

[54] MULTICOLOR TEXTILE PATTERN TRANSLATOR

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[51] Int. Cl. **G01j 3/34**

[58] Field of Search **250/226, 208, 209; 356/186, 190, 195, 176, 177; 178/5.2 R, 5.2 A**

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Primary Examiner—Walter Stolwein

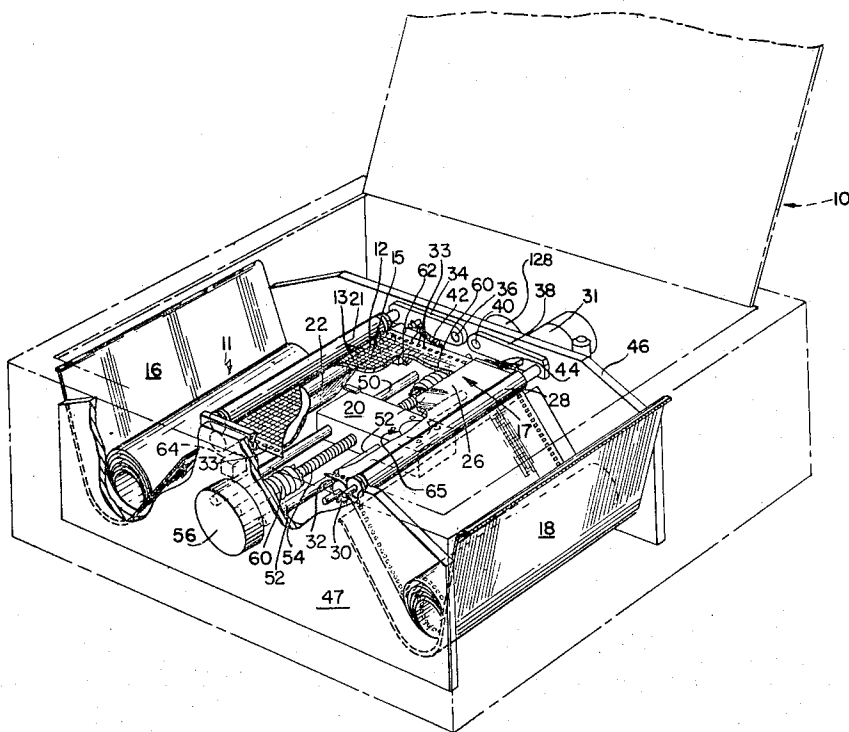
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[57]

ABSTRACT

A multicolor textile pattern translator has a scanner arranged to scan a color pattern. The scanner includes a light source for directing light toward the pattern and a plurality of light sensors arranged to receive light reflected from the pattern. Each light sensor is responsive to a different, very narrow, nonoverlapping spectral band of the reflected light, and each sensor produces an electrical signal in response to reflected light within its corresponding spectral band. The chosen colors are such that they can produce two magnitude levels of light reflection, one level is called high and one called low and the reflection combination of high and low levels for each sensor is different.

