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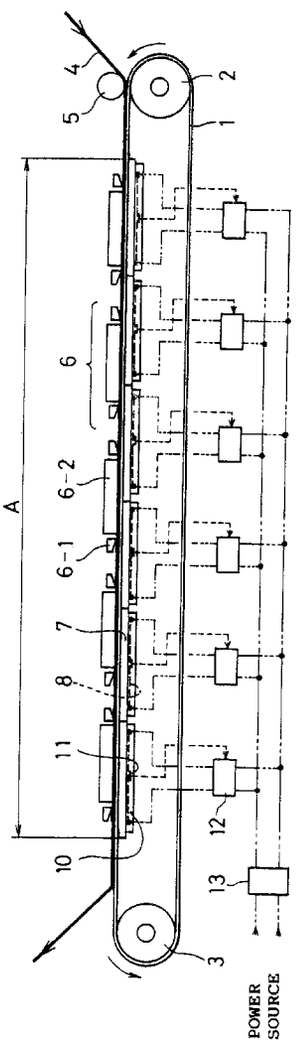
(54) Automatic screen printing machine and printing method.

(57) A heating device in which a printing table (7) is homogeneously and uniformly heated to use it as a hot table, and an endless belt (1) is heated using the heat conducted therefrom, in order to produce printed products of improved quality preventing the color pastes from oozing out and colors from being mixed together and yet increasing the degree of color value, without permitting the automatic screen printing machine to become bulky or elongated. In an automatic screen printing machine in which a number of printing units (6) each consisting of a pair of a screen (6-1) and a squeeze (6-2) are arranged on a frame, and the printing operation is carried out by sticking a fabric (4) to be printed onto an endless belt and intermittently conveying the endless belt, a heating device of the automatic screen printing machine comprising a table which is divided into units maintaining a distance in a direction in which the endless belt travels and of which the upper surfaces work to support the endless belt, planar heating elements (8) provided in the form of units for each of the table units, temperature sensors (9) provided for each of the planar heating elements to detect the temperature of the table units or of the planar heating elements, and temperature control mechanisms (10) which control the electric power supplied to the planar heating elements depending upon the detect signals from the temperature sensors provided for the planar heating elements.

FIG. 1



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The present invention relates to a heating device of an automatic screen printing machine. More specifically, the present invention relates to a heating device of an automatic screen printing machine in which a printing table is heated so that it serves as a hot table, and an endless belt is heated by the heat conducted from the hot table in order to produce printed products of improved quality by preventing color pastes from oozing out and colors from being mixed and yet increasing the degree of color value.

The present invention further relates to an automatic screen printing method of the type of saving water and to an automatic screen printing machine used for this method. More specifically, the invention relates to an automatic screen printing method of producing printed products of excellent quality using reduced amounts of washing water for the printing operation, and to an automatic screen printing machine therefor.

The automatic screen printing machine is a printing system of a so-called wet-on-wet type based on an ideal printing method which features high precision and high ability requiring reduced man power. That is, this system carries out the multi-color printing by overlapping another wet color paste on a wet color paste maintaining a cycle which is as short as about two to five seconds without providing the time for drying the color pastes. Therefore, the following problems are involved deteriorating the quality of the printed products.

a. Colored sizing materials ooze out, and colors are inevitably mixed together making it difficult to accomplish the printing maintaining sharp contours.

b. contours are crushed by the squeeze pressure of a succeeding printing unit.

c. Color pastes permeate into the printed fabric causing the degree of color value to decrease on the surface.

d. In the case of a thin clothing fabric, the interior of the succeeding drying machines is fouled due to the back street of color pastes.

In the hand printing or the printing carriage which is the wet-on-dry printing system, there exists a long period of blank time for the printing of second and subsequent colors after the printing of the first color. Since the color paste is almost dried spontaneously during this period of time, there can be obtained a vivid and deep printing maintaining sharp contours and sufficient color value on the surface.

Even in connection with the conventional automatic screen printers, there have been proposed many methods and apparatuses to dry by heating the color pastes applied during the printing in order to improve the quality of printing in the hand printing and printing carriage as taught in Japanese Patent Publications Nos. 18395/1961, 3992/1963, Japanese Laid-Open Patent Publication No. 108389/1974, Japanese Utility Model Publication No. 22194/1960 and Japanese Utility Model Laid-Open Publication No. 133436/1983.

It has been strongly urged to provide an automatic screen printing machine of the wet-on-dry printing system and many mechanisms have heretofore been contrived as described above. It, however, may sound quite strange that the above-proposed mechanisms have not been put into practical use. This is because, with the conventional mechanisms, the apparatus becomes so large in size and is elongated that it is not adapted to practical use. Moreover, it becomes difficult to even out the temperature on the whole printing surface in order to uniformly dry the color paste.

In the automatic screen printing machine as is widely known, furthermore, the endless belt is washed in a belt washing device to wash away color pastes, fluffs of fabric and waste threads adhering to the surface thereof through the fabric after the fabric that is printed has been peeled off the endless belt. To effect this washing, the belt washing device consumes fresh water in an amount of three to five tons per hour.

That is, when the squeeze printing is effected via the screen, the color paste permeates to the back surface of the fabric due to the squeeze pressure and capillarity and adheres to the surface of the endless belt to foul it. This becomes conspicuous particularly in the case of printing thin fabrics, and the color pastes adhere in large amounts to the surface of the belt. Therefore, if the belt is not sufficiently washed in the belt washing device, fouling develops on the back surface of the fabric that is printed, and the printed products become defective.

In particular, the color paste adhered permeating through the fabric will have been half dried and hardened before it reaches the belt washing device. Depending upon the kind of dye and sizing agent, furthermore, the color paste is difficultly washed away in spite of using large amounts of washing water. Therefore, it has been strongly demanded to provide a water-saving type automatic screen printing machine which is capable of saving water which is a precious natural resource.

It is therefore an object of the present invention to provide a heating device in which a printing table is homogeneously and uniformly heated to use it as a hot table, and an endless belt is heated using the heat conducted therefrom, in order to produce printed products of improved quality preventing the color pastes from oozing out and colors from being mixed and yet increasing the degree of color value, without permitting the automatic screen printing machine to become bulky or elongated.

Another object of the present invention is to save the use of the washing water, to suppress the adhesion of color pastes, i.e., to suppress the permeation of color pastes to the back surface of the fabric which is a

serious factor of fouling on the surface of the endless belt, to effect the printing maintaining the back surface white, and to wash the endless belt with water in amounts just required for removing fluffs and waste threads therefrom.

According to the present invention, there is provided an automatic screen printing machine in which a number of printing units each consisting of a pair of a screen and a squeeze are arranged on a frame, and the printing operation is carried out by sticking a fabric to be printed onto an endless belt and intermittently conveying the endless belt, wherein a heating device of the printing machine comprises a table which is divided into units maintaining a distance in a direction in which the endless belt travels and of which the upper surfaces work to support the endless belt, planar heating elements provided in the form of units for each of the table units, temperature sensors provided for each of the planar heating elements to detect the temperature of the table units or of the planar heating elements, and temperature control mechanisms which control the electric power supplied to the planar heating elements depending upon detect signals from the temperature sensors provided for the planar heating elements.

