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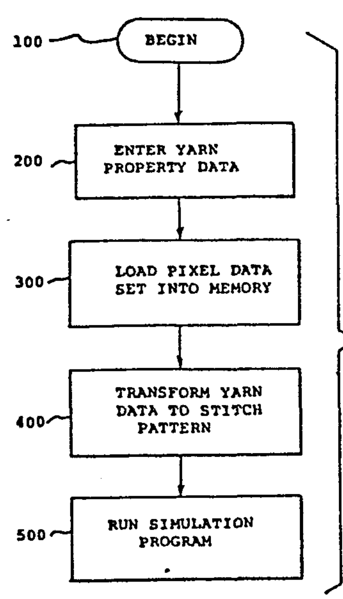
(54) **Method of simulating by computer the appearance properties of a warp knit fabric.**

(57) A direct printing technique for simulating the appearance streaks in warp knit fabrics. Simulation parameters are confirmed by comparison of simulations with actual warp knit fabrics.



F I G. 4

EP 0 199 552 A2

TITLE

METHOD OF SIMULATING BY COMPUTER THE APPEARANCE PROPERTIES OF A WARP KNIT FABRIC

BACKGROUND OF THE INVENTION

This invention relates to simulating the appearance properties of a warp knit fabric based on properties of the yarn in the fabric. The simulation is comparable to the actual fabric knit from yarn of those properties.

Both yarn manufacturers and fabric producers are faced with the problem of variations in yarn properties (e.g. denier, shrinkage, cross section, dyeability) and the effect of these variations on fabrics. In the past the effects of these variations in the actual fabric could only be determined by actually making test fabrics from the yarns which is expensive and time consuming.

SUMMARY OF THE INVENTION

The present invention provides a method for simulating actual fabric appearance by just knowing the constituent yarn properties without having to make the actual fabric. The method comprises the steps of obtaining a data set of yarn physical properties for each yarn in the warp knit fabric then programming a digital computer to average the yarn physical properties for each yarn in the fabric according to the stitch pattern of the fabric to produce a wale average property for each wale in the fabric. The pixel density for the graphics display equipment associated with the computer is then calculated from the average wale properties and displayed to represent each wale in the fabric.

D-4145

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram of the front and back bar of a warp knit fabric of the type simulated by this invention.

Fig. 2 is a drawing of a graphics display of a warp knit fabric simulated according to the invention.

Fig. 3 is an enlarged representation of a portion of a warp knit fabric simulated according to the invention.

Figs. 4-6 represent flow charts of a program to operate a computer for simulating a warp knit fabric according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A warp-knit textile fabric as intended herein is best defined in terms of a stitch pattern as shown in Fig. 1. While many other patterns constituting warp-knitting are possible the one shown represents a jersey tricot warp knit construction. Knitting needle positions for each of five successive wales and courses for the front and back bars are represented in Fig. 1. The horizontal rows of dots represent courses 1-5 while the wales of the fabric are represented by vertical rows of dots A - G. More particularly, referring to Fig. 1 the stitch construction of the fabric is notationally set out and shows that the threads of the front bar indicated as 21-25 have back and forth movement to non-adjacent needles in successive courses and the threads of the back bar, indicated as 31-35 have similar movements.

As indicated above this technology is a tool to investigate the effects of yarn properties on the visual appearance of fabrics. The technology uses a Hewlett Packard HP9845 model 270 to print patterns which model the appearance of jersey warp knit fabrics.

Direct printing of simulations requires high resolution graphics and printing capability. The Hewlett Packard HP9845 desktop computer meets both requirements with individual pixel control of graphics on the CRT and printer. Resolution of the HP9845 printer is 77 pixels/inch in both X and Y directions. Initial experiments with various patterns showed that printing alternate rows provided sufficient resolution (38.5 rows/inch vs. 50 wales/inch in the fabric) to represent each wale in a jersey warp knit fabric. Printing alternate rows gives the printouts a subtle linearity resembling the directionality of wales in a warp knit fabric.

