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Grozinger

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[54] **ELECTRICAL PATTERNING SYSTEM FOR CIRCULAR KNITTING MACHINES**

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Related U.S. Application Data

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[30] **Foreign Application Priority Data**

June 3, 1971 Germany 2127561

[52] **U.S. Cl.** ..... **66/50 R**

[51] **Int. Cl.** **D04b 15/78**

[58] **Field of Search** ..... 66/2 S, 50 R, 154.4; 340/172.5

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[57] **ABSTRACT**

A plugboard is used to prepare a pattern mock-up and simultaneously store electrical pattern information in a rectangular array of information locations arranged in course-rows and wale-rows corresponding to the courses and wales of knitted fabric. Once the geometry of the pattern is established, and a color or other pattern characteristic is assigned to each part of the pattern, the colors or other pattern characteristics can be inverted, or otherwise altered, while preserving the overall pattern geometry. Each panel division of the plugboard normally corresponds to a single-stitch fabric unit. However, the actual knitted pattern can be magnified walewise, coursewise or both walewise and coursewise, so that each plugboard unit will store information for a selectable plurality of one-stitch fabric units. Such walewise and/or coursewise magnification is in addition to an available increase of pattern width and/or height by reflection. The disclosed control system has various other features and capabilities.

23 Claims, 8 Drawing Figures

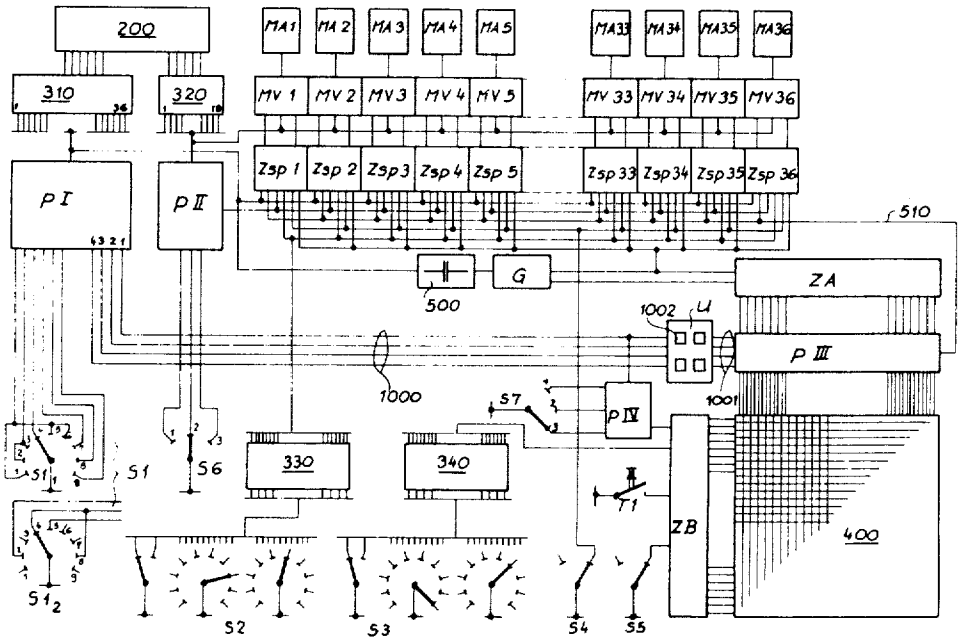
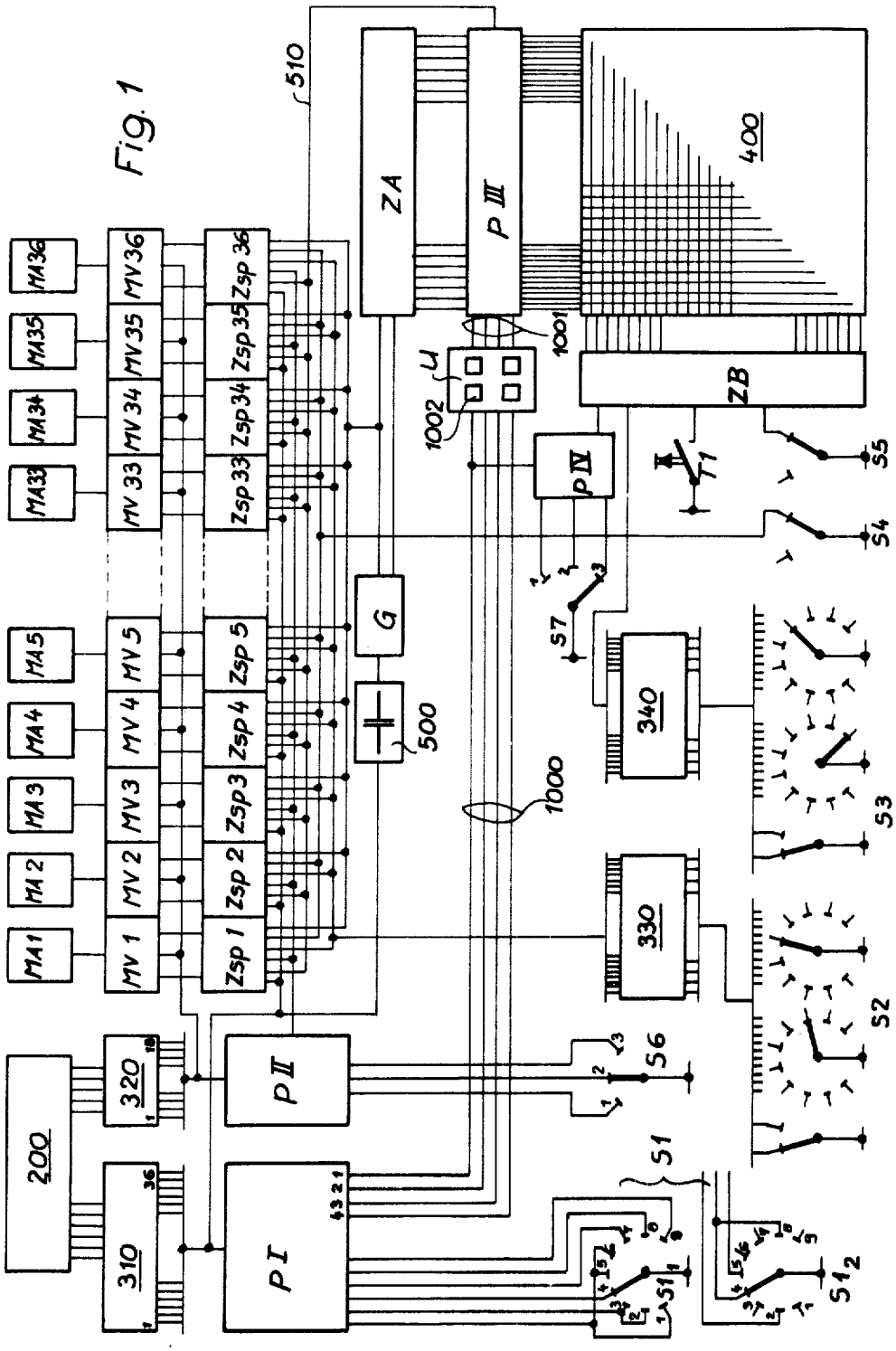
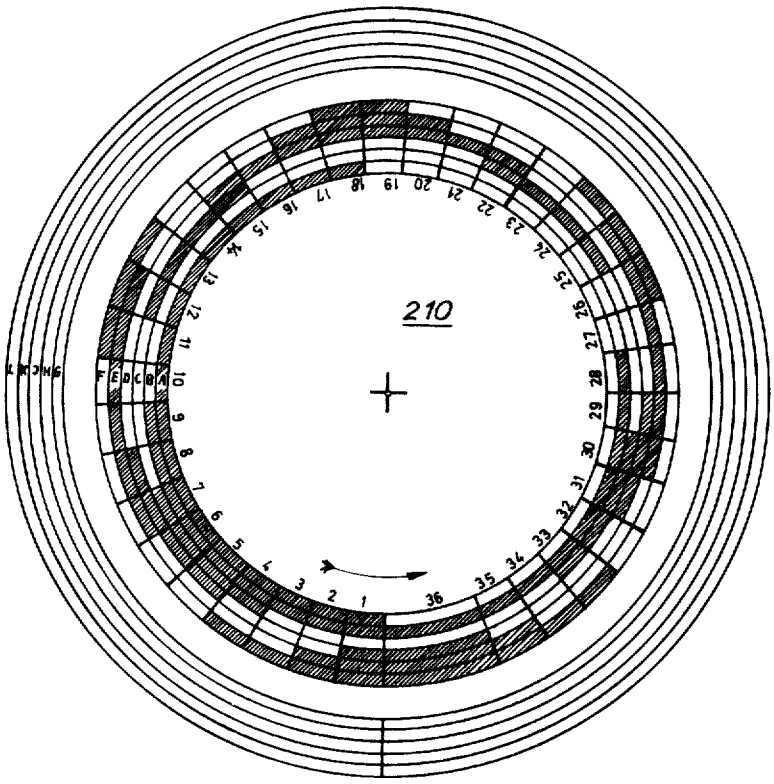


Fig. 1


510
ZA
P III
400
1001
ZB
U
1002
P IV
T1
S5
S4
S7
340
S3
G
500
1000
330
S2
S6
P II
320
200
S1
P I
310
S1 2


210

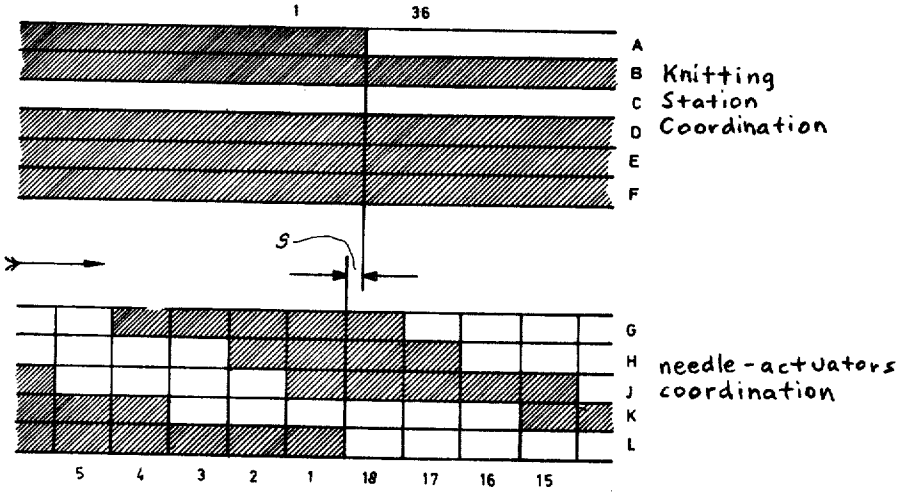

1
36
A
B Knitting
C Station
D Coordination
E
F
S
G
H needle-actuators
J coordination
K
L
5 4 3 2 1 18 17 16 15

