

Computer controlled warp patterning on sectional warping machine

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A computer-based system has been designed and tested under normal industrial working conditions for identifying correct location of different coloured packages on the creel of the sectional warping machine. The controller glows the appropriate LED's on the creel for loading packages of one color one at a time. The system helps in preventing mistakes in warp pattern on the weaving machine. The loading on the creel is done fairly fast even by an unskilled worker.

Keywords: Creel position, Graphical user interface, Interface module, Logic circuit, Sectional warping, Warp pattern

1 Introduction

The section warping machine is used for making patterned warps for weaving machine. The arrangement of colored threads in the warp sheet as per design is achieved by stacking colored packages on the creel in a suitable format. In a creel of about 400 packages the translation of warp pattern into stacking of colored packages is quite complicated and time consuming. Any mistake in placement of colored package on the creel will make a wrong pattern on the weaving machine and it cannot be rectified. For complicated warp patterns it is essential to have some control system to translate the warp pattern into appropriate positioning of colored packages in the creel. A microprocessor based system has been designed for apportioning colored packages on the creel at the appropriate place to prevent mistakes and speed up creeling.

2 Concept of Design

The whole system is conceptualized based on following five basic modules (Fig. 1):

(i) Data Input — The main function of this module is to input the warp pattern into the program, which then processes the input data to generate respective creel positions.

(ii) Software Module — This module consists of following three main components:

- Allotment of Creel Positions – It generates the creel positions for all the yarns in the repeat.

- Conversion of Data – It converts the creel positions data into an I/O interface compatible format.
- Graphical user Interface – This enables the user to input the data as per program requirements.

(iii) Interface Module — An I/O card has been used as an interface. It is a link between the software module and the logic circuit. The software module sends the data compatible with the I/O card to the logic circuit using this module.

(iv) Electronic Circuit — The circuit is divided into following two main parts:

- Logic Control — This part of the circuit takes the input from the software, decodes the digital signal and sends it to the display on the creel.
- Display — Two separate display units have been used, namely (a) console panel – displayed to the system operator for verification, and (b) display on creel—used to display the creeling positions.

(v) Fail Safe — It is one of the most critical parts of the system. It enables timely detection of errors due to faults in circuit components or LEDs.

All the five modules are discussed in details hereunder.

2.1 Data Input

The software requires the input data corresponding to the warp pattern being created. This can be achieved by manually feeding the input data into corresponding file locations through a user interface, which will be then used by the system for calculating the positions of different color yarn packages on the creel and marking the creel electronically for creeling

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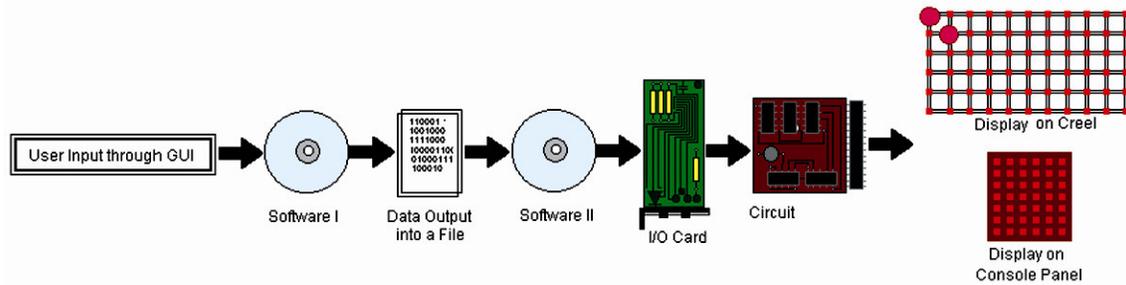


Fig. 1—Concept of design

purposes. For this, a preliminary assessment of the fabric is required to obtain its warp pattern, which can be fed into the program as per the interface of the software (discussed later).

2.2 Software Module

The software module consists of three main parts, namely allotment of creel positions, conversion of data, and graphical user interface.

2.2.1 Allotment of Creel Positions

This program in java reads the warp pattern from the user input and then determines the creeling positions corresponding to various colors, one at a time. The strategy used is as follows:

The program asks the user to input color and the number of threads of that color one by one in the order of their appearance in the pattern. These positions and the color data are stored in a linear array. Thus, all the threads in the repeat are allotted their corresponding positions on a virtual linear creel. This means the color in array $a[i]$ is the color of the thread at the i^{th} position.

