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TREATING METAL STOCK AND/OR ROLLS DURING COLD ROLLING

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This invention relates to the cold rolling of metal, and specifically to an improved method of treating metal during cold rolling to prevent surface damage either to the rolls or to the metal being rolled; and to an improved compound for effecting such treatment. The invention has its principal field of use in the cold rolling of sheet steel, wherein the metal is changed from one shape to another, but without substantial change in gauge, that is, with no appreciable thinning or thickening of the metal stock. However, the method and compound is applicable generally to the cold rolling of steel, irrespective of the kind of shaping effected.

During the cold rolling of metal shapes, as in the formation of drop-center automobile rims from welded cylindrical rings, surface slippage between the stock and rolls necessarily takes place in a direction transversely of the stock and radially of the rolls, and may take place tangentially of the rolls if the stock is not driven by the rolls or otherwise at substantially the peripheral speed of the rolls. Usually, lubrication as by oil or oily compounds is used in connection with such cold rolling, principally for the purpose of minimizing friction during the necessary transverse slippage above mentioned, and roughening of the stock and/or the rolls resulting from failure of surface speeds of stock and rolls to be synchronized. However, the usual lubricating oils, greases and compounds, used to treat the stock and/or rolls, have important disadvantages. Excessive lubricating effect may cause longitudinal slippage and consequent failure of the rolls to drive the stock. Further, in order to condition the rolled metal for commonly used rust-proofing and priming processes, (e. g. Parkerizing and Bonderizing), it is necessary to clean the oil from the rolled product, as by a strong alkaline wash, and subsequently to pickle the product in order to neutralize the alkali. Such cleaning and pickling operations obviously increase production costs and the cleaning solutions which are used frequently cause damage to the workmen, as injury to their eyes and skin.

In my prior patent, No. 1,982,065, issued November 27th, 1934, I have disclosed and claimed one method by which the use of lubricants, such as used theretofore in the cold rolling of metal, may be obviated and their attendant disadvantages overcome. The present invention is a more effective solution to the problem and provides a treatment for metal surfaces during cold rolling, which can be effected at low cost, which is entirely reliable and safe, and which will do superior work. The above indicates the general object.

Another object is to provide a treatment for metal stock and/or forming rolls in the cold rolling of metal strip or sheet, which treatment may be effected without deleterious results to the stock, the rolls or to the workmen, and which requires no subsequent neutralizing treatment beyond subjecting the finished work to a water rinse when desired or necessary, as in order to enable decorative or preservative treatment to be applied more effectively.

The invention will be discussed as recommended for use in connection with the rolling of automobile tire rims of the drop-center type, wherein the cross-sectional shape of the stock is greatly altered but wherein there is very little change in the actual thickness of the stock. The essential characteristics are summarized in the claims.

I have found that application to the stock and/or the rolls, of an aqueous solution containing certain materials of relatively high specific heat, i. e. generally above .20 and slightly on the acid side, prevents tangential slippage between the stock and the rolls, (prevents "glazing") while the necessary radial slippage takes place without causing the stock to be roughened, hair-marked or scarfed. The materials selected are such that the solution does not cling to the surface of the metal to such an extent that it cannot be removed readily by a cold water rinse.

In general, the simple materials recommended to be used in the treating solution are those commonly regarded as weak acids, but which have a high specific heat. For instance, I have found that plain, boric acid, used in concentration from about one percent by weight, up to saturation (say five to eight percent concentration) has the desired result of preventing longitudinal slippage between the stock and rolls, while permitting radial slippage without scarring or otherwise marring the stock or rolls. Boric acid has a specific heat of about .22. Another acid which is highly effective and commercially practicable, is potassium acid sulphate having a specific heat of .24.

Any of the above acids may be used alone preferably in concentrations such that pH is below but close to 7. Such acids should, of course, be miscible in water. None of the above materials in concentrations such as given, are harmful to human skin, and ordinarily there is no reason to remove the treating solution because it does not interfere with subsequent priming or rust-proofing operations.

The above and other acids can be used as neutralizers with ingredients on the alkaline side, such, for instance, as sodium or potassium tetraborate, ammonium nitrate, aluminum calcium silicate (anorthite) and magnesium silicate. (Practically all the silicates work well.) In using such alkaline materials there should be a sufficient effective preponderance of acid used so that the pH of the treating solution is either 7 or slightly below 7, never above 7. Other alkaline substances that can be used effectively are sodium carbonate, lead pyrophosphate and lead biborate. These, in the order mentioned, have specific heats of .27, .82 and .90. All afford good rolling action and, if neutralized as mentioned above, none are deleterious to the human skin. Sodium carbonate, for instance, would be dangerous if not appropriately neutralized because of the high pH of normal solutions, and caustic action thereof.

Specific examples of mixed alkalis and acids are: 1. Trisodium phosphate, neutralized (pH:7 or —7) with boric acid; 2. Sodium metasilicate with boric acid; 3. Sodium carbonate with oxalic acid. In general the concentrations can be about as given above for boric acid; namely: from 1% up to saturation,—from 5 to 8% as a more definite rule.

Sodium sulphate and sodium nitrate can also be used effectively as sole or combined solutes. These salts comprise unions of strong acids and bases in such proportions that the resultant is substantially neutral in each case.

Various organic acids can also be used with good results, either alone, mixed, or as neutralizers for alkaline ingredients such as given. For instance, lauric, formic, propionic, palmitic acids can all be used alone. Oxalic acid can be used for neutralizing purposes, or with acids which are compatible therewith. All the above have specific heats above .20. Other organic acids that may be used are acetic acid, stearic acid and toluic (o-methyl benzoic) acid, with specific heats of from .40 to .65. In cases of acids which (used alone) are not miscible with water, these are used only as neutralizers or to modify the action of other acids.

