Instruction Manual for Fuji Film Densitometer FPD301 and Printer FPD303

TS-SSC 91-133
S. Delchamps
July 1, 1991

On June 25, 1991 I received a faximile of a Fuji film instruction manual printed in English from G.T. Technologies. Here are listed some salient points of Fuji film use which I learned from this fax.

1) The type of film we have is called "mono-sheet." It consists of a layer of polyester with a developer coating and a layer of colorant capsules. The overall thickness of the film is about 6 mils.

2) Higher temperatures and humidities make the developed color darker, so that TEMPERATURE and HUMIDITY must be recorded at the time of exposure.

3) The developed film will grow darker with time, so that a systematic error of unknown magnitude is introduced depending on how long after exposure to pressure.the film is anlayzed. RECORD THE DATE AND TIME OF EXPOSURE WHEN USING.

4) The active area of the FPD301 densitometer is a circle with diameter 2mm.

5) Each exposure of the FPD301 gives the average of 4 readings over 0.6 seconds/

6) The FPD303 will process up to 5 consecutive FPD301 readings, so that the average of 5 x 4 = 20 are available.

7) THE FILM IS TO BE READ FROM THE POLYESTER ("PET") SIDE, WITH A WHITE SHEET UNDERNEATH.

8) **SETTINGS FOR FPD303: When the 303 asks for film "type" used MS-H for "medium" pressure range film and HS-H for "high" pressure range film.**

FACSIMILE MESSAGE NO:

TO: STEVE DELCHAMPS FERMILAB 708-840-3756	FROM G.T. (313) 358-1030 FAX (313) 358-1037 NAME: DONNA PODKUL DATE: JUNE 25, 1991 NO. OF PAGES: 7 This page included
CC:	FILE CODE: FUJI F/U DATE :

SUBJECT: FUJI PRESCALE FILM

MESSAGE: FOLLOWING YOU WILL FIND THE FUJI USER'S HANDBOOK. THERE IS ALSO AN OWNER'S MANUAL IN ENGLISH SPECIFICALLY WRITTEN FOR THE FPD-303; UNFORTUNATELY, AS WE DISCUSSED, IT WILL NOT BE AVAILABLE TO US UNTIL MONDAY, JULY 1ST, AT WHICH TIME WE WOULD HAPPILY FORWARD A COPY TO YOU IF SO DESIRED.

MOST IMPORTANTLY, WE HAVE CONTACTED ONE OF OUR ENGINEERS AND HE CONFIRMED THAT THE "S" DESIGNATION IS FOR MOMENTARY PRESSURE AND THE "H" DESIGNATION IS FOR CONTINUOUS.

WE WOULD LIKE TO DISCUSS WITH YOU THE POSSIBILITY OF SUPPLYING YOUR FUTURE FILM NEEDS AND ANY TECHNICAL ASSISTANCE YOU MAY REQUIRE. PLEASE CONTACT US AT YOUR CONVENIENCE.