According to the present invention, furthermore, there is provided an automatic screen printing method in which a number of printing units each consisting of a pair of a flat screen and a squeeze as well as an endless belt for feeding a fabric to be printed to the printing units are arranged on a frame, the fabric to be printed is stuck to the endless belt to which a sticking adhesive has been applied in advance, the fabric to be printed is successively conveyed to the printing units by the endless belt to carry out the printing operation, the printed fabric is peeled off the endless belt and is sent to the subsequent processing zone, the endless belt from which the printed fabric is peeled is washed with water and, as required, the endless belt is dehydrated or is dried, the improvement wherein the sticking adhesive applied to the endless belt is the one of the pressure sensitive type, heat sensitive type or water-soluble type, the endless belt fed to the printing units is heated from the side of the lower surface thereof by planar heating elements in order to prevent color pastes from being oozed out onto the endless belt, and in washing the endless belt with water, the washing with water is finished when the fluffs and waste threads are removed.

According to the present invention, there is provided an automatic screen printing machine of the water-saving type comprising a frame on which are arranged a number of printing units each consisting of a pair of a screen and a squeeze, an endless belt which is provided with a layer of an adhesive of the pressure sensitive type, heat sensitive type or water-soluble type and conveys the fabric to be printed stuck to it to the printing units, a drive mechanism which intermittently drives the endless belt, a mechanism which sticks the fabric to be printed to the endless belt, a mechanism which peels the printed fabric off the endless belt and sends it, and a water-washing mechanism which washes with water the endless belt after the printed fabric has been peeled off, wherein provision is further made of a table that is divided into units maintaining a distance in a direction in which the endless belt travels and of which the upper surfaces work to support the endless belt, planar heating elements provided in the form of units for each of the table units, temperature sensors for detecting the temperatures of the table units or the planar heating elements, and temperature control mechanisms which control the electric power supplied to the planar heating elements depending upon detect signals from the temperature sensors, and wherein said water-washing mechanism is provided with a cleaning mechanism which removes fluffs and waste threads.

The printing table according to the present invention may be a so-called hard table or a soft table. In the former case, there is used a metal table having rigidity, and planar heating elements are fastened to the lower surface thereof. In the latter case, there is used a rigid metallic base member having on the upper surface thereof a covering layer with cushioning property, and planar heating elements are provided between the base member and the covering layer.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view which schematically illustrates an automatic screen printing machine in which hot tables (hard tables) are arranged according to an embodiment of the present invention;

Fig. 2 is a sectional view showing, on an enlarged scale, the hot table or Fig. 1;

Fig. 3 is a side view which schematically illustrates the automatic screen printing machine in which hot tables (soft tables) are arranged according to another embodiment of the present invention;

Fig. 4 is a sectional view showing, on an enlarged scale, the hot table in the printing machine of Fig. 3;

Fig. 5 is a graph illustrating a relationship between the operation of the temperature control device of the hard tables system of Figs. 1 and 2 and the temperature of the planar heating elements and of the endless belt; and

Fig. 6 is a diagram which schematically illustrates the arrangement of a rotary screen automatic printing machine according to a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

According to the present invention, the printing table is divided into units maintaining a distance in a direction in which the endless belt travels, and planar heating elements are provided in the form of units for the printing table units. Among a variety of heating elements, the planar heating element has such advantages as a large heating area and a large heat conducting area. When the planar heating element is provided in the form of a unit for the printing table for each of the printing unit, therefore, the table that performs the printing operation can be heated directly, efficiently, homogeneously and uniformly without requiring any particular areas or volumes for heating. Therefore, the apparatus does not become bulky or long, and the wet-ob-dry printing operation can be carried out using the machine of a size same as that of the conventional machine of the wet-on-wet printing system.

According to the present invention, furthermore, the printing tables and the planar heating elements are provided in the form of units that are divided in the lengthwise direction, and the temperature can be strictly controlled for the printing units. To achieve this in the present invention, each table unit is provided with a temperature sensor and a temperature control mechanism, and the electric power input to the planar heating element is controlled depending upon the temperature of the table or the planar heating element detected for each of the units. This makes it possible to maintain the temperature on the endless belt within a predetermined range for each of the printing units.

In the automatic screen printing machine equipped with many printing units, color pastes are applied in different amounts depending upon the printing units; i.e., color pastes are applied in large amounts in some printing units and are applied in small amounts in other printing units. Even where the color pastes are applied in different amounts depending upon the printing units according to the present invention, the temperature is detected for each of the table units, the electric input to the planar heating element is controlled, and the temperature is controlled as desired. Therefore, the color pastes are dried to a constant degree on the fabric that is to be printed, enabling the quality of the printed products to be enhanced.

According to the present invention, the printing table is heated by the above-mentioned simply and cheaply constructed means so that it serves as a hot table, and the endless belt is heated by the heat conducted therefrom, and whereby the aforementioned problems involved in the automatic screen printing machine are precluded to improve the quality of the printed products.

The apparatus of the present invention is simply constructed and does not require any extra space. Moreover, the printing table is constructed in the form of units together with the heating element. Therefore, by simply replacing a conventional printing table with the one contemplated by the present invention, the conventional wet-on-wet printing system can be easily converted into the wet-on-dry printing system.

According to the present invention, furthermore, the water content is vaporized by the heat from the endless belt of the lower side before the color paste printed on the surface of the fabric permeates into the fabric textures, and the permeation due to capillarity is suppressed. This helps to suppress the adhesion of color pastes which is a major factor of fouling on the surface of the endless belt, i.e., suppress the color pastes from permeating to the back surface of the fabric, and makes it possible to effect the printing maintaining the whole back surface white. That is, even a dot of ooze-out of the color paste that reaches the endless belt makes it necessary to carefully wash the endless belt with water until it is completely removed such that the printing will not be fouled by the residual color paste in the next printing operation. In the present invention in which the endless belt is uniformly heated by the planar heating elements, the color pastes are completely prevented from permeating to the back surface of the fabric and, hence, the printing is carried out maintaining the whole back surface white. Even at the time of washing the endless belt with water, the washing with water is effected simply to such a degree that the washing is finished when fluffs and waste threads are removed.

In removing fluffs and waste threads that are adhered to the endless belt, a problem arises in regard to stacking by the adhesives. In the present invention which uses the adhesive of the pressure sensitive type, heat sensitive type or water-soluble type, however, the fluffs and waste threads are weakly stuck and can be effectively removed by washing with water. That is, the adhesive of the pressure sensitive type almost loses its sticking force when cooled by the water of washing and the adhesive of the heat sensitive type loses its sticking force upon contact with the water, enabling the fluffs and waste threads to be very easily removed by washing with water. In the case of the adhesive of the water-soluble type, furthermore, the surface of the adhesive to where fluffs and waste threads are adhered dissolves. That is, the sticking force is weakened, and the fluffs and waste threads are easily removed by washing with water.