Fig. 2

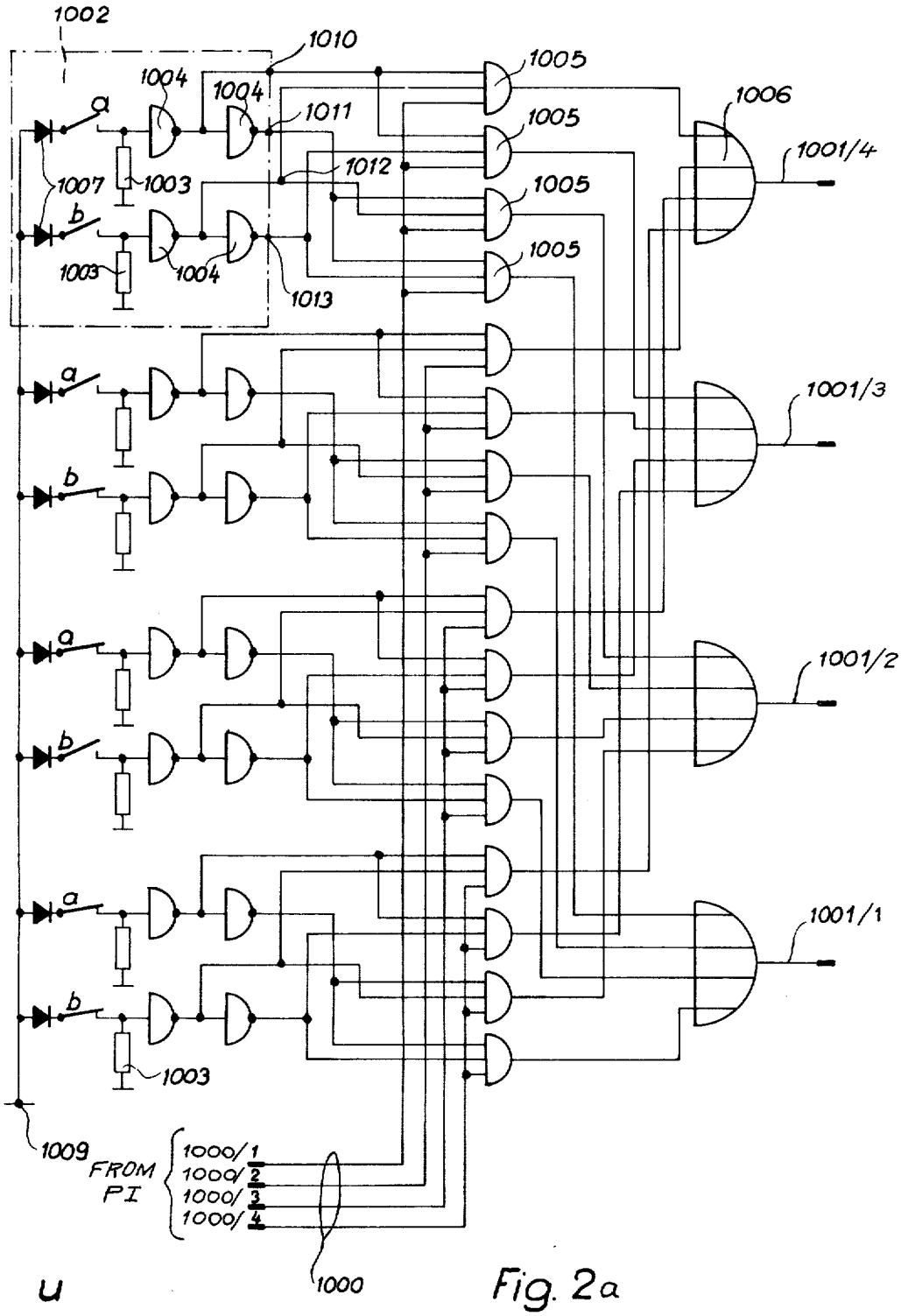

1002
1010
1004
1004
1011
1005
1005
1006
1001/4
a
1007
1003
1012
1005
b
1003
1004
1005
1013
a
1001/3
b
a
1001/2
b
a
1001/1
b
1003
1009
FROM PI
1000/1
1000/2
1000/3
1000/4
1000
u

Fig. 2a

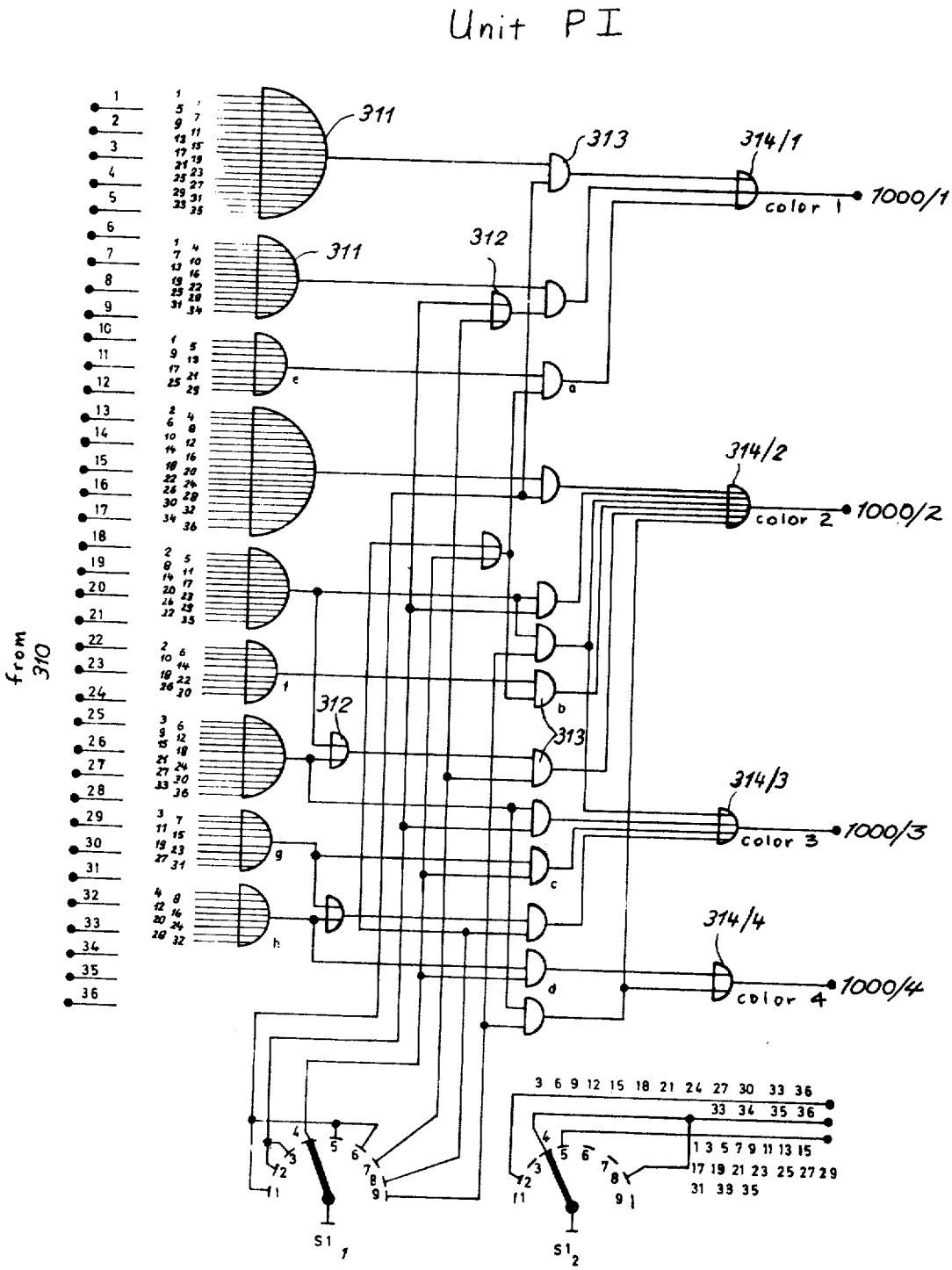

Unit PI
from 310
311
311
312
312
313
313
314/1
314/2
314/3
314/4
color 1
color 2
color 3
color 4
1000/1
1000/2
1000/3
1000/4
a
b
c
d
e
f
g
h
S1 1
S1 2

Fig.3

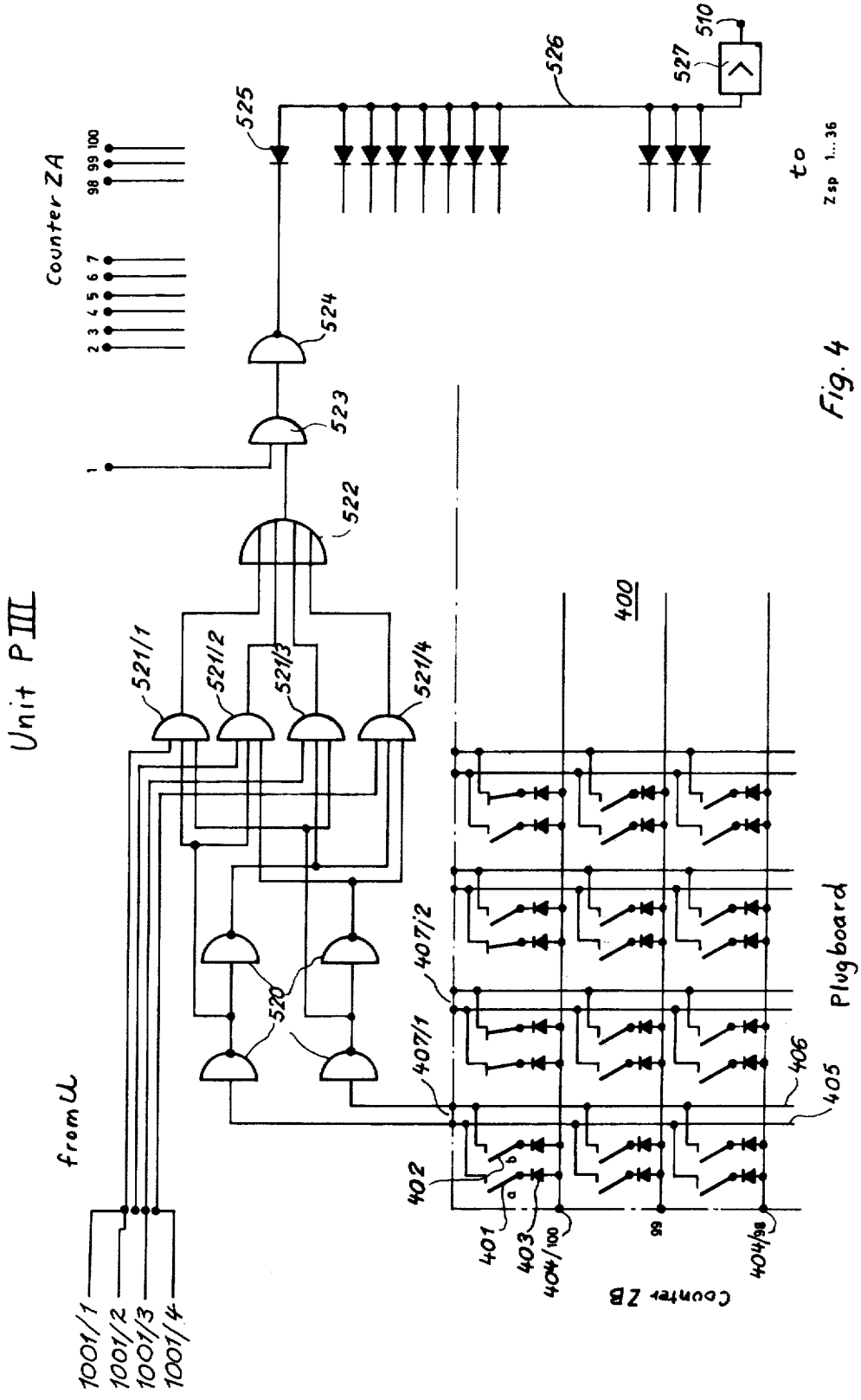

Unit PIII
from UL
1001/1
1001/2
1001/3
1001/4
521/1
521/2
521/3
521/4
522
523
524
525
526
527
510
520
Counter ZA
98 99 100
2 3 4 5 6 7
1
to
Zsp 1...36
400
407/2
407/1
406
405
402
401
403
404/100
404/98
98
Counter ZB
Plugboard

