(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 223 429 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.08.2023 Bulletin 2023/32

(21) Application number: **21874838.2**

(22) Date of filing: **29.06.2021**

(51) International Patent Classification (IPC):
B21C 51/00 *(2006.01)* ***B21B 37/00*** *(2006.01)*
B21B 38/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B21B 37/00; B21B 38/00; B21C 51/00

(86) International application number:
PCT/JP2021/024510

(87) International publication number:
WO 2022/070534 (07.04.2022 Gazette 2022/14)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **29.09.2020 JP 2020164011**

(71) Applicant: **JFE Steel Corporation**
Tokyo 100-0011 (JP)

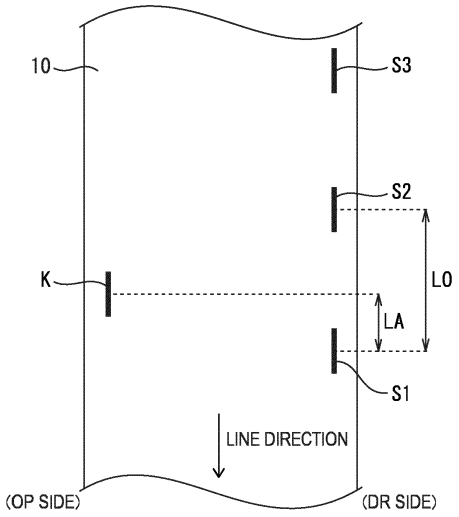
(72) Inventor: **MAKI, Zenta**
Tokyo 100-0011 (JP)

(74) Representative: **Grünecker Patent- und Rechtsanwälte**
PartG mbB
Leopoldstraße 4
80802 München (DE)

(54) METHOD FOR PROCESSING METAL STRIP, MARK APPLICATION METHOD, AND MARK PRINTING DEVICE

(57) To carry out reprinting of a mark with high accuracy in a processing line different from a processing line in which printing has been performed. Processing is applied to a metal strip in a plurality of processing lines. A method for processing a metal strip includes: printing a defect mark (K) to a metal strip in a first processing line; printing a plurality of reference marks (S) arranged at equal intervals in the longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line; cutting a portion of the metal strip, to which the first position specification mark has been applied, in a downstream second processing line;, after the cutting, reprinting a defect mark (K) at the same longitudinal position as the longitudinal position of the defect mark (K) to the metal strip; and, before applying the defect mark (K), detecting at least one of the plurality of reference marks (S) and calibrating tracking information for applying the defect mark (K) based on position information of the detected reference mark in the second processing line.

FIG. 5



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Description

Technical Field

[0001] The present invention relates to a technology for sequentially applying processing to a metal strip in a plurality of processing lines, such as a processing line of manufacturing a cold-rolled steel sheet. The present invention particularly relates to a technology having a feature in a position tracking method between a plurality of processing lines.

Background Art

[0002] As conventional position tracking processing, there is a technology described in Patent Literature 1, for example.

[0003] Patent Literature 1 uses, in a thin steel sheet continuous processing line, a point tracking system using welding points and a method for calculating the conveyance position and the coil length based on detection values of the number of rotations of a roll using a PLG (pulse generator).

Citation List

Patent Literature

[0004] Patent Literature 1: JPH07-32017 A

Summary of Invention

Technical Problem

[0005] The tracking by the PLG has a risk of the occurrence of a deviation (error) due to slippage or the like between the steel sheet to be conveyed and a detection roll. Therefore, there is a risk that a deviation occurs between a measured value by one processing line and a measured value by another processing line, i.e., a deviation occurs in the tracking position.

[0006] Patent Literature 1 corrects the deviation caused by the slippage of the metal strip at the welding point. However, when a coil length deviation occurs, the deviation remains until the welding point with the next coil. Therefore, in Patent Literature 1, even when the amount of each deviation is small, the deviation of the tracking position becomes large when the slip occurs several times. This poses a problem of the occurrence of a longitudinal direction error exceeding the allowable length at the tracking position in the next processing line.

[0007] In a processing line of applying electroplating to a steel sheet to which a defect mark has been applied, there is a tendency that the plating adhesion amount to an edge part of the steel sheet increases due to a current concentration. Therefore, the trimming of the edge part is required to improve the quality. However, there is a possibility that a customer uses portions other than a defect part even for a portion of the metal strip with the defect mark. Therefore, it is preferable to print the defect mark as close to the edge part as possible. Therefore, in cutting the edge part where the plating adhesion amount is excessive large, the defect mark (position specification mark) already printed in the edge part is also cut at the same time. Therefore, in a processing line of cutting the edge part, reprinting of the defect mark needs to be performed to the metal strip.

[0008] However, conventionally, there is a risk of the occurrence of a deviation of an amount equal to or larger than a predetermined amount in the tracking position between the processing lines. Therefore, when printing is carried out in another processing line based on the printing performance at the coil longitudinal position based on the tracking position in one processing line, the print position greatly deviates due to a deviation amount resulting from the slippage or the like described above.

[0009] Therefore, the reprinting of a mark requiring high accuracy, such as defective printing, has been conventionally required to be manually performed.

[0010] It is considered that, when the defect mark is printed to the inside in the width direction to be trimmed, the reprinting is not required. However, in general, the required accuracy for edge printing is 2 mm, for example, which is stricter than the meandering amount in the processing line. For the meandering of the metal strip, the printing to the edge can be always put on standby at the edge of the metal strip with the accuracy within 2 mm by moving a mark printing apparatus body using an edge following device. However, a trimmer body cannot be moved. Therefore, it is considered that, after cutting the edge with the trimmer, the reprinting to the edge can be performed. However, a method for leaving defective printing before the trimming is not realistic. Therefore, under present circumstances, the reprinting is carried out after the cutting of the edge.

[0011] The present invention has been made focusing on the above-described points. It is an object of the present invention to carry out the reprinting of a mark with high accuracy in a processing line different from a processing line in which the printing has been performed.

Solution to Problem

[0012] To solve the problems, one aspect of the present invention is a method for processing a metal strip for sequentially applying processing to the same metal strip in a plurality of processing lines including: applying a first position specification mark to the metal strip in a first processing line selected from the plurality of processing lines; applying a plurality of reference marks arranged with a predetermined regularity along the longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line; cutting a portion of the metal strip, to which the first position specification mark has been applied, in a second processing line as a processing line downstream of the

first processing line;, after the cutting, applying a second position specification mark to the metal strip at the same longitudinal position as the longitudinal position of the first position specification mark; and, before applying the second position specification mark, detecting at least one of the plurality of reference marks and calibrating tracking information for applying the second position specification mark based on position information of the detected reference mark in the second processing line.

[0013] An aspect of the present invention is a method for processing a metal strip for sequentially applying processing to the same metal strip in a plurality of processing lines including: applying a first position specification mark to the metal strip in a first processing line selected from the plurality of processing lines; applying a plurality of reference marks arranged with a predetermined regularity along the longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line; cutting a portion of the metal strip, to which the first position specification mark has been applied, in a second processing line as a processing line downstream of the first processing line; and, after the cutting, applying a second position specification mark to the metal strip at the same longitudinal position as the longitudinal position of the first position specification mark, in which the longitudinal position of the first position specification mark is associated with a reference mark selected from the plurality of reference marks, and, in the second processing line, the longitudinal position of the first position specification mark is specified based on position information of the selected reference mark, and the application position of the second position specification mark is determined.

[0014] An aspect of the present invention is a mark application method for applying a mark to a metal strip in sequentially applying processing to the same metal strip in a plurality of processing lines including: applying a first position specification mark specifying the position to the metal strip in a first processing line selected from the plurality of processing lines; applying a plurality of reference marks arranged with a predetermined regularity along the longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line; applying a second position specification mark at the same longitudinal position as the longitudinal position of the first position specification mark in a second processing line as a processing line downstream of the first processing line; and, in applying the second position specification mark, determining a position at which the second position specification mark is applied by specifying the longitudinal position of the first position specification mark based on the position of a reference mark selected from the plurality of reference marks.

