Sept. 23, 1969 F. UNGERER 3,468,149

PLATE STRAIGHTENING MACHINE

Filed Sept. 13, 1966 2 Sheets-Sheet 1

FIG. 1 (Prior Art)

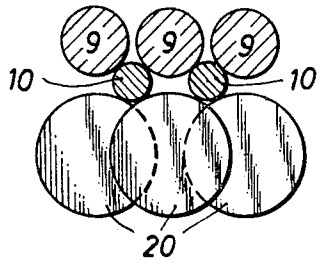

FIG. 2

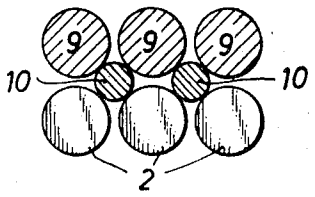

FIG. 3

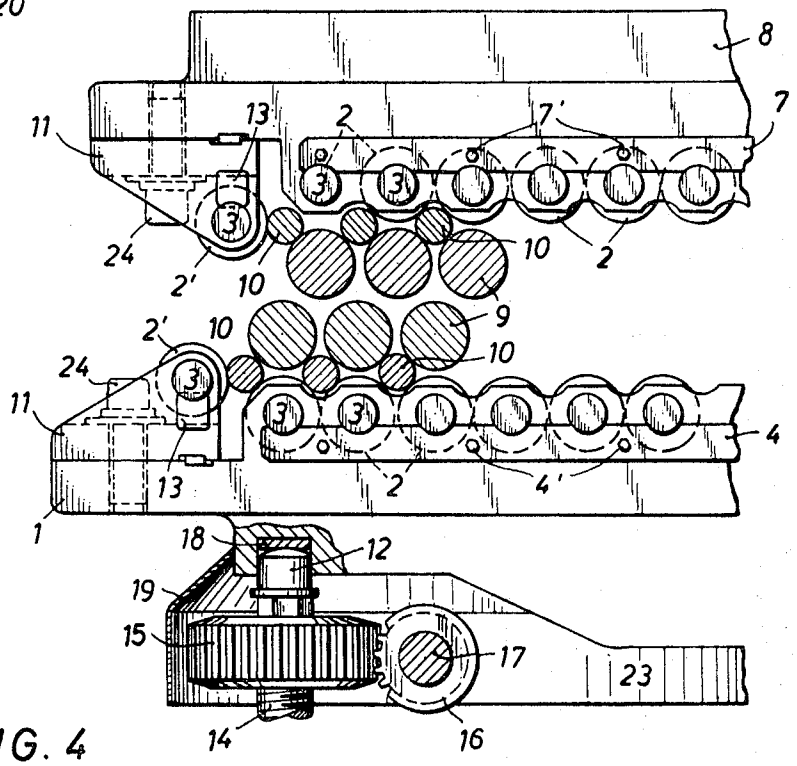

FIG. 4

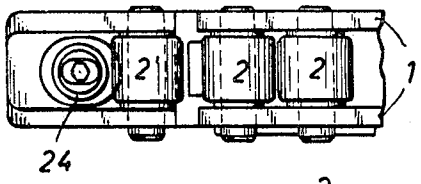

FIG. 5

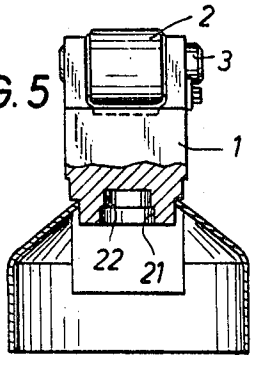

FIG. 6

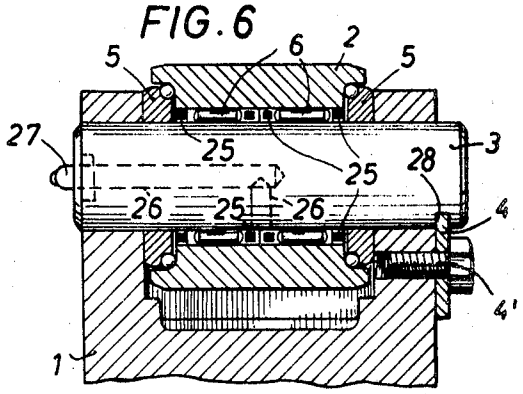

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PLATE STRAIGHTENING MACHINE

Filed Sept. 13, 1966 2 Sheets-Sheet 2

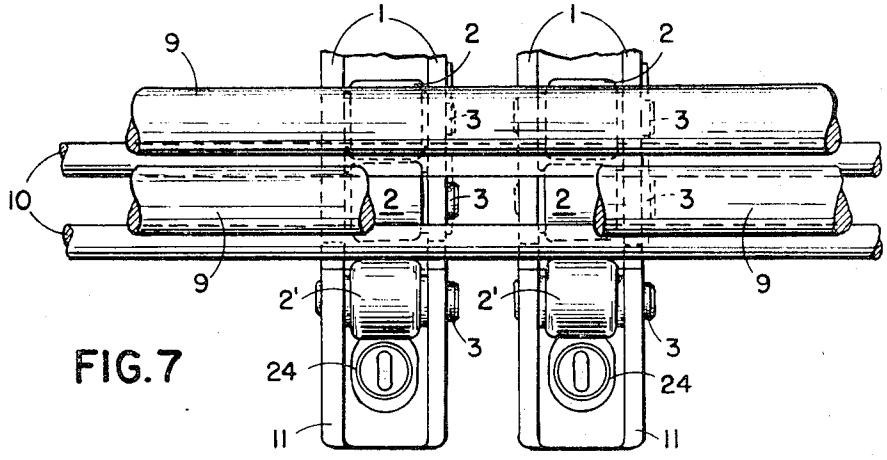

FIG.7

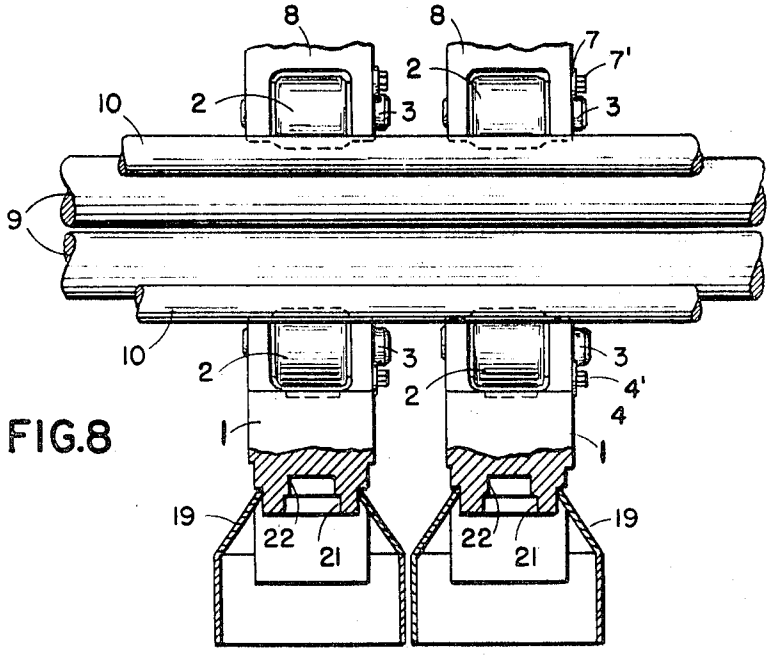

FIG.8

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PLATE STRAIGHTENING MACHINE

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Int. Cl. B21d 1/02, 3/02
U.S. Cl. 72—165 8 Claims

ABSTRACT OF THE DISCLOSURE

A plate straightening machine includes straightening rolls arranged serially in the direction of work movement, intermediate rolls supporting the straightening rolls and vertically adjustable supporting rollers supporting the intermediate rolls. The supporting rollers are arranged in a series of rows each including plural coaxial supporting rollers coaxially adjoining each other, the rows extending parallel to the axes of the straightening rolls and the intermediate rolls. The supporting rollers are arranged in respective series of supporting rollers, as viewed in the direction of motion of the work, with their medial diametric planes aligned along the respective series. The circumferential peripheries of supporting rollers in adjacent rows are spaced slightly from each other whereby the supporting rollers of adjacent rows constitute pairs of rollers forming a saddle mounting an intermediate roll.

