Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.
Nov. 23, 1965

F. W. WARD ETAL

METHOD AND APPARATUS FOR LEVELLING STEEL STRIP
DISPOSED IN A VERTICAL PLANE

Filed Oct. 25, 1961

3,218,835

5 Sheets-Sheet 4

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METHOD AND APPARATUS FOR LEVELLING STEEL STRIP DISPOSED IN A VERTICAL PLANE

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Filed Oct. 25, 1961, Ser. No. 147,581

11 Claims. (Cl. 72—128)

The present invention is directed to method and apparatus for working and recoiling steel strip. The invention is particularly concerned with a vertical leveller employed in the levelling of strip and sheet produced by open coil annealing and customarily requiring re-winding into a tight coil before levelling.

The operation referred to as levelling annealed steel strip handled in coil form is well known in the art and is customarily practised with the width of the sheers disposed in a horizontal position during removal from the annealed coil, passage through the levelling device and during recoil for subsequent handling to another destination for further processing. This well known operation is carried out with the un-winding and re-winding coil rotating about a horizontal axis. In such cases the un-winding and re-winding coils are referred to in the art as tight coils.

Recent improvements in the art of annealing coils of strip steel have employed apparatus generally as "open coil annealing." The coils of steel strip received from the rolling mills must, of necessity, be tightly coiled in order to prevent abrasion of the faces of the coil should they slide relative to each other during the coiling operation. To practice the open coil annealing system, such tightly wound coils must then be "opened" by separating each turn of the coil from the adjacent turns of the coil. One method of doing this involves the interpositioning of a rope, for example nylon rope, between the successive turns of a coil of strip thereby bringing about a more or less uniform gap or spacing between the adjacent turns. This "open" coil is then placed in an annealing furnace with the body of the strip disposed in a vertical position and the coil supported on a horizontal platform so that the gaseous atmosphere of the annealing furnace can uniformly penetrate between the turns of the coil to effect the desired degree of annealing or other process of the metal. After removal from the annealing furnace and cooling, the strip must then be re-wound into a tight coil for re-handling and/or subsequent processing.

Such an annealing system while providing a very satisfactory annealed condition of the steel in the coil has certain difficulties inherent in the system such as coil breaks (a localized deformation extending across the coil rather than a smooth bend of continuous curvature) which occurs with the heavier gauges after the strip has been annealed, and the problems of providing adequate back tension, after annealing, so as to admit optimum cooling tension during the re-wind procedure. A further difficulty is that extra time and labor must be employed in re-winding the coil for carrying to or handling through the presently known type of horizontal levelling devices.

According to the present invention, the strip in "open coil" form is directly fed into a vertically disposed levelling device and suitably re-worked and re-wound into tight coil form after leaving the levelling device. The invention, therefore, accomplishes the annealing and re-working of the strip with the elimination of one recoiling operation and a saving in both space and equipment required for such operation.

One object of the invention is to provide method and apparatus for handling and levelling strip steel with the body of the strip disposed in a substantially vertical plane.

A further object of the invention is to provide a method, in association with an open coil annealing system, whereby work can be imparted to the strip so as to give it the required hardeness and metallurgical characteristics.

Another object of the invention is to provide a method of shape correction in any metal strip while it is in a vertical plane.

Another object of the invention is to provide a method of flattening the random undulations in a strip which invariably occur during annealing process, particularly when the annealing is done in the open coil form.

A still further object of the invention is to provide a levelling device for handling metal strip in a vertical position which is readily adjustable both vertically and transversely for handling different widths and gauges of strip.

These and other objects of the invention will be made apparent from the following description and the drawings forming a part thereof, wherein:

FIG. 1 shows a schematic arrangement of the open coil pay off reel, the leveller and tight coil re-wind reel 6 and strip tracking control and alignment;

FIG. 2 shows in side elevation the arrangement described in connection with FIG. 1 of the drawings;

FIG. 3 shows in front elevation a general arrangement of the leveller;

FIG. 4 shows a side elevation of FIG. 3;

FIG. 5 shows an enlarged view of the base stand and vertical adjusting portions of the leveller of FIG. 3;

FIG. 6 shows a side elevation of the leveller portions of FIG. 5;

FIG. 7 shows a section through the leveller on lines VII—VII of FIG. 3;

FIG. 8 shows a section through the leveller on line VIII—VIII of FIG. 3; and

FIG. 9 shows a view of the base of the roll housings illustrating the bearing pads for adjusting the movable housing.