11 Claims, 4 Drawing Figures



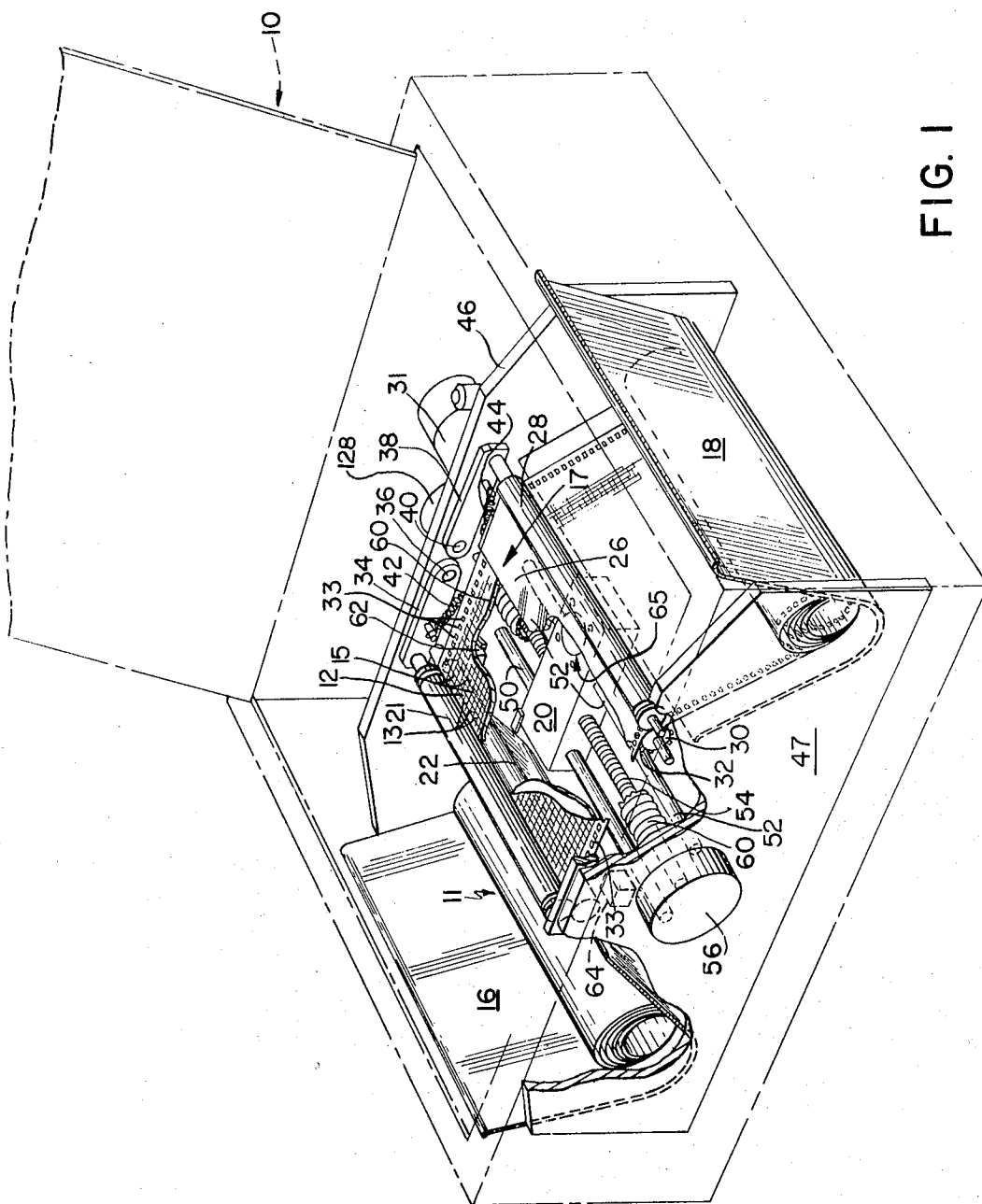


Fig. 1

