(No Model.)

E. MARTIN.

MANUFACTURE OF BIMETALLIC PLATES.

No. 522,347. Patented July 3, 1894.

FIG. 1.

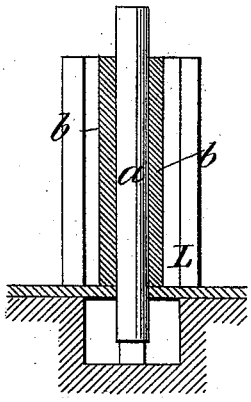


FIG. 3.

FIG. 5

FIG. 6.

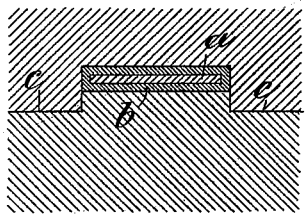


FIG. 2.

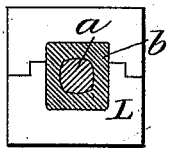


FIG 4.

FIG 7.

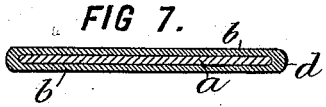


FIG. 13.

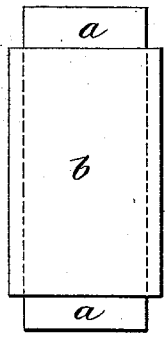


FIG. 8.

FIG. 9.

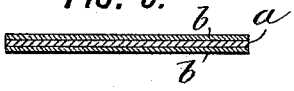


FIG. 10.

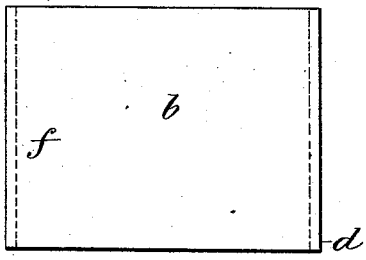


FIG. 14.

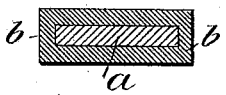


FIG. 11.

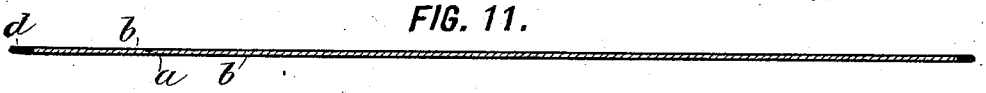
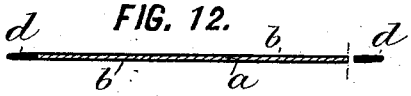


FIG. 12.



WITNESSES:
Fred. Whitz
C. K. Fraser.

INVENTOR:
Edouard Martin,
By his Attorneys,
Arthur G. Fraser & Co

UNITED STATES PATENT OFFICE.

EDOUARD MARTIN, OF PARIS, FRANCE, ASSIGNOR TO THE OBERSCHLESISCHE EISEN INDUSTRIE ACTIEN GESELLSCHAFT FÜR BERGBAU UND HÜTTENBETRIEB, OF GLEIWITZ, GERMANY.

MANUFACTURE OF BIMETALLIC PLATES.

SPECIFICATION forming part of Letters Patent No. 522,347, dated July 3, 1894.

Application filed December 15, 1893. Serial No. 493,792. (No specimens.) Patented in England October 6, 1891, No. 17,009; in France October 6, 1891, No. 216,565; in Belgium October 15, 1891, No. 96,801; in Italy December 31, 1891, XXV, 30,605, LX, 114, and in Austria-Hungary March 16, 1892, No. 48,835 and No. 5,168.

To all whom it may concern:

Be it known that I, EDOUARD MARTIN, a citizen of the Republic of France, residing in Paris, France, have invented certain new and useful Improvements in the Manufacture of Bimetallic Plates, of which the following is a specification.