As indicated above, when an alkaline substance is used and neutralized, sufficient acid is used so that the resultant solution has a pH of 7 or below; in other words, so that the compound is slightly acid. Obtaining such slight acidity may be done by trial with litmus paper or by following any other system as known to chemists. One reason for making certain of staying on the acid side is that most alkaline substances, if left to stand long enough, become rancid, whereas even very weak acids resist decomposition for a longer time. In the use of the preferred acid (boric), and some of the others, the treating solution has well recognized healing properties.

The lack of film strength (tension) as compared to oily or greasy lubricants is of positive advantage. Fragments of metal, abrasives, slag and the like, are unlikely to remain in suspension in the solution and subsequently to cling to the stock or rolls, causing roughening or scarring of either by such foreign material. A specific advantage of neutralizing an alkaline solution to a point such that it has a pH of 7 or closely therebelow, is that even if not washed off, the corrosive properties on steel are substantially nil.

In applying the treatment to the work, the solution or mixture may be placed generously on the rolls, or directly on the work slightly in advance of forming, or on both the work and the rolls.

While I do not know, precisely, the nature of the action of the treatment on the stock and rolls, I deduce, from the results obtained, the following:

The solution has sufficiently low film strength in respect to tension so that the film cannot prevent metal to metal contact between the rolls and stock sufficient to cause driving of the stock by the rolls. The inevitable, though imperceptible roughness of the metal surfaces will secure driving notwithstanding interposition of a weak film. As the metal is distorted it heats up rapidly and then the tensile strength of the film becomes practically valueless. At the same time, the compressive film strength is increased, enhancing continuity of film; and a sufficient film is maintained so that the radial slippage takes place with at least some interposed liquid between the metal of the rolls and the metal of the stock. It should be borne in mind that in case of radial slippage this takes place without counteracting forces comparable to the drag of the metal stock in driving it and resistance due to roughness of surface tending to resist driving. Apparently because the specific heat of the ingredients is relatively high, the solution will withstand the high heat necessarily applied to it as the metal bends or is deformed by the rolls without any considerable portion of it passing off as a gas. Moreover, the chemical action does not change as much as would be the case with materials of lower specific heat; consequently the lubricating and cooling properties normally possessed by the solution of the ingredients at room temperatures remain, under forming heat of the metal, to a sufficient extent to serve the essential purposes notwithstanding unusual heating as in deeper drawing effects of the rolls on the stock.

I claim:

1. The method of treating the complementary contact surfaces of metal stock to be formed and/or forming rolls during the cold rolling of metal as driven by the rolls, comprising maintaining on said surfaces an aqueous solution which is mildly acid, the solute of which has a specific heat above .20.

2. The method of treating the complementary contact surfaces of metal strip stock to be formed and/or forming rolls for forming such stock by cold rolling, comprising maintaining on the contacting surfaces in liquid condition a solution containing an alkali and an acid which solution has a pH not above 7 and not materially below 7.

3. The method of treating the complementary contact surfaces of metal strip stock to be formed and/or forming rolls for forming such stock by cold rolling, comprising maintaining on the contacting surfaces an aqueous solution containing an alkali and an acid in a single vehicle, both alkali and acid having specific heats above .20.

4. The method of treating the complementary contact surfaces of metal strip stock to be formed and/or forming rolls for forming such stock by cold rolling, comprising maintaining on the contacting surfaces in liquid condition a relatively weak solution of a mild alkali and a mild acid which solution has a pH not above 7.

5. The method of treating the complementary contact surfaces of metal stock and forming rolls during the cold rolling of such metal stock, comprising maintaining on the surfaces of the stock and/or rolls a solution containing a salt or liquid selected from the group consisting of sodium ni-

trate, sodium tetraborate, potassium tetraborate, aluminum calcium silicate, magnesium silicate, lead biborate, lead pyrophosphate and sodium carbonate, neutralized if necessary by an acid to an extent such that the pH of the solution is not above 7.

6. The method of treating the complementary contact surfaces of metal stock and forming rolls during the cold rolling of such metal stock, comprising maintaining on the contacting surfaces of the stock and/or rolls an aqueous solution the solute of which is selected from the group consisting of boric acid, sodium sulphate, sodium nitrate, potassium acid sulphate, oxalic, palmitic, propionic, formic and lauric acids, the pH of which solution is not above 7.

7. The method of treating the complementary contact surfaces of metal stock and forming rolls during the cold rolling of such metal stock, comprising maintaining on the surfaces of the stock and/or rolls, an aqueous solution of from 1% to saturation point of boric acid.

8. The method of treating the complementary contact surfaces of metal strip stock to be formed and/or forming rolls for forming such stock by cold rolling, comprising maintaining on the contacting surfaces in liquid condition a solution of borax and boric acid which solution has a pH not above 7.

9. The method of treating the complementary contact surfaces of metal stock to be formed and forming rolls respectively, during the cold rolling of metal as driven by the rolls, comprising maintaining on said surfaces in liquid condition and during the forming operation an aqueous solution of an alkali slightly more than neutralized by an acid of substantially equivalent strength having a specific heat above .20.

10. The method of treating the complementary contact surfaces of metal stock and forming rolls during the cold rolling of such metal stock, comprising maintaining on the surfaces of the stock or rolls a solution having a pH not above 7, containing an alkali selected from the group, consisting of sodium tetraborate, potassium tetraborate, aluminum calcium silicate, magnesium silicate, lead biborate, lead pyrophosphate and sodium carbonate, neutralized by an acid selected from the group consisting of boric acid, potassium acid sulphate and oxalic, palmitic, propionic, formic and lauric acids.

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