Jan. 27, 1970 TOSHIYUKI KAJIWARA 3,491,562

SYSTEM AND APPARATUS FOR EFFECTING A CORRECTION OF DEFLECTION OF STRIP STEEL FROM ITS NORMAL PATH OF TRAVEL IN A TANDEM ROLLING MILL

Filed Oct. 10, 1967

FIG. 1

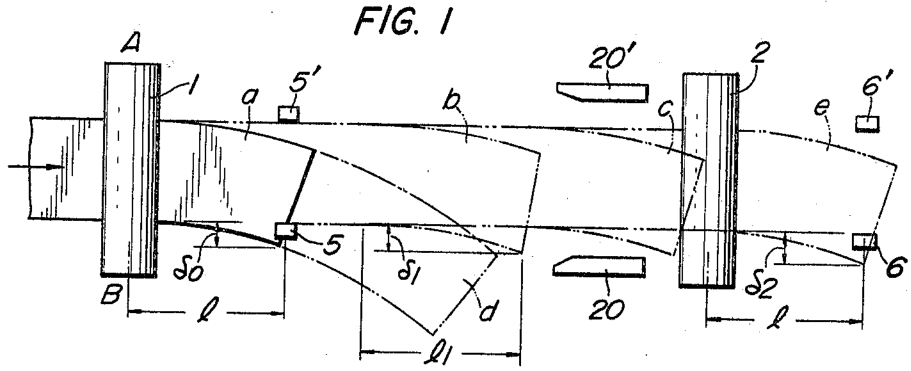


FIG. 2

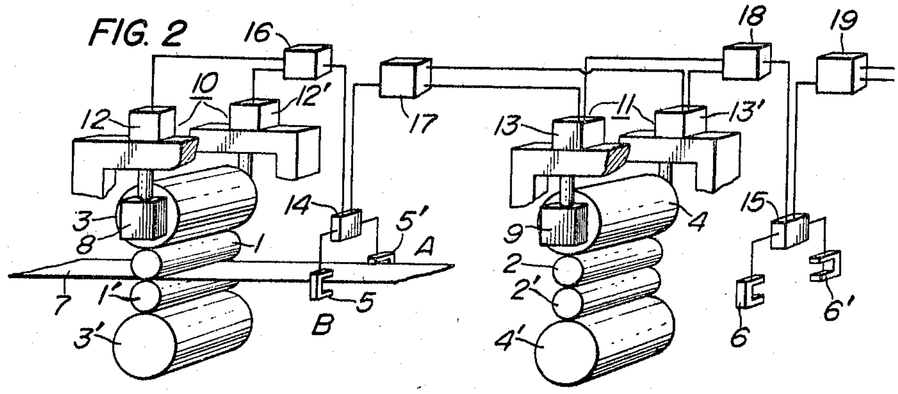
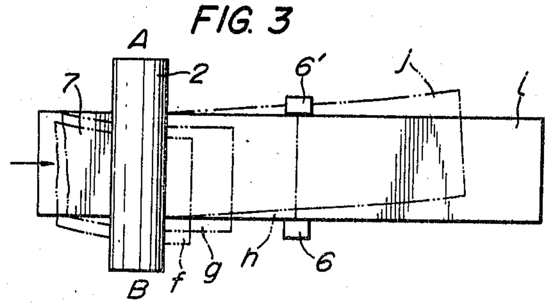


FIG. 3



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3,491,562

Patented Jan. 27, 1970

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3,491,562

SYSTEM AND APPARATUS FOR EFFECTING A CORRECTION OF DEFLECTION OF STRIP STEEL FROM ITS NORMAL PATH OF TRAVEL IN A TANDEM ROLLING MILL

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Filed Oct. 10, 1967, Ser. No. 674,235

Claims priority, application Japan, Oct. 12, 1966, 41/66,611

Int. Cl. B21b *37/04*

U.S. Cl. 72—12 6 Claims

ABSTRACT OF THE DISCLOSURE

System and apparatus for effecting a correction of deflection of a strip from its normal path of travel in a tandem rolling mill in which deflection detection means provided at the outlet of each mill stand gives an instruction signal to deflection correction means of the particular rolling stand concerned and at the same time gives a necessaıy instruction signal to deflection correction means of the succeeding mill stand so as to automatically steering the strip at the threading thereof.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to a system and an apparatus for effecting a correction of deflection of a strip in a tandem rolling mill, particularly in a cold strip mill, whereby deflection of the leading top portion of a strip from its normal path of travel can automatically be corrected.