The first step in the method is obtaining a data set consisting of a yarn property such as denier, modification ratio, yarn shrinkage, or dyeability for each yarn in the fabric. The properties are then averaged according to the stitch pattern in the fabric to produce a wale average property for each wale in the fabric. The simulation program then produces a printout in which the print density (fraction of pixels printed) in each row is given by the equation:

$$PD = AD\ (1 + KZ) \qquad (1)$$

wherein

AD is the arbitrarily selected average print density desired for the simulation (usually .5)

K is the contrast factor and

$Z = \dfrac{\bar{v} - \bar{V}}{\bar{V}}$ where $\bar{v}$ is the computed wale average property value for the wale being printed and $\bar{V}$ is the arithmetic mean of all the values and is calculated as follows:

$$\bar{V} = \frac{(\Sigma v)}{N}$$

wherein

v is the data expressed as individual values and

N is the total number of values.

Determining K (the contrast factor) for a given property requires comparison of a banded implant fabric with simulations printed at a series of K's. The K that results in the best visual match is the correct one to use.

Computer wale average property ($\bar{v}$)

The precise location of each yarn end; for example, 21-25 in Fig. 1, in the fabric is essential for calculating wale average property ($\bar{v}$). Experience has shown that front bar yarns are of more importance than back bar yarns in fabric uniformity because the back bar yarns in warp knit constructions are "sandwiched" in the fabric interior. When denier is the property being simulated, it has been found that front bar yarns make a 75% contribution to uniformity and back bar yarns a 25% contribution. For other properties being simulated it has been found that front bar yarns make essentially a 100% contribution to uniformity.

Referring to Fig. 1 and considering wale C in both the front and back bar it can be seen that yarn 23 appears in three odd numbered courses, e.g. 1, 3 and 5, and yarn No. 21 appears in the even numbered courses in the front bar and for the same wale in the back bar yarn 32 appears in the odd courses while yarn 33 appears in the even courses.

The weighted wale average property (in this case, denier) for wale C becomes:

$$\bar{v} = \left(0.75 \times \frac{\text{v of yarn 23} + \text{v of yarn 21}}{2} + 0.25 \times \frac{\text{v of yarn 32} + \text{v of yarn 33}}{2}\right) \quad (2)$$

where

v is the individual property value of the yarn.

Description of Flow Charts

The numbers preceding each paragraph refer to the flow charts shown in Fig. 4-6.

Step 100 - Running the startup program initializes the computer memory for the following steps.

Step 200 - Provision is made for entering yarn property data from the keyboard or loading data previously stored on flexible disc data files. More than 1 column of data may be entered.

Step 300 - A retrieval program is run to load the previously stored pixel rows into the computer memory. Pixel densities from 5% to 95% of the pixels in a graphics display row are included in the data set in steps of 1%. There are 5 rows of pseudorandomly arranged pixels at each density.

Step 400 - Yarn property data are averaged according to the description on page 4 to provide wale average property data. The transform program allows keeping both the original yarn data and the wale average data in separate columns in a data matrix.

Step 500 - The simulation program is loaded into memory and run.

Step 501 - The operator selects the desired data to simulate (more than 1 set of data can be held in memory).

Step 502 - The computer calculates the average property in the selected data for further calculations (equation on page 3, and fig. 5).

Step 503 - The operator selects the average print density desired for the simulation. Usually 0.5 is the starting level, and subsequent simulations may be run at higher or lower levels to produce darker or lighter simulations. This step does not affect the printout, unless extreme values are chosen (i.e., near the ends of the allowable scale of 0.05 to 0.95 print density). Refer to "AD" in equation (1), page 3.

Step 504 - The computer calculates the print density for the first wale using equation (1), page 3.

Step 505 - The pixel row data are selected corresponding to the calculated print density.

Step 506 - The pixel row is re-randomized. This step is done to extraneous pattern formation in the case that the same pixel density is selected more than 5 times (the number of previously generated pixel rows at each density held in memory) in succession.

Step 507 - The pixel row is displayed on the graphics screen of the computer.

Step 508 - The pixel row displayed on the screen is transferred to the hard copy printer along with a blank pixel row.

Step 509 - The computer checks for additional yarn data, and if available, continues the process from step 504. The program terminates when all the selected data have been printed and the operator signifies that no more simulations are to be run.

EXAMPLE

In an example using nominal 40 denier yarn in the jersey tricot warp knit construction represented in Fig. 1 wale average deniers are calculated according to equation 2 for each wale in the fabric and the pixel density is calculated according to equation 1. The pixel density is displayed in a series of rows to represent each wale in the fabric as shown in Fig. 2 wherein the simulation of the fabric displaying streaks at locations 40 and 41 closely resembles a fabric knit of the actual yarns whose properties were used for the simulation. The simulation was prepared on a Hewlett Packard HP9845 having a thermal printer programmed according to the flow charts shown in Fig. 4.

