United States Patent [19]

Bindernagel et al.

[11] **3,754,425**

[45] **Aug. 28, 1973**

[54] **ROLLING MILLS**

[75] Inventors: **Ali Bindernagel,** Dusselfdorf-Oberkassel; **Werner Demny,** Dusseldorf, both of Germany

[73] Assignee: **Friedrick Kocks,** Dusseldorf, Germany

[22] Filed: **July 14, 1971**

[21] Appl. No.: **162,499**

[30] **Foreign Application Priority Data**

July 7, 1970 Germany ..... P 20 35 482.9

[52] **U.S. Cl.** **72/234,** 72/224

[51] **Int. Cl.** **B21b 13/08,** B21b 13/10

[58] **Field of Search** 72/234, 235, 224

[56] **References Cited**

UNITED STATES PATENTS

3,561,105	2/1971	Cofer	164/76 X
3,380,278	4/1968	Dilling	72/224
3,243,983	4/1966	Norlindh et al.	72/235
3,618,354	11/1971	Bindernagel et al.	72/224
3,643,488	2/1972	Bretschneider	72/191

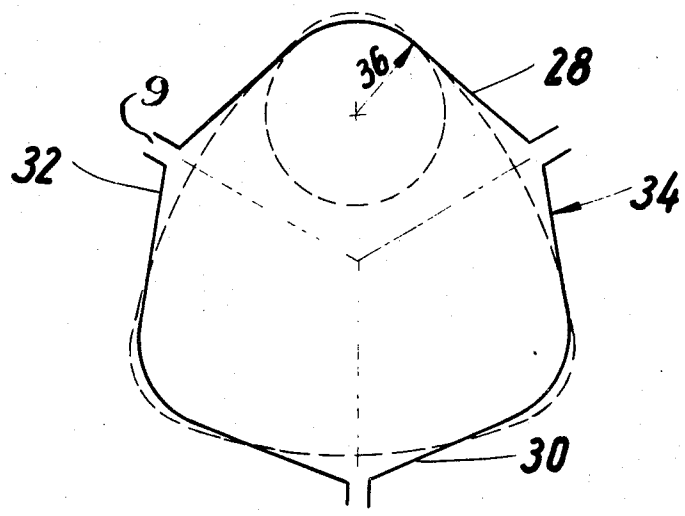
Primary Examiner—Milton S. Mehr

Attorney—Eugene F. Buell et al.

[57] **ABSTRACT**

A rolling mill is provided having a roll line made up of a plurality of successive three roll stands, each defining a pass, which line includes at least two sizing passes disposed beyond a row of flat passes, the rolls of each sizing pass having sizing grooves shaped so that the reduction in cross section of the work in the pass defined by the sizing grooves is at an analytical minimum when the work is in a non twisted state between passes.

4 Claims, 3 Drawing Figures



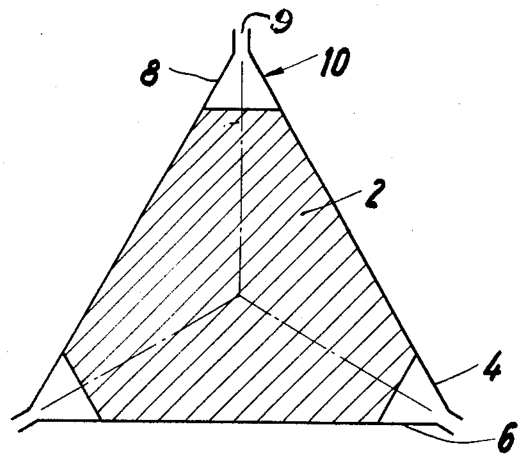


Fig. 1

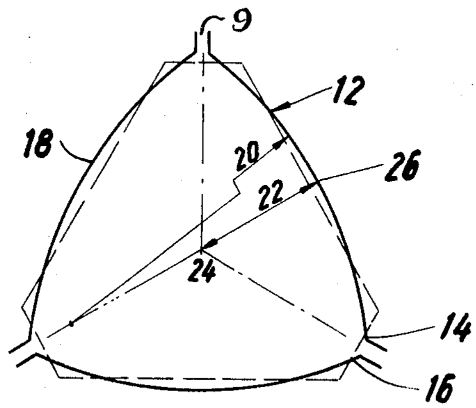


Fig. 2

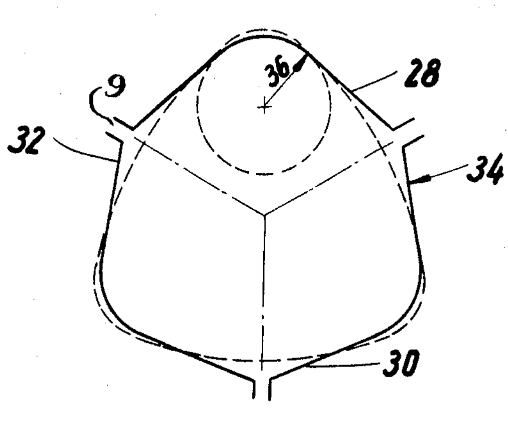


Fig. 3

Inventors.
Ali Bindernagel &
Werner Demny
by Burell, Blinks & Lieschheim
their attorneys

ROLLING MILLS

This invention relates to rolling mills and particularly to sizing passes for small-section rolling mills, such as wire rolling mills, having three-roller passes of which at least two sizing passes are provided beyond a row of flat passes.