Marked advances have been made in the art of tandem cold rolling operations to develop a automatic production system of high production rate. With the advent of high speed feeding operations, rolling speed amounts in some cases to over 2,000 meters (about 6,600 feet) per minute.

In a cold strip mill, rolling operations are performed for each coil of a strip, so that upon completion of rolling of one coil the leading end of a strip of another coil should be successively fed to each mill stand. This feeding operation is usually called threading of the strip. No established system has hitherto been available for automatically carrying out these threading operations. The main reason for this is that it is very difficult to quickly effect a correction or compensation for deflection of strip from its normal straight line path of travel for each mill stand. The top portion of strip which comes out of a mill stand is not tensioned until it is bitten by work rolls of the succeeding mill stand. Under these circumstances, the top portion of strip in many cases does not travel in a straight line to be aligned with the center of roll path of the each succeeding mill stand but tends to be deviated from its straight or normal path of travel. Conseqeuntly, the top of strip impinges on a side guide and the strip is prevented from entering between the work rolls of the succeeding mill stand.

Present practice of strip rolling requires an operator to grip the top of a strip and force the same to move through a side guide. According to this practice, operational efficiency is low and additional labor is required. Proposals have been made to effect a correction of deflection of strip from its normal path of travel in conjunction with adjustment of the screw down of work rolls. As subsequently to be described, however, it has been impossible to effect a full correction of deflection of strip from its normal path of travel according to the conventional technical concept.

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SUMMARY OF THE INVENTION

The present invention has as its object the provision of a system and an apparatus for completely effecting a correction of deflection of strip from its normal path of travel.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is an explanatory view showing the manner in which a strip is deflected from its normal path of travel in a tandem rolling mill;

FIG. 2 is a schematic view showing essential portions of a tandem rolling mill incorporating a system for correcting deflection of strip from its normal path of travel according to the invention; and

FIG. 3 is a view to explain the manner in which a strip travels in a tandem rolling mill incorporating the system according to the present invention.

DESCRIPTION OF THE INVENTION

Deflection of a strip from its normal path of travel in a tandem rolling mill can be caused by various factors such as lack of parallelism between upper and lower work rolls defining a roll gap therebetween, deviation of the strip in the roll path with respect to the center of roll width, irregular thickness distribution of strip in the transverse direction and the like. Of these factors, the lack of parallelism between upper and lower work rolls and the deviation of the strip in the roll path with respect to the center of roll width have been responsible in the majority of cases for deflection of the strip from its normal path of travel. After being rolled, the strip tends to be deflected about its top portion at a certain rate of curvature toward the side of the roll path on which the screw down rate is lower or in the direction in which the center of strip width is deviated in the roll path with respect to the center of roll width. This phenomenon will be explained in detail with reference to FIG. 1. Assuming that the roll gap between work rolls **1**, **1'** is smaller on the A side than on the B side that is; the screw down rate is higher on the A side than on the B side, the portion of the strip on the A side is stretched a greater amount than the portion on the B side, causing the top portion of strip to be curved as shown at *a*. If the top of strip were left free, it would move in the direction *d* shown in imaginary lines and an amount of its deflection from the normal path of travel would increase as it continues to proceed, making it impossible to effect automatic strip threading. It is to be noted in this connection that if the roll gap between work rolls can be controlled in such a manner that the screw down rate of the work rolls **1**, **1'** is reduced on the A side and increased on the B side so as to bring about parallelism between the upper and lower work rolls, it will be possible to effect a correction of deflection of the strip from its normal path of travel. In one method of correcting such deflection, deflection detection means **5**, **5'** may be provided which detects an amount of deflection δ_0 and produces a signal in accordance with the amount detected. If the roll gap between the work rolls is adjusted according to this signal, the strip will travel as shown in *a*, *b* and *c*, thereby bringing the amount of deflection to δ_1. (Where $\delta_1 > \delta_0$ because it takes time to effect adjustments of a roll gap between rolls.) However, use of such correction means alone does not warrant automatic strip threading. The reason is this, the construction of a rolling mill is such that it is physically impossible to install deflection detection means as close to the rolls **1**, **1'** as might be wished. Therefore, a correction of deflection of the strip cannot be effected with respect to its forward top portion l_1. If the strip with its forward end portion deflected as described above is introduced into the roll path between the next following work rolls **2**, **2'** the forward top portion will be deviated from the roll path with respect to the center of roll width so that it is deflected a greater amount from its normal path of travel as shown at *e*.