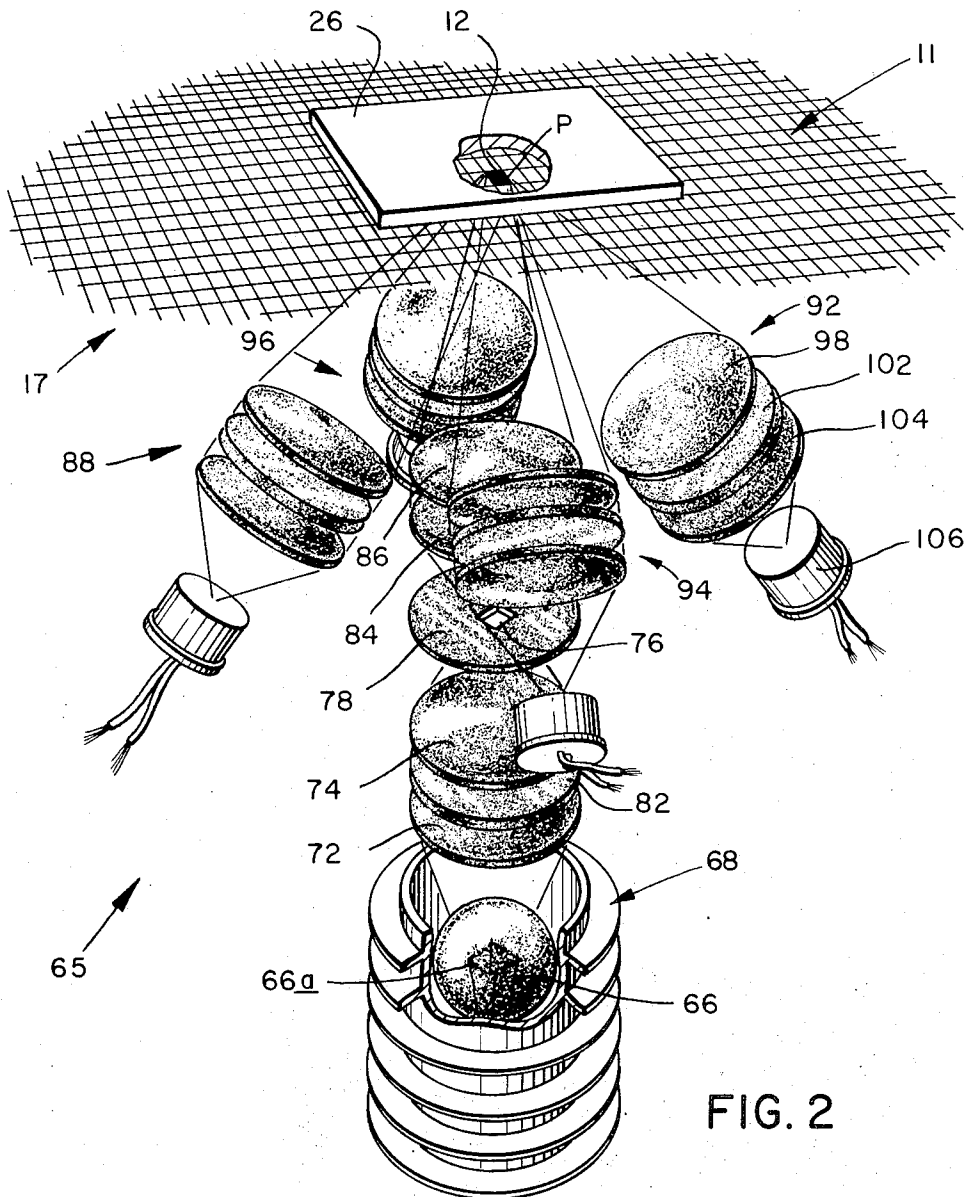
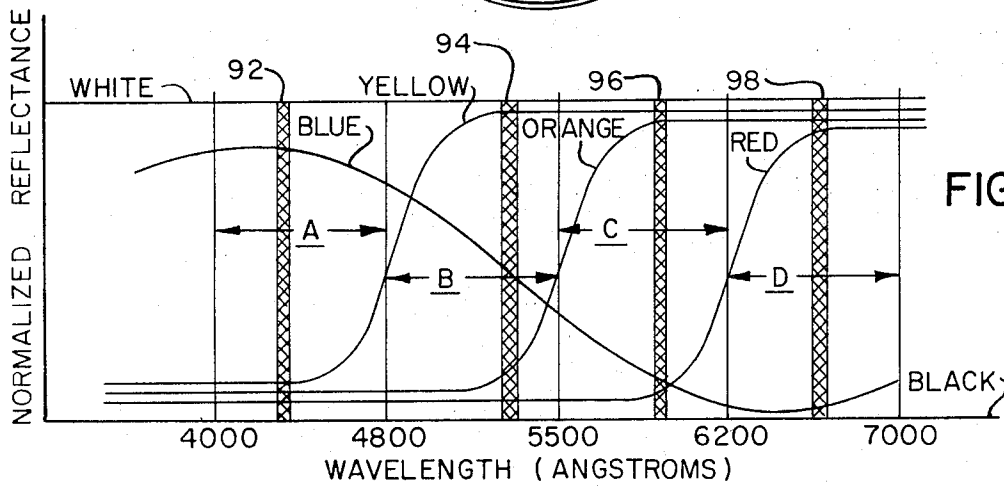


