METHOD AND APPARATUS FOR STRAIGHT-ENING SHEET MATERIAL

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This invention relates to a method of, and apparatus for, flattening or straightening sheet, strip and plate material in machines of the roller leveler type.

The great majority of roller levelers heretofore in use have employed the principle of inclining the upper set of straightening rolls relative to the lower set of straightening rolls, or vice versa, in order to produce deep corrugations at the entry side of the sheet and waves or corrugations of gradually diminishing magnitude towards the exit side of the machine. Such adjustment may have been made either by individual roll adjustments or by unit adjustment of one row of straightening rolls with respect to the other.

These known designs however have a number of shortcomings. It is for instance necessary to readjust the inclination of the rolls when the straightening direction is reversed. Furthermore, the work sheet is subjected to the deepest corrugations or waves at the entry side of the machine so that it is difficult to start a sheet in the machine. To facilitate the feeding of the work material, pinch rolls and the like have been used before. Due to the fact that the deepest waves are produced at the entry side of the machine, the traction of the rolls is not sufficient to carry the sheet into the rolls without slipping.

Such slipping of the sheet between the rolls is accompanied by transverse marks on the sheet. These marks are called “entry marks” in the steel trade. To eliminate these entry marks, that portion of the sheet which shows the same has to be sheared off.

One of the objects of this invention is to provide means for the adjustment of the straightening roll inclination so as to eliminate readjustment of the straightening rolls when the operating direction of the machine is reversed.

Another object is to provide means for facilitating the feeding of the work sheet into the entry rolls of the machine, whereby entry marks may be eliminated for work material of differing hardness.

These and other objects which will be pointed out in the specifications and especially in the claims to follow, I attain by means of my invention disclosed in the drawings, wherein:

Fig. 1 is a side view of a sheet straightening machine.
Fig. 2 is a sectional front view of the machine on line 2—2 Fig. 1.
Fig. 3 is a top view of the machine.
Fig. 4 illustrates a sectional front view of a supporting arrangement of a tilting roller block on line 4—4 Fig. 1.
Fig. 5 is a sectional side view of a tilting roller block and supporting arrangement on line 5—5 Fig. 4.
Fig. 6 depicts an adjusting device for the height adjustment block on line 6—6 Fig. 1.
Fig. 7 shows a sectional side view of the wing adjustment mechanism on line 7—7 Fig. 2.
Fig. 8 is a sectional front view of a coupling on line 8—8 Fig. 7.
Fig. 9 illustrates a sectional top view of parts of a tilting block or wing on line 9—9 Fig. 1.
Figs. 10 and 11 show diagrammatically roller arrangement with different displacements of the tilting wings. Fig. 12 illustrates diagrammatically a modified roller arrangement with the supporting rolls positioned on top of the straightening rolls.

In Figs. 1 to 11 inclusive, one embodiment of the invention is shown by way of example in connection with roller levelers having supporting or backing rolls which are arranged in staggered relation to the straightening rolls. In order to preserve a unit height adjustment for all the upper rolls and at the same time provide means for the independent angular adjustment of the straightening rolls on the entry as well as on the exit or delivery side of the machine, the upper row of straightening rolls is divided into three sections.

Referring more particularly to Figs. 1, 2 and 3, the machine comprises two frame elements or housings 18 which are suitably connected to each end of the base 16. Each housing 15 includes two parallel uprights 17 and one cap frame 18 secured to said uprights. Two cross beams 19 are provided to strength and stiffen the housings 15.

For adjusting all upper straightening rolls as a unit, each of the two adjustable blocks 26, one of which is located in each housing 15, is provided with two suspension screws 21, Fig. 6. Screws 21 engage threaded sleeves 22 which are rotatably guided in cap frames 18. At the top of each sleeve is a worm-wheel 23 rotatable by a worm 24. The lower ends of screws 21 are mounted on pivots 14 in blocks 26. Blocks 20 are guided on uprights 17 by gibs 13.

By raising or lowering the screws 21, the complete upper roll unit may be raised or lowered which is essential in order to regulate the distance between the upper and lower straightening rolls according to the thickness of the work material.
Two worms 24 are secured to each shaft 25 and 26. The latter are mounted in suitable bearings 51. Both shafts carry respective helical gears 28 and 29 which in turn engage respective helical gears 30 and 31 on shaft 32 which is located at right angles to shafts 25, 26, and rotatably sustained in bearings 62. 

