COLD ROLLING MILL AND METHOD FOR COLD ROLL FORMING A METALLIC STRIP

Inventors: Udo Brockes, Niederkruchten (DE);
Olaf Norman Jepsen, Siegen (DE);
Michael Zielenbach, Siegen (DE);
Manfred Stachuletz, Dusseldorf (DE);
Angela Stachuletz-Kuhbacher, Dusseldorf (DE)

Correspondence Address:
THE FIRM OF KARL F ROSS
5676 RIVERDALE AVENUE
PO BOX 900
RIVERDALE (BRONX), NY 10471-0900 (US)

Abstract

The invention relates to a method for cold roll forming a metallic strip, a steel strip in particular, comprising a single frame (I), having means for adjusting a roll gap, a winding device (9) which is arranged upstream of the cold roll single frame for unwinding the strip (8), and a winding device (10) which is arranged downstream of the cold roll single frame (I) for winding the strip (8). The aim of the invention is to eliminate all problems connected to strip tension when the thickness of the strip varies and to increase the speed of the strip. To achieve this, a strip accumulator (2) is arranged between the upstream winding device (9) and the single frame (I) for controlling the mass flow and/or tension of the rolling process, particularly when flexible rollers are used.
FIG. 3
COLD ROLLING MILL AND METHOD FOR COLD ROLL FORMING A METALLIC STRIP

[0001] The invention relates to a cold rolling mill and to a method of cold rolling metal strip, especially steel strip, with a single-frame rolling mill with means for adjusting a rolling gap and a coiler device upstream of the cold rolling mill frame for uncoiling the strip fed to the mill.

[0002] In previously known cold rolling with single frame mills, only incoming strip with a narrow thickness tolerance can be used and the strip thickness reduction is maintained constant over the strip length. To the extent that these requirements cannot be met, the strip speed is greatly limited and problems have to be expected with respect to the rolling operation.

[0003] In WO 99/55474 a Steckell rolling mill is described for hot rolling, having at least one reversible rolling mill frame as well as coilers disposed upstream and downstream thereof. Between the coilers and the reversing mill frame, respective loop lifters are provided which supply actual values for a tension control and a mass flow control. Such a Steckell rolling mill, however, relates to hot rolling mills and, therefore, not to any cold rolling process.

[0004] Starting from the background of cold rolling technology, the invention has as its object to provide a method of cold rolling as well as a cold rolling mill with a single-frame mill and which in spite of changes in the strip thickness and large strip speeds does not have any problems with respect to the mass flow and/or the strip tension.

[0005] These objects are achieved with a cold rolling mill with the features of claim 1 as well as by a method with the features of claim 3. Advantageous further developments are described in the dependent claims.

[0006] According to the invention it is proposed that between the upstream coiler and the single mill frame for the cold rolling, a strip storage is disposed for a mass flow regulation and/or a stripper tension regulation of the rolling process, especially in the case of flexible rolling.

[0007] Because of the strip storage in the strip travel direction upstream of the single mill frame, mass flow changes or strip speed changes which have their origins in a variation in the strip thickness or a variation in the strip thickness pattern in flexible rolling are compensated. This has the advantage that a rolling remains possible at higher speeds even in the case of changing strip thicknesses or strip thicknesses which sequentially follow one another.

[0008] The speed changes because of changes in the strip thicknesses in the rolling gap are greatest at the inlet side of the single mill frame so that the strip storage according to the invention is provided at least at the inlet side or in the inlet region. Since the detriment caused by changes in the strip thickness pattern in the case of flexible rolling occur as well, although they are not as great, at the outlet side and are reflected in changes in the strip speed at the outlet side in a preferred embodiment of the invention, it is also proposed to dispose a strip storage at the outlet side of the single mill frame.

[0009] Preferably each of the strip storages has a dancer roller. A dancer roller or a dancer roller arrangement includes a roller which is pressed with a certain force against the strip and which is adjustable within a certain angle so that a loop is formed in the strip around the dancer roller and such that the loop length varies with the position of the roller. In this manner more or less of the strip can be stored. According to a preferred embodiment of the invention, a respective dancer roller is provided both at the inlet and at the outlet regions of the single mill frame and both are advantageously of identical construction.

[0010] The proposed method is described in detail with the aid of the following Figures in which the individual Figures show:

[0011] FIG. 1 a layout of an apparatus of an embodiment of a cold rolling frame according to the invention with flexible cold rolling with respective dancer rollers at the inlet and outlet regions;

[0012] FIG. 2 a detailed elevation of the dancer roller as well as a preferred embodiment of its positioning and control;

[0013] FIG. 3 an overview of the strip tension and mass flow control circuits with flexible cold rolling with a single frame mill;

[0014] FIG. 4 an overview of the strip thickness control circuit in combination with the strip tension control as well as a compensation of the mass flow faults with flexible cold rolling with a single frame mill.

[0015] FIG. 1 provides an overall view of an apparatus having a single frame cold rolling mill 1 with strip storage 2, 3 at both the inlet region 4 and the outlet region 5 of the single frame mill 1 and each of which encompasses a dancer roller 6, 7. The coiled up strip 8 is uncoiled with the aid of a coiling device 9 and is fed into the rolling frame 1 in the direction of the arrow. After traversing the single frame mill 1, the strip is coiled up by means of a second coiler 10. In each of the inlet regions 4 and the outlet regions 5, a respective dancer roller 6, 7 is provided, the dancer coilers being of identical construction and have been illustrated in detail in FIG. 2 with other adjustability. The single frame mill 1 itself is comprised, in the illustrated embodiment, of two backup rolls 11, two intermediate rolls 12 and the working rolls 13, 14. Any other arrangement of rolls in a single frame can also be used. Between the roll frame 1 and the dancer rolls 6, 7, for example at the outlet side 5, a marking device 15 can be arranged in the strip line.

