United States Patent [19]

Strandell

[11] **3,848,447**

[45] **Nov. 19, 1974**

[54] **ROLLING METHOD AND A ROLLING MILL FOR CARRYING OUT THE METHOD**

[75] Inventor: **Per-Olof Strandell,** Taby, Sweden

[73] Assignee: **AB Metalform,** Stockholm, Sweden

[22] Filed: **Nov. 6, 1972**

[21] Appl. No.: **303,842**

[52] **U.S. Cl.** **72/199,** 72/366
[51] **Int. Cl.** **B21b 1/00**
[58] **Field of Search** 72/199, 229, 225, 366, 72/250; 29/527.7

[56] **References Cited**

UNITED STATES PATENTS

1,808,752	6/1931	Banner	72/225
3,557,595	1/1971	Illert	72/237
3,580,032	5/1971	Stone	72/199
3,757,556	9/1973	Kawawa et al.	72/366

Primary Examiner—Milton S. Mehr
Attorney, Agent, or Firm—Stevens, Davis, Miller & Mosher

[57] **ABSTRACT**

A rolling method for producing a semi-finished metal section from a larger metal section of substantially rectangular cross-section and with which the width of two opposing, first sides exceeds the width of the remaining two, second sides. The metal section is reduced by reversable rolling without being turned around its long axis in several passes between two working rolls which are capable of being progressively urged towards said second sides of the metal section. The metal section is guided during the reduction process into and out of the roll nip and the original distance between said first sides of the metal section is maintained constant during the entire rolling sequence by means of two pairs of guide rolls arranged on either side of the working rolls, the guide rolls having smooth barrel surfaces and presenting a nip of constant width therebetween and having a diameter which is considerably smaller than that of the working roll.

