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P. A. E. ARMSTRONG  
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METHOD OF MAKING COMPOSITE METAL ARTICLES  
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METHOD OF MAKING COMPOSITE METAL ARTICLES

Percy A. E. Armstrong, Westport, Conn.

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This invention relates to a method of making composite metal articles, particularly so-called clad sheets composed of a facing of a high alloy steel, particularly a chromium steel with or without additional elements as nickel or other metals, of the stainless type, and a backing of mild steel or iron. In particular, the invention relates to the production of such composite articles by casting.

In my Patent No. 1,997,538, issued April 9, 1935, I have described a method of making cast composite articles by electroplating iron on the outer faces of two plates of an alloy, such as a chromium containing steel, under conditions to prevent the formation of an intervening oxide layer and then casting metal around the two plates while they are held together with a separating medium between them.

I have found that in carrying out such a process a difficulty occurs which is largely attributable to the low thermal conductivity of the alloy steels; that is, the outside surface of the alloy sheets tends to heat more rapidly than the inside, causing a bowing which tends to displace the sheets.

In accordance with the present invention, the two plates of alloy steel (or other metals to which this invention is applicable, such for example as plates of nickel or nickel alloys) are arranged face to face with an intervening layer of material which will prevent welding and their outer surfaces are electroplated as described in my said patent. I then enclose this assembly in an entire casing, preferably of mild steel, and the flat or side members of this casing preferably carry a surface of electroplated iron both inside and outside, applied as specified in my said patent. This casing is preferably welded together complete with all four sides and ends and I find it advantageous to make this casing so that it does not bind on the internal assembly; in other words, the internal assembly should be free to move in all directions in the casing and the casing should in particular permit of substantial movement endwise or sidewise of the sheets. The faces may or not touch but they should not be pressed together as it is advantageous that there should not be a rapid heat transfer between the casing and the internal assembly.

When the alloyed or other plates are encased in a casing as above described, they are put on edge in an ingot mold and backing metal such as iron or a relatively low carbon steel is preferably bottom poured around the entire assembly. In such case the casing members, being made of a steel which is a good heat conductor, will heat through quite rapidly and this effect will be increased due to the relatively slow transfer of heat by conduction to the enclosed plates. Because of this comparatively uniform heating, the casing members will show little or no tendency to buckle. Once the ingot is fully poured, the weight of the cast metal will substantially prevent any buckling of the enclosed alloy plates. This may also be aided by the fact that the alloy plates are heated relatively slowly and primarily by the radiation from the surrounding casing. Of course, during solidification there will be a tendency for the molten metal to compress the casing around the enclosed plates and this will occur as the enclosed plates are heating up and so counteract their tendency to warp. Subsequently, the whole ingot will be subjected to hot rolling as is customary.

This invention can readily be understood from the following example which is illustrated in the accompanying drawing, in which Fig. 1 shows a perspective view of an assembly, with a portion of the casing broken away at one end, which is ready for casting except for the addition of spacing supports; Fig. 2 shows the assembly in place in the ingot mold, and Fig. 3 shows a modification using only one plate of alloy steel.

In this case two plates of 10 and 9 chromium, nickel steel (designated by the numeral 10 in Fig. 1) were welded together with appropriate separating material and electroplated with iron as described in my patent above referred to. These plates were each 34 inches wide, 56 inches long and 2 1/2 inches thick. The layer of electroplated iron was .020 inches thick. The weld between these plates is indicated at 12, though actually it was largely covered up by the electroplated iron. Two plates 14 of mild steel were pickled and electroplated (also as set forth in my patent) with iron on both sides, this electroplated layer being .020 inches thick. The two plates 14 were then placed on either side of the assembly made up of the plates 10, and spacer bars 16 were put in all around the outer edges of the assembly between the edges of the plates 14. The spacer bars 16 and the plates 14 were then welded together so as to make a closed container as shown in Fig. 1, the weld being indicated at 18.

The total assembly then had welded to it on its shortest ends four support bars, the bottom
ones of which are designated as 10 in Fig. 2 and the upper ones as 22 in that figure. These bars were 2 inches thick and 4 inches wide and the bars 20 were provided with feet 24 to keep the bars away from the bottom of the ingot mold. The complete assembly was then made hand with the molten steel as indicated diagrammatically in Fig. 2, and the ingot was bottom poured in the usual fashion, the casting being conducted continuously. The distance between the wide walls of the ingot mold are about 24 inches, so that a cast layer about 8½ inches thick was formed on each side of the assembly.

