United States Patent

[11] 3,628,362

[72] Inventor **John James Stone**
Marengo, Ill.
[21] Appl. No. **810,278**
[22] Filed **Mar. 25, 1969**
[45] Patented **Dec. 21, 1971**
[73] Assignee **The Arnold Engineering Company**
Marengo, Ill.

[54] **MILL FOR ROLLING A THIN, FLAT PRODUCT**
5 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **72/242**
[51] **Int. Cl.** **B21b 29/00**
[50] **Field of Search** 72/237, 240, 241, 242, 243, 163, 164, 165

[56] **References Cited**
UNITED STATES PATENTS
2,776,586 1/1957 Sendzimir 72/243

Primary Examiner—Charles W. Lanham
Assistant Examiner—B. J. Ollila
Attorneys—Richard A. Speer, Vincent G. Gioia and Howard R. Berkenstock, Jr.

ABSTRACT: A cluster-type rolling mill for rolling very thin sheet, strip or the like, which applies rolling force substantially over only the width of the rolled product thereby eliminating roll flexing forces conventionally existing in the rolls outside the width of the rolled product.

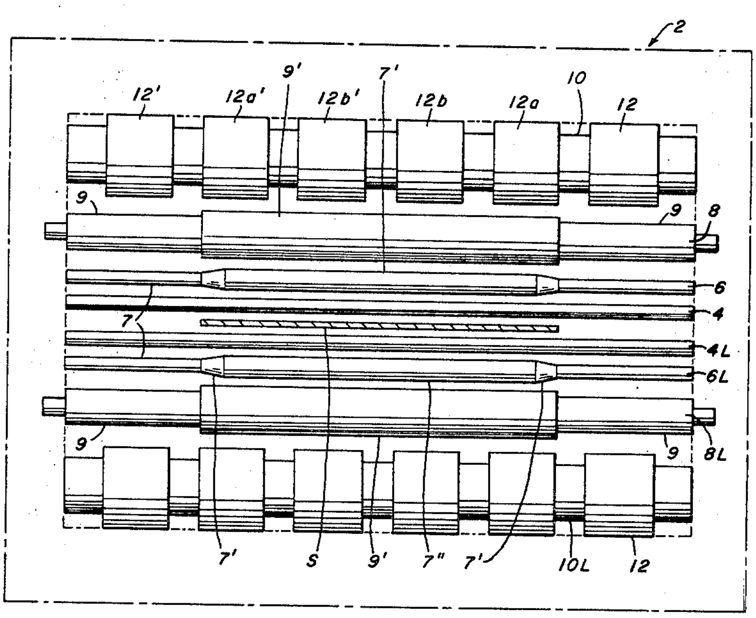
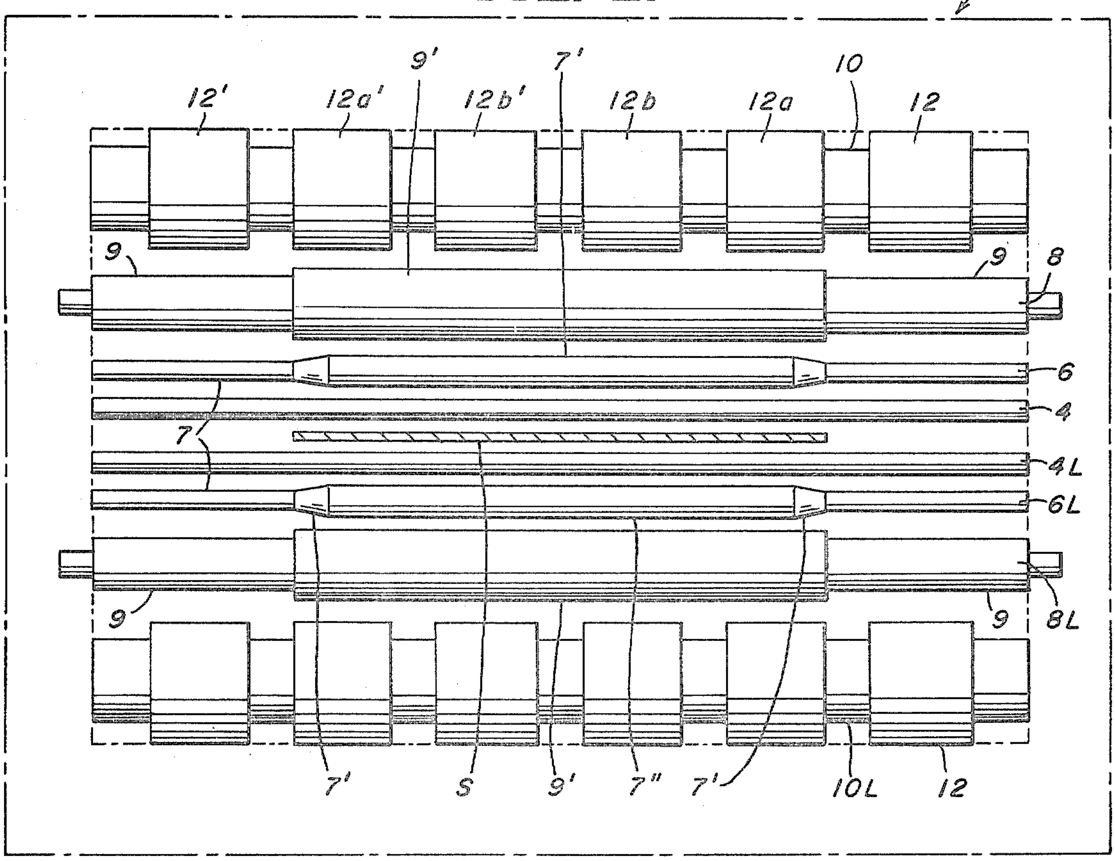


