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ROLLING AND ANNEALING PROCESS

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My invention relates to processes for the production of sheet and strip metal of fairly thin gauge by means of a series of roll reductions and heat treatments, wherein the final product is formed from the original slab in single thicknesses, without doubling or pack formation as a necessary incident.

My process relates more particularly to the production of material which is wide as well as thin. Although I do not wish to limit myself to any particular width of thin material, my invention has special application to the production of metal of sheet gauges with a width of, say, more than 20–24 inches.

With the use of modern machinery and modern processes of active pass control in the rolling mill whereby extremely heavy drafts can be obtained, it is possible to produce what has been termed "sheet metal" in the trade by continuous rolling thereof in successive stands of rolls, at the rate and often in lengths comparative to the production in strip mills and skelp mills of the past.

There are certain problems, however, which attach to the production of sheet metal at strip or skelp rates, namely, (1) attainment of uniformity of gauge, (2) attainment of uniformity of temper, (3) attainment of a non-"slivering" surface upon deep drawing or forming.

The substantial width and thinness of the metal incident to continuous, high speed hot rolling of sheets, results in variations in thickness in zones or areas of a long piece that probably arise from localized differences of temperature. Where the piece is colder than at other points, the rolls will not effect so much of a reduction. When a piece having what may be termed "thick spots", is cold rolled, the percentage difference in thickness will be increased rather than decreased, because the thick spots have a different temper from the thin spots; further, even though the reduction were equal in amount at thick and thin portions, the proportion varies in favor of the thin portions, and the percentage difference in thickness is likewise increased.

This difficulty, which results in unevenness of gauge, by repeated cold rolling, will produce a further unevenness of temper which will show up in the product when any forming or working is applied to it, in spite of subsequent annealing.

Furthermore, a cold rolling at the enormous pressures required, tends to produce a surface condition which is not obviated by annealing and pickling, and which shows up when the product is bent, in the partial or complete breaking away of fine slivers of material.

I have found that if the hot rolling operation on a continuous or tandem mill of wide, thin pieces of metal is so controlled that even the coldest parts of the piece are at annealing temperature at the conclusion of said hot rolling, or if the piece is raised even momentarily to annealing temperature, that the subsequent cold rolling will largely iron out the variations in thickness, and reduce the piece to uniform gauge without any changes in temper which subsequent treatment cannot eliminate. The same result may be attained by heating the hot-rolled product to a normalizing temperature prior to the cold-rolling. This may easily be accomplished in a continuous furnace.

I have further found that if, at the end of the cold rolling or before the final cold rolling passes, I normalize the product, the slivering will not occur, and that the unevenness of temper as a persistent factor is largely eliminated. Pickling succeeded by box annealing is used following my process as desired. Also, after normalizing it is often desirable to give the piece a quick pickling and washing treatment, the scale formed by normalizing being of a minimum amount.

In a co-pending application filed by me on January 8, 1929, and bearing Serial No. 330,989, I have defined a procedure which consists of rolling the hot rolled strip produced in a continuous mill after it has become cold, but without removing the hot-mill oxide, and then annealing and pickling before the required cold rolling to gauge. In this process there is an anneal which equalizes strains and fits the piece for a subsequent substantial cold rolling reduction. My present process merely calls for a heat treatment prior to cold rolling, or the production of a

product at a temperature in the hot rolling mill which is within the annealing or normalizing range; then after or before the final cold rolling passes, normalizing the product.

In other words, the teaching of my invention is a step in the manufacture of high finished sheets for deep drawing purposes which will produce uniformity of gauge, uniformity of temper and a non-slivering surface, which step comprises, in addition to all well-known steps, normalizing and a subsequent pickling process prior to box annealing, and preferably prior to at least a part of the cold rolling. Referring to the first problem, the attainment of uniformity of gauge is very important. The copending application hereinabove referred to sets forth one method of attaining it. Other efforts have comprised an attempt to produce hot rolled strip of uniform temper by finishing it on the hot mill at self-annealing temperature; but this is difficult of control. Several very light passes in the cold rolls after the main cold reduction has been accomplished, are also sometimes practiced, but involve obvious disadvantages, and fail to attain a solution of the second and third problems. It is to be pointed out that a normalizing which precedes a substantial cold reduction will enable me to produce material of uniform gauge; a normalizing following reduction to gauge, will not per se affect gauge. Normalizing thus solves the second and third problems, and does this regardless of non-uniformity of gauge, and regardless of any previous treatment. It produces evenness of temper and destroys the tendency toward slivering.

