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Vydrin et al.

[11] **3,911,713**

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[54] **METHOD OF ROLLING METAL SHEET ARTICLES**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 157,257, June 28, 1971, abandoned.

[52] **U.S. Cl.** **72/205;** 72/366

[51] **Int. Cl.²** **B21B 39/08;** B21B 1/00

[58] **Field of Search** 72/205, 232, 199, 366

[56] **References Cited**

UNITED STATES PATENTS

3,238,756	3/1966	Coffin, Jr.	72/234 X
3,253,445	5/1966	Franek	72/205 X
3,709,017	1/1973	Vydrin et al.	72/205

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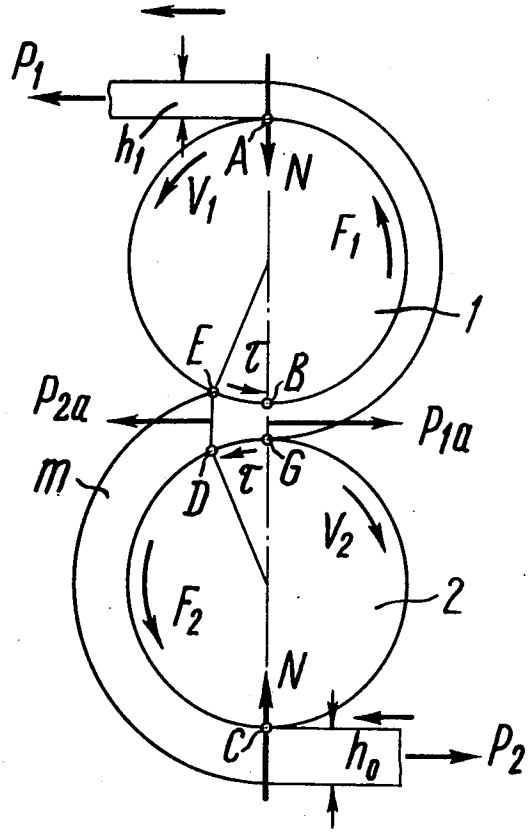
[57] **ABSTRACT**

A method of rolling metal sheet articles between the driving rolls, in which the rolls of an adjacent pair are rotated in opposite directions at different peripheral speeds, with tensile forces being applied to the input and output portions of the article by successively enveloping the rolls by the article, at ratios of the peripheral speeds of the rolls equal to the ratios of the thicknesses of the article before and after the rolling in the pair of adjacent rolls and at a speed of movement of the output portion of the article equal to the peripheral speed of the roll rotating at a higher peripheral speed, while maintaining a constant pressure on the rolls regardless of any change in the distance therebetween.

2 Claims, 2 Drawing Figures



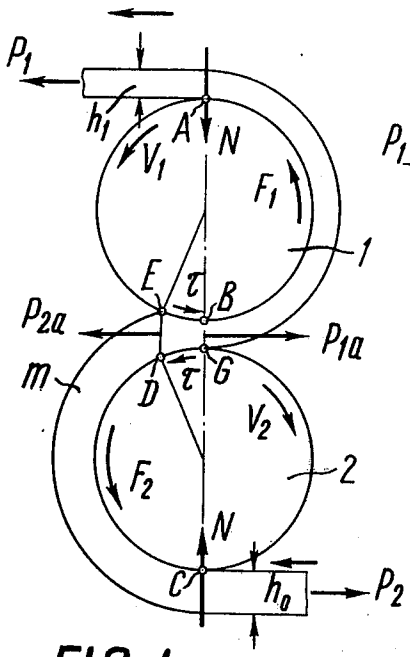

P1
h1
V1
A
N
F1
1
E
τ
B
P2a
P1a
m
D
τ
G
V2
F2
2
N
C
h0
P2

FIG. 1

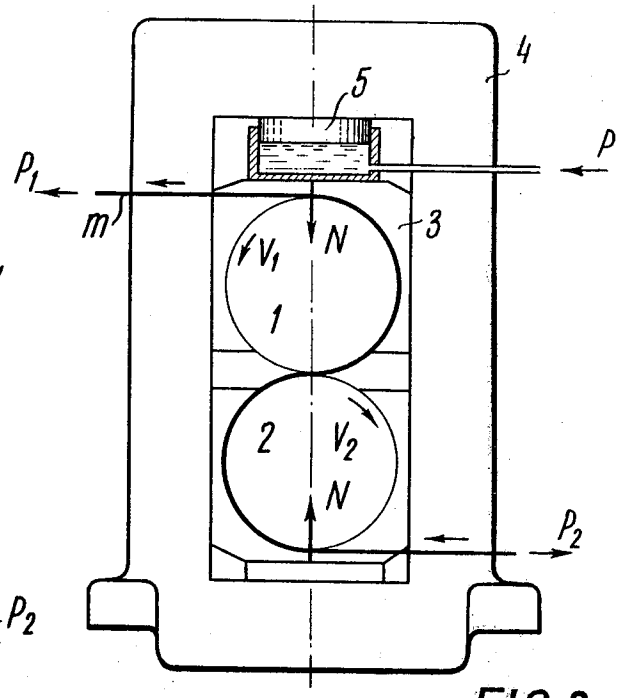

4
5
P
P1
m
V1
N
3
1
2
V2
N
P2

FIG. 2

METHOD OF ROLLING METAL SHEET ARTICLES

BACKGROUND OF THE INVENTION

The present application is a continuation-in-part application of our pending U.S. application No. 157,257 filed June 28, 1971, now abandoned.