The left hand side of the machine, Fig. 2, has been chosen as the operating side and all controls for the various adjustments are concentric thereto. The end of shaft 32 is provided on the operating side of the machine with a suitable handwheel 33. A rotation thereof will actuate the gearing described, whereby the whole upper roll unit may be raised or lowered as required. 

Cross beam 34 which is shown to be fast to adjustable blocks 20 forms part of the middle section of the upper roll unit and sustains straightening rolls 35 at their ends in bearings frames 34. Above straightening rolls 35 and staggered in a located supporting rolls 103, 38 and 39. In order to increase their stiffness, these supporting rolls are comparatively short and three such short backing rolls are placed along each straightening roll (Fig. 2). These ends of these backing rolls are held in bearings 34 suitably fastened to cross beam 34. 

Below the upper straightening rolls 35 of the middle section are located their cooperating lower straightening rolls 41, 42, 43, 44, 45, 46, 47, 48, 49, and 50. All these lower straightening rolls are shown to maintain their horizontal position at all times and they are prevented from sagging under load by means of the lower supporting rolls 51 which are in staggered relation to their straightening or working rolls, similarly as described in conjunction with the upper straightening rolls 35 and their backing rolls 103, 38, 39. 

Referring to Figs. 7, 10 and 11 of the drawings, the nine upper straightening rolls may be classified to belong to three distinctly different sections of the machine. Each of these sections has to produce certain desired effects during the straightening process. 

The three centrally located upper straightening rolls 35, together with their cooperating lower rolls already described, represent the middle section. This section has the primary task of thoroughly kneading the work material to eliminate internal strains, kinks, bends and so forth, in the work material. When providing the straightening rolls with deflecting mechanisms such as shown and described for example in my Patent No. 2,069,508 of July 30th, 1935, it is further possible to perform a positive stretching action along the short areas of a distorted work sheet. The kneading or "wrapping" of the material or "corrugating" of the same is accomplished by subjecting the work sheet to a series of deep transverse waves or corrugations as may be seen in Figs. 10 and 10. The kneading effect of a number of waves as shown in the illustrations 10 and 12 works the material to a much higher degree than the same number of gradually decreasing waves. A better straightening result will therefore be obtained with the same number of straightening rolls. 

The three upper straightening rolls 52, 53, 54 belong to the left wing 55. The three working rolls 56, 57 and 58 form part of the right wing or tilting frame 59. 

Depending on the feeding direction, left and right tilting frames 55 and 59 respectively, have different tasks. When feeding a work sheet from left to right in Fig. 10, the right wing 59 must smoothly flatten or spread the deep corrugations formed by the middle section of the machine (rolls 35, 41, 42, 43, 44). The elimination of these deep corrugations or waves is accomplished by tilting the rolls 56, 57, 58 of the right wing 59 in such a manner that the apex of the tilting angle is directed towards the middle section of the machine. The tilting of the right wing 59 is shown to have as fulcrum the longitudinal axis of straightening roll 58. Thus the latter will not be raised by the tilting movement, but will maintain the same relative position to the lower straightening rolls. Rolls 57 and 59, however, will be raised differing amounts relative to their cooperating lower straightening rolls. 

The distance between rolls 57 and 58 and their lower rolls 50, 49, 48 will be increased, thereby gradually decreasing the depth or magnitude of the waves to which the work sheet is subjected by the preceding rolls 41 as well as to facilitate the roll 36 of the middle section to produce a flat sheet, the distance between the exit roll tris 56, 43, 48 is selected as a general rule about equal to the thickness of material to be straightened. However, this amount of adjustment depends to a great extent on the hardness and on the condition of the work material so that it is essential for efficient operation to be able to adjust the roll opening of the exit or delivery roll tris 56, 43, 48 to suit the condition and physical characteristics of the work material, without, however, being forced to disturb the height adjustment of the rolls in the middle section of the machine. 

Generally speaking it may be said that the depth or magnitude of the waves is gradually decreased from a maximum as between the roll tris 58, 41, 59 to zero between exit roll tris 56, 49, 48. 

