June 30, 1964 J. H. WERTHMAN 3,138,981

METAL SCRIBING

Filed April 12, 1962

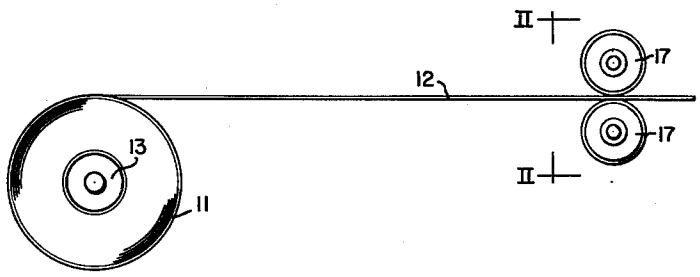

FIG.1

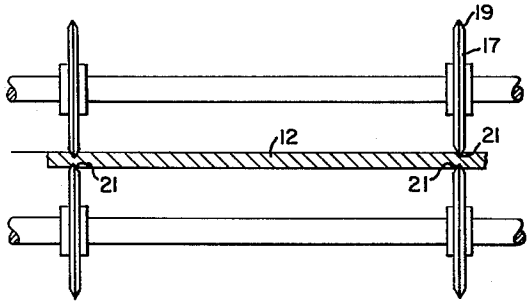

FIG.2

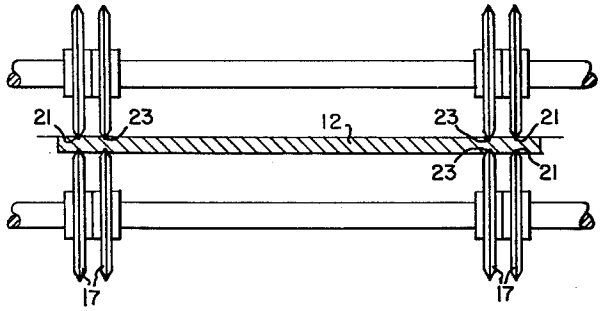

FIG.3

United States Patent Office 3,138,981 Patented June 30, 1964

3,138,981

METAL SCRIBING

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Filed Apr. 12, 1962, Ser. No. 186,895
7 Claims. (Cl. 80—60)

This invention relates to an improvement in the processing of metal strip and relates in particular to a method of reducing edge trimming losses during strip processing.

In the processing of metal strip, particularly stainless steel strip, slabs or ingots of the metal are conventionally hot rolled into bands which are subsequently cold roll-anneal cycled in a continuous manner until they reach their ultimate gauge and finish. During both hot rolling and cold rolling many grades of steel strip develop edge checks or small cracks along their edges due to their lack of plasticity and inability to take such reductions without such edge ruptures occurring. If the edge checks or cracks are ignored or neglected prior to further processing, they will progress or grow into the strip during subsequent mechanical reduction and processing and may either cause a complete rupture of the width of the strip or may render the ultimate product useless.

To avoid the effect of edge checks or cracks, it is conventional practice to eliminate the edge of the strip before further processing or shipping by trimming from the edge of strip exhibiting such a phenomenon up to 2" of the metal in order to remove that portion of the strip which exhibits such edge checks or cracks. Such shearing or trimming is generally accomplished by means of a slitter during the continuous movement of the strip and such an operation may have to be repeated three or four times prior to final processing and shipment of the ultimate coil. Such practice results in considerable loss of metal during the strip processing and materially reduces the usable portion of each ingot or slab product that is successfully reduced into strip.

It has now been found that by employing the method of the present invention, the number of times strip must be edge trimmed during continuous processing may be reduced so as to effect a savings in reducing the amount of metal scrap produced.

Accordingly, it is the object of the present invention to provide a method wherein the amount of metal lost to the edge trimming caused by edge checking or cracking in the continuous processing of metal strip may be materially reduced.

It is also an object of the present invention to provide a method wherein the number of times that metallic strip must be edge trimmed during processing may be reduced.

Further objects and advantageous features of the method of the present invention will be obvious from the following description and the drawings wherein:

FIGURE 1 is a side view in elevation showing a coil being unwound and passing through scribing rolls;

FIG. 2 is a partial end view partially in cross-section taken substantially along the lines II—II of FIG. 1, and

FIG. 3 is a cross-sectional end view of a strip scribed in accordance with a second embodiment of the method of the present invention.