FIG. 2



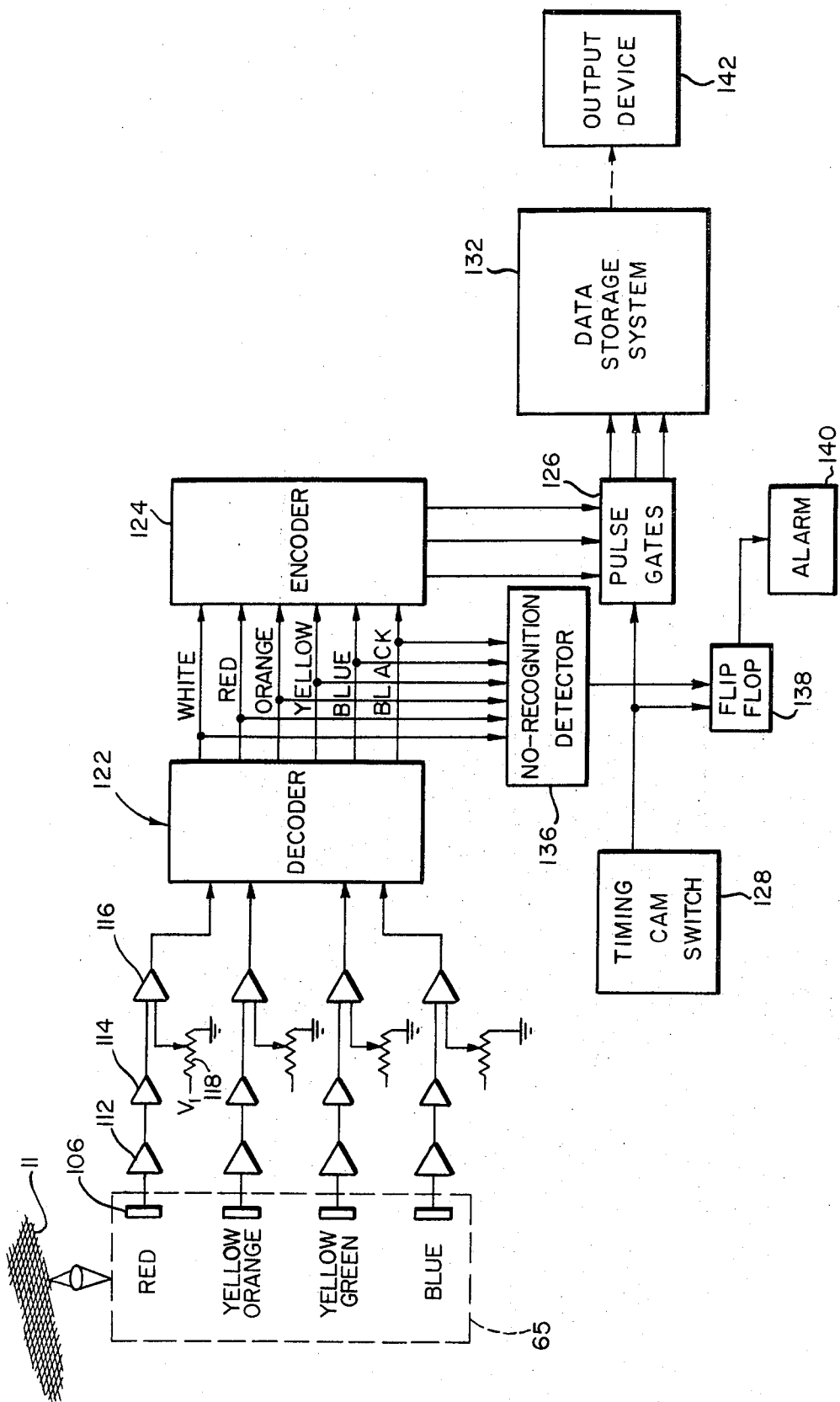


FIG. 4

MULTICOLOR TEXTILE PATTERN TRANSLATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the reproduction of textile pattern instructions in a form readable by programmable textile machines. Specifically, the invention relates to the translation of textile patterns from a multi-colored, graticulated pattern format utilized by the textile designer to a punched card or magnetic tape or other format readable by a textile knitting or weaving machine.

The textile designer normally lays out a design pattern on a strip of drawing material which we shall call the scanner art medium. A graticulated pattern is overlaid on the art medium, with each individual element of the resultant grid being a cell of the design pattern. A "row" of the art medium is a sequence of cells traversing the width of the medium while a "column" is a sequence of cells extending lengthwise of the medium.

The designer has two or more colors at his disposal with which to mark the cells of the art medium. Each cell corresponds to a particular location on the final textile fabric. Each color, according to the code being used, may represent a particular variable in the textile design pattern. For example, the color in the cell may represent a particular thread color, type of stitch, or size of thread in the corresponding location on the textile fabric.

The color-coded pattern must be translated into a format which is meaningful to the textile machine. The following discussion will center on the well-known jacquard knitting machine; however, the invention is fully applicable to other textile machines controlled by a coded input. The jacquard machine responds to instructions punched on a suitable medium utilizing a binary code. The medium may be punched cards or punched tape. For purposes of this discussion, we will assume a tape is employed. Since the textile machine senses the presence or absence of a hole in the punched tape for each of the different colors involved, it is necessary to have a field of a corresponding number of columns on the tape for each row on the art medium. That is, each column of cells in a given field on the tape corresponds with a single cell in the art medium and a single location in the textile fabric. Each of the rows in the tape field, on the other hand, corresponds to one of the colors at the artist's disposal. One of the cells in the tape column is punched, in accordance with the color in the corresponding art medium cell, to designate the desired feature in the particular textile location.

2. Prior Art

Ordinarily, the translation from the color-coded art medium to the punched tape is done manually. The operation requires two people; one operator scans the cells of the art medium while the other operates the tape-punch machine. The machine advances the tape one column at a time.

Inherent in the two-operator, manual translation method are several problems which tend to cause errors in translation. The scanner may improperly identify the cell location; the punch operator may misunderstand the cell location identified by the scanner; or the punch operator may position the punch mechanism over the incorrect point on the tape or card, even though he properly hears the scanner. Moreover, the

manual translation process is quite tedious and this increases the probability of error.

Some systems have been proposed to perform the scanning operation either automatically or semi-automatically. One such machine has a scanning head that moves along each row of the art medium, focuses light on successive cells of the row, and senses the color located in each cell. Simultaneously with the scanning operation, a card-punching machine is actuated to punch the translated information into a machine-readable format.

In one type of system, the scanner head contains one photodetector with color filters located on a disc between the art medium and the photodetector. The disc rotates so that all the filters are successively interposed between the art medium and the photodetector every time a cell of the art medium is sensed. In this manner, each cell is sensed for all possible colors during the scanning operation.

That type of system has failed to gain widespread commercial acceptance, apparently for several reasons. For example, in a system to be used in connection with a jacquard machine, punching the tape simultaneously with the scanning operation complicates the machine decoding process by requiring that the punching commands control motion in two dimensions, so that any of the colors of the code may be punched on the machine-readable card. Specifically, the card punch controller must allow translation of the punch mechanism over a relatively wide area matrix; i.e. the punched card field corresponding to each row of the art medium. Moreover, it appears to us that that system is less mechanically reliable than one would desire.

Recently, an improved textile pattern translator has been devised which does solve most of the above problems. This is disclosed U.S. Pat. No. 3,710,020 dated Jan. 9, 1973 entitled Textile Pattern Translator, owned by the assignee of the present application. That translator has a scanning head including two color-sensitive photodetectors. The head automatically scans successive rows of a graticulated textile design pattern so that the photodetectors sense the colors of successive cells in each row. The photodetector outputs are stored in a memory each time an individual cell is traversed and after an entire row has been scanned, the stored information is read out of the memory and used to control a card-punching machine.

That approach greatly simplifies the required circuitry and enables one to use a relatively simple card-punching machine having only a single row of punches. However, it is limited to the sensing of four colors (including black and white), insufficient for some multi-color pattern representations. This is because it identifies the color of light flux by measuring its intensity at the photodetectors after transmission through separate appropriately chosen broad spectrum filters. Since the dyes and pigments used in all coloring materials have spectral reflectances which are far from ideal and since there may be imperfections in the color markings being applied to the cells of the art medium, the system is limited in the number of colors between which it can discriminate.

Also, it would be desirable to simplify the circuitry of translators of this type even more.

Accordingly, this invention aims to provide an accurate and reliable machine for translating a color-coded art medium to a format readable by a textile machine.

