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METHOD OF OPERATING A HOT STRIP-FINISHING TRAIN WHEN A LEADING END OF STRIP TO BE ROLLED HAS BEEN STUCK

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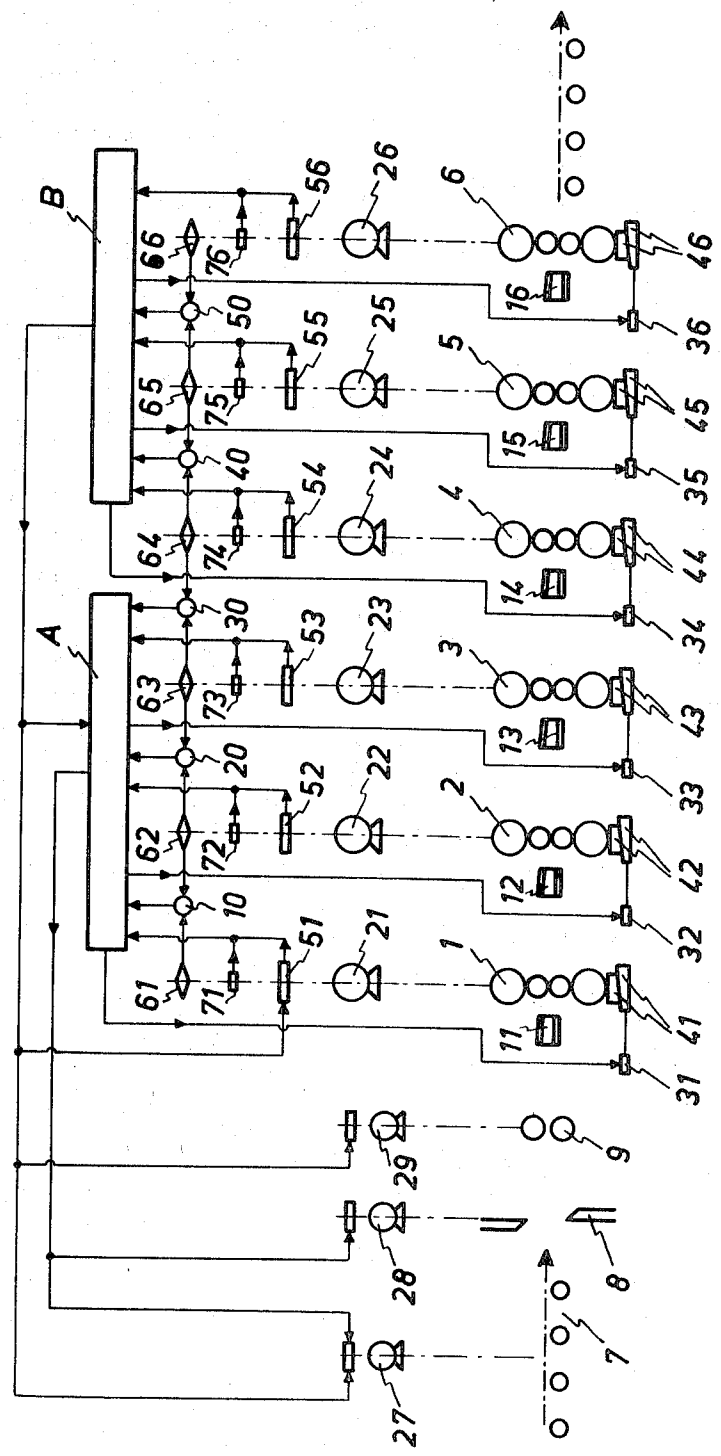

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METHOD OF OPERATING A HOT STRIP-FINISHING TRAIN WHEN A LEADING END OF STRIP TO BE ROLLED HAS BEEN STUCK

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ABSTRACT OF THE DISCLOSURE

An automatic control system to prevent damage when a leading end of a strip has been stuck in a hot rolling mill train. The system operates to sever the strip before the first stand or between the first and second stands, to reverse the roller bed and scale breaker, to maintain rotation of the stands succeeeding the location of the stuck portion and to open the rolls of stands preceding the location of the stuck portion.

