Sept. 22, 1953 W. L. KEENE 2,653,117

METHOD OF MAKING A COLD FORMED BIMETALLIC SHAPE

Filed Dec. 26, 1951

Fig. 1.

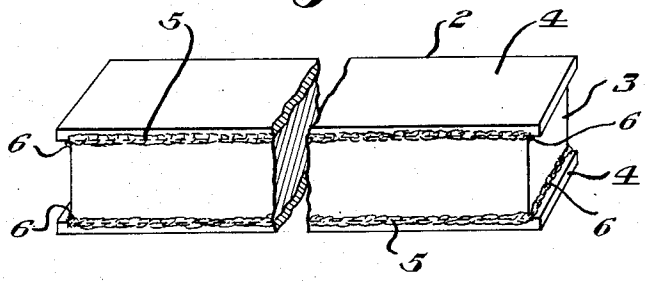


Fig. 2.

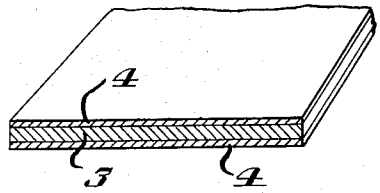
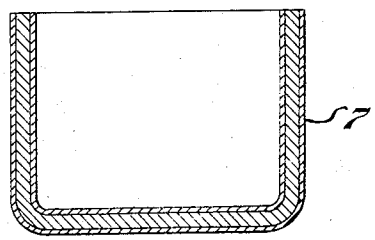


Fig. 3.



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Patented Sept. 22, 1953

2,653,117

UNITED STATES PATENT OFFICE

2,653,117

METHOD OF MAKING A COLD FORMED BIMETALLIC SHAPE

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Application December 26, 1951, Serial No. 263,203

1 Claim. (Cl. 148—12)

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This invention relates to a method of making a cold formed bimetallic shape. The method solves a heretofore unsolved problem incident to the making of cold formed bimetallic shapes having a component of straight chromium type stainless steel containing less than .2% carbon.

Cold formed bimetallic shapes are made by forming a bimetallic billet, hot rolling the billet to form bimetallic strip, heat treating the bimetallic strip and cold forming the strip, as, for example, by deep drawing. A cold rolling step may follow the heat treating step and precede the cold forming step; in such case the cold rolling step is preferably followed by a stress relieving heat treatment.

When one of the components of the bimetal is straight chromium type stainless steel containing less than .2% carbon the heat treatment required to prepare the stainless steel component of the hot rolled bimetal for cold forming is a severe spheroidizing at a temperature of the order of 1400–1600° F. Normally the spheroidizing is carried out in a closed chamber for an extended period of time which may range up to five hours or longer. The time is dependent upon the bulk and thickness of the stainless steel component; it is important that all of such component, including the innermost portion thereof, be brought fully up to temperature.

No one was able prior to my invention, so far as I am aware, to produce cold formed bimetallic shapes having a component of straight chromium type stainless steel containing less than .2% carbon and having the stainless steel free from cracks and uniformly adherent to the other component of the cold formed bimetallic shape. The stainless steel component was cracked or "crazed" and flaked or peeled off from the other component of the shape. All efforts to obviate such results were to no avail.

It has been supposed by some workers in the art that carbon migration from a carbon steel component to a stainless steel component of a bimetallic billet or strip, which carbon migration is believed to be responsible for the cracking and flaking off of the stainless steel in the ultimate cold formed bimetallic shape, may be prevented by disposing a sheet of substantially pure iron between the components. However, I have found that when the stainless steel is straight chromium type stainless steel containing less than .2% carbon, necessitating a severe spheroidizing heat treatment after hot rolling, to prepare the stainless steel for cold forming a sheet of substantially pure iron will not prevent

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carbon migration. The spheroidizing heat treatment at a temperature of 1400–1600° F. causes carbon migration even through a sheet of substantially pure iron. To the best of my knowledge and belief I am the first to discover that that happens. It does not happen in lower temperature relatively mild heat treatments, when a sheet of substantially pure iron may satisfactorily inhibit carbon migration. Such lower temperature relatively mild heat treatments are of no utility when the stainless steel component is straight chromium type stainless steel containing less than .2% carbon.

Consequently, I have discovered that a problem exists in the making of a cold formed bimetallic shape having a component of straight chromium type stainless steel containing less than .2% carbon due to the fact that the necessary spheroidizing heat treatment at a temperature of the order of 1400–1600° F. causes carbon migration from carbon steel into the stainless steel even through an intermediate sheet of substantially pure iron.

I have further discovered that the problem can be solved by employing together with the component of straight chromium type stainless steel containing less than .2% carbon a component comprising predominantly iron which is substantially free from migratable carbon. Such component may be of substantially pure iron such as ingot iron, it may be of wrought iron or it may be of low carbon steel containing a stabilizer, i. e., a metal which combines with any free carbon rendering the steel substantially free from migratable carbon. I have found that when such a component comprising predominantly iron which is substantially free from migratable carbon is employed together with a component of straight chromium type stainless steel containing less than .2% carbon cold formed bimetallic shapes can be produced which have smooth even surfaces free from cracks and in which the components are uniformly adherent throughout.

