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STEEL STRIP TEMPERING

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1 Claim. (Cl. 148—12)

1

This invention is concerned with the art of tempering annealed cold reduced wide steel strip in tin plate gages and made of basic open-hearth steel of tin plate composition.

Those unfamiliar with this art should refer to pages 1227 through 1309 of the "Making, Shaping and Treating of Steel," fifth edition, published by the Carnegie-Illinois Steel Corporation, this specification using the same terms as are used by this text. These pages give a well rounded outline of the art but do require amplification to the extent of explaining that regardless of the chemical composition of the steel made into the cold reduced wide steel strip, after it is annealed to a dead soft condition and is thoroughly cleaned and ready for tempering, the tempering of the strip in the cold rolling temper mill must be done with both the strip and the temper mill rolls completely dry to avoid soiling or rusting the strip. In addition, it is better to explain that when the four-high mills, which must be used to work wide steel strip in tin plate gages, are lubricated by means of liquid lubricants, the friction between the working rolls and the strip is greatly reduced so that it is not very difficult to plastically deform the strip, but while such lubrication is possible in the case of the cold reduction mills, it cannot be resorted to in the case of the temper mills because of the necessity for producing completely clean strip as previously explained, so in the case of temper cold rolling the friction between the working rolls and the strip is very high and it is very difficult to effect even the very slight amount of plastic deformation of the strip necessary to put the cold work strain into it required to provide the tempers now currently demanded by the users of tin mill products in general and tin plate in particular.

Now in addition to the above, the tin can manufacturers, who use most of the cold reduced tin plate produced, in some instances have come to the opinion that the steel from which tin plate is made should have a chemical composition that is very low in all the metalloids commonly specified and considered in the case of basic open-hearth plain carbon steel from which cold reduced tin plate is made, so it is not possible to run the hardening alloys up a little above what is common in basic open-hearth steel, such as by resorting to high phosphorus for example, even though this would aid in procuring the higher tin plate tempers now also being demanded simultaneously with the requirement for low metalloids again by some of the can manufacturers. That is to say, basic open-hearth steel rephosphorized to give

2

it a phosphorus content in the neighborhood of that common to Bessemer steel, greatly facilitates temper rolling of the steel to high tin plate tempers, and while this practice was resorted to in the past it is no longer possible, because of the requirement for very low phosphorus in tin plate steel.

The present invention was especially developed to meet the requirements for a minimum temper represented by a surface hardness of at least about 61 Rockwell T-30, in the case of cold reduced tin plate made from steel containing from .05 to .12% carbon, from .25 to .60% manganese, not more than .015% phosphorus, not more than .050% sulphur, not more than .010% silicon, not more than .060% copper, not more than .04% nickel, not more than .06% chromium, not more than .02% arsenic and not more than .05% molybdenum. It is to be observed that this steel is not only low in phosphorus and the other metalloids usually considered in the case of plain carbon steel, but also that it is very low in all of those alloys not usually specified in the case of plain carbon steel but which are present as residuals resulting from their unintentional presence in currently available steel making materials. With this particular composition, the described surface hardness can be given the dead soft annealed cold reduced wide steel strip in tin plate gages, from which the tin plate must be made, by cold rolling it in a temper mill, but more than one rolling pass is required and sometimes other expedients must be used, this increasing the cost of making the tin plate, to an undesirable extent.

According to the present invention, during the making of the above steel, nitrogen is added to it to provide the annealed cold reduced wide steel strip, which must be tempered, with a minimum nitrogen content of .008%, this being done by any proper steel making practice so as to give the defined chemical composition to the finished steel excepting that it will also contain at least the .008% nitrogen described. The steel making art is at a stage where steel makers are fully aware of how to make the steel by the basic open-hearth process so as to finish it with this nitrogen content and otherwise with the composition described.