The present invention relates to a method of rolling metal sheet articles such as strips, bands, sheets, and foil, preferably in a cold state.

PRIOR TECHNIQUES

Known in the art is a method of rolling metal sheet members (U.S. Pat. No. 3,709,017), in which the rolls of an adjacent pair of rolls are rotated in opposite directions at different peripheral speeds, with tensile forces being applied to the input and output portions of the article by successively enveloping the rolls by the article at ratios of the peripheral speeds of the rolls equal to the ratios of the thicknesses of the article before and after the rolling in the adjacent pair of rolls and at a speed of movement of the output portion of the article equal to the peripheral speed of the roll rotating at a higher peripheral speed.

When effecting this method, the rolling mill is adjusted for predetermined reduction by means of a special screwdown arrangement used for setting the rolls into a required position. The screwdown arrangement of the mill with a mechanical or electrical drive of the screw housings is complicated and requires high precision in its manufacture. Furthermore, said screwdown arrangement complicates the control of the rolling operation.

Also known is a method of forming of articles, realized in a device described in the U.S. Pat. No. 3,253,445, consisting in elongating an article between the adjacent rolls rotating in opposite directions at different peripheral speeds and at a pressure on the contact surface of the rolls with said article smaller than that required for plastic deformation of the article. The reduction of the article by means of rolls is not provided for under this method.

However, the elongation of the article without its reduction by the rolls results in a sharply decreased value of the maximum possible deformation of the article, whereas attempts to increase such deformation have resulted in breaks in said article. Therefore, such method of forming is employed only for levelling and tempering of the article. For rolling articles with a higher level of their deformation such method is not practical.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention is to provide a method of rolling metal sheet articles, making it possible to produce accurately sized sheet articles with the self-setting of the rolls into a predetermined position.

The above and other objects of the invention are accomplished by providing a method of rolling metal sheet articles by way of reduction said article between the driving rolls, which involves the steps of: imparting to a pair of adjacent rolls, the rotation from individual motors or with the aid of mechanical transmission means from one motor, in opposite directions at different peripheral speeds; applying, to the input and output portions of the article, tensile forces smaller than a force required for a plastic deformation of the article, by way of successive enveloping of the rolls of said pair by the drawn article at equal ratios of the peripheral speeds of the rolls and the thicknesses of the article before and after the rolling in the pair of adjacent rolls and at a speed of movement of the output portion of the article equal to the peripheral speed of the roll rotating at a higher peripheral speed. According to the invention, the rolling operation is carried out by maintaining a constant pressure on the rolls by a hydraulic pressure head, sufficient for the plastic deformation of the article by way of its reduction with the rolls, which permits attaining the required deformation regardless of any change in the distance between said rolls.

The present invention thus provides a method of rolling metal sheet articles between the driving rolls, which makes it possible to obtain sheet articles of uniform thickness without using complex screwdown arrangements and without any preliminary adjustment of a gap between the rolls.

The invention will be more apparent from the description of an exemplary embodiment with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates apparatus used in a method of rolling metal sheet articles between the driving rolls according to the invention; and

FIG. 2 illustrates a diagram of a hydraulic cylinder in the working stand of the rolling mill.

DETAILED DESCRIPTION OF THE INVENTION

In the process of rolling sheet metal articles according to the present method, rolls **1** and **2** (FIG. 1) are rotated by drives (not shown) in opposite directions (shown with arrows) at different peripheral speeds V_1 and V_2.

The rolls are rotated by individual motors (not shown), which permits, if necessary, to vary the ratio of the rolls rotation speeds over a wide range.

The rolls may also be actuated with the aid of one motor and a mechanical transmission therefrom, e.g., by means of pinion drives (not shown). Such a drive permits the maintenance, with high accuracy, of the predetermined ratio of the rolls rotation speeds without the necessity of providing for intricate automatic control systems.

The roll **1** is rotated at a higher peripheral speed than the roll **2.** The ratio of the peripheral speeds of the rolls **1** and **2** is to be equal to the ratio of the thicknesses of an article *m* before and after the rolling in the pair of adjacent rolls **1** and **2,** i.e.,

$$\frac{V_1}{V_2} = \frac{h_0}{h_1}$$

(the direction of the article rolling is shown by arrows in FIG. **1.**).