The number of threads for each part of the creel is calculated and the division of the repeat is done accordingly. The threads in respective creels are allotted such that all the packages on the creel are at the shortest distance from the warp beam. A creel with loading arrangement from top-back position in the left panel to bottom-back position in the right panel has been assumed.

2.2.2 Conversion of Data

The data corresponding to the occupied creel positions need to be converted into a format compatible with the interface module. This module maps the linear positions of the threads on to a 2-dimensional matrix and generates their corresponding X and Y coordinates. These coordinates are further converted into the binary format to be sent to the interface module. The whole

exercise is done separately for distinct colors once the signal for that color to glow is encountered. Hence, every time a color needs to be displayed on the creel, corresponding data is generated and given to the interface module.

2.2.3 Graphical User Interface

This module enables the user to input the data as required by the software program. The various facilities available with the GUI are as follows:

(i) Color Selection — This facility gives user the liberty to select any color of his choice from the entire color spectrum through following three modes:

- Color pallet — The user can select a color from an already displayed color pallet, which displays 45 distinct basic shades, simply by clicking on the color of interest. This displays the selected color on the main color panel and if the shade needs to be modified, fine adjustments can be done using RGB scroll bars (Fig. 2).
- RGB scrollbars — The user can also create a custom color by scrolling the RGB scrollbars and view the varying color simultaneously on the color panel. The corresponding RGB coordinates are also displayed for future reference (Fig. 2).
- Re-selection of colors — A user can select any color already used in the pattern again by clicking on a separate display of already selected colors (Fig. 2).

(ii) Repeat Input and Status Display — After selecting a color, the user is required to type in the number of threads of that color in the repeat at that position. The selection is confirmed by clicking on the OK button. After every selection total number of threads and total number of distinct colors are displayed (Fig. 3).

(iii) Warp Pattern Display — As the user inputs the repeat (on clicking OK button), the pattern build-up is displayed on the screen (Fig. 3). This procedure is



Fig. 2—GUI for color selection

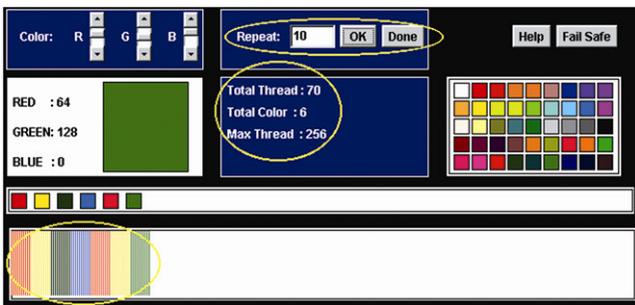


Fig. 3—GUI for status and pattern display

repeated until the complete pattern has been fed. To proceed to the next stage, i.e. display on the creel for creeling, the user has to click on the DONE button.

(iv) Creel Pattern Display—The pattern is divided and displayed on two separate display panels representing left and right creel (Fig. 4).

(v) Selection of Color for Creeling — All the colors forming the pattern are displayed on the screen. The user needs to click on the color for which creeling has to be done. The selected color is highlighted and the number of positions glowing on the creel is displayed. This process can be repeated to select other colors (Fig. 4).

(vi) Help — The screens also display HELP buttons, which can be clicked at any stage if a user needs to refer to the instruction manual. The help system gives more information about creeling software. One can choose a colour as all the colours in the pattern are displayed on the screen. One can select the desired colour.

2.3 Interface Module

I/O card is used as an interface between the computer program and the logic control circuit. An I/O card is an electronic card, which has two connectors (CN1 and CN2) each having three input /

