Feb. 26, 1963 F. K. MAUST 3,078,909

METHOD OF TENSION LEVELING WORK MATERIAL

Filed Aug. 15, 1960

FIG. 1.

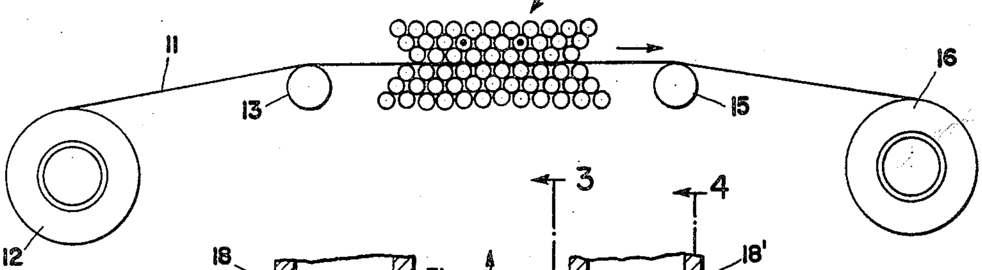


FIG. 2.

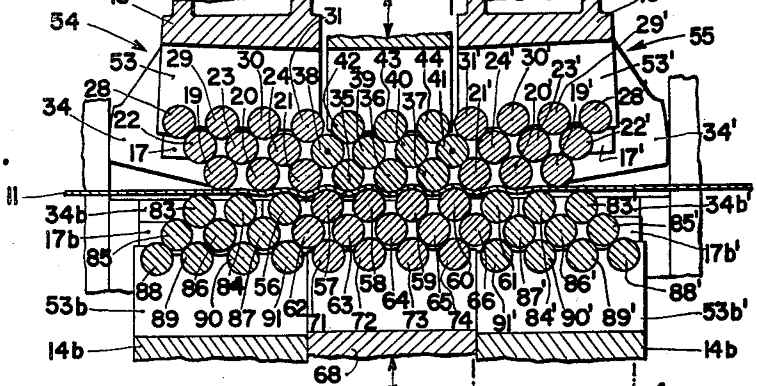


FIG. 3.

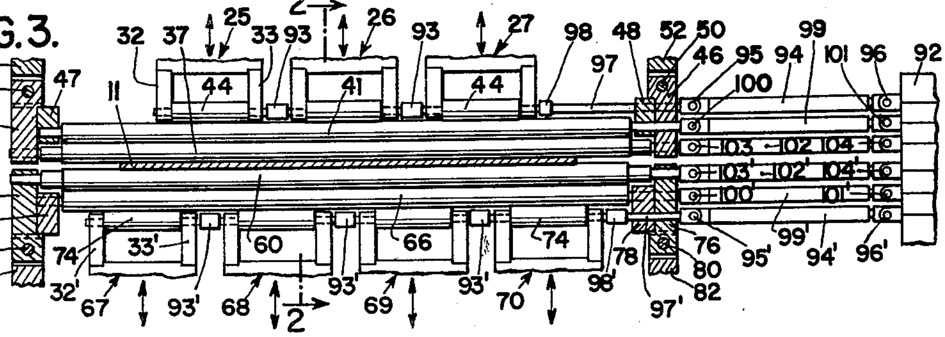
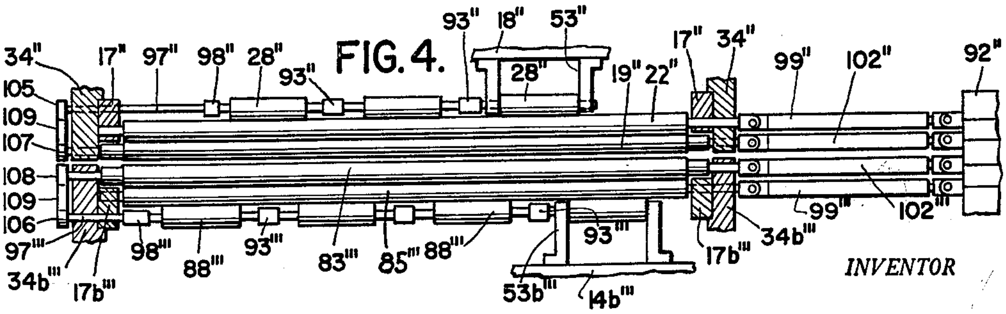


FIG. 4.



