New Products & Technologies

Automatic X-Ray Radiographic System for UOE Pipe Ends*

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1 Introduction

UOE pipe is mainly used for transporting crude oil and natural gas, and its manufacture is performed mainly to the API specification 5L, which specifies welded pipe ends to be subjected to radiographic examination. X-ray is used as the source of the radiographic examination, and an identification number as shown in **Fig. 1** is simultaneously photographed on the X-ray photographed film by using film markers made of an X-ray non-penetrable material. This is for an ease of identifying the positions of the pipe and the photographic device. Since the arrangement of the film marker varies for each pipe and requires sufficient confirmation, it was a burdensome manual labor for operators despite of its mechanical type of task.

On the other hand, such a mechanical and simple operation has come to be easily automated as a result of the recent development of computers and robots. Against these backdrops, the authors have constructed a fully-automated photographing system (1) by developing and installing a device which automatically performs the compilation and setting of the film marker that corresponds to the preparation for photographing and setting and resetting of the film cassette and (2) by linking the conventional X-ray photographing device, pipe tracking system and pipe transporting system.

In the following, the automatic X-ray radiographic system for UOE pipe ends is reviewed.

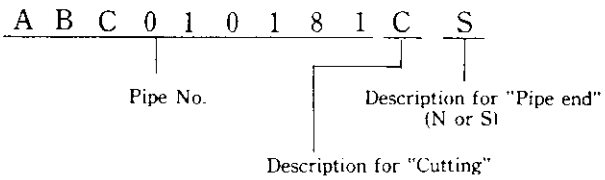

Fig. 1 Detail of film mark

2 Outline of Apparatus

Dimensions, specifications, etc., of the UOE pipe are shown in **Table 1**. X-ray radiographic examination of pipe ends is conducted, after the pipe-ends are machined on the finishing process line at the UOE Plant and after the magnetic particle examination has been completed. Ordinarily, two pieces of pipe are simultaneously photographed. Namely, the rear end of the leading pipe and the leading end of the succeeding pipe are photographed by two units of X-ray equipment.

The system flow chart and the sketch of the automatic setting device are shown in **Figs. 2** and **3**, respectively. The operator prepares the necessary X-ray film cassette and recovery of the photographed cassette in the developing room. When the pipe is transported on

Table 1 Available sizes of Kawasaki's UOE pipe

Outside dia.	508 mm (20″)~1 626 mm (64″)
Wall thickness	6.0 mm~44.5 mm
Length	5.5 m~18.0 m
Standard	API 5L, JIS STK/STPY, etc.

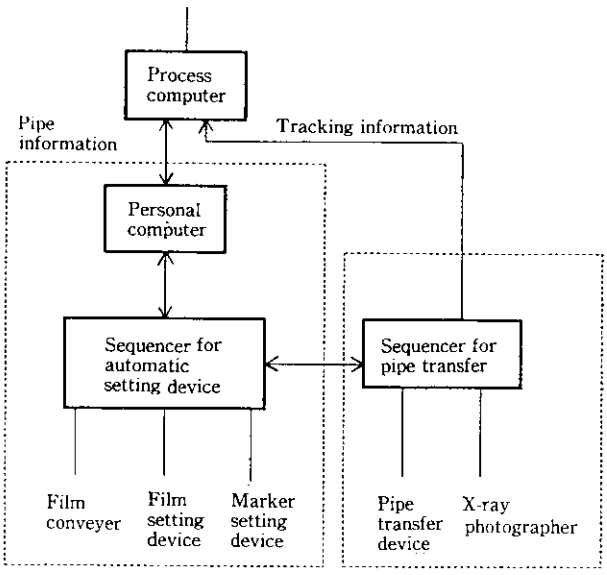

Fig. 2 Information flow

* Originally published in *Kawasaki Steel Giho*, 22(1990)4, 302-303

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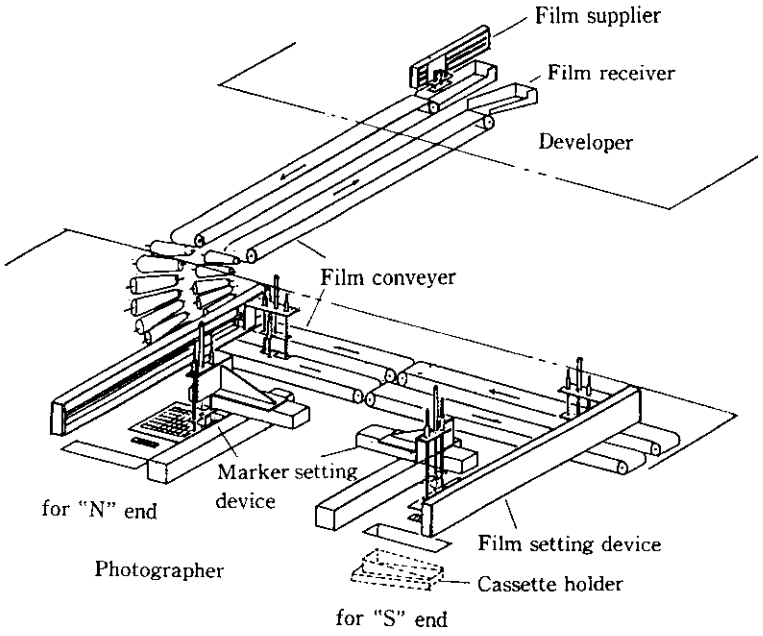

Fig. 3 Outline of automatic film and marker setting device

to the X-ray radiographing line, the pipe number concerned is transmitted by tracking information to the automatic setting device, and the markers shown in Fig. 1 are automatically set up in the marker holder. The marker holder and the X-ray film cassette are moved on to the cassette holder of the X-ray radiographic equipment. The pipe is stopped at the prescribed position, and after the welded bead is set just above the X-ray equipment line, the X-ray photographing unit is inserted into the pipe, thereby performing X-ray photography. After photographing is completed, the X-ray photographing unit returns to its position, and the X-ray film cassette and the marker holder are recovered. By returning the marker to its original position and by sending the cassette to the developing room, a series of operations is completed.

The film marker is made of the conventional X-ray non-penetrable material which has a size of 3 mm t × 7 mm × 12 mm and weighs 1 g and molded by plastics. An flexible cassette is used for the X-ray film cassette. In order to move these film-marker and film cassette, a vacuum pad and an elevating air cylinder using air pressure are used. For lateral movement, a high-accuracy servo-motor and a pulse-controlled moving device, which uses the precision ball screw, are employed in combination.

When the film size to be used is changed, the operator changes beforehand the film-stop position by the change-over switch installed on the conveyor. Film length can be adjusted in four types.

For information processing, the following units are used:

(1) UOE process control computer, TOSBAC 7/70E
(2) Transportation sequencer, MELSEC-310
(3) Information-relay personal computer, NEC PC9801
(4) Robot control sequencer, MELSEC-A2

3 Concluding Remarks

A world-unprecedented automatic X-ray radiographic system for UOE pipe ends was installed. The features of the equipment are as follows:

(1) Since marker setting such as pipe number and other identification mark can be automatically performed depending upon pipe tracking, human error cannot occur.
(2) Since the operator conducts the supply and recovery of film cassettes in the developing room, a series of photographing operations can be made full-automatically.

This equipment has been operating satisfactorily since its commissioning in April 1988.