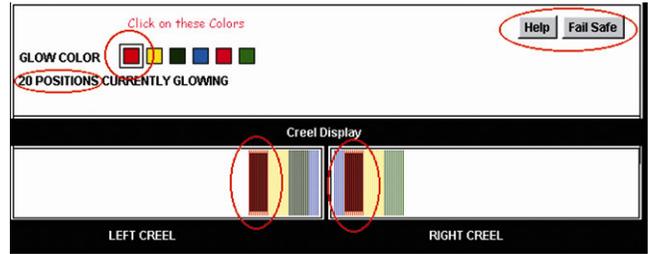


Fig. 4—GUI for displaying colors on the creel

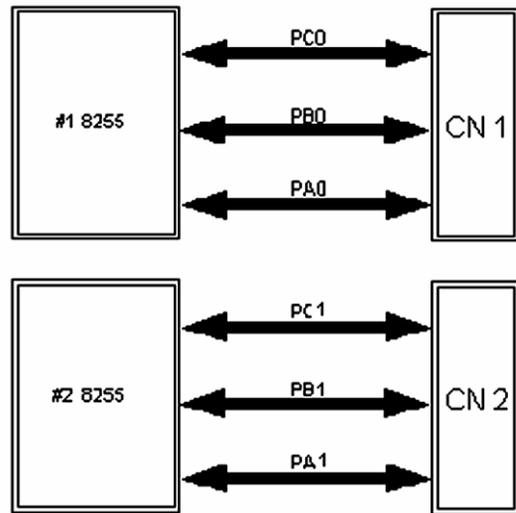


Fig. 5—I/O ports block diagram

output ports, namely A, B, and C. The input / output ports of the card used PET-48DIO emulates as two Intel 8255 general-purpose programmable peripheral interfaces (PPI) (Fig. 5).

The port C can be used as two individual 4-bit ports, namely C_L (lower) and C_U (upper). Any port can be used as an input or output port. The type of I/O card used has 48 input / output lines which can be expanded to any number in multiples of 24.

In this system, for 256 creel positions, a 16x16 matrix of LEDs has been used. It requires 16-bit inputs both for 16 rows and 16 columns. Thus, in all 4 output ports are needed. This has been achieved by using ports A and B of both connectors, named as ports A0, B0, A1 and B1.

For extending the above circuit for 600 creel positions, a 25x25 matrix of LEDs can be assumed. To get 25-bit data for both 25 rows and 25 columns, a total of 8 distinct output ports is required. Thus, two I/O cards are needed. The ports A0, B0, C0 and A1 of both I/O cards can be used to get the required 8 ports.

2.4 Electronic Circuit

2.4.1 Logic Control

This part of the circuit takes the input from the software, decodes the digital signal and sends it to the display on the creel. The design development stages are as follows.

2.4.1.1 Preliminary Design

This design is based on sending the signals, generated by the software according to the color pattern of warp, to the LEDs corresponding to the respective creel positions for different colors one at a time.

One terminal of all the LEDs is grounded (0) and the other is connected to various decoders through latches. Port A of the I/O card is used as main data out port and port C for the selection of latches for the final display (Fig. 6). Port C_L sends data to octal buffers whose output is used to enable the 600 latches, which results in glowing of the LED. In order to choose these octal buffers, while inputting the data into the latches, a 3:8 decoder is used, the input of which is again governed by rest of the output bits of the 5th octal buffer that is using only half of its bits to select latches. This decoder is enabled using output from port C_U.

Port B is not used in this design. Thus, for a particular color, a software program first generates

creel positions according to the color pattern. These positions are then converted into hexadecimal codes according to the circuit requirements. These values are fed to the circuit one by one and the status for all the LEDs is stored in their corresponding latches. Finally, all the latches are enabled to pass on the data to the LEDs, which glow only if the signal sent to them is 1 (high).

2.4.1.2 Drawbacks of Preliminary Design

- Since each LED is controlled independently, separate wire is required for each LED. This increases the number of wires to more than 600, which becomes difficult to manage.
- Since there is large number of wires, there are more chances of occurrence of circuit fault due to mishandling.
- Since there are large numbers of hardware elements in the circuit, it increases the manufacturing cost.
- Circuit is complex.

In order to overcome the above drawbacks, various improvements were made in the design. However, some of the problems remained as such, because they were inherent to the design itself. Thus, a new approach was used and after many prototypes the final design was developed.