[0015] An aspect of the present invention is a mark application device for applying, in a second processing line selected from a plurality of processing lines in sequentially applying processing to the same metal strip in the plurality of processing lines, a second position specification mark at the same longitudinal position of the metal strip as the longitudinal position of a first position specification mark which has been applied in a first processing line upstream of the second processing line including: a printing device for reference marks arranged in the first processing line or in a processing line upstream of the first processing line and printing a reference mark to the metal strip; a reference mark printing processing unit carrying out processing of printing a plurality of reference marks arranged with a predetermined regularity along the longitudinal direction to the metal strip via the printing device for reference marks; an associated information acquisition unit obtaining associated information in which the reference mark selected from the plurality of reference marks is associated with the first position specification mark; a mark detection unit provided in the second processing line and detecting the reference mark; a reprinting device arranged in the second processing line and applying the second position specification mark to the metal strip; and a reprinting processing unit carrying out processing of specifying the longitudinal position of the metal strip of the first position specification mark from the associated information obtained by the associated information acquisition unit and position information of the reference mark detected by the mark detection unit, and printing the second position specification mark via the reprinting device based on the specified longitudinal position.

Advantageous Effects of Invention

[0016] According to the aspects of the present invention, a position tracking deviation is compensated (calibrated) by the reference marks arranged in the longitudinal direction according to a certain rule. As a result, the aspects of the present invention enable printing with high accuracy at the same longitudinal position in different processing lines. More specifically, the aspects of the present invention can suppress a tracking deviation to a low degree. Therefore, the aspects of the present invention make it possible to automatically perform printing processing which has been manually performed until now in performing reprinting at the same position.

Brief Description of Drawings

[0017]

FIG. 1 is a view for illustrating an equipment configuration of a first processing line according to an embodiment based on the present invention.

FIG. 2 is a plan view for illustrating an arrangement of printing devices.

FIG. 3 is a view for illustrating a configuration of a first processing control unit.

FIG. 4 is a view illustrating a printing performance data group 11.

FIG. 5 is a view illustrating a printing example corresponding to FIG. 4.
FIG. 6 is a view illustrating a printing performance data group 11.
FIG. 7 is a view for illustrating an equipment configuration of a second processing line according to the embodiment based on the present invention.
FIG. 8 is a view for illustrating a configuration of a second processing control unit.
FIG. 9 is a view illustrating a printing example corresponding to FIG. 4.
FIG. 10 is a view illustrating an example of reprinting.
FIG. 11 is a view for illustrating a comparative example.

Description of Embodiments

[0018] Next, an embodiment of the present invention will be described with reference to the drawings.

[0019] This embodiment relates to a method for processing a metal strip and processing equipment sequentially applying processing to the same metal strip (steel sheet or the like) in a plurality of processing lines. This embodiment gives a description assuming a processing line of manufacturing a metal strip, particularly a processing line of manufacturing a cold-rolled steel sheet.

[0020] It is noted that the present invention is not limited to the processing line of manufacturing a metal strip. The present invention is applicable to any processing equipment of sequentially applying processing to the same metal strip in a plurality of processing lines.

[0021] This embodiment gives a description taking a case where a metal strip is processed while unwinding the metal strip in the form of a coil, and then the metal strip is wound up again in each processing line as an example. Therefore, the metal strip is sometimes expressed as a coil. The present invention is applicable even when the metal strip is not wound up in each processing line.

[0022] The term "longitudinal direction" as used herein refers to a longitudinal direction (conveyance direction) of the metal strip to be processed.

[0023] This embodiment includes at least a first processing line and a second processing line as the plurality of processing lines.

[0024] The first processing line is a processing line of applying a first position specification mark to the metal strip. The second processing line is a processing line downstream of the first processing line. The second processing line is a processing line of applying a second position specification mark at the same longitudinal position as the longitudinal position of the first position specification mark. In this embodiment, the first position specification mark is a defect mark indicating the longitudinal position of a defect present in the metal strip. The second position specification mark is a reprinted mark of the defect mark. The first position specification mark and the second position specification mark may not have the same shape.

[0025] One or more other processing lines may be provided between the first processing line and the second processing line. In this embodiment, the first processing line is an electroplating processing line.

[0026] The first processing line may not be the electroplating processing line.

(First processing line)

[0027] As illustrated in FIG. 1, the equipment configuration of the first processing line includes a payoff reel 1, a tension reel 2, a PLG 3, a plating processing unit 4, a defect inspection device 5, a printing device 6, and a first line control unit 7.

<Payoff reel 1 and Tension reel 2>

[0028] The present invention is configured such that the payoff reel 1 and the tension reel 2 carry out unwinding/winding processing of a metal strip 10 in the form of the coil, and the metal strip 10 is conveyed from the payoff reel 1 to the tension reel 2.

<Plating processing unit 4>

[0029] The plating processing unit 4 is arranged on the upstream side of the defect inspection device 5 and carries out processing of applying plating to the surface of the metal strip 10.

<PLG 3>

[0030] The PLG 3 containing an encoder and other components detects the number of rotations of rollers rotating with the conveyance of the metal strip 10, and supplies a detection signal to the first line control unit 7.

<Defect inspection device 5>

[0031] The defect inspection device 5 is a device for detecting defects of the surface and the inside of the metal strip 10 to be conveyed, and, upon detecting a defect, supplies a defect detection signal to the first line control unit 7.

<Printing device 6>

[0032] The printing device 6 is arranged on the downstream side of the defect inspection device 5. The printing device 6 includes a printing device for defect marks 6A and a printing device for reference marks 6B as illustrated in FIG. 2.

[Printing device for defect marks 6A]

[0033] The printing device for defect marks 6A of this

embodiment is arranged on the side of an operator (hereinafter also referred to as "OP side") of the metal strip 10, for example. The printing device for defect marks 6A prints a defect mark K by ejecting ink to an end part on the OP side of the metal strip 10 based on a printing signal from the first line control unit 7.

[Printing device for reference marks 6B]

[0034] The printing device for reference marks 6B in this embodiment is arranged on a drive side (hereinafter also referred to as "DR side") of the metal strip 10, for example. The printing device for reference marks 6B sequentially prints a reference mark S by ejecting ink to the end part on the DR side of the metal strip 10 based on the printing signal from the first line control unit 7. More specifically, in this embodiment, the defect mark K is printed on one end part in the width direction of the metal strip 10 and the reference mark S is printed on the other end part.

[0035] The OP side is the side of an operator in the width direction of the metal strip 10. The DR side refers to the side opposite to the OP side, and refers to the equipment side in the width direction of metal strip 10.

<First line control unit 7>

[0036] The first line control unit 7 contains a program logic controller (PLC) or the like. The first line control unit 7 includes a first position tracking unit 7A, a defect mark printing processing unit 7B, and a reference mark printing processing unit 7C as illustrated in FIG. 3.

<First position tracking unit 7A>

[0037] The first position tracking unit 7A carries out the detection of the line speed of the metal strip 10 and known tracking processing for the longitudinal position from a tip part of the metal strip 10 based on the detection signal from the PLG 3, and arithmetically operates position tracking information.

<Defect mark printing processing unit 7B>

[0038] Once the defect detection signal from the defect inspection device 5 is input, the defect mark printing processing unit 7B acquires the longitudinal position of the defect detection position based on the position tracking information from the first position tracking unit 7A. The defect mark printing processing unit 7B supplies a printing signal to the printing device for defect marks when the defect detection position in the longitudinal direction comes to the print position by the printing device for defect marks 6A based on the line speed. The defect mark printing processing unit 7B supplies the printing signal considering an operation delay. Thus, the defect mark K is printed on the end part on the OP side of the metal strip 10.

[0039] The defect mark printing processing unit 7B outputs a printing performance data 11 of the printing of the defect mark K via the printing device for defect marks 6A to a database 8. Each printing performance data 11 includes a data of a mark type and the print position which is longitudinal position information of the metal strip 10, for example.

<Reference mark printing processing unit 7C>

[0040] The reference mark printing processing unit 7C performs processing based on the tracking information from the first position tracking unit 7A and the line speed of the metal strip 10. More specifically, the reference mark printing processing unit 7C sequentially outputs a printing signal to the printing device for reference marks 6B such that the reference marks S are printed at equal intervals along the longitudinal direction from a predetermined reference position. The predetermined reference position is the reference position in the longitudinal direction away from the unwinding tip of the metal strip 10 by a preset distance. Thus, the reference marks S are sequentially applied at equal intervals (e.g., every 10 m) along the longitudinal direction to the end part on the DR side of the metal strip 10. The plurality of reference marks S may not be printed at equal intervals but may be printed to be arranged with a predetermined regularity along the longitudinal direction.

[0041] The reference mark printing processing unit 7C outputs the printing performance data 11 of the printing of the reference mark S via the printing device for reference marks 6B to the database 8. Each printing performance data 11 includes a data of a mark type and the print position which is the longitudinal position information, for example.