According to the present invention, the printing table is heated by the above-mentioned simply and cheaply constructed means so that it serves as a hot table, and the endless belt is heated by the heat conducted therefrom. This makes it possible to carry out the wet-on-dry printing operation while offering such features as sharp printing contours, increased printing concentration on the surface and the like, and contributes to enhancing

quality of the printed products.

Furthermore, the color pastes are prevented from being oozed out onto the endless belt. By selecting the adhesive applied to the endless belt, moreover, the endless belt needs be washed with water to a small degree and the water is used in very greatly reduced amounts. Moreover, the surface of the endless belt is not fouled with the color paste, and drain water from the belt washing device is not turbid with the color pastes and can, hence be re-used by simply removing fluffs and waste threads through filtration, contributing to preventing environmental hazard due to polluted water.

Fig. 1 is a side view which schematically illustrates an automatic screen printing machine in which hot tables (hard tables) are arranged according to an embodiment of the present invention, and Fig. 2 is a sectional view showing the hot table on an enlarged scale.

With reference to Fig. 1 which illustrates the arrangement of the automatic screen printing machine of the present invention, the surface of an endless belt 1 for conveying the fabric is coated with an adhesive resin that will be described later. A fabric 4 to be printed is press-adhered thereto by a sticking roller 5 and is conveyed so as to be printed by a squeeze 6-2 via a screen 6-1 of a printing unit 6. After the printing, the fabric 4 that is printed is peeled off the endless belt 1 and is guided into a drying machine. The endless belt is washed and dehydrated through a belt washing device 15 installed on the rear part (left side in Fig. 1) under the printing machine, and to which a fabric 4 to be printed is newly stuck at an upper portion in front (right side in Fig. 1) of the printing machine.

A printing table 7 is provided under the endless belt 1 over the whole printing zone, and is divided into sectional units of a predetermined length. On the lower surface thereof (back surface) are provided planar heating elements 8 having a width and a length to heat nearly the whole surface of the printing table.

In this embodiment, the printing table 7 is a so-called hard table which is made of a metal such as an aluminum plate, a steel plate or a stainless steel. The metal conducts the heat and its heat capacity helps uniformalize the temperature for every portion in each unit. It is desired that the printing table has a thickness which is greater than three millimeters. In order to heat the printing table, furthermore, the heating elements, i.e., the planar heating elements should be brought to intimate contact with the lower surface (back surface) of the printing table, such that the heating is favorably accomplished while preventing the planar heating elements from being worn out.

The planar heating elements 8 are continuous in the direction of width of the endless belt 1 so that there will not develop a difference in temperature, and may be arranged in a plurality of number in parallel for each of the units, each of the planar heating elements having a narrow width in a direction in which the endless belt 1 travels. Furthermore, the planar heating elements 8 may be arranged not for the whole printing table 7 but for the required portions only.

In this embodiment, the planar heating elements 8 are protected by a heat-insulating material 20 and a cover 21. Due to the elasticity of the heat-insulating material 20, furthermore, the whole heating surface is brought into intimate contact with the lower surface (back surface) of the printing table 7. Or, the heating surface may be adhered to the lower surface of the printing table 7 using an adhesive, a double-sided adhesive tape or the like. Moreover, the printing table 7 is divided into units together with the planar heating element 8, heat-insulating material 20 and cover 21.

As the planar heating elements 8, there can be used a heating carpet, a heating floor board, or those that are mass-produced and placed in the market for use in a variety of industries. The planar heating elements include those of the following types which are easily available and can be easily used to fulfill the objects of the present invention.

a. Those of the form of woven fabric obtained by interweaving carbon fibers or like fibers together with heat-resistant fibers.

b. Those obtained by printing a carbon ink or a like ink onto a heat-resistant film describing the pattern of a lattice.

c. Those obtained by chemically etching a thin metallic resistance foil in the form of a lattice or those obtained by arranging metallic resistance wires into a required length.

Both surfaces and peripheries of the planar heating elements are sealed with an insulating/protecting covering.

The endless belt 1 is heated via the printing table 7 in order to accomplish the above object. In this case, the surface temperature of the endless belt should be such that the color pastes are dried or gelled and lose fluidity or are prevented from being mixed together. The temperature may differ depending upon the kinds of color pastes but is usually from 30°C to 70°C and, particularly, is about 50°C. When the room temperature is 20°C, then the temperature needs be raised by about 30°C and this temperature should then be maintained.

As required, furthermore, a preheating device may be provided before the printing zone.

The higher the surface temperature of the endless belt 1, the more effective in drying the color pastes.

As the temperature exceeds 80°C, however, the endless belt 1 is greatly elongated and loses stability and precision for intermittent feeding. There further develop such problems as drying and loading of screen mesh.

The planar heating elements placed in the market produce the heating temperature of from 50°C to 200°C though it may differ depending upon the manufacturers and the types. The temperature required for the present invention can be easily obtained by selecting the type and the specifications and by adjusting the voltage applied thereto. In this case, the electric power density is from 700 W/m^2 to 3000 W/m^2 and the voltage used is AC 100 V to 200 V.

The planar heating element 8 has a temperature sensor 9 which is connected to a temperature control device 10. That is, the temperature sensor 9 detects the temperature of the table or of the planar heating element 8, and the temperature control device 10 controls the electric input to the planar heating element 8 in response to the detect signal, in order to carry out the predetermined temperature control. This operation is carried out for each of the units. As required, furthermore, the whole temperature is adjusted by using a voltage adjustor 11. This operation is effective when the temperature of the open air greatly differs such as during summer and winter when the atmospheric temperature differs greatly.

Fig. 3 schematically illustrates the arrangement of the automatic screen printing machine using a hot table (soft table) according to another embodiment of the present invention, and Fig. 4 is a sectional view showing, on an enlarged scale, the hot table (soft table) according to the another embodiment. Though Fig. 3 does not illustrate the water-washing device, it should be noted that there has been employed the same device as that of Fig. 1.

In Figs. 3 and 4, the endless belt drive system and the printing units are arranged in the same manner as those of Fig. 1. In this embodiment, a covering layer 22 having cushioning property is provided on the table base member 7, so that the squeezing operation is smoothly carried out maintaining cushioning property by the printing units under the condition where the screen 6-1 is in contact with the fabric 4 that is to be printed. Moreover, tension members 23 are provided at both ends of the table to give tension to the covering layer. The planar heating element 8 is arranged between the table base member 7 and the covering layer 22 having cushioning property for each of the printing units to heat the color pastes that are applied.

Fig. 5 illustrates a relationship between the operation of the temperature control device of the hard table system of Figs. 1 and 2 and the temperatures of the planar heating elements and of the endless belt.

In the embodiment of Fig. 5, the planar heating element 8 has an electric capacity of 2600 W/m^2 and a voltage applied thereto is AC 200 V.

The setpoint temperature (70°C in this embodiment) is reached requiring a time T of about 5 minutes after the power source is connected to the temperature control device 10.