Another object of the invention is to provide a translator of this type which can reliably translate a larger set of colors than prior similar apparatus. As such, it is an improvement on the device disclosed in the afore-said pending application.

A further object is to provide a textile pattern translator which can accurately translate a pattern despite a relatively simple and straightforward circuitry.

It is a further object of this invention to provide a translator of this type which requires minimal service or repair. A further object of this invention is to provide a machine that is easily adaptable to a broad variety of textile weaving or knitting machines and to other processes which require translation of an encoded multicolor pattern to a machine-control format.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

SUMMARY OF THE INVENTION

Our translating machine comprises an indexing mechanism which moves the art medium through a scanner row-by-row. Each time the medium is indexed, a scanner head moves a set of photodetectors along a row of the medium to develop outputs in a binary code format corresponding to the colors of successive cells in the row.

Each time the color of an individual cell has been sensed, the information is electrically stored in a memory. Thus, the information stored in the memory corresponds to the pattern on the art medium. This is encoded subsequently to a format capable of controlling a conventional machine to reproduce the pattern on the art medium.

The scanner head contains a light source which is focused on a single cell of the design pattern. Thus, as the head moves along a row of the art medium, the light beam successively illuminates each cell in the row. Diffusely reflected light from each illuminated cell is simultaneously sensed by several photodetectors mounted in the scanner head.

However, instead of identifying the color of light flux by measuring the intensity after transmission through broad spectral filters as is done in the prior translators, we sense each color by measuring its intensity at a few appropriately chosen narrow points of its spectrum and then obtain a binary code of "high" and "low" reflection levels which correspond to the sensed colors. Using this technique, we are able to translate reliably as many as six colors and, for purposes of this discussion, we will specify a set of six colors.

In our system, the color set to be translated is chosen so that any pair of colors will differ very substantially in one or more regions of the color spectrum. With an ideal set of eight colors, the spectrum could be divided into three spectral regions. In each region, any color of the set would be either totally reflecting or totally absorbing. Then only three photodetectors and optical filters, each having its transmission band within one of the three regions, would be required to develop binary representations of the eight colors being sensed. Specifically, if we ascribe the value 1 to a region in which a color is totally absorbing and the value 0 to a region in which it is totally reflecting, an ideal set of eight colors might provide the following value sets corresponding to their reflections in the three spectral regions: black (000), red (001), green (010), yellow (011), blue (100), purple (101), cyan (110) and white (111).

In practice, however, pigments and dyes do not have sharp cutoff characteristics. Instead, they have a great amount of spectral overlapping.

In order to extend our technique to six colors under this limitation, we add an extra bit to our logical code: that is, we add one more optical filter to have four bits instead of three bits which is theoretically sufficient.

Six color separation is achieved by our using very narrow transmission band optical filters. Then, with four spectral regions, our system employs four photodetectors, each photodetector being faced with one of the narrow band optical filters. Consequently, the filtered photodetector outputs together comprise a four-bit binary code representative of the colors.

The color selection procedure will be described in more detail later. Suffice it to say at this point that the preferred color set consists of the warm colors deep red, orange and yellow, together with white, greenish blue, and black.

If during the scanning of a row in the art medium there is more than one color in any cell due to smearing or mixed colors, the system can always decide which color predominates and correspondingly store that color in the memory. As an alternative, the machine can be arranged to stop if it does not recognize a single color. In this event, the operator decides what color should have been read and registers this decision electronically into the memory. Another possibility is to erase the contents of the cell in question and color it properly. He then resets the machine which rescans the same row.

The art medium we prefer to use is a transparent white matte plastic tape which is preprinted with a light quadrille, each square being one cell. The tape may be colored by any convenient means such as color pencils, inks, poster paints, etc. A suitable plastic is polyethylene terephthalate (Mylar) slightly roughened or textured on one side to facilitate marking by the textile designer. The tape is viewed by the scanner against a white reflecting background. Since one of the colors in the chosen set is white, the white cells are simply left blank.

It should be mentioned at this point that the actual effect used by the detectors is a combination of reflection and double transmission. That is, part of the incident light from the scanner head is diffusely reflected by a colored cell and part is transmitted through the color and tape, reflected by the backing surface and then retransmitted diffusely by the colored cell. However, the combined reflected light which is incident on the photodetectors has a spectral intensity which is characteristic of the color in the cell.

The pencils, etc., used to color the art medium produce markings which are readily erased to correct mistakes in coloring the tape. Also, a plastic tape colored in this manner can easily be washed to remove the textile pattern recorded on it, while leaving the grid, row numbers, etc. which are indelibly preprinted. The tape can thus be used again and again for different textile patterns.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a pictorial view, partly broken away, of a textile pattern translator embodying the invention;

FIG. 2 is a simplified pictorial view of the scanner head;

FIG. 3 is a diagrammatic view showing the spectral regions and transmission bands of the detectors used in the present translator superimposed on the spectral reflectances of a typical color set; and

FIG. 4 is a block diagram showing the electronic circuitry associated with the FIG. 1 translator.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 depicts the textile pattern translator with its cover 10 raised, exposing the internal mechanism of the translator. The art medium, in the form of a white matte transparent tape 11, carrying a graticulated pattern with cells 12 arranged in columns 13 and rows 15, is loaded into a feed bin 16 and advanced row-by-row, across a scanning area 17 into a spill bin 18. Each tape advance brings a new row 15 into the scanning area 17, where a scanner 20 below the tape traverses the tape 11 to sense the colors of the cells 12 in the row. The sensed data is electronically stored and may later be used to control a card or tape punching machine or to directly control an electronically controlled textile machine in the manner disclosed in the aforesaid copending application.