This invention relates to plate straightening machines of the type including straightening rollers arranged serially in the direction of motion of the plate and resting on and between elastic intermediate rolls which, in turn, rest on supporting rollers which can be adjusted vertically from opposite sides from points distributed over their length, these supporting rollers being axially so narrow and axially so closely adjacent that, in dependence on the respective vertical adjustments, narrow adjacent plate zones are subjected, during straightening, to different deformations. More particularly, the present invention is directed to a novel construction and mounting of the supporting rollers in such a plate straightening machine.

In known machines of this type, the supporting rollers have a diameter about twice that of the straightening rolls. In addition, they are so staggered relative to each other that the intermediate rolls, throughout their lengths, engage alternately first a supporting roller on one side thereof and then a supporting roller on the other side thereof. Large diameter supporting rollers in a staggered arrangement have been used because this provided for easy mounting of the rollers. Furthermore, the large diameters of the supporting rollers, and their alternating or staggered arrangement, has an advantage in scale screenings which had to be taken into account particularly because, in former times, it was primarily scale-covered black iron plates which required straightening. In later years, when an increasing number of cold-rolled iron plates have been used, narrow supporting rollers yielded undesired polished strips on the straightening material, and these strips were avoided by the use of intermediate rolls.

For straightening finer and thinner plates, the straightening rolls have had a smaller diameter and the intermediate rolls a correspondingly smaller diameter. When exerting localized high straightening pressures, as is necessary if a particularly large force is to be exerted on a certain narrow path in the plate, it has been found that the intermediate rolls yielded elastically so that their center axis was no longer straight but extended locally in a

S-shape or sinusoidal curve. It was thus no longer possible to transmit, at these points and through the intermediate rolls, a sufficient pressure for a corresponding deformation of the straightening rolls. The undesired yielding deformation of the intermediate rolls also had the result that the straightening rolls, during straightening of strips instead of plates, yielded in one direction or the other under the traction of the strip.

Two supporting rollers, staggered relative to the axis of the supported roll, have up to now always been arranged in outboard or overhanging relation on respective opposite sides of a common carrier, considered in the direction of work movement. Consequently, the staggered arrangement of the large diameter supporting rollers has always resulted, during entry of the plate into the machine, in a slight tipping of the supporting roller carrier together with the supporting rollers mounted thereon. This was due to the fact that a single roller, extending to one side only of the carrier, was always stressed first, for example, the roller on the left on the entry end or the roller on the right at the entry end. Once the roller carrier has been thus deflected, it frequently no longer returns to its correct position in operation.

An object of the invention is to provide, in a plate straightening machine, an improved construction and mounting of the supporting rollers by means of which the difficulties of the prior art are avoided and yielding of thin intermediate rolls is prevented.

Another object of the invention is to provide a plate straightening machine in which the supporting rollers are arranged coaxially in adjacent rows extending parallel to the direction of the straightening rolls and the intermediate rolls, with the supporting rollers of adjacent rows opposing each other in pairs.

A further object of the invention is to provide a plate straightening machine of the type just mentioned in which the supporting rollers have a diameter which is either substantially the same as, or only slightly smaller than, the diameter of the straightening rolls.