The left wing 55, Fig. 10, when feeding a sheet from left to right, is tilted upwards around the straightening roll 54. The object of this tilting movement, which may be the exact duplicate of that of wing 59 with the apex of the tilting angle also towards the middle section of the machine, is to gradually increase the depth of the waves in the entering sheet from zero to maximum. Fig. 10 depicts the distance roll tris 52, 45, 46 as being about equal to the thickness of material. Consequently, these first rolls will not subject the work sheet to waves, but as all the straightening rolls are individually driven these entering rolls will grip the sheet and exert traction thereon. The next roll tris 46, 52, 53, however, will produce waves in the sheet. The depth or magnitude of these waves however are smaller than those of the following waves produced by roll tris 42, 46, 47, 48, 54, 57, 47, 44, 40 and so forth. Each roll trio subjects the work material to one wave or one wave-shaped roll pass and may comprise one upper and two lower rolls, or one lower and two upper rolls, respectively. 

It will be noted that due to the close center, staggered arrangement of the lower rows of straightening rolls in roller levelers, each roll, with the exception of the first and the last roll 45 and 48, respectively, forms part of more than one roll trio and participates therefore in more than one roll pass. Figs. 10, 11, and 12 show that the work material is bent in reversed directions between successive roll trios. The effect of the gradual increase in wave depth on the entry side of the machine is to facilitate feeding.
of the stock, eliminating such means as pinch rolls and the like used and required heretofore. Furthermore, the traction developed on the sheet by the entry roll trio will help to bend the work sheet around the second roll trio (46, 52, 53). However, as the traction obtained by these two roll trios is considerably greater than required to produce the formation of the comparatively small corrugation in the sheet (51, 53), there is an accumulation of surplus of traction available to carry the work sheet through the subsequent rolls without slipping. The objectionable entry marks on the work sheet are thereby eliminated with a resulting saving due to the elimination of extra handling, shearing as well as waste.

In addition to that, the mechanism described may be operated from either side without any readjustments and without introducing expensive mechanisms, and furthermore, without loss of time.

Each of the upper and lower straightening rolls is individually driven by universal joints 60, Figs. 2 and 3, and connected to a transmission device 61, in the base of the stock. Due to the close center distances of the straightening rolls and the greater center distances of the driving spindles on the transmission device on account of the gearing required for driving each spindle individually, the operating angles of the driving spindles and consequently those of the universal couplings for the straightening rolls in the right and left wings 55 and 59 respectively, are greater than those in the middle section of the machine (Fig. 3). However, contrary to conventional designs, in the arrangement shown the leads to be carried by the spindles of greater operating angle are smaller than those carried by the spindles which possess a smaller driving angle.

With respect to the angles of inclination which the left and right wings and their straightening rolls form with the lower straightening rolls, it will be understood, that these angles may be identical as shown in Figs. 10 and 12. This is especially desirable when the machine is to be frequently reversed. When working for a longer period of time in the same direction, the entry wing may form a smaller or larger angle of inclination than the exit wing. This depends primarily on the hardness of the material. While it may be possible to diminish the angle of inclination of the entry wing compared to that of the exit wing when comparatively soft material is flattened which requires less force to bend the same around the entry roll trios if entry marks are objectionable, it may be necessary to increase the angle of inclination of the entry wing when handling harder material. If the straightening of hard material represents the majority of work, the number of straightening rolls in both wings may also be increased to interpose more steps for the gradual increase of wave depth from zero to maximum.

To oscillate wings 55 and 59 around the longitudinal axes of respective straightening rolls 54, 58, respective gear segments 63, 64 may be mounted on top of these wings (Fig. 7). Worms 65, 66 are in engagement with these gear segments. The helix angle of both gear segments and worms is of a degree so as to make the same self-locking. Worms 65, 66 are free on shaft 67 and may be engaged and disengaged by respective jaw clutches 68, 69. The slidable clutch members 70, 71 of said jaw clutches are threaded in keyways 72 and are each moved into and out of clutch engagement by means of respective bifurcated levers 73, 14, Fig. 8. These levers are fast to respective clutch rods 75, 76, each of which has at its operating end a respective hand lever 77, 78, Fig. 3. The clutch rods are supported in suitable bearings 79, near the operating end of the machine, while the opposite clutch rod ends are rotatably mounted in the gear bracket 80, fastened to the top surface of cross beam 31.

Gear bracket 80 also supports shaft 81 with its worms and clutches in bearings 104 and carries in its base the rotatable shaft 81 which actuates the wing adjustment. A helical gear 82 is fast to the bracket end of this shaft 81. A similar gear 83, which is shown to be located in the middle of shaft 67 is in engagement with gear 82. Shaft 81 is maintained in bearings 84 and is provided at the operating side of the machine with a suitable handwheel 85 for the rotation of said shaft and gears.

