

[54] MULTI-COLOR DYE-TRANSFER  
APPARATUS

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101/171, 178, 180, 183, 219

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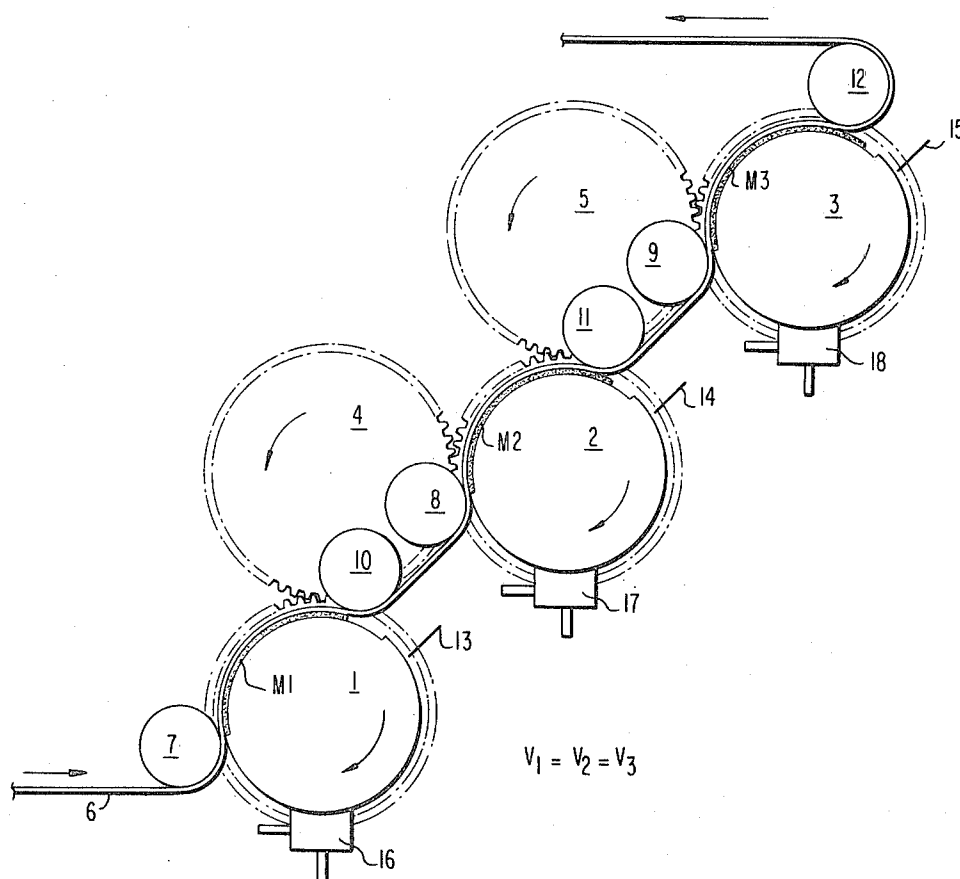
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## [57] ABSTRACT

