A permanent basic pattern store in the form of a switch plug board is interrogated in time with the rotation of the needle cylinder of a circular knitting machine to obtain patterning signals that are stored in buffer stores, one for each knitting station, from which they are read out and routed, in dependence on the pattern to be knitted, to the correct one of the needle or jack actuators.

12 Claims, 7 Drawing Figures
Fig. 2

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FIG. 7
ELECTRICAL PATTERNING SYSTEM FOR CIRCULAR KNITTING MACHINES

BACKGROUND OF THE INVENTION

The invention relates to an electrical patterning system for a circular knitting machine having a plurality of knitting stations and a rotatable needle cylinder. Electromagnetic actuators operate the needles or jacks, the butts of which are located in different planes. A permanent patterning store contains the patterning information. An electronic arrangement is provided for controlling the operation of the actuators in dependence on the information in the store and on the rotation of a needle cylinder. The stored information is read out in dependence on signals from a coded generator that operates in time with the needle cylinder.

Patterning systems of the aforesaid kind, such as the one described in the British Pat. No. 1,091,547, have the disadvantage that the knitter himself cannot program a desired pattern or else the possibility of programming is so extremely limited that the knitting machine cannot be used universally. Consequently, a great amount of electronic circuitry required with such knitting machines does not pay for itself.

SUMMARY OF THE INVENTION

An object of the invention is an electrical patterning system that the knitter himself can program for a desired basic pattern that is to be repeated in the knitted goods.

Another object of the invention is a patterning system that enables the patterns to be increased in length and/or width simply by the knitter manually adjusting a control element.

A still further object of the invention is a patterning system that enables different colors, kinds of yarn, or kinds of stitches to be knitted simply by the knitter manually operating the control elements.

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 the entire knitting system of the invention;

FIG. 2 is a top view of the coded disc of the code generator, the bottom part of FIG. 2 showing the binary coded track of the disc;

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

FIG. 4 shows a part of the plug board and the associated program switch unit PII;

FIG. 5 schematically shows the logic circuit arrangement of the additional program switch unit PIII;

FIG. 6 schematically shows the buffer store Zsp1 for the first knitting station of the knitting machine; and

FIG. 7 is a circuit diagram of the unit 560 of FIG. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows the interconnections between the different circuits and parts of the electrical patterning system of the invention. FIG. 1 shows that the system comprises a movable code generator 200 that includes means for moving the code generator 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 an additional switch unit PII. The code generator 200, which includes read-out means, in the present example, is designed for a circular knitting machine having 36 knitting stations and 18 electrical magnetic actuators per knitting station. The main program switch unit PI has a multi-pole switch SI with two gangs S1 and S2, 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 plug board 400, which enables the programming of a basic pattern having a width of 100 wales and a length of 100 courses. The plug board being connected to a program switch unit PIII. The basic pattern is stored in the plug board 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 elements of the basic pattern. The aforesaid plugs are not shown in the Figures. 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 PII. 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 . . . Zsp36. 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 PI to receive control pulses therefrom.

The output of each of buffer stores Zsp1 . . . Zsp36 is connected to a respective magnetic amplifier MV1 . . . MV36, each of which controls a respective one of the 36 electromagnetic actuators units MA1 . . . MA36. Each unit is associated with a respective knitting station and contains, in the present example, 18 electromagnetic 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 plug board 400. A switch S4, con-
ected to the buffer stores, Zsp, and a switch SS, con-
nected 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 plug
board 400. The switch T1, connectected to the course
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, bythe knitting machine through a non-slip
drive so that one rotation of the needle cylinder corre-
sponds to one rotation of the disc 210. The coded disc
210 has six inner tracks A, B,C,D,E,F and five outer
tracks G,H,J,K,L, each in the form of a concentric
circle. The five inner tracks A to F, which provide signals
for coordinating the knitting stations, are provided
which 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 cir-
cumference 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
round 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 theouter 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 2 is pro-
vided with an optical read-out arrangement having a
readout 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
coder 310 in a known manner by AND gates to form
36 knitting station signals. The five trains of pulses ob-
tained by reading out the outer tracks of the disc 210
are decoded in a second decoder 320 to form 18 actua-
tor 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 sig-
nals are used in the main program switch unit PI for in-
terrogating the plug board 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 suitabale inter-
connection of logic means.