An enlarged portion of Fig. 2 is shown in Fig. 3 wherein alternate rows are printed to give subtle linearity and one pixel is represented by a square as designated at 50.

CLAIM:

1. A method of displaying appearance properties of a warp knit fabric having a stitch pattern with courses and wales based on average yarn physical properties comprising the steps of:

obtaining data set of yarn physical properties for each yarn in the warp knit fabric;

averaging said yarn physical properties according to said stitch pattern to produce a wale average property for each wale in said fabric;

calculating print density from said wale average properties; and

displaying said print density as a display element to represent each wale in said warp knit fabric.

2. A method of displaying appearance properties of a warp knit fabric having a stitch pattern of wales based on average yarn physical properties comprising the steps of:

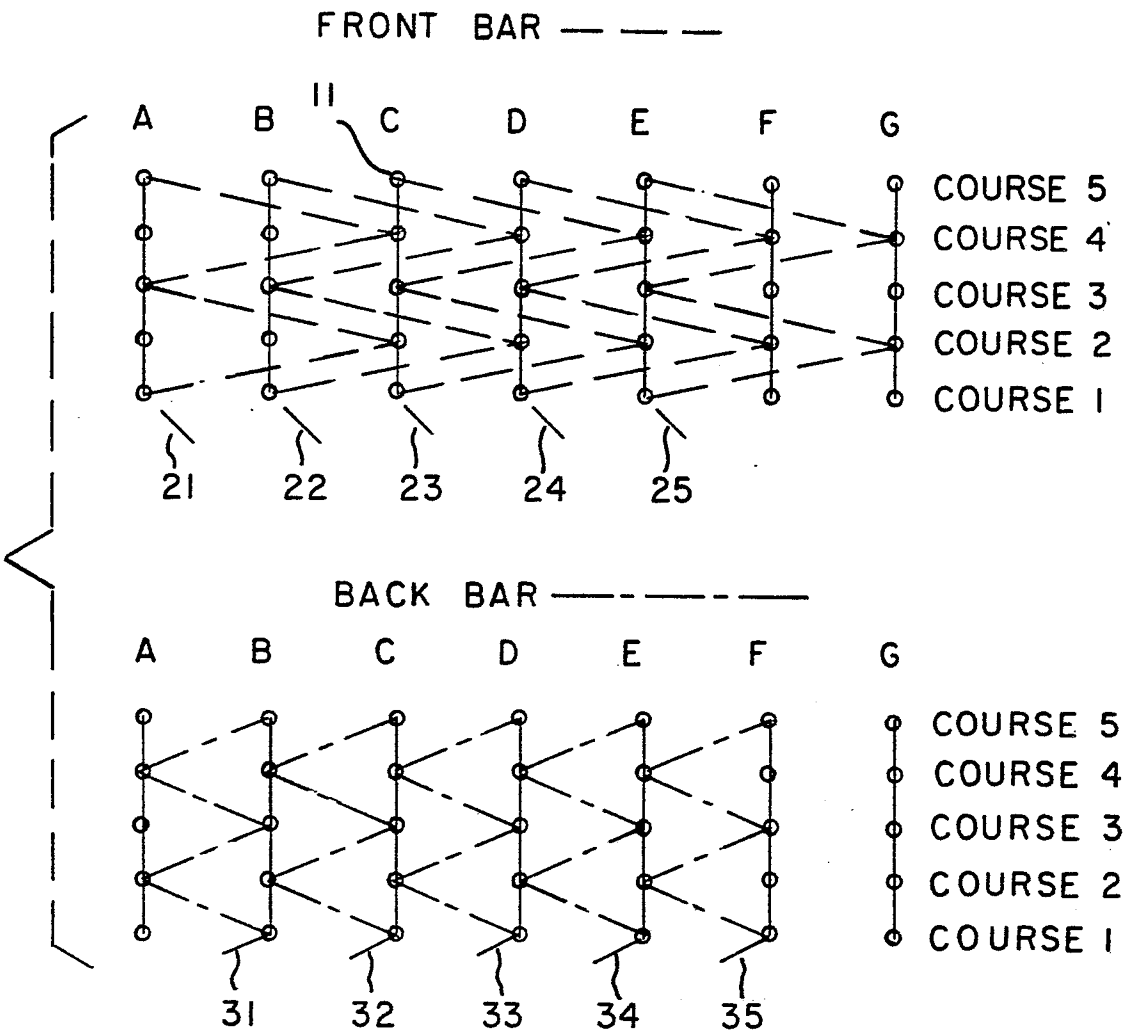
obtaining data set of yarn physical properties for each yarn in said fabric;