When the setpoint temperature is reached, the temperature control device 10 is turned off. When the temperature t drops, however, the temperature control device 12 is turned on again. This operation is repeated. Here, the temperature difference Δt is set to be 2°C.

The surface temperature of the endless belt 1 rises being delayed behind the planar heating element 8. In this embodiment, the saturation temperature of about 54°C is reached being delayed by about 15 minutes.

The above time and temperature may change depending upon the voltage applied to the planar heating elemtn 8 and room temperature (normal temperature). In this embodiment, the temperature is controlled by turning the power source on and off. The temperature, however, may be controlled in a proportional manner, as a matter of course.

According to the present invention, the adhesive applied to the endless belt in advance may be the one of the pressure sensitive type, heat sensitive type or water-soluble type. Examples of the adhesive of the heat sensitive type include acrylic and methacrylic heat sensitive-type adhesives such as Newdyne manufactured by Yokohama Polymer Co., PT Wax manufactured by Sanyo Shikiso Co., MC polymer manufactured by Murayama Kaken Co., Suncoat manufactured by Sanko Shoji CO., and the like, pressure sensitive vinyl chloride-type adhesives such as Esdyne manufactured by Sekisui Kagaku Co., MC polymer #7000 manufactured by Murayama Kaken Co., Troresin manufactured by Sanko Shoji Co., and the like to which only, however, the adhesive used in the present invention is in no way limited.

As the adhesive of the heat sensitive type, there can be used a composition of a heat-softening resin and a stickiness-imparting agent. As a resin component, there can be used as acrylic or methacrylic resin, vinyl acetate-type resin, or the like resin. As the stickness-imparting agent, there can be used a phenol resin, rosins, a petroleum resin, a styrene-type resin, or the like resin. Suitable examples include Thermoplast manufactured by Fritz Buzer Co., Coat Resin manufactured by Sanko Shoji Co., and the like to which only, however, the stickiness-imparting agent used in the present invention is in no way limited.

Examples of the water-soluble adhesive include a polyvinly alcohol, a water-soluble acrylic resin and the like. These water-soluble adhesives are particularly adapted resin and the like. These water-soluble adhesives are particularly adapted to printing natural fibers and cellulose fibers. The water-soluble adhesive can be ap-

plied by using a sizing roller. After washed away with water, it should be applied again.

The pressure sensitive-type adhesive and the heat sensitive-type adhesive are suited for synthetic fibers and, particularly, for hydrophobic fibers. However, these adhesives can be used for the natural fibers, too, as a matter of course. When once applied, the pressure sensitive-type and heat sensitive-type adhesives can be continuously used to some extent. By using the pressure sensitive-type adhesive, the fabric is adhered utilizing pressure. By using the heat sensitive-type adhesive, the fabric is adhered utilizing the heat and pressure of the sticking roller. It is allowable to use these resins in combination. For instance, the water-soluble adhesive is provided on the layer of the pressure sensitive-type adhesive to accomplish reliable adhesion.

The adhesive is applied usually in an amount of from 20 to 50 g/m^2 per unit area though it may vary depending upon the type thereof.

In the present invention, the printing operation is carried out in a manner as described above. After the printed fabric 4 is peeled off the endless belt 1, however, the color pastes that have permeated through the fabric and the fluffs and waste threads of the fabric will have been adhered on the surface of the endless belt. The colored sizing materials, fluffs and waste treads of fabric are washed away from the surface of the endless belt which is then dehydrated using the belt washing device 15 installed in the lower portion. The washing may be effected by using hot water to maintain the temperature of the belt.

When printed by the conventional method, the color pastes permeate in large amounts. As the printing is effected using many colors, in particular, the color pastes adhere in large amounts onto the surface of the belt and are half dried and solidified while they are being intermittently sent making themselves difficult to be completely washed away through the belt washing device 15.

According to the present invention, the fabric is printed maintaining its back surface white by suppressing the permeation of the color pastes as described above. Therefore, the belt washing device 15 needs bear a reduced burden, and the washing water can be saved.

As shown, the belt washing device 15 is constituted by roll brushes 16, shower pipes 17 for feeding the washing water, dehydrating doctors 18 for dehydrating the surface of the belt after the washing, and a water-washing vessel 19 that contain all of them.

The roll brushes 16 are driven by a motor that is not shown via a chain or a belt, and are rotated in a direction opposite to the direction in which the endless belt 1 travels. In the diagram, the roll brushes 16 are provided in a number of two. According to the prior art, the roll brushes 16 are provided in a number of three since the washing operation involves difficulty as described earlier.

The shower pipes 17 are provided in a plurality of numbers as shown, arranged in the direction of width of the endless belt 1, i.e., arranged at right angles with the direction in which the endless belt travels, and are served with the washing water. The shower pipes 17 have numerous small holes perforated in the lengthwise direction thereof and through which the washing water is injected toward the portions where the surface of the endless belt 1 is in contact with the roll brushes 16.

The dehydrating doctors 18 are made of a synthetic rubber such as nitrile urethane or the like, have a length greater than the width of the endless belt 1, and are brought into pressed contact with the surface of the endless belt in a tilted manner to dehydrate the surface of the belt. The dehydrating device may be a mangle roller instead of the doctor or may use the mangle roller in combination with the doctor.

The water-washing vessel 19 is so provided as to contain the roll brushes 16, shower pipes 17 and dehydrating doctors 18 from the lower side thereof, and has a drain port formed in a lower portion thereof. Usually, the washing water from the shower pipes 17 is drained into a reservoir vessel through the drain port. It is, however, also possible to store water in the water-washing vessel 19 just under the shafts of the roll brushes 16 to effect the washing under the condition where the lower halves of the roll brushes 16 are submerged in water.

In the present invention as described above, the color pastes are suppressed from being permeated and adhered onto the surface of the endless belt 1. Therefore, fluffs and waste threads only need be washed away and, hence, the belt washing device 15 needs bear a reduced burden. Therefore, the washing water can be saved, and the amount of water newly used by the belt washing device 15 can be reduced to about two tons per hour.

Moreover, the number of roll brushes 16 is decreased from a conventional number of three to two, enabling the belt washing device 15 to be simplified as a whole and energy to be saved. The amount of drain water is greatly decreased, too, and water is not polluted with the color pastes, thus making it possible to prevent environmental hazard of water pollution.

Drain water from the belt washing device 15 has been polluted to a small degree. Therefore, water after the belt is washed may be drained untreated. In many cases, however, the drain water is once stored in a storage vessel, diluted with new water and from which fluffs and waste threads are removed through the filtration. The water is then used again being pumped up.

Moreover, the printing conditions such as the material of the fabric 4 to be printed (natural fiber, synthetic fiber, or others), thickness (thin fabric, thick fabric), texture weaving (broad, lawn, and others), viscosity of the color paste, temperature on the surface of the endless belt 1 that would meet the composition, mesh of the screen gauze, and mechanical conditions of the printing unit 6 (squeeze pressure, squeeze speed, squeeze angle, number of times of squeezing, etc.) are adjusted to be most suited for the material of the fabric to be printed. Thus, the color pastes are prevented from permeating onto the back surface of the fabric; i.e., the fabric is printed maintaining its back surface white.