The appearance of these fundamental pattern pro-
grams forms no part of the present invention. In the
present example, nine fundamental pattern programs
are provided, which can be chosen by switching to one
or the other of thenine different possible positions of
the switch S1. The fundamental pattern program 1 is,
for example, a two-color pattern that is stitched 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 individ-
ual yarn colors, kinds of yarn, or kinds of stitches to
certain knitting stations is obtained in the main pro-
gram 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 em-
bodyment 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 deck S1, of
the switch S1, in various ways as determined by the fund-
amental pattern programs, to the n outputs OR gates
314/1 . . . 314/4. In the present example, n=4, because
different pattern elements are to be stitched. The
outputs of these four OR gates 314 constitute the four
pattern element, or 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 signal ap-
pears at the output 315/1 when the color 1 is to be knitted,
and a signal appears at the output 315/4 when the
-color 4 is to be knitted, and so on. These pattern ele-
ment, or color, signals determine, when, for example,
knitting with two or more colors, which color is to be
read out in the plug board 400.

The second deck S12 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 S12
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 plug
board 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 plug
board.

The pair of switches 401 and 402 of each plug-in po-
sition, or switch means, constitutes an information lo-
cation of the plug board. These two switches together
can have four different positions, or states, each state
storing a 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 plug board 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 plug board so as to insert all of the plugs simultaneously into the plug-in positions. All of the plugs are easily removed from the plug board 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 plug board automatically erases the information stored therein, and leaves the plug board 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 plug board.

Each of the course inputs 404/1 . . . 404/100 of the plug board 400 is connected with a respective one of the one hundred counting stages of the course counter ZB. Each of the list of ten inputs 407/1 . . . 407/100 of the plug board 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 list of ten 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 then 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 1 to 4, and a second input of each of these AND gates is connected to a respective one of the output 405/1 . . . 405/4 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 output 407/1, the second input of the output AND gate 523 is connected to the first number of the course 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 Zsp1 . . . Zsp36. It will be noted that each of the 10,000 information locations is comprised of m switches each capable of assuming 2 different states, so that the m switches are jointly capable of assuming 2^m states, m being so chosen that 2^m = n, where n is the number of different pattern characteristics, for example colors. In FIG. 4, each information location is comprised of two switches 401, 402, and m = 2.

The operation of the wale counter ZA is controlled by the 50 kilocycle counting pulse generator G. It determines the rate at which the program switch unit PIII sends information over its common output lead 510 to successive ones of the buffer stores Zsp1 . . . Zsp36.

The buffer stores will be described later. The program switch unit PIII, 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 PIII 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 531, which cause various interconnections between the 18 inputs of the program switch unit PIII. The 18 inputs of the unit PIII are associated with the 18 actuators of respective ones of the electromagnetic actuator units MA1 . . . MA36. 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 56. The position of the switch 56 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 PIII. The output 534 of the program switch unit PIII 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 56 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 program switch unit PIII. 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 buffer 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 plug board 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 Zsp1, 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 plug board has wale outputs. In the present example, the store 540 consequently has one hundred 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^m 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 store 540 can comprise a conventional binary-to-decimal converter having seven inputs (connected to a, b, c, d, e, f, g) and having 128 outputs of which only 100 are actually of interest. The store 540 would then further comprise 100 information store units, such as flip-flops. At the input to each flip-flop is an AND-gate having one input connected to the information input 544 (see FIG. 6) and having another input connected to the corresponding numbered decimal output of the binary-to-decimal converter. When the outputs a, b, c, d, e, f, g (FIG. 6) are energized in a particular combination, for
example to represent in binary form the number 73, the seventy-third decimal output of the binary-to-decimal converter becomes energized, thereby enabling the seventy-third flip-flop to receive pattern information. The other flip-flops remain disabled, so that only the seventy-third flip-flop receives the information. 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 amplifiers MV1...MV36. The address counter outputs \( a_0, a_1, b_0, \ldots \) are connected to one input of respective AND gates 551, the other input of these gates being connected to the outputs \( a_0, a_1, b_0, \ldots \) of the decoder 330. The pairs of AND gates 551, associated with the outputs \( a_0 \) or \( a_1 \) are connected by respective OR gates 552 with one of the inputs of an AND gate 553, the output of which is connected by a lead 554 to an 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 54, 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, 566, 567 connect the operation switch 560 with 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. AND gate 544 has an upper input connected to line 510; its lower input and also line 567 are connected to a single respective one of the 36 outputs of decoder 310. Input 566 is connected to the output of program switch unit PII, as shown in FIG. 1, to receive pulses at a rate dependent upon the needle-passing rate.

