Oct. 20, 1970 T. W. ABERNATHY ET AL 3,534,576

TAPER ROLLING MILL

Filed May 24, 1968

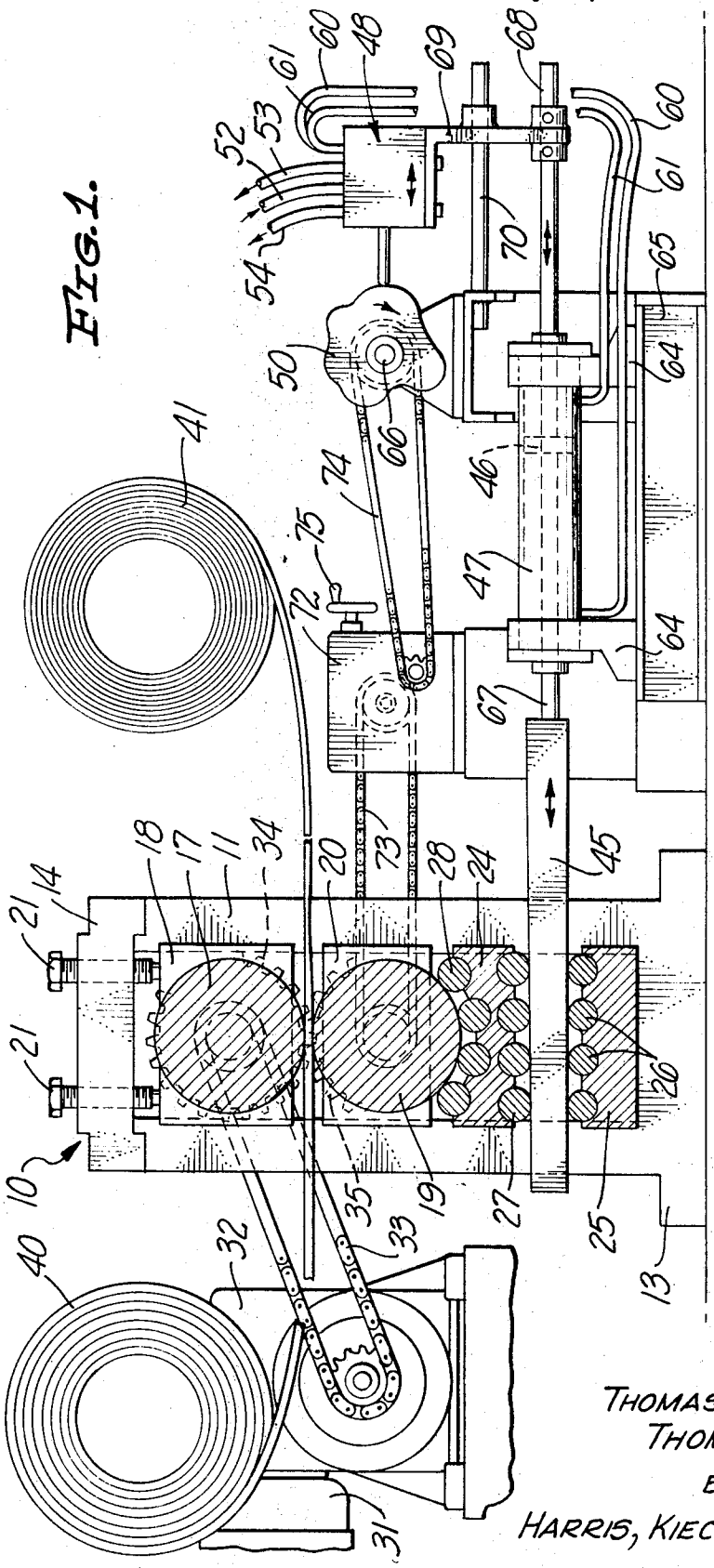


FIG. 1.

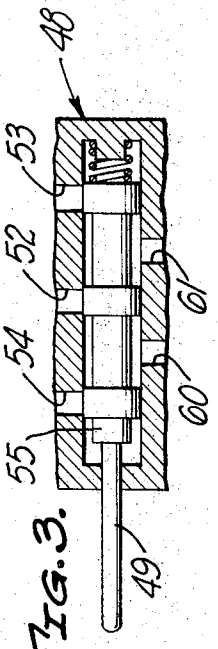


FIG. 3.