[0042] It is preferable to apply identification information for identifying each reference mark S to each of the plurality of reference marks S. As the identification information, numbers in ascending order of the printing can be exemplified.

[0043] The processing line of printing the plurality of reference marks S may be a line on the upstream side of the first processing line.

[0044] When the processing line of printing the plurality of reference marks S and the processing line of printing the defect marks K are the same line (first processing line), the following configuration is preferable. More specifically, it is preferable that the printing device for defect marks 6A and the printing device for reference marks 6B face each other in the width direction of the metal strip 10 across the conveyance direction of the metal strip 10 as illustrated in FIG. 2. When the processing line of printing the plurality of reference marks S and the processing line of printing the defect mark K are the same line, the configuration is as follows, for example. More specifically, the processing of printing the defect mark by the printing device for defect marks 6A and the processing of printing the reference marks by the printing device for reference

marks 6B need not be performed at the same time. It does not matter which one is carried out first insofar as the processing is carried out in the same line (first processing line). This is because, when the processing is carried out in the same processing line, the position information of the defect mark and the position information of the reference marks do not have a relative deviation or only a slight deviation in the longitudinal position.

[0045] Between the lines, the tracking information in each line deviates by, for example, about 3% due to the influence of slippage or the like. This causes a deviation of about 30 m at 1000 m, for example.

[0046] The plurality of reference marks S is arranged at equal intervals, for example, along the longitudinal direction of the metal strip 10. Therefore, the first or last reference mark S can be printed close to an end part in a longitudinal direction of the metal strip 10 for example, and therefore information accuracy of the tracking position is high. Herein, a case is assumed in which the defect mark K is applied in a processing line subsequent to the processing line of applying the reference marks S. In this case, when the print position of the defect mark K is specified while the tracking position is calibrated by the position of the reference mark S, the relative relationship between the longitudinal positions of the reference mark S and each defect mark K is in a highly accurate state.

(Upper computer 9)

[0047] An upper computer 9 is an upper computer with respect to the first line control unit 7 and a second line control unit 26 described later. The upper computer 9 includes an associated information acquisition unit 9A.

<Associated information acquisition unit 9A>

[0048] The associated information acquisition unit 9A is executed after the completion of the processing in the first processing line. The associated information acquisition unit 9A carries out processing of arranging the printing performance data 11 in the database 8 in ascending order with the longitudinal position as a key to create a printing performance data group 12 as illustrated in FIG. 4. FIG. 4 illustrates a case of cutting the final end of the coil with a cutting device (not illustrated). A processing performance data of the cutting position is also obtained as a part of the printing performance data 11. Herein, the printing performance data group 12 illustrated in FIG. 4 is an example of a case where the defect mark K and the reference marks S illustrated in FIG. 5 are applied to the metal strip 10.

[0049] This makes it possible to associate each defect mark K with one or two or more reference marks S selected from the plurality of reference marks S.

[0050] At this time, in a case where identification information is applied to the reference mark S, for example, a symbol to that effect may be imparted to the reference mark S for specifying the position of the defect mark K in the printing performance data group 12. For example, an identification number may be printed as the reference mark S together with the mark itself. As numbers to be printed, numbers changed in ascending order or in descending order in each printing using a counter, for example, are used.

[0051] Further, a data group of information of the reference mark S for specifying the position of the defect mark K and information of the separation distance from the reference mark S to the target defect mark K may be separately provided.

[0052] The reference mark S for specifying the position of the defect mark K may not be the reference mark S closest to the defect mark K.

[0053] Herein, a case is assumed in which an odd number of other processing lines are present between the first processing line and the second processing line. In this case, the unwinding directions of the coil forming the metal strip 10 in the first processing line and the second processing line are the same.

[0054] On the other hand, a case is assumed in which there are no other processing lines or an even number of other processing lines are present between the first processing line and the second processing line. In this case, the directions of the coil to be processed in the first processing line and the second processing line are opposite directions. Therefore, the winding outside of the coil to be processed in the first processing line is the core of the coil to be processed in the second processing line.

[0055] In this case, processing of arranging the printing performance data 11 in the database 8 in descending order with the longitudinal position as a key is carried out. Then, processing of converting the print position to the longitudinal position from the tip side of the coil is carried out and the printing performance data group 12 is created as illustrated in FIG. 6. In this case, the shear cut position that has become the trail end in the first processing line becomes the leading end in the second processing line.

[0056] The processing of the associated information acquisition unit 9A may be carried out by the first line control unit 7 and the second line control unit 26 described later.

(Second processing line)

[0057] As illustrated in FIG. 7, the equipment configuration of the second processing line includes a payoff reel 20, a tension reel 21, a PLG 22, a printed mark recognition device 23, a trimming device 24, a reprinting device 25, and the second line control unit 26.

<Payoff reel 20 and Tension reel 21>

[0058] The payoff reel 20 and the tension reel 21 carry out the unwinding/rewinding processing of the metal strip 10 in the form of the coil. The present invention is configured such that the metal strip 10 is conveyed from the payoff reel 20 toward the tension reel 21.

<PLG 22>

[0059] The PLG 22 including an encoder and the like detects the number of rotations of rollers rotating with the conveyance of the metal strip 10, and supplies a detection signal to the second line control unit 26.

<Printed mark recognition device 23>

[0060] The printed mark recognition device 23 constitutes a mark detection unit. The printed mark recognition device 23 contains an imaging device, such as a camera, detects the reference mark S applied to the surface of the metal strip 10, and outputs a detection signal to the second line control unit 26. At this time, it may be acceptable that a recognition counter is provided, and, once the reference mark S is detected, the counter is decreased or increased to improve the identification degree of the detected reference mark S.

<Trimming device 24>

[0061] The trimming device 24 of this embodiment is arranged on both sides in the width direction of the metal strip 10 and continuously cuts both end edge parts of the metal strip 10 to be conveyed. The trimming device 24 in this embodiment performs the cutting before reprinting in the reprinting device 25.

[0062] A case is assumed in which the reprinting of the defect mark is carried out only on one end part side in the width direction. In this case, it may be acceptable that the trimming device is arranged on the downstream side of the reprinting device 25 and an end part on the reference mark S side (DR side) is cut after reprinting. The trimming device is a trimming device cutting the end part on the reference mark S side (DR side) present on the other end part side.

[0063] In this embodiment, the defect marks are reprinted on both end parts in the width direction, and therefore the end parts on both sides are cut at the same time.

[0064] It is also considered that, after the reprinting by the reprinting device 25, the cutting processing by the trimming device 24 is performed. However, in this case, the reprinting is performed inside the defect mark printed in the first processing line. However, a metal strip to be subjected to such processing does not require the application of reference marks and also does not require reprinting in many cases. Further, there is also a problem that, when the reprinting is performed before the cutting of the end parts, the cutting width becomes larger than necessary.

<Reprinting device 25>

[0065] The reprinting device 25 of this embodiment ejects ink to the end part of the metal strip 10 based on the printing signal from the second line control unit 26 to reprint the defect mark K serving as the second position specification mark.

<Second line control unit 26>

[0066] The second line control unit 26 contains a program logic controller (PLC) or the like. The second line control unit 26 includes a second position tracking unit 26A and a reprinting processing unit 26B as illustrated in FIG. 8.

<Second position tracking unit 26A>

[0067] The second position tracking unit 26A carries out the detection of the line speed of the metal strip 10 and known tracking processing for the longitudinal position from the tip part of the metal strip 10 based on the detection signal from the PLG 22, and arithmetically operates the position tracking information.

[0068] The second position tracking unit 26A of this embodiment refers to the created printing performance data group 12 whenever a detection signal of the printing from the printed mark recognition device 23 is input. Then, the second position tracking unit 26A calibrates the longitudinal position information (tracking information) obtained by the detection by the PLG 22 of the corresponding reference mark S by the longitudinal position of the printing performance data 11, thereby improving the accuracy of the tracking position information.

<Reprinting processing unit 26B >

[0069] The reprinting processing unit 26B refers to the created printing performance data group 12 based on the position tracking information from the second position tracking unit 26A. Then, the reprinting processing unit 26B determines whether the longitudinal position of the printing performance data 11 to the next defect mark K comes to the print position by the reprinting device 25 in the longitudinal direction. When determined as described above, the reprinting processing unit 26B supplies a printing signal to the reprinting device 25. The printing signal is supplied considering an operation delay. Thus, the defect mark K is reprinted on the end part trimmed on the OP side in the metal strip 10.

