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DE FR GB(71) Applicant: **SUMITOMO HEAVY INDUSTRIES, LTD**
2-1 Ohtemachi 2-chome Chiyoda-ku
Tokyo 100(JP)(72) Inventor: **Yamamoto, Keiji**
8-16, Shonaicho-5-chome
Niihama-shi(JP)
Inventor: **Ushigami, Yoshihiro**
220-34, Shimoshimayama Ko
Saijo-shi(JP)(74) Representative: **Henkel, Feiler, Hänzel & Partner**
Möhlstrasse 37
W-8000 München 80(DE)(54) **Tension roller leveler.**

(57) A tension roller leveler which will produce neither abnormal noise nor flaws called chatter marks even in a high-speed treatment line. A plurality of work rolls are disposed on each of an upper frame and a lower frame. The upper frame and/or the lower frame can be regulated to adjust opening degrees of the work rolls in the inlet side and the outlet side for a strip. A plurality of the work rolls are each supported independently over substantially the entire length by one set of backup rolls in two rows, and the backup rolls in two rows are arranged in a zig-zag pattern such that shaft support portions of one set of the backup rolls in two rows will not overlap with each other.

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a tension roller leveler, and more particularly to a tension roller leveler capable of high-speed treatment.

Prior Art

As an apparatus for reforming strip plates or sheets, there has been conventionally known, by way of example, a tension leveler in combination of extension rolls 20 and succeeding anti-cambering rolls 31 as shown in Fig. 4, or an apparatus including a roller leveler 22 which is located down-stream of such a tension leveler and comprises a number of work rolls 1', 2' respectively arranged on the upper and lower sides of a strip plate S.

In the former tension leveler, however, sensitivity is so high that a curl (longitudinal curvature), particularly, is changed to a large extent upon a small amount of penetration, as shown in Fig. 6. This results in the necessity of delicate control and hence difficulties in achieving a stable levelling effect.

In the latter apparatus, sensitivity is not so sharp as the former tension leveler, as shown in Fig. 7, meaning that a stable levelling effect can be attained relatively easily in a control sense. Although the latter apparatus is superior to the former tension leveler from that point of view, the roller leveler 22 inherently requires not only a number of the work rolls 1', 2' having a relatively small diameter, but also backup rolls 3', 4' for respectively supporting those work rolls 1', 2'.

Because the backup rolls 3', 4' need to have sufficient strength to prevent the work rolls 1', 2' from bend, their diameter must be remarkably larger than that of the work rolls 1', 2'.

With the work rolls 1', 2' arranged closely to each other, therefore, an installation space enough to accommodate the backup rolls 3', 4' cannot be secured. For that reason, it is usual that intermediate roll 3' or 4' is disposed in a straddling relation to plural (two) work rolls 1' or 2' so as to support the plural (two) work rolls by an intermediate roll. Alternatively, as disclosed in Japanese Patent Publication No. 48-44629, work rolls are independently supported by intermediate and backup roll arranged with a spacing therebetween in the lengthwise direction of the work rolls. More specifically, two rows of backup roll pairs are arranged at positions different from each other in the lengthwise direction of the work rolls such that one pair (group) of backup rolls support one work roll in an independent manner and the other pair (group) of backup rolls support another work roll, adjacent to

the one work roll, in an independent manner.

Generally, while the above-described tension leveler can relatively easily remove such deformation as edge waves and center buckles of treated materials (strip) through its levelling process, there occur a curl and a cross bow (gutter) by bending under tension, which residual curvatures remain even after levelling.

To remove those residual curvatures, therefore, the strip is subjected to a roller leveler under a low-tension or no-tension state.

Meanwhile, recent frequent use of those metallic strips, which are thin and hard material, has provided that the conventional roll arrangement cannot satisfactorily remove such residual curvatures.

