June 6, 1939. F. G. WHITE 2,161,116

STEEL SHEET AND PLATE AND THE MANUFACTURE THEREOF

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FIG. 1.

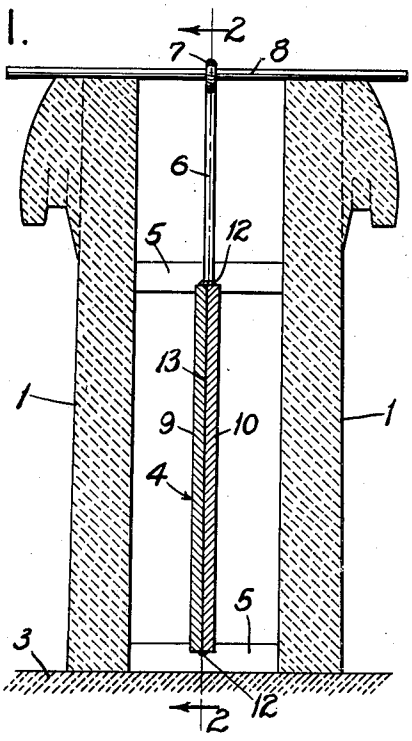


FIG. 3.

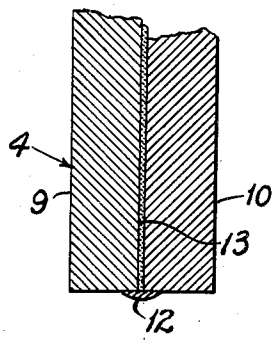


FIG. 4.

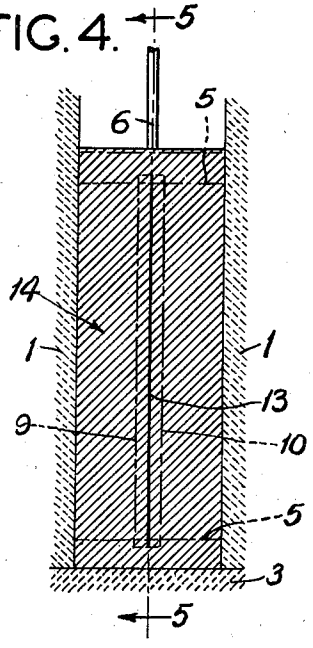
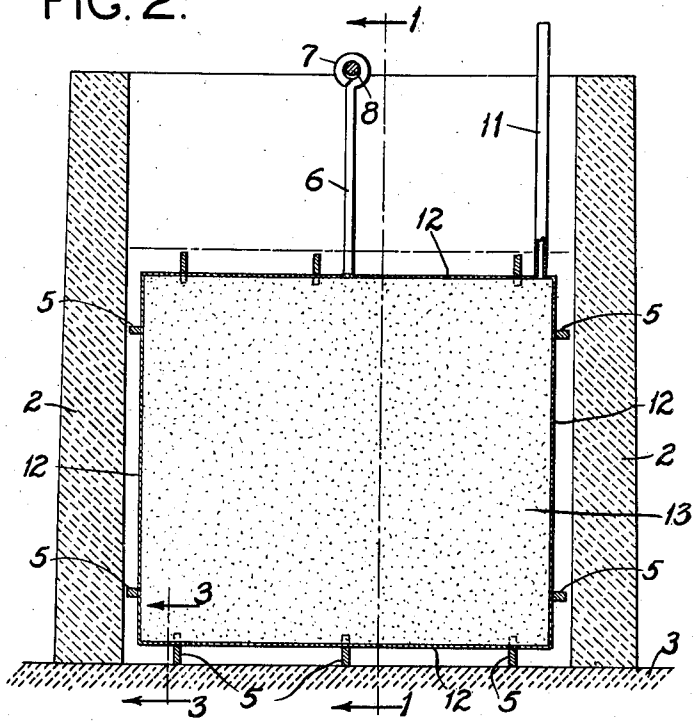


FIG. 2.



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FIG. 5.

