METHOD OF AND APPARATUS FOR DETECTING THE POSITION OF THE END OF A COIL OF STEEL STRIP

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ABSTRACT

A method of and apparatus for detecting the position of the end of a coil of steel strip or other strip material which is to be paid out and setting the end of the coil at a predetermined position on the outer peripheral surface of the coil for initiating feeding of the steel strip to a rolling mill or other equipment. Support means mounting detection means is maintained in contact with the outer peripheral surface of the coil. The support means is adapted to operate in response to a variation in the outer diameter of the coil at the point of contact between the support means and the outer peripheral surface of the coil. The position of the end of the coil is detected by detecting a variation in the level of the outer peripheral surface of the coil or by detecting the action of the end portion of the coil to spring back by its own resilience as the end of the coil is moved past the detection means while the coil is rotated in a direction opposite to the paying out direction.

12 Claims, 5 Drawing Figures
METHOD OF AND APPARATUS FOR DETECTING THE POSITION OF THE END OF A COIL OF STEEL STRIP

This invention relates to a method of and an apparatus for initiating the feeding of a steel strip or other metallic material in strip form which is wound in convolutions into a coil. More particularly, the invention is concerned with a method of and an apparatus for detecting the position of the end of such coil on the peripheral surface thereof.

The apparatus provided by this invention is best suited for detecting and automatically withdrawing the end of a steel strip wound in coil so as to pay out the steel strip which is fed to a rolling mill in cold rolling equipment.

Advances in the progress of the art of automation in the field of rolling have recently brought about an epoch-making increase in production efficiency, a great saving in labor cost, and a marked improvement in the quality of rolled products. In automating rolling equipment, the greatest importance is generally attached to fully automating the operation of successively feeding steel strips wound in coil form to a rolling mill prior to effecting rolling of the steel strips. Particular emphasis has been laid on providing means for automatically detecting the position of the end of a coil of steel strip wound in convolutions and automatically setting the detected end of the steel strip at an optimum position relative to the position of the peeling tool so as to attain the end of fully automating rolling equipment. However, this has presented many problems that are hard to obviate.

In the field of rolling, automation devices for detecting the position of the end of a coil of steel strip wound in convolutions have not been available or have failed to function satisfactorily if ever they were available. The most up-to-date devices of this type comprise coil end detection means which is maintained in contact with the outer peripheral surface of a coil so that the position of the end of the coil may be detected by detecting a variation in the position of said detection means or by detecting a movement thereof caused by a difference in level between the outermost convolution and the next adjacent convolution. In detecting the position of the end of the coil by detecting a variation in the position of the detection means, it is required to effect adjustments of the detection means wherever there is a variation in the diameter of coils handled. Detection of the position of the end of the coil by detecting a movement of the detection means is disadvantageous in that the movement of the coil as a whole which occurs when the end of the coil is moved past cradle rollers may cause a movement of the detection means, thereby producing a signal by mistake.

In both of these apparatus and methods, it is impossible to accurately detect the position of the end of coils as aforementioned if the coils are not of complete circle and the diameters of the coils show fluctuations, because the detection means is actuated in positions other than the position in which the end of the coil is disposed. Thus, it has hitherto been impossible to fully automate the operation of initiating the feeding of a steel strip in coil form or of paying out the steel strip and consequently it has been impossible to fully automate rolling equipment as a whole.

Accordingly, a principal object of this invention is to provide a method of and an apparatus for automatically and positively detecting the position of the end of a coil which obviates the aforementioned disadvantages of prior art methods and apparatus. More specifically, the invention provides a method of and an apparatus for automatically and positively detecting the position of the end of a coil by using a coil end support means mounted on support means which is maintained in contact with the outer peripheral surface of the coil at all times and operate in response to a variation in the level of the outer peripheral surface of the coil. The use of such detection means permits to automatically position the coil at an optimum position relative to the position of the peeling tool after the position of the end of the coil is automatically detected. The present invention thus makes it possible to fully automate the operation of paying out a coil of steel strip after its feeding is automatically initiated and supplying the steel strip to a rolling mill or other apparatus for treating the same.

Another object of the invention is to provide a method of and an apparatus for detecting the position of the end of a coil which relies on detection of a variation in the level of outer peripheral surface of the coil between the outermost convolution and the next adjacent convolution or a variation in the level of the outer peripheral surface of the coil which corresponds to the thickness of the strip. This method and apparatus are advantageous in handling coils of steel strips of thick gauges.

