Oct. 12, 1954 J. B. BRENNAN 2,691,208

METHOD OF LAMINATING STRIP METAL

Filed Aug. 14, 1948 2 Sheets-Sheet 1

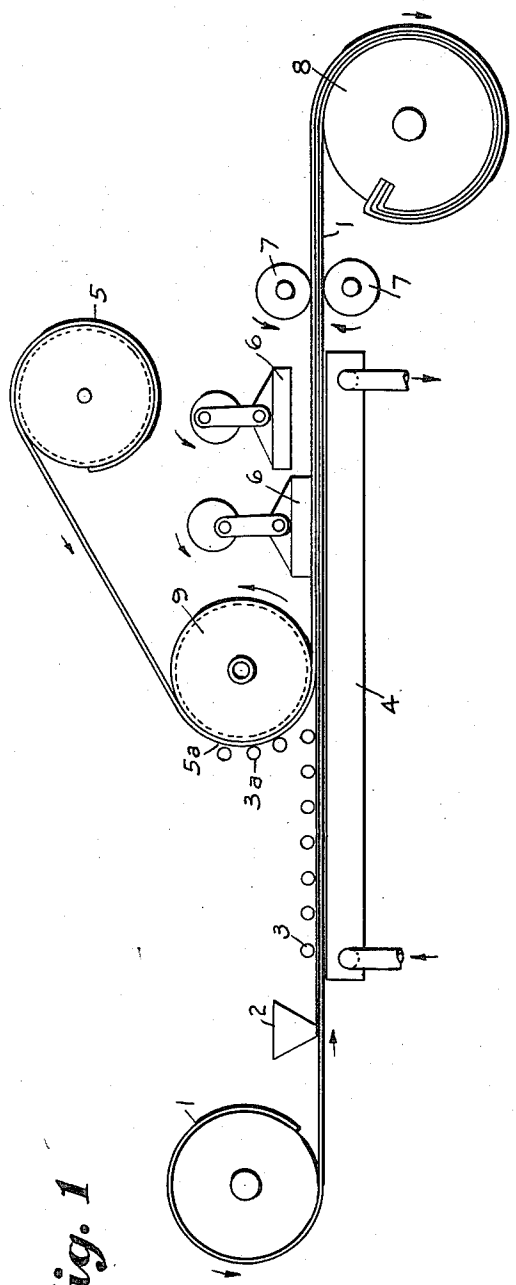


Fig. 1

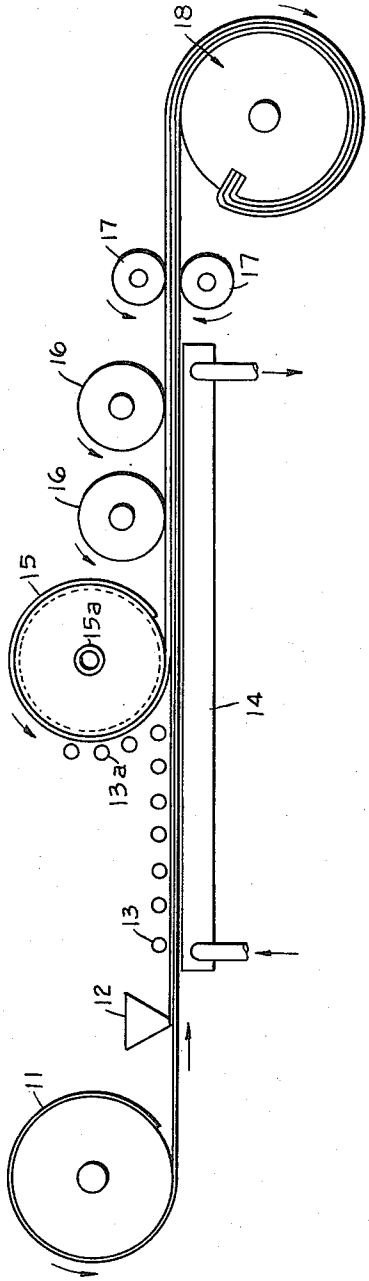


Fig. 2

INVENTOR.
Joseph B. Brennan
BY
West & Oldham
attorneys

Oct. 12, 1954 J. B. BRENNAN 2,691,208

METHOD OF LAMINATING STRIP METAL

Filed Aug. 14, 1948 2 Sheets-Sheet 2

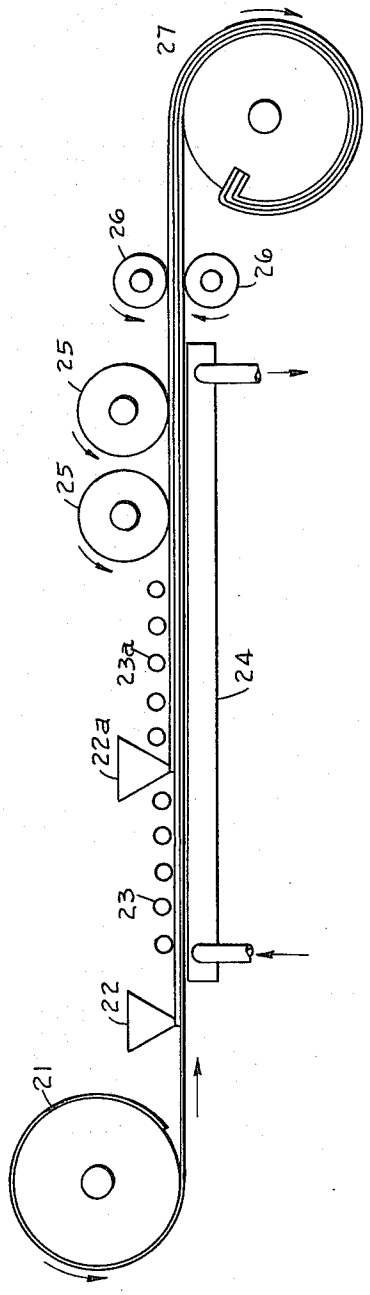


Fig. 3

INVENTOR.
Joseph B Brennan
BY
West & Oldham
attorneys

Patented Oct. 12, 1954

2,691,208

UNITED STATES PATENT OFFICE

2,691,208

METHOD OF LAMINATING STRIP METAL

Joseph B. Brennan, Cleveland, Ohio

Application August 14, 1948, Serial No. 44,305

5 Claims. (Cl. 29—189)

1

This invention relates to method of continuously laminating two or more strips of metal such as a strip of copper and a strip of cold rolled steel or a strip of bronze and a strip of cold rolled steel, or for example a strip of silver and a strip of cold rolled steel.

This invention is a continuation-in-part of my pending application Serial No. 598,080, filed June 7, 1945, now Patent No. 2,530,853, issued November 21, 1950, insofar as common subject matter exists, and also of my pending application Serial No. 605,857, filed July 18, 1945, now Patent No. 2,580,652, issued January 1, 1952, insofar as common subject matter exists.

An object of this invention is to bond two or more strips of metal in face-to-face and aligned relationship so that a bimetallic or multi-metallic layer of strip results therefrom which can be used in making for instance split bushings and bearings in the case where a thin strip of bearing material such as bronze is laminated to a thin strip of steel.

The resultant product of laminated strip metals according to my invention is flexible and can be distorted and twisted and forged cold without separating the laminations.

Thus, for example, according to my invention I am able to laminate flexible strip leaded bronze to flexible strip steel continuously in such a way that little distortion is effected in the two separate strips prior to bonding or in the resultant strip after bonding. Also other metals such as silver and copper and their alloys may be bonded to ferrous base metals by this invention.

In carrying out my invention, I draw two strips of thin metal of approximately the same width through a zone where they approach each other and then become facially abutted. Prior to bringing the inside faces of the strip material together I coat one of these faces lightly with, for example, 300 mesh nickel powder either by dusting the nickel powder on lightly or brushing it on with a light brush or by applying the nickel powder through a hopper discretely on one face of one of the strips and fusing the thin discrete particles of nickel by heat in a preferably deoxidizing atmosphere or flame.