In hot-strip finishing trains, the rolling operation may be suddenly interrupted when the hot strip enters the train because the leading end of the stock has been stuck in a nip between the rolls of a rolling mill stand or in a strip guide which precedes a stand. This defect, which is described as sticking, occurs more or less often, depending on the care of the operators, and results in considerable damage to the rolls.

The previous efforts directed to entirely avoiding the causes of such sticking, namely, an overloading of the roll-driving motor due to an insufficiently large roll nip, doubling at the leading end of the strip, an insufficient clearance between the guide rails and the like, have not yet given satisfactory results.

When sticking occurs, it is usual to shut down all rolling mill stands which are in contact with the stock in order to prevent an intolerable accumulation of stock immediately before the point where sticking has occurred. The hot stock remains in the nips between the stopped working rolls for a relatively long time until it is removed from the rolling mill train so that hot cracks are formed in these working rolls. The damaged rolls must be removed and dressed to such an extent that the surface is free of cracks. If a roll having such cracks at its surface is reinstalled and re-used, its cracks will increase in depth, the satisfactory surface of the roll will be peeled off, beginning at the cracks, and the strip can no longer be rolled satisfactorily. Because the fine cracks are completely smeared over as the rolls are dressed and can hardly be rendered visible, it is difficult to define the thickness of the layers which are to be removed by dressing. In most cases, a relatively thick layer is removed by dressing but even that may sometimes be insufficient.

When sticking has occurred, the stock must be removed from the rolling mill train and rolls must be replaced. These operations, the former of which is relatively difficult, require a shut down of the rolling mill train for a long time.

It is an object of the invention to avoid the damage which occurs when the leading end of the strip has been stuck and to provide a process which enables a resumption of the operation after a relatively short time.

This object is accomplished according to the invention in that the strip is severed before the first rolling mill train or between the two first rolling mill trains, the direction of operation of the roller bed and, if desired,

the scale breaker, is reversed, at least immediately after the strip has been severed, whereas the direction of rotation of the rolling mill stands which succeed the point of severance and precede the point where sticking has occurred, is maintained, and that the nip between the rolls at least of any rolling mill stand in which sticking has occurred is opened, whereafter the cut-off strip section is removed in known manner from the hot strip-finishing train. The severing of the strip before or between the two first stands enables a continued rotation of the working rolls which succeed the point of severance and precede the point where sticking has occurred without causing an intolerable accumulation of stock before the point where sticking has occurred because only the short strip section which has been cut off continues to move. The remaining strip section is returned by the reversed roller bed and possibly by the scale breaker and leaves the hot strip-finishing train. When sticking has occurred between two working rolls, the nip between these rolls is opened to avoid a long time of contact between these working rolls and the stock. It is not essential to open the nip between the rolls of the rolling mill stands which precede the point where sticking has occurred because these stands remain in operation so that the surfaces with which the working rolls contact the stock change continually and hot cracks cannot occur. After leaving the stand which immediately precedes the point where sticking has occurred, the cut-off strip section may be removed from the hot strip-finishing train in a simple manner, e.g., by means of a crane.

In a development of the process according to the invention, the nips between the rolls of all stands having rolls in contact with the strip are opened at least immediately after the strip has been severed. In hot strip-finishing trains comprising a substantial number of stands the stretching of the cut-off strip section by the working rolls which continue to rotate may result in an undesirably large accumulation of stock before the point where sticking has occurred so that the removal of the strip section becomes rather difficult. The nips between the rolls concerned are opened to avoid such stretching of the cut-off strip section.