A typical procedure under my process will be to produce a long, hot-rolled, thin, wide strip, and then pass it through a furnace in which all parts of the strip are momentarily raised to annealing or normalizing temperature. The piece is then given a quick pickling treatment and washing, whereupon it is taken to the cold mills for further continuous reduction. After the cold rolling passes necessary to bring the piece to finished gauge, or nearly to finished gauge, have been performed, the strip is passed through a furnace where it is brought to a normalizing temperature, i. e., beyond the A3 point, this normalizing being followed by rapid cooling, whereupon a quick pickling and washing will be applied to remove the slight scale formed by normalizing.

The piece may then be cut up into shorter sections and given a concluding pass or passes in cold rolls or not, as desired, and then usually will be regularly boxed annealed.

My process deals generally with ferrous metals and alloys, but more particularly with iron or mild steel.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. The process of producing sheet metal, which consists in passing a continuously hot rolled strip which has been at normalizing temperature after the hot rolling thereof has been completed, through cold rolls where heavy drafts are applied thereto, resulting in a reduction of gauge, and, after a part at least of the cold rolling operation, raising the temperature of the strip above the A3 point and relatively quickly cooling said strip.

2. The process of producing sheet metal, which consists in raising a continuously hot rolled strip to normalizing temperature, and when same is cool, passing the strip through cold rolls where heavy drafts are applied thereto, resulting in a reduction of gauge, and after a part at least of the cold rolling operation, raising the temperature of the strip above the A3 point thereafter relatively quickly cooling said strip.

3. The process of producing sheet metal, which consists in passing a continuously hot rolled strip which has been at normalizing temperature after the hot rolling thereof has been completed, through cold rolls where heavy drafts are applied thereto, resulting in a reduction of gauge, and, after a part at least of the cold rolling operation, normalizing said strip, and cleaning the strip after said normalizing.

4. The process of producing sheet metal, which consists in raising a continuously hot rolled strip to normalizing temperature, and when same is cool, passing the strip through cold rolls where heavy drafts are applied thereto, resulting in a reduction of gauge, and after a part at least of the cold rolling operation, raising the temperature of the strip above the A3 point, thereafter quickly cooling said strip, and cleaning the strip after both heating operations.

5. The process of producing sheet metal, which consists in passing a continuously hot rolled strip which has been at normalizing temperature after the hot rolling thereof has been completed, through cold rolls where heavy drafts are applied thereto, resulting in a reduction of gauge, and, after a part at least of the cold rolling operation, normalizing said strip, then finishing the cold rolling, and finally box annealing the material to impart softness.

6. The process of producing sheet metal, which consists in raising a continuously hot rolled strip to normalizing temperature, and when same is cool, passing the material through cold rolls where heavy drafts are applied thereto, resulting in a reduction of gauge, and after a part at least of the cold rolling operation, normalizing said material, and after the cold rolling box annealing the material to impart softness.

7. The process of producing sheet metal, which consists in passing a continuously hot rolled strip which has been at normalizing

temperature after the hot rolling thereof has been completed, through cold rolls where heavy drafts are applied thereto, resulting in a reduction of gauge, and, after a part at least of the cold rolling operation, raising the temperature of the strip above the A3 point and rapidly cooling it, cleaning the strip after said heating, and after the cold rolling box annealing the material to impart softness.

8. The process of producing sheet metal, which consists in raising a continuously hot rolled strip to normalizing temperature, and when same is cool, passing the material through cold rolls where heavy drafts are applied thereto, resulting in a reduction of gauge, and after a part at least of the cold rolling operation, normalizing said material, cleaning the material after both heating operations, and after the cold rolling, box annealing the material to impart softness.

9. That process of producing sheet metal, which comprises continuously hot rolling the metal piece to thin gauge, thus producing sheet stock characterized by gauge and strain inequalities, heating said metal above its A3 point, and then rapidly cooling it, whereby the strain inequalities are removed, and cold rolling said metal with substantial reduction, whereby the piece is reduced to uniform and finished gauge, afterward again raising said metal to a temperature above its A3 point followed by a relatively rapid cooling, whereby the strain inequalities produced by cold rolling said metal while of non-uniform gauge are substantially removed, and finishing said metal.

10. That process of producing wide sheet metal in long bands, which comprises hot rolling slabs to produce strip sheets characterized by gauge and strain inequalities, continuously normalizing said strip sheets, continuously picking said strip sheets, cold rolling them to uniform and finished gauge with a substantial reduction, afterward continuously normalizing, pickling, and finishing said strip sheets.

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