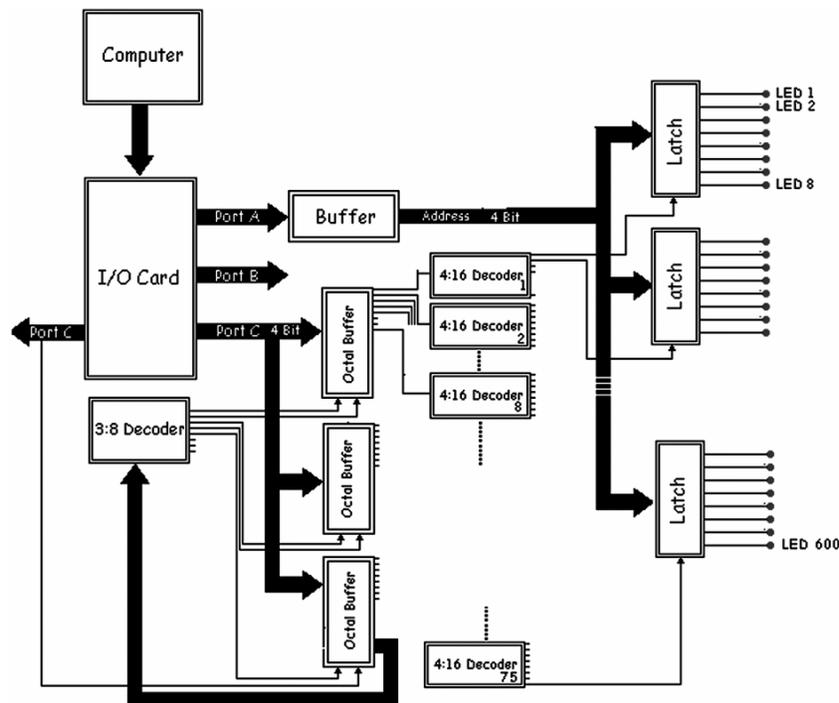


Fig. 6—Logic control circuit for preliminary design

2.4.1.3 Final Circuit Design

In this design, a LED (corresponding to a particular creel position) is identified as an index in a matrix having X-Y coordinates, where X and Y coordinates refer to the column and the row number respectively.

Principle Used — The main characteristic feature, which differentiates this circuit design from the preliminary design, is the principle of scanning in a loop. To glow the required LEDs, a loop is employed in which each row is scanned one by one.

Starting with the first row, the selected LEDs in that particular row glow and then the control moves on to the next rows, glowing each row one by one. The scanning of row occurs such that at any instant, selected LEDs of only one row are glowing. This process is repeated in a continuous loop at a speed greater than the minimum perceptibility of human eye, i.e. 20 frames per second. Thus, it seems as if all the required LEDs are glowing together.

Row and Column Selection — Row selection for 256 creel capacity circuit is done using the two 8-bit buffers connected to port A0 and B0 of CN1 and column selection is done using the two 8-bit buffers connected to port A1 and B1 of CN2. To glow a particular LED, a high (1) signal is given to the row index where the positive pole of LED is connected and a low (0) signal is generated at the column index where the negative pole of LED is connected. This is achieved using the following circuit (Fig. 7):

- For Row Selection — The logic control circuit is used to drive 256 LEDs, and to drive such high loads, we need higher voltage. Therefore, IC 7407 (IC1) is used as a buffer in order to give voltage other than the logic voltage. It is an open collector buffer, i.e. it allows a voltage flexibility of up to 24V due to the absence of the parallel resistor which is compensated by putting a separate pull-up resistor in parallel (R1). This buffer drives the IC UDN2981 (IC2), also called Darlington Array. This IC is also an open collector and hence can be used to provide additional voltage. The eight gates of this IC are capable of sinking a current of up to 500 mA collectively and thus act as a good current sinker. This IC drives the transistor CL 100 (T1), which is a NPN (- + -) transistor. The capacitor (C1) across the base resistor is used as a speed-up capacitance. When the base is high and the collector is low, the current flows from base to collector and the transistor drives another transistor BD242 (T2), connected to its collector. BD 242 is a PNP (+ - +) transistor, i.e. current flows from base to emitter. Since the rows are connected to the emitter, it acts as a voltage source to the LEDs. A parallel combination of resistance and capacitance (R-C) is also provided. Whenever all the LEDs are glowing, the capacitance stores up energy and when all are in off state, it discharges through the resistor. The