Levers 71, 78, Figs. 1, 2 and 3, are shown in horizontal positions, holding the jaw clutches in a disengaged position. By raising one or both of these hand levers 77, 78, one or both jaw clutches may be engaged by means of respective handwheels 86. One or both wings may be inclined as desired. The arrangement of separate jaw clutches for each wing makes it possible to tilt both wings to the same angle of inclination or to different angles as required by the particular characteristics of the work sheet to be flattened.

Both wings 55 and 59 are in sliding engagement with adjusting blocks 20 in the manner illustrated in Figs. 4 and 5. Each wing is suspended at each of its ends on two rods 86, Fig. 4. Nuts 87, resting on the top surface of adjusting block 20 permit adjustment of rods 86 in vertical directions. The rods 86 sustain a roller 88 which is rotatable on trunnions 89 in bearings 90. Rollers 88 rest on cylindrical surfaces 91 which form part of the wings. The fulcrums of the sliding surfaces 92 on the wings coincide with the longitudinal axes of straightening rolls 54 and 58 respectively. The sliding surfaces 92 on each wing are also cylindrical and the fulcrums thereof are also the centers of respective rolls 54 and 58.

The sliding surfaces 92 at the ends of each wing, Fig. 9, bear against surfaces of identical contours on the height adjustment blocks 20. Suitable gibbs or plates 93, fastened to these blocks prevent the wings from dislocation.

In order to maintain the three sections of the upper straightening rolls against lateral movement, the bearing frames 94, carrying the straightening rolls 35 of the middle section, and bearing frames 95 in which the straightening rolls of the other sections are rotatably mounted, engage each other on cylindrical sliding surfaces 96. The fulcrums of these sliding surfaces coincide with the respective straightening roll axes 54, 58.

As the backing rolls 97, 98 and 99; and 100, 101 and 102 respectively, are mounted in wings 55 and 59 respectively, they will follow the tilting movement of these wings. Consequently, when tilting the wings, backing rolls 99 and 100, respectively, will be moved towards straightening rolls 103 and 33, respectively, of the middle section. However, due to the common fulcrums of sliding surfaces 92, 91 and 95, the center distances between straightening rolls 54, 58 and their backing rolls 99, 100, respectively, will always remain the same, as backing rolls 99, 100 will move in an arc around the centers of their respective straightening rolls 54, 58. Thereby, the straight-
ening rolls 54 and 58 will always be effectively supported, regardless of whether all the upper rolls are in neutral locations or whether one or both wings have been tilted.

Pins 105 located at the outer bottom portion of blocks 20 positively locate each wing in its horizontal position. This horizontal or neutral position of the wings is shown for example in Fig. 1. It will be seen that in this neutral position, the straightening rolls carried in the wings are in the same horizontal plane as the straightening rolls 35 of the middle section and do not form an angle of inclination with the lower straightening rolls.

Plates 105 are of help in locating all upper straightening rolls in one common plane which may be desirable after the left or right wings have been adjusted individually to different angles of inclination. The stop surfaces 106 on the inner, upper portion of wings 55 and 59 and beam 34 of the middle section may also be used for the same purpose.

A rotation of handwheel 35 with both jaw clutches engaged, will tilt or oscillate both wings and raise the outside ends of wings 55 and 59 from their neutral horizontal locations shown in Fig. 1 to the angular positions depicted in Figs. 10 and 12. The tilting of both entry and exit wings may be referred to as "double tilting".

Diagrammatic view 11 shows the right wing 59 in neutral location, while the left wing is tilted. This illustrates the possibility of operating the machine either with both entry and exit wings tilted as depicted in Figs. 10 and 12, or only with one wing tilted. It will be realized that the operating direction in Fig. 11 must be from right to left and may not be reversed without readjustment of the right wing for flattening out the waves in the sheet.

Fig. 12 illustrates a similar arrangement to that of Fig. 10 with the exception that the supporting rolls 101 are in the same vertical plane as the corresponding straightening rolls. In other words, the supporting rolls are located on top of the straightening rolls and are not staggered as shown in the other views. It will be noted that the double tilting may be similarly applied in this case. Furthermore, roller levers without any backing or supporting means for the straightening rolls may be similarly arranged with double tilting of the entry and exit rolls.