Where a strip plate has a thickness of 0.15 mm and a yield stress of 60 kgf/mm², for example, a roller leveler requires work rolls having a diameter of about 16 mm. But, the roller leveler comprised of the so many and thin work rolls encounters difficulties in reforming at a high speed over 300 mpm. In high-speed lines, the diameter of each work roll is usually desirable to be in a range of about 30 to 40 mm from the standpoints such as of maintaining the roll accuracy and ensuring the roll's service life.

In the case of handling the thin and hard strip, however, the roller leveler comprised of the work rolls having a diameter in a range of about 30 to 40 mm cannot produce any plastic strain due to bending and thus cannot offer any effect in reforming residual curvature, as will be seen from Fig. 8.

On the other hand, it is also known that even in the thin and hard strip, a plastic strain effect can be attained by applying a tension and also imposing a deformation due to bending under the tension, as will be seen from Fig. 9.

However, since the adjacent work rolls are contacted and coupled with each other via the backup roll as shown in Fig. 5 and a plastic elongation caused by that roller leveler produces a corresponding speed difference between portions of a strip held in contact with the inlet side work roll and the outlet side work roll, such a speed difference appears as a relative slip at any location in the roller leveler.

The above relative slip due to a plastic elongation practically gives rise to few trouble in levelling at low-speed less than 300 mpm as practiced conventionally and, especially, no problem in equipment where the reforming is carried out under a wet condition using a cleaning liquid or the like.

On the contrary, when the levelling is carried out in a high-speed range not less than 300 mpm, particularly, under a dry condition, the above relative slip due to a plastic elongation generates abnormal noise and causes damages, called chatter

marks or scratch marks, on the strip, whereby the surface state of the strip is so greatly deteriorated as to impair its commercial value.

Fig. 10 shows the relationship between a line speed and a noise level in the roller leveler of the type that one backup roll is disposed in a straddling relation to a plurality of work rolls as shown in Fig. 5. As will be seen from Fig. 10, when the line speed is regulated to increase, abnormal noise due to resonance has occurred in a range exceeding 500 mpm. Conversely, when the line speed is regulated to decrease, abnormal noise due to resonance has occurred until lowering down to 400 mpm. Note that although the occurrence of such abnormal noise is fluctuated to some extent depending on the size of the strip S, surface roughness and other properties, a similar tendency appears under any conditions.

Meanwhile, where work rolls are independently supported by two groups of backup rolls arranged with a spacing therebetween in the lengthwise direction of the work rolls as disclosed in the above-cited Japanese Patent Publication No. 48-44629, the foregoing problem of the relative slip due to a plastic elongation will not occur, but there produces a difference in press force between the portion where the work rolls are supported by the backup rolls and the portion where they are not supported by the backup rolls because the work rolls are simply supported by the backup rolls at different positions from each other in the lengthwise direction of the work rolls. Such a difference appears as linear flaws on the surface of the strip, which impairs its commercial value.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a tension roller leveler by which stable curl and gutter reforming can be performed even in a high-speed range not less than 300 mpm without causing abnormal noise and vibration, while ensuring superior surface condition of a strip and final products with a high commercial value.

According to the present invention, there is provided a tension roller leveler comprising an upper frame for mounting a plurality of upper work rolls thereon, a lower frame for mounting a plurality of lower work rolls thereon in opposite relation to said upper work rolls, and means for regulating relative positions of said upper frame and said lower frame to adjust opening degrees of said upper and lower work rolls in the inlet side and the outlet side for a strip, wherein said work rolls are each supported independently by one set of backup rolls in two rows, and said backup rolls in two rows are arranged in a zig-zag pattern such that axial positions of shaft support portions of said

backup rolls in two rows will not overlap with each other.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic side view of an embodiment of the present invention.

Fig. 2 is a schematic plan view showing an arrangement of backup rolls in the present invention.

Fig. 3 is a side view of a roller leveler unit in the present invention.

Fig. 4 is a schematic side view of a conventional tension leveler.

Fig. 5 is a schematic side view of a combination of a conventional tension leveler and roller leveler.