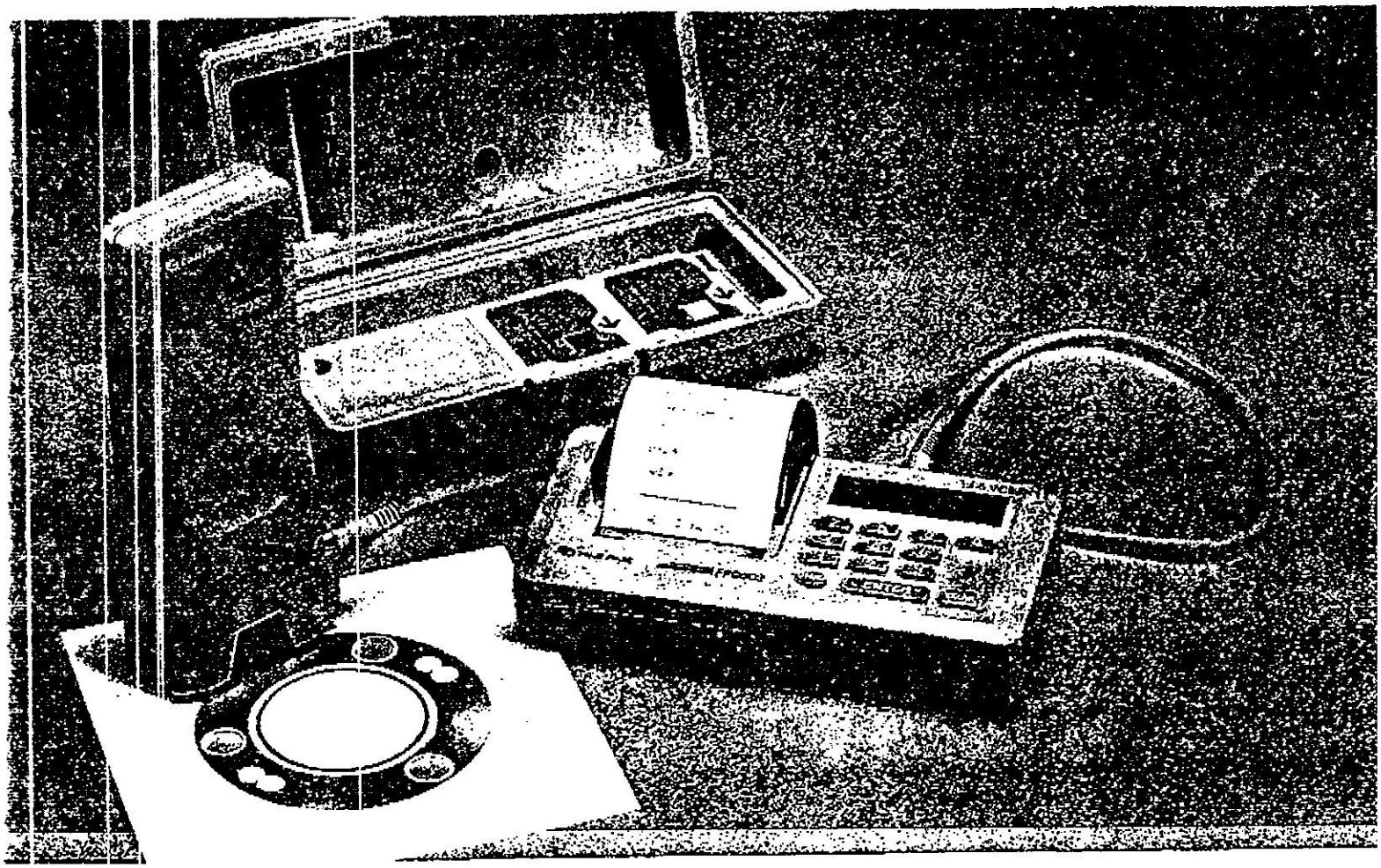
BEST REGARDS,
DONNA PODKUL
GTC

JAN 25 '91 13:10 STC

FUJI FILM PRESCALE

Pressure Measuring System

USER'S HANDBOOK



NEW TYPE

PRESSURE MEASURING FILM "FUJI PRESCALE FILM"

PRESSURE MEASURING FILM "FUJI PRESCALE FILM"

Tomoaki Komatsu (FUJI PHOTO FILM CO., LTD.)

PRESSURE MEASURING FILM "FUJI PRESCALE FILM"

The "FUJI PRESCALE FILM" is a pressure measuring film developed on the principle that the microcapsule containing color formers is destructed as the pressure is applied and that the colorless and transparent specific dye contained is absorbed into colourants and then reacts to red colors. The "FUJI PRESCALE FILM", which was first introduced to the market in 1977, has been improved entirely newly. Explanation will be made on its structure, features, measuring method and usages.