[0070] Alternatively, if a detection signal of the reference mark S from the printed mark recognition device 23 is input, the reprinting processing unit 26B refers to the created printing performance data group 12. The reprinting processing unit 26B determines whether the detected reference mark S is the previous reference mark S on the upstream side of the printing performance data 11 to the next defect mark K. When the detected reference mark S is the previous reference mark S on the upstream side of the printing performance data 11 to the next defect mark K, the reprinting processing unit 26B performs the following processing. More specifically, the reprinting processing unit 26B specifies the longitudinal position of the defect mark K from the position information of the

reference mark S detected by the printed mark recognition device 23 and the printing performance data group 12. Then, the reprinting processing unit 26B supplies a printing signal to the reprinting device 25 based on the line speed. This processing is carried out when it is determined that the position obtained by adding the separation distance from the reference mark S to the defect mark K to the longitudinal position of the determined mark position in the longitudinal direction comes to the print position by the reprinting device 25. The printing signal is supplied considering an operation delay. Thus, the defect mark K is reprinted on the end part trimmed on the OP side in the metal strip 10.

(Operations and others)

[0071] In this embodiment, the reference marks S are printed at equal intervals on the end part on the DR side of the metal strip 10 as illustrated in FIG. 5 in the first processing line. In the first processing line, the defect mark K is printed on the OP side of the metal strip 10. In the first processing line, the printing performance data 11 of the defect mark K and the plurality of reference marks S are sequentially stored in the database 8.

[0072] The plurality of printing performance data 11 stored in the database 8 is sorted in ascending order or in descending order with the longitudinal position as a key to form the printing performance data group 12 (see FIGS. 4, 6).

[0073] Further, in the embodiment, the reference mark S is detected, and the position tracking information is calibrated by print position information in the printing performance data 11 of the detected reference mark S in the second processing line. Thus, a printing deviation is calibrated. As a result, the accuracy of the position tracking information to the defect mark K position in the second processing line is improved.

[0074] In the second processing line, the end part on the OP side of the metal strip 10 is trimmed, and then the defect mark K is reprinted at the same longitudinal position as the longitudinal position of the printed defect mark K.

[0075] At this time, the longitudinal position for reprinting is specified with the position of the reference mark S as a reference.

[0076] Herein, a case is assumed in which the longitudinal directions of the coil in the first processing line and the second processing line are the same. In this case, the reprint position of the defect mark K can be specified from a separation distance LA in the longitudinal direction from the reference mark S on the upstream side of the target defect mark K as illustrated in FIG. 5 based on the printing performance data group 12.

[0077] On the other hand, a case is assumed in which the longitudinal directions of the coil in the first processing line and the second processing line are reversed. In this case, the reprint position of the defect mark K can be specified from a separation distance LB in the longitudinal direction from the reference mark S on the upstream side of the target defect mark K as illustrated in FIG. 9. Since a distance L0 between the reference marks S adjacent to each other is already known, the separation distance LB can be determined based on L0 - LA = LB.

[0078] At the position advanced by the separation distance LA or LB from the tracking position of the reference mark S selected from the plurality of reference marks S, the defect mark K as the second position specification mark is reprinted as illustrated in FIG. 10. In FIG. 10, the reprinting of the defect mark K is carried out in both right and left end parts, but the reprinting may be carried out in only one side. In FIG. 10, the reference numerals 10A indicate cut portions of the end parts in the metal strip 10.

[0079] Alternatively, in this embodiment, the reprinting is performed by specifying the reprint position in the longitudinal direction based on the printing performance of the defect mark K while the tracking information is calibrated by the reference mark S in the second processing line.

[0080] It is theoretically possible to detect the defect mark K, which has been printed in the first processing line, in the second processing line and print it at the same longitudinal position of the steel sheet as the longitudinal position of the defect mark K, without printing the plurality of reference marks S. However, there is a possibility that the defect mark K cannot yet be detected or overlooked.

[0081] This is because of the following reasons. When the printed mark is detected at the line speed, a camera cannot recognize the type of the mark, and therefore only the presence or absence of the printing is detected. Therefore, when the defect marks K are densely continuous as illustrated in FIG. 11, there is a possibility that the plurality of marks is recognized as one mark and some of the defect marks K are not detected. There is also a possibility of recognizing and over-detecting a dirt 30 as the defect mark K. When such two identification errors occur, the defect marks K are shifted by one, for example. This results in a difference between the defect type and the printed mark for all defects after the mark for which the identification error occurs, which leads to a serious quality error.

[0082] In contrast thereto, in this embodiment, the use of the plurality of reference marks S arranged according to a predetermined rule enables the reprinting of the defect mark K based on the distance from the reference mark S. Therefore, the possibility of the occurrence of non-detection due to the dense defect marks K can be reduced. Further, the recognition of the dirt 30 as the defect mark K can be prevented.

[0083] Further, in this embodiment, the reference marks S are printed at predetermined intervals, such as fixed length intervals. Therefore, an interval deviation between the reference marks S is small, and parts other than the periphery of parts of the printed marks can be masked. This makes it possible to prevent the overlooking caused by recognizing a dirt or the like as a mark. Further, since the non-detection of the reference mark S

can be determined depending on the presence or absence of the detection in a part where the reference mark S is to be detected, the non-detection can be early found.

[0084] As described above, in this embodiment, the plurality of reference marks S is printed and the reprinting is performed with the plurality of reference marks S as a reference, and thus the defect mark K can be reprinted with higher accuracy.

(Advantageous effects)

[0085]

(1) This embodiment is a method for processing a metal strip for sequentially applying processing to the same metal strip in a plurality of processing lines including: applying a first position specification mark to the metal strip in a first processing line selected from the plurality of processing lines; applying a plurality of reference marks arranged with a predetermined regularity along the longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line; cutting a portion of the metal strip, to which the first position specification mark has been applied, in a second processing line as a processing line downstream of the first processing line;, after the cutting, applying a second position specification mark to the metal strip at the same longitudinal position as the longitudinal position of the first position specification mark in the second processing line; and, before applying the second position specification mark, detecting at least one of the plurality of reference marks and calibrating tracking information for applying the second position specification mark based on position information of the detected reference mark in the second processing line.

[0086] The processing of the metal strip 10 is processing of manufacturing the metal strip 10, for example. The processing is processing of the metal strip 10 for manufacturing a cold-rolled steel sheet.

[0087] According to this configuration, the position deviation of the position tracking for applying the second position specification mark is calibrated by the reference marks S arranged in the longitudinal direction according to a certain rule in the second processing line. As a result, this embodiment makes it possible to perform printing at the same longitudinal position in different processing lines. More specifically, according to this configuration, the tracking deviation can be suppressed to a low degree. This makes it possible to automatically perform printing processing which has been manually performed until now in performing reprinting at the same position.

[0088] (2) This embodiment is a method for processing a metal strip for sequentially applying processing to the same metal strip in a plurality of processing lines including: applying a first position specification mark to the metal strip in a first processing line selected from the plurality of processing lines; applying a plurality of reference marks arranged with a predetermined regularity along the longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line; cutting a portion of the metal strip, to which the first position specification mark has been applied, in a second processing line as a processing line downstream of the first processing line; and, after the cutting, applying a second position specification mark to the metal strip at the same longitudinal position as the longitudinal position of the first position specification mark in the second processing line, in which the longitudinal position of the first position specification mark is associated with a reference mark selected from the plurality of reference marks, and, in the second processing line, the longitudinal position of the first position specification mark is specified based on position information of the selected reference mark, and the application position of the second position specification mark is determined.

[0089] According to this configuration, the position tracking deviation is compensated by the reference marks S arranged in the longitudinal direction according to a certain rule. As a result, the printing at the same longitudinal position in different processing lines is enabled. More specifically, according to this configuration, the tracking deviation can be suppressed to a low degree. This makes it possible to automatically perform printing processing which has been manually performed until now in performing reprinting at the same position.

[0090] (3) In this embodiment, after the processing of cutting (trimming) a portion of the metal strip 10, to which the first position specification mark has been applied, the second position specification mark (reprinting mark) is applied to a portion of an end part in the width direction of the metal strip 10 which has not been removed in the cutting processing in the second processing line.

[0091] In this case, the processing of cutting the portion of the metal strip 10, to which the first position specification mark has been applied, is carried out before applying the second position specification mark.