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METHOD OF TENSION LEVELING WORK MATERIAL

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This invention relates in general to tension leveling with backed-up roller levelers for leveling and flattening ferrous and non-ferrous sheet and strip material.

Backed-up roller levelers or so-called four-high levelers as used heretofore have an upper and lower bank of small diameter straightening rolls or work rolls between which the work material is repeatedly flexed beyond its elastic limit by subjecting it to series of alternate half-waves transverse to the pass direction. The upper work rolls produce one series of half-waves; the lower work rolls produce another series of half-waves.

To prevent undesired deflection of the small diameter work rolls during the leveling operation, series or banks of short back-up or supporting rolls are provided in direct contact with them and located along their longitudinal axes. Backed-up roller levelers have proved of great benefit to rolling mills and other industries. They have, however, one drawback, particularly noticeable and objectionable when leveling highly finished stock such as bright aluminum, brass, copper, polished and painted material, resulting from the marking effect of the back-up rolls. The intense localized pressure contact of the short back-up rolls with the work rolls has a tendency to blemish the surface finish of the work rolls and causes so-called "streaks," "patterns" or markings throughout the length of the work material passing through the back-up roller leveler.

The prior art shows attempts to solve this problem of streaking in backed-up roller levelers. Reference is made to my U.S. Patent No. 2,949,147, for instance, which shows a novel arrangement of a plurality of support roll sections driven at substantially the same circumferential speed as their associated work rolls. However, while this design has proved satisfactory for many applications, the trade requirements are becoming more critical as far as surface quality is concerned.

It has also been suggested to employ non-driven long intermediate rolls between work rolls and their short back-up rolls. But the non-driven intermediate rolls cause serious rotational difficulties because the work rolls alone are positively driven by a toothed gearing type drive and they must rotate their intermediate rolls by frictional contact. Any such friction wheel type drive inherently is accomplished by slip. Thus the circumferential speed of the frictionally driven intermediate rolls is lower than that of the work rolls. The intermediate rolls, already rotating at a slower circumferential speed than the work rolls, must now in turn rotate their short back-up rolls also by frictional contact. This compounds the problem because the circumferential speed of the intermediate rolls is still further reduced compared to the positively driven work rolls. Furthermore, the short back-up rolls also slip relative to the intermediate rolls, i.e. loose circumferential speed compared to the intermediate rolls. The resulting total slip causes a grinding action between work rolls and intermediate rolls and between the short back-up rolls and the intermediate rolls so that the finely ground surfaces of these rolls are damaged to such an extent that the surface qualities of the work material passing through the leveler suffer accordingly. It has also been proposed to arrange the short back-up rolls in such a manner that their bodies overlap each other. At best, this results in a more or less uniformly streaked, dull surface of the work material.

Perceiving the basic cause for the shortcomings of roller levelers proposed heretofore, a novel six-high roller leveler is disclosed in the present application, in which individual driving means of the toothed gear type are employed for rotating the work rolls as well as their long intermediate rolls and also the short back-up rolls at substantially identical circumferential speeds and without slip relative to each other.

While the novel six-high leveler may be used for cut-to-length sheets, best results will be obtained by the method of leveling continuous strip material in coil form under tension with a pay-off and rewind reel or equivalent means for creating tension, such as bridle rolls. This method of leveling under tension eliminates another possible source of marking the work material on account of slippage of the stock in the work rolls because the power driven rewind reel may be exactly synchronized with the linear circumferential speed of the work rolls. For best results the rewind reel should develop as a minimum sufficient pull on the strip so that no slippage occurs. Any slippage of the stock in the work rolls not only damages the surface finish of the stock but also has a damaging abrasive effect on the finish of the work rolls themselves which in turn affects the life of the work rolls and frequency of regrinding.