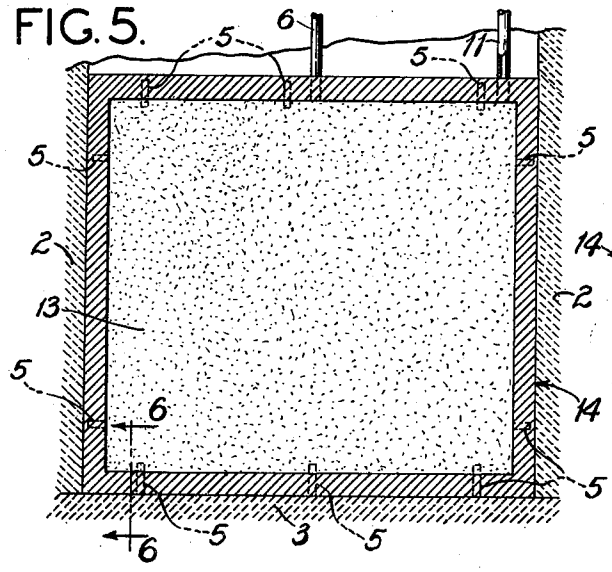


FIG. 6.

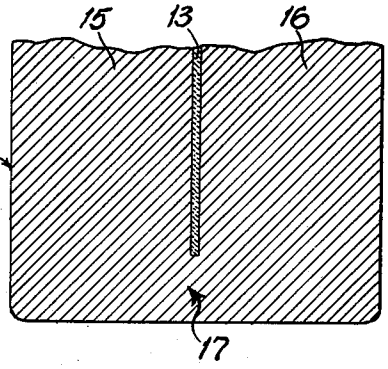


FIG. 7.

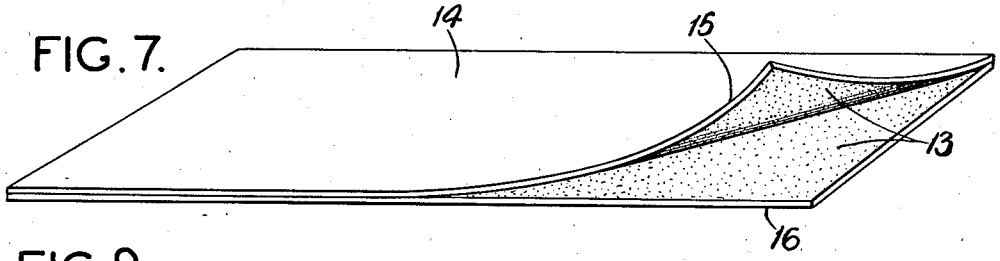
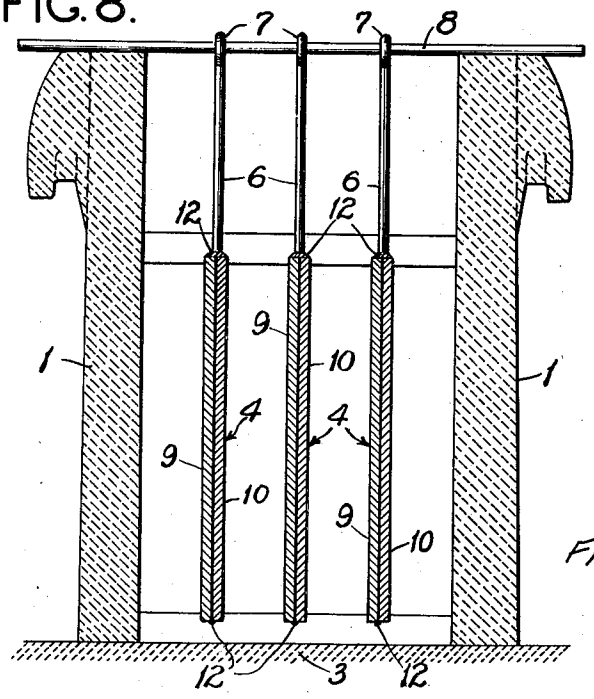


FIG. 8.



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UNITED STATES PATENT OFFICE

2,161,116

STEEL SHEET AND PLATE AND THE MANUFACTURE THEREOF

Francis Guy White, University City, Mo., assignor to Granite City Steel Company, Granite City, Ill., a corporation of Delaware

Application December 20, 1934, Serial No. 758,390

1 Claim. (Cl. 29—189)

This invention relates to steel sheets and plates, and the manufacture thereof, and with regard to certain more specific features, to a method of manufacture wherein a plurality of sheets or plates are produced at one time.