According to the present invention which employs the above-mentioned printing system, the concentration of the printed color and vividness can be strikingly improved. That is, the concentration can be increased by about 20 to 50% compared with that of the printing at normal temperature. When the concentration is the same, the dye can be saved by about 20 to 50%. This will be described hereinbelow.

1. Stereostructure of color and numerical expression.

As the colors are decomposed into components using a prism and as the stereostructural theory of color is established, it has now been discussed that all colors necessarily exist in steric three-dimensional space such as of a cylindrical shape, an elongated spherical shape or an elongated cylindrical shape. To express the positions of the colors, furthermore, the color light is passed through a spectroscope (or a spectrophotometer), the reflected light is grouped into three components, i.e., R (red), G (green) and B (blue). Then, by using their reflection factors as basic numerals, the positions in the stereospace are expressed as X, Y, Z or L, a, b. Thus, the theory of color has rapidly developed.

By coupling a PC (personal computer) and the spectroscope together, furthermore, there are developed CCM (computer color matching) and CCS (computer color searching). The industries that deal with colors are quickly introducing the above systems, and technology for controlling the color matching is progressing relying upon the traditional experience and sense.

2. Expression of color and color difference.

In contrast to three elements (R, G, B) of light, the three primary colors, Y (yellow), M (magenta), C (cyan), usually include yellow, red and blue, which represent the Hue. By adding luminosity (value) and saturation (Chroma), furthermore, the color should correctly be expressed using these three elements, i.e., H, V and C.

As for a color difference, we often say that the color is different, dense, pale, fouled, bright, dark, etc. This can be numerically expressed by using ΔE, Δa, Δb, Δc, and ΔH.

That is, between the two colors:

- ΔE represents a straight distance in the stereospace,
- Δa represents reddish color when it has a + sign and represents greenish color when it has a - sign,
- Δb represents yellowish color when it has a + sign and represents bluish color when it has a - sign,
- Δc represents blackish (darkish) color when it has a + sign and represents brightness when it has a - sign, and
- ΔH represents deviation of hue (circumferential angle on a plane).

3. Apparent strength and chromatic strength.

The computer check table contains items of the above characters expressing weaker and stronger in a unit of percent.

Apparent is an area represented by the reflected light web expressing, in other words, the fact that the color is dense or pale though the hue is different.

Chromatic represents that a curve of reflected light has a high peak value or a low peak value, i.e., the color is dense or pale having the same hue.

When the fabric is died using a single dyestuff, there exists almost no difference in the concentration of the dyestuff, i.e., almost no difference between the apparent and the chromatic, and the same numerical value is exhibited. When the fabric is died using a plurality of blended dyestuffs, the dyestuff components in many cases exhibit different degrees of dyeing power, and the apparent and the chromatic are not the same in many cases.

With reference to the dyeing effect (effect of dense dyeing) using the hot table of the present invention, it can be difficult to exclusively say which one of the apparent or the chromatic be selected. However, it can be confirmed from the data (see Table 1) that the colors are uniformly more dense when the printing is effected using the hot table.

Table 1

Measured data of printed concentration

Conditions	Printed colors					
	Red	Dark green	Medium green	Pale green	Yellow	Orange
Apparent strength						
Normal-temp. printing	100	100	100	100	100	100
Heated printing	144.4	133.9	119.9	119.7	146.5	117.5
Chromatic strength						
Normal-temp. printing	100	100	100	100	100	100
Heated printing	147.8	133.9	120.7	126.5	150.8	117.5

Note: Unit:%

Measuring device: Color computer manufactured by Computer Color System Co. (England)

Spectroscope: manufactured by Macbeth Co.

Normal temperature: surface temperature of belt, 22°C

Heating: surface temperature of belt, 50°C

Printed fabric: cotton fabric (broad)

Though the present invention was described with reference to the case of flat screen printing, it should be also noted that the invention can be adapted even to the rotary screen printing.

Referring to Fig. 6 which schematically illustrates the arrangement of the rotary screen automatic printing machine according to a further embodiment of the present invention, the members 1 to 19 are common to those of the flat screen printing of Fig. 1. In this embodiment, the belt 1 is continuously driven by the front and rear drive rollers 2 and 3, and a rotary screen printing unit 30 is driven in synchronism with the belt 1. The rotary screen printing unit 30 is constituted by a rotary screen 30-1, a receiving roller 30-3 positioned thereunder with

the belt 1 and the fabric 4 to be printed thereon interposed therebetween, and a squeeze 30-2 contained in the rotary screen 30-1. The color pastes applied to the fabric 4 to be printed are heated, dried, and are prevented from permeating to the back surface by the planar heating elements 8 arranged among the receiving rollers 30-3.

According to the present invention, the printing machine is equipped with the printing tables and planar heating elements in the form of units that are divided in the lengthwise direction, the temperature is detected for each of the units, the electric inputs to the planar heating elements are controlled to accomplish desired temperature and to achieve the following advantages.

It becomes possible to directly, efficiently, homogeneously and uniformly heat the table on which the printing operation is practically carried out without using any particular areas or volumes for the heating. Therefore, the apparatus does not become bulky or long, and the wet-on-dry printing operation is carried out using the machine of the same size as that of the conventional wet-on-wet printing system. There are further obtained various advantages such as sharp contour of printing, increased printing concentration on the surface, and the like.

In the automatic screen printing machine equipped with many printing units, the temperature is detected for each of the table units that are divided and the electric inputs to the planar heating elements are controlled to perform predetermined temperature control even when the color pastes are applied in different amounts depending on the printing units. Therefore, the color pastes are dried to a constant degree on the fabric that is to be printed, and the quality of the printed products can be enhanced.

According to the present invention, the apparatus is simply constructed without requiring any extra space, and each printing table unit is constructed together with the heating element. By simply replacing the printing table of a conventional machine by the one of the present invention, therefore, it is allowed to easily convert the conventional wet-on-wet printing system into the wet-on-dry printing system.

In the present invention, furthermore, there is used an adhesive of the pressure sensitive type, heat sensitive type or water-soluble type as a sticking adhesive which is applied to the endless belt. Then, the endless belt fed onto the printing units is heated from the side of the lower surface thereof using planar heating elements in order to prevent the color pastes from oozing out onto the endless belt. Thus, the color pastes are completely suppressed from permeating onto the back surface of the fabric, enabling the fabric to be printed maintaining the whole back white. In washing the endless belt with water, the washing with water is effected to only a slight degree; i.e., the washing is finished after fluffs and waste threads are removed. Moreover, the sticking force of fluffs and waste threads is weakened so that fluffs and waste threads can be easily removed by washing with water.

The surface of the endless belt is not fouled with color pastes, the drain water from the belt water-washing device is not turbid with the color pastes and can be used again by simply removing fluffs and waste treads through filtration, contributing to preventing environmental hazard such as water pollution.