Referring now in detail to FIGS. 1 and 2 of the drawing, an open coil 1 is mounted upon a pay off table 2 from which the strip leaving the coil passes through deflector roller 6 and pinch roll 7 maintaining back tension between coil 1 and leveller, thence past a strip alignment signal 3 into a suitable strip tracking controller 4. The strip then passes through the vertical leveller 5 to deflector roller 62 and tight recoiling reel 68 to form a new tight coil 9. The open coil method of annealing is old, as is the strip alignment signal. The strip tracking control device may be of any suitable form for feeding the vertically disposed strip in a straight line into the vertical leveller.

The vertical leveller, as shown in FIGS. 3 and 4 is comprised of a base portion 10 receiving a vertically adjustable frame 11 upon which are mounted the housings 12, 13 for the work rolls. Due to the overall height of the leveller, the base portion is customarily disposed within a suitable pit below the floor line in a plant where the strip coils are being processed.

The base 10, as best shown in FIGS. 5 and 6, has a rectangular bottom frame formed of connected members 14, 15 at the corners of which are hollow column base members 16 receiving columns 17 for vertical reciprocal movement therein. Inwardly of each column 17 is a post column 18 reinforced by member 19. In vertical spaced relation to column 17 is a fixed rectangular platform 20 whose corner portions provide hollow collar members 21 through which pass the columns 17. Said platform being held in fixed relation to the base frame members 14, 15 by the posts 18 and
reinforcing members 19. Disposed vertically above fixed platform 20 is a vertically adjustable frame 11 which may be of any suitable construction and is shown as a casting having corner openings receiving the upper ends of columns 17. Frame 11 is supported on columns 17 by the column end portions 17a retained in place by wedge assembly 22a. Vertical adjustment of frame 11 is obtained through an adjusting device, now to be described.

Mounted on members 20 are four suitable jacks, such as a worm gear jack 23 whose screws 33 are connected at one end with frame 11 and whose opposite end extends through member 20 into hollow post member 18. Jacks 23 on opposite sides of member 20 are driven in pairs by suitable shafts 24 and couplings 25. Each pair of jacks 23 is driven through a suitable gear box 26 mounted on bracket 27 secured to a member 20, and both gear boxes 26 are driven by suitable motor 28 and couplings 29 suspended from bracket 30. Motor 28 acting through gear boxes 26 and shafts 24 drive jacks 23 to raise and lower vertically adjustable frame 11 for a purpose hereinafter described.

Mounted upon the vertically adjustable frame 11 is a strip levelling section comprised of a front support 31 and rear support 32 between which are disposed a fixed rolling housing 33 and an adjustable rolling housing 34, all as shown in FIGS. 2, 3, 7 and 8. The supports 31, 32 are secured, at their bottom portions, in fixed relation to frame 11 and their top portions are connected by a suitable top plate 35. The end uprights 31a and 32a of said supports are provided with suitably shaped portions providing fixture holes by which the entire levelling section may be removed for any suitable purpose. The front and rear supports have suitable central openings 31b and 32b wherein for passage of the strip through the leveller section. The fixed and adjustable rolling housings are supported upon the frame 11 and extend between the supports 31, 32. As shown in FIGS. 4, 7 and 8, the fixed rolling housing 33 is secured to the front and back supports 31, 32 at 36 and held fixed to frame 11 by the fasteners 37 securing such supports to said frame. The adjustable rolling housing 34 is provided with bottom bearing pads 38 (FIG. 9) at each side thereof in engagement with the frame 11 and top and bottom side bearing pads 39 engaging the front and back supports 31 and 32. Said bearing pads and the members engaged thereby have machined engaging surfaces providing minute accurate adjustment relative to the rolling housing 34, no matter what the condition of the metal.

