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Efforts to Improve Steel Plate Identification and QA

KINUGAWA Teruhisa[*1] TAKAHASHI Seichi[*2] AKITA Toshikazu[*3]

Abstract:

Steel plate products are identified by spraying, engraving and side indication. Automation of identification of products finished at shear lines was promoted in the past, and automatic identification is now performed based on tracking by computer, but offline work was still done manually. Although there was a risk of misidentification of products in offline manual work, identification by automatic matching of products using barcodes and the introduction of an offline automatic stamping machine has substantially reduced abnormalities in identification.

In addition, the online automatic stamping machine at the shear line was also updated, and adoption of a pin-dot type system has eliminated the need to exchange stamps. The QA level has been improved by introducing a mechanism that reads the characters on the stamp to determine that stamping has been performed correctly.

1. Introduction

Identification of steel plate products is carried out by spray display, engraving and side display. Since workers performed identification and collation visually, there were cases where identification abnormalities such as incorrect identification occurred, and its eradication was an indispensable issue. Therefore, we have attempted to prevent identification abnormalities in each type of identification work by introducing automated equipment. This paper describes barcode judgment of stencils, introduction of a side marker, introduction of an offline automatic stamping machine, updating of an online automatic stamping machine, and introduction of a device that reads identification stamps introduced in the plate mill at JFE Steel's West Japan Works (Kurashiki District).

2. Introduction of Marking Stencil Barcodes

2.1 Problems of Marking Stencils

When identification marking is performed offline, a stencil with punched marking items is placed on the plate at the specified position and sprayed with a color spray. In the past, the operator visually checked the product number (plate number) punched on the stencil to confirm that the material being marked was correct. Therefore, abnormalities such as marking with a similar plate number could occur by mistake, or when multiple stencils were marked on a plate in addition to the main marking, such as the shipping mark, spraying might be omitted.

2.2 Introduction of Marking Stencil Barcodes

First, as an alternative to the visual confirmation of identification by workers, we introduced a terminal that recognizes the stencil plate number as character information. A work instruction card that describes information concerning the steel plate standards, dimensions, work contents, and judgment standards such as tolerances is issued for each steel plate product. Identification was automated by collating the product number (plate number) of this work instruction card with the plate number punched on the stencil by using a character authentication terminal. This system had a certain effect, but it was not possible to confirm the required number of stencils when marking multiple shipping mark stencils on one steel plate because the collation target was only the plate number, and as a result, there was a risk of identification abnormalities

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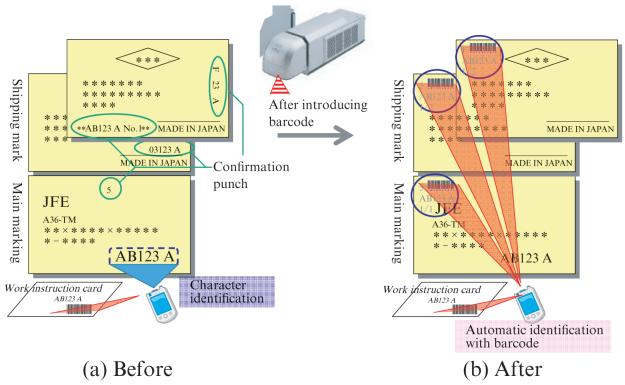
*1 Manager,
Plate Rolling Plant,
Plate Rolling Dept.,
West Japan Works (Kurashiki),
JFE Steel

*2 Staff Assistant Manager,
Plate Rolling & Forging Technology Sec.,
Plate Rolling Dept.,
West Japan Works (Kurashiki),
JFE Steel

*3 General Manager,
Plate Rolling Dept.,
West Japan Works (Kurashiki),
JFE Steel



(a) Before (b) After

Fig. 1 Comparison before and after barcode introduction to stencil

due to omission of spraying of marking items.

Therefore, as shown in **Fig. 1**, we introduced a system that prints barcodes on the work instruction cards and each stencil and collates the barcodes. For steel plate products that require spraying of multiple stencils, the number of stencils can be collated by adding serial number information to the barcode. It was also possible to eliminate unnecessary spraying mistakes by removing the punch of the plate number for confirmation.

3. Updating to Online Side Marker

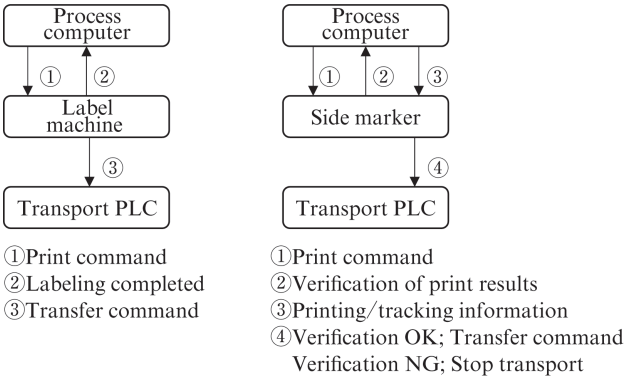
3.1 Background of Side Marker Update

Previously, a sticker type label was attached to the side surface of the steel plate. The online label affixing device attached a label, which was held on the device head by vacuum suction, to the side of the plate, and recognized that labeling was completed when the vacuum pressure decreased. If the label was not attached correctly and remained on the head due to the stickiness of the adhesive, the label of the next plate would stick to the previous label, causing a double-labeling identification abnormality in which both the label of the previous plate and the label of the next plate. Control of this labeling machine comprised (1) a labeling command from the host computer, (2) a message that the labeling operation was complete from the labeling machine to the host computer, and (3) a transport start command to the transport PLC. Since there was no check process, identification abnormalities could not be discovered.