Claims

1. A heating device for use in an automatic screen printing machine in which a number of printing units each consisting of a pair of a screen and a press are arranged on a frame, and the printing operation is carried out by sticking a fabric to be printed onto an endless belt and intermittently conveying the endless belt, said heating device comprising: a table which is divided into units spaced apart in the direction in which the endless belt travels and the upper surfaces of which support the endless belt;

   planar heating elements provided in the form of units for each of the table units;

   temperature sensors provided for each of the planar heating elements to detect the temperature of the table units or of the planar heating elements; and

   temperature control mechanisms which control the electric power supplied to the planner heating elements depending upon the detect signals from the temperature sensors provided for the planar heating elements.

2. A heating device according to claim 1, wherein said table is a metallic table having rigidity, and has planar elements fastened to the lower surface thereof.

3. A heating device according to claim 1, wherein said table comprises a metallic base member having rigidity and a covering layer having cushioning property provided on the upper surface thereof, and the planar heating elements are provided between the base member and the covering layer.

4. An automatic screen printing method in which a number of printing units each consisting of a pair of a screen and a press as well as an endless belt for feeding a fabric to be printed to the printing units are arranged on a frame, the fabric to be printed is stuck to the endless belt to which an adhesive has been applied in advance, the fabric to be printed is successively conveyed to the printing units by the endless belt to carry out the printing operation, the printed fabric is peeled off the endless belt and is sent to the subsequent processing zone, the endless belt from which the printed fabric is peeled is washed with water and, as required, the endless belt is dehydrated or is dried, wherein the adhesive applied to the endless belt is the one of the pressure sensitive type, heat sensitive type or water-soluble type; the endless belt fed to the printing units is heated from the side of the lower surface thereof by planar heating elements in order to prevent color pastes from being oozed out onto the endless belt, and in washing the endless belt with water, the washing with water is finished when the fluffs and waste threads are removed.

5. An automatic screen printing method according to claim 4, wherein the endless belt is heated so that the surface temperature thereof is maintained within a range of from 30°C to 70°C.

6. An automatic screen printing machine of the water-saving type comprising a frame on which are arranged a number of printing units each consisting of a pair of a screen and a press, an endless belt which is provided with a layer of an adhesive of the pressure sensitive type, heat sensitive type or water-soluble type and conveys the fabric to be printed stuck to it to the printing units, a drive mechanism which intermittently drives the endless belt, means for sticking the fabric to be printed to the endless belt, means for peeling the printed fabric off the endless belt and sending it, and a water-washing means for washing the endless belt with water after the printed fabric has been peeled off;

a table that is divided into units spaced apart in the direction in which the endless belt travels and of which the upper surfaces support the endless belt travels;

planar heating elements provided in the form of units for each of the table units;

temperature sensors for detecting the temperatures of the table units or the planar heating elements; and

temperature control mechanisms which control the electric power supplied to the planar heating elements depending upon detect signals from the temperature sensors, and wherein said water-washing mechanism is provided with a cleaning means which removes fluffs and waste threads.

