July 31, 1962 O. R. SINGLETON, JR 3,046,640

PROCESS AND PRODUCT OF ZINC AND ALUMINUM LAMINATION

Filed Dec. 4, 1957

FIG.1.

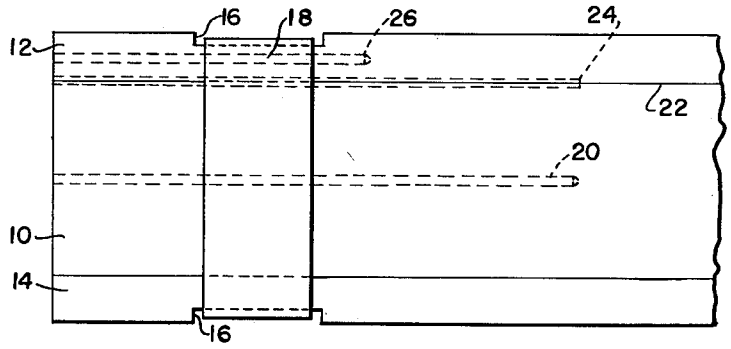
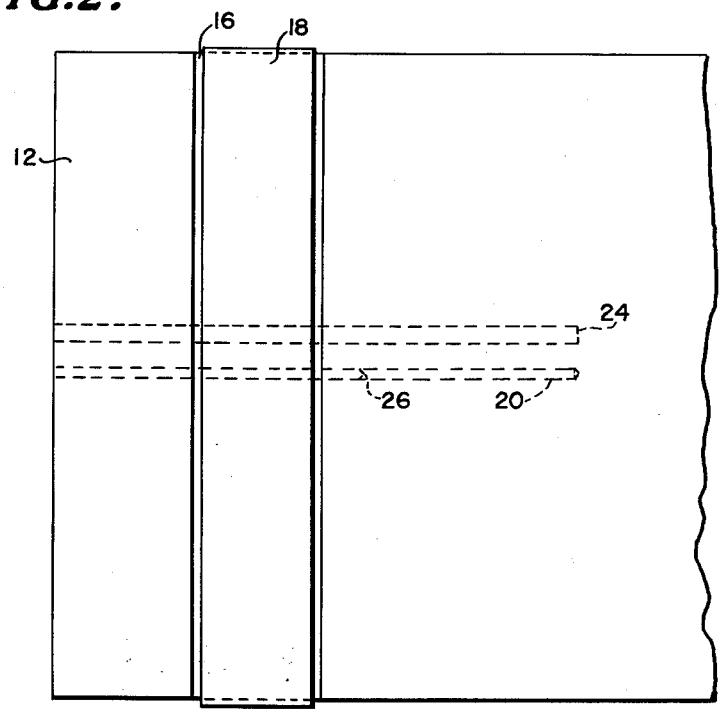


FIG.2.



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PROCESS AND PRODUCT OF ZINC AND ALUMINUM LAMINATION

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This invention relates to improvements in cladding of aluminum with zinc or zinc alloys.

In accordance with the present invention, aluminum cores clad on one or both sides with zinc may be manufactured, starting from the ingot stage, by novel and efficient procedures. The present method simplifies initial adherence between the aluminum and the zinc, helps to avoid edge cracking during hot rolling, and tendency of the zinc liners to extrude outwardly. The method assures a clad product having lining layers of uniform thickness firmly bonded and free from blisters and holidays, and having good formability, mechanical properties and corrosion characteristics. The clad product may be used as a replacement for materials such as copper, brass and galvanized iron in applications in which solderability is of importance. In such applications, the new clad product may be soldered by means of conventional equipment and techniques, and special solders and fluxes, equipment and controls heretofore required to solder aluminum are unnecessary.

Previous methods of uniting aluminum with laminations of other metals by mechanical means, as distinguished from chemical or electro-deposition, have generally been based upon the use of an intermediate layer of aluminum foil or alloy to serve as a bonding agent between the cladding metal and the aluminum core. It is known, for example, to bond a copper-base cladding metal to aluminum strip, slabs or ingots by means of a preliminary rolling of the copper-base metal with aluminum foil, followed by a second rolling at raised temperatures to effect a bond with the aluminum core. In another known method, aluminum is applied as a surfacing metal on zinc by means of an intermediate bonding layer of zinc-aluminum alloy. In yet another known method, other metals are bonded to aluminum by cold rolling using as much as a 60% reduction in a single pass. For practical purposes, these prior art methods are confined to the production of relatively thin sheets or foils from thin cores and liners.