Fig. 4

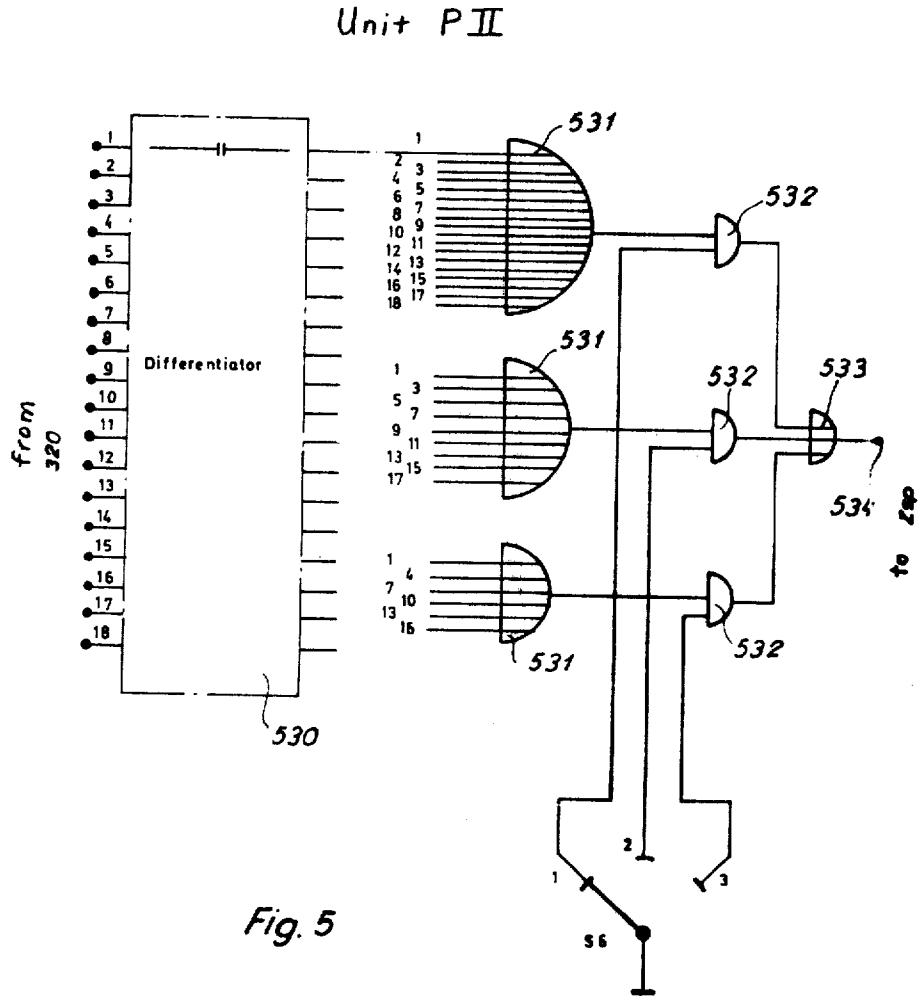
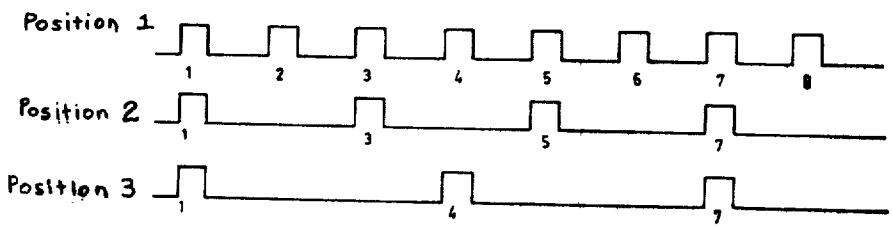

Unit PII
Differentiator
from 320
530
531
532
533
534
to 540
S6

Fig. 5


Position 1
Position 2
Position 3

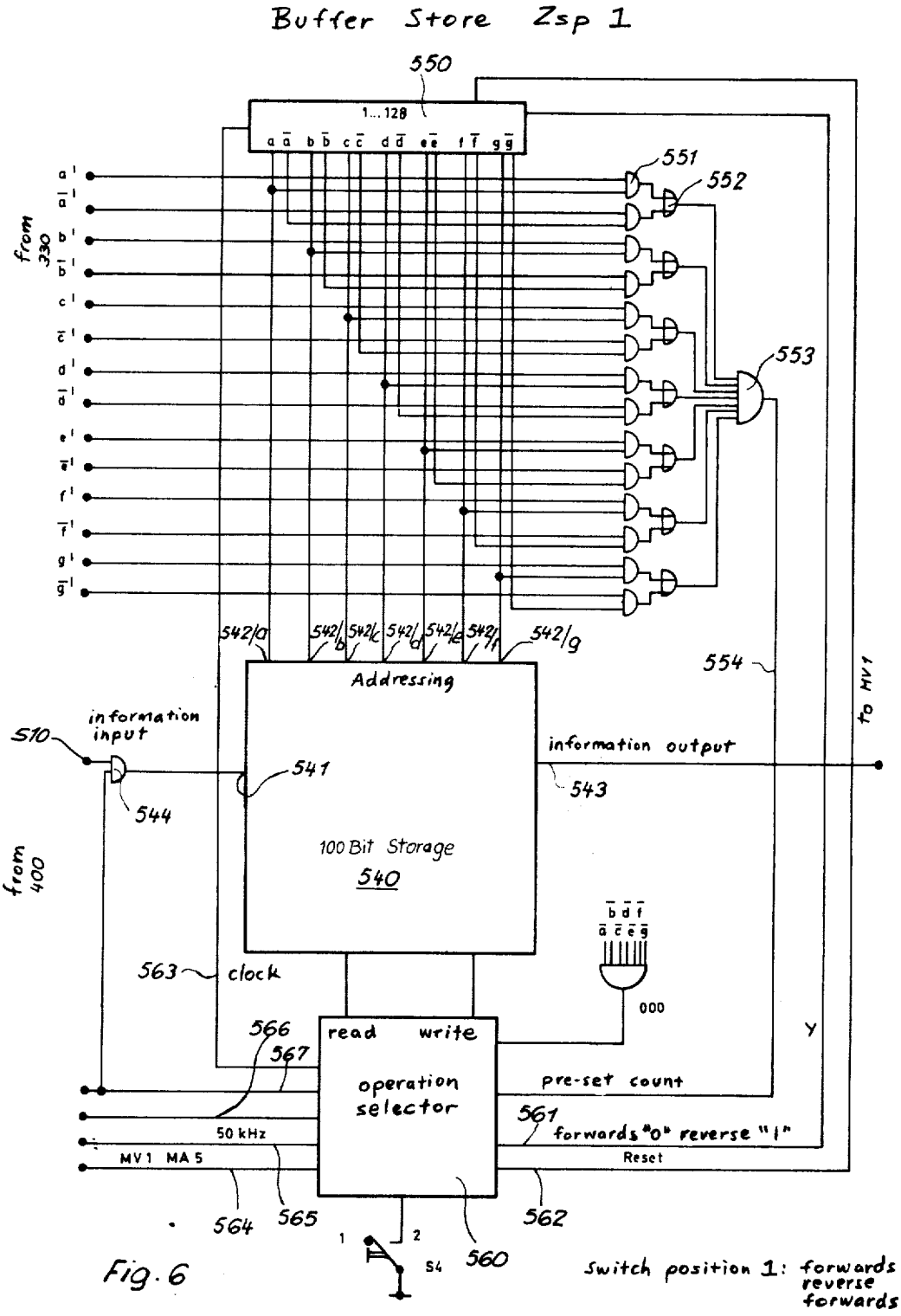


Fig. 6

Switch position 1: forwards reverse forwards

Switch position 2: forwards reset forwards

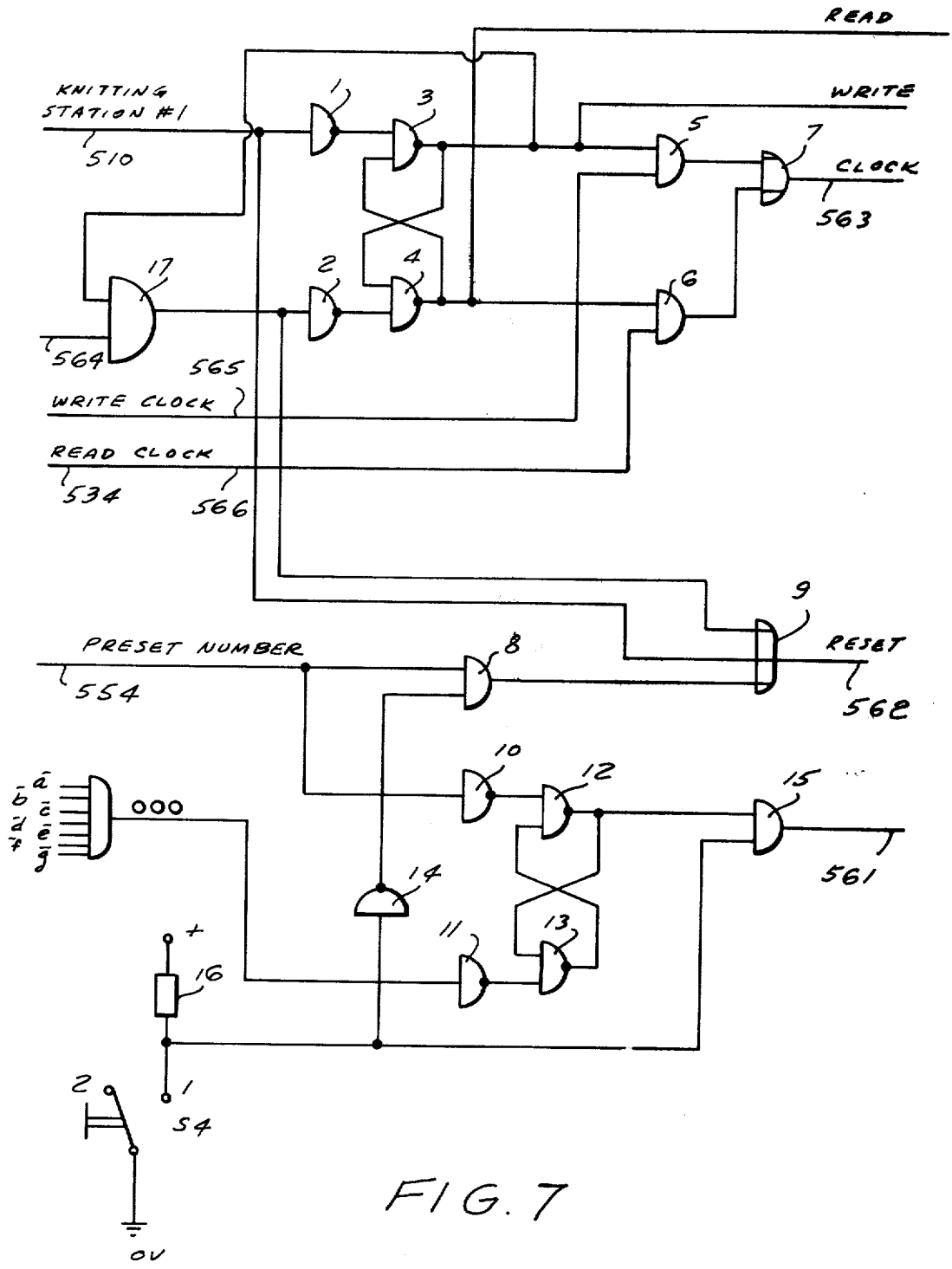

READ
WRITE
KNITTING STATION #1
510
CLOCK
563
564
565
WRITE CLOCK
READ CLOCK
534
566
PRESET NUMBER
554
RESET
562
000
561
+
16
2
1
S4
0V

FIG. 7

ELECTRICAL PATTERNING SYSTEM FOR CIRCULAR KNITTING MACHINES

CROSS-REFERENCE TO RELATED APPLICATION

The present application is a continuation-in-part of my copending application Ser. No. **94,365**, entitled "ELECTRICAL PATTERNING SYSTEM FOR CIRCULAR KNITTING MACHINES," and filed Dec. **2**, **1970**.

BACKGROUND OF THE INVENTION

Control systems for circular knitting machines are already well known. However, known systems suffer from limited flexibility. For instance, once the basic pattern is fed into a prior art control system, it is not possible to make major changes in pattern scale, color distribution, yarn or stitch distribution, etc., except by a complete reprogramming of the system. This is extremely inconvenient, because known programming methods are quite tedious. When punched tape, magnetic tape, perforated disks and the like are used to bear the pattern program, the recording of a new program is a disagreeable task.

Plugboards are known with which the insertion of color-coded pegs into a rectangular array of sockets simultaneously effects construction of a visual mock-up and the reading-in of pattern information into a 2-dimensional array of information locations. This is clearly a better programming expedient. Even so, however, reprogramming can be inconvenient. For instance, a plugboard having **100** rows and **100** columns necessitates the plugging in of **10,000** color-coded pegs, or the like, and this can be very time consuming.

SUMMARY OF THE INVENTION

It is the general object of the invention to provide a control system for circular knitting machines having greater flexibility than hitherto.

More particularly, it is an object to provide a control system wherein a single plugging of a pattern panel mockup will establish a pattern geometry which can later and easily be varied in scale in one or two dimensions.

It is another object to provide such a system wherein, once the pattern geometry is established, the color scheme and/or distribution of colors within the pattern, can be easily and quickly changed, for example by throwing a number of switches.

It is another object to provide such a system wherein, once the pattern geometry is established, the pattern can be enlarged in one or two dimensions by mirror-reflection of the entire basic pattern.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a block diagram of a control system according to the invention;

FIG. **2** is a top view of the coded disc used in the system of FIG. **1** to supply coordinating and timing signals;

FIG. **2***a* is a circuit diagram of selecting means U shown schematically in FIG. **1**;

FIG. **3** is a circuit diagram of the main program switching unit of the patterning system;

FIG. **4** shows a part of the plugboard pattern panel **400** and the associated rectangular array of information locations represented schematically in FIG. **1**, as well as color classifying means PIII;

FIG. **5** is a logic circuit diagram of the program switch unit PII; and

FIG. **6** is a schematic diagram of buffer store Zsp**1** for the first knitting station of the knitting machine; and

FIG. **7** is a circuit diagram of the operation selector **560** of FIG. **6**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Because the system of the invention is very complex, it will first be discussed in general and functional terms, to permit the reader to acquire an idea of its operation and capability. Afterwards, a detailed discussion of certain mechanical features and of the circuitry employed will be provided, and may be consulted by persons requiring such specific details.