In straightening machines with intermediate rolls, it has been known to use supporting rollers which had about the same diameter as the straightening rolls, but whose lengths were about 5 to 8 times larger than their diameters. Because of the diameter and length of the supporting rollers, it was not possible, in these known machines, to exert, on sufficiently narrow zones of the plate extending in a longitudinal direction, greater stresses than on adjacent zones. In order to be able to achieve this, the supporting rollers had to be narrower and their number had to be increased. However, they were then also increased in diameter, as mentioned above, and arranged in staggered position in order to be able to install ball bearings in accordance with the existing technology.

Accordingly another object of the invention is to provide, in a plate straightening machine, a novel construction and mounting of supporting rollers providing well designed bearing saddles for elastic intermediate rolls whereby even thin elastic intermediate rolls are firmly supported so that the straightening rolls mounted on the intermediate rolls, despite different adjustability at certain points, are also firmly supported.

With this construction, at the points of greater adjustment, the desired straightening pressure can be safely transmitted, so that the straightening operaion can be adapted successfully to any material. The straightening machine is thus more effective. Furthermore, since the novel arrangement of the supporting rollers provides an increase of the straightening pressure beyond the conventional values, it is possible, by simple and inexpensive reinforcement of the foundation and the yoke parts of the machine, to design the entire machine for higher outputs.

This increases greatly the versatility of the machine and has the effect that, in order to obtain good straightening results, only one or two passes through one or two machines are necessary, even in those cases where, up to the time of the present invention, two or three passes through two or three machines were necessary.

A further object of the invention is to provide a plate straightening machine in which the rotatable mounting means of the supporting rollers are contained within the shells of the supporting rollers.

With this supporting roller mounting, the necessary axial width of each supporting roller becomes very small, so that many supporting rollers can be arranged axially closely adjacent to each other over the machine width, for the absorption of even greater forces.

Still another object of the invention is to provide, in a plate straightening machine, supporting rollers which are mounted by means of needle bearings on bolts or short axles and between axially effective ball bearings.

Needle bearings with needles of a small diameter are available today and are suitable for very large loads, so that the support of the present invention is much cheaper than if radial forces were absorbed, as hitherto, by roller bearings or ball bearings.

In accordance with another object of the invention, two needle bearings are arranged side-by-side between each roller shell and its supporting shaft, and lubricating grease can be introduced simply through a channel into the annular space between the two needle cages. Depending on the operating time, lubrication in this type of design is necessary only once every three to six months.

A further object of the invention is to provide a novel supporting roller mounting in which the supporting roller shafts are supported at both ends in a supporting roller carrier and are secured in the latter against axial displacement.

With the larger diameter supporting rollers hitherto used, the bearing pins were arranged in overhung or outboard relation, thus requiring relatively large diameter bearing pins. By supporting the shafts or bolts of the support rollers at both ends, it is possible, in accordance with the present invention, to reduce the shaft diameter substantially.

For an understanding of the principles of the invention, reference is made to the following description of a typical embodiment thereof as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a schematic side elevation view, partly in section, of a known straightening roll arrangement utilizing intermediate rolls resting on supporting rollers arranged in staggered relation;

FIG. 2 is a view, similar to FIG. 1, illustrating, in accordance with the invention, the intermediate rolls resting on supporting rollers arranged in rows and opposing each other in pairs, with the supporting rollers having diameters of the same order as those of the straightening rows;

FIG. 3 is a partial side elevation view, partly in section, illustrating a straightening machine embodying the invention and with the lateral columns omitted;

FIG. 4 is a partial top plan view of the supporting roller carrier;

FIG. 5 is an end elevation view, partly in section, of the supporting roller carrier shown in FIG. 4;

FIG. 6 is an axial sectional view, on an enlarged scale, through a supporting roller and its mounting;

FIG. 7 is a partial plan view corresponding to a horizontal plane between the upper and lower supporting rollers of FIG. 3; and

FIG. 8 is an end elevation view, partly in section, corresponding to FIG. 7.