For the purpose of imparting solderability, it has hitherto been the practice to coat aluminum with zinc or tin by brushing the molten zinc or tin onto the surface of the heated aluminum with wire brushes to form a surface alloy. These methods are laborious and the surface alloys penetrate into the aluminum to a greater extent than is desirable, with adverse effects upon the ductility of the aluminum.

In accordance with copending application Serial No. 636,232, now Patent 2,987,814, an aluminum core may be clad with zinc or a zinc alloy containing less than 1% by weight of alloying metals which have a melting point below that of pure zinc (about 786° F.), when the cladding is applied to only one side of the core, and less than 0.02% of said low melting metals when the cladding is applied to both sides of the core. The said limit on low melting metals is desirable to avoid hot shortness. A greater amount of alloying metals having a melting point higher than zinc is permissible, and is a safeguard against hot shortness. For example, up to about 1% copper may be used in the alloy, up to about 0.15% titanium, up to about 0.52% manganese, or about 10% aluminum. However, other factors, such as corrosion, grain growth, ductility and size of composite, make it advisable to limit

the amount of alloying metals of all kinds as far as practicable. For the best and most consistently good results in practicing the invention, the zinc liner preferably contains not more than 0.01% by weight of non-zinc materials, particularly where a double liner is applied. Where a single liner is applied, the zinc may have a larger proportion of impurities, e.g., 0.36% lead, 0.27% cadmium and 0.019% iron, the balance of 99.351% being zinc.

In accordance with said application Serial No. 636,232, now Patent 2,987,814, the cladding metal layer or layers are first placed in contact with the aluminum core to form an assembled composite. This composite is then heated to a temperature slightly below the melting temperature of the cladding metal. Since there is a tendency toward the formation of an eutectic alloy between the cladding metal and the aluminum, the heating temperature is preferably kept slightly below the melting temperature of such eutectic alloy. The time of preheating of the zinc-aluminum composite will depend upon its dimensions, and may vary from two or three hours up to thirteen or fourteen hours for larger sizes. The heated composite of cladding metal and aluminum core is then rolled lightly several times, using a very small reduction per pass, to effect initial adhesion or sticking of the cladding layer to the core. The composite is then hot rolled in accordance with normal aluminum hot rolling practice, using as large a reduction per pass as practicable, until the desired hot line gauge is obtained. The clad aluminum may be further cold rolled in accordance with customary aluminum cold rolling practice to any desired gauge.

The above described method makes possible the utilization as starting materials of aluminum cores in the form of ingots or slabs ranging in thickness from 1" up to 12" or more, and of cladding zinc layers in the form of plates as much as 1" or more in thickness. The cladding may be applied to one or both faces of the core, or to a portion of one or both faces. This provides for the production of heavier gauges of clad aluminum, and improved economy of production of lighter gauges of clad aluminum.

Pure zinc is generally regarded as the most corrosion resistant soldering metal for joining aluminum, but has not been widely adopted for this purpose owing to its poor flow properties. Cladding pure zinc to aluminum, however, is equivalent to a preplacing of the solder, and thus eliminates the need for high flow-ability requirements. Such zinc cladding not only provides a solderable surface, but when the coating is of sufficient thickness, the zinc itself acts as a solder.

The properties of the final product may be varied in accordance with the relative thickness of zinc cladding employed. This thickness may range, for example, from about 3 to 10% of the overall thickness of the composite, using a single liner. Thus, a zinc liner of 0.2" to 0.6" thickness may be applied to one or both sides of an aluminum ingot approximately 2.5" thick. On a larger scale, an ingot about 11" thick may be combined with one or two zinc plates each about 1" thick, to form a cladding composite. These types of composites may then be rolled, for example, to an overall thickness of 0.006", of which 0.0004" is zinc (half on each side) and 0.0056" is aluminum core, or to an overall thickness of 0.012" of which 0.0012" is zinc (half on each side) and 0.0108" is aluminum core.