Fig. 6 is a graph showing the relationship between an amount of penetration and an amount of residual curvature in the conventional tension leveler.

Fig. 7 is a graph showing the relationship between an amount of penetration and an amount of residual curvature in a combination of the conventional tension leveler and roller leveler.

Fig. 8 is a graph showing stress distribution when a strip plate is subjected to bending under no tension.

Fig. 9 is a graph showing stress distribution when a strip plate is subjected to bending under tension.

Fig. 10 is a graph showing the relationship between a line speed and a noise level in the conventional tension roller leveler.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Hereinafter, an embodiment of the present invention will be described with reference to Figs. 1 to 3.

As shown in Fig. 1, upper work rolls 1a, 1b and lower work rolls 2a, 2b arranged on the upper and lower sides of a strip S are supported to an upper roll support 5 and a lower roll support 6 via backup rolls 3a, 3b and 4a, 4b, respectively.

The upper work rolls 1a, 1b and the lower work rolls 2a, 2b are each separately supported by a pair of backup roll rows 3a, 3b and 4a, 4b, respectively. More specifically, as shown in Fig. 2, the backup roll rows 3a, 3b and 4a, 4b each comprise a plurality of rolls divided in the lengthwise direction of the work rolls 1a, 1b, 2a, 2b and joined to each other via bearing members (not shown) disposed between every adjacent divided rolls such that the total length is substantially equal to the length of the work rolls 1a, 1b, 2a, 2b. A pair of every two backup roll rows 3a, 3b or 4a, 4b sepa-

rately supports each of the upper or lower work rolls 1a, 1b or 2a, 2b in an independent manner, respectively.

Then, the pairs of two backup roll rows 3a, 3b, or 4a, 4b are arranged in a zig-zag pattern so that the bearing members of ones of the paired backup roll rows 3a or 3b, 4a or 4b will not overlap with the bearing members of the other counter-part backup rolls.

The upper roll support 5 and the lower roll support 6 are fixed to an upper frame 7 and a lower frame 8, respectively, either one of which (the lower frame 8 in this embodiment) is supported in a movable manner.

More specifically, the lower frame 8 is supported at its lower surface by rods 11a, 11b which are movable up and down by worm jacks 10a, 10b, respectively, whereby the lower frame 8 can be moved vertically and also tilted upon actuation of the worm jacks 10a, 10b. Accordingly, the work rolls 1a, 1b, 2a, 2b can be controlled to desirably adjust an amount of closing and opening degrees (penetration) of the inlet side work roll and the outlet side work roll.

Denoted at 12a, 12b are rollers rotatably supported on the opposite sides of the lower frame 8. These rollers 12a, 12b are arranged to respectively rest on rails 13a, 13b when the lower frame 8 is descended, thereby allowing the lower frame 8 to move laterally (in a direction normal to the drawing sheet of Fig. 3).

Denoted at 14a, 14b are bridle rolls respectively disposed on the inlet side and the outlet side of the work rolls 1a, 1b, 2a, 2b for applying a predetermined tension to the strip S.

While the number of the work rolls 1a, 1b, 2a, 2b is illustrated in this embodiment to be eleven in total, i.e., five for the upper work rolls plus six for the lower work rolls, the number of the work rolls may be of any desired one so long as the number of the upper work rolls is one more (or less) than that of the lower work rolls and the total number of both the work rolls is not less than five.

Further, it is desirable that the work rolls 1a, 1b, 2a, 2b have their diameters which are so selected as to gradually increase from the inlet side toward the outlet side of the roller leveler for the purpose of gradually decreasing the curvature of bending of the strip S.

Operation of this embodiment will now be described.

The strip S is moved to pass through the work rolls 1a, 1b and 2a, 2b while undergoing a predetermined tension from the bridle rolls 14a, 14b.

Accordingly, the strip S is repeatedly subjected to bending under the tension and thus delivered from the inlet side toward the outlet side of the roller leveler while causing an elongation due to

plastic strain, as explained above in connection with Fig. 9.