As clearly shown in FIGS. 2, 3 and 8, the adjustment of housing 34, relative to fixed housing 33, is obtained by top and bottom screw jack 40, 41 fixed in pairs to the side face of housing 33 adjacent the front and rear faces thereof. The vertically aligned jacks 40, 41 are driven by suitable motors 42 mounted on top plate 35, and each connected with the respective jacks by a suitable shaft 34 and couplings 44. Motor 42 is provided with a suitable brake (not shown). Within each jack is mounted a suitable non-rotating shaft 45 disposed transversely of roll housings 33, 34, as best shown in FIG. 8. Here the opposing faces of the roll housing have opposing annular recesses 46, 47 within which are mounted a helical coil spring 48. Such spring has a seat 49 at one end in recess 46 and at the opposite end seats against a washer 50 with sufficient engaging force. Such spring is of substantial size, for example of ¾ in. having an O.D. of 5”, free length of 9½” and solid length of 7” under a force of 4800 pounds, and serves to maintain a constant set opening of the machine in the operating range. The screw 40 passes through washer 50, spring 48 and second washer 51 mounted in housing 34. Washer 51 is retained in fixed relation longitudinally of screw 45 by abutting at one side against a recess 52 in housing 34 and at the opposite side against a key 53 extending through screw 45. The latter, outwardly of key 53, has a rounded end portion 54 engaging a similar rounded portion on an adjusting screw 55 mounted in housing portion 57 and provided with a lock nut 56. Each jack 40, 41 has a suitable worm gear (not shown) engaging screw 45 for moving same relative to said housings.

Referring now to FIGS. 3, 4 and 7 of the drawings, on roll housing 33 and 34 is provided with suitable working rolls 58 and back up rolls 59 including customary bearings and adjusting mechanisms, which have been indicated but not individually described. The construction, operation and adjustment details of such mechanisms concerned with the mounting and driving of rolls 58, 59 along with suitable pressure indicating mechanism are considered to be conventional except being adapted to vertically instead of horizontally disposed rolls.

The roll housings 33 and 34 by reason of being mounted on the vertically adjustable frame 11, have the usual driving mechanisms for the rolls therein also suspended from frame 11. As shown in FIGS. 5 and 6, a suitable gear case 60 and motor 61 are suspended from frame 11 by means of a suitable frame 62. The frame 62 is secured to frame 11 by any suitable means such as bolting, and thus moves concurrent with frame 11 in effecting vertical adjustment of the roll housings 33, 34. The driving gears within gear case 60 are connected by means of the usual spindles 63 with the work rolls 58.

Referring now to the practice of the method and the operation of the apparatus herein disclosed, reference is first made to FIGS. 1 and 2 of the drawings. The strip 64, disposed in a vertical plane, moves in a straight line from the open coil pay off reel 2 through the back tension pinch rolls and the leveller to the deflector roll 8 and thence in an angular direction to the tight re-wind reel 8. It is well known in the art that strip steel coming off a hot mill is tightly coiled to facilitate handling. These tightly wound coils are allowed to cool and in the cooling process anneal the strip to some extent. When the strip is unwound from the coil for further processing, the metal, having a tendency to retain its curved shape, breaks or kinks when straightened. Such kinks or breaks cannot be completely eradicated by subsequent working and, therefore, are unsuitable for certain types of manufacturing requiring a flat surface.

The operation known as "open coil" annealing, for conditioning the metal for further working, is well known in the art and is representative of the present methods in that both faces of each convolution of the coil are exposed to the annealing or treating medium, be it a gas or fluid. The convolutions of the so-called "open coil" are maintained in spaced relation by some suitable means, such as nylon strip or rope. After the annealing operation, the coil is again re-wound into a tight coil for transportation to further processing operations, the cord having been removed before the annealing operation. Such an annealing procedure does not eliminate coil "breaks" in the re-winding.

In the present method, we propose to eliminate the prior re-winding step and process the strip of the open coil through a suitable leveller to so improve the metallurgical and surface characteristics that after re-winding into tight coils for further processing, the metal may be removed therefrom without development of such coil breaks. With such a method the strip or sheet of the "open" coil is passed in a vertical plane through the leveller. The leveller here described is of a size to handle strip or sheet up to 60” wide.

In the open coil, after annealing, is disposed upon a suitable pay off reel 2 which by rotation permits the strip to be drawn from the coil. The leveller 5 should be suitably adjusted as hereinafter discussed, and the strip passed into the leveller 5 with the longitudinal center line of the vertical strip in alignment with the center line of the working area or pass line of the leveller. The strip 5, intermediate
the coil 2 and leveller 5, should have a strip alignment gauge disposed in horizontal alignment with the bottom edge of the strip and engaged with a strip control means 4 to insure the strip being properly entered into the leveller. The strip leaving the leveller is passed about a suitably mounted, freely rotatable deflector roll 60 into the tight re-winding reel which is suitably mounted and driven upon a suitable support such as 8, where it is wound into a tight coil.