The circular knitting machine concerned has a plurality of yarn feeds, herein called knitting stations. In the described embodiment there are **36** knitting stations.

Each knitting station has associated therewith a group of **18** staggered needle actuators (designated MA1, MA2, . . . in FIG. 1), and an associated power amplifier MV1, MV2, etc.

Each knitting station is associated with a particular pattern characteristic, for instance color or stitch or yarntype. In the described embodiment, the pattern characteristic is color. There are four colors, and the knitting stations are divided into groups. For instance stations **1–4** together cooperate, in known manner, to knit a single "visible" course formed of four differently colored yarns.

During a single turn of the needle cylinder, each knitting station can effect a repeated sequence of "knit" and "not-knit" operations. Such sequence may include up to **100** operations, although there are only **18** needle-actuators per station, because of the provision of an associated buffer store Zsp. During knitting, the **18** electromagnetic needle-actuators at each station are continually repositioned as a function of the **100** units of information stored in the respective buffer store Zsp. The manner in which such continual repositioning is effected is somewhat complicated, and will be referred to in more detail later.

As is conventional, the **100** bit-storage in each buffer store contain information for **100** successive stitches in a single course. Each of these buffer stores Zsp must be filled with information derived from a basic pattern according to which the fabric is to be knitted.

The basic pattern is established by "plugging-up" plugboard-type pattern panel **400**. Pattern panel **400** has **10,000** panel portions, arranged in **100** horizontal course-rows and **100** vertical wale-rows, to correspond to the organization of courses and wales in knitted fabric.

Each of the **10,000** panel portions is directly associated with one of **10,000** information locations. The plugging-up of a particular panel portion simultaneously effects storing in a respective information loca-

tion of electrical patterning information representing a particular pattern characteristic, for instance color, which the corresponding fabric unit is to have.

One chief problem with any such control system is the conveying of the large amount of information associated with pattern panel **400** into appropriate ones of buffer stores Zsp, and in the correct sequence. Scanning means and routing means are provided for this purpose.

The scanning means comprises wale counter ZA and course counter ZB. The horizontal course-rows of the pattern panel are scanned in succession left-to-right. For instance, the top course-row is scanned left-to-right, and then the next lower course-row is scanned left-to-right, etc.

The horizontal scanning of a course-row occurs rapidly, and is timed by **50** kHz generator G. The moving-down from one course-row to the next is controlled more slowly by course counter ZB, which in turn is synchronized with needle-cylinder rotation, via switching circuit PI.

Because four colors are involved, each horizontal course-row is scanned four times, once for each color, and the **100** signals generated during each horizontal scanning must be delivered to a respective buffer store Zsp associated with the corresponding color. The routing operation must accomplish the following: For example, as the top course-row is scanned the first time, for color No. **1**, the **100** signals generated must be stored in Zsp **1**. The second scanning of the top course-row follows immediately thereafter, and the **100** signals generated (associated with color No. **2**) must be stored in Zsp **2**, etc.

Four-fold scanning of each horizontal course-row is controlled by sequencing means in switching circuit PI. Specifically, the sequencing means has four outputs **1**, 2, 3, 4, at which successively appear a control signal. The control signal appearing at sequencing means output **1** is the clocking signal for course-counter ZB. Accordingly, every fourth control signal effects a counting-advance of counter ZB, and every courserow of the plugboard is scanned four times.

The pattern signals pass out from plugboard **400** over a single line **510** which is connected to all the buffer stores Zsp. However, only one buffer store at a time is permitted to accept pattern signals, and so proper routing can be effected.

During each scanning of a horizontal course-row actually **4** × 100 signals are generated and pass into color classifier **PIII**. However, color classifier **PIII** allows only **100** signals to pass per scanning of a course-row, namely the **100** signals corresponding to a particular color. Which **100** signals is permitted to pass per horizontal scanning of a course-row, is determined at the input **1,001** of color classifier PIII. Classifier **PIII** has four inputs, respectively corresponding to four colors: a control signal will appear at successive ones of the four inputs, to command passage of a particular **100** pattern signals out of the **400** generated during a single scanning of one horizontal course-row.

The sequence of control signals appearing at input **1,001** is derived from the four outputs **1, 2, 3, 4** of routing circuit PI. As already mentioned, a control signal appears at these outputs **1, 2, 3, 4** in cyclical sequence.

Normally, the control signals appearing at outputs **1–4** of routing circuit PI are conveyed directly and in the same sequence to respective ones of inputs **1,001** of color classifier PIII. Thus, normally, if the plugboard **400** is plugged up with color-coded pegs, or the like, the routing of pattern signals by color will be so performed, that the knitted fabric will have an appearance similar to that of the actual pattern mock-up formed by the color-coded pegs.

However, it is possible to vary the color distribution in the knitted fabric, while preserving the pattern geometry, because of the provision of selecting means U. For example, a pattern formed of a thick red stripe alternating with a triad of narrow blue, yellow and green stripes, can be converted into an analogous pattern formed of a thick blue stripe alternating with a triad of narrow red, yellow and green stripes, etc.

The function of selecting means U, in this embodiment, is simply to transfer the cyclical control signals from outputs **1–4** of PI in altered sequence to inputs **1001** of color classifier PIII. When this occurs, then a group of pattern signals nominally associated with one color will be fed to a buffer store associated with another color.

This color-alteration feature can be put into general terms as follows: Successive ones of the buffer stores are permitted in predetermined sequence, to receive pattern signals. Likewise, successive groups of pattern signals are presented to the buffer stores in a certain predetermined sequence. The color alteration is effected by changing one or both of such sequences. In the described embodiment, the color alteration is effected by changing the sequence in which the different groups of pattern signals are permitted to pass to the buffer stores.

It is another important feature of the control system according to the invention, that the scale of the knitted pattern can be varied in one or two dimensions without replugging the pattern panel **400.** Such variations in scale will be discussed with respect to courses and with respect to wales.

Coursewise magnification involves the knitting of pluralities of adjoining courses for each single course represented on the plugboard **400.** For instance, if the plugboard pattern is formed by alternating red and blue horizontal stripes having a height of five courses each, the actual knitted fabric will have such stripes but with a height of **10** or **15** courses each, etc.

Coursewise magnification is effected, in the illustrated system, by means of height multiplier PIV. Height multiplier PIV has a manual control switch S7 settable to any of three positions, in the illustrated embodiment. Of course, more positions may be provided. The settings **1, 2** and **3** respectively correspond to the factor by which the pattern height is multiplied. The function of multiplier PIV, when set at position No. **3** for example, is to furnish to course counter ZB only every third control pulse appearing at output **1** of the sequencing means PI. Clearly, PIV is a counter. In this way, the number of scannings of each course-row is multiplied by **3.** That is, instead of **12** scannings of **3** successive course-rows, there occur **12** scannings of a single course-row. However, the buffer stores Zsp are programmed to store signals for **3** successive course rows, and accordingly the pattern signals derived from the single course-row will be stored as information for the knitting of three successive courses. In this manner, the height of the pattern is increased. Obviously, when such tripling of the pattern height is effected, the scanning of the entire plugboard will take three times as

long, i.e., will require three times as many rotations of the needle cylinder before it is completed.

As mentioned before, the illustrated system is also capable of magnifying the basic pattern by multiplying the number of wales in the basic pattern, through a reiterative knitting process. This is accomplished as follows:

Each buffer store Zsp stores **100** pattern signals, and presents such **100** pattern signals to the needle-actuator group of its associated knitting station. The buffer store Zsp presents such signals successively and at a predetermined rate. Likewise, the respective needle actuator group MA is programmed to receive signals at a predetermined rate. Usually the rates are identical and are synchronized, so that the buffer store presents a single signal to the knitting station during the time allotted for receipt of a single by such knitting station. The reiterative knitting process can be effected by changing either the rate at which the knitting station is permitted to receive signals or the rate at which the buffer store presents signals to the knitting station, or both.

In the described embodiment, the scale change by which the number of wales in the basic pattern is increased, involves the slowing down of the rate at which the buffer store presents pattern signals to its associated knitting station. Thus, to double the number of wales in the knitted pattern (relative to the number of wales in the plugboard pattern) the buffer store is slowed down, and presents a single pattern signal during the time allotted to the knitting station for the receipt of two pattern signals. Thus, the single pattern signal is received by the knitting station twice, and serves as the equivalent of two identical pattern signals. As the knitting station effects knitting along a course, it will perform each knitting operation ("stitch" or "not-stitch" or a particular kind of stitch) twice.

It is of course possible to vary the scale of the actual knitted fabric in two dimensions simultaneously, and by a first scale factor walewise, and by a second scale factor coursewise, or by the same scale factor both walewise and coursewise. This variability is of great importance to the designer of knit fabric. It is well known that a pattern which presents a satisfactory aesthetic appearance on a plugboard, or on graph paper, may be disagreeably distorted upon translation into actual knit fabric, because of the dimensionsal asymmetry of such fabric. The control system of the invention, allows the designer to vary the pattern scale in such manner as to possibly preserve the desired pattern appearance, and also so as to achieve various unusual and other effects.

The foregoing explanation, although not a complete description of the entire operation of the control system, should be sufficient for an understanding of the subject matter claimed, namely: the method and means for color-combination changes, the method and means for increasing the pattern height, the method of increasing the pattern width, and the method and means for simultaneously increasing both pattern height and pattern width. The foregoing explanation should be sufficient in particular for those already conversant with the various methods of programming circular knitting machines. Persons requiring details of the operation and circuit design of the illustrated system may refer to the following, more detailed description.

FIG. **1** shows the interconnections between the different circuits and parts of the electrical patterning system of the invention. The system comprises a rotary code generator **200** that includes a coded coordinating disk and means for moving the disk in time with the needle cylinder (not shown). A first decoder **310** connects the code generator to a main program switch unit PI, and a second decoder **320** connects it to a program switch unit PII. The code generator **200**, which includes readout means, in the present example, is designed for a circular knitting machine having **36** knitting stations and **18** electrical magnetic needle-actuators per knitting station. The main program switch unit PI has a multi-pole switch **S1** with two gangs $S1_1$ and $S1_2$, this switch enabling the knitter to switch to one of several different fundamental pattern programs. The program switch unit PII is provided with a switch **S6**, which can be operated by the knitter to enable knitting of one, two, or three neighboring stitches per course so as to increase the width of the basic pattern.

The permanent patterning store of the patterning system consists of a plugboard-type pattern panel **400**, having **100** × 100 panel portions each directly associated with a respective information location which stores information for a corresponding unit of fabric to be knitted. A unit of fabric corresponds to a single knitted stitch or a plurality of identical stitches, or to the empty space in a knitted fabric having tuck stitches. The pattern panel is connected with program switch unit PIII. The basic pattern is stored in the plugboard by inserting into it plugs that are coded according to the colors, kinds of yarn, or kinds of stitches that are to be knitted for the different pattern characteristics of the basic pattern. The aforesaid plugs are not shown in the FIGS. The plugs can be coded by changing their shape or their color. The information stored in the plug board is interrogated, or read out, coursewise and walewise by means of a course counter ZB and a wale counter ZA.

The main program switch unit PI has four outputs **1**, **2**, **3** and **4**, one for each of the pattern elements to be knitted, these four outputs being connected to respective inputs of the program switch unit PIII. It is here explained that the term "pattern element" means a part of the basic pattern that differs from another part of the basic pattern by color, by stitch, or by yarn. The control input of the wale counter ZA is connected to a **50** kilocycle counting pulse generator which delivers the counting pulses for the counter ZA. The input of the generator G is connected by way of a differentiating network **500** with the **36** inputs of the main switch unit PI.

The program switch unit PIII is connected by a common output lead **510** with one of the several inputs of **36** buffer stores Zsp1 . . . Zsp**36**. Each buffer store is associated with a different one of the **36** knitting stations of the knitting machine, and the further input of these **36** stores is connected with one of the **36** inputs of the main program switch unit PI. A third input of these buffer stores is connected to the program switch unit PII to receive control pulses therefrom.

