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METHOD OF PRODUCING FERROUS SHEET MATERIAL

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My invention relates more particularly to the production of ferrous sheet material, especially cold reduced sheet material, or sheet metal, coated, as for example by molten tin, as in the case of the production of tin-plate, or terne.

The invention furthermore has to do with the production of such material provided in sheet form of relatively light gage, viz., of about 30 gage or lighter.

One of my objects is to provide improvements in the production of cold reduced ferrous material of relatively light gage, to the end that flat sheet material having the desired rigidity or stiffness to prevent fluting and stretcher strains, in forming the material to shape, may be produced more economically, and by less expensive equipment, than hitherto possible.

Another object is to provide for the production of a flatter cold reduced ferrous sheet of relatively light gage than has hitherto been possible; and other objects as will be manifest from the following description.

My novel method involves the skin rolling, after annealing, of cold reduced sheet material with rolls the working surfaces of which are dull or rough, as distinguished from the smooth bright surfaces of what are commonly known in the metal rolling art as bright or smooth rolls, to effect a substantial portion, preferably the major portion, of the full reduction to which the sheet material is to be subjected after the annealing operation referred to; the sheet material, thus rolled and with the opposite faces thereof thereby dulled or roughened, being then rolled, in the production of smooth coated material, on rolls the working faces of which are smooth, with the result of smoothing the roughened surfaces of the sheet material sufficiently to permit of the desired smooth and even application, in a well known manner, of the desired coating material, as for example tin, or terne, in molten condition, to the surfaces of the sheet material.

As a specific example of procedure within my invention the following may be cited, but without any intention of limiting the invention thereto.

Hot rolled strip material, such as steel, from which the finished sheets are to be produced is cold reduced from the hot band size at least about 50% on a tandem mill in accordance with common practice, to about 30 gage or lighter, as desired, and within about 1½% to about 5% of the gage desired of the finished sheets, the sheet material in this operation being rolled into relatively long wide strip sheet form of light gage. The material thus cold reduced is wound into a coil and in coil form is subjected to an annealing operation, preferably thorough as will be understood by those skilled in the art and in accordance with the common practice of manufacturing tin plate, namely, subjected to such heat and for such length of time as to cause all portions of the sheet material to become completely annealed and render the material of maximum softness throughout. The annealed material is then passed, in uncoiled, but in strip sheet condition, through a pair of dull surfaced skin rolls referred to in dry condition which operate to effect a substantial portion of the above-referred-to about 1½% to about 5% reduction of gage of the cold reduced sheet material, preferably to effect the major portion of the about 1½% to about 5% reduction above stated even up to about 85% of the total reduction desired after annealing, and cause the opposite surfaces of the sheet material to be roughened or dulled; these dull surfaced skin rolls being provided preferably as the working rolls of a mill of the 4-high type. The skin-rolled sheet material is then passed through the smooth surfaced rolls, referred to, which are in dry condition, primarily for the purpose of rolling the rough surfaces of the sheet material into sufficiently smooth condition as to permit of application of the metal coating smoothly and uniformly to the sheet surfaces. Such smooth rolling of the material involves the reduction of the sheet material by the smooth rolls to an amount sufficient to cause the sum total of the reduction by the rough rolls and the smooth rolls to equal that desired, viz., about 1½% to about 5% in the example given; and to the extent that the sheet material is reduced, amounts to a skin rolling operation supplementing that performed by the dull surfaced rolls. The sheet material is then cut into the desired sheet lengths; pickled as by sulfuric acid in accordance with common practice; and then coated with the desired metal, as for example molten tin, to form tin-plate, in accordance with common practice; the reduction given in the skin-rolling of the material being of such amount as stated as to ensure the retention in the finished metal coated sheet material after subjection to the temperature used in the applying of the metal coating, of sufficient temper to avoid fluting or stretcher strains as above referred to.

By providing the dull or rough surfaced rolls as referred to the sheet material may be reduced uniformly by a single skin pass operation to an extent sufficient to render the finished metal-coated sheet material sufficiently rigid to avoid

fluting when bent as for example in the forming of can bodies and to avoid stretcher strains as for example in can tops and bottoms as by drawing; and by rolling the roughened sheet material in a mill having smooth working rolls the roughened condition of the sheet material may be reduced to the extent desired, while the roughened surfaces of the material allow for uniform reduction thereof which insures the production of flat sheets.

As will be understood, however, the percentage of reductions obtained by the rough rolls and the smooth rolls may be varied from that described to the end that the combined amounts of reduction obtained by the rough rolls and the smooth rolls serve to render the finished metal coated sheet material sufficiently rigid to avoid fluting and stretcher strains in the forming of the finished material to shape, and result in the production of flat sheets.