After the steel is finished it goes through the remainder of the steps described in the defined text as required to process it to completely cleaned annealed cold reduced wide steel strip in tin plate gages, when it naturally has the described chemical composition. At this time it has a surface hardness appreciably less than the

61 Rockwell T-30 required as the minimum temper, so it is then, as the next step in its tempering, dry cold rolled to a degree tempering it to at least this defined surface hardness. This may be done by a single pass through any dry four-high cold rolling mill capable of precision rolling, which is what a temper rolling mill is. Naturally, higher tempers may be produced within the temper range common to tin plate, and in all instances higher tempers can be obtained than in the case of the prior art practice. Furthermore, by controlling the nitrogen content to a known value predetermined as giving the precise temper desired for a given amount of temper cold rolling extension of the strip, it is possible to more accurately control the temper of tin plate, it not having heretofore been the practice to worry about the nitrogen content of tin plate steel. It has been found that a maximum nitrogen content of .011% gives the maximum temper required in the case of tin plate or, for that matter, cold reduction tin mill products in general.

The present invention embraces the further step of tinning the tempered strip, this being an important consideration because tinning involves the heating of the tin to at least its fusion temperature while it is in contact with the strip, this heating heating the strip also and sometimes being a factor in determining the temper of the finished tin plate, but in the case of the present invention it has been found that there is no appreciable decrease in the temper of the tin plate obtained by the combined steps of the nitrogen addition to the steel and the temper cold rolling. A certain increase of hardness is commonly recorded after tinning operation presumably assosiated with the aging phenomena occurring during melting of coating.

It is to be understood that the manufacture of tin plate starts with the making of the steel from which the ultimate product is processed. The steel making is an actual step in the making of the tin plate, as are each of the various other steps described in the text previously identified. In the case of the present invention, the tempering of the annealed wide steel strip in tin plate gages, from which cold reduced tin plate must be ultimately produced, goes clear back to the steel making, the addition of the nitrogen at that time being required so that the nitrogen will be in the strip during the tempering step and can cooperate with the temper cold rolling to give a surface hardness having a higher Rockwell value than can be obtained in the case of steel having exactly the same composition excepting for the lack of the nitrogen, but otherwise processed exactly like the one containing the defined amount of nitrogen and involving the same temper cold rolling extensions. It is to be understood that the amount of cold working put into the strip during the temper rolling is usually measured in terms of the extension of the strip, and the temper of the strip is usually determined by its surface hardness.

Although the invention has proven its great value in the field of giving the specifically defined temper to tin plate having the specifically defined steel composition, it is generally useful in the art of tempering annealed cold reduced wide steel strip in tin plate gages and made of basic open-hearth steel of tin plate composition which is naturally low in phosphorus.

Before closing, it might be well to emphasize that the very low metalloid composition of the specifically defined steel is demanded partly because of its forming characteristics during the can making and particularly because of its corrosion resistance characteristics, the latter being important in those instances when the tin coating continuity is not perfect, which it sometimes isn't. Nitrogen has not been found to affect the corrosion resistance and forming characteristics of tin plate to any appreciable degree and so its addition to even the very high quality tin plate steel specifically defined has been found permissible, this being an important consideration since it is one of the reasons that the use of the nitrogen, instead of phosphorus, for instance, as a tool facilitating the tempering of the strip to the higher tempers, is such a valuable addition to the art with which this invention is concerned.

I claim:

The method of producing steel sheets for tin plating having a surface hardness of at least 61 Rockwell T-30, which comprises the steps of adding nitrogen to open hearth steel in an amount productive of a nitrogen content from 0.008 to 0.011% in the finished steel, the steel otherwise consisting of: 0.05 to 0.12% carbon, 0.25 to 0.60 manganese, maximum of 0.015% phosphorous, maximum of 0.050% sulphur, maximum of 0.010% silicon, maximum of 0.060% copper, maximum of 0.04% nickel, maximum of 0.06% chromium, maximum of 0.02% arsenic, maximum of 0.05% molybdenum, the remainder, iron, hot-rolling the steel to form a strip, cold-rolling the strip to approximately the final gauge thickness of tin plate, annealing the strip whereby its hardness is materially reduced, and temper rolling the strip by only a single pass of the strip through a dry roll temper mill.

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REFERENCES CITED

The following references are of record in the file of this patent:

"The Metallurgy of Deep Drawing and Pressing," Jevons, 2nd ed., 1942, John Wiley and Sons Inc., N. Y. C., page 63.