The severity of the deflection of the work rolls also affects the surface finish of sensitive work material. Heretofore, usually one bank of work rolls has been provided with individually adjustable back-up roll sections for the deflection of the work rolls for correcting the mill shape of the stock. These correction adjustments had to be severe enough to stretch the short portions of the material to the same length as the rest of the stock by increasing the amplitude of the transverse waves along the localized short portions. Severe correction adjustments have a tendency to dull the stretched portions because of the displacement of the grain structure along these stretched portions of the work material. I have found that in tension leveling with a backed-up roller leveler having individually adjustable back-up roll sections for both work roll banks, less severe correction adjustments are needed to render the work material of a given mill shape flat because each of the two work roll banks subjects the material to half-waves of differing transverse amplitude and less severe deflection of the work rolls of each bank is needed than when the total correction must be accomplished by the deflection of one work roll bank. The grain structure of the stock seems to be less disturbed and the original surface finish of the work material is better preserved.

One object of the present invention is to provide a method of correcting the mill shape and for leveling work material in a six-high roller leveler by employing any of the well-known drives of the toothed gear type for driving full-length intermediate rolls between short back-up roll sections and work rolls for minimizing the streaking effect of said short back-up roll sections.

Another object is to provide a method and apparatus of the type described in a novel six-high leveler with the support roll sections for one work roll bank located in staggered relation to the support roll sections of the other work roll bank including means for individually adjusting each of said support roll sections to reduce the severity of the work roll deflection for mill shape correction, resulting in minimum displacement of the grain structure of the stock and preservation of its surface finish.

Another object is to provide a method of leveling under tension in said novel six-high leveler with tension of at least sufficient magnitude to prevent slippage of the work material in the work rolls.

A further object is to provide driving means of the toothed gear type for rotating positively the work rolls, intermediate rolls and short back-up rolls in a six-high leveler at substantially identical circumferential speeds.

These and other objects and advantages of my invention will become apparent from a consideration of the following description and claims, taken together with the accompanying drawings.

In the drawings:

FIG. 1 is a diagrammatic sectional view of a tension leveling line incorporating the new six-high roller leveler.

FIG. 2 is a fragmentary diagrammatic cross-section through a six-high roller leveler taken along line 2—2 of FIG. 3, looking in the direction of the arrows.

FIG. 3 shows a partial diagrammatic front view of the six-high leveler, partly in section, taken along line 3—3 of FIG. 2, looking in the direction of the arrows.

FIG. 4 shows a partial diagrammatic front view, partly in section, of the novel leveler embodying a modified form and taken along line 4—4 of FIG. 2, looking in the the direction of the arrows.

Tension Leveling Line

FIG. 1 shows a tension leveling line. The work material or stock **11** is unwound from pay-off reel **12**, passes over front billy roll **13** into the novel six-high leveler **14** and over rear billy roll **15** unto rewind reel **16**. The operating direction is assumed to be from left to right as indicated by arrow. The pay-off reel **12** and rewind reel **16** may be of any suitable known design. Pay-off reel **12** may be provided with suitable braking means, such as band brake or drag generator (not shown) to provide adjustable back tension on strip **11** between pay-off reel **12** and leveler **14**. Rewind reel **16** is suitably power driven (not shown) to provide adjustable front tension between leveler **14** and rewind reel **16**. The respective amounts of front and back tension on the strip will depend on its gauge, width, physical properties and mill shape. In any event, front tension of sufficient magnitude must be employed to pull said strip through said banks of staggered work rolls without slippage.

The freely rotatable billy rolls **13** and **15** may be mounted on the leveler proper or in separate roll stands. They are so located vertically as to provide a fixed pass line for the work material **11**, regardless of the respective amounts of work material on reels **12** and **16**.

