FUNCTIONS OF OUR PLATE SCANNER "DEMIA" IN AUTO-PRESET INKING SYSTEM AND EXISTING STATE OF THE UTILIZATION IN JAPAN

Tsunehiko Imamoto*

Abstract: We have successfully developed, for the first time in the world, an auto-preset inking system for offset printing including the plate scanner (DEMIA).

The important factors for the development of the plate scanner include:
(1) Ability to measure accurately the image areas of various printing plates.
(2) Ability to produce, with simple operation, data for various types of printing presses.

For attaining these purposes, a light source and a sensor were selected from the spectroscopic characteristics, and with the optical structure appropriately conceived, the accuracy of within ±5% was achieved in measuring image area. Also, it has been made possible to store the data of 32 types of printing presses concerning the plate size and the number and pitches of the ink fountain keys, so the information of the image area correspond to a specific press can be produced with simple key operation.

A total of 90 sets of this system are now in operation as of the March 1983 (including 60 DEMIA's), thus contributing to a quick printing start and saving waste at the same time.

Introduction

In order to secure further growth of offset printing, major areas where more efforts must be made are:
(1) Shorter makeready time

---

*Engineering Research Laboratory
Dai Nippon Printing Co., Ltd.
Tokyo, JAPAN

(2) Lower wastage of paper
(3) Simpler press operation

Existing offset litho presses have been designed on the assumption that all press controls are done by manual operation of skilled press crew. Initial ink change, plate mounting and paper loading are easy operations but sheet size adjustment, inking adjustment and registering operations are the more complicated and thus skill-requiring operations. These operations are also time-consuming and waste-making process. Recent activities by press builders and users have been concentrated on improvements of those complicated processes.

Electronics technology in graphic arts fields was first introduced in the pre-press fields in 1950's and now becoming a powerful tool for automatic control of printing presses thanks to the development of application technology of microcomputers and sensing/analysing equipment. Presetting of various press functions can be made by digitising all information obtained through sensors and processing it by computers to output necessary data to set presses to any desirable operating conditions, which will result in shorter makeready time, lower wastage of printing materials, lower work load on press crew and more stable print quality. This type of system have long been desired by printing industry all over the world.

An unique auto-preset inking system for offset litho presses has been successfully developed against this background by Engineering Research Laboratory of Dai Nippon Printing Co. under the cooperation with Mitsubishi Heavy Industries Ltd.

Signification of auto-preset inking system

Traditionally, inking adjustment in the offset litho printing presses is one of the most complicated areas, requiring many years of expertise and skill for establishing optimum printing conditions. Press operators could easily spend five years struggling for obtaining proper skill for the inker control, which is due to the fact that there have been no means except crew expertise by which he can know exact amount of adjustment needed.

The necessary amount of ink for any particular print is determined by the size and density of image area on the printing plate. Press operators are supposed to examine the plate and adjust inking keys, determining by his experience how much ink will be needed for individual inker columns. An experienced press operator can easily spend approximately 20 minutes for inking adjustment and waste 1,000 impressions on a web press.

To overcome this problem, we have concentrated since 1979 on developing a system whereby inking adjustment can be fully automated. The cores of the developmental work were:

(1) Digitising the density distribution information of printing plates
(2) Calculation by computor software of amount of ink to be supplied
(3) Development of inking mechanism to allow precise presetting of ink key opening

To meet all these design parameters, latest technology of sensors and computors were utilised.

Various inking control systems have been already available in the market. However, most of them aim to maintain set printing conditions after it is established at optimum level through manual inking adjustment by press crews. Therefore, these systems do not meet our requirements, seeking for capability of presetting before the press is put into production run. Also the system utilised in newspaper production where screened positive film is scanned for obtaining density information can hardly be used in our publication and commercial fields because of the fact that several pieces of small positives are used to shoot printing plates by step and repeat process.

Under these circumstances, we have developed and released in February 1981 our first inker presetting system which can be used in the fields of magazine and commercial printing.

Composition of the system

The new auto-preset inking system is composed of following three components.

(1) A plate scanner to detect image areas on printing plates (DEMIA)
(2) Input and Output Desk for handling presetting data
(3) Divided inking key mechanism which is remotely controlled by digital data input

Figure 1 is a schematic drawing of the system.