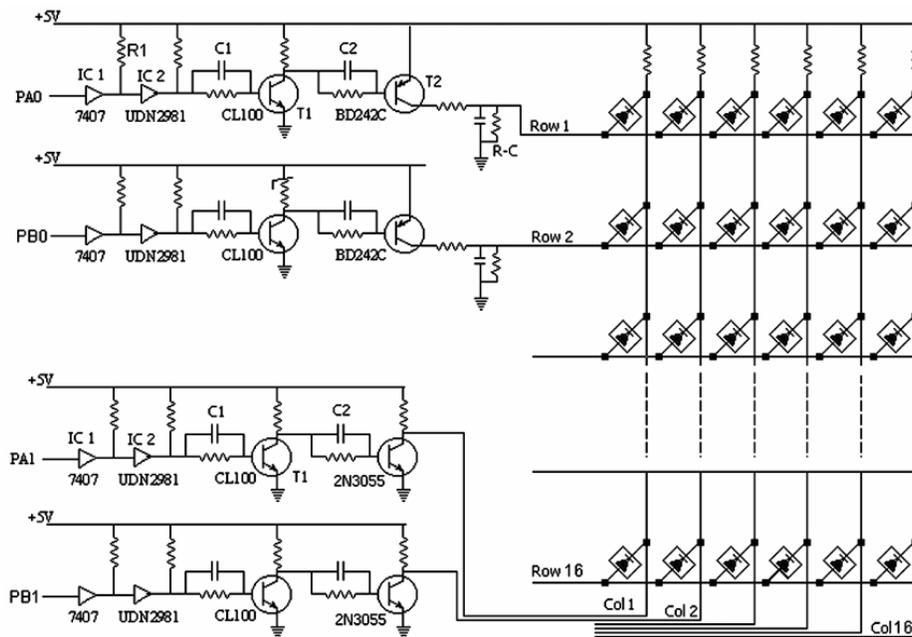


Fig. 7—Logic circuit for 256 creel capacity

same circuit is repeated for all rows, and whenever we need to select any row, we send a high (1) at the pin of that row in the buffer (IC 7407).

- For Column Selection — To select any column, we have to provide a row at that column. This is achieved by providing a sink instead of a source, i.e. the PNP transistor BD 242, used for row selection is replaced by a NPN transistor 2N3055 (T3). This transistor provides a current sink at collector as the current flows from collector to emitter. The same circuit is repeated for all

columns, and whenever we need to select any column, we send a low (0) at the pin of that column in the buffer (IC 7407).

2.4.1.4 Circuit Layout

The overall circuit layout is shown in Fig. 8. CN1 and CN2 represent the connector pins for output ports from I/O card 1. Out of the 48 ports available, only 32 are used, 16 in CN1 and 16 in CN2. Similarly, CN3 and CN4 are the connector pins for I/O card 2. To connect the cable from I/O cards to the PCB, a 50-pin flat cable connector has been used [Fig. 9(c)]. U1-U12 in the circuit layout represent the 14-pin IC