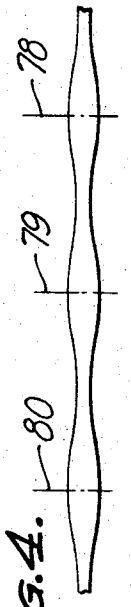


FIG. 4.

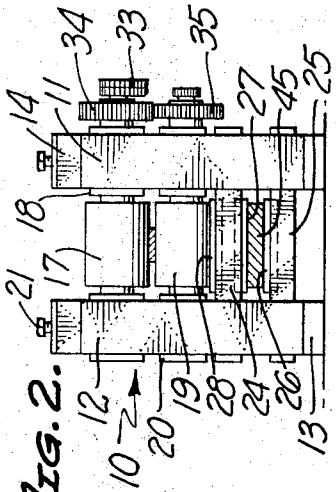


FIG. 2.

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United States Patent Office

3,534,576
Patented Oct. 20, 1970

3,534,576

TAPER ROLLING MILL

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Filed May 24, 1968, Ser. No. 731,986
Int. Cl. B21b *31/20*
U.S. Cl. 72—240 9 Claims

ABSTRACT OF THE DISCLOSURE

A rolling mill for rolling a strip with a varying thickness, particularly suited for rolling a continuous strip with a cyclically repeating thickness pattern. Apparatus for moving one roll relative to another roll and comprising sets of smaller pressure rollers engaging a roll and a tapered actuating bar. A hydraulic system with a continuous template for driving the actuating bar as a function of roll rotation.

This invention relates to a new and improved rolling mill for rolling a strip with a controlled varying thickness.

Various forms of rolling mills for producing strips with varying thicknesses have been proposed in the past but have suffered from a variety of disadvantages and none are in widespread commercial use at the present time. It is an object of the present invention to provide a new and improved rolling mill which is particularly adapted for the rolling of a continuous strip and for producing a cyclically repeating thickness pattern in a continuous strip. An additional object is to provide such an apparatus wherein the thickness pattern can be readily changed by substituting a cam or template. A further object is to provide such an apparatus wherein the length of a strip for a single cycle can be readily varied by controlling the roll-to-cam coupling ratio.

It is a further object of the invention to provide a new and improved rolling mill wherein one of the rolls is moved with respect to the other for varying the size of the rolling space, with roll movement being produced by a plurality of additional rollers spreading the roll moving forces over the surface of the roll to reduce roll surface deterioration, and to reduce the amount of force required for roll movement.

It is a specific object of the invention to provide a rolling mill incorporating a frame and first and second rolls mounted therein, with one roll movable relative to the other providing a strip rolling space therebetween. A further object is to provide such a mill incorporating a movable pressure roller saddle mounted in the frame and carrying upper and lower sets of pressure rollers for engaging a movable roll and an actuating bar, with the actuating bar moving between the lower set of rollers of the saddle and a fixed set of rollers in the frame. An additional object is to provide such a structure incorporating means for moving the bar relative to the rollers for producing movement of the saddle and roll. A further object is to provide such a structure incorporating hardened and polished sliding surfaces in placed rollers for engaging the bar.

It is another object of the invention to provide such a structure incorporating an automatic control system for controlling the actuating bar movement as a function roll revolution. A specific object is to provide such an apparatus incorporating a template driven by a roll and a template follower for actuating a power unit driving the actuating bar.

The invention also comprises novel details of construction and novel combinations and arrangement of parts,

which will more fully appear in the course of the following description. The drawing merely shows and the description merely describes a preferred embodiment of the present invention which is given by way of illustration or example.

In the drawing:

FIG. 1 is a side view of a rolling mill illustrating a preferred embodiment of the invention;

FIG. 2 is an end view of the roll stand of FIG. 1;

FIG. 3 is a diagrammatic view of a typical control valve actuated by the cam follower; and

FIG. 4 is a side view of a typical roll strip produced by the mill of FIG. 1, with the thickness exaggerated for illustrative purposes.

