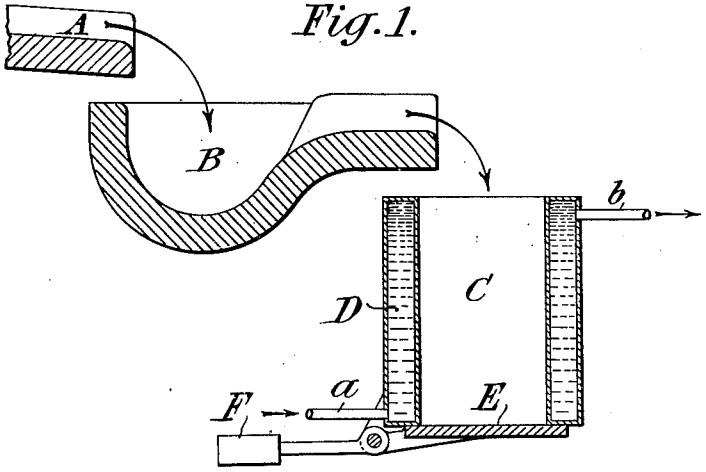
Oct. 28, 1930. W. F. EPPENSTEINER ET AL 1,779,534

METHOD OF CASTING AND ROLLING COPPER

Filed Feb. 13, 1928

Fig. 1.



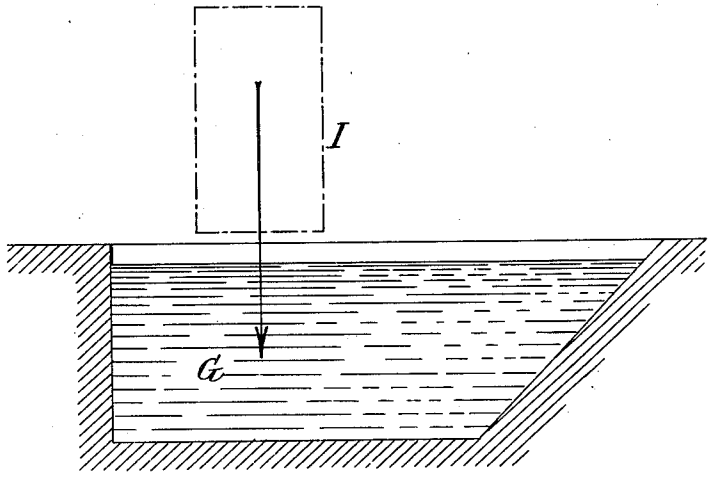


Fig. 3.

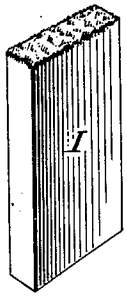


Fig. 2.

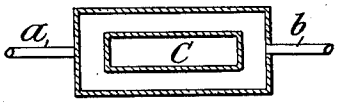
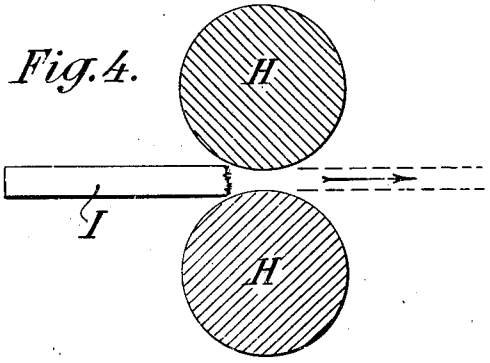


Fig. 4.



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UNITED STATES PATENT OFFICE

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METHOD OF CASTING AND ROLLING COPPER

Application filed February 13, 1928. Serial No. 253,825.

This invention relates to improvements in the casting and rolling of copper for the production of sheet or strip copper.

According to existing practice, considerable difficulty is encountered in the production of sheet copper free from blisters, cavities or other defects. It is customary to cast the copper in a slab or cake and then by repeated passes between rolls to roll this down into a sheet. The cake has been cast in a shallow mold, the depth of the casting determining the thickness of the cake, and the mold having the size and shape of the outline of the flat sides of the cake; this has resulted in the exposed surface of the cast pool of molten copper becoming rapidly oxidized on contact with the air, the superficial layer of copper becoming more or less saturated with oxygen. The resulting impurities in this layer are such as to require that the cake be planed or scalped off on the upper side to such depth as to remove the oxide and reach a surface of pure uncontaminated copper, whenever sheets of high quality are desired. If this is not done the oxide is rolled down into the sheet and forms an irregular scale which peels off or otherwise leaves the sheet with superficial imperfections or with a pitted or irregular surface. The planing or scalping is an expensive operation, and the impure copper removed requires to be turned back and remelted and refined.

To diminish these disadvantages the copper cakes have in some cases been cast edgewise whereby to reduce the area of the upper surface of molten copper which alone becomes oxidized; this may involve some difficulty in discharging the cast cake from the mold unless the mold be made decidedly tapering or wedge-shaped to insure that when inverted the cake (having slightly contracted in cooling) will drop out; but the rolling of such wedge-shaped cakes presents difficulties, and the sheet when finished has along one side for its entire length a marginal portion of imperfect and more or less oxidized copper which has to be sheared off at considerable loss.