More specifically, the tape 12 passes from the bin 16 between a top roller 21 and a bottom roller 22, and under a backing plate 26 in the scanning area 17 and then passes between a top roller 28 and a bottom roller 30 and finally into the spill bin 18.

The tape 11 is advanced by a stepping motor 31 which is coupled to the bottom roller 30.

The resulting rotation of the bottom roller 30 pulls the tape 11 across the scanning area 17 by means of cogs 32 that mesh with sprocket holes 33 along both edges of the tape. These cogs 32, and similar cogs on the bottom rollers 22 also serve to position the tape 11 in both the longitudinal and transverse directions, thereby assuring that each tape advance brings a new tape row 15 into the correct location in the scanning area 17.

Still referring to FIG. 1, top roller 21 is supported by an arm 34 which rotates on a pivot 36. The top roller 28 is similarly supported by an arm 38 on a pivot 40. Tension springs 42 and 44, connected to the arms 34 and 36, maintain pressure between the top rollers and their corresponding bottom rollers. The rollers are all ultimately supported by housing walls 46 and 47.

To load the tape 11, the top rollers 21 and 28 are swung upwards, thereby enabling the operator to thread the tape 11 over the bottom rollers 22 and 30.

The scanner 20 is mounted on guide rods 50 and 52 and is coupled to a lead screw 54. A drive motor 56 mounted on wall 47 rotates the lead screw 54 to advance the scanner 20 across the tape 11, i.e. along a row 15. A boot 60 protects the lead screw 54 from dirt or other damaging substances.

The colors of the tape cells 12 are sensed in a scanner head 65 as the scanner 20 advances. When the scanner has traversed a tape row 15, it is automatically returned to its starting position where it awaits a signal to scan the next row 15. A limit switch 62 is engaged when the scanner 16 is at its starting position, and a second limit switch 64 is engaged when the scanner 20 has traversed to the opposite end of a tape row 15.

Turning now to FIG. 2, the scanner head 65 carries a tungsten lamp 66 powered by a well-regulated current source and having a flat, square-format filament

66a. The lamp is recessed in a heat-dissipating housing 68. A first pair of lenses 72 and 74 positioned directly above the lamp images the filament near a small, square aperture 76 in a plate 78 with the image entirely filling the aperture. An infrared reflecting filament 82 is included between lenses 72 and 74 to block light in that spectral region. A second pair of lenses 84 and 86 positioned directly above aperture 76 images the illuminated aperture 76 on a plane P a few millimeters beyond the end of head 65. The center of this image constitutes the focal point of the scanner head. The area of this image is slightly smaller than the area of a cell 12 on the tape 11 (typically about 1/10 inch square).

The tape 11 is positioned so that, in the scanning area 17, its underside lies in the image plane P of the head. Accordingly, its underside is illuminated by a bright square of light giving rise to color-indicating reflections from that surface. A set of four photosensors subassemblies 88, 92, 94 and 96 are arranged symmetrically in a ring about the optical axis of lenses 72, 74, 84 and 86 and adjacent to the image plane P. Each subassembly is oriented at an angle so that its optical axis passes through the focal point of head 65.

The subassemblies are identical except for their spectral transmission characteristics. Therefore, we will describe only subassembly 92 in detail. It consists of a first lens 98 which has its primary focus at the focal point of the head 65 so that reflected light emanating from that point is collimated by this lens. A narrow band interference-type filter 102 is positioned beyond the lens and is oriented at an angle such that the passband of the filter with respect to the collimated light flux is centered in one of the desired spectral regions to be described later. Then a second lens 104 situated beyond the filter condenses the light transmitted by the filter onto the face of a photodetector 106. The only difference between the four subassemblies is in the spectral characteristics of the respective filters 102. Each photodetector 106 generates an output only in response to the light transmitted by its associated filter.

Turning now to FIG. 3, as mentioned previously, the six colors of the color set are chosen so as to maximize the differences between them in a set of spectral regions defined by reflectivity transitions of certain of the colors. Since these transitions are sharper for the longer wavelength colors, we select three colors from the long-wavelength side of the spectrum, namely, deep red, orange, and yellow to define the spectral region. The normalized reflectances of these colors at various wavelengths over the spectrum are shown by the correspondingly designated curves in FIG. 3. The transition wavelengths of these three "warm" colors define the four spectral regions designated A, B, C, D whose nominal boundaries are at 480, 550 and 620 angstroms, respectively. Also, the transition wavelengths of these three colors are preferably chosen so as to make the middle regions of equal width.

The fourth color is chosen from the short-wavelength side of the spectrum, e.g. blue. This "cool" color has a transition from the short-wavelength reflective region to the long-wavelength absorption region which is quite gradual and is specifically selected so that its transition range extends across one or both of the middle spectral regions B and C. In the illustrated embodiment, it is greenish-blue. The remaining two colors of the set are white and black which are at the ends of the reflectance scale in FIG. 3.