The apparatus as illustrated in FIGS. 1 and 2 includes a roll stand **10** comprising a base **13** and vertical frame members **11, 12**, each closed by a cap **14**. A roll **17** is mounted in the stand in bearing blocks **18**. Another roll **19** is mounted in the stand in bearing blocks **20**. Screws **21** in the caps **14** provide for roll leveling. A roller saddle **24** is mounted in the stand below the roll **19**. A roller block **25** is mounted in the stand resting on the frame members **11, 12**.

A set of four rollers **26** is mounted in the block **25**. Another set of four rollers **27** is mounted in the saddle **24** facing the set **26**. Another set of four rollers **28** is mounted in the saddle **24** in a curved arrangement, with the upper surface of the set of rollers **28** corresponding to the surface of the roll **19**. The rollers may be positioned in conventional bearings (not shown) carried in the saddle **24** and block **25**.

Means are provided for driving the rolls **17, 19** in rotation, and typically may include a motor **31** mounted on a gear reduction unit **32**, with the gear reduction unit connected to the roll **17** by a chain **33**. The roll **19** may be driven from the roll **17** through gears **34, 35**, which are illustrated here as equal diameter gears with relatively large diametral pitch to permit movement of one roll relative to the other roll.

The material to be rolled passes between the rolls **17, 19**. The embodiment illustrated is particularly adapted for handling a continuous strip of material which may be fed from a raw stock roll of material **40**, through the space between the rolls **17, 19**, and onto a finish stock roll of material **41**.

An actuating bar **45** is positioned between the roller set **26** and the roller set **27**. The bar **45** is tapered and is moved longitudinally to vary the distance between the roller sets **26** and **27**, thereby raising and lowering the saddle **24** and the roll **19** to vary the spacing between the rolls **17** and **19**.

In an alternative arrangement a hardened and highly polished surface may be used in place of the set of rollers **27** at the bottom of the saddle **24** and in place of the set of rollers **26** at the top of the block **25**. The actuating bar **45** would operate against such surfaces, using a high pressure lubricant.

In the embodiment illustrated, the actuating bar **45** is driven by a hydraulic piston **46** and cylinder **47** controlled by a valve **48** which in turn is actuated by a pin or cam follower **49** riding on a continuous cam or template **50**. A typical control valve is illustrated in FIG. 3, with fluid under pressure being supplied on line **52** and exhausting on lines **53** and **54**, depending upon the position of the valve element **55** which is moved by the rod **49**. When the rod **49** is moved to the right, fluid under pressure is directed through line **60** to the left end of the cylinder **47**, moving the piston **46** to the right. Fluid is exhausted from the right end of the cylinder **47** via line **61** back to the valve and out through line **53**.

The cylinder **47** is mounted in appropriate support blocks **64** on a frame **65**. The template **50** is mounted

on the frame **65** for rotation about a shaft **66**. The left end **67** of the piston **46** is connected to the actuating bar **45**. The right end **68** of the piston **46** projects from the cylinder and the valve **48** is carried thereon, on a valve mounting bracket **69**. The mounting bracket **69** may also ride on a guide shaft **70** carried on the frame **65**.

The design and operation of the control valve and the cylinder and piston assembly are conventional and various modifications thereof may be utilized. When the rod **49** is moved in one direction to open the valve, the piston will be moved in the same direction to move the actuating bar and also to move the valve body so as to close the valve, such that the motion of the actuating bar follows the motion of the rod **49**.

The template **50** preferably is rotated as a function of movement of the strip of material between the rolls and a preferred structure for accomplishing this motion is illustrated. The roll **19** is connected to the input of a gear box **72** by a chain **73**. The output of the gear box **72** is connected to the shaft **66** by another chain **74** such that the template **50** is driven in rotation by the roll **19**. The ratio of template rotation to roll rotation may be varied by varying the setting of the gear box **72**, as by manually turning the control handle **75**. The configuration of the template **50** is somewhat exaggerated for purposes of illustration.