This invention has been patented in Great Britain by Patent No. 17,009, dated October 6, 1891; in Belgium by Patent No. 96,801, dated October 15, 1891; in France by Patent No. 216,565, dated October 6, 1891; in Italy by patent, Reg. Gen., fol. XXV, No. 30,605, Reg. Att., fol. LX, No. 114, dated December 31, 1891, and in Austria-Hungary by Patents No. 48,835, Tom. 42, fol. 662, and No. 5,168, Tom. XXVI, fol. 612, dated March 16, 1892.

This invention relates to the manufacture of sheets, foils and plates of two different metals, the one a dense or hard metal, and the other a soft or ductile metal. Steel or iron for the dense metal, and copper for the ductile metal are most generally employed in such plates.

Prior to my invention great difficulty has been experienced in manufacturing bimetallic plates, both because of the trouble in properly rolling the plates due to the different ductility of the two metals employed, and by reason of the great liability to imperfect adhesion or union between the adjacent surfaces of the two metals. The process most generally employed heretofore has been that known as "plating," which consisted in superposing a copper and a steel plate and rolling them together while heated. The resulting product has almost invariably been impaired by air bubbles between the plates which prevented a complete union between their surfaces.

A bimetallic plate, in order to be available for the various purposes for which such plates are desired, must be so perfectly united throughout its entire mass that the different sheets of which it is composed will always adhere intimately together during all manipulations, such as spinning, stamping or bending, to which the plate may be subjected in use. Prior to my invention the difficulties in the way of accomplishing such a perfect and enduring union between the plates were so great that their manufacture was too expensive to permit of their general employment in the art.

In or about the year 1885 I invented an improved process for the manufacture of bimetallic wire, for which invention Letters Patent of the United States No. 410,368, dated September 3, 1889, were granted to me. By this process a copper shell was cast upon the central portion of a steel rod, and the ingot thus formed was passed through closed compression rollers which acted to uniformly compress the ingot from the circumference inwardly at all points according to the well known operation of "drawing," thereby reducing the compound ingot to a compound wire composed of a steel core and a uniform peripheral coating of copper. This wire was very advantageous by reason of the extremely perfect union between the core and coating. Its manufacture was facile since the drawing operation was one of continual and equal inward pressure in which there was no opportunity for the soft coating to flow off from the harder core.

Realizing the many advantages incident to the perfect union between the copper and steel obtained by my said process of manufacturing bimetallic wire, I conceived the idea that if it were possible to avail of the principle therein employed for the manufacture of sheets, plates and foils, that such articles so manufactured would have the like advantage of complete union between their respective metals. Being satisfied as to the resulting advantages I endeavored to discover or invent a process by which such articles could be manufactured. Great mechanical obstacles presented themselves, not the least of which was the evident result that in flat rolling an ingot of the kind used in my said process, the softer metal would flow entirely off from the compressed faces of the harder metal leaving the latter exposed. After many tedious and unsuccessful experiments in this direction I eventually succeeded in discovering

a process by which bimetallic plates could be manufactured from compound ingots of the general character disclosed in my said patent, and now many such plates, sheets and foils are successfully manufactured and are extensively used.

The bimetallic plates produced by my improved process have the advantage, that any desired thickness of the plate as a whole, and that any desired relative proportion of the iron and the copper, may be employed, that the union between the different metals is perfect and is not impaired by any manipulation to which they are subsequently subjected, and that the expense incident to their manufacture is little if any greater than that of the manufacture of ordinary metal sheets, plates or foils of like dimensions.

In carrying out my improved process in its preferred and most complete form, I proceed as will be hereinafter fully set forth, referring to the accompanying drawings, in which—

Figure 1 is a vertical section of an ingot and its mold. Fig. 2 is a cross section of the ingot, the mold being shown in plan. Fig. 3 is a side elevation of the ingot. Fig. 4 is a cross section thereof. Fig. 5 is a cross section of the ingot, partially rolled. Fig. 6 is a fragmentary section of the closed rolls for rolling the ingot after it has received the rolling bringing it to the cross section shown in Fig. 5. Fig. 7 is a cross section of the ingot after further rolling. Fig. 8 is a cross section similar to Fig. 7. Fig. 9 is a cross section of a piece of the compound ingot cut for cross rolling. Fig. 10 is a face view thereof. Fig. 11 is a longitudinal section of a bimetallic sheet rolled according to my invention. Fig. 12 is a cross section thereof. Fig. 13 is an elevation of a modified form of ingot and Fig. 14 is a cross section thereof.