Still another object of the invention is to provide a method of and an apparatus for detecting the position of the end of a coil which relies on detection of a variation in the level of outer peripheral surface of the coil between the outermost convolution and the next adjacent convolution or a variation in the level of the outer peripheral surface of the coil which corresponds to the thickness of the strip. This method and apparatus are advantageous in handling coils of steel strips of thick gauges.

A further object of the invention is to provide a method of and an apparatus for detecting the position of the end of a coil in which support means or detection means can be utilized as a coil peeling tool. This arrangement eliminates the use of a separate coil peeling tool, thereby simplifying the apparatus and facilitating the control of the rotary motion of the coil.

Additional objects as well as features and advantages of this invention will become evident from the description set forth hereinafter when considered in conjunction with the accompanying drawings, in which:

FIG. 1 is a side view of one embodiment of the coil paying out apparatus in which the method of and the apparatus for detecting the position of the end of a coil according to this invention can be incorporated; and

FIGS. 2 to 5 are sectional side views showing different embodiments of the apparatus for detecting the position of the end of a coil according to this invention.

FIG. 1 shows a coil unwinding apparatus for feeding a strip material such as a steel strip of thin gauge to a four-high rolling mill. Prior to describing the method and apparatus of this invention in detail, the arrangement of the equipment involved and the operation thereof will first be explained for better understanding of the invention. A coil 1 transferred to a coil carriage 2 from a coil storage by a conveyor or the like is delivered to an intermediate position A where the position of the end of the coil is detected and feeding of the steel strip is initiated prior to movement into a coil paying out position B.

In detecting the position of the end of the coil 1, a snubber roller 6 pivotally connected to a frame 10 is brought into contact with the outer peripheral surface of the coil 1 to prevent separation of the end of the coil from the outer peripheral surface of the coil. The coil 1 having the snubber roller 6 maintained in contact therewith is rotated in the counterclockwise direction by cradle rollers 3 mounted on the coil carriage 2 and having drive means. At this time, the coil 1 is moved upwardly by a lifter 5 on the coil carriage 2 which is provided with wheels 4 mounted on rails 22. In addition to the snubber roller 6, a peeling tool 7 urged by a spring 8 to contact the outer peripheral surface of the coil and adapted to accommodate a variation in the level of outer peripheral surface of the coil is also in engagement with the outer peripheral surface of the coil. Said peeling tool 7 serves as coil end detector as subsequently to be described. If the coil 1 is rotated in the counterclockwise direction which is opposite to the coil paying out direction on the coil carriage 2, the coil end detector produces a coil end detection signal when the end of the coil 1
moves below a contact portion at the forward end of the tool 7. Said coil end detection signal terminates the rotation of the cradle rollers 3 which are caused by a control circuit (not shown) of electric motor control circuits to start rotating in the clockwise direction (coil paying out direction). The rotation of the coil 1 in the clockwise direction causes a pivot motor (not shown) directly connected to the snubber roller 6 to rotate, with the rotation of the coil 1 being terminated after a predetermined number has been counted. During the time the coil rotates, the peeling tool 7 opens up the outermost convolution of the coil and the coil is paid out till its end moves past the tool 7 and retaining shelves or guides 9 and 12 and reaches a position which is slightly beyond pinch roll means 14. A predetermined length of the strip material paid out from the coil in this way is retained by said retaining shelves 9 and 12. Said length of strip material paid out from the coil 1 and held by the retaining shelves 9 and 12 is maintained in a level above the level of a strip material 24 of a preceding coil 23 which has already been paid out by an unwinding device in the position B. Upon completion of feeding of the strip material 24 of the preceding coil 23 to a rolling mill 17, the retaining shelves 9 and 12 move in sliding motion on beds 11 and 13 respectively for a predetermined amount at right angles to the roll path or to the plane of Fig. 1 so as to thereby move the strip material of the coil 1 to and into the upper nip 16 of the pinch roll means 14 which is aligned with the roll path. Then, an upper roll 15 is moved downwardly into contact with the strip material to hold the same between the upper roll 15 and lower roll 16 and feed the same to the rolling mill 17 comprising upper and lower working rolls 20 and 21 and upper and lower backing rolls 18 and 19. When this operation is performed, the coil carriage 2 is moved from the position A to the position B as the wheels 4 rotate on the rails 22. If the coil 1 is mounted on an unwinder 25 in the position B, the coil carriage 2 is moved downwardly to a position shown in dot-and-dash lines and returned to the original position.