In the operation of the mill, the distance between the rolls **17**, **19** and therefore the thickness of the strip being rolled, is directly controlled by the position of the actuating bar **45**, which in turn is controlled by the position of the template **50**. Hence, the thickness pattern called for by a particular template will be repeated for each revolution of the template. A section of a typical strip after rolling is illustrated in FIG. 4, where the thickness has been exaggerated for illustrative purposes. Assuming a starting point at **78**, the strip starts at a relatively thick condition and is rolled to a relatively thin condition and returns to the initial relatively thick condition at **79**. This pattern is then repeated between the points **79** and **80**. After the complete roll of stock material has passed through the mill, the roll of material can be sheared at the points **78**, **79**, **80** to provide individual strips of identical thickness pattern. Thus, it is seen that the apparatus of the invention provides for continuously rolling a strip of material with a cyclically repeating thickness pattern. The apparatus provides a positive control for the thickness throughout the rolling operation. The apparatus provides for changing the pattern by changing the template and by changing the ratio between roll rotation and template rotation. The provision of the sets of pressure rollers **26** and **27** for engaging the bar **45** and the set **28** for engaging the roll **19** permit utilization of high forces while spreading the forces over large surfaces and thereby substantially reducing the deterioration of the rolls and the actuating bar.

Although an exemplary embodiment of the invention has been disclosed and discussed, it will be understood that other applications of the invention are possible and that the embodiment disclosed may be subjected to various changes, modifications and substitutions without necessarily departing from the spirit of the invention.

We claim:

1. In a mill for rolling a strip with controlled varying thickness, the combination of:

a frame;

a first roll mounted in said frame;

a second roll mounted in said frame for movement relative to said first roll and providing a strip rolling space between said first and second rolls;

a pressure roller saddle mounted in said frame for movement relative to said first roll;

a first set of pressure rollers mounted in said saddle and engaging said second roll;

pressure means on said saddle and said frame defining an actuating space therebetween;

an actuating bar of varying thickness positioned in said actuating space engaging said pressure means;

means for driving at least one of said rolls in rotation to move a strip through said rolling space; and

means for moving said bar relative to said frame to vary the size of said actuating space and thereby vary the size of said rolling space.

2. An apparatus as defined in claim **1** in which said pressure means includes a second set of pressure rollers mounted in said saddle and a third set of pressure rollers mounted in said frame, with said actuating bar engaging said second and third sets.

3. An apparatus as defined in claim **1** including control means for said bar moving means for moving said bar as a function of rotation of one of said rolls.

4. An apparatus as defined in claim **1** including:

a continuous template;

means for coupling one of said rolls to said template in driving relation; and

a template follower engaging said template and energizing said bar moving means as a function of template follower movement to cyclically move said bar through a predetermined pattern as a function of rotation of said one roll.

5. An apparatus as defined in claim **4** in which said means for coupling includes ratio changing means for changing the ratio of roll revolution to template revolution.

6. An apparatus as defined in claim **1** in which said bar moving means includes:

a power cylinder and piston, with said piston connected to said bar;

a control valve for directing fluid under pressure to said cylinder for moving said piston, said valve including a valve body and a valve element, with said valve body connected to said piston;

a template;

means for coupling one of said rolls to said template in driving relation; and

a template follower connected to said valve element and engaging said template, whereby said bar is moved as a function of roll rotation.

7. An apparatus as defined in claim **6** wherein said mill is adapted for rolling a long and continuous strip, and said template is a continuous template, providing for cyclically repeating the pattern of bar movement as a function of a template revolution for a plurality of template revolutions.

8. An apparatus as defined in claim **7** in which said means for coupling includes ratio changing means for changing the ratio of roll revolution to template revolution.

9. An apparatus as defined in claim **1** including:

means for feeding a continuous strip through said rolling space; and

control means for said bar moving means for cyclically moving said bar through a predetermined pattern as a function of rotation of one of said rolls.

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MILTON S. MEHR, Primary Examiner

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,534,576 Dated October 20, 1970

Inventor(s) Thomas William Abernathy et al.

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

In the heading to the printed specification, lines 4 to 6, "assignors to Tronchemics Research, Inc. of California, Sun Valley, Calif., a corporation of California" should read -- assignors to Tronchemics Research Incorporated, South Hackensack, N. J., a corporation of Minnesota --.

Signed and sealed this 23rd day of February 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents

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