Referring to all the views, let *a* indicate the core or denser metal, *b* the covering or coating of the more ductile metal enveloping the same, L the mold in which the covering is cast about the core, and *c* the rolls for rolling the ingot.

The core *a* may be any relatively dense or hard metal, as iron or steel for example, and may be of any suitable cross section, preferably elliptical, ogive or oblong. It is of greater length than, and projects at each end from, the coating *b*.

The coating *b* may be of any suitable metal of greater ductility or less density than the core. Its shape and disposition upon the core may be varied as desired, but it is essential, that it be cast upon the core. Preferably it is of less length than the core and is cast upon all sides of the central portion thereof. The mold L is of well known construction, being a two-part mold surrounding the core and receiving the molten metal of the coating as the latter is applied to the core. The core projects at top and bottom beyond the mold and thus the coating is confined to the middle portion of the core.

In carrying out my improved process in its preferred form I cast the coating metal upon the core, as was done in my said process for manufacturing bimetallic wire, the copper or other metal used for the coating being applied only to the middle portion of the core. The compound ingot thus formed may then be immediately subjected to the rolling operation, or it may first be reheated to a red heat in any suitable manner and then subjected to such operation.

According to my invention the compound ingot is first rolled in closed grooves, preferably in the first instance in grooves of elliptical cross section, as for example, the cross section shown in Fig. 5.

The rolling pressure in this first rolling is preferably a relatively moderate pressure, and the result of this rolling is to extend the softer coating metal along the harder core, and partially flatten the ingot. The rolling in this manner is preferably continued until the soft coating is extended to the ends of the hard core. In this operation the closed grooves through which the ingot is rolled confine it and are of such cross section that material lateral displacement of the coating relatively to the core is prevented, wherefore when the ingot has passed this operation the coating of softer metal is of substantially uniform thickness throughout the circumference of the ingot. This rolling has the effect of gradually extending the coating along the uncovered surfaces of the core in such manner, that as it extends, the coating forms an intimate union with such surface of the core, which is found in practice to result in a permanent adherence between the two metals. It is also the result of this extending of the coating that as it is extended in rolling the coating metal mechanically removes any oxide or other matter which may have formed on the uncovered surface of the core, thus preparing this surface for the intimate adhesion of the coating, whereby when the rolling is completed the resulting ingot is found to be entirely free from rifts or flaws between the two metals.

In reducing the ingot to the condition last described, it is essential that closed rolls be employed. Preferably the rolls having elliptical grooves are first employed and then those having flat rectangular grooves are employed to reduce the ingot to a flat bar, which when the coating entirely envelops it, has a substantially uniform thickness of coating on its top and bottom faces and its side edges. The ingot as it comes from the flat grooved rollers has a flat hard metal core of uniform thickness throughout covered at top and bottom by flat coating of soft metal of uniform thickness throughout, and like intermediate coatings at its side edges. It is then ready for the succeeding operation according to my improved process.

The ingot may be reheated or not, as circumstances dictate. It is then passed through flat rolls, which roll the combined ingot out

longitudinally. This rolling is continued, giving a proportionate lateral spreading of both the metals of the ingot, until the desired cross section has been attained, heating being employed when necessary; the article during this rolling has substantially the cross section shown in Fig. 7.

When reduced to the desired thickness the bimetallic plate thus formed is cut into sections to form sheets, plates or foils, the sections varying according to the weight and length desired. These separate sections are then further rolled out to thin sheets by passing them between flat rollers and cross rolling them to the desired extent. In this operation the thickness of both the core and the copper coating is reduced. In cross rolling the plates the excess of the softer coating which flows to the edges or margins *d* of the sheets drops off and is available for fresh casting, the remainder of the sheet, that is the hard core and the soft coating remaining thereon are respectively of equal thickness throughout their length although relatively of different thickness.