FIG. 1

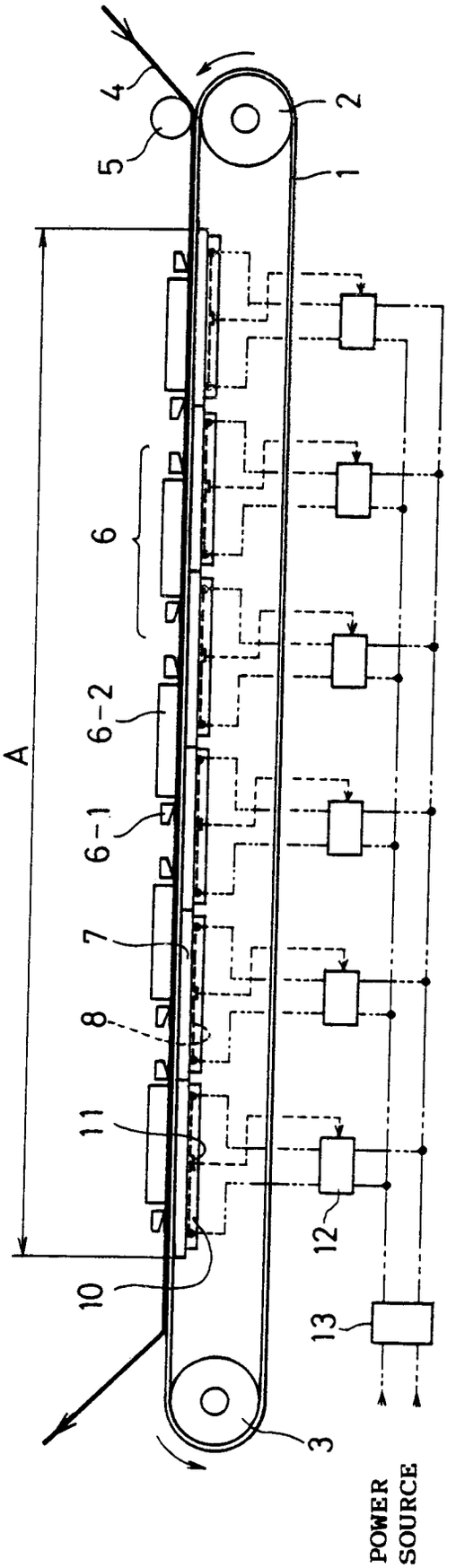


FIG. 2

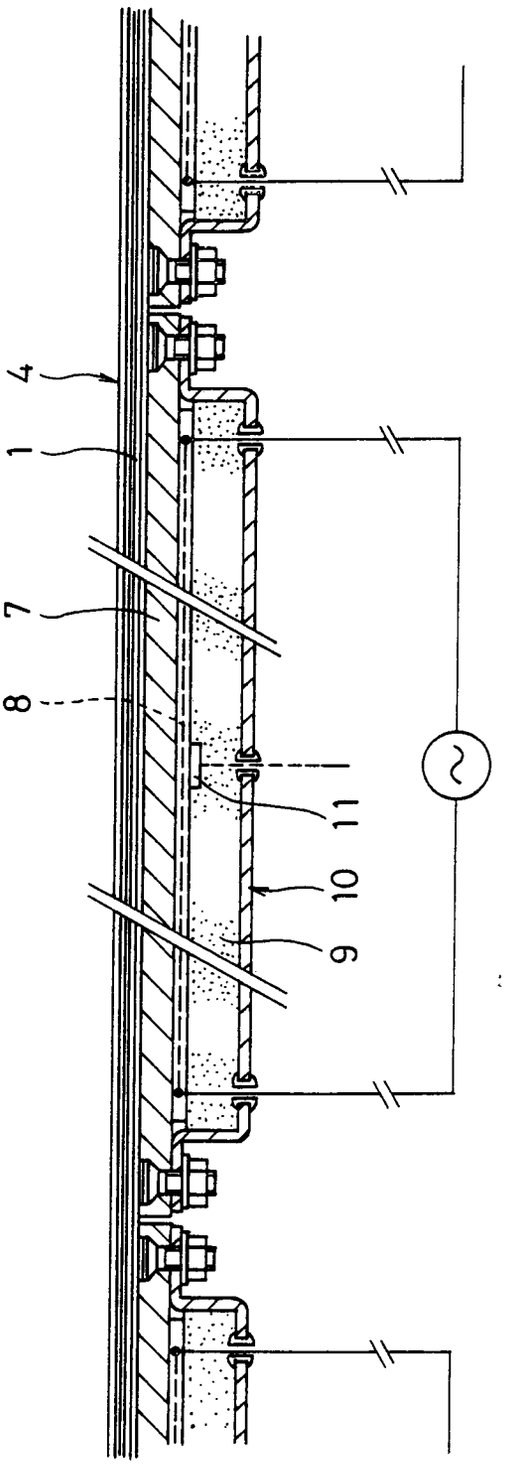
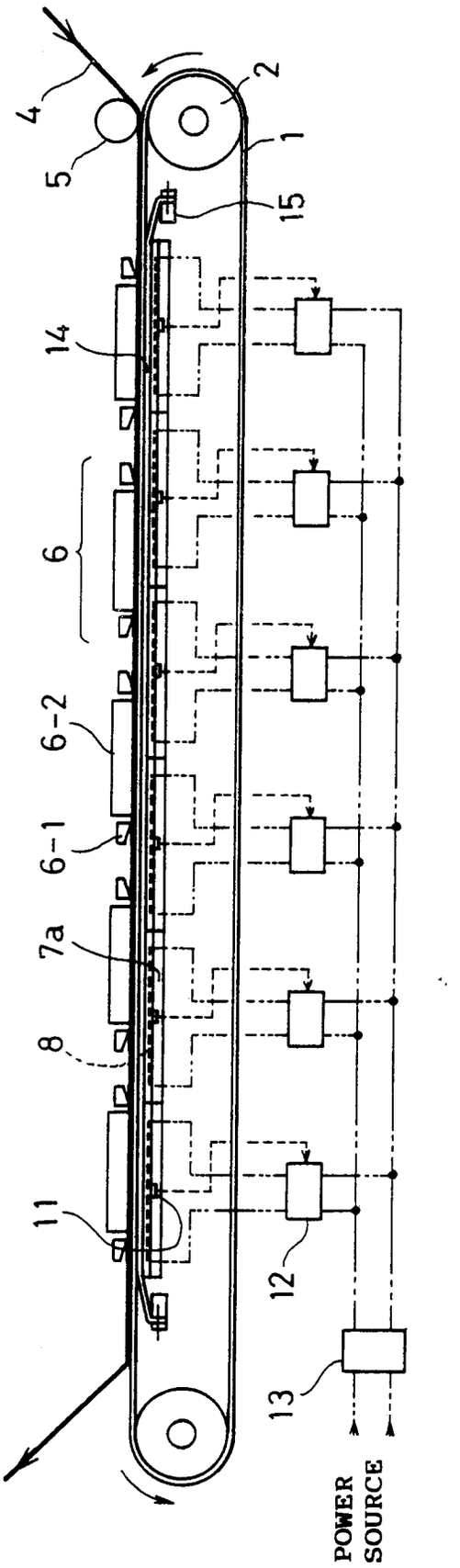