FIG. 1.



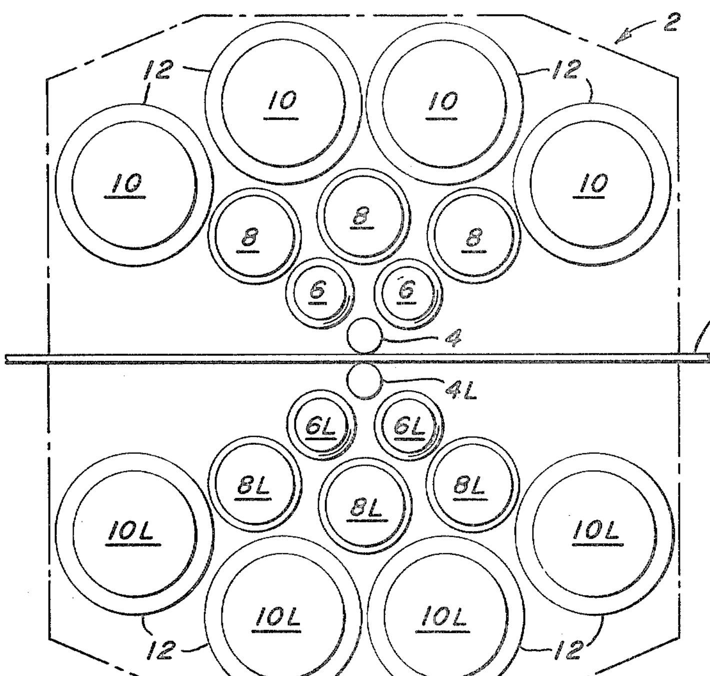


FIG. 2.

INVENTOR.
JOHN J. STONE
By
Attorney

MILL FOR ROLLING A THIN, FLAT PRODUCT

BACKGROUND OF THE INVENTION

In cold rolling metal stock, such as sheet, strip, or the like, in a cluster mill, it is generally preferable to roll a flat product (i.e., one of uniform thickness and without wrinkles and buckles). In conventional rolling mills, deflection and end flexing of the rolls in certain situations result in the rolled product not being flat, i.e., cambered, distorted, and nonuniform.