FIG. 2 shows in an enlarged schematic side view one embodiment of the apparatus for detecting the position of the end of a coil according to this invention. In this embodiment, the detection of the position of the end of the coil relies on the action of the end portion of the coil to spring back by its own resilience. Support means 30 having mounted at its forward end a keep roller 31 for maintaining contact with the outer periphery of the coil 1 is pivotally supported by a shaft 32 supported and pivotally connected to said keep roller 31. A spring 33 connected to said support means 30 urges said keep roller 31 downwardly into engagement with the outer peripheral surface of the coil 1 at all times. The force exerted by the spring 33 on the keep roller 31 to maintain the latter in contact with the outer peripheral surface of the coil 1 is selected such that it gets the better of the force with which the outermost convolution of the coil 1 tends to spring back from the rest of the coil by its own resilience so as to prevent the peeling off of the outermost layer of the coil. Detection means 34 pivotally mounted on a pin 36 supported by the support means 30 for pivotal movement relative to the support means 30 may be in the form of a peeling tool as explained previously with reference to FIG. 1. The tip of the peeling tool is maintained in contact with the outer peripheral surface of the coil 1 by the biasing force of a relatively weak spring 37. The detection means 34 which serves concurrently as a peeling tool is mounted such that the position in which its tip engages the outer peripheral surface of the coil is spaced apart from the position in which the keep roller 31 engages the outer peripheral surface of the coil 1 in a predetermined distance L in the direction opposite to the coil paying out direction.

Thus, if the coil 1 is rotated in the counterclockwise direction in FIG. 2 or in a direction opposite to the paying out direction and the end 43 of the outermost convolution of the coil 1 is moved past the keep roller 31, then a length of the coiled strip material forming the end portion of the coil 1 is lifted from a position shown in dotted lines to a position shown in solid lines because of the resilient force of the end portion of the coil with which it resumes its original form in reaction to the bending deformation to which it is subjected gets the better of the biasing force of the spring 37. This displacement of the tip of the detection means 34 is increased by the detection means 34 itself and actuates a limit switch 38 mounted on a roller in the neighborhood of the motor (not shown) for automatically shutting off the power to the motor when this displacement reaches a predetermined limit. If further rotation of the coil 1 causes the end 43 of the coil 1 to move past the tip of the detection means 34, then the detection means 34 is urged by the biasing force of the spring 37 to move downwardly till the rear portion of the detection means 34 is brought into engagement with a stopper 39 mounted on the frame 40 and restored to the position shown in dotted lines where the tip of the detection means is kept in engagement with the next following convolution of the coil 1. At the same time, the limit switch 38 is restored to its original position.

Assuming that the peripheral speed of the coil 1 is V, a signal indicating the position of the end of the coil can be produced if the limit switch 38 remains operative during the time interval corresponding to V/L. As aforementioned, the number of revolutions of the coil 1 is controlled such that the end of the coil 1 is disposed halfway between the tip of the detection means 34 and the snubber roller 6 when the signal is generated. Actually, the distance L is so small that if a command to terminate rotation of the coil 1 is issued immediately when the limit switch 38 is triggered, it is possible to place the end of the coil 1 in a predetermined position. If necessary, a timer or the like may be used so as to stop rotation of the coil 1 with a predetermined time lag.

Upon termination of rotation of the coil 1 in the counterclockwise direction, the coil 1 is caused to rotate in the clockwise direction or in the paying out direction for a predetermined time so as to start peeling off and unwinding of the outermost convolution of the coil 1. FIG. 3 shows an embodiment in which the position of the end 43 of the coil 1 is detected by detecting a variation in the level of the outer peripheral surface of the coil 1. As shown, detection means 54 is pivotally supported by support means 50 for movement relative thereto, said support means 50 being maintained in contact with the outer periphery of the coil 1. Said support means 50 which may be in the form of a peeling tool as explained with reference to FIG. 1 is pivoted on a shaft 51 supported by a bracket 52 connected to a frame 53. The tip of the support means 50 is urged by the biasing force of a spring 56 into engagement with the outer peripheral surface of the coil 1. A spring 33 connected to said support means 50 urges said keep roller 31 downwardly into engagement with the outer peripheral surface of the coil 1 at all times. The biasing force of the spring 56 mounted between the detection means 54 and support means 50. The detection means 54 is mounted such that the position in which the tip thereof engages the outer peripheral surface of the coil 1 is spaced apart from the position in which the tip of the support means 50 engages the outer periphery of the coil 1 a predetermined distance L in the coil paying out direction.