Control of deflection of a strip become complicated from the fact that there is no means provided to effect a correction of this deflection till the top of strip reaches the next following deflection detection means **6, 6'**. Accordingly, the amount of deflection δ_2 of strip when it reaches **6'** will be greater than δ_1. In the work roll **2'**, it is impossible to effect a correction of deflection of strip while it is travelling for the distance *l*. From the foregoing description, it will be understood that if the method described above is employed to effect control over deviation of strip, the amount of deflection of strip will be increased as it passes through each mill stand until at last the deflection becomes so great in amount that the strip cannot be admitted into the path through a side guide **20, 20'**.

The present invention can obviate the problem of deflection of the top of a strip from its normal path of travel encountered during threading in tandem rolling mills.

The invention is characterized by the provision of deflection detection means at the outlet of each mill stand, which is adapted to give an instruction signal to deflection correction means of the particular mill stand concerned and at the same time give a necessary instruction signal to deflection correction means of the succeeding mill stand.

The invention will now be explained in detail with reference to FIGS. 2 and 3. The tandem rolling mill shown in the drawings is illustrated as having only two mill stands. However, such rolling mill generally has four to six mill stands, and it is to be understood that the rest of the stands are omitted. A first mill stand includes work rolls **1, 1'** and back-up rolls **3, 3'**, and a second mill stand includes work rolls **2, 2'**, and back-up rolls **4, 4'**. Deflection detection means **5, 5'** are disposed rearwardly of the first mill stand, while deflection detection means **6, 6'** are disposed rearwardly of the second mill stand. **7** is a strip to be rolled. The back-up rolls of the first and second mill stands are provided with bearing boxes **8** and **9**, respectively. **10** and **11** are screw down adjusting means for the first and second mill stands, respectively, which serve concurrently as deflection correction means in the present invention. Screw down electric motors **12, 12'** are disposed on the A side and on the B side respectively of the first rolling stand, while screw down electric motors **13, 13'** are mounted similarly on the A side and on the B side, respectively, of the second rolling stand.

The deflection detection means **5** is provided with a transducer **14** which provides detected signals to control means **16, 17** for generating instruction signals. According to the instruction signals, respective screw down motors **12, 12'** and **13, 13'** of the first and second mill stands are capable of adjusting amounts of screw down of the work rolls **1, 1'** and **2, 2'** on the A side or the B side or both sides so as to steer the strip, that is; to correct deflection of the strip from its normal path of travel. The deflection detection means **5** may comprise a pair of position detectors disposed on the opposite sides of the predetermined straight line path as shown in the drawings. Position detectors may be those detecting a change in electromagnetic fields, a change in light beams or a change in X-ray beams. The deflection detection means **6** is provided with a transducer **15** which is operatively connected to the screw down motors **13, 13'** of the second mill stand through control means **18** as well as screw down motors of the next following rolling stand (not shown) through control means **19**.