Where, for example, the thickness of the zinc coat in the final sheet is about 0.0004", the product possesses a surface solderable with conventional solders. For instance, joints can be made using commercial rosin core or acid core lead-tin solders. If the zinc coating in the final sheet is greater than about 0.001" in thickness, the coating is not only solderable, but is itself solder furnishing.

This material may be used to zinc solder using techniques now employed for brazing using brazing sheet. It has been found in furnace soldering the clad solder furnishing sheet that temperatures of about 850° F. to 950° F. produce strong, well sealed joints. Flow of zinc is excellent above 850° F., since the aluminum core has been pre-wetted in the cladding process. Typical proprietary fluxes, usually aqueous solutions of zinc chloride and ammonium chloride, suitable for soldering galvanized steel work well on the zinc clad aluminum.

I have found that initial adherence (sticking) of zinc liners to aluminum cores in hot rolling may be greatly facilitated, the number of light rolling passes necessary for this purpose reduced, and the permissible reductions employed in these light rolling passes materially increased, by proper control of the interface temperature, that is the temperature of the adjoining core and liner faces during adherence. The ease and effectiveness of initial adherence appears to be largely dependent on the interface temperature, and I have discovered that initial adherence is best accomplished when the interface temperature is within the range of from about 450° F. to about 650° F. Within this range, initial adherence may be accomplished most readily and effectively when the interface temperature is in the neighborhood of 600° F. When the interface temperature is substantially above 650° F., it appears that light rolling passes are largely ineffective for the purpose of initial adherence.

I have further discovered that initial adherence between an aluminum core and a zinc liner is enhanced when the liner is at a lower temperature than the core. For example, I find initial adherence particularly effective when the core temperature at its center is from about 600° F. to about 750° F. and the liner temperature at its center is between 450° F. and 600° F.

Further, I have discovered that zinc plates tend to be oxidized or similarly affected by prolonged heat, for example, more than five hours, in air, to the degree that initial adherence to an aluminum core may be detrimentally affected or prevented. Another difficulty sometimes encountered, when zinc liners are heated to high temperatures, for example above 700° F., is a tendency of the zinc to "roll out" or extrude laterally during hot rolling of the composite.

I find that the initial adherence may be facilitated and other advantages attained by a procedure which I term "core heating." This procedure is adapted to effect optimum bonding temperature at the interface, to avoid excessive oxidation of the zinc liners, and to effect a desirable temperature differential between the aluminum core and the zinc lining plates. In accordance with this procedure, the aluminum core ingot is heated to a temperature above the desired hot rolling temperature, and a plate or plates of zinc is then applied thereto, the zinc plates being at a materially lower temperature. The zinc plates may be, for example, at room temperature or may be slightly heated, for example, to about 300° F. When a relatively cooler zinc plate is applied to the heated ingot, heat flows from the ingot to the plate and the interface temperatures rapidly approach each other and come within the desired range. The heated core is thus utilized as the main source of heat for heating the liners. The desired interface temperatures may be easily achieved by proper selection of core and lining temperatures, having in mind their relative mass and related factors. Rolling is initiated desirably as soon as the interface temperatures come within the desired range. When the composite is prepared and heated in this manner, initial adherence between the aluminum and the zinc may be consistently accomplished by a small number (as few as 3 or 4) of light rolling passes, which may be made with reductions of .05" to .10" per pass.

The rolling procedure may be improved by securing the composite, at least during the early sticking passes, with steel bands. For example, as soon as the composite is assembled, a steel band may be engaged tightly about one end thereof. In this case, the initial light rolling passes should be applied in a single direction, with the banded end forward. The single band prevents curling of the zinc plate relative to the aluminum ingot prior to adherence, and appears to facilitate initial bonding. After initial bonding, the composite may be rolled by normal procedure in both directions, and the securing band may then be removed. If desired, the securing band may remain in place throughout the hot rolling and may be removed in normal end trimming.