An alternative method of applying the nickel powder in discrete pattern is to lightly spray it on one face of for example the steel strip with a Schoop metallizing gun or its equivalent and thereafter fuse.

In any case, after applying the nickel dust or powder to one face of one of the two strips of metal I heat the face of the strip to which the

2

nickel dust or powder has been applied to a bright cherry red heat which causes the nickel to become closely alloyed with the face of the steel strip. At the same time that I heat the nickel powdered face of the steel strip I cool the opposite side thereof by maintaining it in contact with and moving it over a heat conductive fluid cooled surface. In this way distortion of the steel strip due to tension and pressures involved in the bonding processes is substantially eliminated. This is because I need to heat the strip only to for example 10% of its thickness in order to secure the bonding of the nickel particles thereto and this is rendered possible by the use of preferably high frequency heating coils adjacent the nickeled face of the steel strip and the cooling means in back of adjacent to the opposite face of the steel strip. The steel strip is moved progressively and continuously through this heating and cooling means as it moves toward for example the bronze strip to which it is to be laminated. A preferably deoxidizing flame can be used to preclean the steel face to which the nickel is applied and also to fuse the nickel thereto if desired.

The face of the bronze strip as it is being drawn to approach abutment with the nickeled face of the steel strip has its face which is nearest to and approaching the nickeled side of the steel strip preferably heated to a slight depth with high frequency heating coils. Arranged near this nearest face and adjacent to and against the opposite side of the bronze strip is a cooling means so that the high frequency heat applied to the inner face of the bronze strip does not disturb the shape, tensile strength and other physical characteristics of the bronze strip appreciably. The high frequency heat applied to the moving bronze strip on one face renders this face somewhat plastic to a depth of say 10% of its thickness while maintaining the remaining body of the bronze strip in solid condition.

As the two strips of metal to be laminated are brought together the facial heating and facial cooling thereof is maintained right up to the point of abutment. The abutment can be done between one or more pairs of fluid cooled rolls. The speed of passing the strips of metal to be laminated through these rolls is maintained by the speed with which the interfaces of these strips can be brought to a high heat while maintaining the outside faces thereof solid and relatively cool. The speed of passing between the bonding rolls must be such that at the instant of application of pressure the interfaces of the

two strips are somewhat plastic so that an intermolecular bond is set up between the two faces which are immediately chilled if desired thereafter.

If preferred, water cooled rolls if of sufficiently large diameter and sprayed at the proper speed can be used to keep the outside faces of the two strips of metal cool and in solid condition and not distorted while the approaching inside faces of the two strips are rendered somewhat plastic by the high frequency heating coils which can be arranged to conform to the curvature of the rolls.

The instant the two strips of metal having their interfaces highly heated to a slight depth enter the bight of the small rolls they are bonded together which bond becomes permanent the instant the so-bonded and so-laminated strip is cooled.

If desired swaging or hammering or pressing means may be used instead of the rolls to supply the pressure necessary to bond the strips together. Thus a continuously pressurized pair of chains or belts may be applied to the outside surfaces of the two strips of metal after they have been brought together with their interfaces heated if desired to maintain the pressure on the interfaces for a longer period than would be available with the rolls.

It is also within the scope of my invention that surface heating and cleaning may be accomplished with flame application to one face or any other suitable means provided the other faces of the strips being laminated are kept in their normal shape by temperature control means.

In any case the principal object of my invention is to continuously bond two layers of strip metal by passing each strip through an interfacial heating and exterior facial cooling zone simultaneously to the application of bonding pressures to the outside faces thereof.

Referring to the drawings which accompany and are a part of this specification,

Fig. I is a schematic view of apparatus for forming a composite strip by utilizing presses to effect the bond.