6 Claims, 3 Drawing Figures

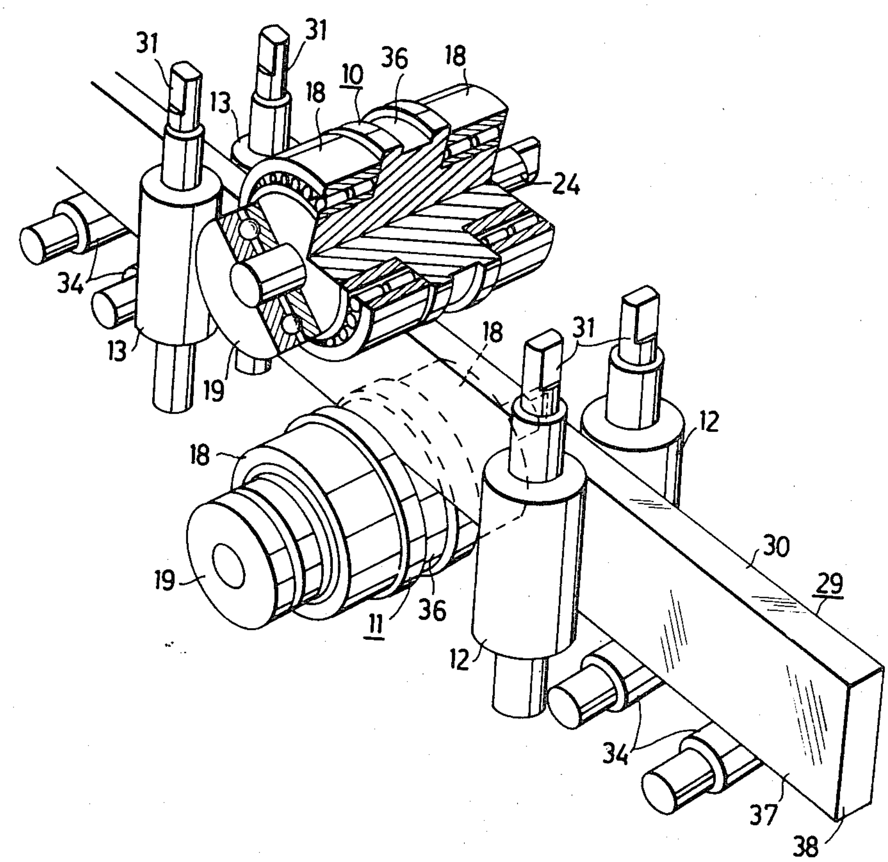


Fig.1

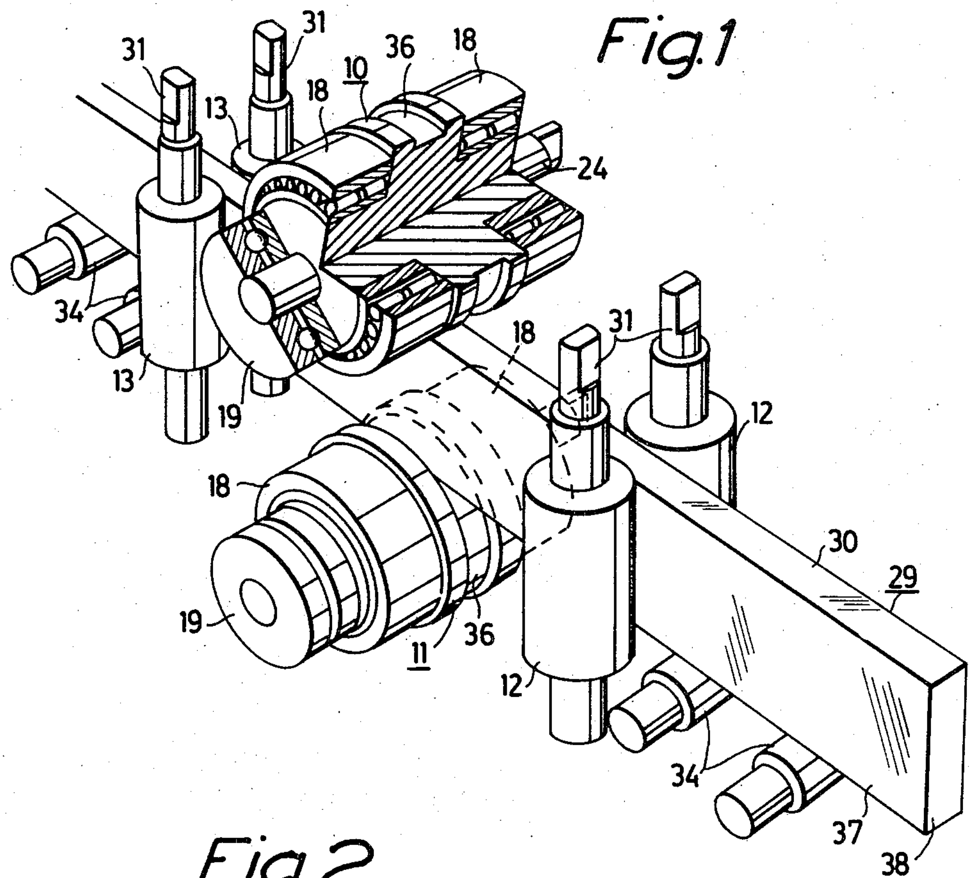

31
31
36
18
10
18
13
24
34
13
19
18
31
12
18
30
29
19
11
36
12
34
37
38

Fig.2

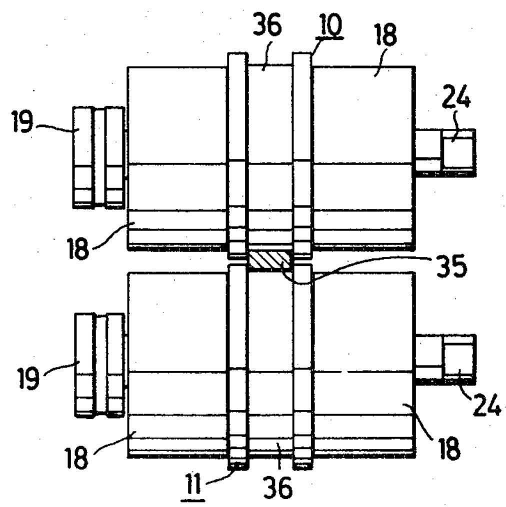
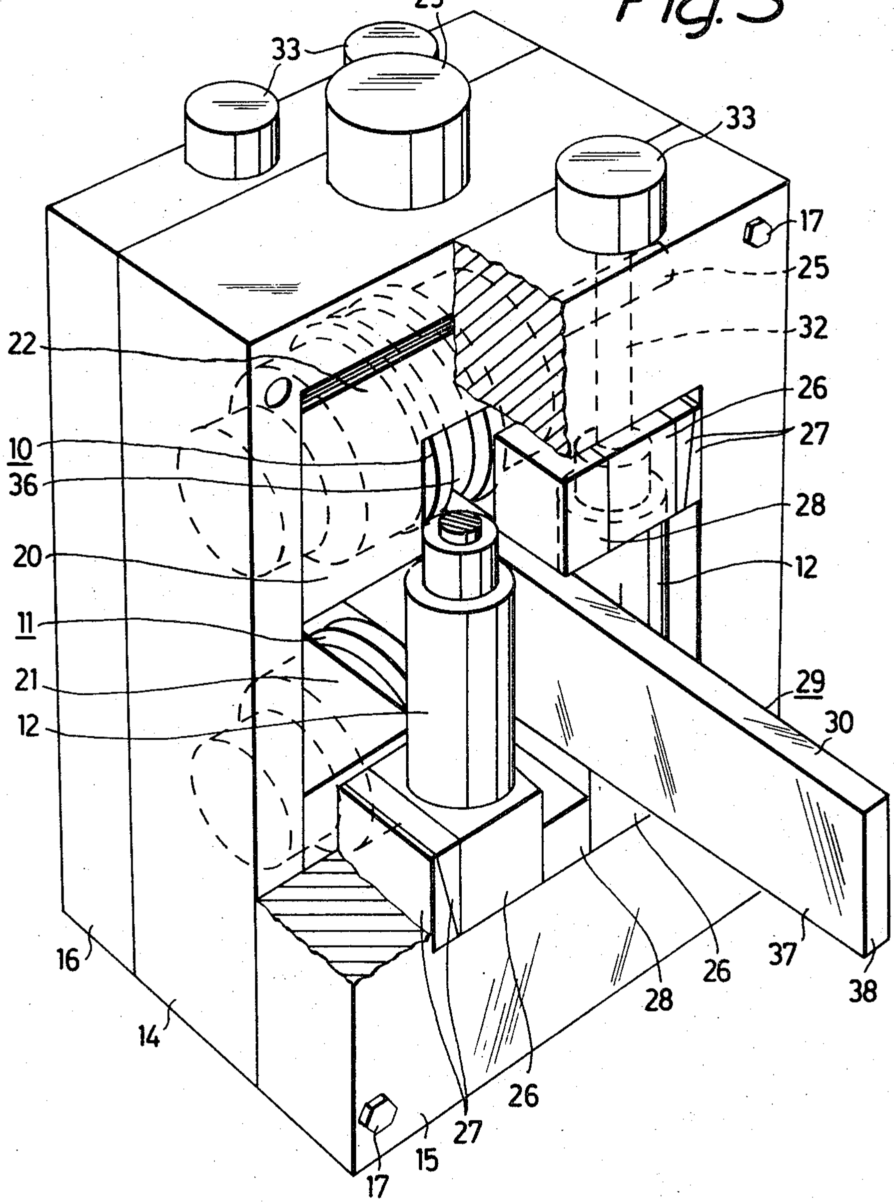

36
10
18
19
24
18
35
19
24
18
18
11
36

Fig. 3


23
33
33
17
25
32
22
26
27
10
36
28
20
12
11
21
29
30
12
16
37
38
28
26
14
26
27
15
17

ROLLING METHOD AND A ROLLING MILL FOR CARRYING OUT THE METHOD

The present invention relates to a novel hot rolling method for producing a semi-finished metal section from a larger metal section of substantially rectangular cross-section and with which the width of two opposing, first sides exceeds the width of the remaining two, second sides. The invention also relates to a rolling mill for carrying out the novel method.