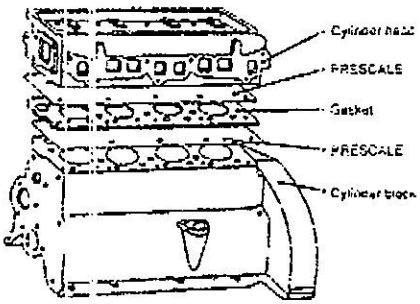
1. Introduction

PRESCALE FILM is a pressure measuring film developed by Fuji Film by fully employing its thin-layer coating and micro capsule technologies in order to satisfy the needs of many industrial fields. It is, at present, contributing greatly to improving the quality, increasing the productivity, reducing the cost of mass-production items, as well as in troubleshooting and cause analyzing for problems during production process, in a wide range of industrial fields.

For example, PRESCALE FILM has been used since immediately after sales start in April, 1977 for measurement of the pressure distribution and pressure values at the time of cylinder gasket tightening on an automobile engine and it is evaluated highly. The gasket has the mission of completely separating the fuel gas in the engine, cooling water and lubrication oil without leakage and for this reason, the face pressure is an extremely important element. In the past, some part of the pressure could not be expressed numerically, but PRESCALE FILM enables the user to quantitatively measure the pressure, brining in a great effect in the quality stabilization. Accordingly, PRESCALE FILM was adopted as a device for the performance test of "cylinder head gasket for automobile engine" of JIS D3105, dated March 1, 1979.

Under such circumstances of expansion in the application of PRESCALE FILM, we have improved the PRESCALE FILM in all aspects and the new PRESCALE FILM is explained in this brochure.

Fig. 1 Application of PRESCALE FILM to cylinder gasket



8.3 Measurement method Note (2) and (3) of JIS D3105 "Cylinder head gasket for automobile engine"

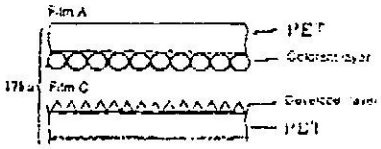
2. Structure

The new PRESCALE FILM is available in two types in the structure: one is "Two-sheet type" and the other is "Single-sheet type". (what we have)

2.1 Two-sheet type

In this type, Film A, which is made of a PET (Polyester) film coated with micro-capsule containing coloant, and Film C, which is coated with a developer, are used at the same time with the coated sides facing each other.

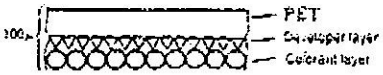
Fig. 2 Structure of two-sheet type PRESCALE FILM



2.2 Mono-sheet type

In this type, a PET film is coated with a developer and a micro-capsule containing coloant is coated over the developer layer.

Fig. 3 Structure of mono-sheet type



3. Principle

The micro-capsules in the colorant layer are destructed in the degree of the pressure applied, the colorless transparent leuco dye contained in the micro-capsule is adsorbed to the developer and a chemical reaction takes place resulting in a red color.

Since the micro-capsules that contain the colorant are adjusted to a variety of strength and the red color density varies by the pressure applied.

4. Performance

Care must be taken on the following points since the PRESCALE FILM film changes by the pressure condition.

4.1 Temperature dependence

The temperature range in which PRESCALE FILM can be used is 5 to 35°C. The higher the temperature, the easier the micro-capsules are destructed, making the red density higher. ✓

Higher T → darker color

4.2 Humidity dependence

The range of relative humidity in which PRESCALE FILM can be used is 20 to 90% RH. The higher the relative humidity, the easier the adsorption of the colorant to the developer, making the red density higher.

higher humidity → darker color

4.3 Pressing speed dependence

PRESCALE FILM is capable of sensing a pressing speed as high as 1/100,000 second. The higher the pressing speed, the higher the red density.

4.4 Measuring pressure and others

The maximum pressure value is kept on the record and intermediate values cannot be measured.