In previously proposed rolling mills of this kind, a plurality of round passes for sizing directly follow a row of flat passes, all the passes in the row being alternately angularly offset relatively to one another by half the pitch angle between the roller axes. To enable the work-material to be broadened, the round passes are open towards the roller gap, the size of the opening becoming smaller towards the last pass. The work-material emerges from the last flat pass in the form of a hexagon whose cross section has three short sides and three long sides in an alternating order. The three long sides of the hexagonal cross section are produced by the working surfaces of the rollers of the last flat pass, while the three short sides are formed by slight under-filling of the pass in the region of the gaps. When the work-material, provided with this cross section, enters the first sizing pass, there is the risk of the work-material twisting between passes such that the short sides of the cross section lie in the pass openings located in the region of the gaps. Similarly, there is the risk of the work-material twisting by half a pitch angle between the individual round passes, so that the portion of the cross section, which has passed through the opening in the preceding round pass, again lies in the angularly offset opening in the next pass. This results in a surface finish marred by ribs which impair further processing. Moreover, twisting of the work-material results in a non-circular finished cross section, and the wear on the rollers is increased by non-uniform progress of the work-material through the passes.

Attempts have been made to prevent twisting of the work-material by means of additional guides, although this measure does not always act in a reliable manner and it is also expensive.

A feature of this invention is to design the calibrating passes such that stable, twist-free guidance of the work-material is ensured.

In accordance with the invention, the pass grooves in the sizing passes are so designed that the reductions in cross section achieved in the said passes are an analytical minimum when the work-material is in the non-turned state.

In rolling mills according to this invention, the cross section of the work-material is always placed in the following pass in the position in which it receives the minimum reduction in cross section, i.e. it progresses through the passes without twisting.

A large number of shapes are possible for the pass grooves in the rolling mill according to the invention. Preferably, the rollers forming the sizing passes have conic profiles which are disposed symmetrically of the bottom of the pass groove and which, alternating from pass to pass, have in the bottom of each pass groove a radius of curvature which is alternately greater and less than the distance between the centre of the pass and the bottom of the pass groove.

The rollers can be readily provided with conic profiles by means of tools which may be manufactured by appropriate grinding of round steel.

Alternatively, the rollers of the last but one sizing pass or, if four or five sizing passes are provided, the last but three of the sizing passes, may have an arcuate profile whose radius of curvature is greater than the distance between the centre of the pass and the bottom of the pass grooves. The arcuate profile has the advantage that it is the simplest of all conic profiles to produce. However, the uneven numbered sizing passes, i.e., the last sizing pass and, if provided, the second from last and the fourth from last sizing passes, have to be formed by rollers whose profiles have a curvature composed of different radii of curvature, for example an elliptical curvature, the radius of curvature located in the bottom of the pass groove being the small circle. If an even number of sizing passes is provided, the first sizing pass following the row of flat passes may be disposed without angular displacement relative to the last pass in the row of flat passes.

However, when there is an even number of sizing passes and the first sizing pass has to be angularly offset relative to the last pass in the row of flat passes because of the arrangement of the roller drives, the last flat pass may be provided with a comparatively slight reduction such that, in the hexagonal cross section resulting in the said flat pass, the three sides of the hexagon abutting against the rollers are the shorter.

Alternatively, however, the rollers of the last sizing pass may have an arcuate profile whose radius of curvature must, of course, be smaller than the distance between the centre of the pass and the bottoms of the pass grooves.

In the foregoing general description of this invention certain objects, purposes and advantages have been set out. Other objects purposes and advantages will be apparent from a consideration of the following description and the accompanying drawings, in which:

FIG. 1 diagrammatically illustrates the last pass in a row of flat passes in a rolling mill in accordance with the invention,

FIG. 2 diagrammatically illustrates the first of two sizing passes in the rolling mill, and

FIG. 3 diagrammatically illustrates the second or last sizing pass.

In the embodiment illustrated in the drawings, successive passes in a rolling mill, e.g., a rod mill, are defined by three-roller stands arranged in a line with the passes, are alternately angularly offset relatively to one another by half a pitch angle, i.e., half the angle between the roller axes. Two sizing passes are provided beyond a row of flat passes. The hexagonal cross section work-material emerging from the row of flat passes being rolled in the two sizing passes to a substantially round profile. The rollers are disc-like and in each stand, the three rollers are arranged with their axes at 60° to one another.

The last pass **10** of the row of flat passes is formed by three disc-like rollers **4, 6** and **8,** whose perpheries only are shown and the strand or work-material leaves the last pass **10** with a hexagonal cross section which has three equal short sides and three equal long sides in alternating order. The long sides of the hexagonal cross section are produced by the rollers **4, 6** and **8** defining the pass, while the short sides are produced by slightly under-filling the pass between the rollers in the region of the gaps **9** formed between adjacent rollers.