Semi-finished metal sections which are to be subjected to further metal shaping processes, such as rolling or forging processes, are normally produced by reducing an essentially square, large metal section, such as an ingot, to a square metal section of smaller cross-sectional area. With a conventionally applied method, semi-finished metal sections are produced by reducing an ingot of square cross-section, having sides approximately 500 mm in width, to square sections whose sides have a width of from 80 to 100 mm. Rolling is carried out in a reversible two-high mill provided with grooved rolls. The grooves are several in number and are arranged in series of decreasing cross-sectional area. The metal section, subsequent to having been reduced in one or more passes through a groove of large cross-sectional area is transferred to a groove of smaller cross-sectional area and further reduced therein. Between every second or fourth pass through the rolls, the section is turned 90° around its long axis. Despite the fact that several passes can be made through the same roll groove, this method of reducing metal sections necessitates the provision of a plurality of grooves, which in turn requires a long roll barrel in order for all the necessary grooves to be accomodated. Because the roller conveyor paths by which the metal section is moved on both sides of the rolling mill must have a width corresponding to the barrel length, a long barrel consequently necessitates a wide roller path, which renders such paths heavy and expensive. The same is also true of the guide means used for lateral movement of the metal section on the roller paths from one groove to another. The rolling operation and apparatus connected therewith are further complicated by the turning hooks or like devices which must be used to turn the metal section around its long axis. The entire rolling mill is thus large, heavy, relatively complicated, extremely bulky and expensive. Similar disadvantages are also found with rolling mills for reducing or finish-rolling prerolled sections.

The technique of forming metal sections by continuous casting methods has expanded rapidly over recent years. This technique is applied conventionally for continuously casting metal sections of square cross-section as starting material for other metal working processes, such as the manufacture of rod and wire material. Instead of casting sections of square cross-section, it is, however, desirable to cast metal sections of rectangular cross section, where the depth or thickness of the section is small in relation to the width, since with metal sections of this configuration the casting speed can be increased and the production rate of the continuous casting plant consequently raised. Owing to the lack of a suitable rolling method and rolling mill, metal sections having a rectangular cross-section can only be worked into metal sheet.

An object of the present invention is therefore to provide a rolling method with which ingots and other metal sections of substantially rectangular cross section with

which the width of two opposing first sides, hereinafter called the broad sides, exceeds the width of the two remaining second sides, hereinafter called the edge sides, can be reduced to sections of essentially rectangular cross section and of substantially any desired relationship between the width and the depth of the metal section, in a particularly simple and practical manner and with the use of constructionally simple means. A further and special object of the invention is to provide a method by means of which an ingot or other metal section of small thickness in relation to the width can be rolled to a metal section of square cross-section, the width of the sides of which is substantially equal to said thickness, or of rectangular cross-section where two opposing sides each have a width substantially equal to said width and where the width of each of the remaining two, opposing sides is smaller than said width.

For the purpose of achieving these objects, it is proposed in accordance with the invention that, when practicing a rolling method of the type referred to in the preamble to the description, the metal section is reduced by reversable rolling techniques without being turned around its long axis, in several passes between two working rolls which are capable of being progressively urged towards said second sides of the metal section, and that the metal section is guided during the reduction process into and out of the roll nip, and that the original distance between said first sides of the metal section is maintained constant during the entire rolling sequence by means of two pairs of guide rolls arranged on either side of the working rolls, the guide rolls having smooth barrel surfaces and presenting a nip of constant width therebetween and a diameter which is considerably smaller than that of the working rolls.

When practicing the method of the present invention in connection with continuous casting techniques where the casting has an elongate cross-section, the casting is first cut into sections of suitable length and the sections rolled to the desired shape and size, optionally after adjusting the temperature of the sections to a magnitude suitable for hot rolling purposes. The method of the present invention is thus totally independent of the rate at which the casting is formed.

Another object of the present invention is to provide a rolling mill which is not encumbered with the aforementioned disadvantages and which can be used for practicing the novel method of the invention. For the purpose of achieving this latter object, there is provided in accordance with the invention a rolling mill for producing a semi-finished metal section from a metal section having a substantially rectangular cross-section and with which the width of two opposing first sides exceeds the width of the two second sides, the rolling mill being characterized in that it comprises three pairs of rolls arranged in a straight line in a juxtaposed relationship in a common frame structure, the central pair of rolls comprising a pair of reversably drivable working rolls which can be adjusted to vary the nip therebetween and which are capable of being applied to said second sides of the metal-section to be reduced. The two remaining roll pairs, hereinafter called the guide roll pairs, have a smooth roll surface and a face length which considerably exceeds the face length of the pair of working rolls and the nip present between co-acting rolls extends at right angles to the roll nip of the working roll pair, while the width of the nip of the working rolls is pre-set in a manner such as to coincide with the width of said second sides, i.e. the edge sides, of the metal section, to be reduced. The rolling mill of the present invention is extremely compact and requires but little space, and is also much lighter and cheaper and requires much simpler and less expensive operating equipment than conventional rolling mills. The rolling mill of the present invention is therefore also suited for low-capacity steel and metal works, for which conventional rolling mills are uneconomical, and provides at the same time considerably increased selectivity with respect to the ratio of width to depth of the metal section rolled therein.