[0092] According to this configuration, the second position specification mark can be applied to the end part of the metal strip 10 with high position accuracy.

[0093] A method for performing reprinting before the trimming has no advantages. This is because the printing in the first processing line and the reprinting have the same information, and therefore there is no need for reprinting.

[0094] (4) In this embodiment, identification information for identifying each reference mark S is applied to the plurality of reference marks S.

[0095] According to this configuration, each reference mark S can be individually identified.

[0096] (5) In this embodiment, the longitudinal position of the first position specification mark is specified from the separation distance in the longitudinal direction of the metal strip 10 from the selected reference mark S.

[0097] According to this configuration, the longitudinal position of the first position specification mark can be associated with the selected reference mark S.

[0098] (6) In this embodiment, processing of cutting the portion of the metal strip 10, to which the plurality of reference marks S has been applied, is performed in the second processing line.

[0099] For example, the processing of cutting the portion of the metal strip 10, to which the plurality of reference marks S has been applied, is carried out before applying the second position specification mark.

[0100] According to this configuration, the reference mark S can be removed.

[0101] (7) In this embodiment, the first position specification mark and the second position specification mark are defect marks K indicating the longitudinal position of a defect present in the metal strip 10.

[0102] According to this configuration, the defect mark K can be reprinted with high accuracy.

[0103] (8) This embodiment is a mark application method for applying a mark to a metal strip in sequentially applying processing to the same metal strip in a plurality of processing lines including: applying a first position specification mark specifying the position to the metal strip in a first processing line selected from the plurality of processing lines; applying a plurality of reference marks arranged with a predetermined regularity along the longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line; applying a second position specification mark at the same longitudinal position as the longitudinal position of the first position specification mark in a second processing line as a processing line downstream of the first processing line; and, in applying the second position specification mark, determining a position at which the second position specification mark is applied by specifying the longitudinal position of the first position specification mark based on the position of a reference mark selected from the plurality of reference marks.

[0104] According to this configuration, the position tracking deviation is compensated by the reference marks S arranged in the longitudinal direction according to a certain rule. As a result, the printing at the same longitudinal position in different processing lines is enabled. More specifically, according to this configuration, the tracking deviation can be suppressed to a low degree. This makes it possible to automatically perform printing processing which has been manually performed until now in performing reprinting at the same position.

[0105] (9) This embodiment is a mark application device for applying, in a second processing line selected from a plurality of processing lines in sequentially applying processing to the same metal strip in the plurality of processing lines, a second position specification mark at the same longitudinal position of the metal strip as the position of a first position specification mark which has been applied in a first processing line upstream of the second processing line including: a printing device for reference marks arranged in the first processing line or in a processing line upstream of the first processing line and printing a reference mark to the metal strip; a reference mark printing processing unit carrying out processing of printing a plurality of reference marks arranged with a predetermined regularity along the longitudinal direction to the metal strip via the printing device for reference marks; an associated information acquisition unit obtaining associated information in which the reference mark selected from the plurality of reference marks is associated with the first position specification mark; a mark detection unit provided in the second processing line and detecting the reference mark; a reprinting device arranged in the second processing line and applying the second position specification mark to the metal strip; and carrying out processing of a reprinting processing unit specifying the longitudinal position of the metal strip of the first position specification mark from the associated information obtained by the associated information acquisition unit and position information of the reference mark detected by the mark detection unit, and printing the second position specification mark via the reprinting device based on the specified longitudinal position.

[0106] According to this configuration, the position tracking deviation is compensated and calibrated by the reference marks S arranged in the longitudinal direction according to a certain rule. As a result, the printing at the same longitudinal position in different processing lines is enabled. More specifically, according to this configuration, the tracking deviation can be suppressed to a low degree. This makes it possible to automatically perform printing processing which has been manually performed until now in performing reprinting at the same position.

[0107] (10) The plurality of reference marks S may be applied with identification information for identifying each reference mark S.

[0108] According to this configuration, the identification of each reference mark S is facilitated.

[0109] (11) In this embodiment, the associated information includes information of the separation distance in the longitudinal direction of the metal strip 10 between the longitudinal position of the first position specification mark and the longitudinal position of the reference mark S selected from the plurality of reference marks S.

[0110] According to this configuration, the longitudinal position of the first position specification mark can be associated with the selected reference mark S.

[0111] The entire contents of JP 2020-164011 A (filed September 29, 2020), for which this application claims priority, form part of this disclosure by reference. Herein, the description is given with reference to a limited number of embodiments, but the scope of the invention is not limited thereto and modifications of each embodiment based on the disclosure above are obvious to those skilled in the art.

Reference Signs List

[0112]

1	payoff reel
2	tension reel
2,	PLG
4	plating processing unit
5	defect inspection device
6	printing device
6A	printing device for defect marks
6B	printing device for reference marks
7	first line control unit
7A	first position tracking unit
7B	defect mark printing processing unit
7C	reference mark printing processing unit
8	database
9	upper computer
9A	associated information acquisition unit
10	metal strip
11	printing performance data
12	printing performance data group
20	payoff reel
21	tension reel
21,	PLG
23	printed mark recognition device
24	trimming device
25	reprinting device
26	second line control unit
26A	second position tracking unit
26B	reprinting processing unit
K	defect mark
S	reference mark

Claims

1. A method for processing a metal strip for sequentially applying processing to a same metal strip in a plurality of processing lines comprising:

applying a first position specification mark to the metal strip in a first processing line selected from the plurality of processing lines;
applying a plurality of reference marks arranged with a predetermined regularity along a longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line;
cutting a portion of the metal strip, to which the first position specification mark has been applied, in a second processing line as a processing line downstream of the first processing line;
after the cutting, applying a second position specification mark to the metal strip at the same longitudinal position as a longitudinal position of the first position specification mark in the second processing line; and
before applying the second position specification mark, detecting at least one of the plurality of reference marks and calibrating tracking information for applying the second position specification mark based on position information of the detected reference mark in the second processing line.

2. A method for processing a metal strip for sequentially applying processing to a same metal strip in a plurality of processing lines comprising:

applying a first position specification mark to the metal strip in a first processing line selected from the plurality of processing lines;
applying a plurality of reference marks arranged with a predetermined regularity along a longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line;
cutting a portion of the metal strip, to which the first position specification mark has been applied, in a second processing line as a processing line downstream of the first processing line; and
after the cutting, applying a second position specification mark to the metal strip at a same longitudinal position as a longitudinal position of the first position specification mark in the second processing line, wherein
the longitudinal position of the first position specification mark is associated with a reference mark selected from the plurality of reference marks, and
in the second processing line, the longitudinal position of the first position specification mark is specified based on position information of the selected reference mark, and an application position of the second position specification mark is determined.

3. The method for processing a metal strip according to claim 1 or 2, comprising applying identification information for identifying each reference mark to the plurality of reference marks.

4. The method for processing a metal strip according to claim 2 or 3, comprising specifying the longitudinal position of the first position specification mark from a separation distance in a longitudinal direction of the metal strip from the selected reference mark.

5. The method for processing a metal strip according to any one of claims 1 to 4, comprising performing processing of cutting a portion of the metal strip, to which the plurality of reference marks has been applied, in the second processing line.

6. The method for processing a metal strip according to claim 5, wherein the processing of cutting the portion of the metal strip, to which the plurality of reference marks has been applied, is carried out before applying the second position specification mark.

7. The method for processing a metal strip according to any one of claims 1 to 6, wherein the first position specification mark and the second position specification mark are defect marks indicating a longitudinal position of a defect present in the metal strip.

8. A method for manufacturing a metal strip comprising: the method for processing a metal strip according to any one of claims 1 to 7.

9. The method for manufacturing a metal strip according to claim 8, wherein a cold-rolled steel sheet is manufactured.

10. A mark application method for applying a mark to a metal strip in sequentially applying processing to a same metal strip in a plurality of processing lines, the mark application method comprising:

applying a first position specification mark specifying a position to the metal strip in a first processing line selected from the plurality of processing lines;
applying a plurality of reference marks arranged with a predetermined regularity along a longitudinal direction to the metal strip in the first processing line or in a processing line upstream of the first processing line;
applying a second position specification mark at a same longitudinal position as a longitudinal position of the first position specification mark in a second processing line as a processing line downstream of the first processing line; and
in applying the second position specification mark, determining a position at which the second position specification mark is applied by specifying the longitudinal position of the first position specification mark based on a position of a reference mark selected from the plurality of reference marks.