programming a digital computer to produce a wale average property for each wale in said fabric, said computer having graphics capability with individual pixel control of the graphics to average said yarn physical properties according to said stitch pattern;

calculating pixel density from said wale average property by means of said digital computer; and

displaying said pixel density as a series of rows of pixels, wherein the number of pixels in each row is proportional to said wale average property for each wale in said fabric, to represent each wale in said warp knit fabric.

F I G. 1


FRONT BAR
A
B
11
C
D
E
F
G
COURSE 5
COURSE 4
COURSE 3
COURSE 2
COURSE 1
21
22
23
24
25
BACK BAR
A
B
C
D
E
F
G
COURSE 5
COURSE 4
COURSE 3
COURSE 2
COURSE 1
31
32
33
34
35

F I G. 2

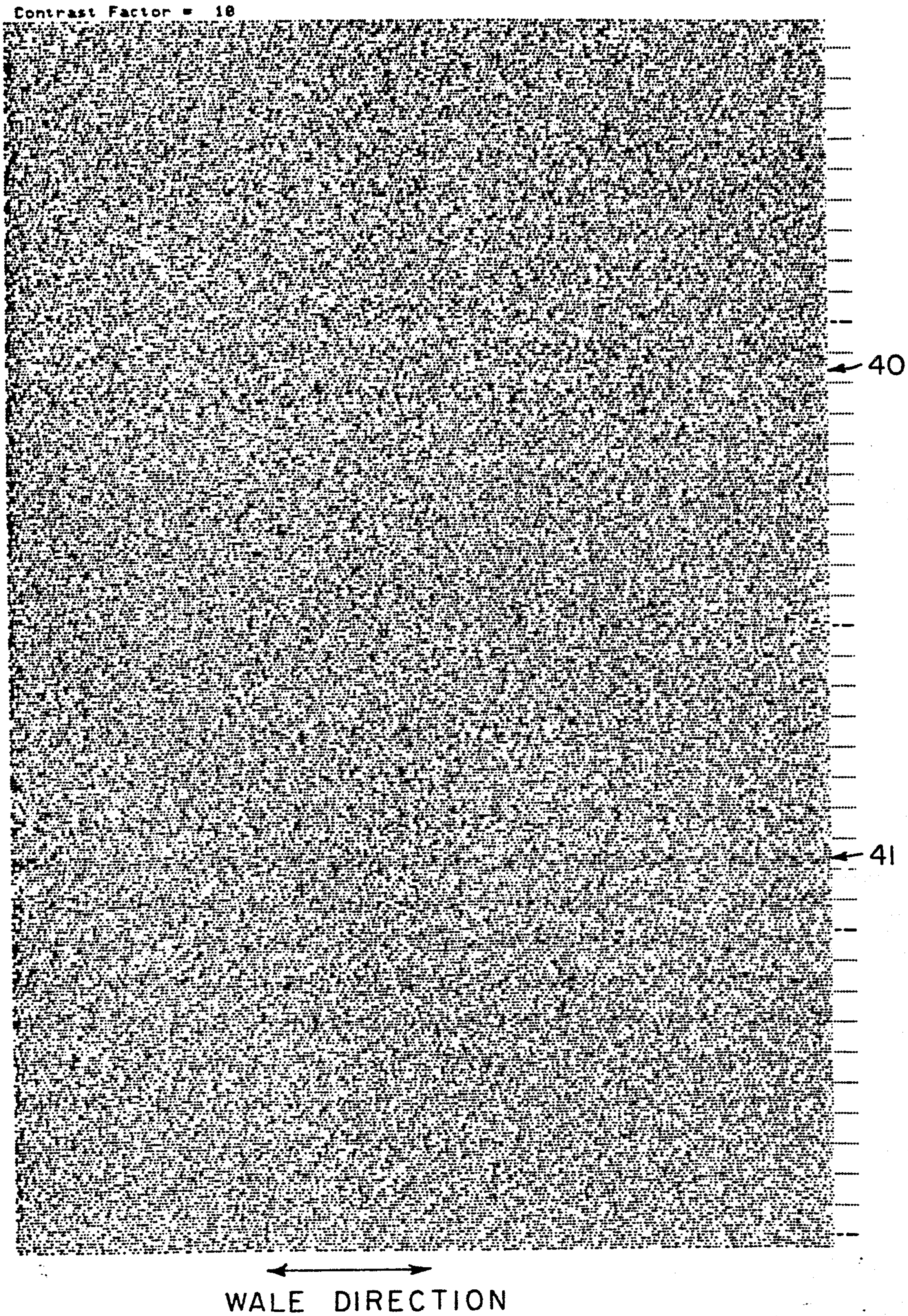
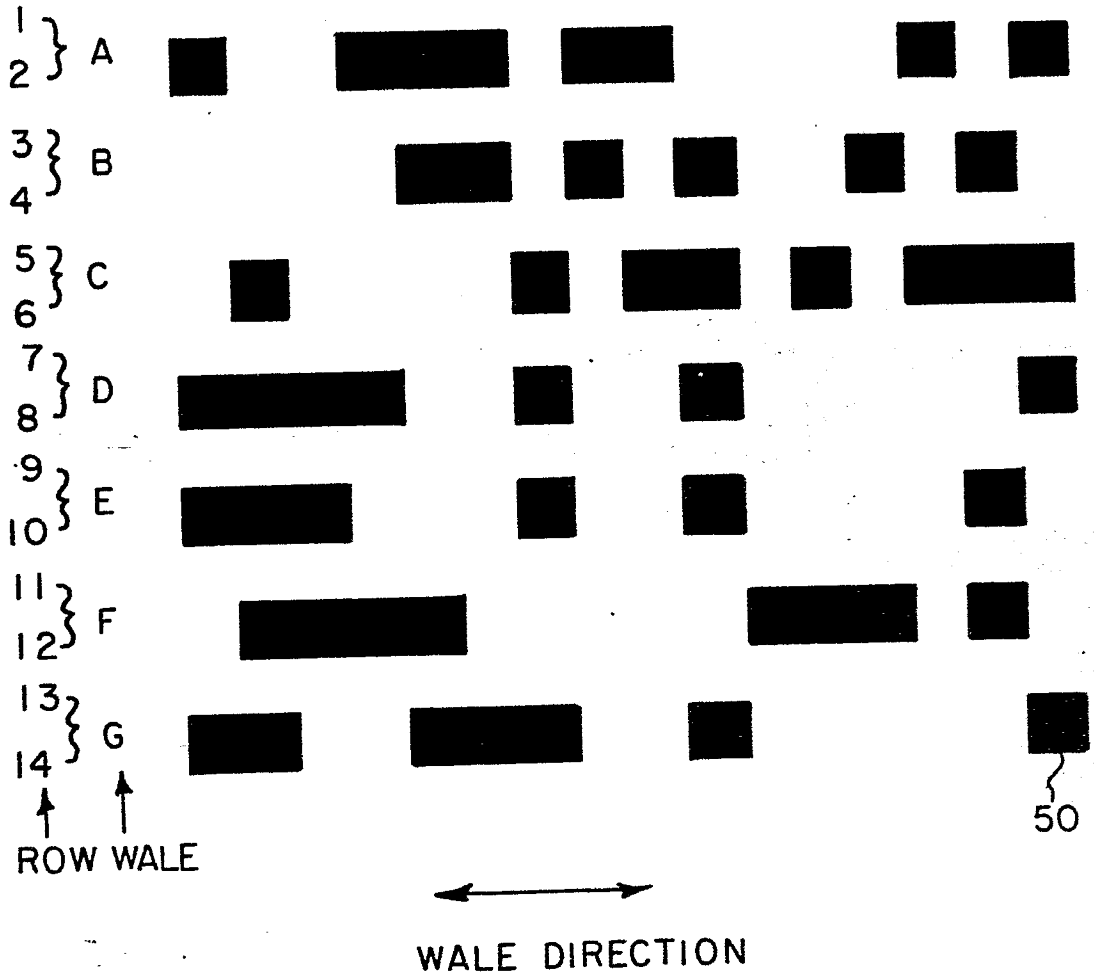
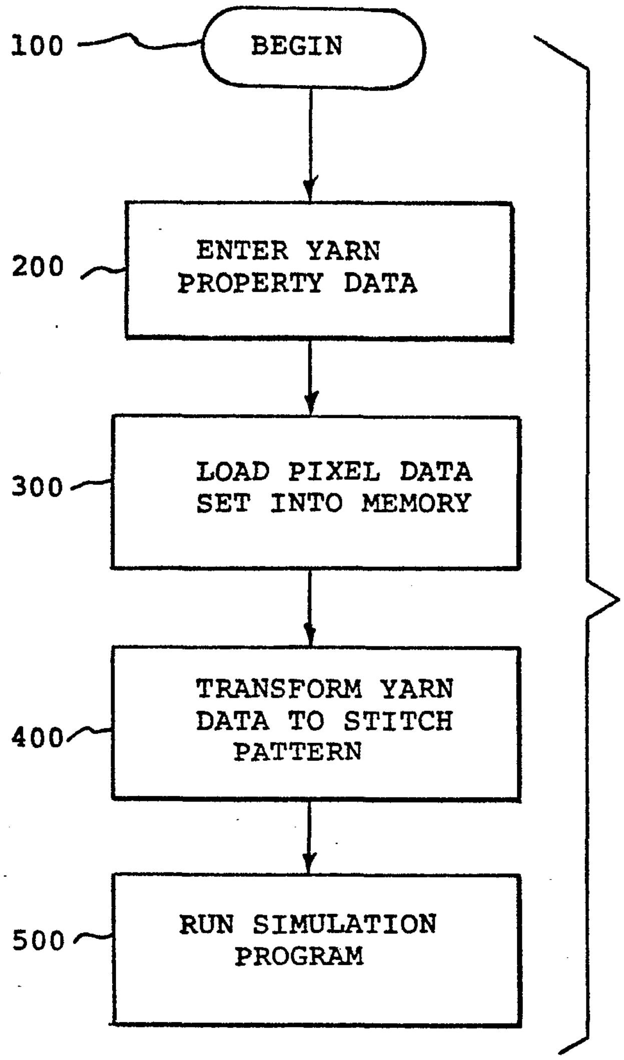