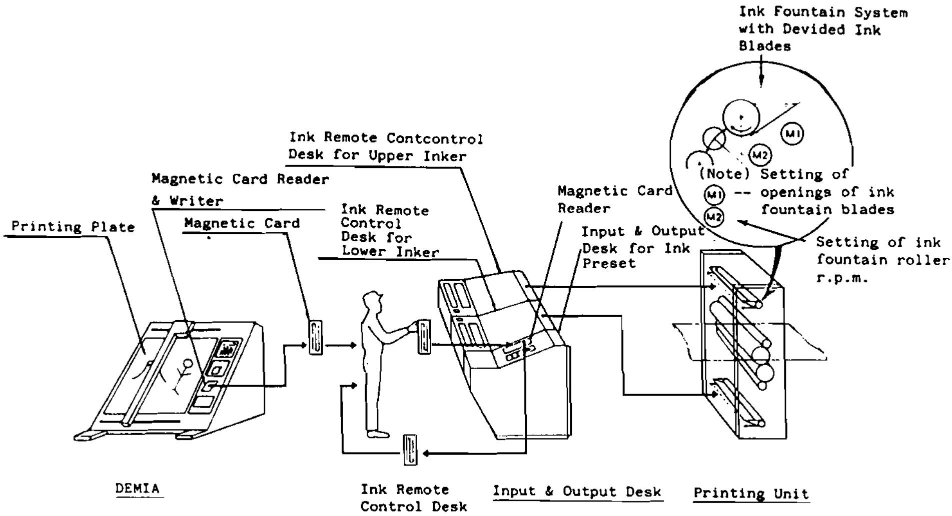

Figure 1. Auto-preset inking system

On DEMIA, density distribution of image area across the plates can be optically scanned and the information is recorded on a magnetic card. Then the card is inserted in Input and Output Desk for processing the information to work out proper amount of ink key openings across the web (sheet). Worked out data is then fed to printing presses to control individual ink keys. The newly developed inking keys are individually devided and allow completely independent control of the others in accordance with the input data of density distribution across the printing plates.

Some more detailed description of the system is as follows:

Plate Scanner (DEMIA)

DEMIA is the most important component of the system which collects and processes image information and outputs digital signals. The component which is equivalent to eyes of press operators is the first piece of equipment developed in the world.

Available already in the market is the system where a positive film is scanned to collect image information. However, disadvantages of the system are:

(1) A printing plate for publication and commercial printing is exposed with plural number of positive films in accordance paging plan. Accordingly, in scanning operation, the films must be laid out in accordance with paging plan. Also computor program must be made to process the information in accordance with page layout.
(2) Information from films may not be accurately reflecting image density information on printing plates because of dot gain in transferring images from films to plates.

These are the reasons why to plate scanner "DEMIA" (Device for Measuring an Image Area) has been developed. (Refer to Figure 2.)

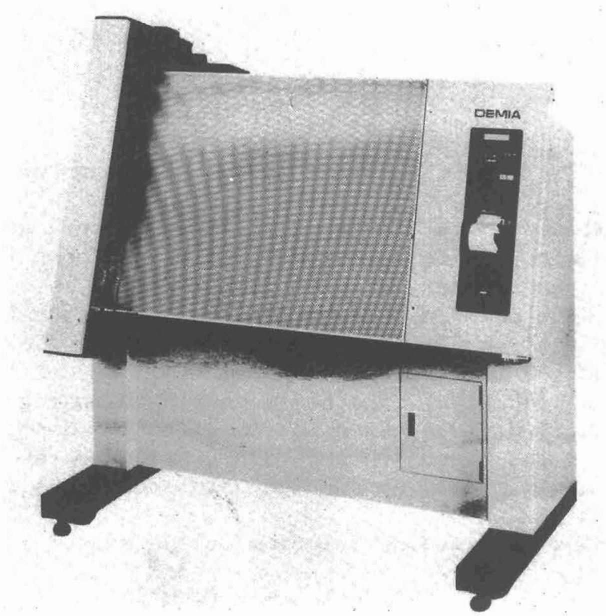

Figure 2. Plate scanner (DEMIA)

We are both a developer and a user of this system. In the course of development of DEMIA, we have emphasized the following two factors, taking the users' conditions into account:

(1) Ability to measure accurately the image areas of various printing plates.

(2) Ability to produce, with simple operation, data for various types of printing presses.

First, the former factor will be described.

The concept of detecting the image area from the printing plate is not new, but the technical difficulties as mentioned below hampered its practical application.

