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BLUING STEEL

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This invention is concerned with bluing steel, it being understood that this means providing the steel with an oxide film which is normally blue but which may depart somewhat from this color in some instances.

Blued steel as it is ordinarily provided the trade, is subject to certain undesirable characteristics, the most prominent being the frangibility and the lack of adherence to the steel of the oxide film, and, in the case of sheets in particular, the lack of uniformity in color and thickness of the oxide film over the entire surface of the steel. The first of these has prevented or retarded the use of blued steel where its fabrication into the ultimate article necessitates its deformation to any material degree, while the second detracts greatly from the appearance of the product and, also, results in the product not being uniformly protected against corrosion to the desired degree. As is well known, the blue oxide film on the steel is supposed to provide mild corrosion protection as well as to impart the peculiar beauty so familiar to all.

The object of the present inventor is to blue steel so that the above mentioned objectionable characteristics are eliminated to a practical degree while, at the same time, permitting the maintenance of high production schedules in the case of steel products that can be handled by continuous methods, such as wire and, most particularly, strip steel produced by the cold rolling methods now in vogue. Furthermore, he aims to provide for a more economical production of annealed, cold rolled, blued steel strip than can be attained by the prior art methods of processing this product.

Broadly speaking, the invention is based on the present inventor's discovery that when bright steel, practically free of any oxide film, is heated to an oxidizing temperature under conditions preventing any preliminary oxidation, and the steel is then suddenly exposed with rapidity to an oxidizing atmosphere, that an oxide film forms almost immediately and does not have the objectionable characteristics discussed to nearly so great a degree as has heretofore been common. That is to say, the oxide film adheres to the steel with great tenacity and is sufficiently ductile to permit considerable deformation of the steel without breaking, while in the case of flat products such as strip, a very even film of uniform color and thickness is provided.

In its more specific form, the invention involves a number of features other than the above broad conception. It is being commercially

worked at the present time in the production of annealed, cold rolled, blued steel strip, beautified by a glossy surface resulting from temper rolling the product to adjust its stiffness, this being possible because of the tenacity with which the oxide film adheres to the strip and because of the ductile characteristics of this film. The manner in which this product is processed will now be disclosed as consisting of a specific example involving all the features of the invention.

At the present time, cold rolled steel strip is produced on cold rolling reduction mills which reduce the steel to its ultimate gage from relatively thick, hot rolled, steel strip. The surfaces of the rolls of these mills which work against the strip, are ordinarily lubricated with an oily liquid which normally is an emulsion of palm oil, engine oil and water. Therefore, the strip leaves the mill carrying a thin film of this lubricant.

In carrying out the invention, this cold rolled strip, bearing a part, or all of its oily film, is passed through a continuous bright annealing furnace provided with a cooling chamber, the furnace and cooling chamber directly intercommunicating and both being flooded with a non-oxidizing atmosphere, the furnace entrance and the cooling chamber exit being respectively provided with seals for retarding the entrance of air insofar as is mechanically possible. The construction of the furnace and cooling chamber is such that the strip is not supported at any point from the time it enters the furnace until after it leaves the cooling chamber, it passing through the furnace in the form of a catenary loop. The furnace and the cooling chamber are sufficiently short to keep this catenary loop at a practical length, the furnace being operated under such conditions as to put sufficient heat into the strip to properly remove its cold worked hardness, while the cooling chamber is worked under such conditions as to remove just sufficient of the heat from the strip that is imparted to the latter during its passage through the furnace, to lower the temperature of the strip to a proper oxidizing temperature. This temperature may range from 425° Fahrenheit, to 1100° Fahrenheit, depending on the type and color of the oxide film desired, true bluing being obtained in the higher portions of this temperature range.