11. A mark printing device for applying, in a second processing line selected from a plurality of processing lines in sequentially applying processing to a same metal strip in the plurality of processing lines, a second position specification mark at a same longitudinal position of the metal strip as a longitudinal position of a first position specification mark which has been applied in a first processing line upstream of the second processing line,
the mark printing device comprising:

a printing device for reference marks arranged in the first processing line or in a processing line upstream of the first processing line and configured to print a reference mark to the metal strip;
a reference mark printing processing unit configured to carry out processing of printing a plurality of reference marks arranged with a predetermined regularity along the longitudinal direction to the metal strip via the printing device for reference marks;
an associated information acquisition unit configured to obtain associated information in which the reference mark selected from the plurality of reference marks is associated with the first position specification mark;
a mark detection unit provided in the second processing line and configured to detect the reference mark;
a reprinting device arranged in the second processing line and configured to apply the second position specification mark to the metal strip; and
a reprinting processing unit configured to carry out processing of specifying the longitudinal position of the metal strip of the first position specification mark from the associated information obtained by the associated information acquisition unit and position information of the reference mark detected by the mark detection unit, and printing the second position specification mark via the reprinting device based on the specified longitudinal position.

12. The mark printing device according to claim 11, wherein the plurality of reference marks is applied with identification information for identifying each reference mark.

13. The mark printing device according to claim 11 or 12, wherein the associated information includes information of a separation distance in a longitudinal direction of the metal strip between a longitudinal position of the first position specification mark and a longitudinal position of the reference mark selected from the plurality of reference marks.

14. The mark printing device according to any one of claims 11 to 13, wherein the first position specification mark and the second position specification mark are defect marks indicating a longitudinal position of a defect present in the metal strip.

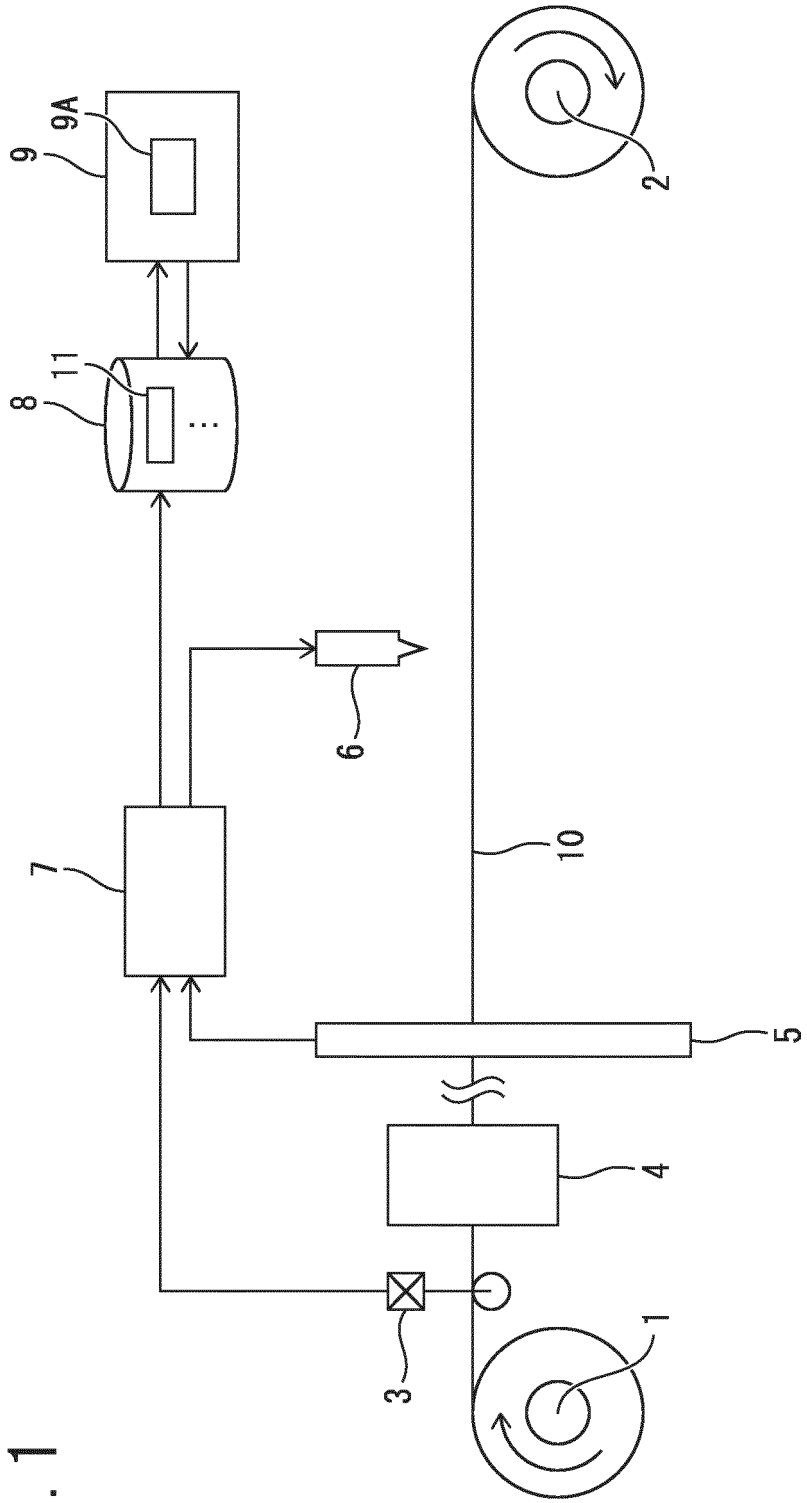


FIG. 1

FIG. 2

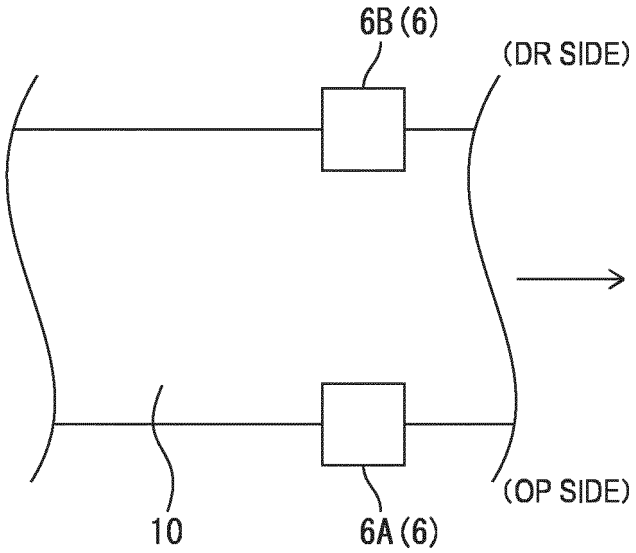


FIG. 3

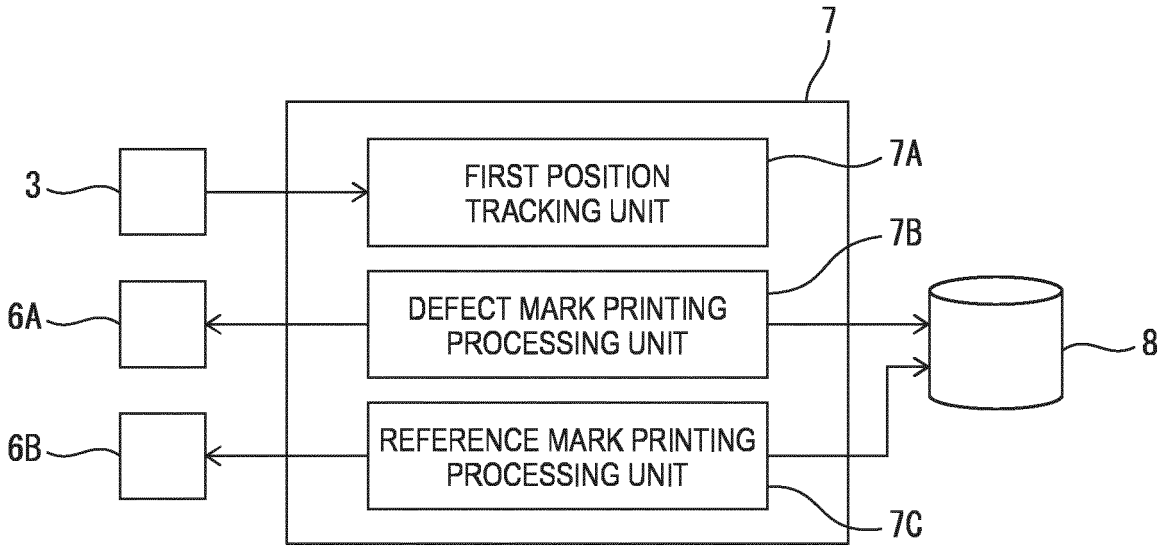

7
3
FIRST POSITION TRACKING UNIT
7A
7B
6A
DEFECT MARK PRINTING PROCESSING UNIT
8
6B
REFERENCE MARK PRINTING PROCESSING UNIT
7C

