the shape and thickness of the individual component blanks. Such variations and modifications are to be considered within the purview of the present specification and the scope of the appended claims.

I claim:

1. A method for producing a cooking utensil of cladded metal possessing a high degree of corrosion resistance on an exposed surface and a high degree of heat conductivity in a direction parallel to the plane of said surface, which comprises the steps of producing blanks suitably contoured to produce the finished utensil from sheets of nickel-chromium alloy, separately producing similarly contoured blanks from sheets of copper, cleaning and nickel plating one face of said nickel-chromium alloy blanks, arranging one of said copper blanks interfacially, engaging the plated face of one of said nickel-chromium alloy blanks, bonding said assembled contoured blanks together to provide a contoured composite blank by subjecting the assembled blanks to a temperature of from 1700° F. to about 1975° F. in a reducing atmosphere and under pressure and thereafter forming said cooking utensil from said composite contoured blank thereby to substantially eliminate the production of composite metal scrap.

2. A method for producing a cooking utensil of cladded metal possessing a high degree of corrosion resistance on its exposed surfaces and a high degree of heat conductivity in a direction parallel to the plane of said surfaces, which comprises the steps of producing blanks suitably contoured to produce the finished utensil from sheets of nickel-chromium alloy, separately producing similarly contoured blanks from sheets of copper, cleaning and nickel plating one face of each of said nickel-chromium alloy blanks, arranging one of said copper blanks in intermediate arrangement with two of said nickel-chromium alloy blanks with the nickel plating interfacially adjacent an oppositely disposed face of the copper blank, inseparably bonding said assembled contoured blanks together to provide a contoured composite blank by the application of heat and pressure and forming said cooking utensil from the resulting composite contoured blank so as to substantially eliminate the production of composite metal scrap.

3. A method for producing a cooking utensil of cladded metal possessing a high degree of corrosion resistance on its exposed surfaces and a high degree of heat conductivity in a direction parallel to the plane of said surfaces, which comprises the steps of producing blanks suitably contoured to produce the finished utensil from sheets of nickel-chromium alloy, separately producing similarly contoured blanks from sheets of copper, cleaning and nickel plating one face of each of said nickel-chromium alloy blanks, arranging one of said copper blanks in intermediate arrangement with two of said nickel-chromium alloy blanks with the nickel plating interfacially adjacent an oppositely disposed face of the copper blank, inseparably bonding said assembled contoured blanks together to provide a contoured composite blank by subjecting the assembled blanks to a temperature of from about 1700° F. to about 1975° F. in a reducing atmosphere and for about one-half hour to two hours and under pressure and forming said cooking utensil from the resulting composite contoured blank so as

to substantially eliminate the production of composite metal scrap.

HERBERT DAVID TIETZ.

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