Thus, when reducing a metal section by means of the method and rolling mill of the present invention, the section is passed longitudinally backwards and forwards through the rolls without being moved laterally and without being turned about its longitudinal axis between the passes. The working rolls act on said second sides or edge sides of the metal section being reduced and are normally screwed down between each pass. The guide rolls arranged on each side of the working rolls have a smooth, cylindrical barrel and the guide rolls are permanently adjusted with respect to the metal section in question, i.e. the nip of the guide rolls is constant and identical for both guide roll pairs during the entire rolling operation.

The guide rolls, which preferably are driven, serve, among other things, to maintain the correct position of the metal section being reduced for entry into the working roll nip and to guide the section during the rolling operation and to counteract widening of the metal section during the reduction process, thereby maintaining the distance between the first or originally the broadest sides of the metal section. Thus, the guide rolls form effective guide means and replace the guides and operating bars used with conventional rolling mills. The working rolls may have a smooth barrel surface, although each of the rolls is normally and preferably provided with a groove having a width corresponding to the width of the edge sides of the metal section to be reduced. The groove, however, is shallow and preferably has a depth of at most one third the width of the edge sides of the metal section to be reduced, and hence the effective guidance afforded by the guide rolls is required when feeding the metal section between the nip of the working rolls and while reducing said metal section between said rolls, in order to prevent the metal section being reduced from becoming misaligned or deformed, as a result of the metal section climbing over the edges of shallow grooves arranged in the working rolls during the rolling operation.

The roller paths located in front of and behind the rolling mill of the present invention may be of very narrow construction, and when using horizontal working rolls and vertical guide rolls, as is preferred, the rollers of the roller paths may be provided with grooves to effectively support the metal section being reduced, since the width of the metal section being reduced is constant during the entire rolling operation. Owing to the effective guide effect obtained by the guide rolls, the rollers of the roll paths may, if the guide rolls are driven — as is preferred according to the invention — be freely rotatable or may be freely rotatable during the actual rolling operation and arranged to be driven substantially only when feeding the metal section to be reduced to the rolling mill or removing the finally reduced metal section therefrom.

If the amount by which the section is reduced on each pass is excessively small, a decrease in width is obtained at the center portion of the section, which means that this portion of the section is not surface worked by the pair of guide rolls, thereby incurring the risk of surface faults. This risk can be eliminated and the capacity of the rolling mill increased by using, in accordance with the invention, working rolls having a diameter which is at least 0.8 times the original height or depth of the section and a greater reduction is made per pass, suitably a reduction of the order of 0.08–0.12 times the diameter of the working rolls.

In order to obtain the desired guiding effect of the guide rolls, the guide rolls should be located as close to the working rolls as possible. In accordance herewith it is preferred that the distance from the nips of the guide roll pairs to the nip of the working roll pair is at most $(D+d)$, preferably at most $0.7\ (D+d)$, where D is equal to the diameter of the working rolls and d is equal to the diameter of the rolls of the guide roll pair in question. Further, the diameter of the guide rolls is suitably only about 0.25–0.50 times that of the working rolls.

Although the invention is not restricted thereto, a metal section having a width relationship between the broad side and the edge side of a ratio in the range of 2:1 to 5:1 and preferably 3:1 to 4:1, can be reduced preferably by means of the apparatus and method of the invention. Without being turned around its long axis, the metal section can be reduced to such an extent by means of the working rolls that the metal section obtains a width relationship between the original broad side and edge side of 0.2–1.0, wherewith the metal section is lengthened from 2 to 25 times its original length, and a width relationship of 0.25–0.33, whereby the metal section is lengthened from 6 to 20 times its original length. For example, a continuously cast metal section whose broad sides are 300 mm in width and whose edge sides are 90 mm in width can be reduced to such an extent while utilizing the same barrel region of the working rolls that, while constantly maintained the width of the edge sides, the original broad side obtains a width of 27 mm. The rolled section can then be charged directly to a continuously operating finishing rolling mill.