FIG. 4

12

MARK TYPE	PRINT POSITION (mm)
REFERENCE MARK S1	XX
DEFECT MARK K (14)	XX+ β
REFERENCE MARK S2	XX+ α
REFERENCE MARK S3	XX+2 α
:	:
SHEAR CUT	YY

FIG. 5

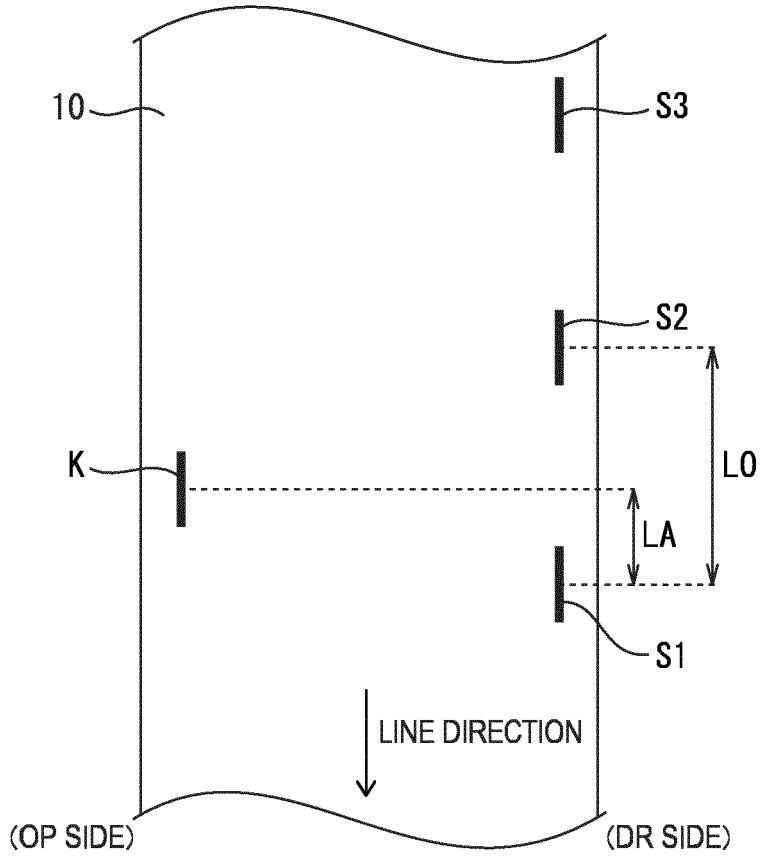


FIG. 6

MARK TYPE	PRINT POSITION (mm)
SHEAR CUT	0
:	:
REFERENCE MARK S3	YY−XX−2 α
REFERENCE MARK S2	YY−XX− α
DEFECT MARK K (14)	YY−XX− β
REFERENCE MARK S1	YY−XX