Therefore, the path length of the strip S is changed between the every two work rolls adjacent to each other. With the present invention, however, the adjacent work rolls are each separately supported by a corresponding pair of backup roll rows so that the individual work rolls 1a, 1b, 2a, 2b are rotatable in an independent manner.

If the adjacent work rolls are supported by a common single backup roll as with the prior art, those adjacent work rolls are held in slide contact with each other and the rotation of one work roll is mechanically fed back to the other work roll, thereby causing both the work rolls to be forced to rotate at the same speed. For that reason, where an extension of the strip S occurs between both the work rolls, a relative slip is necessarily caused at any location in the roller leveler unless a speed difference corresponding to the amount of such an elongation is provided. In contrast, with the present invention, the adjacent work rolls are mechanically separated from each other and separately rotatable, resulting in no possibility of the occurrence of such a relative slip.

As described above, according to the present invention, since work rolls are each supported by one pair of backup rolls, even if a strip is repeatedly subjected to bending under tension in a tension leveler and thus extended so as to change the path length between the adjacent work rolls, the work rolls and the backup rolls can be rotated in an independent manner, whereby no relative slip is caused at any location in the tension leveler for absorbing an extension of the strip between the adjacent work rolls unlike the conventional tension roller leveler. Consequently, while the relative slip has produced abnormal noise due to abnormal resonance and has resulted in flaws called chatter marks in a conventional high-speed treatment line, any such abnormality will not occur in the present invention.

Further, although the backup rolls are each formed by joining a plurality of rolls to each other in the lengthwise direction of the work rolls, a pair of backup rolls are arranged in a zig-zag pattern such that the bearing members of the divided rolls of one backup roll will not overlap with the bearing members of the divided rolls of the other. Therefore, the joints between the divided rolls of each backup roll will not be transferred to the surface of the strip via the work roll to appear as linear flaws. As a result, the tension roller leveler with superior stability in a high-speed range can be obtained.

Claims

1. A tension roller leveler comprising an upper

frame for mounting a plurality of upper work rolls thereon, a lower frame for mounting a plurality of lower work rolls thereon in opposite relation to said upper work rolls, and means for regulating relative positions of said upper frame and said lower frame to adjust opening degrees of said upper and lower work rolls in the inlet side and the outlet side for a strip, wherein said work rolls are each supported independently by one set of backup rolls in two rows, and said backup rolls in two rows are arranged in a zig-zag pattern such that axial positions of shaft support portions of said backup rolls in two rows will not overlap with each other.

2. A tension roller leveler according to claim 1, wherein one set of said backup rolls in two rows are brought into contact with said work roll over substantially the entire length.
3. A tension roller leveler according to claim 1 or 2, wherein said tension leveler has a reform speed not lower than 350 mpm.