In addition, when reattaching a label that had been peeled off, an identification error in which the wrong label was attached could occur.

Therefore, in order to prevent these identification abnormalities, we updated the side marker to an inkjet printing type.

Fig. 2 Example of side marker printing



(a) Conventional (b) Side marker

Fig. 3 Flow of confirmation between print information and tracking

3.2 Overview of Side Marker

For the side marker, an inkjet printing method that does not cause double-labeling or peeling was adopted, and a barcode was added to improve the level of identification verification. (See **Fig. 2**)

As shown in **Fig. 3**, the control flow is as follows: (1) A print command is received from the host computer, (2) the marked barcode is read and collated with the setting in the side marker, and the collation result is sent to the host computer, (3) the tracking information is collated, and (4) if the collation result is OK, a transfer command is issued to the transfer PLC via the side marker. When the collation result is NG, a remark command and alarm are issued and transportation is stopped to prevent the release of the misidentified product.

4. Offline Automatic Stamping Machine

4.1 Background of Introduction of Offline Automatic Stamping Machine

In conventional manual stamping, as shown in **Fig. 4**, a key was set in the stamp holder according to the work instructions, and was the manually stamped on the steel plate with a hammer. The contents of the stamp were checked by the worker by rubbing of the stamp. Identification abnormalities could occur if the worker misread the work instruction card or set the stamp incorrectly. There were also cases where the worker failed to check the stamped content and

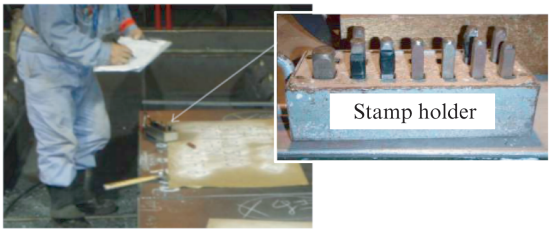


Fig. 4 Offline manual stamping

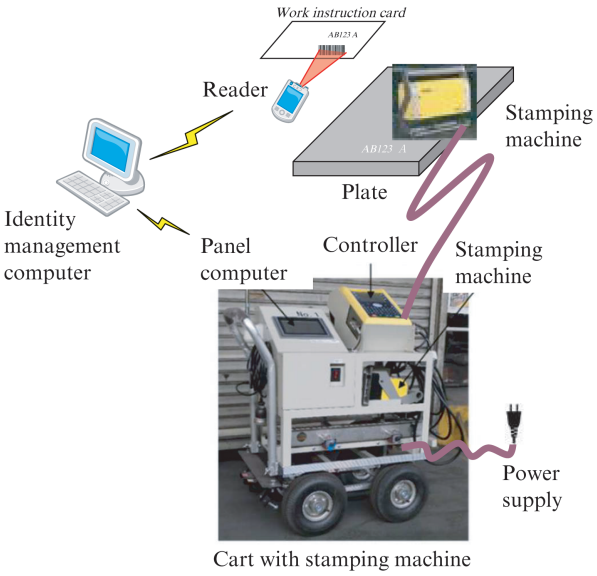
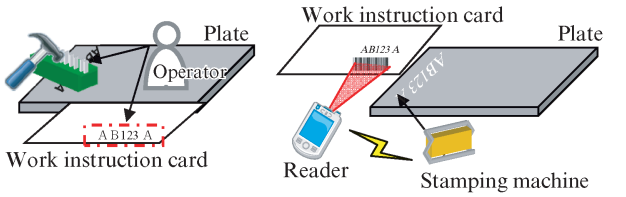


Fig. 5 Configuration of offline automatic stamping system

Fig. 6 Characters on new stamping machine



(a) Conventional work (b) Offline automatic stamping machine

Fig. 7 Work before and after introduction of offline automatic stamping machine

released an incorrectly marked product to the customer. In order to solve these problems, we introduced an automatic stamping machine for offline use, which prevents identification abnormalities by reading the barcode on the work instruction card and automatically stamping the identification.

The stamping machine was selected on the condition that it could be used wirelessly to ensure offline mobility. However, since no existing stamping machine had a wireless function, wireless communication was realized by connecting a panel personal computer that acts as an interface above the machine.

The head of the stamping machine and the controller are connected by a cable. After moving the dolly to the side of the steel plate, only the head is set at the position where marking is to be performed, and then the marking is performed.