Alternatively, the composite may be banded when assembled at both ends, and the bands retained at least through initial adherence. In this case the initial light rolling passes may be taken in both directions, the bands not only preventing curling, but also effectively preventing relative skewing and facilitating initial bonding in both rolling directions.

According to an alternative procedure, each zinc liner is preliminarily grooved transversely on one face adjacent each end thereof. The liners are applied to the heated core, when the composite is assembled, with grooved faces out, and the composite is engaged by steel bands disposed in the grooves or recesses. The groove depth preferably exceeds the thickness of the steel bands, whereby the bands may be countersunk or recessed completely therewithin. The steel bands so engaged not only prevent skewing prior to initial adherence, but apparently minimize any tendency of the liners to buckle.

Engagement of the composite by steel bands during the initial rolling passes affords considerable latitude in the composition of the zinc liner plates. For example, it has been found that by this procedure zinc plates composed of high purity zinc alloyed with 0.5% copper, of high purity zinc alloyed with 0.1% titanium, and of zinc of 99.90% purity, may be adhered to aluminum as in the case of high purity zinc plates.

The banding of a composite with grooved liners is illustrated in the accompanying drawing, wherein

FIGURE 1 is a side elevational view of a zinc-aluminum composite ready for initial hot rolling, and

FIGURE 2 is a plan view of the composite of FIGURE 1.

In the drawings, **10** represents a heated aluminum core, and **12** and **14** are liner plates of high purity zinc. Each zinc plate is provided on its outer face with a transverse groove **16**, and the composite assembly is engaged adjacent the end thereof by an encircling steel band **18**, disposed in the groove **16**.

The drawing also illustrates how the core, liner and interface temperatures may be determined. The temperature at the center of the core may be measured by a thermocouple, not shown, the junction of which is placed at the bottom of the bore **20**. The bore **20** may be a 3/16" diameter hole, 5" deep, disposed along the center line of the central plane of the core, as shown. After the thermocouple is in place, the bore may be filled with foil and sealed with an aluminum plug. The temperature of the core-liner interface **22** may be measured by a thermocouple junction disposed at the bottom of the groove **24**, jointly formed by aligned grooves in the adjoining faces of the core **10** and the liner **12**. This thermocouple junction may be maintained in place by the pressure of the band **18**. The temperature at the center of the liner may be measured by a thermocouple having its junction placed at the base of the bore **26**, which may be 3/16" in diameter and 3" deep along the center line of the central plane of the core. The bore **26** may be stuffed with the zinc drilling chips to secure the thermocouple.

As previously indicated, the zinc liner plates when excessively hot are prone to extrude laterally in hot rolling, and may overhang the aluminum core. In such cases, the composite may be prone to edge cracking which apparently originates in the zinc layers. As previously indicated, this tendency may be reduced by initially adhering the elements of the composite when the zinc liners

are at a temperature below that of the aluminum core. I have found that edge cracking initiating in the zinc liner may be further reduced, by utilizing zinc liner plates somewhat narrower than the aluminum core. The liner plate or plates may be 5 or 10% narrower than the core, and should be relatively centered with respect to the core when the composite is assembled. After initial adherence, and a few heavy passes in subsequent hot rolling, the zinc plates of lesser width sink readily into the core. The exposed edge of the composite is then that of the aluminum core, and possesses the properties of the aluminum core, which is not prone to cracking. The aluminum edges may be removed by edge trimming in final fabrication. This procedure has the further advantage of facilitating initial cross-rolling of the composite, if desired.

Zinc clad aluminum may be hot rolled in accordance with the present invention from an initial overall thickness of the order of 12" or 14" to a gauge of about 0.15" and then cold rolled to a gauge of about .064", without annealing or otherwise relieving stresses. To roll the product to thinner gauges, I find it desirable to anneal the product and then cold roll the clad aluminum to a thickness of about .020". The product may be subsequently reannealed and further rolled by normal cold rolling procedures to gauges of the order of .006" or less. In all cases, a uniformly clad product can be obtained, wherein the cladding layers are continuous and uniform in thickness.