Novel Six-High Leveler

The novel six-high leveler shown in FIGS. 2 and 3 is of basic double tilt design as described in detail in my United States Patent No. 2,945,530, issued July 19, 1960. The fragmentary view shown in FIG. 2 is similar to FIG. 3 of the above mentioned patent with the exception that both top and bottom center groups of work rolls are deflectable.

Upper Center Roll Group

The center group of upper rolls comprises work rolls **35, 36, 37**; full-length intermediate rolls **38, 39, 40, 41** supported by three sections or banks of vertically adjustable support rolls **25, 26, 27**. Each of these adjustable support roll sections consists of short support rolls **42, 43, 44** located in staggered relation and nesting their associated intermediate rolls and rotatably mounted at their ends in support roll bearing blocks **32, 33**, respectively. The bearing necks at opposite ends of the center or middle group of upper work rolls are journaled in bearing blocks **45, 46**, respectively. The bearing necks at opposite ends of their associated full-length intermediate rolls are similarly journaled in bearing blocks **47, 48**, respectively, which are suitably secured to work roll bearing blocks **45, 46**, respectively, to form bearing block units. Each bearing block unit is free to rock around hinge pins **49, 50**, respectively, which connect these bearing block units to saddles **51, 52** to permit rocking when the center work rolls and their associated intermediate rolls are deflected by any or all of the vertically displaceable support roll sections **25, 26, 27**.

The saddles **51, 52** are fastened to a cross-member forming part of the screw-down mechanism (not shown). Any suitable means, such as screws, eccentrics or wedges (not shown) may be employed to displace these support roll sections individually and selectively in vertical directions for the deflection of the centrally located intermediate rolls and their associated work rolls as known in the art.

Entry and Exit Tilt Roll Groups

The left hand group of upper rolls mounted in left hand tilt assembly **54** comprises work rolls **19, 20, 21**, which may be designated as the upper entry tilt roll group; associated staggered full-length intermediate rolls **22, 23, 24** which are in turn supported along their longitudinal axes by three banks of short support or back-up rolls, similarly as described in connection with the center roll group. Each of these series of sections of support rolls consists of short support rolls **28, 29, 30, 31**, rotatably mounted at their ends in bearing elements **53** which are suitably fastened to tilt yoke **18** extending from front to rear of the leveler. The work rolls **19, 20, 21** are rotatably supported at their opposite ends in work roll bearing blocks **34** fastened to tilt yoke **18**. The intermediate rolls **22, 23, 24** are rotatably carried at their opposite ends in bearing blocks **17** which are secured to work roll bearing blocks **34** as shown in the modification illustrated in FIG. 4.

Tilting means such as disclosed in my United States Patent No. 2,945,530 may be employed to tilt the left and right hand tilt assemblies **54, 55** around the rotational axes of intermediate rolls **38** and **41**, respectively. The right hand tilt assembly **55** is a mirror image of the above described left hand tilt assembly **54**. Corresponding parts have received identical numerals with a prime mark attached to simplify the description. The work roll group **19', 20', 21'** may be referred to as the upper exit tilt roll group.

It will be noted that FIG. 2 shows the entry and exit tilt roll groups tilted symmetrically with respect to the center group of rolls. This tilt adjustment permits operation in either direction.

Lower Roll Bank Structure

The lower work roll bank is also shown divided into three roll groups. The lower center roll group comprises work rolls **56, 57, 58, 59, 60, 61** with associated full-length intermediate rolls **62, 63, 64, 65, 66**. The latter are supported by vertically adjustable support roll sections **67, 68, 69, 70**. Each of these sections consists of short back-up rolls **71, 72, 73, 74**. The work rolls **56, 57, 58, 59, 60, 61** are rotably mounted at their opposite ends in work roll bearing blocks **75, 76**, respectively. Their associated intermediate rolls **62, 63, 64, 65, 66** are similarly mounted in respective bearing blocks **77, 78**. The latter are fastened to work roll bearing blocks **75, 76**, respectively to form bearing block units which are rockable about hinge pins **79, 80**, respectively, which connect these common bearing blocks to saddles **81, 82**, respectively, mounted on base **14b** of the leveler. The rocking action of the common bearing block units is important to avoid corner loads on the bearings when the center groups of intermediate rolls and work rolls are being deflected together by any or all of the adjustable support roll sections **67, 68, 69, 70**.