[0016] FIG. 2 shows the mechanism and control of a dancer roller 6 with a flexible cold rolling. With the aid of the adjustment of the dancer roll on the strip 8 with respect to two neighboring rollers 16, 17, a loop is formed in the stripper 8 with a loop length which changes with the position of the dancer roller 6 or its angular setting with respect to the roller 16. The deeper the dancer roller 6 penetrates into the strip 8, the more of the strip which is stored. The illustrated embodiment shows a hydraulic adjustment 18 for the dancer roller 6.

[0017] The dancer roller 6 is associated with a force controller 19. For this control, an actual force value as well as an actual angle value of the positioning of the dancer roller 6 are obtained. This actual force value is supplier to the force controller 19 together with a force setpoint value. In this case, the force setpoint value is not predetermined but rather is calculated from the measured actual angle value and a predetermined setpoint tension. The force control
circuit provides, as a result of the comparison of the setpoint and actual force values, a force correction value which is applied to the positioning unit 18, here a hydraulic piston and cylinder unit for the dancer roller 6. By means of the force correction, a correction of the tension developed by the strip in traction is achieved.

[0018] The actual angle value measured at the dancer roller is also used for the control of the rotary speed setting of the coiler devices (9, 10) and thus torque control of the coilers for mass flow control. For this purpose the actual angle value as well as a predetermined setpoint angle are fed to an angle controller. As a function of the result of the setpoint-actual value comparison, an angle correction value is calculated. This angle correction value serves for control of the speed in the coiler devices for mass flow control.

[0019] An overview of this strip tension control and mass flow control by means of the dancer rollers 6, 7 at the inlet and outlet regions (4, 5) of a cold rolling frame 1 has been shown in FIG. 3. The strip tension control is effected by calculating a setpoint force for controlling the hydraulic setting of the dancer roller, starting from the actual force value while the mass flow control results from control of the speed of the coilers.

[0020] In the control circuit for coiler speed, that is the uncoiler speed or the recoiler speed, the setpoint value is the strip speed. This also serves as a setpoint for the roll speed control.

[0021] With the aid of FIG. 4, the strip thickness control has been shown in the case of flexible rolling. A flexible rolling process means that there will be a change in the rolling gap in the course of rolling and thus an variation in strip thickness patterns over the strip length. A setpoint strip thickness pattern is predetermined. This setpoint value of the course of the strip thickness is used for initial control of the inlet side dancer roller. From the setpoint course of the strip thickness, the change in the inlet speed of the strip in the rolling mill frame is calculated together with the strip tension required for it to maintain a constant strip tension. For mass flow compensation, the inlet tension can be further smoothed out. Additionally the values of the setpoint strip thickness course can be supplied to a thickness controller which with the aid of actual strip thickness values obtained at the inlet and outlet side, corrections and values for the strip thickness can be calculated, these correction values further supplied to a position controller which controls the rolling gap setting in the cold rolling frame.

1. A cold rolling mill for the cold rolling metallic strip (8), especially steel, with a single-frame mill (1) with means for adjusting a rolling gap as well as a coiler device (9) upstream of the single-frame cold rolling mill for unwinding the strip (8) of the single-frame cold rolling mill for unwinding the strip (8) and a coiling device (10) downstream of the single-frame cold rolling mill (1) for winding up the strip (8), characterized in that the upstream coiling device (9) and the single frame rolling mill (1) a strip storage (2) is arranged for a mass flow control and/or strip tension control of the rolling process, especially in the case of flexible rolling.

2. A cold rolling mill according to claim 1, characterized in that in addition to the first strip storage (2) arranged between the upstream coiler device (9) and the single frame mill (1), a second strip storage (3) is arranged between the single frame mill (1) and the downstream coiler device (10).

3. A method of cold rolling a metal strip (8) especially of steel, in a cold rolling mill with a single frame (1) with means for adjusting a rolling gap for the cold rolling of the strip as well as a coiler device (9) arranged upstream of the single frame (1) for unwinding the strip (8) and a coiler device (10) downstream of the single frame (1) for winding up the strip (2), characterized in that by means of the single frame (1) a rolling, especially a flexible rolling is carried out in which the strip thickness during the rolling is continuously changed in accordance with a predetermined pattern and that by means of a strip storage (2) which is arranged between the upstream coiler device (9) and the single frame mill (1) a mass flow control and/or a strip tension control of the rolling process is effected.

4. The method according to claim 3, characterized in that the coiler devices (9, 10) are speed-controlled coiler devices.

5. The method according to claims 3 or 4, characterized in that in a control circuit for the control of the position of the strip storage (2, 3), especially of a dancer roller (6, 7), a force correction value is calculated by means of a force controller from an actual force value and a setpoint force value obtained from the positioning unit (18) whereby the setpoint force value is calculated from an actual angle value derived from the dancer roller and a predetermined setpoint tension value.

6. The method according to one of claims 3 to 5, characterized in that the strip storage (2, 3) is controlled as a function of a known variation in the strip thickness pattern.

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