In processing metal strip, and particularly in processing metal strip wherein the metal is not highly plastic during mechanical reduction, whether at elevated temperatures or at room temperatures, edge checking or cracking is very probable. The condition is inherent in many metals and varies only in degree. For example, edge checking and cracking is common in the production of mild steel strip and similar steel strip products such as electrical grades of silicon steel strip. Conversely, it is not nearly

so common in the production of austenitic stainless steel strip since this material generally is sufficiently plastic that it does not readily check or crack at its edges. In the production of the more plastic materials, the yield or the weight of the finished strip product in its relationship with the weight of the starting ingots is relatively high or the finished strip constitutes nearly all the metal that originally was in the form of the ingot. The yield, as it relates to such material as mild steel and electrical grades of silicon steel strip, is relatively low in that sometimes not more than about 60% of the weight of the ingot is successfully converted into the strip product. By reducing the amount of scrap or waste that is caused by numerous trimming operations, applicant's method has increased the yield of the less ductile steels by about 2%. Hence, the process of the present invention constitutes a significant advance in the processing of metal strip, and particularly steel strip.

In addition to causing a loss in product, strip metals frequently must be slowly processed through the cold rolling mills so they may be carefully watched for possible cracks developing along the edges to avoid the possibility of a dangerous rupture during processing. Applicant's method limits the penetration of such a rupture into the strip and, hence, enables more rapid processing of metal strip products.

A check or crack occurring at the edge of a strip grows and progresses inwardly during further processing and particularly during additional mechanical reduction. In the prior art, such cracks have been eliminated as has been heretofore stated by shearing the edge from the strip between rolling operations with a resulting reduction in the recoverable over-all width. By applicant's method, the crack or check is prevented from progressing into the metal strip by providing a barrier that will stop and prevent further growth of such cracks or checks. This is accomplished by "scribing" or "grooving" the strip near each edge and continuously for the length of the strip. Such grooves or scribe marks may be present on either or both sides of the strip. When they occur on both sides they are preferably in a position to mechanically work or affect the metal in the vicinity of the groove or scribe which serves to halt or prevent further progression of cracks or checks through or past the groove or scribe mark.

FIG. 1 is a schematic and illustrative drawing showing a coil **11** of strip **12** which is in the process of being unwound or "paid off" a pay-off roll **13** and of being continuously processed by being passed through scribe rolls **17**. There would, of course, preferably be four sets of scribe rolls **17** so as to effect aligned opposing grooves adjacent both edges of the strip **12**. In conventional practice, each scribe roll **17** of each opposed pair, of course, would be slitters or knife blades slightly offset to function to trim the edge of the strip away from the strip. However, in applicant's method, the opposed scribe rolls **17** of each pair are in alignment and are shaped with points **19** that penetrate only part way into the face of the strip **12** adjacent the edge thereof so as to form grooves or scribe marks as are shown in particular in FIG. 2, instead of shearing the edge of the strip. The resultant strip possesses paired grooves or scribes **21** near both edges of the strip that serve to prevent edge checks or cracks from progressively growing from the edge of the strip to an area past the groove **21**.

FIG. 3 shows another embodiment of the method of the present invention wherein in addition to paired grooves **21**, there is provided a second set of grooves or scribes **23** which would require four spaced pairs of opposing scribing members **17** in place of the two pairs of opposing scribing members employed to obtain the

strip 12 of FIGS. 1 and 2. The strip 12 shown by FIG. 3 may be employed for edge checking and cracking which is of a more serious nature (for example, in the case of the electrical grades of silicon steel) where edge checks or cracks may be so severe as to possibly succeed in penetrating through the first set of opposed grooves 21, but will in all eventuality be halted before penetrating a second set of opposed grooves such as grooves or scribes 23. How close or far the scribe marks or grooves 21 may be to the edge of the strip itself is dependent on the severity of the edge checking and cracking condition for any particular strip metal. In some instances, such as in the production of mild steel where the metal is reasonably ductile, it may be possible to scribe it at a distance of about ⅛" from the edge of the strip; however, where the material edge checks or cracks during hot working to a considerable extent, it may be advantageous or even necessary to provide the opposed scribe marks or grooves at a distance of approximately 1" from the edge of the strip. The exact distance from the edge of the strip may be even greater than 1" depending on the properties of the material being processed. A very ragged edge may require one to scribe far from the edge of the metal; however, it should be borne in mind that the metal on the outside of such a scribe mark is eventually sacrificed and sheared or slit from the coil and one would not care to provide the scribe mark any further from the edge than is of practical necessity.