To reduce tension P_1 of the output portion of the article *m* and tension P_2 of the input portion of this article, the latter is bent, under tension, around the rolls **1** and **2** so as to utilize forces F_1 and F_2 of static friction on arcs AB and CD of bending rolls **1** and **2** by the article *m* to forces P_1a and P_2a in deformation zone BEDG, which are smaller than the force required for the plastic deformation of the article. The static friction is the friction that develops between the article and the roll when said article and roll are moved without slipping. Inasmuch as the forces F_1 and F_2 of static friction on arcs

AB and CD of bending rolls **1** and **2** by the article *m* may vary over a wide range under the same tension P_1 of the output portion of the article and tension P_2 of the input portion of the article, the process of rolling will run smoothly, i.e., without slipping of the article *m* on arcs AB and CD of bending rolls **1** and **2** (the direction of application of the forces P_1, P_2, F_1, F_2, P_1a and P_2a are shown by arrows in FIGS. **1** and **2**).

The diagram of FIG. **1** makes it possible to judge the effect of the friction force τs within the deformation zone BEDG for the process of deformation; the friction forces τ on the opposite contact surfaces BE and DG of the deformation zone are equal and act in opposite directions so that the pressure N acting on the rolls at the side of the article *m* being rolled is considerably reduced (the direction of application of the pressure N is shown with arrows).

When effecting the present method, the rolling operation is effected maintaining a constant pressure on the rolls regardless of any change in the distance between the rolls, which permits obtaining the required deformation of the article.

A required value of pressure on the rolls is preset sufficient for the plastic deformation of the article by its reduction with the rolls. The constant pressure on said rolls is maintained by means of a hydraulic pressure head.

As shown in FIG. **2**, provided between pads **3** of the upper roll **1** and a frame **4**, there is installed a hydraulic cylinder unit **5**. The pressure N on the rolls is created by feeding liquid under pressure *p* to the hydraulic cylinder unit **5** (the direction of feeding is shown with arrow) by means of a hydraulic accumulator (not shown). The pressure N from the hydraulic cylinder **5** is transmitted to the rolls **1** and **2** between which said article *m* is being rolled.

The thickness h_o of the input portion of the article *m* (FIG. **1**) may vary due to the irregularities of the initial thickness. When a thicker portion of the article *m* is fed into the gap between the rolls **1** and **2**, the pressure N on the rolls remains unchanged, and the rolls **1** and **2** are moved apart by a distance proportional to the increase in the thickness of the article, while the relative deformation thereof remains constant, i.e.,

$$\frac{h_o}{h_1} = \frac{V_1}{V_2}$$

The constant relative deformation of the article is maintained due to reserve of the forces F_1 and F_2 of the static friction on the arcs AB and CD of bending the rolls **1** and **2** by the article *m* and due to the constant speeds of the input and output portions of the article.

An advantage of the present method of rolling metal sheet articles consists in obtaining constant elongation of the article $\tau = V_1/V_2$ at constant pressure and in the presence of initial differences in the thickness of the article, and this is of a great practical importance. At present, during the cold rolling of metal sheet articles, the magnitudes of deviations from the average thickness increase by a factor of **2** to **3**. The present method of rolling metal sheet articles makes it possible to keep the relative deviations of thickness of a hot-rolled blank constant during cold rolling up to obtaining a finish without using the screwdown arrangements and accurate adjustment of the rolls.

The experimental rolling of bands with a thickness of 0.05 to 2.0 mm and made from carbon and alloyed steels, has proved the advantages and promises of the present method of rolling metal sheet articles.

What we claim is:

1. A method of rolling metal sheet articles by reduction of an article between driving rolls, comprising the steps of: imparting to a pair of adjacent rolls the rotation from individual motors in opposite directions at different peripheral speeds; applying to input and output portions of the article tensile forces smaller than a force necessary for the plastic deformation of the article through successive enveloping of the rolls of said pair by means of the article under tension at equal ratios of the peripheral speeds of the rolls and the thicknesses of the article before and after the rolling in the pair of adjacent rolls and at a speed of movement of the output portion of the article equal to the peripheral speed of the roll rotating at a higher peripheral speed; maintaining, by means of a hydraulic head, a required constant pressure on the rolls sufficient for the plastic deformation of the article by way of its reduction with the rolls, which permits attaining the required deformation of said articles regardless of any change in the distance between the above rolls.

2. The method of rolling metal sheet articles by reduction of an article between driving rolls, comprising the steps of: imparting to the pair of adjacent rolls the rotation with the aid of a mechanical transmission from one motor in opposite directions at different peripheral speeds; applying to input and output portions of the article, tensile forces smaller than a force necessary for the plastic deformation of the article by way of successive enveloping of the rolls of said pair by means of the article under tension at equal ratios of the peripheral speed of the rolls and the thicknesses of the article before and after rolling in the pair of adjacent rolls and at a speed of movement of the output portion of the article equal to the peripheral speed of the roll rotating at a higher peripheral speed; maintaining, by means of a hydraulic head, constant pressure on the rolls, sufficient for the plastic deformation of the article by way of its reduction with the rolls, which permits attaining the required deformation of the article regardless of any change in the distance between the rolls.

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