By translating the reflectance value of each color in each region into a binary format, i.e. ZERO for low and ONE for high, the six colors can be represented in binary form as follows in terms of their reflectances in the spectral regions A, B, C and D: Red — 0001, Orange — 0011, Yellow — 0111, White — 1111, Blue — 1X00 (where X denotes an ambiguity because blue is neither highly reflective nor highly absorptive in region B and the detectors for this region may therefore sense or fail to sense reflected energy when a blue cell is scanned), and Black — 0000.

Photosensor subassemblies 92, 94, 96 and 98 (or more particularly their filters 102) have very narrow passbands, each of which is located in one of the regions, A, B, C and D, respectively. These transmission bands are shown by the hatched areas in FIG. 3 and bear the same identifying numerals as the associated subassemblies. These bands are made as narrow as possible, the limiting requirement being that there must be enough transmitted energy for reliable detection by the photodetectors 106. The center wavelength of each transmission band is chosen to correspond to a wavelength of maximum color difference in the corresponding spectral region. As seen from FIG. 3, then, due to the characteristics of the various filters 102, the subassembly 92 detects only blue light and assembly 94 detects yellow light. Further, subassembly 96 detects yellow and orange light, while subassembly 98 responds to red, orange and yellow light. Further, all of the subassemblies respond to white light and none of them respond to the color black. The assembly 94 may or may not detect blue light.

Turning now to FIG. 4, the output of each of the four photodetectors 106 is amplified by a pair of linear amplifiers 112 and 114 and applied to a comparator 116. Each comparator is basically an operational amplifier which compares the amplified out of a detector 106 with a reference voltage across a variable resistor 118. The output of comparator 116 is a voltage having one or two levels depending upon whether the voltage applied to the comparator from the associated detector 106 is greater (i.e. the ONE level) or less (i.e. the ZERO level) than the voltage across its variable resistor 118. The resistor 118 thus provides a threshold. Accordingly, the light sensed by the photodetector 106 associated with the color red, for example, must be of sufficient intensity to develop a voltage which is higher than the threshold level before the corresponding comparator will produce a ONE output level indicating that the color red has been sensed.

Each threshold level is chosen halfway between the typical voltage levels obtained from the nearest two colors that have opposite binary values in that particular spectral region. For example, in FIG. 3, the variable resistor 118 associated with the D region subassembly 98 is set so that it provides a threshold voltage which is midway between the typical levels obtained when assembly 98 is illuminated by red and blue cells. Similarly, the threshold level of assembly 96 is set midway between the values obtained when it encounters orange and red, which are the closest opposites to the color orange in the C region.

Thus, for each one of the six possible colors in the pattern of the tape 11, the four comparators 116 will produce a characteristic set of voltage levels representing that color. The outputs of all four comparators are applied to a decoder 122. Depending upon comparator

outputs, a signal appears on one of six decoder 122 output lines.

The following Table I shows the outputs of the four comparators as a function of the color reflected from a cell 12:

TABLE I

COLOR DETECTED	Output from comparator in subassembly			
	92 (blue)	94 (yellow green)	96 (yellow orange)	98 (red)
Deep red	0	0	0	1
Orange	0	0	1	1
Yellow	0	1	1	1
White	1	1	1	1
Greenish blue	1	0.1	0	0
Black	0	0	0	0

As seen from Table I, there are seven combinations of comparator outputs that produce recognized color signals. (There are two combinations of the color blue because the response in the B region is ignored for that color since its spectral transition is quite gradual.) The nine other possible combinations of the four comparator outputs are not decoded by decoder 122. Thus, the system is unresponsive to colors other than the six described above. An unrecognized color may be present, for example, when one or more of the colors applied to tape 11 is defective or smeared or where one of the cells 12 contains mixed colors. However, since the present system only responds to wavelengths of maximum color difference, it can tolerate a wide range of imperfection in the color of the cell being scanned before signalling an improper color.

A parallel binary encoder 124 encodes the signals on the six lines from decoder 122 into a compact three-bit binary signal which appears on three lines leading to a conventional pulse gate 126. A timing cam (not shown) rotating with lead screw 54 momentarily closes a switch 128 (FIGS. 1 and 4), thereby producing a synchronizing pulse whenever the head 65 is centered on a cell 12 of the art medium as it scans across that medium. This assures that the system output is truly representative of the colors in the individual cells 12. This synchronizing pulse from switch 128 is applied to the pulse gates 126 so that the signals on the three lines from gates 126 consist of coded pulses which represent the color in successive cells being scanned by head 65. These coded color signals are stored in a data storage system 132.

The six lines from decoder 122 are also connected to a "no recognition" detector 136 which is simply another set of gates. Detector 136 senses the absence of a signal on any of the six lines from decoder 122. When this condition occurs, detector 136 applies a signal to a flip-flop which is also gated by the synchronizing pulses from timing cam switch 128. Thus, an ON state of flip-flop 138 signifies an unrecognized or undecided color in the particular art medium cell being scanned at the time. The output of flip-flop 138 may be used to actuate an alarm 140 to apprise the operator that an improper color has been detected, or to disable motor 56 to stop the scan and give the operator an opportunity to correct the color in the cell.