The red density value slightly increases as the time goes by after the color development and it is preferable that the density is measured after elapse of a certain time. darker w/ time

The measuring precision error is within ±10% of the value measured with the PRESCALE densitometer.

± 10% intrinsic error

5. Types of PRESCALE

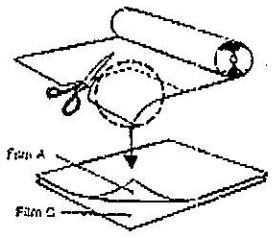
There are four types in PRESCALE FILM as shown in the table below; super-low pressure, low pressure, medium pressure and high pressure.

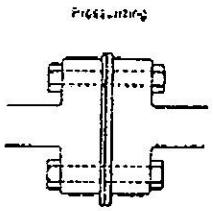
6. Use Method of PRESCALE FILM

(1) Cut PRESCALE FILM to a size necessary for the measurement.
(2) Set Film A and Film C that have been cut with the coated sides facing each other.
(3) Insert the set of Film A and Film C into the measuring position and apply pressure.
(4) Take out the film set. The color density on Film C shows the pressure distribution.

Fig. 4 PRESCALE use procedure

Cut the film and make a set of Film A and Film C.





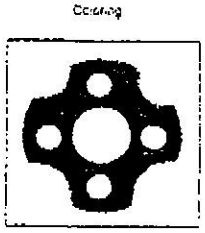


Table of PRESCALE types

Pressure grade	Code	Applicable pressure range	Available size	Thickness
Super-low pressure	LLW	5 – 25 kgf/cm²	270 mm(W) × 5 m(L)	Two-sheet type
Low pressure	LW	25 – 100 kgf/cm²	270 mm(W) × 10 m(L)	
Medium pressure	MW	100 – 500 kgf/cm²	270 mm(W) × 10 m(L)	
High pressure	HS	500 – 1300 kgf/cm²	270 mm(W) × 10 m(L)	Mono-sheet type

7. Determination of Pressure Value (Measuring method)

Either one of the following four methods can be used to determine the pressure distribution and pressure value.

7.1 Using PRESCALE FILM only

Since the red color density varies by the pressure applied, the state of pressure distribution is known immediately from the look of colored film. The darker part shows that the pressure is high and the lighter part shows that the pressure is low.

7.2 Combined use of PRESCALE and standard chart

To know the pressure value approximately, in addition to the pressure distribution, visually compare the red density on the colored PRESCALE FILM with the standard color samples provided with the manual.

Also, use the standard chart in which the temperature and relative humidity ranges of 5 to 35°C and 20 to 90% RH are divided into four zones of A through D and the representative pressure-temperature- and humidity characteristic curve in each zone is shown to know the approximate pressure value.

7.3 Combined use of PRESCALE FILM, Prescale Densitometer FPD-301 and standard chart

To know the pressure value more exactly, measure the red density on PRESCALE FILM using PRESCALE Densitometer FPD-301 and compare the obtained value with the standard chart.

7.4 Combined use of PRESCALE FILM, Prescale Densitometer FPD-301 and pressure converter FPD-303

Connect FPD-301 and FPD-303 and contact the special densitometer with PRESCALE FILM at the position to measure the pressure value and press the measurement switch. The pressure value is automatically printed out.

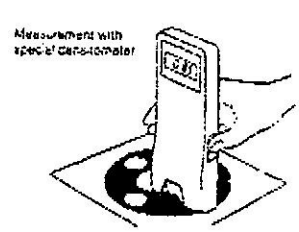
8. Prescale Densitometer FPD-301

The FPD-301 Prescale Densitometer is a reflection densitometer which digitally shows the density values of pressure distribution expressed in light and dark red colors on PRESCALE.

It has the following major features.