The invention will now be described in more detail with reference to an embodiment of the novel rolling mill illustrated in the accompanying drawing, in which:

FIG. **1** is a perspective and diagrammatically view of the working roll pair and guide roll pairs of a rolling mill constructed in accordance with the invention, and also illustrates portions of two roller conveyor paths connected to both sides of the rolling mill and a metal section being reduced in the mill, portions of one working roll being cut away to enable the construction of the roll to be seen more clearly.

FIG. **2** is a front view of the working rolls illustrated in FIG. **1**, and shows the rolls subsequent to the metal section having been finally reduced therebetween.

FIG. **3** is a diagrammatic and perspective view of the rolling mill according to the invention and shows the arrangement of the working rolls and guide rolls in a common frame structure, of which structure portions have been cut away to illustrate the construction more clearly.

In FIGS. **1–3**, the reference numerals **10** and **11** indicate the upper and lower rolls of a pair of horizontally extending working rolls. The working rolls **10, 11** are arranged between two pairs of vertically extending guide rolls located close to said working rolls, one pair of guide rolls being shown at **12** and the other at **13.** It will be understood, however, that the invention is not restricted to the illustrated orientation of the working rolls and guide rolls, but that the working rolls may extend vertically or be inclined to the horizontal plane and that the guide rolls may extend horizontally or be displaced to an angle of 90° relative to the working rolls when seen in the rolling direction. FIG. **3** illustrates the working and guide rolls mounted in a common frame structure, comprising an intermediate frame **14,** in which the working rolls **10, 11** are journalled for rotation and for movement towards and away from each other, and two outer frames **15, 16,** in which the guide rolls **12** and **13** are mounted for rotation. In the illustrated embodiment, the frames are joined together to form a frame structure or stand by means of bolts **17.**

The working rolls **10, 11** have radial bearings **18** and axial bearings **19,** which are housed in bearing housings **20** and **21.** The bearing housings **21,** of which only one is shown in FIG. **3,** are stationarily mounted in the frame **14** and accomodate the bearings **18, 19** of the lower and thus stationary working roll **11,** while the bearing housings for the bearings **18, 19** of the upper working roll **10** are connected with or form a portion of a yoke structure **22,** which is mounted for vertical movement in the frame **14** and arranged to be displaced upwards and downwards for the purpose of varying the size of the nip of the working rolls and for screwing down the upper working roll **10,** by means of a hydraulic motor shown at **23.** The working rolls **10, 11,** are provided at one end thereof with driven trunnions **24,** intended to be connected in a conventional manner to a reversible drive motor (not shown) via a drive spindle **25** (FIG. **3**).

Similarly to the lower working roll **11,** the vertical guide rolls **12** and **13** are also journalled radially and axially in bearing housings **26** in respective frames **15** and **16.** Only three bearing housings **26** for the rolls **12** are shown in the frame **15** in the drawing. The bearing housings not shown in the drawing for the rolls **13,** however, are arranged in the same manner as the bearing housings for the guide rolls **12.** The bearing housings **26** are arranged to be stationary, but are supported laterally by means of wedges **27,** which in turn bear against the inside of the vertical portions of the associated frame, and by means of exchangeable distance means **28,** so that adjustment of re-setting of the bearing housings and therewith the nip of the guide rolls is made possible, for example to permit such adjustment to be made after grinding the barrel surface of the guide rolls **12, 13** or when it is desired to adjust the rolling mill in respect of metal sections **29** having a different width of the edge side **30.**

Similarly to the working rolls **10, 11,** the guide rolls **12, 13** are provided with trunnions **31** which are driven in a conventional manner, via spindles **32,** by one or more reversible motors **33.** As will be seen, the illustrated drive arrangement is shown in extremely simplified form. The arrangements required to drive sequentially arranged rolls at different speeds are, however, known to those skilled in the art, and although such arrangements form part of the novel rolling mill they do not constitute part of the present invention and are not therefore disclosed in detail.