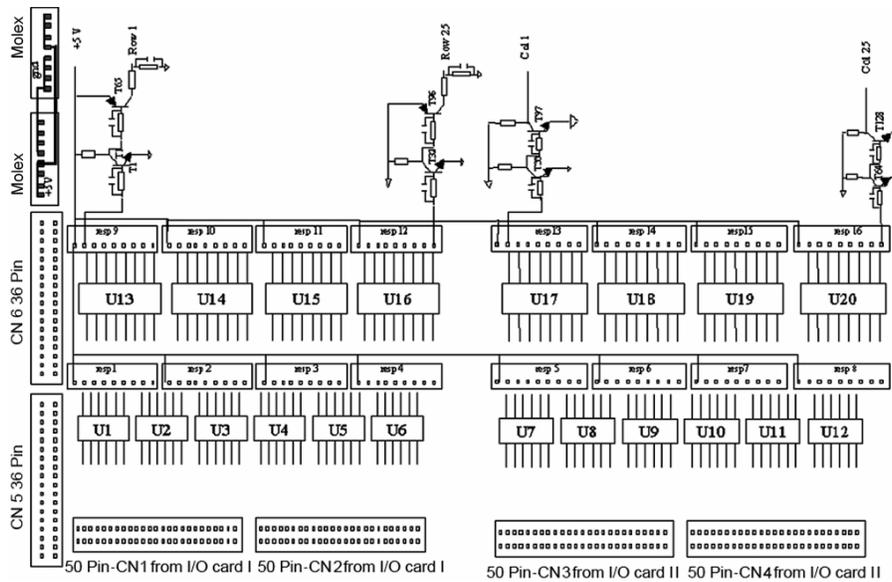


Fig. 8—Circuit layout

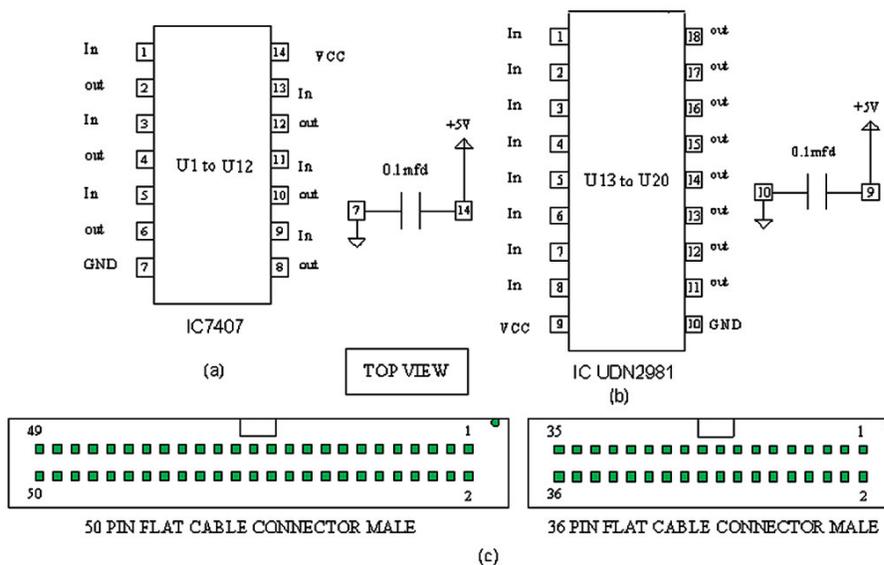


Fig. 9—(a) Pin arrangement for IC7407, (b) Pin arrangement for IC UDN2981 and (c) Type of cable connectors used

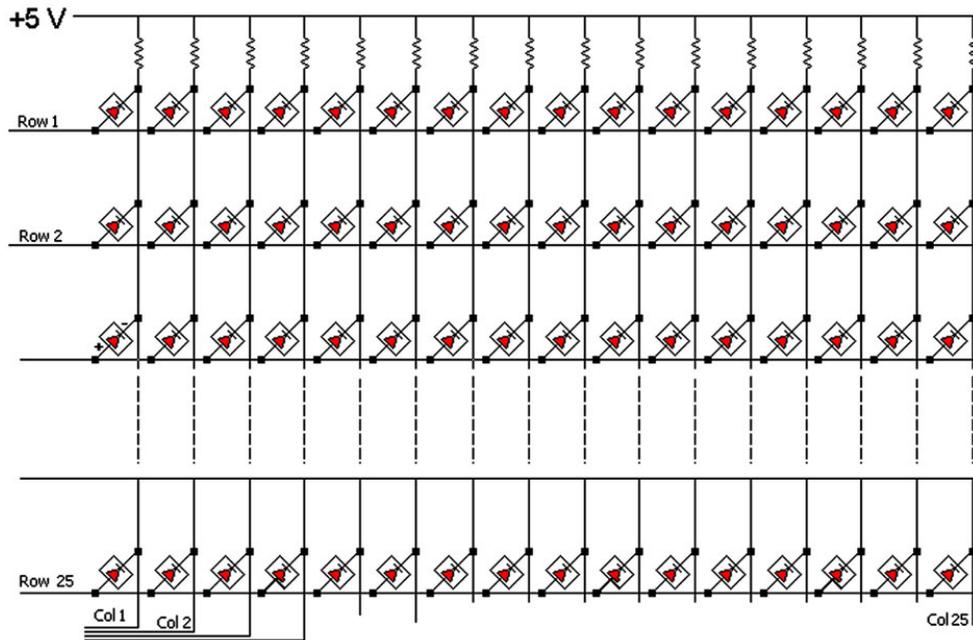


Fig. 10—Circuit of LED matrix

7407 [Fig. 9(a)], of which U1-U6 are connected to the ports of I/O card 1 and U6-U12 are connected to the ports of I/O card 2. These ICs are connected to the 10-pin IC UDN 2981 [Fig. 9(b)], which are represented by U13-U20. Since both these ICs are open-collector, they need a pull-up resistance. Instead of using normal horizontal resistances, resistance packs, represented by resp1 to resp16 in the circuit layout, have been used. These packs have vertically arranged resistances and thus occupy less space on the PCB. Two 36-pin connectors (CN5 and CN6) have been provided on the control panel PCB to give the same output to the logic circuit for creel display. They are connected to the I/O cards through respective pins of CN1, CN2 and CN3, CN4.