When sticking has occurred adjacent to the first or second stand, the strip must be severed before the stands if damage is to be avoided. For this reason, the process according to the invention comprises in such case a severing of the strip before the first rolling mill stand by flying shears. When sticking has occurred in the last stands or guides of the rolling mill train, the strip is severed between the first two stands so that the cut-off strip section is short and a substantial accumulation of rolled stock before the point where sticking has occurred is avoided. To prevent a tearing of the strip between the first two stands, the roll-driving means of the first stand are stopped whereas the drive means of the second stand and the other drive means which precede the point where sticking has occurred continue to operate. When the strip has been severed, the nip between the rolls of the first stand is opened and the roller bed and the scale breaker are reversed to return the remaining strip so that it leaves the hot strip-finishing train. The cut-off strip section which is condensed before the point where sticking has occurred may now be removed in a simple manner from the rolling mill train.

The invention provides also an apparatus which serves to carry out the process and which is characterized in that two electric control units are respectively associated with a forward group and a rear group of rolling mill stands and guides, one of said electric control units is responsive to sticking within the forward group by automatically initiating the operation of the shear-driving means, the

reversal of the roller bed, and the operation of the drive means for opening the nips between the rolls at or behind which sticking has occurred, whereas the other electric control unit is responsive to sticking in the rear group by stopping the drive means of the first rolling mill stand and initiating the reversal of the roller bed and the scale breaker and the operation of the drive means for opening the nip between the rolls at least of the first rolling mill stand and the rolling mill stand has associated with it a switching device which is responsive to an overloading of its roll-driving motor, a timer is associated with every two succeeding rolling mill stands and set to the normal transit time of the leading end of the strip between said two stands, and the two control units are responsive to the operation of any of the overload switching devices and any of the timers. The timer which is associated with two adjacent rolling mill stands senses the transit time of the leading end of the strip between said two rolling mill trains and gives a response when the normal transit time is exceeded, and the switching device which is associated with a motor and responsive to an overloading thereof, will respond to sticking because the same results in a longer than normal transit time and/or an overloading of the motor and in this case will initiate the operation of the corresponding control unit, which in the case of sticking in the forward group of rolling mill stands will automatically initiate the operation of the shear-driving means, the reversal of the roller bed and the operation of the drive means for opening the nip between the rolls at least of any stand where sticking has occurred. When sticking has occurred in the rear one of the two groups of rolling mill stands, the corresponding other control unit stops the drive means of the first rolling mill stand in order to cause the strip to be torn apart, reverses the direction of movement of the roller bed and of the scale breaker so that the remaining strip section is returned, and initiates the operation of the drive means for opening the nips between the rolls at least of the first rolling mill stand and of any rolling mill stand where sticking has occurred. This arrangement ensures an automatic performance of the several steps of the process with the aid of relatively simple electric means.

In a development of the invention, relatively adjustable adjusting wedges arranged in pairs are provided to open the nips between the rolls. To avoid damage, particularly hot cracks, at the working rolls, the nip between them must be opened quickly. This cannot be accomplished with the usual housing screws. The provision of adjusting wedges according to the invention permits of opening the nips between the rolls within a sufficiently short time in a simple manner.

The accompanying drawing is a diagrammatic view showing by way of example a hot strip-finishing train provided with the apparatus according to the invention.

The hot strip-finishing train comprises six rolling mill stands **1**, **2**, **3**, **4**, **5**, **6**, each of which is preceded by a guide **11**, **12**, **13**, **14**, **15**, or **16**, furthermore, and is provided at its receiving end with a roller bed **7**, shears **8** and a scale breaker **9**. Motors **21**, **22**, **23**, **24**, **25**, **26** serve to drive the rolling mill stands. Motors **27**, **28** and **29** serve to drive the roller bed **7**, shears **8** and scale breaker **9**. A pair of adjusting wedges **41**, **42**, **43**, **44**, **45** or **46** serve to open the nips between the rolls of each of stands **1** to **6**. The first three mill stands **1**, **2**, **3** provided with the guides **12**, **13**, **14** are associated with a control unit A, which is connected by leads to switching devices associated with the drive motors **27**, **28** and with drive means **31**, **32**, **33** controlling the position of adjusting wedges **41**, **42**, **43**. A control unit B is associated with the group of rolling mill stands **4**, **5**, **6** provided with the guides **15** and **16** and is connected by suitable leads to the switching devices associated with the drive motors **27**, **29**, a motor-protecting switch **51** associated with the motor **21**, and drive means **34**, **35**, **36** controlling the position of the adjusting wedges **44**, **45**, **46**.