The operation of the present invention will now be explained with reference to FIG. 3. Assuming that the top of strip travelling from the work rolls **1, 1'** to the work rolls **2, 2'** is deflected a certain amount from its normal path of travel to the B side of the rolls, the deflection detection means **5** will detect the deviation and provide a signal through the transducer **14** corresponding to the amount of deflection to control means **16** which produces instruction signals to the screw down motors **12, 12'**. The instruction signal controls the motors so as to adjust the screw down rate of the work rolls **1** through the back-up rolls **3, 3'** in such a manner that the roll gap therebetween is increased on the A side and reduced on the B side. At the same time, a signal will be also issued to the screw down motors **13, 13'** of the second mill stand through control means **17**, which similarly adjust the roll gap between the work rolls **2, 2'** through the back-up rolls **4, 4'** in such a manner that the screw down rate of work rolls **2** is made higher on the B side than on the A side. This causes the top of strip **7** to be stretched a larger amount on the B side than on the A side so that the top of strip comes out from the rolls **2** in the manner as shown at *f*. Then the top will successively proceed in its path of travel in the manner shown at *g* and *h*. After passing through the phase *h*, the top of strip **7** would be deviated to the opposite side as shown in imaginary lines *j* if it were left to follow its own course, since the stretching of strip **7** has by then grown larger on the B side than on the A side. However, deflection of strip **7** in the opposite direction has by then been detected by the deflection detection means **6** so that the top of strip does not proceed in the manner as shown at *j* but travels straight as shown at *i* since adjustment of roll gap between the work rolls **2** are effected by actuation of the deflection detection means **6**. If the strip were deflected from its normal roll path between the rolls **2**, a correction of the deflection could be effected in the same manner in cooperation with the succeeding mill stand.

From the foregoing description, it will be appreciated that the present invention makes it possible to automatically steer a strip at the threading, that is, to automatically effect a correction of deflection of the top of a simple device, thereby permitting to effect full automatic strip threading operations in a tandem rolling mill.

I claim:

1. A system for effecting a correction of deflection of a strip from its normal path of travel in a trandem rolling mill characterized in that deflection detection means provided at the outlet of each mill stand gives an instruction signal to deflection correction means of the particular mill stand concerned and at the same time also gives a necessary instruction signal to deflection correction means of the succeeding mill stand to automatically effect a correction of deflection of strip steel from its normal path of travel whereby deflection of the top of the strip fed to a tandem rolling mill can automatically be corrected.

2. A system for effecting a correction of deflection of a strip from its normal path of travel in a rolling mill as claimed in claim **1** in which said deflection detection means is operative to adjust the roll gap between upper and lower work rolls by varying the screw down rate on opposite sides of the rolls for effecting a correction of deflection of the strip from its normal path of travel.

3. A system for effecting a correction of deflection of strip steel from its normal path of travel in a rolling mill as claimed in claim **1** in which said instruction signal is transmitted through a transducer mounted in said deflection detection means to said deflection correction means including screw down electric motors so as to adjust the roll gap between upper and lower work rolls for effecting a correction of deflection of the strip from its normal path of travel.

4. An apparatus for steering a strip at threading operation in a tandem rolling mill including at least first and second mill stands each having screw down mechanism to adjust the roll gap thereof wherein the improvement comprises deflection detecting means provided at the outlet of the first mill stand for providing a detected deflection signal according to a deflection of the strip from the predetermined path thereof and control means operatively coupled with the deflection detecting means and the respective screw down mechanisms of the first and second mill stands for providing necessary screw down instruction signals to the first and second mill stands according to the detected deflection signal so as to steer the strip.

5. An apparatus according to claim **4**, in which said deflection detecting means comprises a pair of detectors disposed on the opposite sides of the predetermined path of the strip so as to produce a detected signal corresponding to the deflection of the strip from the predetermined path.

6. An apparatus according to claim **4**, in which said control means comprises first and second control means operatively connected to the screw down mechanisms of the first and second mill stands, respectively, for providing

most pertinent instruction signals to the first and second mill stands, respectively.

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U.S. Cl. X.R.

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