The output of each buffer store Zsp1 . . . Zsp**36** is connected to a respective magnetic amplifier MV1 . . .MV**36**, each of which controls a respective one of the **36** electromagnetic actuator units MA1 . . . MA**36**. Each unit is associated with a respective knitting station and contains, in the present example, **18** electro-

magnetic actuators for the jacks or needles of the needle cylinder.

The patterning system further comprises a switch S2, which is also operated by the knitter and consists of three decks for setting the units' tens', and hundreds' place of the number of wales of the desired pattern width of the knitted goods. A decoder 330 connects this switch to the buffer stores Zsp1 . . . Zsp36. With another switch S3, which is similar in construction to the switch S2, the knitter can set the desired length of the basic pattern as expressed in the number of courses. A decoder 340 connects this switch to the course counter ZB of the plugboard 400. A switch S4, connected to the buffer stores ZSP, and a switch S5, connected to the course counter ZB, respectively enable the knitter to double the width or the length of the basic pattern, by knitting in the width or length of the goods, a mirror image of the pattern stored in the plugboard 400. The switch T_1, connected to the course counter ZB, starts the electrical patterning system and resets the counter ZB to 1.

The code generator 200, which is shown in detail in FIG. 2, has a disc 210, which is driven, in a manner not shown, by the knitting machine through a non-slip drive so that one rotation of the needle cylinder corresponds to one rotation of the disc 210. The coded disc 210 has six inner tracks *a*, *b*, *c*, *d*, *e* and *f*, and five outer tracks *g*, *h*, *j*, *k* and *l*, each in the from of a concentric circle. The five inner tracks a to *f*, which provide signals for coordinating the knitting stations, are provided with an unambiguous binary code for the 36 knitting stations. The spacing between successive information locations of a track a to f corresponds to the spacing between successive knitting stations around the circumference of the needle cylinder.

The binary code of the outer tracks coordinate the 18 actuators of each knitting station. The tracks of the coded disc 210 are photoelectrically read out by read-out means (not shown), and the resulting signals are amplified. There is one read-out means for each of the circular tracks.

The lower half of FIG. 2 shows, on enlarged scale, the different tracks and the two codes for coordinating the knitting stations and the actuators. Clearly shown is that, for either the inner or the outer group of tracks, only one information location changes in progressing from one number to the next. To ensure that a knitting station coordinating signal always appears before the corresponding actuator's coordinating signal, the code tracks a to f are advanced a distance S with respect to the outer tracks, as is visible in FIG. 2.

As previously remarked, the code generator 200 is provided with an optical read-out arrangement having a read-out head for each track of the disc 210.

The train of signals resulting from the read-out of the tracks *a* to *f* of the coded disc 210 is decoded in the decoder 310 in a known manner by AND gates to form 36 knitting station signals. The five trains of pulses obtained by reading out the outer tracks of the disc 210 are decoded in a second decoder 320 to form 18 actuator signals.

The 36 knitting station coordinating signals obtained from the first decoder 310 control the 36 buffer stores Zsp1 . . . Zsp36 so as to ensure a definite relationship of these buffer stores to the individual knitting stations. Thus, the buffer Zsp1 is associated with the knitting station 1, the buffer store Zsp2 with the knitting station 2, and so on.

Moreover, the 36 knitting station coordinating signals are used in the main program switch unit PI for interrogating the plugboard 400. The main program switch unit with its 36 inputs is shown in FIG. 3. Certain fundamental pattern programs are permanently stored in the main program switch unit PI by a suitable interconnection of logic means.

These fundamental pattern programs are individually of conventional type. In the present example, nine fundamental pattern programs are provided, which can be chosen by switching to one or the other of the nine different possible positions of the switch 1. The fundamental pattern program 1 is, for example, a two-color pattern that is knitted by two knitting stations, all 36 knitting stations of the machine being used and two successive stations complement each other. The fundamental pattern program 4 is, for example, a four-color pattern for which only 32 knitting stations are used. The knitter receives a plan for these fundamental pattern programs, the plan showing for each of the programs which knitting stations knit the same color of yarn. The association of the individual yarn colors, kinds of yarn, or kinds of stitches to certain knitting stations is obtained in the main program switch unit PI by means of OR gates 311, which enable various interconnections of some of the 36 inputs of the main program switch unit PI, as the numbers along side the inputs of these OR gates 311 indicate. In the embodiment illustrated, nine OR gates are provided. The outputs of the OR gates 311 are connected by OR gates 312 and AND gates 313, and by the first decks $S1_1$ of the switch S1, in various ways as determined by the fundamental pattern programs, to the n output OR gates 314/1 . . . 314/4. In the present example, n=4, because four different pattern characteristics are involved. The outputs of these four OR gates 314 constitute the four color outputs 315/1 . . . 315/4 of the main program switch unit PI. These four outputs 315 correspond to the four different states of each switch of the plug board, which will be described. When knitting with four different colors, a control signal appears at the output 315/1 when the color 1 is to be read-out, and a signal appears at the output 315/4 when the color 4 is to be read-out, and so on.

The second deck $S1_2$ of the switch S1 connects, for the particular fundamental pattern program chosen, to the individual magnetic amplifiers MV, the numbers of which are shown along side the output leads connected to the deck. The connection made by the deck $S1_2$ switches these magnetic amplifiers to "knit" or "not knit".

FIG. 4 shows the first four plug-in positions, or switch means, of the three courses 98, 99 and 100 of the plugboard 400. Each plug-in position or switch means, is constituted by two switches 401 and 402, which are connected by a diode 403 with one of the one hundred course inputs 404/1 . . . 404/100. The two switches 401 and 402 are also connected to respective common "wale" leads 405 and 406, which in pairs form the one hundred wale outputs 407/1 . . . 407/100 of the plugboard.

The pair of switches 401 and 402 of each plug-in position, or switch means, constitutes an information location of the plugboard. These two switches together can have four different positions, or states, each state

storing different pattern element information. These four different states are shown in the uppermost row of switch means corresponding to the course input **100**. When knitting in four different colors, these four different states can be as follows:

color 1: switch **401** open, switch **402** open;
color 2: switch **401** open, switch **402** closed;
color 3: switch **401** closed, switch **402** open; and
color 4: switch **401** closed, switch **402** closed.

The switches **401** and **402** of the individual plug-in positions of the plugboard **400** are operated by four different kinds of synthetic plastic plugs, not shown. Each of the four kinds of plugs operates cams on the switch **401** and **402** to move the latter to one of the four different possible states.

In accordance with the invention, a holding plate, advantageously transparent, can be provided for the plugs. The plugs are inserted into the plate, which is then placed over the holes of the plugboard so as to insert all of the plugs simultaneously into the plug-in positions. All of the plugs are easily removed from the plugboard simply by removing the holding plate. A desired pattern can be retained simply by leaving the plugs in the holding plate. Removal of a holding plate from a plugboard automatically erases the information stored therein, and leaves the plugboard free to be stored with information of a new basic pattern merely by placing another holding plate, with plugs inserted therein in accordance with the desired pattern, over the plugboard.

Each of the course inputs **404**/1 . . . 404/100 of the plugboard **400** is connected with a respective one of the one hundred counting stages of the course counter ZB. Each of the wale tandem outputs **407**/1 . . . 407/100 of the plugboard is connected with the respective one of the switching stages of the program switch unit PIII, of which FIG. **4** shows a switching stage connected to the wale tandem output **407**/1. The NAND gates **520** classify the signals on the common lines **405** and **406** according to one of the four-color signals, which are conducted to one of the inputs of four AND gates **521**/1 . . . 521/4. Each of these AND gates is associated with a different one of the four colors, and a second input of each of these AND gates is connected to a respective one of the color outputs **315**/1 . . . 315/4 of the main program switch unit PI. An OR gate **522** conducts the outputs of the four AND gates **521** to one of the two inputs of an output AND gate **523**, the other input of which is connected with one of the one hundred counting stages of the wale counter ZA. Since the switching stage shown in FIG. **4** is associated with the first wale tandem input **407**/1, the second input of the output AND gate **523** is connected to the first number of the wale counter ZA. The output of the AND gate **523** is connected by an inverting gate **524** and a diode **525** to a common line **526**, which latter is connected to an amplifier **527**, the output of which is connected to the common output line **510** of the program switch unit PIII. The line **510** is connected to one input of each of the buffer stores Zsp**1** . . . Zsp**36**.

The buffer stores will be described later. The program switch unit **PII**, the construction of which is shown in FIG. **5**, controls the read-out of the information stored in the buffer stores Zsp. The program switch unit **PII** has **18** inputs that are connected with corresponding outputs of the decoder **320**. A differentiator **530** connects these inputs to the input of at least one (in the chosen example) of three or gates **521**, which cause various interconnections between the **18** inputs of the program switch unit PII. The **18** inputs of the unit PII are associated with the **18** actuators of respective ones of the electromagnetic actuator units MA**1** . . . MA**36**. The outputs of the OR gates **531** are connected to one input of a respective AND gate **532**, the other input of which is connected to a respective switch position of the switch **S6**. The position of the switch **S6** determines which of the OR gates **531** is active and is connected by the associated AND gate **532** and a common output OR gate **533** with the output **534** of the unit PII. The output **534** of the program switch unit PII is connected with one of the inputs of each of the buffer stores.

From the numbers associated with the inputs of the three OR gates **531**, it is apparent, with the position of the switch **S6** as shown in FIG. **5**, that there appears at the output **534** a clock pulse for reading out the store with every input signal on the **18** inputs of the program switch unit PII. In switch position **2**, which causes activation of the middle one of the OR gate **531**, there appears an output signal after every second input signal, and in the switch position **3**, there appears an output signal after every third input signal, as shown by the train of signals in the lower part of FIG. **5**. This means that in the switch positions **2** and **3**, the buffers stores are interrogated, or read out, at only one-half or one-third of the normal speed, so that every information location (every switch means) of the plugboard **400** causes the knitting of two or three neighboring stitches, thereby doubling or tripling the width of the basic pattern.

FIG. **6** shows the construction of the buffer store Zsp**1**, all **36** of the buffer stores being alike. Each buffer store comprises a store **540** of any desired kind, such as a magnetic core store, having as many information locations as the plugboard has wale outputs. In the present example, the store **540** consequently has **100** cores, or information locations. An address counter **550** routes the signals appearing at the data input **541** to the individual information locations in the store **540**. In the present example, the address counter can count to a value of 2^7, and is controlled by the **50** kilocycle counting pulse generator G, as is the wale counter ZA. The addressing is accomplished through seven address inputs **542**/a. . . **542**/g. The address counter **550** also controls the read-out of the stored data, or information, which is read-out in time with the rotation of the needle cylinder and appears at a data, or information, output **543** of the store **540**, from where it is conducted to the magnetic amplifier MV**1** . . . MV**36**. The address counter outputs $a, \bar{a}, b, \bar{b}, \ldots g, \bar{g}$ are connected to one inut of respective AND gates **551**, the other input of these gates being connected to the outputs $a', \bar{a}', b', \bar{b}'$ $g', \bar{g}'$ of the decoder **330**. As mentioned earlier, switch **S2** is a switch for setting a decimal number from **1** to **100**, and is provided with a unit's switch member a ten's switch member, and a hundred's switch member. The manner in numbers are manually set on the switch **S2** is self-evident.

Unit **330** (FIG. **1**) is a simple decimal-to-binary decoder. Unit **330** has **14** outputs $a', \bar{a}', b', \bar{b}', c', \bar{c}', d', \bar{d}', e', \bar{e}', f', \bar{f}', g', \bar{g}'$, not labelled in FIG. **1**, but explicitly depicted in the upper left-hand portion of FIG. **6**, accompanied by the label "from **330**".

The functional correlation between the positions of the three switch members of switch **S2** and the signals

at the fourteen outputs of decimal-to-binary decoder **330** is as follows. When switch **S2** is set for a particular number, for example **27**, a binary representation of the number appears on the outputs a', b', c', d', e', f', g' of unit **330**. For example, in binary arithmetic, the numeral **27** is represented as **0011011**. The seven digits of this seven-digit number are respectively associated with the seven pairs of outputs of the decoder **330**, explicitly depicted in FIG. **6**. When the digit associated for example with the pair of outputs c', $\overline{c}'$ is a "**1**," then the c' output will be energized; conversely, when the digit associated with the pair of outputs c', $\overline{c}'$, is a "**0**," then the $\overline{c}'$ output will be energized. The pairs of AND gates **551**, associated with the outputs a, $\overline{a}$ or a', $\overline{a}'$ are connected by respective OR gates **552** with one of the inputs of an OR gate **553**, the output of which is connected by a lead **554** to operation switch **560** of the buffer store. Among its other functions, the operation switch **560** switches the store **540** between read-in and read-out. The operation switch also controls, in dependence on the position of the switch **S4**, and by means of the leads **561** and **562**, the operation of the address counter **550**, as well as, by means of a lead **563**, the conduction of each clock pulse to the address counter **550**. Additional connecting leads **564**, **565**, **534**, **567** connect the operation switch **560** witn other circuits of the patterning system. For example, an AND gate **544** ensures that only when a signal associated with the first knitting station appears on the input lead **567**, will patterning information be fed into the data input **541** of the store **540**.