It has also been proposed to further diminish the area of the cast copper which is exposed to oxidation by casting the cake on end so that only the upper end of the cake is subject to oxidation; but this has involved serious difficulty in removing the cast cakes from the molds unless the molds were greatly tapered from end to end, thereby producing a cake much larger at one end than at the other, which has greatly increased the difficulty in rolling such cakes down into sheets. Aside from this difficulty, this last proposal has the advantage that the imperfect copper in the rolled sheet is confined to one end thereof, and as the irregular ends of the sheet require in any event to be sheared off, this greatly diminishes the loss incident to scrapping that portion of the sheet which is impure or imperfect.

The present invention, which has been developed as the result of many experiments in the effort to diminish oxidation and other impurities in the casting of the copper cake and to reduce the disadvantages thereof in the resultant rolled sheets, avoids the most serious troubles heretofore encountered and enables sheet copper to be produced devoid of oxide pockets, blisters, scale and other impurities, and with greater economy than has heretofore been possible.

According to the present invention the cakes are cast on end, but instead of the ordinary casting method requiring a considerable tapering of the mold cavity, the mold is made with this cavity parallel, or substantially so, and the cast cake is caused to shrink to such extent that the cast cake may be dropped out from one end of the mold. It may be desirable to make the mold cavity with a very slight taper from end to end, this taper, however, being so slight as to be practically imperceptible, the mold having to all effect an essentially parallel-sided cavity. To avoid having to invert the mold, the mold is best formed with a bottom opening closed by a door which may be opened for dumping.

Such shrinkage of the cast cake is caused by proper and sufficient cooling or chilling of the mold at the time when the molten copper is cast into it. This chilling is accomplished by water-jacketing the mold and causing a

sufficiently energetic circulation of water (or other cooling fluid) through such jacket. The chilled and shrunken cake when being dropped out from the mold may desirably be received in a bath of water for further cooling and is then carried away.

In the subsequent reduction the cake is rolled down in the usual manner employed in endwise rolling, but the rolling is greatly facilitated by the fact that the cake is of substantially uniform thickness from end to end (instead of being seriously tapered or wedge-shaped as heretofore) so that the rolls have a uniform action upon the copper from end to end of the cake. The successive rolling operations consequently are performed with greater facility than would otherwise be possible. The oxidation of the copper being confined to the exposed upper surface of the molten copper at the upper end of the mold cavity is of the smallest possible area and is presented solely at one end of the cast copper cake. It results from this that in the rolling down of the copper the imperfections existing at this exposed end of the cake are carried only into the end portion of the rolled copper sheet. In the rolling of copper sheets the end portion is always necessarily trimmed off because of its irregularity in shape and thickness; and in the present process the end containing the oxide layer thus trimmed off is of but little, if any, greater mass than that heretofore necessary in the rolling of copper sheets. The side of the sheet, containing no oxide, requires little if any trimming.

To make the practice of the process more apparent, reference may be had to the accompanying drawings, in which

Figure 1 is a more or less diagrammatic view showing the mold in vertical mid-section with the appurtenant means for casting into the mold and for removing the cast cake.

Fig. 2 is a sectional view of the mold.

Fig. 3 is a perspective view of the cast cake.

Fig. 4 is a side or edge view of the cake showing its presentation to the rolls which are shown in section.

In the drawings A indicates a furnace tap from which the molten copper flows into a ladle B which may be tilted to discharge its contents into the mold C. This mold has a water jacket D and a hinged bottom E which may be carried on a weighted lever F. Water enters the jacket D through an inlet pipe *a* and flows out through a discharge pipe *b*. The inner walls of the mold are either parallel or very slightly divergent; in the latter case, for a cake 30 inches long and about 3½ inches thick, the opposite wall surfaces may diverge as much as ⅛th inch from the top to the bottom; this slight and almost imperceptible tapering serving somewhat to facilitate the discharge of the cast cake, while this extremely slight departure from exact parallelism has no perceptible effect in the rolling of the cake. The cooling of the mold by the circulation of water in the jacket D serves to chill and contract the cake so that its cast sides free themselves from adhesion to the inner surfaces of the mold cavity; with the result that upon the opening of the bottom E, the cast cake immediately falls out from the mold. It is preferable to place a water bath G beneath in position to receive the cast cake. In this bath the cake is permitted to fall flat and is then drawn out in any suitable direction and by any suitable known means (not necessary here to describe or show), and the cake is then carried away for the usual treatment preparatory to rolling down. The cake is shown in Fig. 3. For rolling, it is passed endwise and flatwise between any usual rolls, shown at H, H in Fig. 4. By suitable successive passes between these rolls or other rolls in a succession or train, the copper is rolled down to a sheet or a strip of the desired thickness.