When the supporting rolls are positioned on top of their straightening rolls (Fig. 12), or when no supporting means are employed, the problem of maintaining the center distances between straightening rolls and their respective supporting rolls is absent. Then, the application of the double tilting method is simplified and individual roll adjustment may be resorted to in order to obtain the objects of the present invention.

It will be understood that while in the embodiment of my invention as disclosed, each of the three sections of the upper straightening rolls comprises three rolls, any desired number of such rolls may be used for each section. Furthermore, the double tilting may be similarly applied to the lower straightening rolls, or to both, upper and lower straightening rolls. The placeable straightening rolls on the entry side and on the exit or delivery side may be located in different planes in their neutral position relative to each other and/or the middle section and not in the same horizontal plane as the remaining straightening rolls therebetween.

While I have shown and described, by way of example, mechanisms for obtaining the stated objects, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications. I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In mechanisms of the character described, rows of cooperating straightening rolls between which a work sheet is to pass, the distances between the longitudinal axes of the rolls of each of said rows being substantially alike, elements to sustain straightening rolls of said rows on the entry and on the delivery end of the machine, means to carry the remaining straightening rolls of said rows, further means to regulate said elements sustaining said straightening rolls on the entry and on the delivery end of the machine relative to said means carrying said remaining straightening rolls so as to gradually increase the magnitude of each of a series of waves to which the material is subjected on the entry side and to gradually decrease the magnitude of each of a series of waves towards the delivery end.

2. In mechanisms of the character described, rows of cooperating straightening rolls between which a work sheet is to pass, separate means for carrying straightening rolls located at each end of said rows, auxiliary means to sustain the remaining centrally located straightening rolls, means to maintain said auxiliary means in neutral location, and common means to displace said separate means including their respective straightening rolls in such a way that the distances between the cooperating straightening rolls at each end increase from said centrally located straightening rolls towards each end.

3. In a roller leveler, rows of straightening rolls and supporting rolls, including groups of straightening rolls and their respective supporting rolls at each end of one of said rows, means to tilt each of said groups around a respective fulcrum, said fulcrum being one of the straightening rolls of the respective group.

4. In a roller leveler, rows of straightening rolls and supporting rolls located in staggered relation thereto including a group of straightening rolls and related supporting rolls at each end of one of said rows, means to tilt each of said groups around a fulcrum formed by the longitudinal axis of one straightening roll belonging to one group, whereby supporting rolls sustaining the fulcrum rolls travel in an arc around said fulcrum rolls.

5. In a roller leveler, one middle section and two wings, straightening rolls and supporting rolls carried by said middle section and said wings and forming one row of supporting rolls, curvilinear sliding surfaces on each of said wings, the fulcums of said sliding surfaces of each wing to coincide with the longitudinal axis of the respective straightening roll of each of said wings which is adjacent to the straightening rolls of said middle section.

6. In a roller leveler, a unit of straightening rolls forming a row, means to adjust said unit in height, said unit to include one or two wing sections to sustain said row of rolls in groups, curvilinear sliding surfaces on each of said wings, said sliding surfaces of each wing to coincide with the longitudinal axis of the respective straightening roll of each of said wings which
is adjacent to the straightening rolls of said middle section, curvilinear suspension surfaces for each of said wings, the fulcums of said sliding surfaces on the wings and said sliding suspension surfaces being identical.

7. In a roller leveler, rows of cooperating straightening rolls between which a work sheet is to pass, one left wing element for sustaining the straightening rolls located at the left end of one of said rows, one right wing element for carrying the straightening rolls located at the right end of one of said rows, one central frame element to sustain the centrally located straightening rolls of said row, common means for tilting said left wing element and said right wing element so that the angles of inclination which the straightening rolls in both said left and said right wing elements form with said centrally located straightening rolls, are substantially identical.

8. In a roller leveler, rows of cooperating straightening rolls, sustaining means for one of said rows of straightening rolls, means to adjust said means including said row of straightening rolls in height as a unit, one middle section and two wing sections for carrying said row of straightening rolls in groups, means to maintain the respective lateral locations of said middle section and two wing sections, means to tilt each of said wing sections upwards relative to said middle section around a respective fulcrum, said fulcums of each of said wing sections to coincide with the longitudinal axis of the respective straightening rolls in each of said wing sections which is adjacent to the straightening rolls of said middle section.