The lower left hand roll group or lower entry roll group consists of work rolls **83, 84**; associated full-length intermediate rolls **85, 86, 87**, and four stationary support roll sections or banks of back-up rolls, similarly as described for the center roll group. Each of said four stationary support roll sections comprises short support or back-up rolls **88, 89, 90, 91**. Said lower left hand work rolls with their associated intermediate rolls and back-up rolls are rotably mounted in respective bearing blocks 34b, 17b, 53b and these bearing blocks may be mounted on the leveler base 14b, because the outside work rolls 83, 84 are not intended to be deflected.

The lower right hand roll group or lower exit roll group is a mirror image of the left hand one just described. Corresponding parts have received identical numerals with a prime mark attached to simplify the description.

It will be noted that in both upper and lower roll banks, the work rolls are nested between their associated intermediate rolls and the latter in turn between their associated short back-up rolls, thus maintaining both work rolls and intermediate rolls from undesired vertical and horizontal deflection.

Roll Drive

Referring to FIG. 3, a common gearbox 92 driven for example by means of an electric motor (not shown) is employed for the positive drive of all rolls at identical circumferential speeds. Adjacent short back-up rolls of upper sections 25, 26, 27 of the upper entry, center and exit roll groups are drivingly interconnected by means of universal joints 93 and driven from the gearbox 92 by drive spindles 94 with universal joints 95 and 96, drive shafts 97 rotatably mounted in the respective work roll bearing blocks 34, 46, 34', and universal joints 98 connecting said drive shafts 97 to their respective aligned flights of back-up rolls.

All upper intermediate rolls are driven from gearbox 92 by individual drive spindles 99 and universal joints 100, 101. All upper work rolls are similarly driven from the gearbox 92 by individual drive spindles 102 and universal joints 103, 104.

The drive of all the lower work rolls, intermediate rolls and back-up rolls is identical to the drive for the upper rolls above described. Corresponding parts have received identical numerals with a prime mark attached to simplify the description.

Instead of driving all rolls from a common gearbox as shown in FIG. 3, it may be found convenient to drive only the upper and lower work rolls and their intermediate rolls from one gearbox as shown in FIG. 4. Parts corresponding to similar parts in FIGS. 2 and 3 of FIG. 4 have received identical numerals with two and respectively three prime marks attached thereto.

In this modification, the drive shafts 97'' and 97''' for the aligned back-up roll flights 28'' and 88''', respectively, extend through the left hand work roll bearing blocks 34'' and 34b''', respectively. At the tends of these shafts 97'' and 97''', which are located on the side of the leveler opposite the common gearbox 92'', respective pulleys 105, 106 are mounted and suitably connected with timer belts 109 to respective pulleys 107, 108 fastened to the left hand ends of the respective upper and lower work rolls, such as shown for one upper and lower work roll 19'' and 83''' and associated respective back-up roll flights 28'' and 88'''. It may be seen that the directions of rotation of work rolls 19'' and 83''' and their associated back-up roll flights 28'' and 88''', respectively, are identical.

Details of gearbox design are not considered to be part of this invention. It is referred to FIG. 20 of my United States Patent No. 2,949,147 which shows a gearbox design as would be required for the modification shown in FIG. 4. For levelers such as shown in FIGS. 2 and 3, two more rows of gears would, of course, be required.

Instead of using timer belts 109, similar results can be obtained by using instead any other equivalent type of positive toothed gear drive such as chain and sprocket drives, or by gearing.