During passage of the strip through the leveller 5, it may be suitably worked by the leveller rolls to effect the desired metalurgical and surface characteristics. Concurrent with such working, the speed of the strip leaving the leveller relative to the speed of the re-wind reel may be controlled through the motor driving the leveller rolls to provide sufficient back drag in the strip to effect the desired tightness in the coil being re-wound provided a measure of initial tension is maintained by tension units 6 and 7. In other words, the leveller can and preferably is so operated to effect the necessary "back drag" in the strip being recoiled. It will be obvious to those skilled in the art that the width of strip passing through the leveller will determine the degree of "back drag" to be imposed on the strip by the leveller. By way of illustration only and not as a limitation, the actual embodiments of the invention disclosed in the drawing provided for a linear speed of 800 f.p.m. for a 60 inch sheet. It will be apparent to those skilled in the art that a smaller size strip can also be operated upon by the leveller disclosed.

Referring now to FIGS. 3 and 4 of the drawing comprising the general assembly of the leveller of the invention, the vertical height thereof suggests the practicability of disposing the base of the leveller below the floor line of the working area where the recoiling is effected. Thus the top plane of the adjustable frame 11 would be located adjacent the said floor line in order that a sheet of maximum width could be handled from an "open coil" thereof supported upon said floor with the frame 11 in its maximum vertically adjusted position. By way of illustration, and not limitation, the vertically disposed working rolls for handling a sheet of maximum width of 60 inches would have a roll face length of approximately 66 inches. Thus the middle of the vertical working face of the rolls would be in excess of 33 inches above the floor line when the frame 11 is at maximum vertically adjusted height.

Assuming it is necessary to adjust the vertical height of frame 11, motor 28 (FIG. 5) would be actuated in a suitable direction of rotation to simultaneously drive jacks 23 on opposite sides of the leveller through gear drives 26 and shafts 24 to raise or lower all four jack screws 25 to raise or lower frame 11. Upon the actuation of the motor 28, it will be noted that the maximum height of frame 11 is shown in full lines and the maximum lowered position of frame 11 is indicated by dot and dash lines. The maximum movement of the base of motor 61 suspended from frame 11 for driving the leveller working rolls is likewise indicated by full and dot and dash lines. Assuming the leveller had been in operation and it is desired to roll a strip or sheet of a different thickness, reference is made to FIGS. 3, 4 and 8 illustrating the mechanism for varying the spacing between the adjacent faces of the work rolls by movement of roll housing 34. Motors 42 mounted upon top plate 35 when suitably actuated in the proper direction of rotation act through shafts 43 to drive jacks 40 and 41 to advance or retract the screws 45 therein. As shown in FIG. 8, non-rotating shaft 45 when advanced towards the left acts to exert pressure on adjustment screw 55 mounted in housing 34 in alignment with the end of screw 45. The spring 49 and screw 45 thus simultaneously exert a pressure to the left upon opposite sides of roll housing 34 causing movement thereof to the middle of the vertical working faces of roll 45, advancing jacks 40, 41 to be actuated in the opposite direction to retract shafts 45, the keys 53 in shafts 45 acting through washers 51 abutting surfaces 52 of the housing would impose a force to the right upon housing 34 causing it to move upon bearing pads 38 and 38c to close the face of the working rolls. As shown in FIG. 9, bearing pads 38 extend substantially the width of housing 34 providing complete stability thereto. Lateral stability in housing 34 is provided by upper and lower bearing pads 39 at opposite sides of the housing.

We claim:

1. The method of levelling and recoiling open coil annealed strip, comprising the steps of:
   (a) supporting the open coil with its axis in a vertical plane;
   (b) passing the strip through an initial tension device;
   (c) feeding the strip in a vertical plane through a levelling device;
   (d) passing the strip about a deflector roll;
   (e) recoiling the strip on a tight recoil reel;
   (f) regulating the speed of the leveller to provide suitable back tension in the strip feeding to the recoil reel.

2. The method of recoiling open coil annealed strip, comprising the steps of:
   (a) supporting the open annealed coil with the axis thereof in a vertical plane;
   (b) withdrawing the strip from the coil under a minimum of back tension and passing it in a vertical plane and a straight line through a leveller;
   (c) working the strip during passage through the leveller to develop the desired metalurgical and flatness characteristics therein;
   (d) recoiling the strip into a tight coil while regulating speed of movement of the strip relative to the rate of recoiling to maintain back tension in the recoiling strip.