Thus, if the coil 1 is rotated in the counterclockwise direction in FIG. 3 or in a direction opposite to the paying out direction and the end 59 of the outermost convolution of the coil 1 is moved past the tip of the detection means 43, then the tip of the detection means 54 moves downwardly from its position shown in solid lines to a position shown in dotted lines a distance corresponding to the thickness of the coiled strip material. This displacement of the tip of the detection means is increased by the detection means 54 itself and actuates a limit switch 38 mounted on a roller in a rear portion of the detection means 54. If further rotation of the coil 1 causes said end 59 of the coil 1 to move past the tip of the support means 50, then the biasing force of the spring 56 gets the better of the biasing force of the spring 57 so that the tip of the support means 50 pivoted at the shaft 51 is moved downwardly a distance corresponding to the thickness of the strip material. This brings
the support means 50 and detection means 54 into relative positions which prevailed before displacements of the tips of the two means occurred. That is, the detection means is, as it were, restored to its original position relative to the support means, thereby rendering the limit switch 58 inoperative.

Assuming that the peripheral speed of the coil 1 is V, a signal indicating the position of the end of the coil can be produced if the limit switch 58 remains operative during the time interval corresponding to V. As aforesaid, the number of revolutions of the coil 1 is controlled such that the end of the coil 1 is disposed halfway between the tip of the support means 50 and the snubber roller 6 shown in FIG. 1. Actually, the distance i is so small that if a command to terminate rotation of the coil 1 is issued immediately upon actuation of the limit switch 58 it is possible to place the end of the coil in a predetermined position. If necessary, a timer or the like may be used so as to stop rotation of the coil 1 with a predetermined time lag. When rotation of the coil 1 is terminated, the coil 1 is then rotated in the clockwise direction or in the paying out direction for a predetermined time so as to start peeling and unwinding of the outermost convolution of the coil 1.

Embellishments shown in FIGS. 4 and 5 are on detection of a variation in the level of the outermost convolution of the coil for detection of the position of the end of the coil as is the case with the embodiment shown in FIG. 3. The difference between the embodiment of FIG. 3 and the embodiment 4 and 5 lies in the fact that whereas the coil end detection mechanism is mounted on the peeling tool in the former, the coil end detection mechanism is provided independently of the peeling tool in the latter.

In FIG. 4, support means 60 pivotally supported by a shaft 62 supported by a bracket 63 connected to a frame 64 has at its forward end a roller 61 which is adapted to maintain contact with the outer periphery of the coil 1. A cylinder 65 operates such that said support means is moved downwardly so as to maintain the roller 61 in contact with the outer peripheral surface of the coil 1 at all times. On the other hand, a limit switch of the noncontact-type 66 mounted on the support means 60 is disposed in a position which is spaced apart from the position in which the roller 61 is mounted a predetermined distance i in the coil paying out direction. The limit switch 66 is constructed such that it is actuated upon increase or decrease in the distance between the switch and the outer peripheral surface of the coil.

Thus, if the coil 1 is rotated in the counterclockwise direction and the end of the coil 1 is moved past the detection end of the limit switch 66, then the distance between the detection end of the limit switch 66 and the outer periphery of the coil is increased by an amount corresponding to the thickness of the strip whereby the limit switch 66 is actuated. If further rotation of the coil 1 causes said end 67 of the coil 1 to move past the roller 61, then the roller moves downwardly a distance corresponding to the thickness of the coil defined material, so that the aforementioned distance between the detection end of the limit switch and the outer peripheral surface of the coil is reduced thereby restoring the limit switch to its original position. A signal produced during the time the limit switch 66 remains operative is used to detect the position of the end of the coil in the same manner as is the case with the embodiments previously described.

In the embodiment shown in FIG. 5, the coil end detection mechanism is not mounted on pivotal support means as is the case with the embodiment of FIG. 4, and support means 70 is adapted to move up and down vertically. However, this embodiment is essentially the same as the embodiment of FIG. 4, so that the detailed description thereof is omitted. In the FIGURE, 71 refers to a roller maintained in contact with the outer periphery of the coil, 72 to a limit switch of the noncontact-type, 73 to a spring urging said roller 71 into engagement with the outer periphery of the coil at all times, 74 to a frame supporting and guiding said support means 70, 75 to a protruding head of the support means 70, and 76 to a shaft supporting the roller 71. It will be evident that the embodiment of FIG. 5 operates in the same fashion as the embodiment of FIG. 4.