(1) The small contrast between the image and non-image areas
(2) The image areas include the coating unevenness of the photopolymer layer, and the non-image areas contain the grinding unevenness of grain and the thickness unevenness of the anode oxidization layer which cause a measurement error.
(3) The printing plate requires such post-treatments as burning and gumming after development, which may change the optical reflection characteristic of the printing plate.

In spite of these hardship, we have proceeded with the development of the apparatus on recognition that, as mentioned above, the printing plate as an object of measurement is an indispensable merit for practical application of the ink presetting system.

The measures taken against the technical problems of DEMIA in development are described below. The result was the achievement of the measurement accuracy of less than ±5%.

(1) Measure against reflection unevenness

The printing plate after exposure and development has a reflection unevenness at the photopolymer layer of the image areas and at the grain surface of aluminum of the non-image areas. Especially, the non-image areas are provided with a fine roughness for improving the hydrophile property, and when the reflectance is measured by use of light ray, the roughness of the detection area has a great effect if its area is too small. Thus the detection area for each sensor of the DEMIA is set to 10 mm x 20 mm, much larger than in the ordinary densitometer. Further, a method has been adopted in which measurements are made a multiplicity of times while moving the detection head to overlay the areas for determining an average value.

(2) Selection of light wavelength

It will be easily understood that with an increase of the contrast between the image areas and non-image areas, the measurement accuracy is more improved. It is therefore important to select a light source having such a wavelength as to increase the contrast. On the other hand, it is naturally necessary to avoid a wavelength which will damage the printing plate in spite of a short measurement time (for instance, the photosensitive wavelength less than 470 nm for positive PS plate). Most of the image areas of the PS plate in our country are blue or green in color and positive in type. For long run, the burning (heat treatment) is often effected, in which case the image areas change from green to brown.

Figure 3 shows an example of the spectral reflectance of the positive PS plate. It will be seen from this example that, regardless of the burning process, the contrast between image and non-image areas is obtained at about 600 nm in wavelength. This wavelength is safe against the positive PS plate, and DEMIA employs the peak wavelength of 600 nm as a light source. The spectral sensitivity of the light-receiving element corresponds to this wavelength.

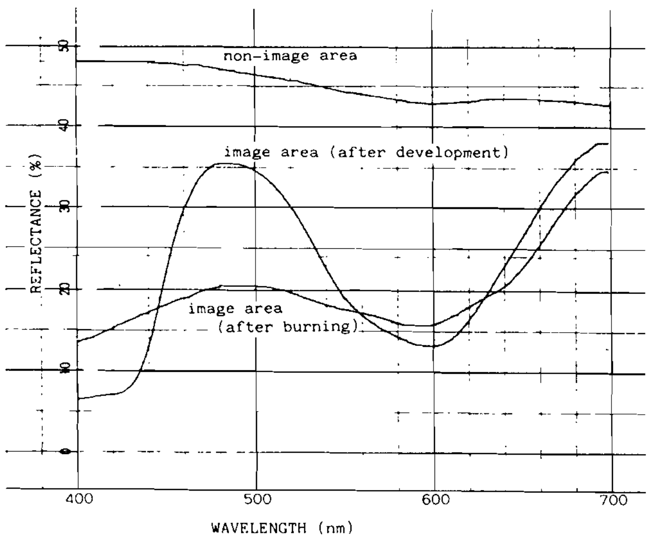

Figure 3. Spectral reflectance of the positive PS plate (Fuji FPS)

(3) Construction of optical system

Figure 4 shows a construction of the optical system of this apparatus. The relative positions of the component elements are determined in such a manner as to minimize the measurement error.

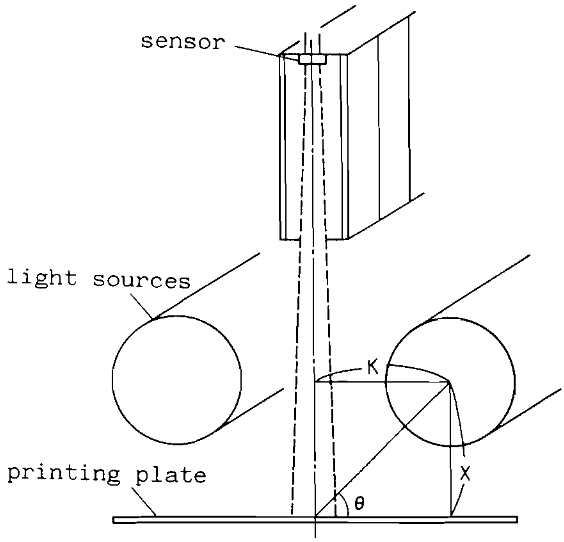

Figure 4. Construction of the optical system of DEMIA

The printing plate to be measured is secured fixedly by being attracted to a vacuum bed for securing the flatness thereof. The printing plate subjected to the burning process, however, develops a thermal distortion and the resulting corrugation is likely to cause a detection error.