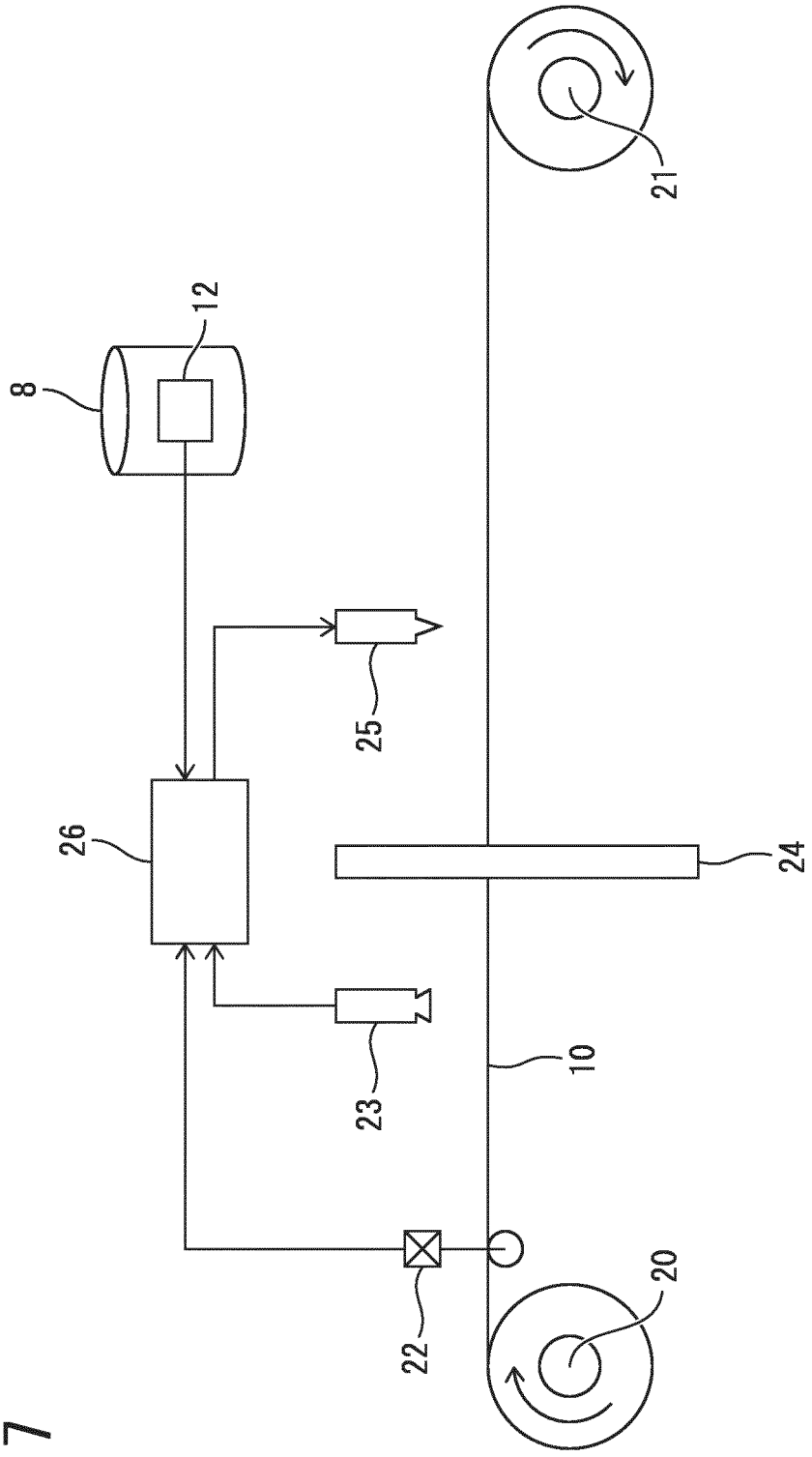


FIG. 7

FIG. 8

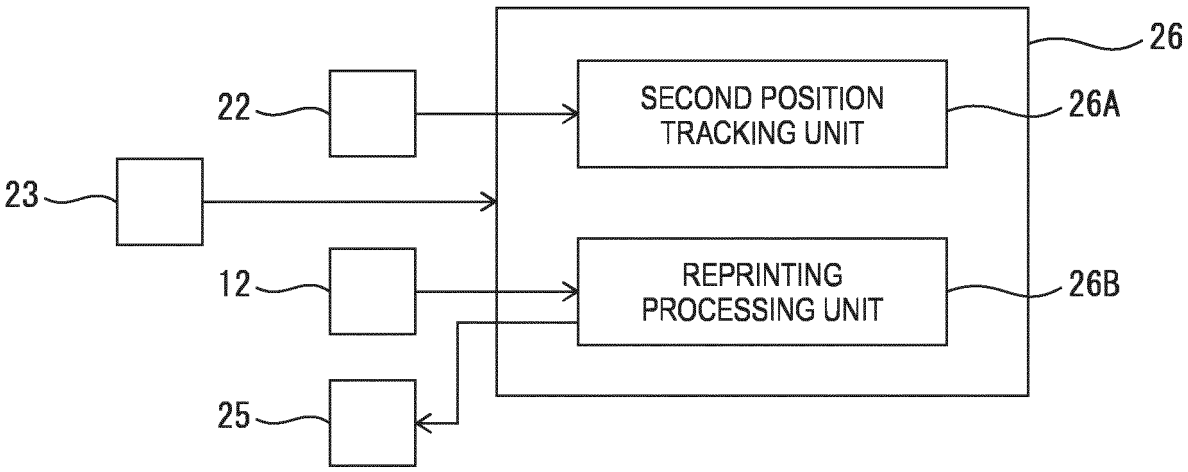

26
22
SECOND POSITION TRACKING UNIT
26A
23
12
REPRINTING PROCESSING UNIT
26B
25

FIG. 9

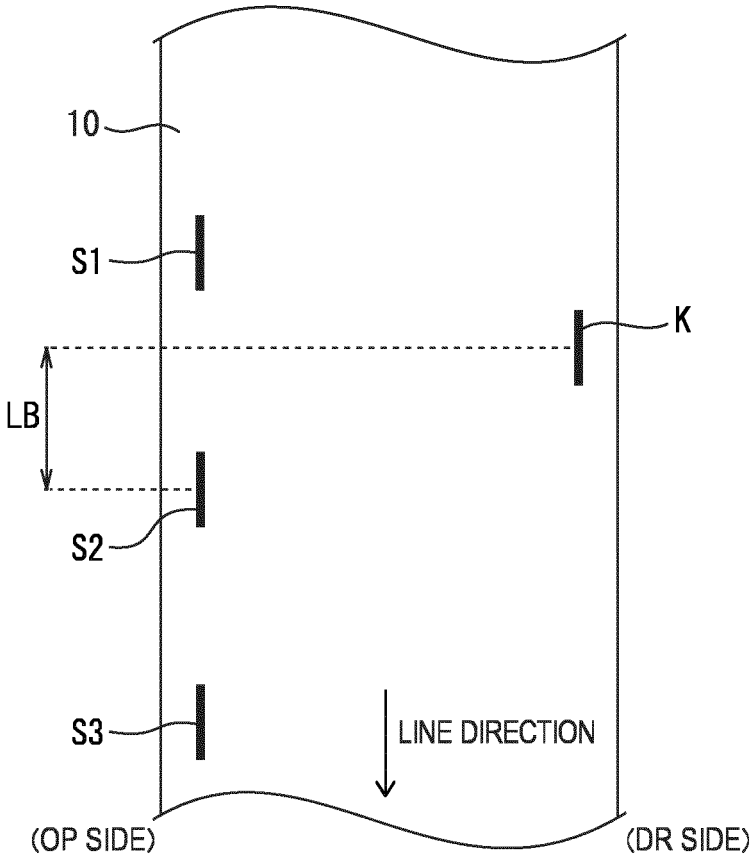


FIG. 10

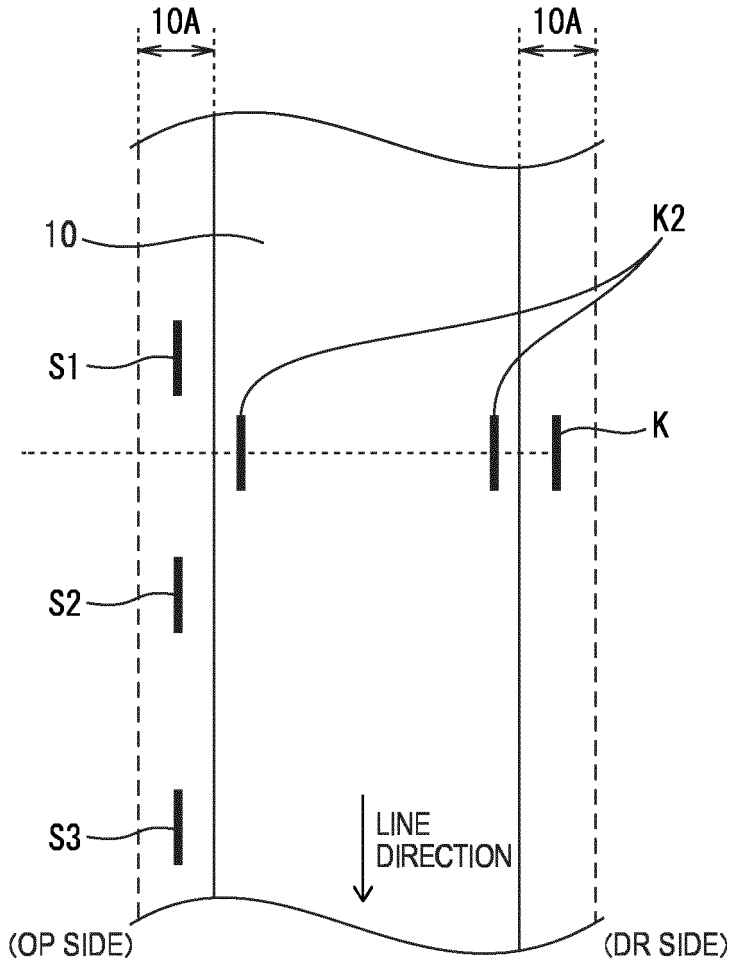
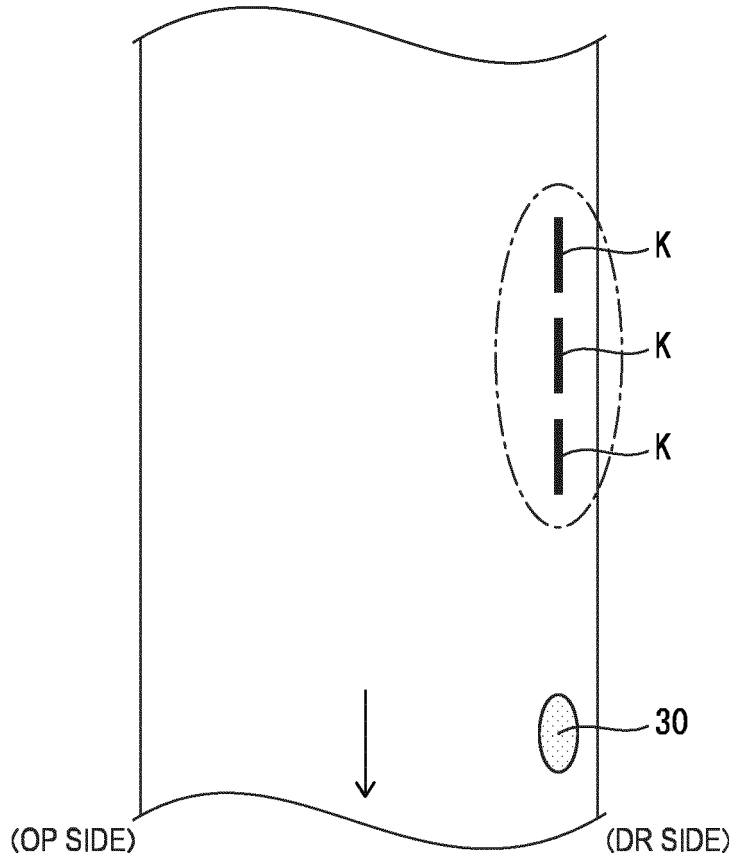


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/024510

A. CLASSIFICATION OF SUBJECT MATTER
B21C 51/00(2006.01)i; B21B 37/00(2006.01)i; B21B 38/00(2006.01)i
FI: B21B37/00 241; B21C51/00 B; B21B38/00 F

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B21C51/00; B21B37/00; B21B38/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-106589 A (JFE STEEL CORPORATION) 21 April 2005 (2005-04-21) entire text	1-14
A	JP 2001-179336 A (NKK CORP.) 03 July 2001 (2001-07-03) entire text	1-14
A	JP 2001-311694 A (NKK CORP.) 09 November 2001 (2001-11-09) entire text	1-14

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search 20 July 2021 (20.07.201)	Date of mailing of the international search report 03 August 2021 (03.08.2021)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/024510

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2005-106589 A	21 Apr. 2005	(Family: none)	
JP 2001-179336 A	03 Jul. 2001	(Family: none)	
JP 2001-311694 A	09 Nov. 2001	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H0732017 A **[0004]**
- JP 2020164011 A **[0111]**