(1) It measures the density four times during 0.6 seconds of lamp lighting and digitally shows the mean value. An optical battery is used for the light receiving element and a 3 V small lamp is used for the light source.
(2) It has a built-in automatic compensator for low density and high density and the zero point adjustment is easy.
(3) Since the measurement area is 2 mmφ, even a narrow part can be measured. 2mmφ
(4) The measuring density range is from 0.01 to 2.0 and the measuring accuracy is ±0.02 or less.
(5) The vertical lighting system adopted minimizes the error caused by the gloss of the surface measured.

The outer dimensions of the main body is 165 mm in the height, 65 mm in the width and 35 mm in the depth. The case outer dimensions are 185 mm in the height, 85 mm in the width and 50 mm in the depth. The weight of main body is 260 g (including four LR6 batteries).



9. Pressure Converter FPD-303

The FPD303 pressure converter quickly converts the density value measured by FPD-301 to a pressure value with built-in microcomputer.
The major features are as follows.

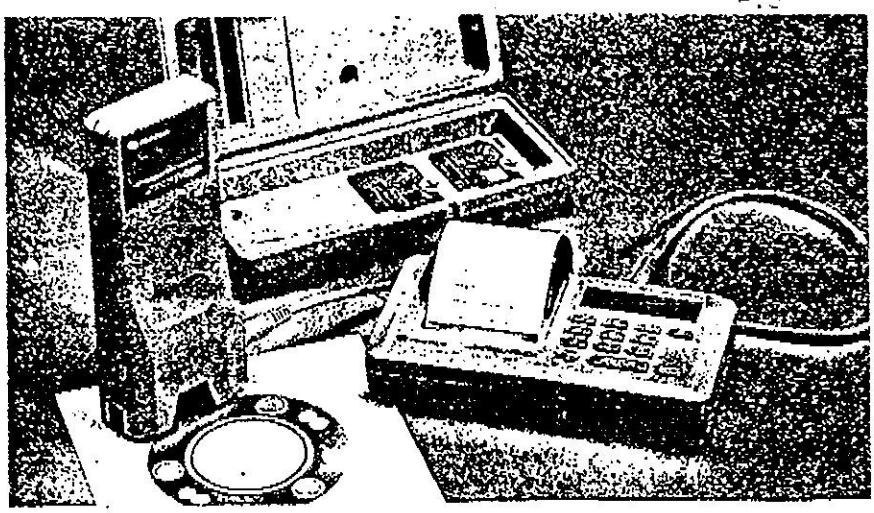
(1) The temperature, humidity, PRESCALE FILM type, conditions of pressing and measurement count can be memorize in a program. When a measurement condition is incorrectly set, an alarm sounds and the set values are automatically cancelled to the initial set values.
(2) It records the maximum and minimum values for each measurement count set. At the same time of display, it calculates and displays the mean value. The mean value can also be printed out.
(3) It has a built-in thermal printer.
(4) Since it has a built-in automatic compensation circuit of the printing character density which is activated by a change of the temperature or decrease of the supply voltage, the printing quality is kept at a certain level.
(5) Since either AC or DC can be used, FPD-303 can be used in any place and it is designed for low energy consumption.
(6) It has a built-in battery check facility. When the battery voltage decreases, a liquid-crystal display and alarm are automatically output and the measurement stops.

10. Cautionary Remarks

10.1 Cautionary remarks on use

(1) Film A is very sensitive to even slight pressure. Do not press of rub it before the use.
(2) If water, oil or solvent sticks to the chemical coated surface, the coloring is not exact. Therefore, sufficiently clean the place to measure beforehand.
(3) Pay attention not to have Film A and Film C rub each other and color develop. On measurement in which sliding force may be applied, use and edge stopper.
(4) Once used, the PRESCALE film cannot be reused.
(5) Since it reacts to light, preserve PRESCALE FILM in a dark place.

light - sensitive



Special densitometer FPD-301 (Left) and pressure converter FPD-303 (Right)

10.2 Cautionary remarks on measurement

(1) Select the standard chart for either continuous pressing or momentary pressing, matching with the pressing condition.
(2) Check the classification of the temperature and humidity conditions at the time of pressing.
(3) When FPD-301 is used, lay a white sheet of 0.01 or lower density value under Film C with developed red color.
(4) Be sure to place Film C with the chemical coated side facing down and measure the density from the PET base side.