Factors which may cause a non-flatness of the printing plate probably leading to a measurement error are dual. One is the illuminance change of the light-receiving surface of the printing plate which is caused by the change of the distance with the light source when the printing plate is raised from the vacuum bed. The other is the illuminance change caused by the tilting of the light-receiving surface which in turn is attributable to the corrugation.

First, description will be made about structural measures to be taken against the change of distance. When the light source is in spot form, the illuminance is inversely proportional to the square of the distance. In the case where the light source is linear and is considered to be a linear concentration of spot light sources, by contrast, the illumination on a certain surface is obtained by integration as a total of the contributions of all the spot light sources radiated on the particular surface. Thus such a linear light source results in the illumination inversely proportional to the first power of the distance from the light source. The illuminance at the center of the detection area, due to the angle θ between the center of the light source and the printing plate as shown in Figure 4, is proportional to sinθ. The relation between these two facts shows that the illuminance of the detection surface is a function of the distance X from the light source and is given as

$$I(x) = A \cdot \frac{X}{K^2 + X^2}$$

where K represents a half of the distance between the two light sources and A a proportionality constant.

The relation of this equation is illustrated in Figure 5. As seen from this graph, the illuminance I(x) has a maximum value at X = K, which means that the illuminance changes little with the change of distance between the printing plate and the light source. In DEMIA, therefore, the value X is set to K, namely, θ = 45 degrees.

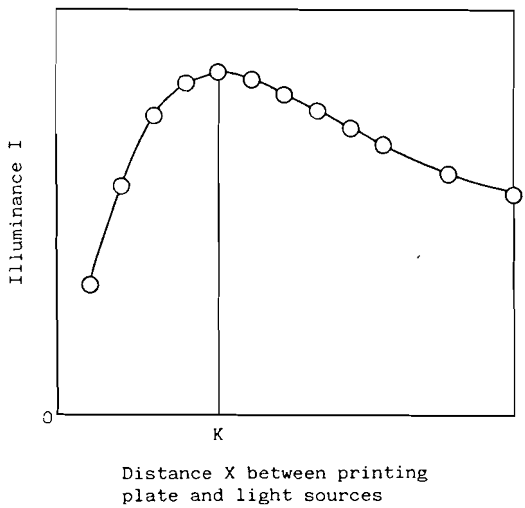

Figure 5. Relation between distance and illuminance

Now, measures against the tilting of the light-receiving surface due to the corrugation of the printing plate will be explained. This is accomplished by a simple method as shown in Figure 4 in which a pair of light sources are arranged symmetrically with respect to the detection area therebetween. In this way, the illuminance change caused by the tilting of the printing plate at the detection area is offset by the two light sources.

(4) Compensation for different types of printing plate

Different types of printing plate have completely different grained conditions of the non-image as well as image areas. Also, as mentioned above, the reflectance depends to a large measure on the burning or gumming after development.

To cope with this variation, the printing plate to be measured by DEMIA is provided with a solid mark called the calibration mark on the gripper side or the opposite side of the plate. Each time of measurement, the reflectance of the image area (100%) and the non-image area (0%) of the printing plate is recognized, so that the area factor of the picture image to be printed is computed on the basis of the value thus obtained.

The second theme of the development of DEMIA, that is the ability to produce with simple operation data for various types of printing presses will be described below.

Generally, a printing company is equipped with printing presses of various makers and sizes. These printing presses are also desirably supplied with data necessary for ink presetting. Specifically, a measure must be taken to meet the following two conditions:

(1) Dimensional specification of printing presses: Compensation for the difference of the size and shape of the printing plates, and the number and pitch of the ink fountain.

(2) Performance of printing presses: For a new printing press, in which the key of the ink fountain is capable of being automatically set by an input from a memory medium, a measure must be taken against the difference of the medium or data format among the printing press makers. Further, adaptation to a printing press of manual set type is necessary.

First, the difference of size and specification of the printing presses is compensated as described below.