The patterning system operates in the following manner. If, for example, the one hundredth row of information locations (corresponding to the hundredth course of a stored pattern) is to be read out of the plug board 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 plug board 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 plug board— 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 100 wale outputs of the plug board and thus the individual switching stages of the program switch unit PII, 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 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 plug board 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 PII. However, the AND gate 521/4 conducts only when a signal appears at the color 4 output of the main program switch unit PII.

As previously remarked, the wale outputs 407 of the plug board 400 are read out through the AND gates 523 of the associated switching stages of the program switch unit PII at a scanning frequency of 50 kilocycles. The input signals on the 36 input 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 100 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 Zsp1...Zsp36, but the input of only one of these buffer stores is open.

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, and the wale counter ZA is reset. At the same time, the address counter 550 of the buffer store is also reset. 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. During the time a buffer store accepts fresh pattern signals, no interrogation of the store occurs. In the present example, this results in the knitting of a five-wale-wide vertical stripe of floats down the fabric tube. The stripe could be made narrower, or even eliminated, by sufficiently increasing the speed of the repatterning operation.

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 connected by the input lead 564 to the operation switch 560 of the buffer store. This synchronizing pulse comes from the associated magnetic amplifier MV. 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 52 and stored in the buffer store by the decoder 330, there appears at the output of the common AND 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 is doubled by knitting a mirror image of the stored pattern. The description 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 electromagnet unit MA1. The outer program tracks G to L 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 P1 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 P1 are switched in, and that the AND gates 313, denoted by the letters a, b, c, and d, are switched in with a signal at one input. The second deck S11 of the switch S1 sets the magnetic amplifiers MV33, 34, 35, and 36 to not knot, thereby inactivating the associated electromagnet actuators MA33 to MA36. Thus, the main program switch unit P1 determines which color or colors will be read out of the plug board 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 plug board 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 consequenc, the programmed pattern starts at the beginning. When the coded disc 210 delivers an input signal "knitting station 1" to the first input of the main program switch unit P1, the output "color 1" of the main program switch unit 560, which is conducted to one input of the AND gates 521/1 of the individual switching stages of the program switch unit PII. 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 PII, the color 1 in the first row of the plug board 400. The resulting output signals on the lead 510 of the unit PII 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 needles knit in response to this information.

After the 75th information location has 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 on full rotation.

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, and the signal causes a signal to scrub on an input of the AND gate 521/2 of the program switch unit PII, 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 plug board 400. The resulting output signals of the program switch unit PII 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 row of information locations of the plug board is read out for the color 3, and when the first needle appears at the fourth knitting station, the first 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 row of information locations of the plug board 400. The course input 404/2 of the plug board
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 on the plug board 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 plug board 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.

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 NAND-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 PI.

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 54, 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 count 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.) 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 zero up, at a counting rate of 50 kHz. Consequently, the store 540 controlled by the counter 550 will be advanced at 540 kHz. That is, successive ones of the 100 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 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 546 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 directed 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 PI. 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 enabling for signal receipt and enabling 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 54 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.

An important advantage of the patterning system of the invention is that the coursewise reading out of the plug board 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 plug board 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 PL 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 PL 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 PL 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.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of circuits and systems differing from the types described above.