3. The method of recoiling open coil annealed strip, comprising the steps of:
   (a) supporting the open coil of strip with the body of the strip in a vertical plane for unrestricted rotation,
   (b) withdrawing the strip from the open coil at a uniform rate,
   (c) passing the strip about a rotating surface deflecting the direction of movement of the strip without imposing coil breaks therein,
   (d) passing the deflected strip to a tight coil rewinding reel,
   (e) working the strip between the open coil and the deflecting surface to improve the metalurgical and surface qualities of the strip, and
   (f) regulating the speed of the strip during such working relative to the speed of the tight coil reel to provide back tension in the strip at the recoil reel.

4. The method as defined in claim 3 wherein the strip between the open coil and deflecting surface has its lower linear edge maintained in a horizontal plane.

5. The method as defined in claim 4 wherein the strip during said working is under uniform pressure at opposite sides of the longitudinal center line of the strip.

6. Apparatus for flattening and working strip metal disposed in a vertical plane, comprising driven trains of vertically disposed opposing rolls between which the strip is passed, a rigid frame member, a fixed housing and a laterally adjustable housing respectively mounted said roll trains of vertically disposed opposing rolls and supported on said rigid frame member in fixed vertical alignment, means for laterally adjusting housing relative to said fixed housing, means suspended from said rigid frame and connected with said roll trains for driving same and means for imparting selective vertical reciprocal movement to said rigid frame to align the longitudinal center line of the strip passing through said roll trains with the upper or lower working faces of the rolls.

7. Apparatus as defined in claim 6 wherein said means for moving said adjustable housing comprises pairs of screw jacks mounted on said fixed housing adjacent the
top and bottom thereof, means for concurrently actuating each vertically spaced pair of screw jacks in alternate directions of rotation, shafts mounted within each said jacks for advancement and retraction relative to said rotating screws and extending transversely through the adjacent fixed housing into the adjustable housing, means on each said adjustable housing providing an abutment for each said shaft, a helical type compression spring encircling each shaft and having opposite ends seated in said respective housing affecting compression of the spring as the housings move towards each other, and means on each shaft engaging within said adjustable housing for advancing the adjustable housing towards said fixed housing as the said shaft is advanced in one direction retracting same through its associated jack, said shaft when advanced relative to its associated jack acting through its associated abutment to move the adjustable housing away from said fixed housing.

8. Apparatus for flattening and working strip metal disposed in a vertical plane, comprising a fixed base portion having a central opening therethrough, a vertically adjustable frame mounted on said base portion for guided movement relative thereto, means secured to said base portion and engaging the under face of said flat frame for effecting vertical adjustment thereof relative to said base portion, means mounted upon the upper face of said frame and embodying a pair of trains of vertically disposed rolls for flattening and working strip passing therethrough, and means suspended from said frame and within said base portion opening for driving said roll trains.

9. Apparatus as defined in claim 8 wherein said base portion includes four hollow vertically disposed corner members, said adjustable frame is provided with depending members slidably received within said base hollow members, and said means secured to said base for effecting vertical adjustment of said frame comprises two pairs of transversely spaced screw jacks, each pair of said jacks being connected by a shaft effecting concurrent actuation of the jacks and said pairs of jacks being interconnected to effect simultaneous operation of all four jacks, each said jack having a screw therein having one end thereof rotatably connected with said frame, and a motor and gear drive connected with one of said jacks for concurrently actuating each of said jack and screw therein for raising and lowering said frame relative to said base portion.

10. Apparatus as defined in claim 8, wherein said means secured to said base portion for effecting vertical adjustment of said frame comprises screw jacks each having a screw therein rotatably engaging said frame and simultaneously selectively actuated to raise and lower said frame relative to said base portion.

11. Apparatus for levelling and re-winding different widths of open coil anneal metal strip, comprising an open coil pay off means maintaining the width of the strip therein disposed in a vertical plane, vertically adjustable levelling and strip reworking means having vertically disposed opposing roll trains, means between said leveller and pay off reel for aligning the bottom edge of the strip entering the leveller, strip deflection means receiving the strip leaving the leveller and re-winding means for receiving the vertically disposed deflecting strip and re-winding same into a tight coil.

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