The patterning system operates in the following manner. If, for example, the one hundredth row of information locations (corresponding the hundredth course of a stored pattern) is to be read-out of the plugboard **400**, the one hundredth counting stage of the course counter ZB delivers a counting pulse to the course input **404**/100, all other course inputs **404** of the plugboard having no signal. The color **1** is programmed, or stored, in the first information location of the hundredth row, because both switches **401** and **402** are open. As a result, the AND gate **521**/1, which is associated with the first color, receives a signal at one of its inputs. If a signal corresponding to color **1** appears at the first output of the main program switch unit **PI** —this being a command to read out the color **1** in the plugboard— the AND gate **521**/1 becomes conductive and causes a signal to appear on one of the inputs of the output AND gate **523**. The wale counter ZA interrogates the one hundred wale output of the plugboard and thus the individual switching stages of the program switch unit **PIII**, one after the other. The counting stage **1** is associated with the wale **1**, and if the first counting stage delivers an output signal, the output AND stage **523** is rendered conductive; and a signal containing information is conducted by the inverting gate **524** to the amplifier **527**, which conducts the amplified signal to the lead **510** and therefore to a determined, and at this time accessible, buffer store Zsp.

The color **4** is stored in the second information location of the one hundredth row of the plugboard **400**, so that a signal is conducted to one input of the AND gate **521**/4 of the associated switching stage (not shown) of the program switch unit **PIII**. However, the AND gate **521**/4 conducts only when a signal appears at the color **4** output of the main program switch unit **PI**.

As previously remarked, the wale outputs **407** of the plugboard **400** are read-out through the AND gates **523** of the associated switching stages of the program switch unit **PIII** at a scanning frequency of **50** kilocycles. The input signals on the **36** inputs of the main program switch unit **PI** are conducted through the differentiating network **500** to the counting, or clock, pulse generator G to control the latter, which is shut off after each of the one hundred counting stages of the wale counter ZA has delivered its pulse. Consequently, the generator G delivers **100** pulses to each knitting station as soon as the rotary hole disc **200** delivers the signal for the respective knitting station. With a **50** kilocycle generator, the scanning time for **100** pulses is only **2** milliseconds. The train of pulses read-out of the plug board is delivered by the common line **510** to all of the buffer stores Zsp**1** . . . Zsp**36**, but the input of only one of these buffer stores is open. The generator G also advances the counter ZA at the rate of **50** kHz.

The following occurs in the buffer store. If, for example, the first needle passes by the first knitting station, the coded rotary unit **200** provides, by way of the decoder **310**, a signal for the first of the **36** inputs of the main program switch unit **PI**; the wale counter ZA is already in reset condition. At the same time, the address counter **550** of the buffer store is also already in reset condition. The address counter **550** has previously been reset by operation selector **560** (FIG. **6**). When the signal appears at the input of the main program switch unit **PI**, the clock pulse generator G is turned on, and it delivers counting pulses to the wale counter ZA and the address counter **550**. After the one hundredth pulse, the generator G stops; and the reading into the buffer store ends.

More specifically, with respect to wale counter ZA, the operation is as follows: the initial appearance (not the continued existence) of a pulse at any of the **36** outputs of decoder **310** turns on clock G. The pulses at the outputs of decoder **310** are passed onto the control input of clock G through the intermediary of a differentiator **500**, so that only the initial appearance of such pulses at the outputs of **310** turns on the clock G. The clock G then drives the counter ZA. After **100** clock pulses have been applied to counter ZA, counter ZA automatically becomes reset (for example, counter ZA may be a ring counter). This having been done, counter ZA feeds back to clock G, via the lower illustrated line connecting together G and ZA, a feedback signal which turns the clock G off. When next a pulse appears on one of the outputs of **310**, the clock G will be turned on again, with the counter ZA already having been reset.

As for the address counter **550**, the situation is basically analogous. The address counter **550** will have been reset prior to the appearance of a pulse of one of the outputs of decoder **310**, and accordingly prior to turning-on of the clock G.

The reading out of the buffer store always begins with the fifth synchronizing pulse after the appearance of the input pulse at the main program switch unit **PI**. This ensures a precise beginning to the knitted pattern. This fifth synchronizing pulse is conducted by the input lead **564** to the operation switch **560** of the buffer store. The fifth synchronizing pulse in question is transmitted to operation selector **560** via line **564** (FIGS. **1** and **6**). Whereas the fifth synchronizing pulse is shown in FIG. **1** as originating from amplifier MV, it is to be under-

stood that the pulse in question actually originates from output No. 5 of decoder 320, and reaches input line 564 via the amplifier MV; in other words, the input line 564 could instead simply be connected to the No. 5 output of decoder 320. Before the read-out can begin, the address counter 550 must be reset. The address counter begins to count again with the appearance of the read-out pulse, this counting being appreciably slower and in synchronism with the rotation of the needle cylinder. In other words, the interrogation of the buffer store is carried out in time with the movement of the needle cylinder. As soon as the address counter reaches the number set by switch S2 and stored in the buffer store by the decoder 330, there appears at the output of the common OR gate 553 a signal that is conducted by the lead 554 to the operation switch 560, causing the latter to switch over. If the switch S4 is open, the address counter receives a reset signal from lead 562, and it begins to count anew from the first number.

The width of the basic pattern in wales is therefore equal to the number to which the switch S2 is set. But if the switch S4 is set to position 2, the address counter 550 receives from the operation switch 560, by way of the lead 561, a reversing signal, so that the address counter counts backwards to all of the counting stages to the first stage. The result is that the width of the basic pattern knitted is doubled by knitting a mirror image of the stored pattern. The described operation of the address counter 550 is repeated until the needle cylinder has completed a full rotation, and fresh information is read into the store 540.

The signals read-out of the store 540 are conducted by way of the data output 543 to the associated magnetic amplifier MV1, which distributes the received signals to, for example, eighteen reversing solenoids, which control the eighteen actuators of the associated electromagnetic actuator unit MA1. The outer program tracks g to 1 of the coded disk 210 control the distribution of the signals to the eighteen reversing solenoids. As previously explained, the program switch unit PII supplies the clock pulses, which are used to read-out the buffer store.

The operation of the patterning system will be further described with reference to an actual pattern. It will be assumed that a four-color basic pattern is to be knitted, the pattern having a width of 75 stitches and a length of 96 stitches. The pattern is stored in the plugged board, and is to be knitted so that a mirror image of the pattern appears both in its width and its length, thereby doubling both the width and the length of the stored basic pattern. Moreover, the pattern width will be doubled a second time by a so-called "double insert," thereby quadrupling the width of the stored pattern.

The knitter sets the program switch S1 of the main program switch unit PI to position 4, which corresponds to the fundamental pattern program "knit with four colors". FIG. 3 shows that the OR stages 311, indicated by the letters *e*, *f*, *g*, and *h*, of the main program switch unit PI are switched in, and that the AND gates 313, denoted by the letters *a*, *b*, *c*, and *d*, and therefore provided with a signal at one input. The second deck $S1_2$ of the switch S1 sets the magnetic amplifiers MV33, 34, 35 and 36 to "not knit," thereby deactivating the associated electromagnetic acutator units MA33 to MA36. Thus, the main program switch unit PI determines which color or colors will be read-out of the plugboard and how these colors will be routed to the individual knitting stations.

The knitter turns the switch S2 to the number 75, which is equal to the number of stitches of the width of the basic pattern. The knitter turns the switch S3 to the number 96, which is the number of stitches of the length of the basic pattern. The numbers thus set are binary encoded in the decoders 330 and 340 in a plurality of bits. The knitter sets the switch S4 to the position 2, so that a mirror image of the basic pattern will be knitted widthwise. The desired mirror pattern in the length is obtained by setting the switch S5. In order that every stitch programmed in the plugboard 400 will be double knitted, the knitter sets the switch S6 to the position 2.

The knitting is started by pressing the button T1, thereby resetting the course counter ZB. As a consequence, the programmed pattern starts at the beginning. When the coded disc 200 delivers an input signal "knitting station 1" to the first input of the main program switch unit PI, the output "color 1" of the main program switch unit has a signal, which is conducted to one input of the AND gates 521/1 of the individual switching stages of the program switch unit PIII. In addition, by way of the operation switch 560, the buffer store Zsp1 of the knitting station 1 is set to read-in. The clock, or counting, pulse generator G is turned on through the differentiating network 500, and delivers one hundred pulses to the wale counter ZA and to the address counter 550 of the buffer store Zsp1. The wale counter ZA reads out, by way of the program switch unit PIII, the color 1 in the first row of the plugboard 400. The resulting output signals on the lead 510 of the unit PIII are read into the first buffer store Zsp1.

During the read-in into the buffer store, the needle cylinder rotates through a distance of as much as three needle steps, depending upon the rotational speed of the needle cylinder. After five needle steps, the operation switch 560 of the buffer store Zsp1 is switched to read-out; and the information contained in the store 540 is read out in time with the rotation of the needle cylinder and conducted to the magnetic amplifier MV1. Since the switch S6 of the program switch unit PII is set to "double insert," only every second synchronizing signal switches the buffer store Zsp, causing the information stored at each information location of the store 540 to be conducted to the magnets of two actuators so that two adjacent needle knit in response to this information.

After the 75 information location have been read-out, the operating switch 560 switches to backward read, in accordance with the preselection. After the first information location has been reached, the operation switch 560 switches back to forward read, and so on, until the needle cylinder has completed one full rotation.

A logic circuit which can be used for the operations switch 560 of FIG. 6 is depicted in FIG. 7. The circuit of FIG. 7 includes a first flip-flop composed of inverters 1, 2 and NAND-gates 3, 4 cross-connected in conventional flip-flop fashion, and a similar second flip-flop composed of inverters 10, 11 and NAND-gates 12, 13. The circuit of FIG. 7 further includes AND-gates 5, 6, 8, 15 and 17, OR-gates 7, 9, and a further inverter 14.

The operations switch 560 depicted in FIGS. 6 and 7 performs two basic functions.

First, it enables the store 540 to receive fresh pattern signals, with destructive read-in; or else it enables the store 540 to be interrogated. These are respectively the "write" and "read" modes. In performing this conversion from one mode to the other mode, the switch unit 560 connects the clock signal input 563 of the addressing counter 550 to either the 50 kHz line 565, or else to the line 566. Line 566 is directly connected to the output 534 of unit PII.

Second, switch unit 560 causes addressing counter 550 to act as a purely forwards counter, or else as a forwards-backwards counter, in cooperation with control switch S4, and in cooperation with the AND-gate 000 (see FIG. 6) and in cooperation with the AND-gate 553. The AND-gate 553 lets the switch unit 560 known when the counter has counted down to zero.

It is assumed that the switch unit 560 shown in FIG. 7 is the one associated with knitting station No. 1.

When a particular needle (call it needle No. 1) passes knitting station No. 1, a pulse appears on line 567. This pulse originates from the No. 1 output of unit 310 (see FIG. 1), to which line 567 is directly connected.

This pulse causes a change of state of flip-flop 1-4. A "1" signal appears at the output of gate 3, readying the store 540 for the receipt of fresh patterning signals. The line marked write in the sketch is identical to the left-hand one of the two lower vertical control inputs of store 540 shown in FIG. 6.

The same pulse is applied to one input of AND-gate 5, whose other input is connected to the 50 kHz line 565. Accordingly, 50 kHz clock signals are applied to the clock signal input 563 of addressing counter 550. The addressing counter 550 counts from zzero up, at a counting rate of 50 kHz. Consequently, the store 540 controlled by the counter 550 will be advanced at 50 kHz. That is, successive ones of the one hundred information storage units inside store 540 will become enabled to receive fresh pattern signals, the successive enabling occurring at the rate of 50 kHz. In this way, the store 540 becomes filled up with fresh pattern signals.

The total time requirement for the filling up of store 540 with fresh pattern signals is assumed to correspond to the time required for three needles to pass the knitting station in question (knitting station No. 1). To establish a margin for error, recommencement of interrogation of store 540 occurs subsequent to initiation of repatterning thereof, after elapse of a time interval corresponding to the passage of five needles past station No. 1.