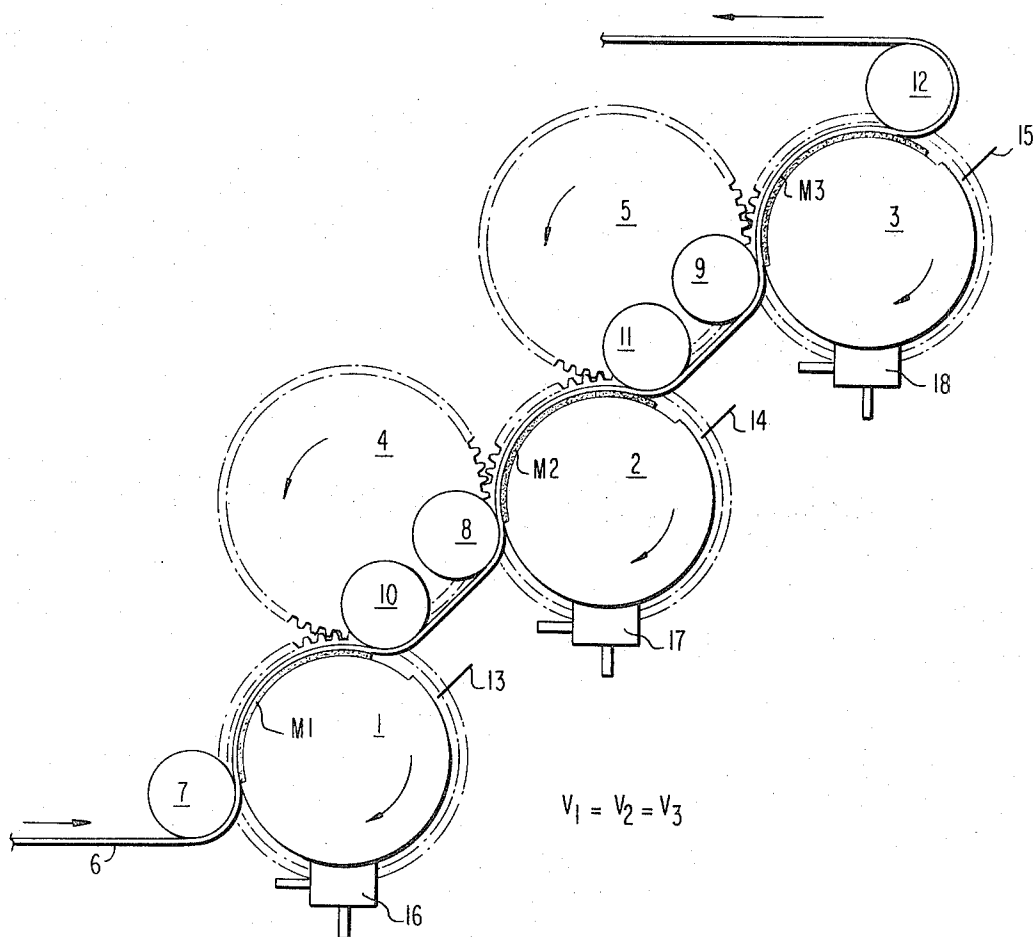
Apparatus for dye-transferring color images, comprising a plurality of rotatable drums driven at the same angular velocity for supporting a matrix thereon, the diameter of each drum being larger than the drum disposed upstream thereof in the dye-transfer process and the matrices are incrementally larger in dimension corresponding to the drum periphery in downstream order. A plurality of dye solution supplying devices are provided adjacent the drums to supply different colors of dyes to the drums, and a plurality of press rollers are disposed in contact with the drums to urge the material to be dye-transferred into contact with the drums for a predetermined time period. In this manner, a multi-color image may be dye-transferred to the material without color displacement.

2 Claims, 1 Drawing Figure



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**MULTI-COLOR DYE-TRANSFER APPARATUS**

This application is a continuation in part application of application Ser. No. 159,968 filed on July 6, 1971.

**BACKGROUND OF THE INVENTION**

The present invention relates to an apparatus for obtaining a multi-color image by a dye-transfer process, and in particular to an apparatus for dye-transferring the dye image in which a large number of images are transferred with the proper position regulation.

The dye transferring process is well known, U.S. Pat. No. 2,652,328 and British Pat. No. 663,005 are descriptive thereof. In this process, a printing matrix (hereinafter referred to as "matrix,") absorbing dye solution in the image pattern, is dyed with the dye solution and then is contacted with a receiving material having a dyeable layer (hereinafter referred to as "material") thereon for transferring the dye image to the material.

In order to obtain a multi-color image based on the principle of the dye-transfer process, three-strip matrices corresponding to the color separation images are prepared, dyed with dye solutions of three different colors, and brought into contact with the material for transferring the dye images in registration.