Operation of Leveler

The upper roll bank, consisting of the non-deflectable entry and exit tilt roll groups 19, 20, 21 and 21', 20', 19', respectively and the deflectable center group of work rolls 35, 36, 37 with their respective intermediate rolls and back-up roll sections are adjusted in height as a unit according to the thickness of the work material as well known in the art, with respect to the lower work roll bank comprising left and right end work roll groups 83, 84 and 84', 83', and the deflectable center work roll group 56, 57, 58, 59, 60, 61 with their associated intermediate rolls and support roll sections.

The upper work roll bank is adjusted relative to the lower work roll bank to subject the material or stock to transverse half-waves of the required amplitudes. The adjustment of the tiltable upper entry roll group is not critical but the upper exit tilt roll group must be so tilted that the work material leaves the leveler in flat condition.

If the work material needs correction, namely preferential longitudinal stretching of one or more localized portions across its width, the straightening rolls of the upper and/or lower center roll groups are deflected into the necessary deflection contours. FIG. 2 shows as an example an upward deflection of the center group of lower work rolls above support roll section 68, obtained by raising the adjustable support roll section 68 with respect to the fixed lower entry and exit support roll groups 88, 89, 90, 91 and 91', 90', 89', 88', respectively. Any of the upper center support roll sections 25, 26, 27 and lower center support roll sections 67, 69, 70 may be similarly adjusted toward or away from their associated intermediate rolls to produce the required deflection contours for the work rolls to correct the mill shape of the material.

It should be specially noted that the upper three support roll sections 25, 26, 27 and the lower four support roll sections 67, 68, 69, 70 are not in vertical alignment but are staggered or offset with respect to each other along the longitudinal axes of their associated intermediate rolls so that as many spaced apart pressure points across the width of the stock are available for the mill shape correction of the stock as the total number of support roll sections employed, namely seven as shown by way of example in FIGS. 3 and 4.

If the material needs no correction but only flattening, all adjustable center support roll sections of upper and lower roll banks are kept in neutral positions so that top and bottom center work roll groups produce half-waves of uniform maximum amplitudes all across the work material. Thus the entering work material will first be subjected to a series of half-waves of gradually increasing but uniform transverse amplitudes between the top and bottom entry roll groups; then secondly to a series of half-waves of maximum but also uniform transverse amplitude across the width of the material between the top and bottom center work roll groups, and thirdly to half-waves of gradually decreasing but also uniform transverse amplitudes to render the work material flat.

If the work material has localized short portions across its width, it needs correction. The first and third steps above described remain the same but in the second step the upper and/or lower center work rolls are suitably deflected to produce in the material half-waves of differing transverse amplitudes to stretch the short longitudinal portions of the strip, or its localized short areas.

By maintaining the top and bottom entry and exit work roll groups in straight, non-deflected positions as described, correction of the mill shape and simultaneous flattening of the material in one single pass is accomplished as fully described in my United States Patent No. 2,945,530.

General

In order to show a leveler of maximum efficiency for mill shape correction and least grain distortion of the stock during the leveling pass, I have described my new leveling method with driven intermediate rolls in connection with a double tilt design with center deflection of both upper and lower center roll groups by means of longitudinally staggered support roll sections. This in addition to adjustable front and rear tension on the work strip results in heretofore impossible preservation of the original surface qualities of the material.

Driven intermediate rolls may also be utilized to advantage in single tilt levelers and for certain types of work material, the drive of the short back-up rolls may be dispensed with. Other changes and modifications will be obvious to those skilled in the art and I desire, therefore, that only such limitations shall be placed upon my invention as specifically set forth in the following claims.

I claim:

1. The method of correcting the mill shape of strip material in a roller leveler which comprises passing said strip material under tension between two banks of rotatable staggered work rolls, subjecting the strip material during passage through said work rolls to transverse waves of differing amplitude across its width by deflecting said work rolls into the required deflection contours by means of a plurality of short back-up roll sections, interposing full-length intermediate rolls driven by toothed gearing means at substantially identical circumferential speeds as said work rolls between said work rolls and said back-up roll sections for absorbing the streaking effect of the latter and to minimize transfer of said streaking unto said work rolls and said strip material.