In the known arrangement shown in FIG. 1, straightening rolls **9** rest on thin elastic intermediate rolls **10** whose diameter is much smaller than that of the straightening rolls. The intermediate rolls extend throughout substantially the entire length of the straightening rolls, and rest on supporting rollers **20** positioned at both sides of each intermediate roll but staggered in an axial direction. The diameter of supporting rollers **20** is about twice that of straightening rolls **9**.

As viewed in FIG. 1, in the plane of the drawing, supporting rollers **20** form saddles in which intermediate rolls **10** rest. Because of the large diameter of the supporting rollers, these saddles are so flat that the intermediate rolls are not held firmly or restrained solely by virtue of resting in the saddles. Apart from this, these are not true saddles because the point of contact of one supporting roller is not directly opposite the point of contact of another supporting roller. Instead, each supporting roller on one side of an intermediate roll is opposite a gap on the opposite side of the intermediate roll.

Referring to FIG. 2, which illustrates the invention arrangement, supporting rollers **2**, viewed in the plane of the drawing, are arranged in pairs whose circumferential peripheries are slightly spaced from each other. Furthermore, there is an uninterrupted sequence of axially adjacent supporting rollers. The intermediate rolls **10** rest in deeper, true saddles. The arrangement of FIG. 2 presupposes that the diameter of the supporting roller is not substantially greater than that of the straightening rolls.

In the plate straightening machine shown in FIGS. 3 through 6, supporting rollers **2** are rotatably mounted on pins, bolts, or short shafts **3**. The bottom supporting rollers **2** are mounted on carriers **1** of which there are a plurality arranged side-by-side over the width of the machine or, that is to say, over the length of the straightening rolls **9**. In each supporting roller carrier, the supporting rollers are arranged severally in series, as viewed in the direction of motion of the work. The top supporting rollers are held in top supporting roller carriers **8**, which are similarly arranged. Since the top straightening rolls **9** are arranged above the saddles formed between the bottom straightening rolls, while the supporting rollers are arranged under and above the associated straightening rolls, respectively, the top supporting rollers are also staggered, relative to the direction of movement of the work, correspondingly with respect to the bottom supporting rollers. Similarly, the top intermediate rolls **10** are staggered, along the direction of travel of the work, with respect to the bottom intermediate rolls **10**.

The pins or shafts **3** for the bottom supporting rollers are mounted at both ends in the bottom supporting roller carriers, and are secured against axial displacement. Such securement is effected by the slot **28**, shown in FIG. 6, at one end of each of the supporting roller pins or shafts **3**. These slots are engaged by a holding bar **4** which is common to all supporting rollers of the same carrier, and is secured to the carrier at the fastening points **4'**. Similarly, the top supporting roller carrier **8** has a corresponding fastening bar **7** which is secured to the carrier at the points **7'**.

Shafts or pins **3** are arranged with sliding fits in bearing bores provided in carriers **1** and **8**, so that they can be easily removed, after removal of holding bars **4** and **7**, respectively, and replaced by another pin or shaft. In the known embodiment, where the supporting roller pins or bolts extend unilaterally from a carrier, it was possible to pull down the roller, mounted with a ball bearing on its shaft or pin, by means of a puller operating toward the free end of the bolt. However, when the bolt, as happens mostly in the case of trouble, was somewhat bent by excessive pressure, the firmly seated pin of the bolt had to be pressed out of its seat by means of a press, and the bolt had to be replaced by another bolt. When the bolts or pins are supported at each end, as in the present invention, undue permanent bends are no longer likely.

The first intermediate rolls **10**, which are arranged on the entry side of the straightening machine, must be specially supported toward the outside. In accordance with the invention, this is effected by means of special supporting rollers **2'** which are similar to supporting rollers **2**. However, rollers **2'** are mounted in front of the assembly of rollers **2**, on bearing blocks **11** secured to supporting roller carriers **1** and **8**. Bearing blocks **11** are secured to carriers **1** and **8** by means of bolts **24**, and fitting means are provided between each bearing block and its supporting carrier. In the same manner as the bearing shafts or bolts of supporting rollers **2** are locked against axial displacement by bars **4** and **7**, the bearing axles or bolts of supporting rollers **2'** are similarly locked against axial displacement by holding plates **13**, as best seen in FIG. 3.