The dye-transfer process which is conducted nowadays can be explained in more detail as follows. The dye-transfer process generally consists of four processes; namely, (1) a process to prepare a matrix from a color transparency or a color negative film, (2) a process to dye the matrix, (3) a process to remove excessive dye from the matrix, and (4) a process to bring the matrix into contact with the material. By repeating the processes except the first process, a number of duplicates can be obtained. However, these processes have been conducted manually in the prior art except one embodiment of the apparatus for carrying out the dye-transfer process.

The foregoing embodiment is an automatic apparatus for duplicating motion picture film in which an elongated plastic having fine perforations is used as a matrix and another elongated plastic having perforations is used as a base for a material to be dye-transferred. In this embodiment, the perforations of the two plastic strips are used for accurately positioning the matrix on the material and the automatization of the process is facilitated.

A general manual operation of the dye-transfer process is conducted as follows: A sheet of matrix, provided with a pin hole for position regulation, is first dyed and washed, then superposed on a material to be dye-transferred provided with a pin hole for position regulation and placed on a baseboard having a pin fixed thereon for regulating the position of the material and the matrix. Then, the dye image on the matrix is transferred to the material placed on the baseboard. In multi-color dye-transfer process, the material to be dye-transferred placed on the baseboard is not to be moved until the three or required number of matrices are all used for transferring different colors of dye images thereon.

Since great labor and care are required to obtain even one sheet of multi-color image by the dye-transferring process as described above, the dye-transfer process is not widely used in spite of the advantages as follows.

In the case of duplicating a large number of images, the dyetransfer process is very advantageous in an economical sense in comparison with the conventional color printing using expensive silver halide photosensitive material to be exposed and developed. In the dye-transfer process, a material to be dye-transferred having only a gelatin layer is enough to duplicate several tens to several hundreds of color images by means of three matrices prepared by exposure and development by the use of photosensitive material. Further, dyes of bright color can be employed in the dye-transfer process since there is no need to fear the effect of the dye on the photosensitive material. As a matter of fact, the brightness of the color image obtained by the dye-transfer process is superior to that of color photography. The main reason for the unpopularity of the dye-transfer process in spite of the economics and the brightness in color is considered to be the tremendous labor and time required thereby. Therefore, it is required in the art of dye-transfer process using sheets of matrix having no perforations that labor and time be saved.

**SUMMARY OF THE INVENTION**

In light of the above disposition of the prior art, the primary object of the present invention is to provide an apparatus for the dye-transfer of multi-color images on a material having no perforations.

Another object of the present invention is to provide an apparatus for the dye-transfer of multi-color images in which the material to be dye-transferred is accurately positioned in relation to the matrices.

Still another object of the present invention is to provide an apparatus for the dye-transfer process which duplicates a number of color images of good quality at a low cost.

**BRIEF DESCRIPTION OF THE DRAWING**

Other objects, features and advantages of the present invention will be made apparent from the following description of a preferred embodiment thereof taken in conjunction with the accompanying drawing which is a schematic side view of a multi-color dye-transfer apparatus constructed in accordance with the present invention.

**DESCRIPTION OF THE PREFERRED EMBODIMENT**

Now referring to the drawing, the reference numerals 1, 2 and 3 indicate matrix drums for holding three matrices  $M_1$ ,  $M_2$  and  $M_3$  obtained through a three color separation. The matrices are contacted and fixed on the surface of the drums 1, 2 and 3. The reference numerals 4 and 5 indicate gears in meshing engagement with the gears fixed to the side of the drums 1, 2 and 3 for rotating the drums at the same rotary speed and in synchronism with each other. The reference numeral 6 indicates a material to be dye-transferred of web shape coming from a mordanting process. The numerals 7, 8 and 9 indicate squeeze rollers and the numerals 10, 11 and 12 indicate guide rollers. The dye applying devices for applying the dye to the surface of the matrix drums are indicated at 13, 14 and 15. The reference numerals 16, 17 and 18 indicate washing devices for washing the excessive dye out of the surface of the matrices.