Normally the component comprising predominantly iron which is substantially free from migratable carbon is a relatively thick backing component and the component of straight chromium type stainless steel containing less than .2% carbon is a relatively thin facing component. The bond zone between the components when my invention is practiced remains substantially free from brittle alloy so that when the bimetal is cold formed into a shape my improved results as above explained are obtained. My invention therefore contemplates a method of making a cold formed bimetallic shape comprising as-

sembling in direct face-to-face contact a facing component of straight chromium type stainless steel containing less than .2% carbon and a relatively thick backing component comprising predominantly iron which is substantially free from migratable carbon, fastening the components together and peripherally sealing them to each other to prevent ingress of air therebetween, hot rolling the thus assembled components and thereby thinning them and bonding them together to form relatively thin elongated bimetal, spheroidizing the facing component at a temperature of the order of 1400–1600° F. while the bond zone between the components remains substantially free from brittle alloy and cold forming the bimetal into a shape, the components in the shape being substantially uncracked and uniformly adherent throughout.

An unexpected phenomenon of my invention is that when wrought iron is used as the backing component of a bimetallic billet having a facing component of straight chromium type stainless steel containing less than .2% carbon the bimetallic billet may be rolled into bimetallic strip or sheets and the bimetallic strip or sheets may after spheroidizing be successfully deep drawn. That result is unexpected because wrought iron is not considered as a deep drawing material and alone cannot be satisfactorily deep drawn. Apparently the bonding of the stainless steel to the wight iron is responsible for the deep drawability of the bimetallic material.

As mentioned above, ingot iron may be employed as the backing component. Ingot iron is substantially the same as wrought iron except that ingot iron does not contain slag fibers such as are contained in wrought iron. In each case, however, the roller and spheroidized product is deep drawable.

Wrought iron and ingot iron normally do not contain over about .02% carbon and such carbon as is present is in solution and hence not free to migrate as in the case of a portion of the carbon of plain carbon steel. This apparently accounts for the fact that carbon does not migrate when a composite billet comprising a component of wrought iron or ingot iron and a component of straight chromium type stainless steel containing less than .2% carbon is hot rolled and spheroidized. As explained above if ordinary carbon steel were employed in place of the wrought iron or ingot iron carbon would migrate into the stainless steel even through an intermediate sheet of substantially pure iron with the result that the bond zone between the components would contain brittle alloy causing cracking or crazing of the stainless steel component and resulting in lack of uniform adherence of the components to each other accompanied by flaking or peeling off of the stainless steel component upon cold forming of the bimetal.

As above mentioned I may employ as the ferrous metal component of a bimetallic billet comprising components of ferrous metal and straight chromium type stainless steel containing less than .2% carbon steel containing what I term a stabilizer; that is to say, a metal which combines with any free carbon with the result that the steel does not have any migratable carbon. By "migratable carbon" I mean carbon which is uncombined or which is combined in compounds less stable than chromium carbide. Such elements as titanium, columbium, vanadium and zirconium and other elements which form carbides more stable than chromium carbide or which have greater affinity for carbon than chromium may be employed as stabilizers. The result in any case—whether the ferrous metal component be wrought iron, ingot iron or low carbon steel containing a stabilizer—is that the ferrous metal component is free from migratable carbon, making it possible to assemble the ferrous metal and straight chromium type stainless steel components in direct face-to-face contact. While it might be possible to use a carbon steel backing component with a facing component of straight chromium type stainless steel containing less than .2% carbon by interposing between the components a buffer layer of cupro-nickel as taught by Patent No. 2,514,873, such provision has the disadvantage that in hot rolling the billet the rolling temperature should not substantially exceed 2,000° F.

For forming deep drawing stock the carbon content of the straight chromium type stainless steel should be less than .2% to insure that the stainless steel will after spheroidizing be soft enough for easy deep drawing and to assist in inhibiting formation of undesirable brittle alloy. The bond between the components, as well as the components themselves, is after hot rolling and spheroidizing sufficiently soft and ductile to permit of deep drawing without flaking, cracking, peeling or other failure. This evidences the absence of carbon migration from the ferrous metal into the stainless steel since carbon migration results in formation in the bond zone between the components of a brittle film which does not withstand cold deformation.

Other details, objects and advantages of the invention will become apparent as the following description of a present preferred method of practicing the same proceeds.

In the accompanying drawings I have illustrated a present preferred method of practicing the invention in which

Figure 1 is a perspective view of a bimetallic billet;

Figure 2 is a view similar to Figure 1 of bimetallic strip made by rolling the billet of Figure 1 and shearing off the edges; and

Figure 3 is an axial cross-sectional view through a cold deep drawn cup formed from the strip of Figure 2.