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FIG. 1

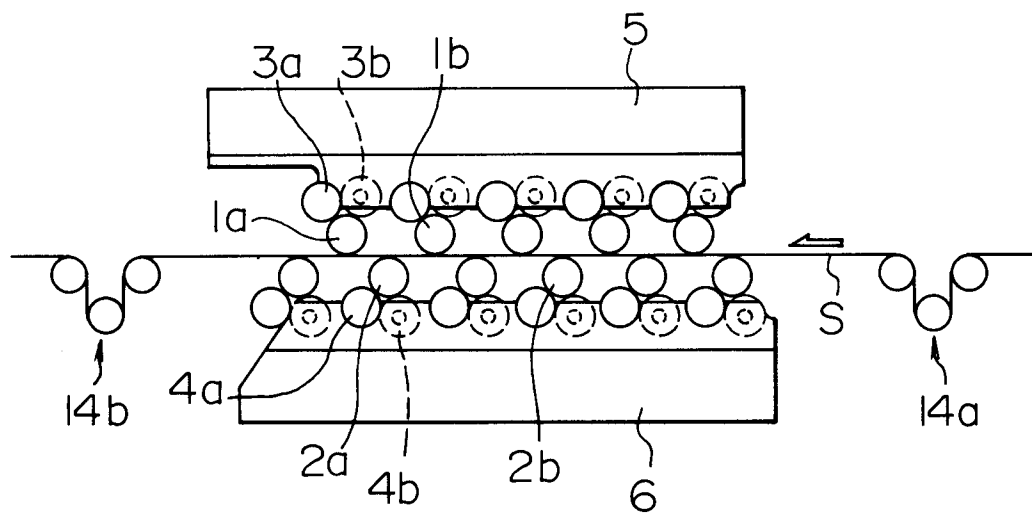


FIG. 2

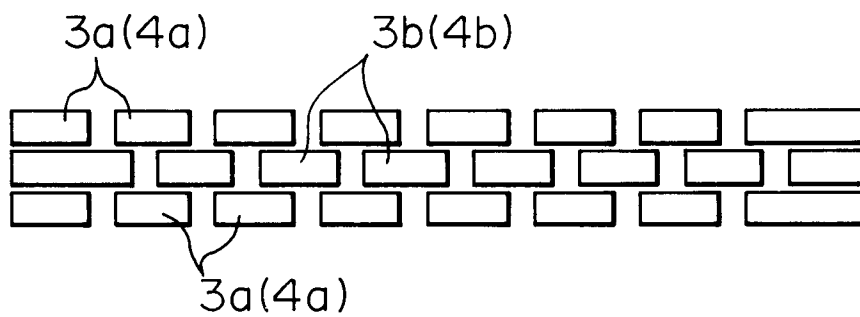


FIG. 3