The following examples illustrate the practice of the invention:

Example I

A direct chilled cast ingot of aluminum alloy 3003 (Aluminum Association Alloy Designation, nominal composition 1.2% manganese, balance aluminum and normal impurities) is scalped to provide a core approximately 2.15" thick, 8" wide and 16" long, and wiped with clean rags soaked with kerosene. The ingot is heated in an air recirculating, electrical resistance, reheat furnace for five hours, to a temperature of 770° F. Two plates of high purity zinc (at least 99.99% zinc content), each about 0.3" thick and corresponding in length and width to the ingot, are wiped with clean rags soaked with kerosene, wired together, and heated for twenty minutes in an air recirculating electrical reheat furnace at 300° F. substantially to that temperature. The zinc plates are removed from the furnace and separated. One plate is supported on spaced iron rods. The heated ingot is removed from the furnace, placed on the supported liner, and immediately covered with the second liner. The composite is then secured by means of steel bands applied adjacent the ends thereof, and placed on the rolling table of a four-high reversing hot roll stand.

About two minutes after removal of the ingot from its furnace, the composite is assembled, banded and in place on the rolling table. At this time, the temperature at the center of the core is 650° F., the temperature at the center of the top liner is 515° F., and the interface temperature is 600° F. The composite is then subjected to a plurality of light rolling passes, with reductions of about .05" per pass, and after four passes the zinc plates are well adhered to the aluminum core. Conventional aluminum hot rolling practice is then followed, to a hot line gauge of 0.25" with no roll lubrication, the reductions per pass being increased progressively to a maximum of 0.25" per pass.

Example II

A composite of two zinc plates comprising high purity zinc alloyed with 0.15% titanium and an ingot of 3003 aluminum alloy is prepared, heated, assembled and rolled as described in Example I.

Example III

A composite of two zinc plates of 99.90% zinc content and an ingot of 3003 aluminum alloy is prepared, heated, assembled and rolled as described in Example I.

Example IV

A composite of two zinc plates comprising high purity zinc alloyed with 0.1% titanium and an ingot of 3003 aluminum alloy is prepared, heated, assembled and rolled as described in Example I.

Example V

A composite of two zinc plates comprising high purity zinc alloyed with 0.52% manganese and an ingot of 3003 aluminum alloy is prepared, heated, assembled and rolled as described in Example I.

Example VI

A composite of two zinc plates comprising high purity zinc alloyed with 0.15% titanium and an nigot of 3003 aluminum alloy is prepared, heated, assembled and rolled as described in Example I.

Example VII

A composite of two zinc plates comprising high purity zinc alloyed with 0.10% titanium plus 0.76% copper and an ingot of 3003 aluminum alloy is prepared, heated, assembled and rolled as described in Example I.

Example VIII

A composite of two zinc plates comprising high purity zinc alloyed with 10.0% aluminum plus 1.0% copper and an ingot of 3003 aluminum alloy is prepared, heated, assembled and rolled as described in Example I.

Example IX

A composite of two zinc plates comprising high purity zinc alloyed with .05% titanium and an ingot of 3003 aluminum alloy is prepared, heated, assembled and rolled as described in Example I.

Example X

A composite is prepared, heated and assembled as described in Example I, and secured by means of a single steel band applied adjacent one end thereof. The composite is subjected to a plurality of light rolling passes, with reductions of about 0.5" per pass. These passes are all taken in the same direction, with the banded end of the composite leading. After five passes the zinc plates are well bonded to the aluminum core, and thereafter six light rolling passes are taken in both directions. Conventional aluminum hot rolling practice is then followed, to a hot line gauge of 0.25".

Example XI

The procedure of Example I is followed, except that two transverse grooves are preliminarily formed in one face of each of the zinc plates. The grooves are 1" wide and approximately ⅛" deep, and about 1" from the ends of the plates. The composite is assembled with the grooved plate faces out, and secured by steel bands applied in the grooves. The steel bands are ¾" wide and about 1/16" thick, so that they are completely countersunk or recessed in the rolling faces of the composite. The composite is lightly rolled as in Example I, without skewing or buckling of the zinc plates. After three passes, the zinc plates are well adhered to the aluminum core. The steel bands are then removed, and conventional aluminum hot rolling practice followed.