Referring now more particularly to the drawings, the bimetallic billet shown in Figure 1 and which is designated generally by reference numeral 2 is of the type disclosed in Patent No. 2,468,206. It comprises a backing component 3 and opposed facing components 4 respectively disposed against the broad faces of the backing component 3. The relative thicknesses of the backing and facing components will vary depending upon the purpose for which the bimetal is to be used. Normally the backing component is relatively thick and the facing components are relatively thin. A bimetallic billet having two opposed facing components will produce strip clad on both faces. If strip clad on one face only is desired one of the facing components will be omitted.

The width of the backing and facing components is shown as being substantially the same. However, the facing components project substantially beyond the backing component at at least the end of the billet which is to be the leading end when the billet is introduced into the first pass in the hot rolling mill. In the structure shown in Figure 1 the facing members project longitudinally beyond the end of the backing

member at both ends of the billet. Such a billet is especially well adapted for rolling in a reversing mill in which the respective ends of the billet alternate as the leading end in successive roll passes.

Each of the facing components is welded to the backing component completely around the periphery of the billet. This is done to exclude air and other gases from between the components. If air and other gases are not excluded an oxide tends to form on the surfaces of the facing members which lie against the backing member, which oxide prevents proper bonding of the facing members to the backing member during rolling. In preparing the billet components for assembly their faces which are to lie in contact with one another are made smooth and clean so that when they lie against one another there is no room between them for any substantial amount of air or other gas. The peripheral welding prevents ingress of air and other gases during heating and rolling and while the weld may become ruptured at some stage of the rolling it will maintain its integrity long enough to exclude from the contacting surfaces of the billet components air and other gases in such quantities as to form oxides which will interfere with proper bonding together of the components. In other words, the components will become bonded to one another before the effectiveness of the peripheral weld as a seal is impaired.

Along the longitudinal edges of the billet the edges of the components are welded together by flush welds 5 since the components are of the same width. However, at the ends of the billet each facing member is welded to the backing member by an inside fillet weld 6, that is, a weld between an end face of the steel backing member and a side face of the stainless steel facing member. Fillet welds may also be employed along the longitudinal edges of the billet if the components are of different widths.

The facing components 4 of the bimetallic billet 2 are of straight chromium type stainless steel containing less than .2% carbon. The backing component will for purposes of explanation and illustration be considered as being of wrought iron containing not over about .02% carbon and also containing slag fibers as known to those skilled in the art. However, the backing component 3 may be of other composition as explained above, as, for example, ingot iron or low carbon steel containing a stabilizer.

The bimetallic billet 2 is heated for hot rolling in the usual way. It may be hot rolled at any temperature found most suitable and no limitation upon hot rolling temperature is imposed by reason of the employment of a buffer layer between the components 3 and 4. No such buffer layer is necessary. When the heated bimetallic billet is hot rolled the components 4 bond to the component 3 to form in effect an integral bimetallic strip whose core is of the material of the components 3 and whose faces are of the material of the components 4. Figure 2 shows the strip after the edges have been sheared off. The components 3 and 4 bond together during hot rolling.

After hot rolling and to prepare the relatively thin elongated bimetal for cold forming such bimetal is spheroidized by heating it to a temperature of the order of 1400–1600° F. and maintaining it at that temperature for a period long enough to insure that all portions of the stainless steel facing components are brought uniformly to temperature. The spheroidizing temperature varies with the bulk and thickness of the stainless steel. In some cases one hour may be sufficient. In other cases the spheroidizing time may be as much as five hours or more. A person skilled in spheroidizing knows how long to subject the work to the required temperature.

After spheroidizing the bimetal may be cold formed, as, for example, by deep drawing, or it may first be cold rolled and then cold formed. If the bimetal is cold rolled before cold forming it is preferably subjected to a comparatively mild stress relieving heat treatment at relatively low temperature before cold forming. In either case when the bimetal is cold formed my improved results as explained above are obtained. Figure 3 shows a cold deep drawn cup 7 formed in accordance with my invention. The bonds between the components maintain their integrity and the components and the bonds are stretched and thinned, the stainless steel facing components at the inside and the outside of the cup being substantially uncracked and uniformly adherent to the backing component throughout the cup.

This application is in part a continuation of my copending application Serial No. 737,498, filed November 22, 1947, now abandoned which is in turn in part a continuation of my application Serial No. 693,560, filed August 28, 1946, now abandoned.

While I have illustrated and described a present preferred method of practicing the invention it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously practiced within the scope of the following claim.

I claim:

A method of making a cold formed bimetallic shape comprising assembling in direct face-to-face contact a facing component of straight chromium type stainless steel containing less than .2% carbon and a relatively thick backing component consisting throughout predominantly of iron which is substantially free from migratable carbon, fastening the components together and peripherally sealing them to each other to prevent ingress of air therebetween, hot rolling the thus assembled components and thereby thinning them and bonding them together to form relatively thin elongated bimetal, spheroidizing the facing component at a temperature of the order of 1400–1600° F. while the bond zone between the components remains substantially free from brittle alloy and cold forming the bimetal into a shape, the components in the shape being substantially uncracked and uniformly adherent throughout.

WALTER L. KEENE.

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