Among the several objects of the invention may be noted the provision of a method of manufacture of the class described which produces sheets or plates of uniform composition throughout their thickness, except for a surface skin or layer of microscopic thickness having improved corrosion resistance qualities; a method of the class described which permits the manufacture of sheet steel with rolling equipment designed for the manufacture of steel plates, and thus economizes in the equipment needed in the rolling mill; a method of the class described which produces articles of uniform and high-grade character, including appearance and uniformity; the provision of steel sheets and plates having uniform compositions throughout their thickness, but having a chromatized skin or layer of microscopic thickness on at least one side, whereby their corrosion-resistant qualities are enhanced; and the provision of a composition of matter for use in the method above indicated. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, steps and sequence of steps, and features of composition and synthesis, which will be exemplified in the products and processes hereinafter described, and the scope of the application of which will be indicated in the following claim.

In the accompanying drawings, in which are illustrated several of various possible embodiments of the invention,

Fig. 1 is a vertical cross-section of an ingot mold with a separator in position, taken on line 1—1 of Fig. 2;

Fig. 2 is a vertical central cross-section of the ingot mold of Fig. 1, taken at an angle of ninety degrees to the angle of Fig. 1, on line 2—2 of Fig. 1;

Fig. 3 is an enlarged cross-section of the separator of Fig. 1, taken on line 3—3 of Fig. 2;

Fig. 4 is a view similar to Fig. 1, but after the ingot has been poured;

Fig. 5 is a view similar to Fig. 2, taken on lines 5—5 of Fig. 4, but after the ingot has been poured;

Fig. 6 is a fragmentary cross-section taken on line 6—6 of Fig. 5 of an ingot after it has been rolled;

Fig. 7 is a diagrammatic view of a procedure of pulling apart two sheets formed from one ingot; and,

Fig. 8 is a view similar to Fig. 1 illustrating another embodiment of the invention.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now more particularly to Figures 1 and 2, numerals 1, 2, and 3 indicate respectively the sides, ends, and bottom of an ingot mold customary in this art. Suspended centrally in this mold is a separator plate 4. The plate 4 is held in position by spacer bars 5, extending crosswise of the mold, along all four sides of the plate 4, and by an eye bar 6, through the eye 7 of which extends a rod 8 resting on the tops of the sides 1 of the mold.

The plate 4 is composite, and is formed up in the following manner: Two plates 9 and 10, preferably of equal thickness and size, are suitably cleaned and pickled. The plates 9 and 10 comprise metal of the composition it is desired to make the product plates or sheets, and may be a low-carbon (0.10 to 0.20% carbon) steel, for example. After the pickling, one side of each sheet is covered with one or more layers of a composition designed to prevent the sheets from fusing together later in the process. Such a composition, for example, may be made of the following ingredients:

	Parts by weight
Water	2
Chromic acid (H_2CrO_4)	3
Chromium oxide (Cr_2O_3)	5

When suitably mixed, the mixture assumes the consistency of a heavy paint, and may be brushed on the plates in the manner of a paint. After one coat has been allowed to dry, another coat is brushed on if necessary. It is usually desirable that at least three coats be applied to the two plates (that is to say, one coat on one plate and two coats on the second plate).

The plates 9 and 10, thus painted, are placed with their painted faces in juxtaposition and clamped together. The eye bar 6 is next placed in position, and in addition a vent pipe 11, and the four edges of the plates 9 and 10 are then welded together and to the bar 6 and pipe 11. Arc welding has been found suitable. The weld seam is indicated by numeral 12. By reference to Fig. 3, it will be seen that the paint coats now comprise a readily-identifiable layer 13. This layer 13 is sealed from the outside except for ventilation through the pipe 11.

The composite plate 4, thus made up, is positioned centrally in the mold by means of the eye bar 6 and the spacers 5, which are likewise preferably made of the same material that is desired for the product sheets or plates. The composite plate 4 is preferably again pickled before its positioning in the mold.

Molten metal of the type that the product sheets or plates are to comprise (and hence the same composition as the plates 9 and 10) is now poured into the mold until the top spacers 5 are just covered. The molten metal at once fuses to the outer faces of composite plate 4, as well as its edges, and desirably also fuses to or even completely melts the spacers 5. The thickness of the plates 9 and 10 has been chosen, however, so that they do not entirely melt under the heat of the molten metal, but merely fuse to a perfect joint with said metal. One-inch plates 9 and 10, for example, in a mold of overall cavity thickness of eight to fourteen inches, will serve the purpose.

The molten metal then cools, establishing an ingot 14 as shown in Figures 4 and 5. The ingot 14 comprises two juxtaposed sections 15 and 16, separated by the layer 13, but having a joined region 17 around each of its four edges. Each section 15 and 16 is of uniform composition throughout its thickness (except insofar as hereinafter mentioned). The original plates 9 and 10, and spacer bars 5, have lost their identity by their surface fusion into the ingot, it being remember that they were of the same composition as the poured metal.