Example XII

A direct chilled cast ingot of aluminum alloy 1175 (Aluminum Association Alloy Designation, nominal composition minimum aluminum content 99.75%) is scalped

to provide a core approximately 2.15" thick, 8" wide and 20" long, and suitably cleaned to remote dirt and residual oil and greases. The ingot is heated in an air furnace for four and one-half hours, to a temperature of 750° F. Two plates of high purity zinc (at least 99.99% zinc content), each about 0.3" thick, 7¼" wide and 20" long, are similarly cleaned, wired together, and heated for twenty minutes in an air furnace at 300° F. substantially to that temperature. The zinc plates are removed from the furnace and separated. One plate is supported on spaced iron rods. The heated ingot is removed from the furnace, placed on the supported liner, and immediately covered with the second liner. In assembling the composite, the liners are centered with respect to the core, so that the core extends laterally on both sides of the zinc plates. The composite is then secured by means of steel bands applied adjacent the ends thereof, and placed on the rolling table of a four-high reversing hot roll stand.

About two minutes after removal of the ingot from its furnace, the composite is assembled, banded and in place on the rolling table. At this time, the temperature at the center of the core is 640° F., the temperature at the center of the top liner is 500° F., and the interface temperature is 590° F. The composite is then subjected to a plurality of light rolling passes, with reductions of about 0.5" per pass, and after four passes the zinc plates are well bonded to the aluminum core. Conventional aluminum hot rolling practice is then followed, to a hot line gauge of 0.25". The zinc plates are forced into the core by the first few heavy passes, and the composite thereafter exhibits the edge characteristics of the aluminum core alloy. No edge cracking of the composite is noted, and there is little or no lateral displacement of the zinc liner material. The temperatures are the important consideration; the passage of time after removal from the furnace will vary with the mass of the material and other variable factors.

Example XIII

A direct chilled cast ingot of aluminum alloy 3003 is scalped to provide a core approximately 2.5" thick, 8" wide and 20" long, and wiped with clean rags soaked with kerosene. The ingot is heated in an air furnace for six hours to a temperature of 775° F. The heated ingot is removed from the furnace, and a plate of high purity (99.99%) zinc, at room temperature, about .25" thick, 8" wide and 20" long, is applied to the upper side thereof. The composite is then secured by means of steel bands applied adjacent its ends, and placed on the rolling table of a four-high reversing hot roll stand.

About three minutes after removal of the ingot from its furnace, the temperature at the center of the ingot is 655° F., the temperature at the center of the zinc plate is 475° F., and the interface temperature is 600° F. The composite is then subjected to a plurality of light rolling passes, with reductions of about 0.5" per pass, and after four passes the zinc plate is well bonded to the aluminum core. Conventional aluminum hot rolling practice is then followed, to a hot line gauge of 0.25".

The clad aluminum produced in accordance with each of the foregoing examples has a continuous zinc coating presenting a solderable surface and in itself providing a source of solder.

Example XIV

The procedure of Example I is repeated, except that the composite is hot rolled to a hot line gauge of 0.10". The zinc clad aluminum is subsequently annealed, and then rolled by conventional cold rolling procedure to .006" gauge.

Example XV

The procedure of Example I is repeated, utilizing zinc plates having a titanium content of 0.15%. The composite is hot rolled to a hot line gauge of 0.15". The hot line gauge material is cold rolled, annealed and further cold rolled to a final thickness of .004".

The clad aluminum produced in accordance with the above Examples XIV and XV has a continuous zinc coating which provides a solderable surface.

While present preferred embodiments of the invention have been illustrated and described, and methods of practicing the same, it will be recognized that the invention is not limited thereto, but may be otherwise variously embodied and practiced within the scope of the following claims.

I claim:

1. The method of cladding zinc to an aluminum core comprising the steps of heating an aluminum ingot to a temperature within the range of from about 600° F. to about 775° F., applying a zinc plate of materially lower temperature to a side of the heated ingot, lightly rolling the composite to adhere the plate to the ingot when the adjoining faces thereof reach approximately the same temperature, and thereafter hot rolling the composite to a suitable hot line guage to complete the bonding of said plate to said ingot.

2. The method of claim 1, in which the plate is adhered to the ingot when the adjoining faces thereof are at a temperature of about 600° F.