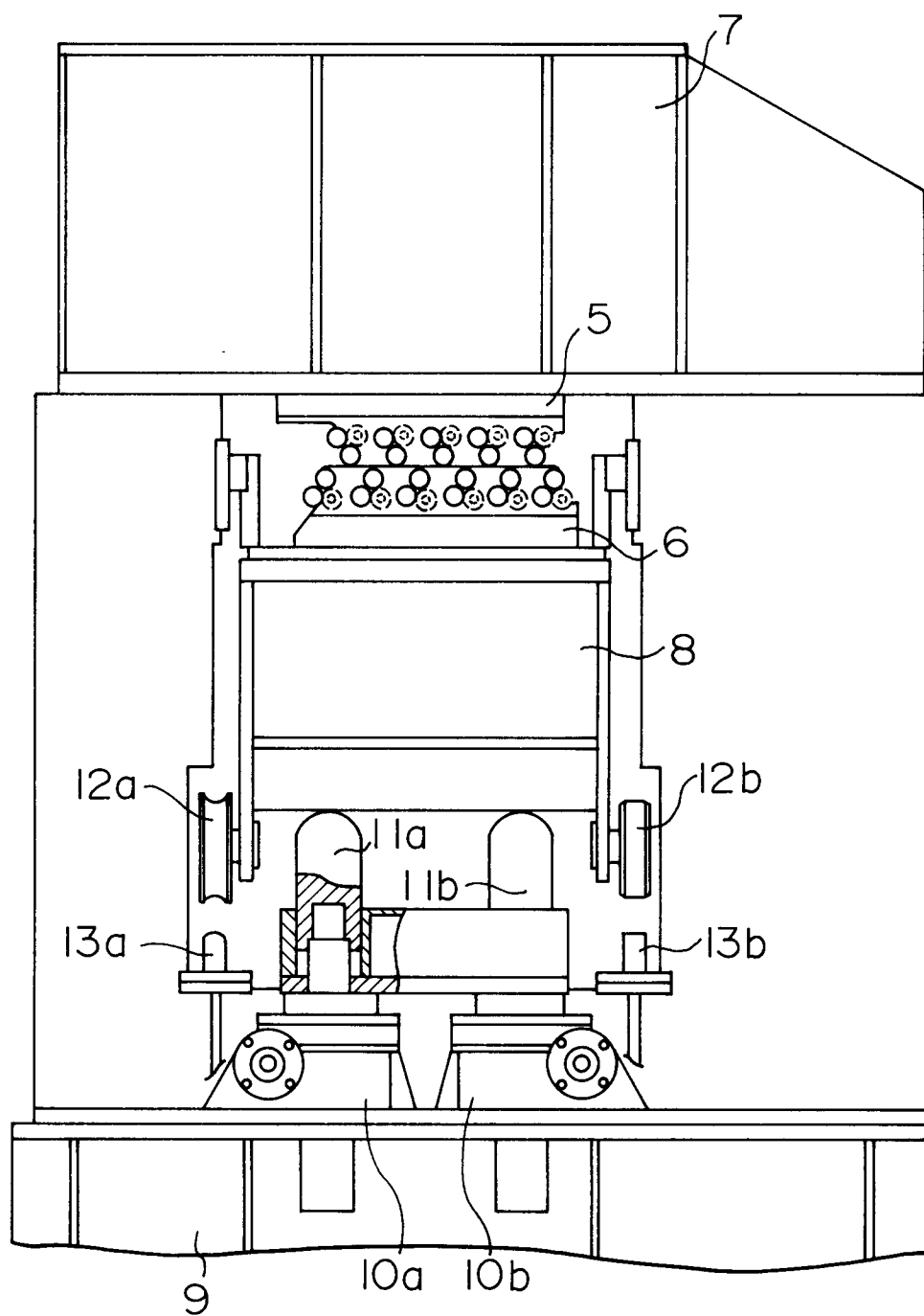


FIG. 4
PRIOR ART

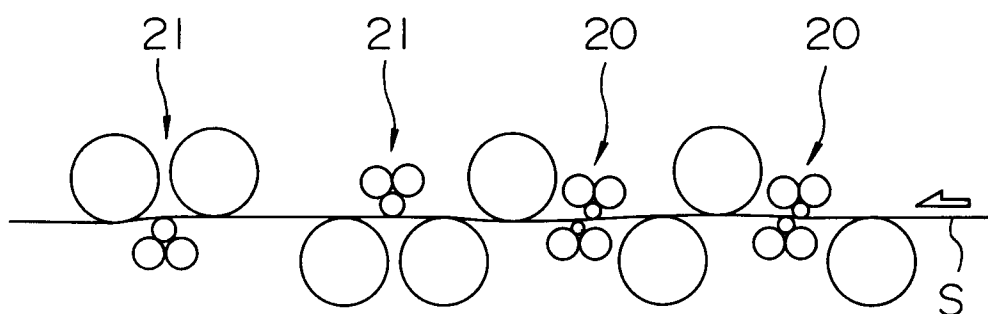


FIG. 6
PRIOR ART

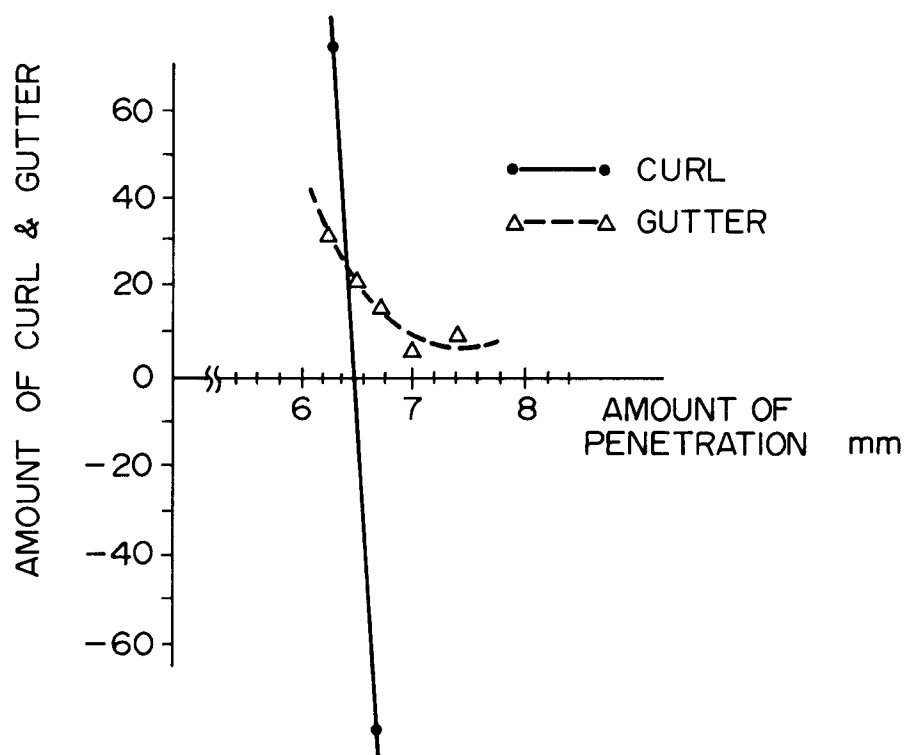