Any suitable dull or rough surfaced rolls may be employed for the dull or rough rolling of the sheet material as described. By way of example, metal rolls, preferably hardened steel rolls, of at least 70° scleroscope hardness blasted with abrasive particles, as for example sand or steel grit, to roughen the working surfaces of the rolls, may be employed. When the abrading particles used are steel grit, the rolls, if of 100 scleroscope, or higher, by way of example, would be first blasted throughout their working surfaces by steel grit of about 30 mesh, followed by the blasting of the rolls throughout their working surface with steel grit of about 50 mesh. In the example given, one may employ air pressure of about 55 pounds to 65 pounds per square inch in blasting with 30 mesh grit, 60 pounds pressure being quite suitable; and in the subsequent blasting with 50 mesh grit, the pressure may, for example, be from 65 pounds to 70 pounds per square inch. For rolls of about 70 scleroscope, the blasting may be done simply with 50 mesh grit, at a pressure of 50 pounds to 60 pounds, preferably about 55 pounds.

While rolls of a scleroscope hardness of over 70 are mentioned above, the invention is not limited thereto as certain advantages of the invention may be availed of by the use of metal rolls of less scleroscope hardness than that referred to.

By the improved method, it is possible to attain the necessary reduction (subsequent to annealing) by a single pass through a pair of rough rolls, followed by a single pass through a pair of smooth rolls,—a sufficient reduction to insure the requisite temper in the sheet metal after it has been passed through the molten coating bath.

While I have described a particular procedure in practicing my novel method I do not wish to be understood as intending to limit my invention thereto as the same may be variously modified and altered without departing from my invention, it being my intention to claim my invention as fully and completely as the state of the art will permit. As an example of a further modification of the method the sheet material instead of being cut to sheet lengths after the smooth roll rolling operation as above described may be cut to sheet lengths either after cold reduction and before annealing or after annealing and before rough skin-rolling, but preferably after cold reduction and before annealing, in the former case permitting the sheets to be annealed in stack condition; and the rolling with dull or rough rolls and subsequently with smooth rolls, as above referred to, performed on the separate sheets instead of on the sheet material in strip sheet form.

What I claim as new, and desire to secure by Letters Patent, is:

1. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous material to a gage approximating the final gage of the finished material, annealing the cold reduced material, skin rolling the annealed material on rough surfaced rolls, and rolling the skin-rolled material on smooth surfaced rolls.

2. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous material to a gage approximating the final gage of the finished material, annealing the cold reduced material, skin rolling the annealed material on rough surfaced rolls to reduce it about 1¼% to about 4¾%, and rolling the skin-rolled material on smooth surfaced rolls.

3. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous strip material to about 30 gage or lighter, annealing the cold reduced material, skin rolling the annealed material on rough surfaced rolls, and rolling the skin-rolled material on smooth surfaced rolls.

4. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous strip material into long strip sheet form to a gage approximating the final gage of the finished material, coiling the material, annealing the cold reduced material in coil form, skin rolling the annealed material in uncoiled condition and in strip sheet form on rough surfaced rolls, and rolling the skin-rolled material on smooth surfaced rolls.

5. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous strip material into long strip sheet form of approximately 30 gage or lighter, coiling the material, annealing the cold reduced material in coil form, skin rolling the annealed material in uncoiled condition and in strip sheet form on rough surfaced rolls, and rolling the skin rolled material on smooth surfaced rolls.

6. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous material to a gage approximating the final gage of the finished material, annealing the cold reduced material, skin rolling on rough surfaced rolls the annealed material cut to sheet length, and rolling the skin-rolled sheets on smooth surfaced rolls.

7. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous strip material into long strip sheet form to about 30 gage or lighter, annealing the cold reduced material, skin rolling on rough surfaced rolls the annealed material cut to sheet length, and rolling the skin-rolled sheets on smooth surfaced rolls.

8. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous material to a gage approximating the final gage of the finished material, cutting the cold reduced material into sheets, annealing the sheets, skin rolling the annealed sheets on rough surfaced

rolls, and rolling the skin-rolled sheets on smooth surfaced rolls.

9. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous material to a gage approximating the final gage of the finished material, annealing the cold reduced material, cutting the annealed material into sheets, skin rolling the sheets on rough surfaced rolls, and rolling the skin-rolled sheets on smooth surfaced rolls.

10. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous strip material into long strip sheet form to about 30 gage or lighter, annealing the cold reduced material, cutting the annealed material into sheets, skin rolling the sheets on rough surfaced rolls, and rolling the skin-rolled sheets on smooth surfaced rolls.

11. The method of producing cold reduced ferrous sheet material to be coated with a metal coating which comprises cold rolling ferrous material to a gage approximating the final gage of the finished material, annealing the cold reduced material, skin rolling the annealed material on rough surfaced rolls, and rolling the skin-rolled material on smooth surfaced rolls, with a reduction of the material by the smooth surfaced rolls materially less than the reduction by the rough surfaced rolls.

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