When sticking occurs in the strip guide **12**, **13** or **14**, the transit time of the leading end of the strip between two adjacent stands is longer than normal. These transit times are sensed in this case by means of the ammeters **61**, **62**, **63** or **64**. In response to the prolonged transit time, a timer **10**, **20** or **30** initiates the operation of the control unit A, which by means of the corresponding leads initiates the operation of the motor **28** for driving the shears **8**, the reversal of the drive motor **27** driving the roller bed **7**, so that the latter is reversed too, and the operation of the drive means serving to open the nips between those rolling mill stand rolls which engage the stock. Hence, the shears **8** sever the strip and the cut-off strip section continues to move to the point where sticking has occurred because the roll-driving means are not stopped. The positioning drive means operate the adjusting wedges to open the nips between the rolls of the stands concerned at a sufficiently high speed. Because the direction of travel on the roller bed has been reversed, the remaining strip section leaves the rolling mill train and the cut-off strip section, which is condensed between the point where sticking has occurred and the stand immediately preceding that point can be removed in a simple manner from the rolling mill train.

When sticking occurs in the nip between the rolls of any of stands **1**, **2**, and **3**, the corresponding motor-protecting switch **51**, **52** or **53** initiates the operation of the control unit and the procedure described above is repeated.

When the leading end of the strip has been stuck in any of the rear rolling mill stands **4**, **5** and **6** or in the guide **15** or **16**, the strip is not severed by the shears **8** because the cut-off strip section would be too long and an excessive amount of stock would be accumulated before the point where sticking has occurred. The strip is now torn apart between the two stands **1** and **2**. When sticking has occurred in one of the guides **15**, **16**, a timer **40** or **50** is triggered by an ammeter **64**, **65** or **66** to operate the control unit B. When sticking has occurred in one of stands **4**, **5** or **6**, the control unit B is operated by the corresponding motor-protecting switch **54**, **55** or **56** or the corresponding current-time limiting switch **74**, **75** or **76**. When the control unit B has been operated by one of the timers or one of the overload switching devices, the control unit B initiates the reversal of the roller bed **7** and of the scale breaker **9** and by the motor-protecting switch **51** de-energizes the drive means of the first frame **1**. The continued operation of the drive means of the remaining stands which precede the point where sticking has occurred causes the strip to be torn between the first two stands **1** and **2**. Immediately after the tearing of the strip, all nips between the working rolls engaging the stock are opened by the position-controlling drive means, which have been energized by the control units A and B and which operate the adjusting wedges. In this case, the control unit B delivers by a suitable lead to control unit A the control signal to energize the position-controlling drive means **31**, **32**, **33**. When the severed strip section has left the stand which immediately precedes the point where sticking has occurred, said strip section may be removed from the hot strip-finishing train, which is now ready for operation again because the reversed roller bed has removed also the remaining strip section from the rolling mill train.

I claim:

1. In the method of operating a hot strip-finishing train which comprises at least first, second, third and fourth rolling mill stands arranged one behind the other, guides respectively preceding each of said stands, and a roller bed, shears, and a scale breaker preceding the guide which precedes said first stand, said roller bed being operable in forward and reverse directions, each of said stands comprising two working rolls forming a nip between

them, and roll-driving means for driving said rolls in a normal sense of rotation,

a sequence of operations to be deformed when a leading end of strip to be rolled has been stuck in one of said stands or guides, said sequence of operations comprising

severing said strip before said second stand so that a strip section is cut off,

operating the roll-driving means of the stand disposed between the point where said strip has been severed and the stuck leading end of said strip in the normal sense of rotation, and

removing the cut-off strip section from the train.