In the above described arrangement, the material 6 to be dye-transferred is pressed against the matrix drums 1, 2 and 3 by squeeze rollers 7, 8 and 9 and the guide rollers 10, 11 and 12. The matrices on the drums 1, 2 and 3 are dyed respectively with the different dyes. The matrices are then provided with washing liquid by the washing devices and the liquid is absorbed by the washing devices together with the excessive dye. The dyed image then is transferred to the material 6 at the positions between the squeeze rollers 7, 8, 9 and the guide rollers 10, 11, 12.

As described above, in the apparatus in accordance with the present invention, the material to be dye-transferred is moved together with the matrix in contact therewith, and the dye transferring is conducted continuously. Further, the apparatus of the present invention does not require any perforations in the matrices or the material to be dye-transferred for the purpose of position regulation and driving. This is because of a lack of color displacement in transferring when the matrices are precisely positioned on the matrix drums at the time of mounting the matrices thereon.

However, if the material 6 to be dye-transferred is a material such as base paper of the conventional photographic paper, it expands and contracts due to tension, moisture, heat and so forth. Such expansion and contraction result in color displacement in the transfer process. The direction of the color displacement is either forward or backward with respect to the advancing direction of the web material 6.

The following three points are considered to be the reasons for the color displacement:

1. The material 6 to be dye-transferred is rubbed by the squeeze rollers 7, 8 and 9;
2. The material to be dye-transferred is unevenly expanded owing to the play of the gears; and
3. The thickness of the gelatin relief of the matrices is different in different matrices and the effective diameters of the drums thus are different for different colors.

It has been found that a stable position regulation can be conducted in the case of using a paper such as the conventional base paper of the photographic paper as the material to be dye-transferred, by making the diameter of the second and third matrix drums 2 and 3 larger than the upstream drums 1 and 2 by 0.02 to 0.5 percent. By the above construction of the drums, slack is prevented between a squeeze roller adjacent to a drum and a guide roller adjacent to the previous drum, and the web material 6 is held in a tensioned condition.

Further, one of the reasons for preventing the color displacement is that the slip between the matrix and the material to be dye-transferred is prevented. The material to be dye-transferred has a layer mainly consisting of gelatin as a layer dyeable with the dye. When the layer is inserted between the squeeze roller and the matrix drum after absorbing water content to the saturated extent, the layer presents a strong resistance against the tension of the material in the longitudinal direction by the boundary tension of the water absorbed therein. Therefore, there is no slip between the matrix and the material to be dye-transferred. Accordingly, the material 6 to be dye-transferred running through the apparatus shown in the drawing is hardly expanded or contracted in the apparatus however strongly the material 6 may be pulled at the portion upstream of the entrance of the apparatus shown or downstream of the exit of the same. In other words, the slack provided within the apparatus cannot be removed from outside the apparatus. It will be understood that the slack provided between the drums also cannot be removed. Further, the slack provided within the apparatus cannot be removed by pulling the web material 6 when it is in a position between the adjacent drums. Preferably, the matrices  $M_1$ ,  $M_2$  and  $M_3$  are in downstream order, longer in dimension corresponding to the periphery of the drums about which they are wrapped in direct proportion to the increase in drum diameter to insure registration of the multi-colored images which increase longitudinally due to web stretch.

The slack of the web material provided in the apparatus naturally results in the color displacement, namely, the displacement of the image in one color from the formerly disposed image in another color. Even if the displacement made during one rotation of the drum is a negligibly small one, the displacement is made larger while the transferring is repeated by the hundreds of rotations of the drum. In the present invention, there is no such displacement since the diameter of each drum is made larger than that of the drum disposed upstream therefrom.