While the present invention has been described with reference to preferred embodiments thereof, it is to be understood that the invention is not limited to the precise forms of the invention and that many changes and modification may be made therein without departing from the scope of the invention which is defined in the appended claims.

What we claim is:

1. A method for peeling a strip material wound in coil form comprising providing detection means adapted to contact the outer peripheral surface of the coil to detect the presence of the end of the coil and peeling means located along the periphery of the coil for permitting the peeling of the coil, rotating the coil in the direction opposite to the paying out direction, detecting the position of the end of the coil on the outer peripheral surface thereof using said detection means, terminating the rotation of the coil at a position where the end of the coil slightly passes said peeling means in response to the detection of the position of the end of the coil by said detection means and thereafter reversingly rotating the coil in the paying out direction to peel the outermost convolution of the coil using said peeling means.

2. A method as defined in claim 1 in which detection of the position of the end of the coil on the outer peripheral surface thereof is effected by detecting the action of the end portion of the coil to spring back by its own resilience to resume its original form as the end of the coil is moved past the detection means.

3. A method as defined in claim 1 in which detection of the position of the end of the coil on the outer peripheral surface thereof is effected by detecting a variation in the level of the outer peripheral surface of the coil occurring as the end of the coil is moved past the detection means.

4. An apparatus for peeling a strip material wound in coil form comprising support means maintained in contact with the outer peripheral surface of the coil and adapted to move in accordance with a variation in the level of the outer peripheral surface of the coil, and detection means mounted on said support means for detecting the end of the coil on the outer peripheral surface thereof, said detection means comprising a resiliently movable member continuously engaging the outer peripheral surface of the coil at a position spaced apart from the position where said support means engages the same at a predetermined distance in a direction opposite to the coil paying out direction.

5. An apparatus as defined in claim 4 in which said resiliently movable member serves to peel the outermost convolution from the coil while the coil is rotated in the paying out direction.

6. An apparatus as defined in claim 4 in which said support means is pivotally located about a fixed point and said resiliently movable member is pivotally positioned relative to said support means, said support means comprising a keep roller mounted at one end thereof and maintained in contact with the outer peripheral surface of the coil and a limit switch actuated by said resiliently-movable member to indicate the position of the end of the coil.

7. An apparatus as defined in claim 6 in which said keep roller is maintained in engagement with the outer peripheral surface of the coil with a force sufficient to prevent peeling off of the outermost convolution of the coil, and said resiliently movable member is maintained in engagement with the outer peripheral surface of the coil with a weaker force so as to be moved by the action of the end portion of the coil to resiliently spring back to resume its original position.

8. An apparatus for peeling a strip material wound in coil form comprising support means maintained in contact with the outer peripheral surface of the coil and adapted to move in accordance with a variation in the level of the outer peripheral surface of the coil, and detection means mounted on said support means for detecting the end of the coil on the outer peripheral surface thereof, said detection means comprising a
movable member continuously engaging the outer peripheral surface of the coil at a position spaced apart from the position where said support means engages the same at a predetermined distance in the coil paying out direction and adapted to move in response to a difference in the level of the outer peripheral surface of the coil between the outermost convolution and the next following convolution detected as the end of the coil is moved past said member.

9. An apparatus as defined in claim 8 in which said support means serves to peel the outermost convolution from the coil while the coil is rotated in the paying out direction, mounted about a fixed point and said movable member is pivotally positioned relative to

10. An apparatus as defined in claim 8 in which said support means is pivotally positioned relative to said support means, said support means comprising a limit switch to indicate the position of the end of the coil actuated by said movable member and having a tapered end in the engagement with the outer peripheral surface of the coil so as to serve as a peeling tool.

11. An apparatus for peeling a strip material wound in coil form comprising support means maintained in contact with the outer peripheral surface of the coil and adapted to move in accordance with a variation in the level of the outer peripheral surface of the coil, and detection means mounted on said support means for detecting the end of the coil on the outer peripheral surface thereof, said detection means comprising a sensing device fixed to said support means at a position spaced apart from the position where said support means engages the outer peripheral surface of the coil at a predetermined distance in the coil paying out direction for sensing a difference in the level of the outer peripheral surface of the coil between the outermost convolution and the next following convolution revealed as the end of the coil is moved past the sensing device.

12. An apparatus as defined in claim 11 in which said support means engages the outer peripheral surface of the coil through a keep roller mounted on one end thereof, said sensing device being a limit switch of the noncontact type rendered operative when it is disposed clear of the outer peripheral surface of the coil upon passage of the end of the coil.