2. A sequence of operations as set forth in claim **1**, which is performed in a hot strip-finishing train in which said scale breaker is operable in forward and reverse directions and which comprises

operating said scale in said reverse direction immediately after the severing of the strip.

3. A sequence of operations as set forth in claim **1**, which is performed when said leading end of said strip has been stuck in one of said stands and which comprises

opening the nip between the working rolls at least of said one stand.

4. A sequence of operations as set forth in claim **1**, in which said strip is severed before said first stand.

5. A sequence of operations as set forth in claim **1**, in which the nips between all working rolls which engage said strip are opened immediately after the severing of the strip.

6. A sequence of operations as set forth in claim **1**, which is performed in a hot strip-finishing train in which said stands form first and second groups when the leading end of said strip has been stuck in a stand of said first group or in a guide preceding a stand of said first group said sequence of operations comprising

operating flying shears to sever said strip before said first stand.

7. A sequence of operations as set forth in claim **1**, which is performed in a hot strip-finishing train in which said stands form first and second groups when the leading end of said strip has been stuck in a stand of said second group or in a guide immediately preceding a stand of said second group, said sequence of operations comprising

severing said strip between said first and second stands.

8. A sequence of operations as set forth in claim **1**, in which said strip is severed in that the roll-driving means of the first stand is stopped whereas the roll-driving means of the second stand is operated to tear said strip apart between said first and second stands.

9. A hot strip-finishing train, which comprises

at least first, second, third and fourth rolling mill stands arranged one behind the other, each of said stands comprising two working rolls forming a nip between them and roll-driving means for driving said rolls in a normal sense of rotation,

guides respectively preceding each of said stands,

a roller bed, shears, and a scale breaker preceding said first group of stands and guides, said roller bed being operable in forward and reverse directions,

sensing means arranged to deliver a signal when a leading end of strip has been stuck in one of said stands or guides,

means for severing said strip before said second stand in response to said signal so that a strip section is cut off,

means for initiating the operation of said roller bed immediately after the severing of said strip,

means for maintaining the operation in the normal sense of rotation of the roll-driving means of the stands disposed between the point where said strip has been severed and the stuck leading end of said strip, and

means for removing the cut-off strip section from the train.

10. A hot strip-finishing train as set forth in claim **9**, in which

each of said rolling mill stands comprise position control means operable to open said nip,

said stands and guides form first and second groups of stands and guides,

said scale breaker is operable in forward and reverse directions,

a plurality of switching devices are respectively associated with each of said roll-driving means and arranged to deliver a signal in response to an overloading thereof,

a plurality of timers are arranged to sense the transit time of the leading end of said strip between every two adjacent ones of said stands and to deliver a signal when said transit time exceeds a predetermined value,

said switching devices and timers are arranged in first and second sensing means groups respectively associated with said first and second groups of stands and guides,

first and second electric control units are arranged to receive any of said signals from said first and second sensing means groups, respectively, and to give predetermined responses upon receipt of any of said signals,

said response of said first electric control unit comprising initiating the operation of said shears, initiating the operation of said roller bed in said reverse direction, and initiating the operation in a nip-opening sense of the position control means of all stands other than those which succeed any stand which is associated with a switching device having delivered such signal or the preceding one of any two adjacent stands associated with a timer which has delivered such signal,

said response of said second electric control unit comprising stopping said roll-driving means of said first stand, initiating the operation of said roller bed and scale breaker in said reverse sense, and initiating the operation in a nip-opening sense of said position control means of said first stand and of any stand associated with a switching device having delivered such signal.

11. A hot strip-finishing train as set forth in claim **10**, in which said position control means comprise pairs of relatively displaceable adjusting wedges.

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