Thus, when needle No. 5 passes knitting station No. 1, a pulse appears on line 564. This synchronizing pulse can be derived simply by connecting input 564 directly to output No. 5 of decoder 320, or equivalently to magnetic amplifier No. 5 of the bank of magnetic amplifiers of knitting station No. 1. A 1 signal on line 564 results in a 1 signal at the output of AND-gate 17 only if the respective store 540 is in the write mode; otherwise, the signal appearing on line 564 will have no effect.

In any event, after the store 540 has been filled with fresh information, a 1 signal does appear on line 564, and accordingly at the output of AND-gate 17. This resets the flip-flop 1, 2, 3, 4. This 1 signal is directly applied to the read-selecting input of store 540, enabling the store 540 to be interrogated. Also this 1 signal is applied to AND-gate 6, to which is also applied the pulses appearing at the output 534 of unit PII. These pulses, having a frequency equal to the needle-passing frequency, or one-half or one-third thereof, become applied to clock signal input 563, so that during interrogation, the interrogation-controlling addressing counter 550 is driven at the needle-passing frequency, or one-half or one-third thereof.

With respect to this first part of unit 560, it should be noted that when feeding of the store 540 with fresh signals is to begin, the counter 550 should of course be in reset condition. This does occur, because the pulse on line 567, which initiates the acceptance of new pattern signals by store 540, also reaches reset line 562 to reset counter 550.

Similarly, upon converting from the mode wherein store 540 receives fresh information to the mode wherein store 540 is interrogated, the counter 550 must likewise be in reset condition at the start of the interrogation. This will in fact be the case, since the interrogation-initiating pulse on line 564 is also applied to the reset line 562 of counter 550 via OR-gate 9 shown in FIG. 7.

This takes care of the conversion of the store 540 back and forth between the read and write modes thereof, namely enablement for signal receipt and enablement for interrogation.

The second part of the circuit shown in FIG. 7 is provided for controlling the interrogation in such a manner as to either produce the described mirror-reflection pattern magnification, or not.

When switch S4 is in position 1, the pattern is magnified by mirror-reflection. Via resistor 16 and inverter 14, a 0 signal is applied to AND-gate 8, blocking the gate. Therefore no reset pulse on line 554 can reach reset line 562. The AND-gate 15 on the other hand, is enabled. If a 0 signal persists on line 561 the counter 550 counts forwards; if a 0 signal persists on line 561, the counter 550 counts backwards. The changeover from forwards to backwards counting, and vice versa, is controlled by flip-flop 10, 11, 12, 13. When the counter 550 reaches a count corresponding to the width of the plugged pattern, a pulse appears on line 554, originating from AND-gate 553 (see FIG. 6). This pulse on line 554 triggers the flip-flop 10, 11, 12, 13, so that a 1 signal appears at the output of gate 12 and therefore on line 561. The counter 550 accordingly counts backwards, instead of being immediately reset; thus pattern-width magnification by mirror-reflection is achieved.

When the now backwards-counting counter 550 reaches count zero, a 1 signal is applied to the input of inverter 11, thereby resetting flip-flop 10, 11, 12, 13. Thus there is a 0 signal at the output of gate 12, AND-gate 15 is blocked, and there is a 0 signal on line 561. Consequently, counter 550 is again put into the forward-counting mode, and the counter 550 then counts upwards again from zero to the number equal to the width in columns of the plugged pattern. This forward-reverse-forward-reverse type of counting continues for the remainder of the needle-cylinder rotation.

In contrast, if the switch S4 is in position 2, no pattern-width magnification by mirror-reflection results. AND-gate 15 will be blocked, with a 0 signal on line 561; this prevents backwards counting by counter 550; the counter can count forwards only. Also, the 0 signal at the input of inverter 14 results in the application of a 1 signal to the lower input of AND-gate 8. Thus, every time a 1 signal appears on line 554, it will be passed through gates 8, 9 to reset line 562, so as to reset

counter 550. As already mentioned, a 1 signal appears on line 554 when the counter 550 has counted up to the number equal to the number of columns in the plugged pattern (the width of the plugged pattern). Thus, with switch S4 in position 2, the counter 550 will count in a forward-reset-forward-reset manner, with no mirror-reflection resulting.

Operations switch 560 performs no other functions.

When the first needle of the knitting machine reaches the second knitting station, an input signal, conducted from the code generator 200 by the decoder 310, is conducted to the second input of the main program switch unit PI. This signal causes a signal to appear on aninput of the AND gate 521/2 of the program switch unit PIII, and it prepares the buffer store Zsp2. The clock pulse generator G is again turned on, and the color 2 is read-out of the first row of information locations of the plugboard 400. The resulting output signals of the program switch unit PIII are conducted over the common line 510 and read into the buffer store Zsp2. After the fifth synchronizing pulse appears —in other words, after the needle cylinder has rotated through five needle steps in the second knitting station— the buffer store Zsp2 is switched from read-in to read-out.

In the very same way, when the first needle appears at the third knitting station, the first course-row of information locations of the plugboard is read-out for the color 3, and when the first needle sppears at the fourth knitting station, the first course-row of information locations is read-out for the color 4.

When the first needle appears at the fifth knitting station, the color 1, in accordance with the chosen fundamental pattern program, is again read-out, but this time in the second horizontal row of information locations of the plugboard 400. The course input 404/2 of the plugboard is made accessible to interrogation by the course counter ZB, which is switched to the second counting stage when the color signal 1 again appears at the corresponding output of the main program switch unit PI. The read-out of the color 1 in the second row of information locations of the plugboard 400 and the reading in of the output signals into the fifth buffer store Zsp5 are done in the previously-described manner.

The continued reading out of the plugboard is done as described for the first five knitting stations. When the signal "color 1" appears at the output of the main program switch unit PI, the course counter ZB is switched to the next counting stage, until the 96 counting stages, corresponding to the desired pattern length, have been gone through. The counter ZB then counts backwards to the 96 stages to cause the lengthwise mirror knitting of the pattern.

An important advantage of the patterning system of the invention is that the coursewise reading out of the plugboard and the storing of the read-out information in the individual buffer stores occurs at one speed, whereas the reading out of the information stored in the buffer stores and its conduction to the respective magnetic amplifiers occurs at a different speed. The reading out of the plugboard occurs each time that the coded generator causes a change to the next knitting station. The information is stored in a few milliseconds in the buffer store associated with the new knitting station, whereupon the information is immediately read-out from the buffer store in time with the rotation of the needle cylinder.

The main program switch unit PI determines which knitting stations, in dependence on the chosen fundamental pattern program, knit which yarn colors, or which knitting stations are not used; with the knitting of raised patterns, the unit PI determines which knitting stations knit the raised portion and which knitting stations knit the fabric base.

A very important advantage of the patterning system of the invention is that the main program switch unit PI contains the most important of the fundamental pattern programs, by the arrangement and the connection of logic circuit elements. The knitter himself can choose one or another of these fundamental pattern programs simply by turning a switch.

FIG. 2*a* shows the logic circuit diagram for the selecting means U of FIG. 1. It is emphasized in advance, that the selecting means of FIG. 2*a* is only one specific expedient.

Clearly, switching can be effected in many different ways.

Selecting means U has four pluggable input divisions 1002. The insertion of a color-coded peg, or the like, into a particular input division 1002 effects closing of switch *a* and/or switch *b*, or neither switch *a* nor switch *b*; this effects storage of one of four distinguishable electrical signals. One end of each of contacts *a* and *b* is connected via a diode 1,007 to a common input 1,009 of the selecting means U which may, for example, be connected to the positive terminal of a voltage source such as a battery. The other terminal of each of contacts *a*, *b* is connected to the input of an inverter 1,004, which in turn is connected to the input of another inverter 1,004. Each input division 1,002 includes four such inverters 1,004 which, together with the four outputs 1,010, 1,011, 1,012 and 1,013, form a decoder. The decoding circuit is connected directly to ground at its input end, via resistors 1,003.

The four outputs of the decoder of each division 1,002 are each connected to the input of two out of a bank of four AND-gates 1,005 associated with the respective division 1,002. The four inputs of the bank of AND-gates 1,005 associated with a particular division 1,002 are all connected via leads 1,000 to one of the outputs 1, 2, 3, 4 of the sequencing means forming part of switching unit PI. As already explained, the sequencing outputs 1, 2, 3, 4 are energized successively and in cyclical manner during the four-fold scanning of course-rows.

The outputs of the four AND-gates 1005 associated with the first of divisions 1,002 are each connected to the input of a different respective one of OR-gates 1006. The four outputs 1, 2, 3, 4 of the four OR-gates 1,006 are respectively connected with the four inputs of color classifier PIII.

As explained before, selecting means U permits transfer, for instance, of information nominally associated with one color to a knitting station supplying yarn of a different color.

By means of the non-illustrated color-coded plugboard pegs, each division 1,002 can be put into one of four distinguishable states, resulting in different routing combinations. In FIG. 2*a* the contacts *a* and *b* of the respective input divisions 1,002 are so positioned as to establish the following logical conditions:

First input division 1,002 (the lowermost in FIG. 2a) corresponding to color No. 1:

OUTPUT	1,010	0
"	1,011	1
"	1,012	0
"	1,013	1

Second input division 1,002 associated with color No. 2:

output	1,010	0
"	1,011	1
"	1,012	1
"	1,013	0

Third division 1,002 associated with color No. 3:

output	1,010	1
"	1,011	0
"	1,012	0
"	1,013	1

Fourth division 1,002 associated with color No. 4:

output	1,010	1
"	1,011	0
"	1,012	1
"	1,013	0

With this combination of logic signals, the sequence of control signals appearing successively at inputs **1, 2,** 3, 4 of selecting means U will appear successively at outputs **4, 3, 2, 1** of the selecting means U, effecting a sequence reversal of the routing governed by color classifier PIII. Naturally, if only two colors are involved, the selecting means U would effect straightforward color inversion.

The selecting means U can have a four-stage input switching circuit instead of the input divisions **1,002** illustrated. In such event, there would be no need for the decoding stage comprised of inverters, **1,004**; and the output of the four-stage switching circuit could be connected directly with the inputs of AND-gates **1,005**, which would then each require only two inputs.

The appended claims set forth the invention in broad terms. It will be appreciated that the "scanning means" referred to signifies, in so far as the described embodiment is concerned, the counters ZA and ZB in particular. Clearly, the major portion of the circuitry described serves the function of routing pattern signals to appropriate ones of the buffer stores and thence to appropriate knitting stations, and in proper sequence. Accordingly, such circuitry is referred to in the claim as "routing means."

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended

1. A method of controlling a circular knitting machine having a plurality of knitting stations responsive to pattern signals and respectively associated with different pattern characteristics and together arranged to knit a patterned fabric composed of fabric units each having one of said pattern characteristics, comprising the steps of establishing a plurality of information locations each corresponding to a respective fabric unit to be knitted; establishing a basic pattern by storing in each location information representing the pattern characteristic selected for the corresponding fabric unit; establishing a scanning scheme according to which said locations are scanned and according to which groups of pattern signals are generated each group indicating which locations store information representing a particular respective one of said pattern characteristics; establishing a routing scheme for routing each of said groups of signals to a respective knitting station associated with a particular respective one of said pattern characteristics; and changing the routing scheme by routing at least one of said groups of signals to a different knitting station associated with a different one of said pattern characteristics, wherein said step of establishing a plurality of information locations comprises organizing said information locations into wale information location groups and course information location groups, wherein said step of establishing a scanning scheme comprises establishing a scanning scheme according to which successive groups of information locations are scanned, and according to which each scanned group is scanned, prior to the scanning of the next group, a number of times equal to the number of different pattern characteristics represented by said information, said knitting machine having a plurality of buffer stores each associated with a respective one of said knitting stations, and wherein said step of establishing a routing scheme comprises establishing the sequence in which successive one of said buffer stores are permitted to receive pattern signals and establishing the sequence in which successive groups of pattern signals are presented to buffer stores, and wherein the step of changing the routine scheme comprises altering at least one of said sequences.

2. A method as defined in claim **1**, wherein said step of establishing a plurality of information locations comprises organizing said information locations into a rectangular array corresponding to the rectangular organization of stitches in knitted fabric.

3. A method as defined in claim **1**, wherein said step of establishing a plurality of information locations further includes establishing a pattern panel comprised of uniformly disposed panel forming a rectangular array representing the rectangular organization of stitches in knitted fabric.