FIG. 3



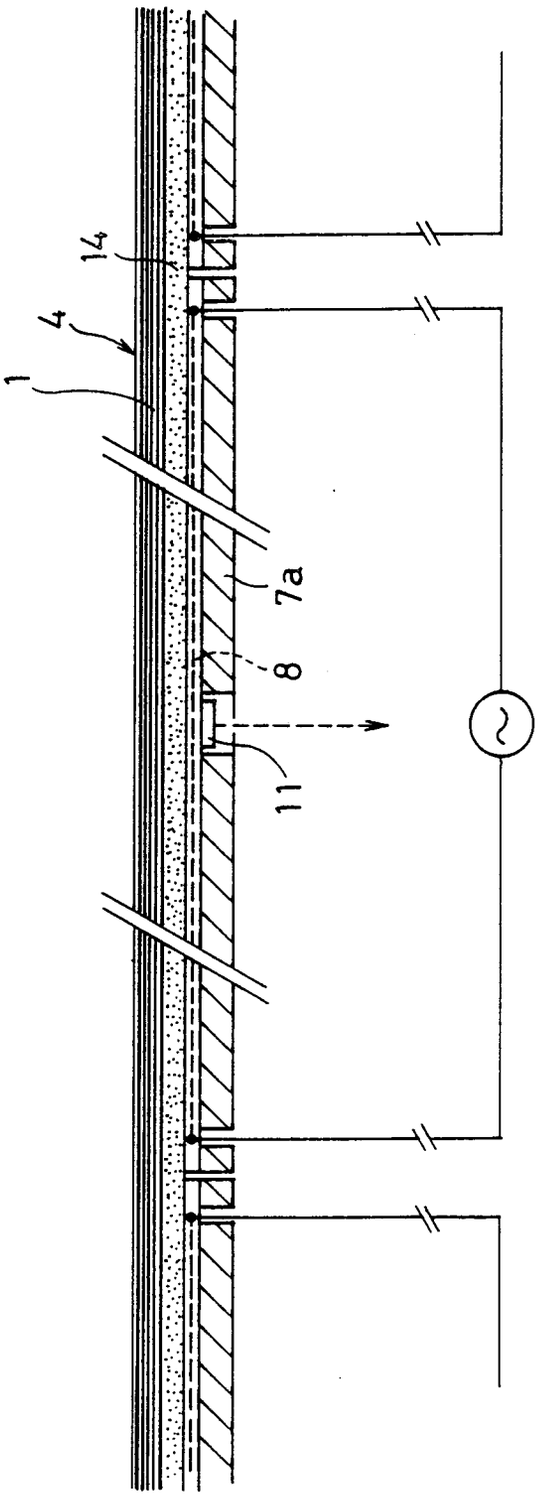


FIG. 4

FIG. 5

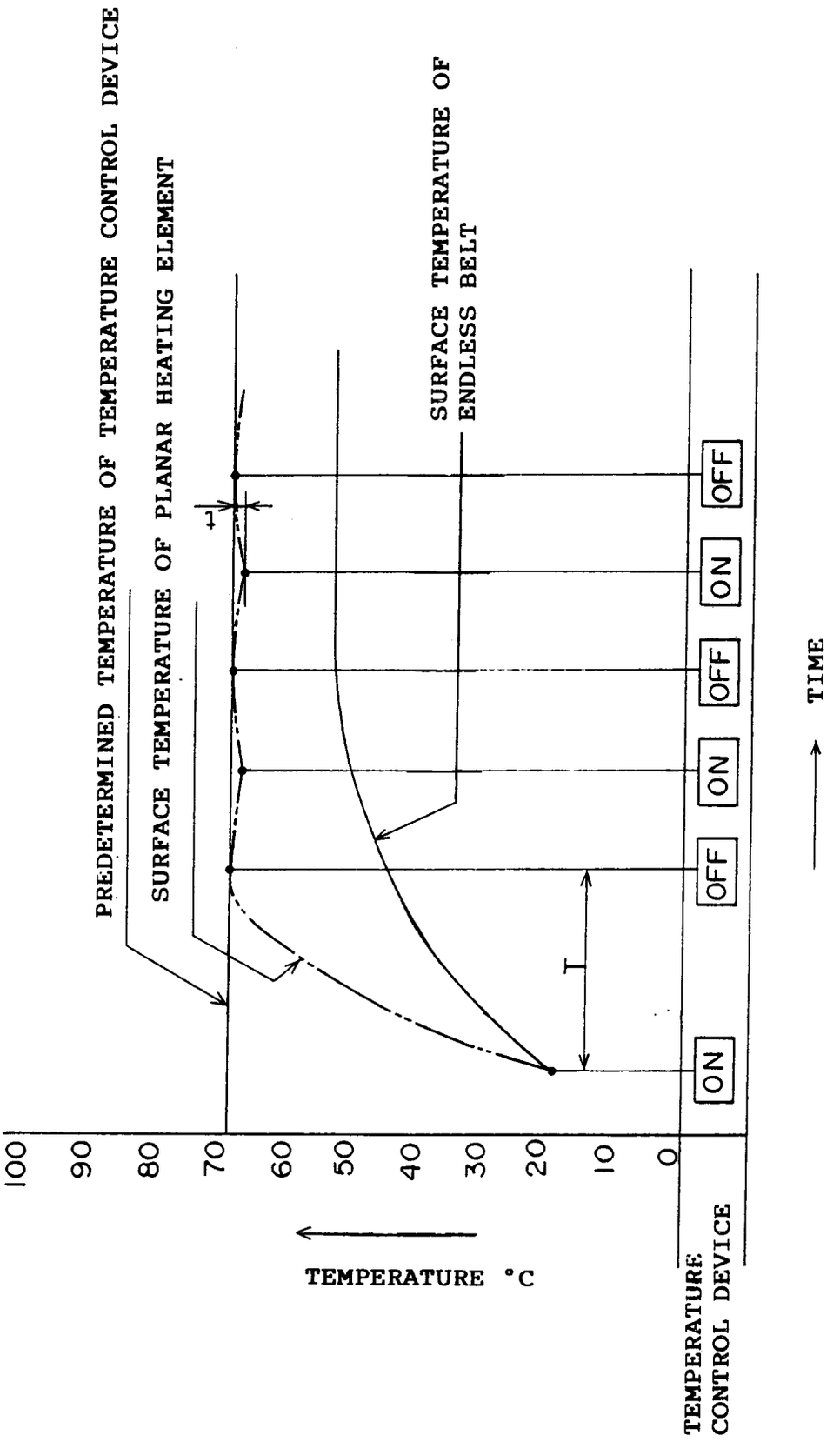
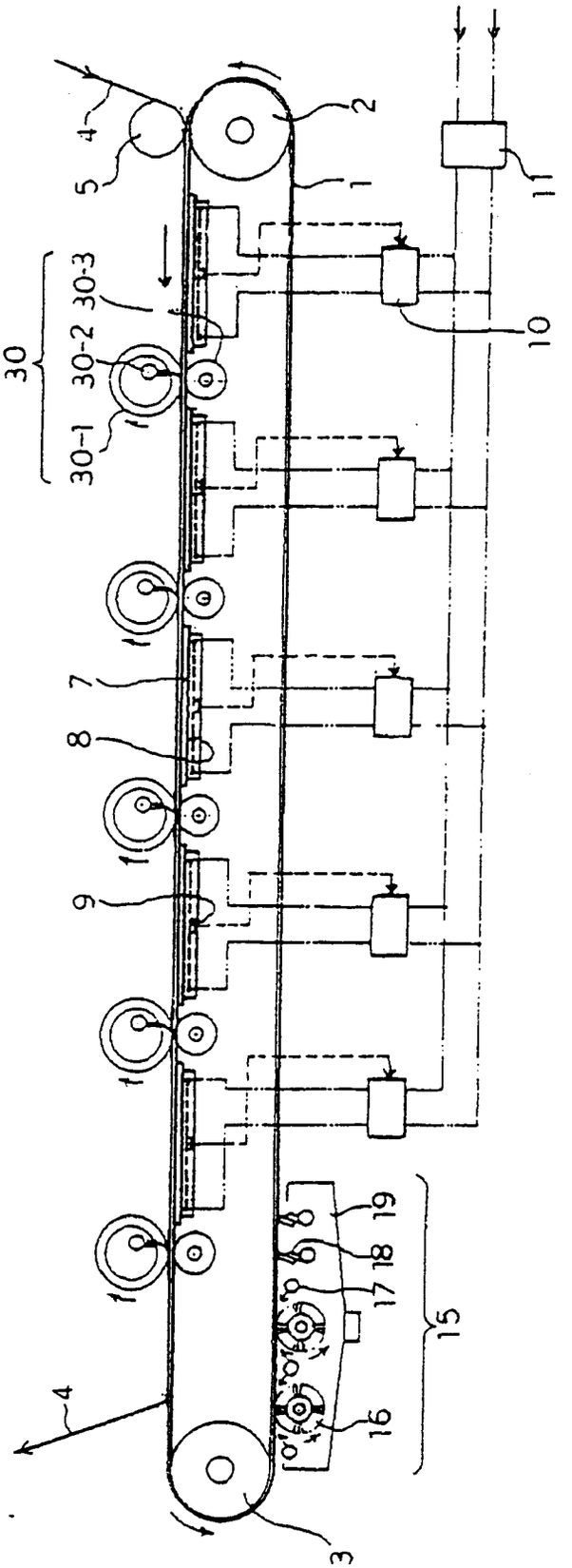

PREDETERMINED TEMPERATURE OF TEMPERATURE CONTROL DEVICE
SURFACE TEMPERATURE OF PLANAR HEATING ELEMENT
SURFACE TEMPERATURE OF ENDLESS BELT
100
90
80
70
60
50
40
30
20
10
0
TEMPERATURE °C
TIME
ON
OFF
ON
OFF
ON
OFF
T
TEMPERATURE CONTROL DEVICE

FIG. 6



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 30 5275

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	GB-A-959 972 (HEBERLEIN & CO.,AG) * the whole document *	1-3	B41F15/08 B41F15/12 B41F15/24
Y		6	
A		4,5	
Y	WO-A-90 15716 (ZIMMER) * the whole document *	6	
A		1-5	
A	US-A-3 877 371 (JAFFA) * the whole document *	1-6	
A	CH-A-398 483 (FRITZ BUSER AG) * the whole document *	1-6	
A	CH-A-383 313 (ICHINOSE) * the whole document *	1-6	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

B41F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 October 1993	MADSEN, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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