During the pouring, the outside protective mild steel plates did not appear to bow; neither did any of the welds let go. The molten steel was a usual steel containing .17% carbon and appeared to lie against the plates 14 without undue cooling the molten metal. The electrolytic iron on the outside of the plates 14 did not peel off at all. Pouring the ingot took about 10 minutes.

The ingot (which weighed about 12 tons) re-mained in the mold until it cooled down sufficiently to be solid, and was then taken over to the soaking pits and soaked at about 2250° F., for three hours, after which it was put on a large plate rolling mill and rolled down until it was 10 inches thick, about 85 inches wide and about 102 inches long. After the usual re-heating in the soaking pits the slab was rolled down until it was about 4½ inches thick and approximately 130 inches wide by 150 inches long. The slab was then trimmed on the edges and the two composite plates readily separated, each being about 2½ inches thick. When fully trimmed down these plates were about 100 inches wide by 110 inches long.

Having the plates 14 definitely separated from the plates 10 had the double advantage of permitting plates 14 to heat rapidly so that they did not bulge and also prevented large amounts of heat being quickly drawn from these plates to heat the center of the assembly so as to chill the iron during casting. Perhaps some welding took place between the plates 10 and the plates 14 due to the pressure occasioned by shrinkage of the metal, but in every event a complete weld took place during the subsequent working, so that two composite plates of great strength were obtained, with the electrolytic iron diffused into both layers. Also there was no trouble in separating the two finished plates, for the alloy steel plates had not bowed sufficiently to permit the separating material to fall out of place.

Under some circumstances, it may be desirable to use the inventive idea here set forth in producing a single sheet of clad material. In this case, the problem of having the two plates of alloy steel bow apart does not exist, but nevertheless it may be worth while to enclose the alloy steel plate in a casing. Since it will obviously not be desirable to have the alloy steel casing members on both sides, separating material should be used on one side, but of course precautions must be taken to prevent this separating material from working between the faces that are to be welded. One way of doing this is illustrated in Fig. 3, in which 14 designates the plate of alloy steel, 15 one casing member separated from the alloy steel 14 by the separating material 18 and welded to the member 11 as indicated at 17. Plate 15, which may be for example of mild steel, acts as one of the casing members and is preferably held slightly spaced from the alloy plate 11 by the filler blocks 21. Both faces of member 18 preferably are covered with electrolytically deposited iron applied by the method of my earlier patent above referred to, as is also the face of the plate 11 which is turned toward member 19. Actually, this electrolytic iron will usually be rough enough so that normal contact will still provide some space between these members. If desired, the area between the plate 11 and the spacer blocks 21 may be packed with steel wool which will tend to prevent the separating material from working down between the plate 11 and the member 15, even if the weld 17 becomes sheared. The casting is done as above described and after rolling, when the edges are sheared, plate 15 will readily separate, whereas plate 18 will be firmly welded to plate 11.

While this invention is primarily of benefit in connection with making composite metals when used in conjunction with the invention of my patent above referred to, it may under some circumstances and working with particular types of inserts be used without the step of electroplating; for example, it may be advantageously used for making composite metal comprising a steel backing and nickel facings.

It is to be understood that the examples given are only by way of illustration and the details and types of metals employed may be widely modified without departing from the spirit of my invention.

What I claim:

1. The method of making composite metal articles which comprises attaching together two metal plates with a layer of separating material between them, enclosing such assembly in a casing of ferrous metal which substantially entirely surrounds such assembly and encloses the same but is not substantially attached to the assembly members, arranging such casing in an ingot mold, pouring ferrous metal around the same, whereby the casing members are heated rapidly while the enclosed assembly is withdrawing relatively little heat from the casing by conduction, and thereafter subjecting the ingot to hot working, trimming and separating the casings.

2. A method as specified in claim 1, in which the casing is made large enough to permit substantial movement of the assembly within the casing in the plane of the assembly plates.

3. A method as specified in claim 1, in which the assembly is substantially covered with electrolytic iron and the face members of the casting are covered with electrolytic iron both inside and outside.

4. A method of making composite metal articles which comprises enclosing a metal plate in a casing of ferrous metal which substantially entirely surrounds such plate but is not attached to such plate on one face, said plate having separating material covering its opposite face, arranging such casing in an ingot mold, pouring ferrous metal around the same whereby the casing members are heated rapidly while the enclosed plate is withdrawing relatively little heat from the casing by conduction, and thereafter subjecting the ingot to hot working, trimming and separating, whereby a sheet is obtained having one face composed of the metal of said plate and the other face composed of the cast ferrous metal with metal of said casing between the two.

PERCY A. E. ARMSTRONG.