Hereinafter is shown the results of some experiments on the color displacement carried out in accordance with the apparatus as shown in the drawing. In the experiments, a material to be dye-transferred having a width of 300 mm is dipped in water for 20 to 60 minutes and dye-transferred at the rate of 450 mm/min. The value of the color displacement is that measured after nine sheets of duplicates have been dye-transferred, namely, the color displacement in the tenth sheet shown in comparison with the conventional apparatus.

|             |                                                                        | diameter of drums (mm) |        |        | color displacement (mm) |             |
|-------------|------------------------------------------------------------------------|------------------------|--------|--------|-------------------------|-------------|
|             |                                                                        | drum 1                 | drum 2 | drum 3 | first sheet             | tenth sheet |
| (Reference) | Baryta paper 210 g/m <sup>2</sup> coated with 10 $\mu$ gelatin.        | 141.00                 | 141.00 | 141.00 | 0.1                     | 1.5         |
| Example 1   | Baryta paper 210 g/m <sup>2</sup> coated with 10 $\mu$ gelatin.        | 141.00                 | 141.10 | 141.20 | 0.0                     | 0.2         |
| Example 2   | Cellulose triacetate 0.2 mm thick coated with 10 $\mu$ gelatin.        | 141.00                 | 141.02 | 141.04 | 0.0                     | 0.1         |
| Example 3   | Polyethylene terephthalate 0.17 mm thick coated with 10 $\mu$ gelatin. | 141.00                 | 141.01 | 141.02 | 0.0                     | 0.0         |

As one device analogous to the apparatus of the present invention, a paper take-up rotary printer has been known in the art. In the rotary printer, two methods are known for regulating the position of the plate with respect to the paper. One of the methods is one in which the length of the paper passage is changed and controlled to modify the printing position between the printing stations. The other of the methods is one in which the rotating angle of the drum is controlled to amend the printing position with respect to the paper. However, the dye-transfer process in which the material to be transferred contains high water content up to the saturation extent is basically different from the process in which a completely dried paper is printed. That is, the paper containing a great amount of water such as baryta paper is expandable by tension and it is hard to contract if once expanded.

Accordingly, in the apparatus of the present invention, the material to be dye-transferred is normally subjected to constant tension until the dye-transfer process is completed with respect to all colors. Further, the color displacement owing to the doubled expansion of the material is prevented in the present invention. In the event that the conventional apparatus used for rotary printing is used in the dye-transfer process, a large space is required to be provided between the matrix drums for exerting tension on the material to be dye-transferred, and accordingly, the size of the apparatus becomes large and the time of passage of the material becomes long. Thus, particular care is required to keep the physical conditions on the material to be dye-transferred constant with respect to the matrices. Further, in the case of the rotary printer, the plate drum and the material to be printed may be in linear contact with each other. Therefore, the relative size of the apparatus to the contact time is much larger in the rotary printer. In contrast to this, in the apparatus of the present invention, the material to be dye-transferred preferably is in surface contact with the surface of the matrix, and the distance between the matrix drums is desired

to be as short as possible to fulfill the physical condition of the material to be transferred. Thus, there are substantial differences, as hereinabove explained, between the conventional rotary printer and the apparatus constructed in accordance with the present invention.

The present invention has been described in detail in the specification with particular reference to a preferred embodiment, but it will be understood that various modifications and variations can be effected within the scope of the invention as described hereinabove and defined in the appended claims.

What is claimed is:

1. In an apparatus for transferring multiple color dye images in superimposed fashion, in sequence, on a tensioned moving web, during which the web becomes water saturated and stretches longitudinally, said apparatus including: a plurality of rotatable drums, each drum supporting a matrix on its periphery, means for driving the drums at the same angular velocity, dye solution supplying devices operatively associated with said drums to supply a different color dye to respective drum matrices, and a plurality of press rollers disposed in contact with the web and pressing the web into peripheral contact with the drums for a prescribed duration, the improvement wherein: the diameters of successive drums increase in the direction of web movement in direct proportion to the longitudinal stretch of the web caused by water saturation during image transfer to compensate for web stretching and prevent slack from occurring within the web from drum to drum, and thereby maintain full web contact with the drums to improve registration of the superimposed color dye images transferred from the various matrices to the web during movement of said web through said apparatus.

2. The apparatus as claimed in claim 1, wherein the matrices are of increased circumferential length, corresponding to drum diameter, progressively in the direction of web movement to further improve multi-image registration.

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