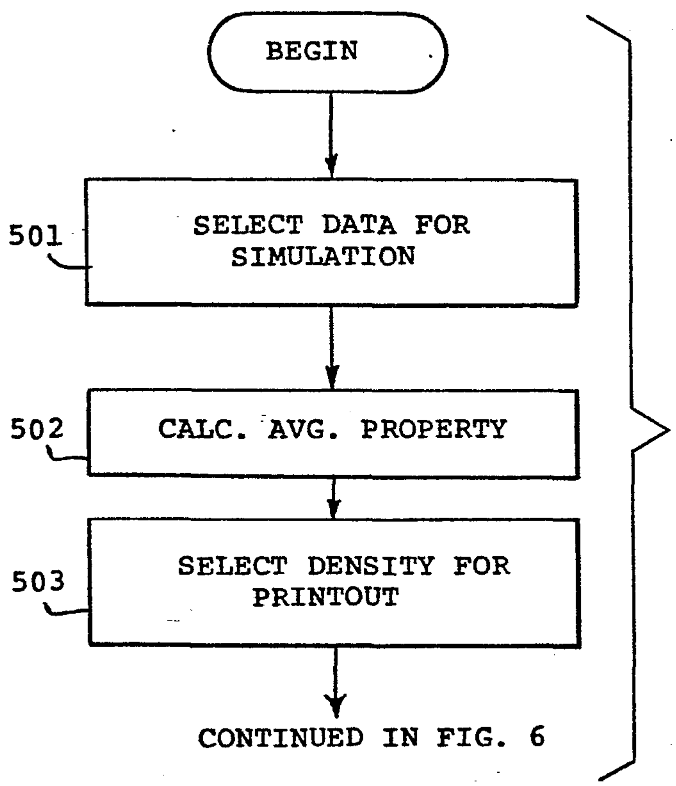
FIG. 3





100
BEGIN
200
ENTER YARN PROPERTY DATA
300
LOAD PIXEL DATA SET INTO MEMORY
400
TRANSFORM YARN DATA TO STITCH PATTERN
500
RUN SIMULATION PROGRAM