The ingot 14 is then removed from the mold and, after cutting off the eye bar 6 and the vent pipe 11, it is subjected, as a unit, to the customary rolling operations for converting it into plates or sheets, as the case may be. This involves a succession of passes (for the thinner sheets, of the order of seventeen, for example) through rolls increasingly closer together. The thickness of the product of course determines the number of passes in the particular instance.

After the final pass through the rolls, the now-flattened ingot is trimmed on all four sides to remove the solid metal region 17 outside the layer 13. It will then be found that the two sections 15 and 16 may readily be separated (as indicated diagrammatically in Fig. 7) along the layer 13 into two sheets or plates. The composition described permits this separation with great facility. Further, it will be found that the juxtaposed surfaces are much smoother than the exterior surfaces as smoothed by the rolls. Furthermore, these surfaces that were adjacent in the casting and rolling operations will be found to have absorbed or chemically combined, at least to a slight extent, with the separating composition, giving rise to what may be termed a chromatized surface on the sheet or plate. While the exact metallurgical characteristics of this action have not been precisely determined, it appears that the action is comparable to that of surface or skin oxidation of pure aluminum. In any event, the surfaces so produced are found to have a considerably enhanced resistance to corrosion over the opposite, merely rolled surfaces. The chromatized layer is so thin that it does not permit of ready separation from the main body of the metal for its chemical analysis; in fact, it is so thin that, in the proper sense, it cannot accurately be termed a layer.

The sheets or plates thus produced may be, and usually are, blued in the customary manner in this art. The chromatized surface blues in the same manner as the non-chromatized surface, the color of the two surfaces not being recognizably different after bluing. However, the chromatized surface usually appears to be smoother after the bluing operation than does the non-chromatized surface.

A particular advantage of the present invention is that it permits the rolling of two sheets or plates at one time, thus conserving in labor charges and the investment of capital in rolling mill equipment. Another advantage is found in the following: The usual rolling mill is equipped with plate rolls and sheet rolls (plates being defined, as is customary in the art, as being about three-sixteenths of an inch or greater in thickness, while sheets are less than three-sixteenths of an inch in thickness). The plate rolls are usually capable of handling a much greater width than the sheet rolls. Occasionally the mill obtains an order for sheets wider than the sheet rolls will take, but within the width capable of production in the plate rolls. By using the present invention, two sheets of a combined plate thickness may be rolled in the plate rolls at the desired width, and then separated. For example, the composite ingot may be rolled in the plate mill to a thickness of one-quarter inch; after separation, then, two sheets, each one-eighth of an inch in thickness are had. The facility of the invention in this respect permits great savings in equipment investment. And, because of the chromatized surface mentioned, the product is greatly superior to the simple plate or sheet.

The description has so far been concerned with the production of a two-section ingot, but the invention is not so limited. For example, Fig. 8 is a view similar to Fig. 1 showing a mold prepared for pouring a four-section ingot, three separator plates 4 being provided in spaced relationship. The resulting ingot may be rolled, in the manner described, to produce four plates or sheets at one time. In this case, the inner two sheets will be chromatized on both surfaces, which is a decided advantage. By such multiple-section ingots, too, it will be seen that thinner sheets may be produced in the plate rolls.

An important feature of the present invention is that the insert plates 9 and 10 making up the separator plate 4 are of the same metal composition as the poured metal forming the ingot. For this reason, the product sheets or plates are of uniform composition, and are not multiple-ply or layered structure. By maintenance of the same composition, no difficulty is encountered with separation of the insert plates and the poured metal upon cooling, due to difference in coefficients of thermal expansion, that is frequently encountered if the insert plate and the poured metal are of different compositions. Of course, by "same composition" it is not meant that the plate and poured metal need to be accurately the same to the last decimal point, but they should be as near the same composition as is practicable.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in carrying out the above compositions and processes without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

The method of manufacturing low-carbon sheet and plate steel having at least one chromatized surface comprising: interposing a layer of an oxygen compound of chromium between two low-carbon steel plates, casting an ingot of low-carbon steel around said plates in such manner that said plates are fused substantially indistinguishably into said ingot, said layer, however, separating said ingot into sections, rolling said ingot to the desired thickness, and separating said sections as determined by said layer, whereby the low-carbon steel surfaces in contact with said layer are chromatized.

FRANCIS GUY WHITE.