The first sizing pass **12,** illustrated in FIG. **2,** is arranged immediately behind the last pass **10** and is

formed by three rollers **14, 26** and **18** each of which has a pass groove with an arcuate profile. The radius **20** of curvature of the roller profile is greater than the distance **22** between the centre **24** of the pass and the bottom **26** of the pass groove.

The first sizing pass, which is the last pass but one, is disposed beyond the row of flat passes such that the long sides of the work-material **2** of hexagonal cross section abut against the arcuate profiles of the rollers **14, 16** and **18** while the short sides of the hexagon run into the pass **12** in the region of the gaps **9** located between adjacent rollers. In the illustrated embodiment, the first sizing pass **12** is not angularly offset relative to the last pass **10** in the row of flat passes. The cross section of the work-material running through the sizing pass **12** is subjected to the minimum of deformation so long as it runs through the pass **12** in a non-twisted state.

Referring to FIG. **3**, the second or last sizing pass **34** formed by the rollers **28, 30** and **32** is angularly offset relative to the preceding sizing pass **12** by half a pitch angle, i.e., by 60° the pitch angle being the angle between the normals to the roller axes. The profiles of the pass grooves of the rollers **28, 30** and **32** forming this pass have an elliptical curvature which is symmetrical about the bottom of the pass groove. The shape of the ellipse is such that the radius **36** of the small circle at the bottom of the pass groove is less than the distance between the centre of the pass and the bottom of the pass groove, the radius of curvature of the bottom of the pass groove corresponding to the small circle radius **36** of the ellipse.

When the last sizing pass **34** has such a configuration and is in this position, the reduction in the cross section of the work-material is again at a minimum so long as the work-material is in the non-twisted state, whereby the work-material is effectively prevented from twisting even in the last sizing pass.

In another embodiment (not illustrated), three sizing passes are provided. In this case, the first sizing pass is angularly offset by half a pitch angle relative to the last pass in the row of flat passes, which might be more advantageous with respect to the arrangement of the drive mechanisms for the rollers and the direction of rotation, and, like the last sizing pass **34** illustrated in the drawings, has elliptical profiles in which the small circle of the ellipse is located in the bottom of the pass groove. The configuration and arrangement of the following sizing passes may be the same as in the case of the passes **12** and **34** of the previously described embodiment.

In a further embodiment (also not illustrated in the drawings), two sizing passes are provided as in the case of the grooving illustrated in the drawings. However, as a result of a given drive mechanism for the rollers, the first sizing pass, which has the same configuration as the pass **12** illustrated in FIG. **2**, has to be angularly offset by half a pitch angle relative to the last pass in the row of flat passes. In this case, the last pass in the row of flat passes has to be designed such that only a slight reduction in the cross section of the work-material is effected in this pass. The three sides of the hexagonal cross section of the work-material abutting against the rollers thus remain shorter than the three sides of the hexagon facing the gaps between the rollers. In such a case, the reduction in the cross section is again a minimum in the first and second sizing passes when the work-material is not turned or twisted.

In the foregoing specification certain preferred embodiments and practices of this invention have been set out, however it will be understood that this invention may be otherwise practiced within the scope of the following claims.

What we claim is:

1. A rolling mill comprising a roll line having a plurality of successive three-roll stands each defining a pass line including a last flat pass intermediate the ends of the pass line having rolls with means to roll metal stock into a generally equilateral triangle having equally truncated apices at all angles, at least two sizing passes disposed after said last flat pass, the rolls of a first sizing pass having arcuate sizing grooves so shaped that the radius of curvature at the bottom of the groove is greater than the distance between the axis of the pass and the bottom of the groove and the rolls of a second sizing pass having arcuate sizing grooves shaped so that the curvature of the grooves is elliptical with the radius of curvature at the bottom of the groove being a smaller circle and being less than the distance between the axis of the pass and the bottom of the arcuate groove, said rollers of said first and second sizing passes being offset relative to one another by half a pitch angle.

2. A rolling mill as claimed in claim **1**, wherein a plurality of first and second sizing passes are provided.

3. A rolling mill as claimed in claim **2**, in which the number of sizing passes is even and in which the rollers of the first sizing pass following the row of flat passes is angularly symmetrical relative to those of the last pass in the row of flat passes.

4. A rolling mill as claimed in claim **2**, in which the number of sizing passes is even and all the stands are positioned in the line with; the rollers in adjacent stands angularly offset relative to one another, and in which the last flat pass is dimensioned to effect section transverse a reduction of a metal stock having said truncated apices transverse to said rollers.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,754,425 Dated August 28, 1973

Inventor(s) Ali Bindernagel and Werner Demny

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, Claim 4, line 49, after "with" delete the semicolon; lines 51 and 52 after "effect" delete --section transverse--.

Signed and sealed this 18th day of December 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

RENE D. TEGTMEYER
Acting Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.