4. A method as defined in claim **1**, wherein said step of establishing a plurality of information locations comprises organizing said information locations into a two-dimensional rectangular array corresponding to the rectangular organization of stitches in knitted fabric and consisting of course-rows and wale-rows which respectively correspond to the courses and wales of knitted fabric; wherein said step of establishing a scanning scheme comprises establishing a rectangular scanning scheme according to which said course-rows are scanned walewise at higher speed and said wale-rows are scanned coursewise at lower speed, and according to which each course-row is scanned n times prior to the scanning of the next course-row, where n is the number of pattern characteristics represented by said information, and according to which n groups of signals are generated in response to the n-fold scanning of each successive course-row.

5. A method as defined in claim **1**, wherein said step of establishing a basic pattern comprises storing in each of said locations information representing the predominant color selected for the corresponding fabric unit.

6. A method as defined in claim **1**, wherein said step of establishing a basic pattern comprises storing in each of said locations information representing the selected yarntype of the knitted stitch occupying the corresponding fabric unit.

7. A method of controlling a circular knitting machine having a plurality of knitting stations responsive to pattern signals and respectively associated with different pattern characteristics and together arranged to knit a patterned fabric composed of fabric units each having one of said pattern characteristic, comprising the steps of establishing a plurality of information locations each corresponding to a respective fabric unit to be knitted; establishing a basic pattern by storing in each location information representing the pattern characteristic selected for the correspondnig fabric unit; establishing a scanning scheme according to which said locations are scanned and according to which groups of pattern signals are generated, each group indicating which locations store information representing a particular respective one of said pattern characteristics; establishing a routing scheme for routing each of said groups of signals to a respective knitting station associated with a particular respective one of said pattern characteristics; and changing the routing scheme by routing at least one of said groups of signals to a different knitting station associated with a different one of said pattern characteristics, wherein said step of establishing a plurality of information locations comprises organizing said information locations into wale information location groups and course information location groups, wherein said step of establishing a scanning scheme comprises establishing a scanning scheme according to which successive groups of information locations are scanned, and according to which each scanned group is scanned, prior to the scanning of the next group, a number of times equal to the number of different pattern characteristics represented by said information, said knitting machine having a plurality of buffer stores each associated with a respective one of said knitting stations, and wherein said step of establishing a routing scheme comprises establishing the sequence in which successive groups of pattern signals are presented to buffer stores, and wherein said step of changing the routine scheme comprises altering said sequence.

8. In a control system for a circular knitting machine which has a plurality of knitting stations respectively associated with different pattern characteristics and together arranged to effect knitting of a patterned fabric composed of fabric units each having one of said pattern characteristics, the combination comprising a plurality of information locations each corresponding to a respective fabric unit to be knitted and each arranged to receive and store information representing the pattern characteristic selected for the corresponding fabric unit, said information locations being organized into information location groups scanning means for scanning said locations and for generating groups of pattern signals, each group of signals indicating which locations store information representing a respective one of said pattern characteristics, said scanning means being operative for scanning each of said information location groups, prior to the scanning of the next group, a number of times equal to the number of different pattern characteristics represented by said information, and routing means for establishing a plurality of different selectable routing schemes according to each one of which each of said groups of signals is routed to a respective knitting station associated with one of said pattern characteristics, and including selecting means for selecting a routing scheme from said plurality of different routing schemes, said routing means and selecting means thereby making it possible to preserve the geometry of a particular pattern while changing the assignment of pattern characteristics within such pattern, said knitting machine having a plurality of buffer stores each associated with a respective one of said knitting stations, and wherein said routing means comprises means for establishing the sequence in which successive ones of said buffer stores are permitted to receive pattern signals, and for establishing the sequence in which successive groups of pattern signals are presented to buffer stores, and wherein said selecting means comprises means for altering at least one of said sequences.

9. A control system as defined in claim 8, wherein said pattern characteristic is the predominant color of a fabric unit.

10. A control system as defined in claim 8, wherein said pattern characteristic is the yarn-type of a knitted stitch occupying a fabric unit.

11. A control system as defined in claim 8, wherein said information locations are arranged into wale information location groups and course information location groups.

12. A control system as defined in claim 8, wherein said information locations are arranged into a rectangular array corresponding to the rectangular organization of stitches in knitted fabric.

13. A control system as defined in claim 8; and further including a pattern panel comprised of uniformly disposed panel portions forming a rectangular array visually representing the rectangular organization of stitches in knitted fabric, and each of said panel portions being directly associated with a respective one of said information locations.

14. A system as defined in claim 8, wherein said scanning means comprises means for scanning each information location n times per scanning cycle, where n is the number of different pattern characteristics represented by said information stored in said plurality of information locations.

15. A system as defined in claim 11, wherein said scanning means comprises means for scanning successive groups of information locations, and for scanning each group n times prior to the scanning of the next group, where n is the number of different pattern characteristics represented by said information.

16. A system as defined in claim 8, wherein said information locations are organized as a two-dimensional rectangular array corresponding to the rectangular organization of stitches in knitted fabric and consisting of course-rows and wale-rows which respectively correspond to the courses and wales of knitted fabric, and wherein said scanning means comprises means for scanning said course-rows walewise at higher speed and said wale-rows coursewise at lower speed, and for scanning each course-row n times prior to the scanning of the next course-row, where n is the number of pattern characteristics represented by said information, and for generating n groups of signals in response to the n-fold scanning of each successive course-row.

17. In a control system for a circular knitting machine which has a plurality of knitting stations respectively associated with different pattern characteristics and together arranged to effect knitting of a patterned fabric composed of fabric units each having one of said pattern characteristics, the combination comprising a

plurality of information locations each corresponding to a respective fabric unit to be knitted and each arranged to receive and store information representing the pattern characteristic selected for the corresponding fabric unit, said information locations being organized into information location groups; scanning means for scanning said locations and for generating groups of pattern signals, each group of signals indicating which locations store information representing a respective one of said pattern characteristics, said scanning means being operative for scanning each of said information location groups, prior to the scanning of the next group, a number of times equal to the number of different pattern characteristics represented by said information; and routing means for establishing a plurality of different selectable routing schemes according to each one of which each of said groups of signals is routed to a respective knitting station associated with one of said pattern characteristics, and including selecting means for selecting a routing scheme from said plurality of different routing schemes, said routing means and selecting means thereby making it possible to preserve the geometry of a particular pattern while changing the assignment of pattern characteristics within such pattern, said knitting machine having a plurality of buffer stores each associated with a respective one of said knitting stations, and wherein said routing means comprises means for establishing the sequence in which successive groups of pattern signals are presented to buffer stores, and wherein said selecting means comprises means for altering said sequence.

18. In a control system for a circular knitting machine which has a plurality of knitting stations respectively associated with different pattern characteristics and together arranged to effect knitting of a patterned fabric composed of fabric units each having one of said pattern characteristics, the combination comprising a plurality of information locations each corresponding to a respective fabric unit to be knitted and each arranged to receive and store information representing the pattern characteristic selected for the corresponding fabric unit, said information locations being organized into information location groups; scanning means for scanning said locations and for generating groups of pattern signals, each group of signals indicating which locations store information representing a respective one of said pattern characteristics, said scanning means being operative for scanning each of said information location groups, prior to the scanning of the next group, a number of times equal to the number of different pattern characteristics represented by said information; and routing means for establishing a plurality of different selectable routing schemes according to each one of which each of said groups of signals is routed to a respective knitting station associated with one of said pattern characteristics, and including selecting means for selecting a routing scheme from said plurality of different routing schemes, said routing means and selecting means thereby making it possible to preserve the geometry of a particular pattern while changing the assignment of pattern characteristics within such pattern, said knitting machine having a plurality of buffer stores each associated with a respective one of said knitting stations, and wherein said scanning means comprises means for generating n pattern signals for each location scanned and n different groups of pattern signals in response to the scanning of a plurality of information locations, where n is the number of different pattern characteristics represented by said information, and wherein said routing means comprises classifying means for separating said groups of pattern signals on the basis of different respective pattern characteristics, and wherein said classifying means has n inputs respectively associated with said n different pattern characteristics and n groups of pattern signals, and wherein the appearance at one of said n inputs of a control signal effects passage of the respective group of pattern signals to the buffer stores, and wherein said routing means further includes sequencing means having n outputs and producing in turn a control signal at successive ones of said n outputs, and wherein said selecting means comprises a gating circuit having n inputs connected to the n outputs of said sequencing means and having n outputs connected to the n inputs of said classifying means, and wherein said selecting means is oeprative for causing a sequence of n signals appearing at successive ones of its n inputs to appear in altered sequence at its n outputs.

19. A system as defined in claim **18**, wherein said gating circuit comprises n output OR-gates each having n inputs, and n banks of AND-gates, the outputs of successive AND-gates within a bank of AND-gates being respectively connected with the inputs of successive ones of said n OR-gates, and the outputs of the n OR-gates being respectively connected to the n inputs of said classifying means, and further including mechanically operated switch means.

20. A system as defined in claim **19**, wherein said mechanical switching means comprise a pair of mechanical switches associated with each of said n inputs of said selecting means.

21. A method of controlling a circular knitting machine having a plurality of knitting stations respectively associated with different pattern characteristics and each arranged to effect knitting of stitches upon receipt of pattern signals, and together arranged to effect knitting of a patterned fabric composed of fabric units each having one of said pattern characteristics, comprising the steps of establishing a plurality of information locations each corresponding to a respective fabric unit to be knitted; establishing a basic pattern by storing in each location information respresenting the pattern characteristic selected for the corresponding fabric unit; scanning and locations and generating, for each location scanned, a predetermined pluraltiy of pattern signals each indicative of the information stored in the respective location, and each thereby indicative of the respective pattern characteristics; and transferring successive ones of the signals in each plurality of signals to respective successive knitting stations each associated with the respective pattern characteristic, so that such successive knitting stations will effect knitting of a plurality of identical adjoining stitches in a single wale and all corresponding to the respective plurality of pattern signals, and thereby corresponding to the information stored in the respective scanned location, said knitting machines having a plurality of buffer stores each associated with a respective one of said knitting stations, and the stores being programmed so that they are successively permitted to receive and store incoming pattern signals, wherein said step of establishing a plurality of information locations comprises organizing said information locations into a two-dimensional rectangular array corresponding to the rectangular organization of

stitches in knitted fabric and consisting of course-rows and wale-rows which respectively correspond to the courses and wales of knitted fabric, and wherein said scanning step comprises scanning successive ones of said course-rows, and scanning each courserow $n \times m$ times prior to the scanning of the next course-row, where n is the number of different pattern characteristics represented by said inforamtion, and where m is an integer greater than unity, so as to generate for each course-row $n \times m$ groups of signals, and wherein said transferring step comprises successively transferring each of said $n \times m$ groups to a buffer store associated with a respective successive one of $n \times m$ successive knitting stations.

22. A method as defined in claim **21**, wherein said scanning step comprises scanning coursewise at higher speed and scanning walewise at lower speed.

23. In a control system for a circular knitting machine which has a plurality of knitting stations respectively associated with different pattern characteristics and each arranged to knit stitches upon receipt of pattern signals, and together arranged to effect knitting of a patterned fabric composed of fabric units each having one of said pattern characteristics, the combination comprising a plurality of information locations each corresponding to a respective fabric unit to be knitted and each arranged to receive and store information representing the pattern characteristic selected for the corresponding fabric unit; scanning means for scanning said locations and for generating, for each location scanned, a predetermined plurality of pattern signals each indicative of the information stored in the respective location, and each thereby indicative of the respective pattern characteristic; and routing means for routing successive ones of said signals in each plurality of signals to respective successive knitting stations each associated with the respective pattern characteristic, so that such successive knitters will effect knitting of a row of identical consecutive stitches located in a single wale and respectively occupying consecutive courses, said knitting machine having a plurality of buffer stores each associated with a respective one of said knitting stations, and the stores being programmed so that they are successively permitted to receive and store incoming pattern signals, wherein said information locations are organized into a two-dimensional rectangular array corresponding to the rectangular organization of stitches in knitted fabric and consisting of course-rows and walerows which respectively correspond to the courses and wales of knitted fabric, and wherein said scanning means comprises means for scanning successive ones of said course-rows, and for scanning each course-row $n \times m$ times prior to the scanning of the next course-row, where n is the number of different pattern characteristics represented by said information, and where m is an integer greater than unity, and for generating for each course-row $n \times m$ groups of signals, and wherein said routing means comprises means for successively routing each of said $n \times m$ groups to a buffer store associated with a respective successive one of $n \times m$ successive knitters.

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