FIG. 5
PRIOR ART

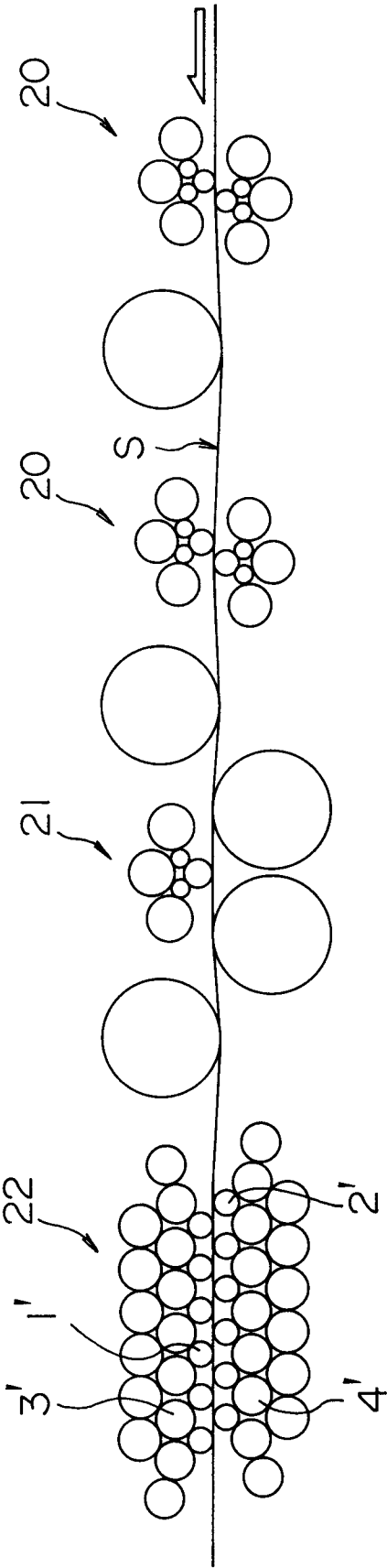


FIG. 7
PRIOR ART

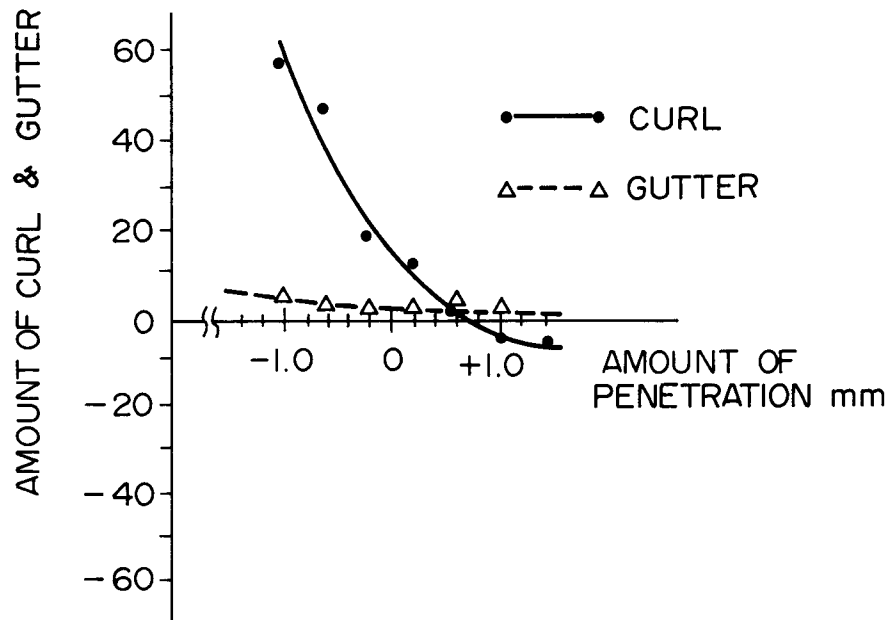
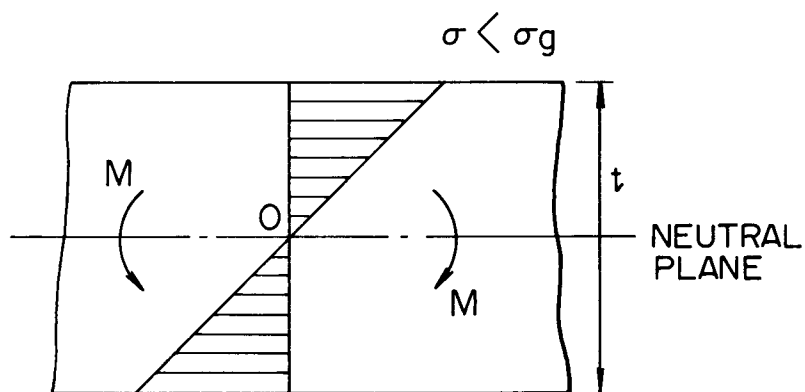