Fig. II is a schematic view of apparatus for forming a composite strip by utilizing rollers.

Fig. III is a schematic view of apparatus for forming a composite strip utilizing powdered metal as the coating material.

1, Fig. I, represents a coil of cold rolled steel in thin strip form being drawn through a nickel dust applicator 2, Fig. I, which deposits a thin descrete particle layer of nickel dust thereon in discontinuous pattern. 3, Fig. I, represents a series of high frequency coils adjacent to the face of the cold rooled steel strip 1, Fig. I, and 4, Fig. I, represents a cooling shoe made of for example cast iron and having water for example flowing therethrough for cooling same. 5, Fig. I, represents a coil of thin strip bronze material which is flexible and which has an end thereof 5–*a*, Fig. I, illustrated as passing through the high frequency heating and cooling zone represented by the high frequency coil 3–*a*, Fig. I, near to the inside face of the bronze strip 5–*a*, Fig. I.

Opposite this high frequency coil 3–*a*, Fig. I, and adjacent to the other face of the bronze strip 5–*a*, Fig. I, is a cooling shoe or roll or means for extracting heat from the bronze strip through conduction. This cooling means has cooling water or some other fluid coolant passing therethrough which keeps the bronze strip 5–*a*, Fig. I, substantially solid throughout most of its thickness and not easily distortable by having one face thereof heated to an almost plastic condition as it approaches a juncture with the cold rolled steel strip 1, Fig. I.

When the bronze strip and the cold rolled strip are brought together under pressure by means of between the roll 9, Fig. I, and the shoe or roll 4, Fig. I, the plastic interfaces become very firmly bonded and sometimes alloyed together so that a very strongly bonded laminated material, Fig. I, is produced thereby when chilled.

I find that the application of the fired-in and fused discrete discontinuous nickel lattice work is of great value in bonding dissimilar metal strips which do not ordinarily have a tendency to wet each other when molten such as for example silver and steel or copper and steel or alloys thereof.

Immediately after passing the laminated strip through a pressurizing means swaging devices may be used to consolidate same and it is frequently desirable to apply a water spray or some other cooling means immediately to the so-laminated strip material whereafter it can be wound into a coil 8, Fig. I, or further processed as by rolling to proper gauge. It is desirable that the strip materials to be bonded be of extremely accurate gauge so that the plasticizing of the faces thereof may proceed at a uniform rate and to a uniform depth in continuous operation. Otherwise considerable distortion and variance in gauge can develop. It is generally desired that the strip metal to be bonded be held to approximately ±.0005 inch. The ordinary strip material purchased commercially frequently does not have the close tolerances required and hence should be sized prior to lamination to a high degree of accuracy in thickness.

Stainless steel strip when deoxidized as by a flame and having the discrete particles of nickel dust applied and fused thereto may be bonded to copper or silver by my invention.

Blanketing the strips' faces with a deoxidizing atmosphere as by a flame is desirable right up to the point of juncture since it facilitates clean and sound bonding.

6, Fig. I, represents one or more presses which can be used instead of or subsequent to the application of pressure to the strips to be bonded and may be used as swaging presses or time delayed presses which travel along with the strip material on a chain holding the continuous strips under pressure for a time to improve the bond.

7, Fig. I, represents a pair of sizing rolls to finish the bonded strip to size and pull it along.

Fig. II illustrates a modification of my invention wherein 11 indicates a coil of strip steel, 12 a device for applying nickel powder thereto, and 13 heating means for interface of the steel strip.

15, Fig. II, indicates a coil of thin flat bronze and 13–*a* illustrates heating means for the surface thereof and 4 indicates cooling shoe or means for cooling opposite face of steel strip and 15–*a* indicates water cooling means for bronze coil 15 and 16, and 17 represents rolling means and 18 wind-up drum for laminated strip.