As indicated by the rollers **34** in FIG. **1,** roller paths are arranged on both sides of the rolling mill for conveying the metal section **29** to the rolling mill and the finally rolled metal section **35** (FIG. **2**) away therefrom.

Although when used for reducing certain metal materials the working rolls **10, 11** may have a smooth barrel surface, it is mostly to advantage, and in a number of cases necessary, that the rolls are provided with shallow grooves **36,** as illustrated in the drawing, the grooves **36** being located exactly in register with the nips of the guide roll pairs and have a width which is equal to the width of said nips. Although the grooves **36** are rectangular in the illustrated embodiment, they may, in accordance with the invention, be at least slightly rounded.

When using the rolling mill of the present invention, a metal section **29** to be reduced and the width of the edge sides **30** of which coincide with the permanently adjusted width of the nips of the guide rolls can be conveyed by means of the rollers **34** to one side of the rolling mill, where the metal section is engaged, for example, by the guide rolls **12** and fed to the working rolls **10, 11,** the width of the nip of which has been adjusted so as to be slightly less than the width of the broad sides **37** of the metal section to be reduced. The distance between the radial bearings **18** of the working rolls should therewith be as short as possible, suitably at most twice the smallest width of the metal section **29.** In this respect, the diameter of each working roll **10** or **11** should be substantially equal to or greater than the height or depth of the highest metal section **29** to be rolled down in the rolling mill, thereby obtaining satisfactory working of the metal section throughout its height while at the same time a high degree of reduction can be had with each pass and local spreading — so-called dog bone profile — can be substantially avoided. The metal section **29** being reduced is engaged on the exit side of the working rolls by the guide rolls **13,** which reduce the section to its original width in those instances when the width of the section has been increased in the working rolls. The diameter of the guide rolls **12, 13** may suitably have a diameter in the region of about 0.25–0.50 times the height of the highest metal section to be rolled in the mill. In this way the surface layer of the broad sides of the section **29** is worked in a manner such as to greatly eliminate surface faults in the finished section. When the end **38** of the metal section **29** has passed through the working rolls **10, 11,** the upper working roll **10** is moved slightly downwardly and a new pass is made in the opposite direction by reversing the drive direction of the roll **10, 11, 12** and **13.** Rolling is repeated in passes in the described manner, until the metal section being reduced has obtained the desired reduction, whereafter the rolled metal section **35** is removed from the rolling mill by means of the rollers **34.**

The invention is not restricted to the described and illustrated embodiment, but the method can be modified within the scope of the following claims.

What is claimed is:

1. A method for producing a semi-finished metal section from an elongated piece of stock of rectangular cross section having two opposing first sides of greater width than the remaining two second sides, said method comprising:

a. passing the stock between two working rolls contacting the second sides, said working rolls having a diameter of at least 0.8 times the width of said first sides and being mounted for adjustable movement toward each other, and two pairs of guide rolls positioned on either side of the working rolls and contacting the first sides, said guide rolls having a smaller diameter than the working rolls and presenting a nip of constant width therebetween;

b. reversing the direction of movement of the stock and again passing it between the rolls without turning the stock around its longitudinal axis;

c. guiding the stock into and out of the roll nip during successive passes;

d. adjusting the working rolls during successive passes to bear against the second sides and to reduce the width of the first sides while maintaining a constant width between the guide rolls.

2. The method of claim **1** including the step of using a metal stock having a width relationship between said first and said second sides of 2:1 to 5:1.

3. The method of claim **1** including the step of reducing the metal stock by means of said working rolls to a width relationship between said first and said second sides of 1:5 to 1:1, whereby the metal stock is extended to 2–25 times its original length.

4. The rolling method of claim **1** including the use of working rolls having smooth barrel surfaces.

5. The method of claim **1** including the use of working rolls having shallow grooves, the width of which corresponds to the width of said second sides of the metal stock to be reduced and a depth which at most is one third of the width of said second sides of the metal stock.

6. The method of claim **1** including the step of using guide rolls having a diameter of from 0.25–0.50 times the diameter of the working rolls.

* * * * *