9. In mechanisms of the character described, a unit comprising straightening rolls forming a row, said row including one middle section and two wing sections to sustain said row of rolls in groups, means for inclining each of said wing sections with respect to said middle section in such a manner that the apices of their angles of inclination are directed toward said middle section.

10. In mechanisms of the character described, a unit comprising straightening rolls forming a row, said row including two wing sections to sustain said row of rolls in groups, common means for raising or lowering said row of said associated straightening rolls, and further means for tilting each of said wing sections in such a manner that the apex of the tilting angle of one of said wings is directed toward the apex of the tilting angle of the other wing.

11. In mechanisms of the character described, rows of cooperating and substantially equidistant straightening rolls between which a work sheet is subjected to a series of wave-shaped roll passes, separate means for carrying the straightening rolls located at each end of one of said rows, auxiliary means to sustain the centrally located straightening rolls of said row, tilting means including curvilinear guiding elements for each of said separate carrying means.

12. In mechanisms of the character described, rows of straightening rolls, supporting rolls arranged in staggered order thereon, means for carrying the straightening rolls and their respective supporting rolls located at each end of one of said rows, auxiliary means to sustain the centrally located straightening rolls of said row, further means to tilt each of said carrying means including their straightening rolls and associated supporting rolls with respect to said centrally located rolls, the fulcums of the tilting movement of each of said carrying means being the longitudinal axis of one of said straightening rolls of said row.

13. In mechanisms of the character described, rows of straightening rolls between which a work sheet is to pass, series of supporting rolls for said straightening rolls, said supporting rolls being located between successive straightening rolls and revolvably engaging the same, means for inclining the straightening rolls and their associated supporting rolls located at each end of one of said rows with respect to the remaining straightening rolls, and further means to maintain the center distances of said supporting rolls and their associated inclinable straightening rolls when said rolls are being inclined.

14. In mechanisms of the character described, a unit comprising straightening rolls forming a row, means to adjust said unit in height, said unit including two wing sections to sustain said row of rolls in groups, means to tilt each of said wing sections, the fulcums of the tilting movement of one of said wing sections to coincide with the longitudinal axis of one of said straightening rolls, and the fulcums of the tilting movement of the other wing section to coincide with the longitudinal axis of another of said straightening rolls.

15. In mechanisms of the character described, rows of cooperating straightening rolls between which a work sheet is to pass, the distances between the longitudinal axes of the straightening rolls of each of said rows being substantially alike, separate means for carrying straightening rolls located at each end of one of said rows, auxiliary means to sustain the remaining centrally located straightening rolls of said row, and individually operable means to displace said separate means including their respective straightening rolls in such a way that the distances between the cooperating straightening rolls at each end increase from said centrally located straightening rolls towards each end.

16. In mechanisms of the character described, rows of cooperating straightening rolls between which a work sheet is to pass, separate means for carrying the straightening rolls located at each end of one of said rows, auxiliary means to sustain the centrally located straightening rolls of said row, means to tilt each of said carrying means independently from the other, and common means for raising or lowering all the straightening rolls of said row.

17. The method of treating sheet and strip material in roller levelers which comprises subjecting the work material during the first straightening step to the bending and flexing action of a group of working rolls in such a manner that the bending action gradually increases from zero to a maximum, thereafter continuing the bending action at maximum during the intermediate straightening step between another group of rolls, and finally flattening out the work material between a third group of rolls, the flexing action of which gradually decreases to zero, the while backing up said working rolls intermediate their ends to avoid detrimental deflection of said rolls and consequent injurious action on the work material.

18. The method of treating sheet or strip material which comprises passing it through a series of roll trios to subject the material to wave-shaped roll passes, directing a lesser bending action upon the material in the first roll trio than in the succeeding intermediate roll trios in such
a way that the bending action in each of said intermediate roll trios is gradually and successively increased, and then gradually decreasing the bending action on the material in the final roll trios to a minimum to flatten out the material.

19. The method of treating sheet and strip material in roller levelers which comprises subjecting the work material during the first straightening step to the bending and flexing action of a group of working rolls in such a manner that the bending action gradually increases from zero to a maximum, thereby accumulating a surplus of traction on the work material, thereafter using said accumulated traction to carry the work material without slipping through another group of working rolls representing the intermediate straightening step and maintaining the bending action at maximum during this intermediate straightening stage, finally flattening out the work material between a third group of rolls, the flexing action of which gradually decreases to zero.

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