The drawings show the mold and consequently the cake in the stated proportion of 30 x 20 x 3.5 inches, but these proportions are given merely as one suitable example and may be varied to any usual or desirable extent according to the result to be attained.

It is important for the rapid and economical casting of copper according to this method, that the mold be cooled to within a suitable range of temperature, the preferable temperature varying according to the proportions of the cake and the melting point of the copper or other metal or alloy under treatment. For copper in cakes of the size and proportions stated, a suitable temperature for the water entering at pipe *a* is between 220° and 270° F.; the temperature of the water emerging at pipe *b* is higher by reason of the heat taken up from the molten copper. For any temperatures the water must be maintained at a corresponding steam pressure. It is preferable to confine the water to a circulating system of the closed type whereby the water may be kept within the desired range of temperature. The water should be circulated somewhat rapidly in order that within the jacket D its flow may be sufficiently energetic to maintain the mold with substantially uniform temperature from top to bottom.

The invention is not limited to any particular cooling medium nor to any particular pressure, nor to any particular temperature in the jacket. Under some conditions it may be desirable to maintain the cooling medium at atmospheric pressure. Where a relatively high temperature is desired, oil or other liquid may be used as the circulating medium.

The use of water heated to a temperature determined by maintaining a given pressure

has been found suitable for the character of cakes that have thus far been cast according to this method. For other proportions or shapes of cakes other conditions may require to be maintained.

The advantage of circulating a liquid through jackets is that the molds are cooled to much below the melting point of copper and can be caused to cool the copper more rapidly than if unjacketed metal molds were used, as has heretofore been most common.

If the taper of the inner walls constituting the mold cavity is increased, this will admit of a different temperature being maintained in the cooling jacket, since the greater the taper the more readily the cake will drop out of the mold when released. It is, however, practically undesirable to form the cakes with more than a very slight taper, and it is one of the advantages of the invention that it enables the cakes to be dropped from the molds with much less taper than heretofore, or with no taper whatever.

It is desirable, after the flowing of the copper into the mold, to wait for a suitable time interval before dumping in order to insure the desired degree of chilling and contraction of the cast cake. It is also desirable after the dumping operation to permit the mold to rest for a suitable time interval before the next casting operation in order that its temperature may be reduced sufficiently by the continued circulation of water in the jacket to enable it to efficiently chill the cast copper at the next casting operation. The method accordingly lends itself well to mechanical casting whereby a plurality of molds is carried around intermittently on a wheel or turntable, the casting being performed at one point thereof, and the dumping of the cast and solidified and shrunken copper cake being performed at some subsequent angular position, so that time is given between the casting and dumping for the chilling and contraction of the cast copper, and after the dumping, for the further cooling down of the mold preparatory to the next casting. We have devised an apparatus for carrying out this method efficiently, which is set forth in a separate application for patent, Serial No. 264,590, filed March 26, 1928.

Our invention may be applicable with other metals or alloys than pure copper. It is applicable wherever the metal has, like copper, the property of superficial oxidation on contact with air in its molten condition. The term "copper" as used herein will be understood to include any such other equivalent metal or alloy.

No claim is made in this application to a cast copper cake as the product of the method herein claimed; but in an application filed August 23, 1930, Serial No. 477,334, we have claimed a copper cake having certain characteristics which might be produced in the practice of this method.

We claim as our invention:

1. The method of producing rolled copper sheets by first casting copper into elongated cakes by pouring into a parellel-sided upright cavity through the open top thereof, chilling the cast metal to shrink it free from the walls of such cavity, and removing the cake from said cavity, whereby is produced a parallel-sided cake having its oxidized portion confined to its smallest area at the top end thereof; then rolling said cake endwise into a thin elongated shape having its oxidized portion confined to its end corresponding to the open top end during casting, and cropping off such oxidized end.

2. The method of producing elongated flat cakes of copper for endwise rolling into sheets or strips, which consists in pouring the metal into the open top of an upright undivided mold having a cavity with parallel sides and with its smallest area at the top, chilling the mold to cause the cast metal to rapidly shrink free from the walls of such cavity, and removing the cast cake by dropping it out endwise from such cavity, whereby is produced a parallel-sided cake having its oxidized portion confined to its smallest area at the top end thereof.

3. The production of rolled copper sheets from parallel-sided cakes produced according to claim 2, by rolling the cast cake endwise into a thin elongated shape having its oxidized portion confined to its end corresponding to the open top end during casting, and cropping off such oxidized end.

4. As a step in the production of rolled copper sheets, casting copper into elongated cakes by pouring into a parallel-sided upright cavity through the open top thereof, chilling the cast metal to shrink it free from the walls of such cavity, and removing the freed cake by dropping it endwise through the bottom of said cavity, whereby is produced a parallel-sided cake having its oxidized portion confined to its smallest area at the top end thereof.

In witness whereof, we have hereunto signed our names.

WILLIAM F. EPPENSTEINER.
HENRY M. GREEN.