FIG. 8



STRESS DISTRIBUTION DUE TO
BENDING UNDER NO TENSION
(NO PLASTIC STRAIN)

FIG. 9

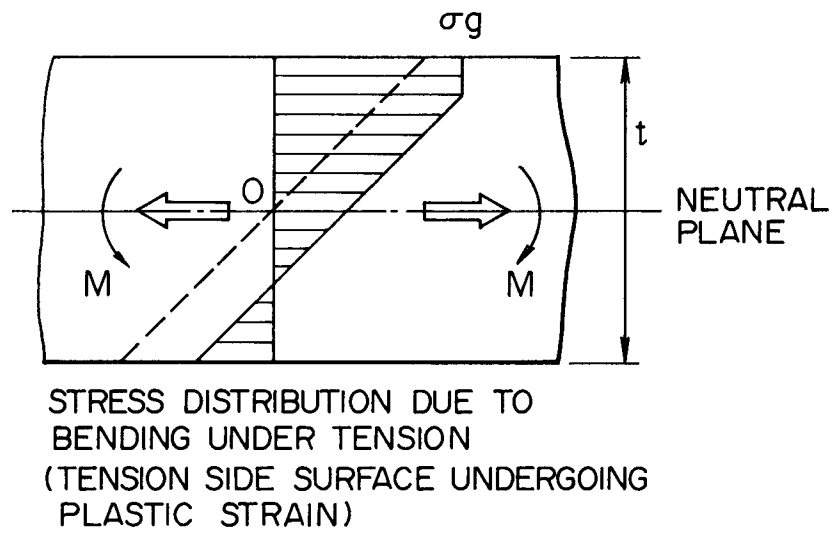


FIG. 10
PRIOR ART