3. The method of claim 1, in which the zinc plate applied to the heated ingot is at a temperature of about 300° F.

4. The method of claim 1, in which a zinc plate is applied and adhered to opposite sides of the heated ingot.

5. A method of claim 1, wherein the zinc plate is narrower than the aluminum ingot, and relatively centered thereon in the composite.

6. The method of claim 1, wherein the zinc plate is engaged to the aluminum ingot by means of a steel band encircling the composite adjacent one end thereof, and the composite is lightly rolled for adherence in one direction only, with the banded end forward.

7. The method of claim 1, wherein the zinc plate is engaged to the aluminum ingot by means of a steel band encircling the composite adjacent each end thereof, and the composite is lightly rolled for adherence in both directions.

8. The method of claim 1, in which the zinc plate is transversely grooved on its outer surface adjacent the ends thereof, the zinc plate is engaged to the aluminum ingot by means of steel bands encircling the composite, said bands being disposed in said transverse grooves, the depth of said grooves exceeding the thickness of said bands, and said bands are removed subsequent to the light rolling and adherence of the composite.

9. The method of claim 1 in which the plate is adhered to the ingot when the temperature at the center of said ingot is from about 600° F. to about 750° F. and said plate temperature at its center is between 450° F. and 600° F.

10. The method of cladding zinc to an aluminum core comprising the steps of heating an aluminum ingot to a temperature within the range of from about 600° F. to about 775° F., applying a zinc plate of materially lower temperature to a side of the heated ingot, lightly rolling the composite to adhere the plate to the ingot when the adjoining faces thereof reach a temperature within the range of from about 450° F. to about 650° F., and thereafter hot rolling the composite to a suitable hot line guage to complete the bonding of said plate to said ingot.

11. The method of cladding zinc to an aluminum core comprising the steps of heating an aluminum ingot to a temperature within the range of from about 600° F. to about 775° F., applying a zinc plate of materially lower temperature to a side of the heated ingot, lightly rolling the composite to adhere the plate to the ingot when the adjoining faces thereof each reach a temperature of about 600° F., and thereafter hot rolling the composite to a

suitable hot line guage to complete the bonding of said plate to said ingot.

12. The method of cladding zinc to an aluminum core comprising the steps of engaging a zinc plate to an aluminum ingot by means of a steel band encircling the composite adjacent one end thereof, the aluminum ingot being at a temperature within the range of from about 600° F. to about 775° F., lightly rolling the composite in one direction only, with the banded end forward, to adhere the plate to the ingot, and thereafter hot rolling the composite to a suitable hot line guage to complete the bonding of said plate to said ingot.

13. The method of cladding zinc to an aluminum core comprising the steps of transversely grooving a zinc plate adjacent the ends thereof, engaging the zinc plate to an aluminum ingot by means of steel bands encircling the composite, the aluminum ingot being at a temperature within the range of from about 600° F. to about 775° F., said bands being disposed in said transverse grooves, the depth of said grooves exceeding the thickness of said bands, lightly rolling the composite to adhere the plate to the ingot, removing said bands subsequent to the light rolling and adherence of the composite, and thereafter hot rolling the composite to a suitable hot line guage to complete the bonding of said plate to said ingot.

14. The method of cladding zinc to an aluminum core comprising the steps of heating an aluminum ingot to a temperature within the range of from about 600° F. to about 775° F., applying a zinc plate of materially lower temperature to a side of the heated ingot, lightly rolling the composite to adhere the plate to the ingot when the adjoining faces thereof reach approximately the same temperature, and hot rolling the composite to a hot line guage of about 0.15".

15. A solder furnishing aluminum article produced by the method of claim 14.

16. The method of cladding zinc to an aluminum core comprising the steps of heating an aluminum ingot to a temperature within the range of from about 600° F. to about 775° F., applying a zinc plate of materially lower temperature to a side of the heated ingot, lightly rolling the composite to adhere the plate to the ingot when the adjoining faces thereof each reach a temperature within the range of from about 450° F. to about 650° F., hot rolling the composite to a suitable hot line guage, and then reducing the thickness of the composite to about .004" by cold rolling and annealing.

17. A solderable aluminum article produced by the method of claim 16.

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