Printing plates are measurable in a wide range from a minimum of 500 x 645 mm to a maximum of 1200 x 1400 mm, and for this purpose, the vacuum area of the vacuum bed for fixing the printing plate is adapted to be automatically changed to make effective fixing possible. Further, a teaching function is provided for storing individual data on 32 printing presses in advance. More specifically, at the time of installation, the press number of the printing press of the plant involved is registered while at the same time storing such individual data as the size and effective printing size of the printing plate and the number and pitch of the ink fountain in the memory of the built-in microcomputor. In actual measurement, the area factor completely corresponding to the size and specification of the printing press is produced simply by entering the press number of the printing press and the color of the printing ink on the keyboard.

The measure taken against the different functions of the printing presses are described below.

Although we have developed an ink preset system including the printing press, the data produced from DEMIA is limited to the image area factor and the conversion to the opening data of the ink fountain key of the printing press is left to the input and output desk for handling the presetting data on the printing press side. This is based on the concept that in consideration of the adaptation to a new printing press of other printing press makers, a limitation to the primary data of basic importance is necessary. On the other hand, outputs are available by a magnetic card for automatic preset and in paper printouts in the form of numerals and bar graphs of area factor. The outputs are thus recognizable visually and helpful for manual preset. An example of paper printouts is shown in Figure 6.

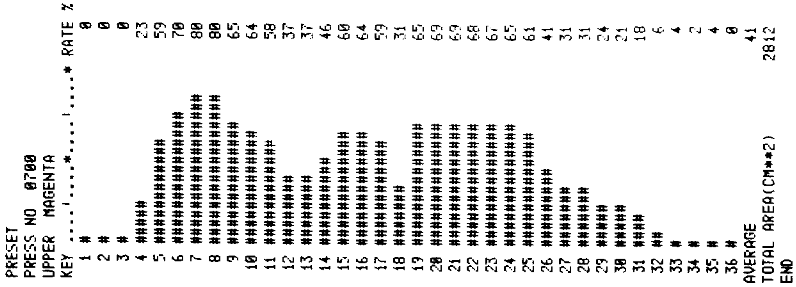

Figure 6. Example of paper printouts

Actual scanning operation can be done quite simply: Mount the plate to be scanned on DEMIA. Input through key board press no., color and upper plate or lower plate in case of web press. This is all what an operator must do. The system automatically scans the plate and outputs in about 10 seconds the data for controlling individual ink keys.

Input and Output Desk

This equipment is normally positioned at control desk of printing press. It reads out the data contained in a magnetic card and processes the data to output signals to determine proper opening of ink keys and revolution of ink fountain roller of printing press. (Refer to Figure 7.)

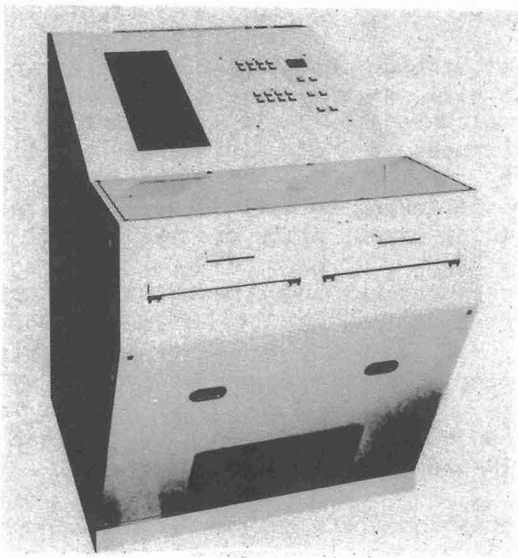

Figure 7. Input and output desk

This component of the system is equivalent to the brain of press operators, converting data from printing plates to the amount of opening of ink keys. The conversion curve is established by ink roller arrangement, plate characteristics as well as influence of dampening solution and paper. In other words the calibration curve is a function of theoretical analysis and field testing of characters of individual model of printing presses.

Operation of this equipment is very simple. The operator is supposed only to insert the magnetic cards for individual colors (inking unit) when the data input is done for all colors, push "start" button. The system automatically checks the data input procedures and starts the presetting operation of individual keys.

In case a repeater print is expected in the future, the operating conditions are stored all together in one new magnetic card for future automatic presetting of all keys on all printing units.

Devided inking key mechanism

Devided Inking Key Mechanism is able to supply accurate amount of ink onto the fountain rollers through automatic fine adjustment of ink keys in accordance with data obtained on DEMIA and processed on Input and Output Desk.