After the cross rolling and the said removal of the margins thereby, the sheets are ready for use as bimetallic sheets, plates or foils.

In carrying out my improved process the first rolling in closed rolls increases the density and hardness of the copper, whereby the more effective is the subsequent rolling to laterally spread the core as well as the coating when the two are rolled in the flat rolls. Simultaneously with the initial and subsequent rollings there takes place a welding together of both metals under the combined influence of the heat and the strong pressure of the subsequent rolling. The metals are moreover, not only welded into each other at their adjacent surfaces and thereby inseparably attached together, but a veritable alloy is formed at the point of attachment, which has the advantage that it avoids the possibility of oxidation or other impairment at the point of union between the two metals.

The bimetallic plates, sheets and foils constructed according to my improved process can be utilized for all purposes, for which previously sheets of either of the metals making up the bimetallic plate were employed. Where great strength is required, together with a protecting coating of copper, the copper coating may be extremely thin and the steel core of the thickness requisite to the strength desired. Where but little strength is necessary each metal making up the plate may be of extreme thinness.

In plates constructed according to my invention the plates may be doubled upon themselves, creased, twisted and bent, hammered or otherwise treated without the slightest impairment of the joint between them. The covering metal will never scale off from the core.

What I claim is—

1. The improved process of making plates, sheets or thin foils of combined metals of different ductility, which consists in casting upon a core of a metal of relatively small ductility a covering of a different metal of relatively great ductility, then rolling the combined ingot into flat form within the closed grooves of rollers, then rolling the resulting bar into a flat sheet between flat rollers, and thereby simultaneously spreading the core and covering thereof laterally and longitudinally, then cutting the resulting sheet into sections, simultaneously spreading said sections laterally and longitudinally into thin sheets by rolling and cross rolling said sections between flat rollers, and removing the margins of said sheets composed of the more ductile metal, substantially as and for the purpose set forth.

2. The improved process of making plates, sheets or foils of combined metals of different ductility, which consists in casting upon a core of a metal of relatively small ductility an enveloping covering of a different metal of relatively great ductility, said covering being of less length than, and cast upon the middle portion of, said core, then extending said covering over the exposed ends of said core by rolling the combined ingot thus formed in the closed grooves of a rolling mill under relatively moderate pressure, then rolling the ingot into a flat sheet having a core of uniform thickness and a coating of uniform thickness, and spreading said core and coating laterally during such rolling, then cutting said sheet into sections, reducing its thickness and removing its margin composed of the metal of greater ductility by rolling and cross rolling under relatively great pressure in flat rolls.

3. The improved process of making bi-metallic plates of two metals of different ductility consisting in casting around a core of oblong cross section composed of relatively less ductile metal an enveloping coating of a different metal of relatively greater ductility, then rolling the compound ingot thus formed in the closed grooves of a rolling mill until said outer coating is extended over the length of said core, then spreading the core and coating simultaneously laterally and reducing the ingot to a flat sheet by rolling it longitudinally between flat rolls, then further reducing the thickness of the resulting sheet and removing the margins thereof composed of the more ductile metal by further rolling through flat rolls under relatively greater pressure, substantially as and for the purpose set forth.

4. The improved process of making bi-metallic sheets, which consists in casting upon the middle outside portion of a core of relative hard metal, said core having an oblong cross-section, a coating of a different metal of relatively great ductility, and of less length than said core, then simultaneously flattening the compound ingot thus formed, preventing lateral displacement of said coating, ex-

tending said coating longitudinally over said core, removing oxide from the core, and welding the coating to the core, by confining the ingot in closed grooves of rollers and rolling it therein, then further flattening and extending the ingot by longitudinal rolling between flat rolls, and then simultaneously thinning the resulting sheet and removing the margins thereof composed entirely of the more ductile metal by spreading both the coating and core longitudinally and laterally by rolling and cross rolling between flat rolls, substantially as set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

EDOUARD MARTIN.

Witnesses:
JULES ARMENGAUD, JR.,
CHARLES MARDELET.