Immediately upon leaving the cooling chamber exit, the desired oxide film forms on the steel strip, the oxygen coming from the air. When the temperature of the exiting strip is adjusted

to the bluing range providing the characteristic dark blue color, the formation of the oxide film can be very easily observed, it initiating almost as soon as the strip leaves the exit, even when its traveling speed is quite high. In all events, the action is that of bright steel, heated to a proper oxidizing temperature, being suddenly exposed to an oxidizing atmosphere without having been afforded any opportunity to pick up any material preliminary oxidation.

It is the belief of the inventor that by leaving the cold mill lubricant on the strip, preliminary oxidation is prevented by air unavoidably dragged into the furnace by the strip, the oily film protecting the strip until its temperature rises to a point dissipating the film, by which time any air is so diluted by the nonoxidizing atmosphere of the furnace as to prevent it having any material effect. Regardless of the theory involved, tests have shown that when the strip is cleaned in the usual manner by means of wet alkali cleaners and then passed through the continuous furnace in the manner described, the resulting product does not have the same uniformly blued finish that results when the strip is passed through the furnace from the oiled mill without being cleaned.

After leaving the furnace, the strip, which now carries the desired blue oxide film, is passed through a tempering mill to adjust its stiffness, this, incidentally, imparting a very beautiful finish to the product by making its blued surface glossy. It is to be understood that in some instances the blued steel strip may not be tempered or otherwise processed, it being uniform in color throughout and having the desired adherent and ductile blue film providing excellent corrosion protection as judged by the standards set for this type of product.

Since the steel strip is a very thin section, it is sometimes desirable to adjust the conditions within the cooling zone so as to cause the strip to leave the cooling chamber exit at a temperature above that known to produce the color desired under static conditions. The blue oxide film forms almost immediately to its maximum thickness because the strip cools so rapidly that it reaches a nonoxidizing temperature only a few feet beyond the cooling chamber exit. Various expedients may be used to adjust the cooling rate of the strip during this phase, such as by using air jets on the strip. Also, the character of the oxide film might be altered by the use of water sprays, steam or various gases played on the strip immediately upon its leaving the cooling chamber exit.

By way of conclusion, attention is called to the fact that although the product resulting from practicing this invention is greatly superior to

that resulting from the prior art practices, operating economies are also very much in evidence. Since the rolling mill lubricant does not have to be removed from the strip, the usual cleaning step is eliminated. Then, because the annealing heat is utilized to provide the bluing heat, the preheating step usually incidental to the production of blued steel sheets is eliminated. Since the invention is practiced as a continuous method, and since the blued finish is obtained almost immediately, high production schedules can be obtained. In other words, a superior product results while very appreciably operating economies simultaneously accrue.

I claim:

1. A method of producing cold rolled steel strip with a blued finish, comprising cold rolling steel strip in an oiled mill so as to leave an oily film on said strip, continuously passing said strip with said oily film thereon through a bright annealing furnace and bright annealing said strip as it passes therethrough, continuously passing said strip directly from said furnace through a nonoxidizing cooling zone and there adjusting its temperature to from 425° to 1100° F., continuously passing said strip directly from said zone into an oxidizing atmosphere, whereby to produce a relatively nonfrangible blued finish, and cold rolling said strip to polish said finish and temper said strip.

2. A method of producing steel strip work with a blued finish, comprising cold reducing said work to gage, subsequently continuously passing said work through a bright annealing furnace and bright annealing said work as it passes therethrough, continuously passing said work directly from said furnace through a non-oxidizing cooling chamber and there adjusting its temperature to from 425° to 1100° F., and then continuously passing said strip directly from said chamber into an oxidizing atmosphere.

3. A method of producing steel strip work with a blued finish, comprising cold reducing said work to gage, subsequently continuously passing said work through a bright annealing furnace and bright annealing said work as it passes therethrough, continuously passing said work directly from said furnace through a non-oxidizing cooling chamber and there adjusting its temperature to from 425° to 1100° F., and then continuously passing said strip directly from said chamber into an oxidizing atmosphere, said cold reducing being done with the aid of an oily lubricant which leaves an oily film on said work and the latter being introduced to said annealing furnace while retaining said film.

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