10.3 Cautionary remarks on storing

Pay attention to the following points when storing unused PRESCALE FILM and Film C that has been colored.

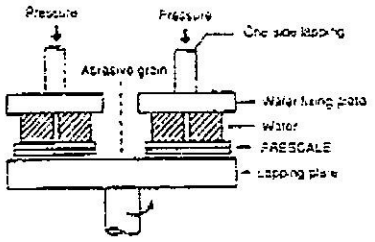
(1) Do not store them in a place of direct sunshine or near fire.
(2) Do not let them contact the following matters.
  1) Diazo copying paper and carbon back paper
  2) Water, oil, solvent and chemical
  3) Vinyl product, cellophane tape and rubber product
  4) Any matter written with indelible ink
(3) Place unused film in the original polyethylene bag and keep the polyethylene bag in a case.
(4) Do not set two colored Film C sheets with the colored sides facing each other and store them in a vinyl bag.
(5) Since the single-sheet type film develops the color by itself, pay attention not to apply any pressure while it is stored.

no sheet

11. Application Examples

11.1 Thick IC

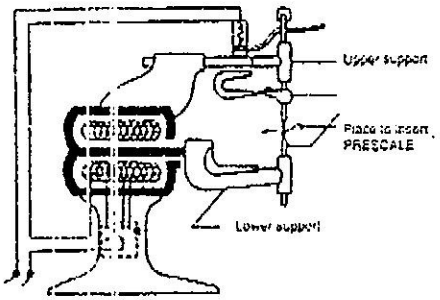
It is said that checking and correction of the squeegee pressure applied at the time of thick IC screen printing are the most important points on the quality control. When PRESCALE FILM is used for the checking and correction, the pressure balance in the front-rear and left-right directions of the squeegee is instantaneously known. Also, with PRESCALE FILM, changes of the paste viscosity and pressure changes caused by squeegee rubber swelling, both of which occur during printing a large amount, can be periodically checked.



11.2 Automatic packing machine

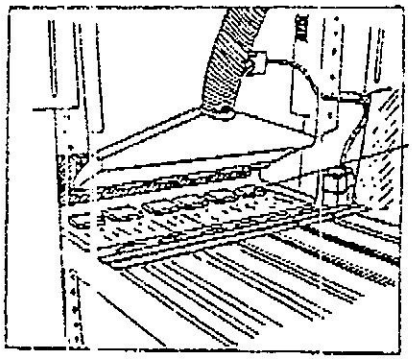
The seal pressure and parallelism (pressure distribution) of a foodstuff or chemical automatic packing machine is determined after looking at the product. If PRESCALE FILM is inserted, the pressure value and parallelism is known instantaneously. On the pressure which is one of the three major elements in seal-

used for control of the pressing force, which is one of the three major elements (current, conducting time and pressing force) of resistance welding, the pressing force and parallelism can be known concurrently. Especially, PRESCALE FILM is extremely useful for electrode plate check on multi-spot or seam welding.



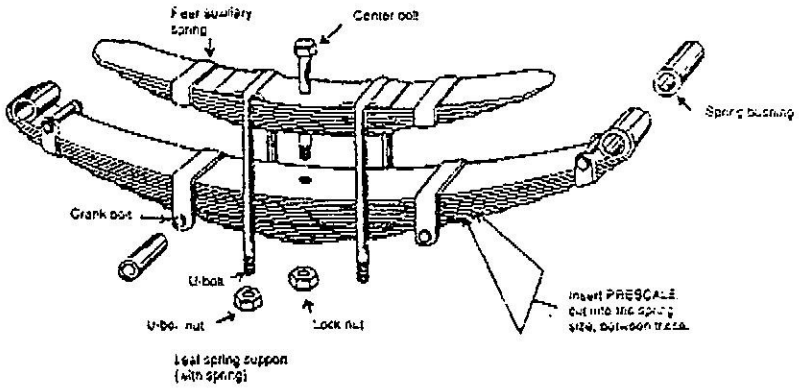
11.12 Press

The pressure distribution is shown immediately when PRESCALE FILM is inserted between press plates. Use of FPD-301 provides an exact pressure value. The total load can be easily calculated by multiplying the press area by the pressure value.