The bottom supporting rollers **2** are adjustable in height by pressure devices acting through the bottoms of their carriers **1**. For this purpose, externally threaded supporting spindles **14** are arranged in foundation box **23** in such a manner that they can be displaced axially but are fixed against rotation. Axial displacement, in either an upward or downward direction, of supporting spindles **14** is effected by worm gears **15**, each threaded on a spindle **14**, the worm gears **15** being secured against axial displacement. Worm gears **15** may be rotated by means of worms **16** secured on worm shafts **17**. Each supporting spindle carries, at its head or upper end, a pressure piece **12** which cooperates with a pressure plate **18** secured in the innermost or bottom part **22** of a downwardly opening recess **21** formed in carrier **1**. Pressure plate or head **12** is in the form of a spherical cap engageable with a spherical depression in pressure plate **18**. Lubricant can be supplied to the superposed pressure surfaces of the parts **12** and **18** by means of a lubricant channel or passage. The supporting roller adjustment means are covered by hoods **19**.

Referring more particularly to FIG. 6, each supporting roller **2** or **2'** is mounted on its respective shaft or bolt **3** by means of two needle bearings **6** positioned inside the shell of the supporting roller. Lubricant is introduced between the cages **25** of needle bearings **6** through a lubricating channel **26** to which lubricant is supplied through a grease nipple **27**. Needle bearing cages **25** are restrained against axially outward displacement by axial ball bearing assemblies **5** arranged at the opposite ends of the supporting rollers **2**.

What is claimed is:

1. In a plate straightening machine having a series of straightening rolls extending in the direction of work movement, and rotatable about spaced parallel axes extending transversely of the direction of work movement, a series of elastic intermediate rolls supporting the straightening rolls and rotatable about axes parallel to the axes of the straightening rolls, and vertically adjustable supporting rollers mounting the intermediate rolls, the intermediate rolls being vertically adjustable from opposite sides, at points distributed along their lengths, by supporting rollers; the improvement in which said straightening rolls and said intermediate rolls have axial lengths which are a large multiple of their diameters and substantially equal to the width of said machine; said supporting rollers having axial lengths of only the order of their diameters; whereby, depending upon the respective vertical adjustment of said supporting rollers, relatively narrow zones of the work are subjected, during a straightening operation, to deformations different from those of adjacent zones; said supporting rollers being arranged coaxially in axially adjacent relation in rows which are parallel to the direction of said straightening rolls and said intermediate rolls; said supporting rollers being arranged in respective sets of supporting rollers as viewed in the direction of motion of the work, with their medial diametric planes aligned along the respective seats; the circumferential peripheries of supporting rollers in adjacent rows being spaced slightly from each other, whereby the supporting rollers of adjacent rows constitute pairs of rollers with each pair forming a saddle mounting an intermediate roll.

2. The improvement in a plate straightening machine, as claimed in claim **1**, in which the diameters of said supporting rollers are substantially equal to the diameters of said straightening rolls.

3. The improvement claimed in claim **1**, in which each supporting roller comprises a tubular cylindrical shell; and means rotatably mounting each tubular shell and disposed within the respective tubular shell; said last-named means comprising a respective short shaft, and needle bearings disposed between each shaft and the interior of the associated shell.

4. The improvement in a plate straightening machine, as claimed in claim **3**, in which each shaft projects beyond the opposite ends of its associated shell; and means supporting both projecting ends of each shaft.

5. The improvement in a plate straightening machine, as claimed in claim **4**, including respective supporting roller carriers supporting each set of supporting rollers and extending longitudinally of the direction of work movement; each supporting roller carrier being formed to support both projecting ends of each shaft.