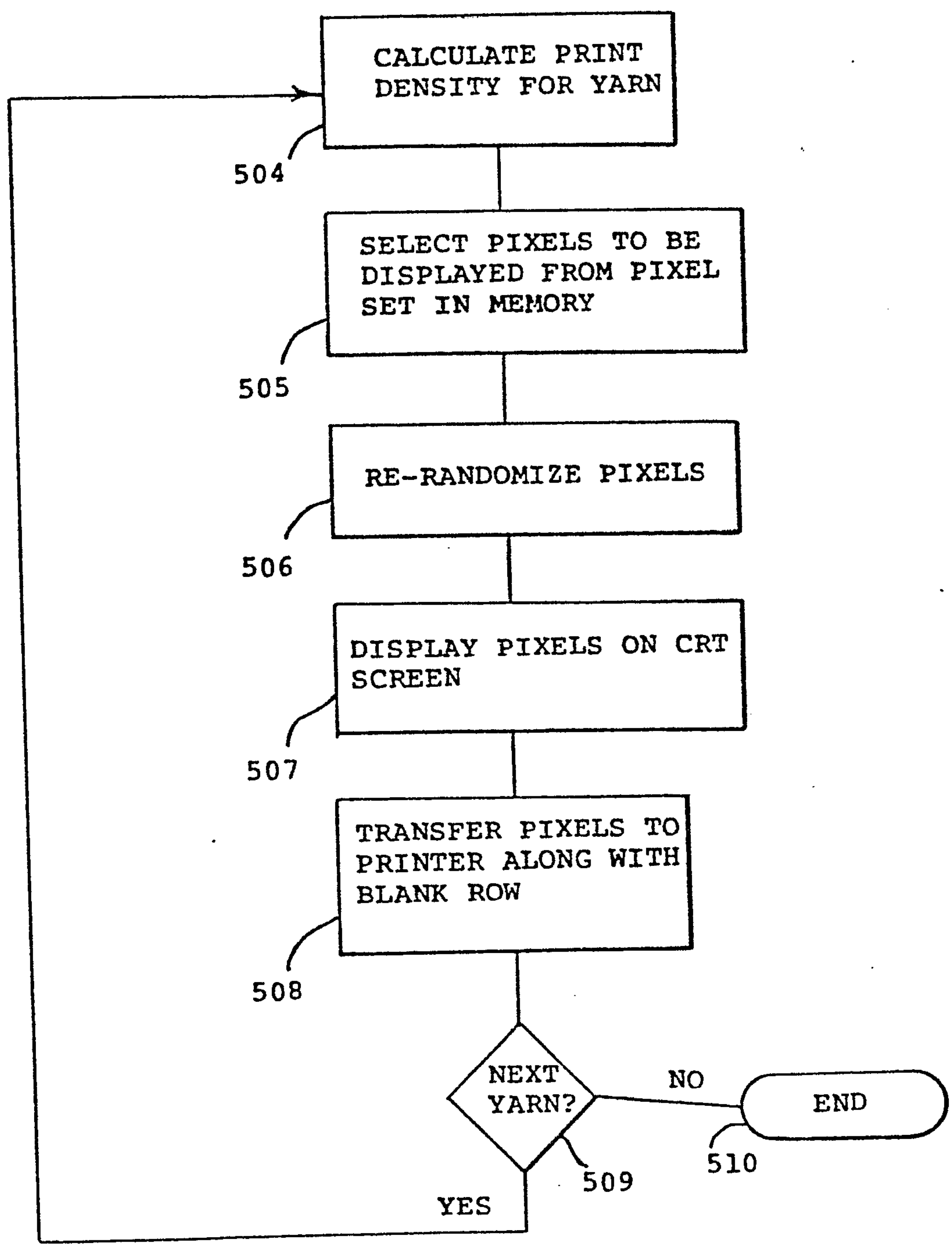
FIG. 4



BEGIN
501
SELECT DATA FOR SIMULATION
502
CALC. AVG. PROPERTY
503
SELECT DENSITY FOR PRINTOUT
CONTINUED IN FIG. 6

FIG. 5

F I G. 6


CALCULATE PRINT DENSITY FOR YARN
504
SELECT PIXELS TO BE DISPLAYED FROM PIXEL SET IN MEMORY
505
RE-RANDOMIZE PIXELS
506
DISPLAY PIXELS ON CRT SCREEN
507
TRANSFER PIXELS TO PRINTER ALONG WITH BLANK ROW
508
NEXT YARN?
NO
END
509
510
YES