11.13 Spring set design

Just insert PRESCALE FILM between leaf springs. The pressure value and pressure distribution at the contacting part are immediately known. Because of this a spring set having uniform contact and good cushion performance can be designed.

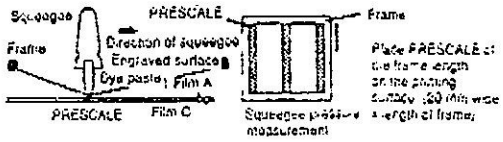


11.14 Tightening of various objective

The influence caused by flange deformation, lubrication state of bolt and nut, material of the bolt and nut, tightening sequence, tentative tightening, final tightening or tool can be checked with PRESCALE FILM.

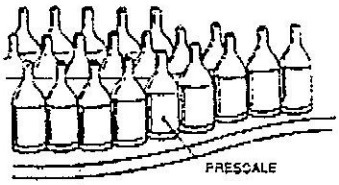
11.15 Dyeing

The mangle roller pressure at the time of continuous dyeing can be easily checked and corrected with PRESCALE FILM. This makes equalization of balance between the left and right sides of mangle rollers and discovery of uneven wear of the rollers easy, enabling the operator to check the rollers periodically.

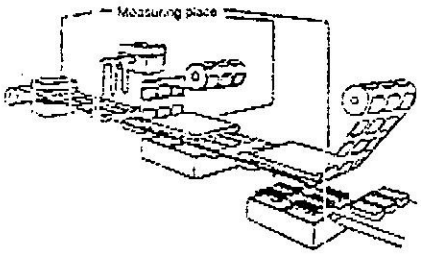


11.16 Contacting pressure between bottles

When PRESCALE FILM is used, empty bottles can be placed on a belt conveyor and automatically filled in, pasted with the label and the contacting pressure between bottles at the cap placement process can be checked. This helps preventing the bottles from bursting or cracking.

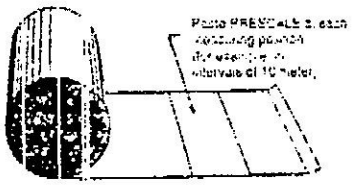


ing, that is, temperature, time and pressure, use of PRESCALE FILM enables the user to do the numerical control and this is very helpful in the quality control.



11.3 Steel plate

Measurement of appropriate rolling tension of a steel plate has been difficult and in many cases, the tension and speed have been determined based on the experience and the rolled result is poor sometimes with the central part swelling up. If the PRESCALE FILM sheets are inserted in a rolling steel sheet and taken out later, the pressure distribution can be observed quickly. The speed adjustment and tension adjustment can be standardized numerically using thus obtained data and this will reduce the finish loss and equalize the steel plate rolling coil



11.4 Screen printing

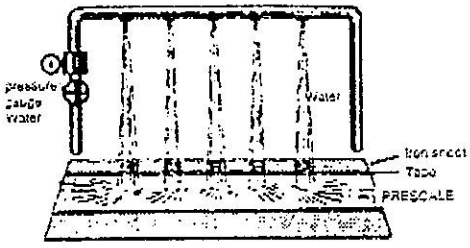
Checking and correction of the squeegee pressure for continuous screen printing greatly influence the degree of uniform dyeing and adjustment of the adequate dyeing paste amount. When PRESCALE FILM is used for the checking and correction, the pressure balance of squeegee in the forward-rear and left-right directions is known immediately, facilitating the squeegee pressure adjustment and uniform polishing of the squeegee.