A note must be made that inking key mechanism of single blade design will not show 1 to 1 ratio between key openings and actual thickness of ink film on fountain rollers, because ink film thickness at a certain ink key position could be influenced by opening degree of neighboring keys. Even with the auto-preset inking system, presses of single blade inking mechanism will thus not allow precise control of inking.

On newspaper presses, adjustment of ink supply pump (stroke of plunger pump) allows ink supply control for individual ink key columns. However, in offset litho printing where inks of heavier viscosity is employed, such system cannot be utilized. We were obliged to design special ink key mechanism which can be used with offset ink and can be digitally controlled in use with presetting system.

The new mechanism (ref. Figure 8.) has been worked out after the analysis of fluid characteristics of offset ink, rigidity of blade materials, possible ink leak from sliding components, etc. The piano-key type mechanism employed in the system allows fairly accurate control of plus or minus 2 - 3 microns to any present value.

Opening of all keys are detected by potentiometers and displayed by 50 step L.E.D. One step of L.E.D. positions is equivalent to ink film thickness of 5 microns on fountain roller, which has turned to be the minimum detectable difference of density by human eyes. Internal control in the system is made in terms of 100 steps, i.e. 2.5 microns.

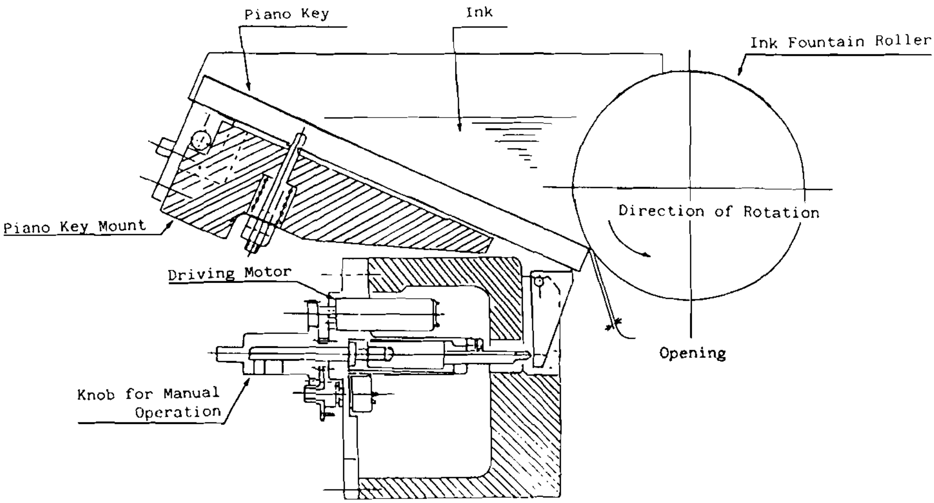

Figure 8. Devided inking key mechanism

Results of field-test and existing state of the utilization

The ink presetting system has already been in operation at Dai Nippon plants mounted on 4/4 color MITSUBISHI web press. Further, we have planned to incorporate the system onto other maker's presses, wherever possible.

By use of this system, ink adjustment operations can be automatically completed within 1 - 2 minutes after the magnetic cards are inserted. After a few impressions for "fine tuning", the press is completely ready for producing saleable sheets.

Average waste has been approx. 1,000 impressions. The new system has made it possible to reduce it way down to 100 impressions.

Another advantage of utilizing this system is that the print quality can be very stable regardless who uses the system and operates printing presses. High production web presses can attain its top performance without wasting too much time waiting for skilled operators.

The great advantage of this system is now recognized and the present trend is more and more toward the manual preset according to the printout data from DEMIA with a scale inscribed on the ink fountain key even for the printing press of manual adjusting type.

90 sets of this system in combination with 60 DEMIAs are now in operation in Japan as of March 1983. According to news after DRUPA '82, numerous similar systems have been placed on the market or released, making this system an established fact in the printing technology.

Under these circumstances, the printing plate makers are required to tackle a new technical development problem of improving a printing plate having a plate scanner adaptability in addition to the technical effort concentrated on the printability and plate making.

Computor control of printing presses has set a milestone by the development of the new auto-preset inking system. We believe more of computor technology will be incorporated in the future presses, reducing dependency on human labor and enhancing productivity of printing operations, which will surely open up a new horizon for the printing industry.

Acknowledgements

In developing the auto-preset inking system, Dai Nippon Printing Co., Ltd., owes a great deal to the engineering staff of Mihara Plant, Mitsubishi Heavy Industries, Ltd. Thanks are herein expressed for their ingenous cooperation.