2. The method of claim 1, in which said plurality of short back-up roll sections are driven by toothed gearing means at substantially identical circumferential speeds as said work rolls and said intermediate rolls to further minimize said streaking effect of said short back-up roll sections on said intermediate rolls and in turn on said work rolls for preserving the original surface qualities of the strip material.

3. method of claim 1, in which said tension on the strip material is at least of a magnitude sufficient to pull said strip material through said banks of staggered work rolls without slippage of said strip material with respect to said work rolls.

4. The method of correcting the mill shape of work material, comprising flexing the work material into a multiplicity of waves transversely to the direction of movement of the work material in a backed-up roller leveler having two cooperating banks of straightening rolls and a bank of intermediate rolls associated with each bank of said straightening rolls, said intermediate rolls being driven by toothed gearing means at the identical circumferential speed as said straightening rolls to preserve the surface finish of the strip material, and while maintaining front and back tension on the work material forming a first series of alternate half-waves of differing transverse amplitude in the work material by selectively deflecting one bank of straightening rolls to stretch a first group of spaced apart localized areas across the width of the work material, and forming a second series of alternate half-waves of differing transverse amplitude in the strip material by selectively deflecting the other bank of straightening rolls to stretch a second group of spaced apart localized areas across the width of the work material, the localized areas of said first group being staggered across the width of the work material with respect to the localized areas of said second group.

5. In a roller leveler, the combination of two banks of work rolls positioned to flex work material between them, a bank of full-length intermediate rolls located along each of said two work roll banks and located to nest their associated work rolls to maintain them against vertical and horizontal deflection, a plurality of vertically adjustable support roll sections located along the longitudinal axes of each of said banks of intermediate rolls, the support roll sections of one intermediate roll bank being located in staggered relationship with respect to the support roll sections associated with the other bank of intermediate rolls, a common gearbox located away from the leveler and including toothed gearing means for positively rotating said work rolls and other toothed gearing means for rotating said intermediate rolls at substantially identical circumferential speeds as said work rolls.

6. A roller leveler as defined in claim 5, in which said common gearbox includes toothed gearing drive means to also positively rotate the support rolls of said support roll sections at substantially identical circumferential speeds as said work rolls and said intermediate rolls.

7. A roller leveler as defined in claim 5, including coupling means between aligned flights of supporting rolls of said support roll sections, a drive shaft for each flight of supporting rolls, said drive shafts extending to the side of the leveler opposite said common gearbox, driving means operatively connecting the ends of the work rolls on the side opposite said common gearbox with their associated drive shafts for rotating said flights of supporting rolls in the same direction and substantially at the same circumferential speed as said work rolls.

8. In a six-high roller leveler, a series of work rolls having bearing necks at opposite ends, a series of full-length intermediate rolls positioned in staggered relation with respect to said work rolls and in contact therewith, said intermediate rolls having bearing necks at opposite ends, a common bearing block unit for journaling the bearing necks of said work rolls and intermediate rolls at one end, another common bearing block unit for journaling the bearing necks of said work rolls and intermediate rolls at the opposite end, a saddle for each of said common bearing block units, and rocking means for each of said two common bearing block units adapted to rock said bearing block units relative to said saddles when the work rolls and intermediate rolls are being deflected.

9. In a six-high roller leveler as defined in claim 8, a gearbox including drive spindles for rotating said work rolls, in combination with other drive spindles for rotating said intermediate rolls at substantially the same circumferential speed as said work rolls.

References Cited in the file of this patent

UNITED STATES PATENTS

1,968,389	Guthrie	July 31, 1934
2,091,789	Maussnest	Aug. 31, 1937
2,256,520	Johansen et al.	Sept. 23, 1941