The cell color information may be stored in system 132 until the entire pattern on tape 11 has been scanned. Then it may be read out to an output device 142. This device may be a paper tape punch, tape re-

corder, or an interface for an electronically controlled knitting machine, etc. More preferably, however, the data representing the cell colors in each row of cells is transferred from system 132 to output device 142 before the next row of cells is scanned by head 65 as described in the aforesaid patent application. This reduces the required memory storage capacity of system 132 and simplifies the output device 142.

To begin operation, motor 56 is energized in the forward direction so that the scanner 20 (FIG. 1) begins to scan a row 15 of the tape 11. Each time the scanner head 65 is centered over a cell 12, the timing cam switch 128 is closed, thereby emitting a synchronizing pulse which indicates that it is properly centered on that cell. At this instant, the signals on the three output lines of decoder 124 accurately reflect the color of that particular cell. Therefore, the first pulse from switch 128 causes the color of the first cell in the row being scanned to be recorded in the information storage system 132. The second pulse from switch 128 causes the color indication of the second cell of the same row to be impressed in the information storage system 132. The colors of all of the cells in the first row being scanned are thus recorded in this manner.

When the scanner 16 reaches the end of the row, it actuates switch 62 which causes the scanner to return to its initial position at the left hand of the lead screw, at which point the limit switch 64 shuts off motor 56. During the scanner return operation, the timing cam switch pulses are not sensed. Therefore, no color information is applied to the data storage system 132. The data representing the cell color in the first row is then transferred to the output device 142 as described in the aforesaid pending application. The translator is now ready to scan the second row of the graticulated pattern on tape 11. To do this, the operator again energizes motor 56, causing the scanner to scan the second row of the pattern and the resultant color information is stored in the data storage system 132, and so on.

In the event that a particular cell in tape 11 contains an unrecognized or wrong color, an indecision signal emitted by the flip-flop 138 will trigger alarm 140 to apprise the operator of this fact and will stop the scanning operation at that point until the proper color correction can be made.

After the scanner has scanned the last row of the tape 11, coded information representing all colors of the cells in the pattern has been transferred to output device 142 to generate a punched card or tape capable of operating a conventional textile machine.

Thus, the present translator is able to reproduce color patterns containing as many as six colors. Furthermore, the system translates these colors quite accurately so that it generates the necessary data to enable a machine to reproduce the master pattern quite accurately. Further, it employs relatively simple circuitry because the measured signals are used directly in binary decision-making.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described.

We claim:

1. A six color design translator comprising
 - A. means for supporting a colored design of up to six colors,
 - B. a scanner positioned adjacent the supporting means, said scanner including
 1. a light for illuminating a design in the supporting means,
 2. not more than four photosensor subassemblies, and
 3. means for transmitting a narrow spectral band of light to each photosensor subassembly, each band being located in a different one of a set of spectral regions defined by the reflectivity transitions of a selected set of not more than four colors, each said photosensor subassembly providing an output signal when it detects light in its respective band only,
 - C. means for moving the scanner and a design in the supporting means relative to one another, and
 - D. decoder means responsive to the photosensor subassembly outputs for generating a series of signal sets, each set being representative of one color in the design being scanned.
2. The translator defined in claim 1 wherein the colors of the set include three colors that reflect primarily in the long-wavelength side of the color spectrum, and one other color that reflects in the short-wavelength side of the spectrum.
3. The translator defined in claim 2 wherein there are four said spectral regions of substantially equal width defined by the reflectivity transitions of said three long-wave reflecting colors.
4. The translator defined in claim 3 wherein the three colors are a red, an orange, and a yellow.
5. The translator defined in claim 3 wherein the three colors are a red, an orange and a yellow, and two other colors are a blue and a magenta.
6. The translator defined in claim 1 and further including means for storing said signal sets until completion of a scan.
7. The translator defined in claim 1 and further including means associated with each photosensor subassembly for providing a color threshold so that the photosensor subassembly will emit a signal when it detects light only when said light is above a selected intensity.
8. The translator defined in claim 7 wherein the threshold providing means is composed of
 - A. means for providing a reference level, and
 - B. means for detecting whether the output signal is above or below the reference level.
9. The translator defined in claim 1 and further including
 - A. means for decoding the signals from the photosensor subassemblies so as to develop a signal which identifies which of the colors in the selected color set is being scanned, and
 - B. means for detecting when a color not in the selected set of colors is being scanned.
10. The translator defined in claim 1
 - A. wherein said colored design is on a translucent sheet, and

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B. further comprising a reflecting surface placed in contact with the sheet at the surface opposite from the scanner and adjacent to the scanner.

11. The method of translating colors in a multi-color design of up to six colors comprising the steps of 5

A. selecting four spectral regions whose connecting borders are defined by sharp reflectivity transitions of three colors at the long wavelength end of the spectrum,

B. illuminating the design so that light reflects from the design, 10

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C. passing the reflected light through not more than four filters, each of said filters having a passband in a different one of the four spectral regions, the width of each passband being only a small fraction of the width of the spectral region in which it is located,

D. detecting the light transmitted through each of the filters, and

E. developing binary electrical signal sets identifying the color of the transmitted light.

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