The stamping machine is driven by an electromagnetic device that can use the power supply in the plate mill, and stamping is performed by a dot method using an NC-controlled vibrating stylus. With this method, complex logos such as company marks and ship classification society stamps can easily be created by using logo creation software. **Figure 6** shows an example of the characters on the new stamping machine.

4.2 Change of Work Method by Offline Automatic Stamping Machine

When working with the new stamping machine, first, the barcode of the work instruction card, which was already introduced to improve the identification level of marking, is read using a handy terminal, the plate number information of the steel plate is acquired, and the content of the stamp is requested from the host computer via the identification personal computer that serves as the terminal. After receiving the content to be stamped, the identification personal computer transmits the information to the stamping machine. The stamping machine starts stamping when all the information is available.

Transmission of the contents of markings using barcodes and automatic stamping in this manner have made it possible to eliminate manual work such as setting stamps and reduce the risk of identification abnormalities.

5. Enhanced Identification by Online Automatic Stamping Machine

5.1 Background of Online Automatic Stamping Machine Update

The old online automatic stamping machine installed on the shearing line had restrictions on the number of stamps that could be set on the stamping head and the number of characters that could be stamped, and the stamps were replaced daily to perform automatic stamping. Due to this restriction, workers also performed manual stamping of stamps that could not be stamped automatically. In addition,

in the conventional air hammer type stamping machine, stamping stops in the middle of the stamping pipe, and there was a mechanical risk that the stamping might not be performed.

In order to solve these problems, the new stamping machine uses the pindot method to eliminate stamp replacement work, increase the number of characters that can be engraved, and reduce manual work.

5.2 Overview of New Online Automatic Stamping Machine

Two heads of the new online automatic stamping machine were installed on the line, eight internal pins were arranged, and the cycle time was made the same as before by using 5 characters/pin. (**Fig. 8**)

In order to automatically engrave all the contents of the stamping specified in the steel plate specifications, a maximum of 3 steps with 40 characters in each step, or 120 characters in total, can be stamped in one stamping operation, and the frequency of manual stamping work has also been reduced by about 80%.

5.3 Construction of Automatic Engraved Character Collation System

Conventional online stamping inspection were conducted by a sampling method, in which the line was stopped once an hour and the stamping instructions and the stamped content were visually collated character-by-character, and other steel plates were simply checked to determine whether stamping had been performed or not. Since the contents of engraving were inspected by sampling, identification abnormalities such as missing characters and missing stamps sometimes occurred.

Therefore, we constructed a system that automatically collates the stamping on all steel plates by means of a marking character recognition system based on data captured during transportation after stamping,

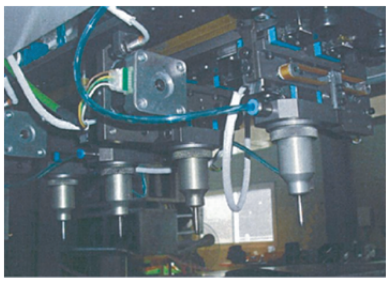


Fig. 8 Appearance of needle pin

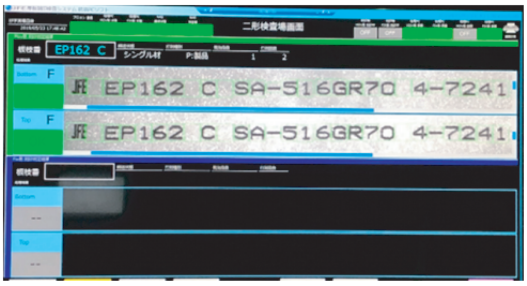


Fig. 9 Example of monitor screen with stamp

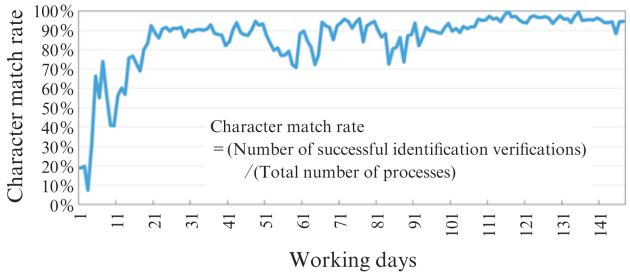


Fig. 10 Transition of character collation rate

and displays the pass/fail judgment on the operation room monitor. This function makes it possible to prevent the release of products with imprint defects by issuing an alarm to the operator when the engraving does not match the indicated characters or when the engraving is unclear. An example of the monitor screen is shown in **Fig. 9**.

As shown in **Fig. 10**, when the system was started up, the accuracy of reading and identifying the stamping varied depending on the surface texture of the steel plate and the condition of stamping, and characters could not be recognized correctly and the character collation rate was low. Therefore, we tuned the image processing software and improved the character collation rate to 95 % or more.

6. Conclusion

This paper has introduced efforts to reduce manual work and improve the QA level of error prevention in steel plate identification and marking work by the authors up to the present. As a result of advances in image processing technology in recent years, it has become possible to perform character collation and shape recognition at low cost. We will continue to work to further improve the level of identification.