Referring to Fig. III of the drawings herewith 21 represents a coil of base strip material as of steel having a nickel powder applicator 22 over the advancing strip base material and heating means 23 over the nickeled base strip and cooling means 24 underneath and in contact therewith. 22–*a*, Fig. III, represents a device

such as a metallizing gun for spray depositing a layer of metal to be bonded over the nickeled base strip whereafter such spray gun the so-deposited layer may be heated by heating means 23–*a* to consolidate the spray deposited layer with the nickeled base strip and bond it thereto which bonding is assisted by the water cooled rolls 25 pressing on the water cooled table 24 and also by the rolls 26. 27 is the wind-up reel for the laminated strip so-produced. The base metal strip may be preheated prior to applying any fusing particles thereto, if desired.

Molten metal can be applied to a heated surface of the metal strip, while the opposite surface of such metal strip is being positively cooled. Thus the article 22ª in Fig. III could comprise a hopper in which molten metal is stored and suitably heated, if necessary, and is applied as a thin film or layer over the moving surface of the base strip as it is drawn under the discharged end of such member 22ª.

Having thus described my invention, what I claim is:

1. The method of continuously laminating two bondable strips of metal which comprises longitudinally moving each strip, superficially heating one face only of successive longitudinal sections of each strip to bonding temperature, simultaneously artificially cooling the other face of the same successively longitudinally sections to maintain each strip for a substantial portion of its thickness at less than bonding temperature, and pressure contacting successive longitudinal sections of the heated faces of the strips with each other while the other faces are maintained in cooled state as aforesaid.

2. The method of continuously laminating strip steel and a strip bearing metal selected from the group consisting of bronze, copper, silver, and alloys thereof which comprises longitudinally moving each strip through opposed heating and cooling zones simultaneously effective to heat one face only thereof to bonding temperature and to artificially cool the other face thereof through a substantial portion of its thickness to less than bonding temperature, and contacting the heated faces of the strips with each other under pressure to bond the strips together.

3. The method of continuously laminating strip steel and a strip bearing metal selected from the group consisting of bronze, copper, silver, and alloys thereof which comprises applying nickel particles to one face of the steel strip, longitudinally moving each strip through opposed

heating and cooling zones simultaneously effective to heat only the nickel particle coated face of the steel strip to bonding temperature to fuse such particles thereto and to heat one face only of the bearing metal strip to bonding temperature and to artificially cool the other face of each strip through a substantial portion of its thickness to less than bonding temperature, and pressure contacting the heated nickel particle coated face of the strip steel with the heated face of the bearing metal strip under pressure to bond the strips together.

4. Strip metal laminating apparatus comprising opposed members between which bondable metal strips are adapted to pass longitudinally for being pressed into face-to-face pressure contact, heating means effective to heat to bonding temperature only those faces of the strips which are to be pressed into face-to-face contact by said members, artificial cooling means effective at all times to maintain the opposite faces and substantial portions of the thicknesses of the strips at less than bonding temperature, and means for longitudinally feeding the strips simultaneously past the respective heating and cooling means therefor and subsequently between said members to cause heating and cooling of the strips as aforesaid and bonding together thereof.

5. The apparatus of claim 4 wherein said artificial cooling means comprises coolant fluid circulated through said members and with which members the strips are in contact during heating thereof by said heating means and during pressing together of the heated faces.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,374,110	Pittevil	Apr. 5, 1921
1,850,878	Hunt	Mar. 22, 1932
1,998,496	Fiedler	Sept. 13, 1935
2,092,018	Quarnstrom	Sept. 7, 1937
2,223,312	Briggs	Nov. 26, 1940
2,290,338	Koehring	July 21, 1942
2,330,202	Brennan	Sept. 28, 1943
2,320,329	Meduna	May 25, 1943
2,348,528	De Witz	May 9, 1944
2,390,452	Mudge	Dec. 4, 1945
2,367,715	Chapman	Jan. 23, 1945
2,409,422	Egan	Oct. 15, 1946
2,414,511	Dyar	Jan. 21, 1947
2,481,962	Whitfield	Sept. 13, 1949