2.4.2 Display Circuit

Two separate display units have been used, namely console panel and display on creel.

2.4.2.1 Circuit Design of LED Matrix

The LEDs are so placed in the matrix that the positive poles of the LEDs are connected to rows and the negative poles are connected to the columns (Fig.10).

To glow any LED, a high at the positive pole and a low at the negative pole is required. Whenever a row is selected, as explained earlier, a high occurs at all the LEDs in that selected row. But none of the LED glows because all the columns are connected to the

5V supply, i.e. all negative poles are connected to a high through a resistance. Thus, for any LED to glow, a low must appear at its negative pole. The low is achieved by providing a sink at the column of the LED that has to glow. Hence, for any LED to glow, its row must be connected to a source and its column must be a sink.

Console Panel Circuit

A compact console panel made of a matrix of LEDs is displayed near the system operator. The panel is placed so that the operator can observe and verify the output being displayed on the creel. The console display is in the form of the matrix, i.e. same as the circuit for LED matrix.

Display on Creel

For display on the creel, each LED is picked up from its matrix position and placed on the creel when the whole system is commissioned. The display arrangement on the creel depends upon the method followed for creeling. To design the software program, we have assumed the following creeling method. But the same system can be used for any creeling method with slight adjustments.

All the threads in a repeat are first arranged into a linear fashion as shown in Fig. 11. The threads are then divided into two groups, each for left and right creels. Position on the top left corner of the creel is designated as position 1. The positions have been

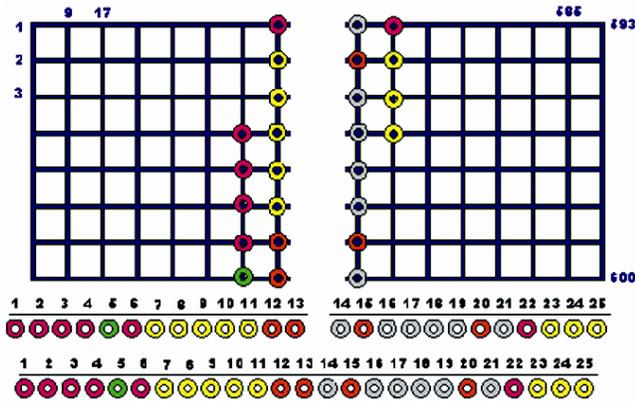


Fig. 11—Creeling method

assigned from top to bottom and moving from left to right, as shown. A mapping of this linear array of packages is done onto the creel, such that the packages are loaded nearest to the sectional warping beam. The numbers in black denote relative positions of the thread in the pattern and the numbers in blue denote the position on the creel. Package number one, in the example shown, is mapped on to the position number 287 of the creel.

2.5 Fail Safe

One of the problems, which were identified with the system, was the error which might creep in if any LED or any circuit component goes out of order. On a signal for glowing LEDs for a particular color either some of the LEDs may not glow (if they fuse) or some extra LEDs may glow (if any circuit component malfunctions). This problem is very difficult to detect on the creel. To take care of these problems following features have been incorporated.

(i) Fail Safe Button — The GUI displays a Fail Safe button on the screen. Clicking on this button will send a signal to the circuit to glow all the LEDs. This check can be employed every time before and after the system is used or at any stage if need is felt.

(ii) Console Panel — A separate matrix of LEDs is kept near the user. Every time the signals for glowing the LEDs, the number of positions that should glow on the creel is displayed on the screen which should match the number of LEDs glowing on the console. Any difference between these numbers would indicate an error. Thus, using the above features a plausible error can be detected and prevented from causing any undue wastage.

3 Conclusions

The system was tested in the industry under practical conditions. LED was fitted on individual package holder on the creel. Warp pattern was read through computer using the controller. The LED for one color packages were lighted to facilitate the creel boy to load specific coloured package at lighted LED locations. The process was repeated for all the colors in the pattern. This system helped to get the correct warp pattern fairly quickly and eliminated the need of skilled worker.

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