6. In a plate straightening machine having, a series of straightening rolls extending in the direction of work movement, and rotatable about spaced parallel axes extending transversely of the direction of work movement, a series of elastic intermediate rolls supporting the straightening rolls and rotatable about axes parallel to the axes of the straightening rolls, and vertically adjustable supporting rollers mounting the intermediate rolls, the intermediate rolls being vertically adjustable from opposite sides, at points distributed along their lengths, by the supporting rollers, and the supporting rollers being axially so narrow and axially so closely adjacent that, depending upon the respective vertical adjustments of the supporting rollers, relatively narrow zones of the work are subjected, during a straightening operation, to deformations different from those of adjacent zones: the improvement in which said supporting rollers are arranged coaxially in axially adjacent relation in rows which are parallel to the direction of said straightening rolls and said intermediate rolls; said supporting rollers being arranged in respective sets of supporting rollers as viewed in the direction of motion of the work, with their medial diametric planes aligned along the respective sets; the circumferential peripheries of supporting rollers in adjacent rows being spaced slightly from each other, whereby the supporting rollers of adjacent rows constitute pairs of rollers forming a saddle mounting an intermediate roll; each supporting roller comprising a tubular cylindrical shell; means rotatable mounting each tubular shell and disposed within the respective tubular shell, said last-named means comprising a respective short shaft, and needle bearings disposed between each shaft and the interior of the associated shell; axially operating ball bearings at each end of each shell and restraining said needle bearings against axially outward displacement; each shaft projecting beyond the opposite ends of its associated shell; means supporting both projecting ends of each shaft; respective supporting rollers carriers supporting each set of supporting rollers and extending longitudinally of the direction of work movement; each supporting roller carrier being formed to support both projecting ends of each shaft; and means locking each shaft against displacement axially of itself relative to its associated carrier; said means restraining said shafts against axial displacement comprising elongated holding bars each associated with a respective carrier and each engaged in the notches of all of the shafts mounted in the respective carrier.

7. The improvement in a plate straightening machine, as claimed in claim **6**, including releasable means securing

each locking bar at spaced points therealong to the exterior surface of the associated carrier.

8. In a plate straightening machine having a series of straightening rolls extending in the direction of work movement, and rotatable about spaced parallel axes extending transversely of the direction of work movement, a series of elastic intermediate rolls supporting the straightening rolls and rotatable about axes parallel to the axes of the straightening rolls, and vertically adjustable supporting rollers mounting the intermediate rolls, the intermediate rolls being vertically adjustable from the opposite sides, at points distributed along their lengths, by the supporting rollers, and the supporting rollers being axially so narrow and axially so closely adjacent that, depending upon the respective vertical adjustments of the supporting rollers, relatively narrow zones of the work are subjected, during a straightening operation, to deformations different from those of adjacent zones; the improvement in which said supporting rollers are arranged coaxially in axially adjacent relation in rows which are parallel to the direction of said straightening rolls and said intermediate seats of supporting rollers being arranged in respective sets of supporting rollers as viewed in the direction of motion of the work, with their medial diametric planes aligned along the respective sets; the circumferential peripheries of supporting rollers in adjacent rows being spaced slightly from each other, whereby the supporting rollers of adjacent rows constitute pairs of rollers form a saddle mounting an intermediate roll; a plurality of supporting roller carriers, each mounting one set of supporting rollers, and each extending longitudinally of the direction of work movement; a plurality of bearing blocks, each secured to a respective carrier adjacent the work inlet side of the machine; and a plurality of additional supporting rollers, each additional supporting roller being rotatably mounted in a respective bearing block; said additional supporting rollers being coaxially aligned transversely of the direction of work movement and cooperating with the leading row of the first mentioned supporting rollers to support the leading intermediate roll.

References Cited

UNITED STATES PATENTS

2,975,663	3/1961	Platzer	29—116 X
2,999,530	9/1961	Ungerer	72—163
3,078,909	2/1963	Maust	72—163
3,107,718	10/1963	Ruple	29—116 X

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