In the rolling of a very thin strip such as foil, deflection due to rolling forces produces an exaggerated result in that a specific amount of camber constitutes a greater percentage of nonuniformity over the thickness of the strip. This problem has generated a number of solutions to compensate for the deflection and flexing in order to roll a flat product. Familiar solutions for the problem all accept or even induce deflection and flexing of the rolls and employ rolls of corrective shapes. These corrective rolls, which may be crowns, flats and tapers, are most often used as backup rolls to reduce or counteract work roll flexing and thus produce a flat product. Beyond corrective rolls, elaborate roll bending systems may be incorporated in rolling mills to correct shape and eliminate work roll flexing. The grinding and honing of rolls to corrective shapes is an expensive operation requiring a high degree of skill. The operation of roll bending devices to correct work roll flexing also requires considerable skill. In order to produce a variety of products from a mill, large numbers of corrective rolls of varying shape have to be maintained ready for use, thereby necessitating expenditure of large sums of money and time. Further, setup and start-up procedures for various products are time consuming and also require very high-skilled personnel to achieve the right combination of roll shapes to produce a specific flat product. Quite often for a new product setup, procedures are prolonged as a trial and error period and are needed to achieve the right combination of rolls to produce the new flat product. The invention herein described eliminates many of the above disadvantages in rolling flat sheet, strip, or the like.

SUMMARY OF THE INVENTION

The present invention provides apparatus for rolling a flat product such as sheet, strip, or the like between work rolls wherein the forces for rolling the product are transmitted to the work rolls over a width substantially equal to the width of the rolled product. In operation of rolling mills, I have found that the application of rolling forces to the rolls over an area wider than the width of the rolled product results in end flexing of the work rolls around the work. This roll flexing causes the work to become cambered, distorted, and nonuniform. I have also discovered that if the rolling forces are maintained uniform on the rolls over the width of the rolled stock and no rolling forces are exerted on the work rolls beyond the edges of the stock, the problem of end flexing is considerably overcome.

Accordingly, it is an object of this invention to provide a cluster rolling mill in which flexing of the work rolls is minimized.

Another object of this invention is to provide a cluster rolling mill which omits the use of costly crowned or tapered work rolls.

Still another object of this invention is to provide a cluster rolling mill in which a minimum inventory of rolls is required to produce various types of rolled products.

A further object of this invention is to provide a cluster rolling mill which distributes the rolling forces equally over the rolling surface on a given roll and minimizes forces transmitted to unsupported areas of a given roll.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of a cluster of rolls as would be mounted in a Sendzimir Mill.

FIG. 2 is a side view of a cluster of rolls as would be mounted in a Sendzimir Mill.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and more particularly to FIG. 1, numeral 2 indicates a cluster of rolls as may be grouped in a Sendzimir-type mill for cold rolling steel sheet, strip, or the like. An upper work roll 4 and a lower work roll 4L are mounted in the cluster so that the work S to be rolled, e.g., strip may be passed therebetween. Upper first intermediate rolls 6 and lower first intermediate rolls 6L, having undercut surfaces 7, and tapered surfaces 7' and force-transmitting surfaces 7'' are mounted above and below, and in contact with their associated work rolls 4 and 4L. Upper second intermediate rolls 8 and lower second intermediate rolls 8L having undercut surfaces 9 and force-transmitting surfaces 9' may be mounted in the cluster above and below and in contact with the first intermediate rolls 6 and 6L. Upper saddle bearing rolls 10 and lower saddle bearing rolls 10L with pairs of backing bearings 12 and 12', 12*a* and 12*a*', and 12*b* and 12*b*' are mounted in the cluster above and below the associated second intermediate rolls 8 and 8L.

FIG. 2 illustrates the cluster arrangement of the rolls described in FIG. 1 and strip S being passed between the work rolls 4 and 4L.