11.5 Tile products

Since wall and floor tiles are made through a baking process, the product size is smaller than that of moulding. How small it becomes depends on the moisture content and filling density of the soil and the key point to obtain an exact square tile is the uniformity of filling density. In the past, the filling density was controlled based on the experience and intuition. If, however, PRESCALE FILM is used, the uniformity of filling density can be easily checked with color lightness and darkness, and the dimensional accuracy of tiles can be increased.

11.6 Ingot rolling

When an ingot is rolled, there is a process in which the iron oxide is removed by water pressure. Conventionally, this water pressure is adjusted using a water pressure gauge attached to the valve but the water pressure that is actually applied to the ingot from the nozzle and pressure distribution have been unable to measure. When the machine temperature decreases somewhat while the machine is stopping, PRESCALE FILM wrapped by a poly film can be pasted to the iron sheet. When the water is jetted out from the nozzle, the pasted PRESCALE FILM is colored to red by the water pressure, indicating the water pressure and its distribution. The water pressure can be adequately adjusted based on the red color development, thus enabling the operator to completely remove the iron oxide.



11.7 IC package

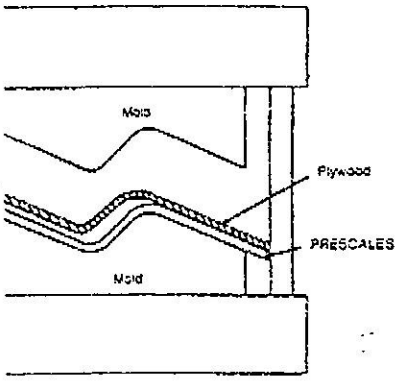
It is said that the most important point for increase of the yield at the time of starting IC packaging with mold is the checking of the mold contact. In the past, the method applied is use of the actual products several times or carbon paper. If the products are used, a loss in the unit of 100 IC pieces occurs and, if carbon paper is used, the strength of contact is not too clear. Since the tendency of burr generation is expressed in lightness or darkness of the developed color when PRESCALE FILM is used, the check and correction can be completed in a short time.

11.8 Lathe cutting

The tightening pressure of the chuck generates a dimensional error or danger in the work because of uneven wearing of nib or aiming of the parallelism, resulting in a defective product. If PRESCALE FILM is used and the chucking pressure is periodically measured, the nib can be completely adjusted and the product can be made in stabilized quality.

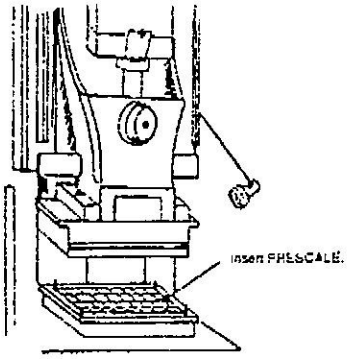
11.9 Manufacture of music instruments and furniture

Whether or not the mold is good greatly influences the bonding quality of the bonding curved parts. In the past, the bonding state is checked based on the experience and intuition. However, if PRESCALE FILM is pressed together with the bonding material, the pressure distribution in the whole surface of the bonding part and the pressure value are known and this facilitates determining whether or not the mould is good and increases the product reliability. On the roller pressing or curved surface, the roller pressure can be easily measured with PRESCALE FILM and the set change time can be substantially shortened.



11.10 Printed circuit board

Often the uniform pressure or pressing ability cannot be grasped in blanking (mainly compound mold) of circuit boards. However, if the blanking is done together with PRESCALE FILM, the pressure distribution and capacity of the press machine can be easily known. When PRESCALE FILM is used for checking, unevenly applied pressure can be immediately corrected, ensuring stabilized production, as well as extending the service life of the mold and reducing the production cost.



11.11 Welding

In spot welding, projection welding or seam welding, if PRESCALE FILM is