The embodiment of FIG. 2 shows one scribe mark or groove near each edge and the embodiment of FIG. 3 shows two scribe marks; however, any number of scribe marks may be provided depending on the individual necessity as affected by the plasticity or mechanical properties of the material being converted into a strip product.

The depth of the scribe mark or groove is also dependent to a great extent on the type of material being processed. In processing steel, it is unlikely that much advantage would be obtained by effecting a groove or scribe that is less than about .001" in depth on either side of the strip surface. It is also unlikely that one would wish to employ a scribe mark or groove that was deeper than about .011" since to go deeper may cause the material to "sickle out" or double over during mechanical reduction. Such sickling out or doubling over of the material may cause edge checks or cracks to occur inside the scribe mark. When scribing extremely thin gauge material, for example, material thinner in gauge than about .028", it is advisable not to consume more than about 50% of the thickness of the material in opposing scribe marks or grooves, in that to exceed this combined depth may once again effect a sickling out or a breaking out of the metal near the edge caused by such scribe marks.

Scribe blades 17 having points 19 that scribe grooves with cross-sectional sides of about 60° have been successfully employed; however, such grooves may vary widely in angle depending on the material being processed. It is doubtful that a scribe blade having cross-sectional sides (or points) of less than about 10° or greater than about 100° would be useful in the steel industry.

Where a plurality of scribe marks is employed, it is, of course, advantageous to provide such a distance between such marks as one would provide between a single scribe or groove and the edge of the strip. In other words, in most applications where the first groove is ½" from the edge of the strip, the second groove will be

½" from the first groove; however, this may not always be necessary or desirable and depends on the properties of the materials being processed.

In practicing the process of the present invention, ingots of silicon steel strip (consisting essentially of about 2 to 3% Si, balance Fe), have been hot rolled to hot rolled 35½ inch wide bands of approximately .085" gauge. As in conventional practice, this material was then continuously normalized, wheelabrated, pickled and edge trimmed or sheared to 33½" wide strip to eliminate edge checks and cracks. The material was then cold rolled to an intermediate gauge (.025–.028"), continuously normalized and then scribed with two sets of opposing scribes approximately ¼" and ½" from each edge with a 60° angular groove to a depth of approximately .006" at the top and bottom. The material was then cold rolled to finish gauge and edge trimmed to a width ranging from about 31 to 33 inches.

In conventional practice, the hot rolled band (about .085" gauge) is rolled to 36½", is normalized, wheelabrated and pickled. It is then sheared to 34½" wide material, cold rolled to intermediate gauge (.025–.028" gauge), normalized and edge trimmed again to 33½" material, normalized and cold rolled to final gauge and edge trimmed to from 31" to 33" wide material.

Hence, it may be seen that by practicing the method of the present invention, it has been possible to effect full width material (31 to 33") from 35½" hot rolled band, while in conventional practice full width material is obtained from hot rolled band material that is 36½" in width.

I claim:

1. In the method of rolling steel strip in which there are at least two rolling passes and wherein during the first pass edge checks or cracks may be initiated and during the second pass the edge checks or cracks tend to progress inwardly from the edges the improvement which comprises, scribing grooves on said strip near its edges after the first pass and before the second pass whereby progression of the edge checks or cracks will be arrested when they reach a groove.

2. The method of claim 1 wherein the grooves are placed from about ⅛" to about 1" from the edges.

3. The method of claim 1 wherein the grooves are from about .001" to .011" deep.

4. The method of claim 1 wherein opposing grooves are scribed on opposite sides of the strip.

5. The method of claim 4 wherein the grooves are each from about ⅛" to about 1" from the edge.

6. The method of claim 4 wherein the grooves are from about .001" to about .011" deep.

7. The method of claim 4 wherein there are two parallel grooves adjacent each edge of the strip on each side thereof.

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