To roll a thin flat product by use of my invention, I undercut the diameter of the upper and lower second intermediate rolls 8 and 8L over their end portions thereby forming surfaces 9'. I have found that undercutting to a depth of 0.030 inch, for example, over a distance sufficient to make the width of the force-transmitting surface 9' of the roll substantially the same as the width of the rolled product is satisfactory. Thus, to roll a 12-inch strip the second intermediate rolls would be undercut equally on both ends to a distance sufficient to leave about a 12-inch force-transmitting surface. Rolling forces are applied to the work rolls 4 and 4L from the saddle bearing rolls 12 through the intermediate rolls 6, 6L, 8, and 8L. To further insure that rolling forces will not be applied beyond the width of work product S, those backing bearings extending beyond the product (e.g., 12 and 12') S may be backed off. This prevents the bearings 12 and 12' from making contact with the second intermediate rolls 8 and 8L, restricting transmission of the rolling forces to the width of the product S.

First intermediate rolls 6 and 6L may also be undercut to the width of the rolled product similarly to second intermediate rolls 8 and 8L, thereby producing force-transmitting surface 7''. This may be done to both sets as shown in the intermediate rolls 6 and 6L in the example, or to just upper or lower first intermediate 6 or 6L. By undercutting only one set, the inventory of various width first intermediate rolls is minimized while still extending the principle of limitation of roll force-transmitting surface to product width into the first intermediate rolls. To enhance product edge control, the undercut first intermediate rolls 6 have a limited slight taper 7' (exaggerated in FIG. 1). Edge control is required because of the tendency of the material of the product to move more readily under a given rolling force at the edge where it is unrestrained. Additionally, product to be rolled usually is nonflat and has some crown induced by previous conventional rolling and thus requires some corrective shape to remove that slight crown. The tapering of the rolls for edge control is unlike conventional tapering to correct for roll flexing in that the taper is generally limited to the outer 1 inch of the force-transmitting surface of the undercut first intermediate roll and extends to a depth of only 0.0003 inch.

A rolling mill in accordance with the invention can roll a variety of sizes and types of thin flat products and for each product the mill responds as though it were designed solely to roll the width of that product by applying rolling forces only over the width of the rolled product. The inventory of rolls is substantially reduced and only flat rolls need be stocked, these in sufficient multiple lengths to ensure having all widths of rolled product which can be accommodated by a single mill. By practicing the invention it is no longer necessary to stock a variety of shapes to achieve a deflection equal to the roll flexing induced by a product of particular width and hardness nor is it necessary to induce roll bending through elaborate hydraulic or mechanical means. My invention provides a mill that can be set up once for any product of specific width avoiding the trial and error approach and further avoiding the problems of wrinkling and buckling associated with roll bending.

While several embodiments of my invention have been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope thereof.

I claim:

1. A cluster mill for rolling articles such as strip, sheet or the like, comprising upper and lower work rolls; upper and lower bearing rolls for applying forces for rolling; a set of intermediate rolls comprising at least one combination of upper and lower first intermediate rolls in contact with said work rolls and at least one combination of upper and lower second intermediate rolls in contact with said bearing rolls; said work rolls and intermediate rolls being longer than the width of articles to be rolled therein; said second intermediate rolls being undercut from the ends thereof toward the roll's center to provide a force-transmitting surface substantially equal to the width of said article to be rolled.

2. A cluster mill according to claim 1 wherein said first intermediate rolls also have a force-transmitting surface substantially equal to the width of said article to be rolled.

3. A cluster mill according to claim 2 wherein the roll ends of said first intermediate rolls are tapered to provide a force-transmitting surface substantially equal to the width of said article to be rolled.

4. A cluster mill according to claim 2 wherein the roll ends of said first intermediate rolls are undercut to provide a force-transmitting surface substantially equal to the width of said article to be rolled.

5. A cluster mill according to claim 1 wherein said bearing rolls also have a force-transmitting surface substantially equal to the width of said article to be rolled.

* * * * *