While the invention has been illustrated and described as embodied in an electrical patterning system for circular knitting machines, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

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 standpoints 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 patterning system for a circular knitting machine having a plurality of knitting stations, knitting needles, and electrically operated actuators for directly or indirectly controlling the needles, in combination, a permanent patterning store including a stationary switch matrix having information locations arranged in rows and columns representing courses and wales of knitted fabric, each information location having a different selectable state, the states representing different pattern characteristics; means for generating coded signals for controlling knitting at the knitting stations; counting means controlled by said means for generating coded signals for scanning said matrix to produce patterning signals; program logic switch means connected to said matrix for passing said patterning signals from said matrix in dependence upon the pattern characteristic represented by said patterning means; main program switch means connected to said program logic means and controlled by said means for generating coded signals for coordinating said patterning signals from said matrix with the individual knitting stations; at least one buffer store for each knitting station, each buffer store being connected to said program switch means to receive therefrom said patterning signals, and groups of needle actuators connected to each of said buffer stores for controlling the knitting at the respective knitting stations, wherein said program logic switch means has a logic circuit means for each respective column of said matrix, each logic circuit means having a AND gates, said main program switch means having n outputs of which each is connected to an input of a respective one of said AND gates, OR gate means, the inputs of said OR gate means being connected to the outputs of said AND gates, and an output AND gate having at least two inputs one of which is connected to the output of said OR gate means, and further wherein said counting means includes a wale counter having a plurality of counting states each associated with a respective column of said matrix, and each one of said counting stages being connected to the other input of the output AND gate of the respective logic circuit means, and further including a common conductor connecting the outputs of all of said logic circuit means to said buffer stores for transmitting patterning signals to the latter.

2. A patterning system as defined in claim 1, wherein said means for generating coded signals selects which buffer store is to be filled with information, and further
including a counting pulse generator connected to said wale counter for operating the latter each time a different buffer store is to be filled with information; and switch means for setting the number of columns of said matrix to be scanned.

3. A patterning system as defined in claim 2, wherein said counting means includes a course counter, said course counter having an output for every row of said matrix, said main program switch means causing said course counter to switch from one output to the next, and further including additional switch means for setting the number of rows of said matrix to be scanned.

4. A patterning system as defined in claim 3, wherein at least one of said counters is a reversible counter operable for scanning said matrix in a first direction and then in opposite second direction to cause pattern enlargement by mirror-reflection.

5. A patterning system as defined in claim 3, further including decoder means connected to receive the output of said means for generating coded signals, said decoder means having one output for each knitting station, and wherein said main program switch means has a plurality of OR gates as inputs, the inputs of said OR gates being connected to outputs of said decoder means so as to obtain a plurality of different logical interconnections between said decoder means outputs to establish a plurality of fundamental programming schemes, logic means connecting the outputs of said OR gates to said n outputs, and program switch means connected to said logic means for selecting the desired fundamental programming scheme.

6. A patterning system as defined in claim 5, including electrical differentiating means connected between the input of said counting pulse generator and outputs of said main program switch means.

7. A patterning system for a circular knitting machine having a plurality of knitting stations, knitting needles arranged on a needle cylinder and electrically operated actuators for directly or indirectly controlling the needles, in combination, a permanent patterning store including a stationary switch matrix having information locations arranged in rows and columns representing courses and wales of knitted fabric, each information location having n different states, the states representing different knitting patterns; means for generating coded signals for controlling knitting at the knitting station; counting means controlled by said means for generating coded signals for scanning said matrix to produce patterning signals; program logic switch means connected to said matrix for passing said patterning signals from said matrix in dependence upon the pattern characteristic represented by said patterning signals; main program switch means connected to said program logic means and controlled by said means for generating coded signals for coordinating said patterning signals from said matrix with the individual knitting stations; at least one buffer store for each knitting station, each buffer store being connected to said program logic means to receive therefrom said patterning signals; and groups of needle actuators connected to each of said buffer stores for controlling the knitting at the respective knitting stations, wherein said means for generating coded signals is movable and is driven in time with the needle cylinder, said means for generating coded signals including a plurality of binary coded tracks providing, when read out, routing signals for routing patterning signals to different ones of the buffer stores and to the individual needle actuators of each knitting station, said means for generating coded signals including read-out means for each of said binary coded tracks; first and second decoders connected to the outputs of said read-out means, the outputs of said first decoder being connected to said input means of said main program switch means, and further including additional program switch means for interrogating the buffer stores, said additional program switch means having input means connected to the output of said second decoder, and wherein said additional program switch means has an output connected to said buffer stores and is operating for interrogating said buffer stores in a sequence correlated with the routing of information to said needle actuators, said input means of said additional program switch means having inputs for each actuator of said knitting station; a plurality of OR gates comprised by said program switch means for variously logically interconnecting said inputs of said additional program switch means to effect a whole number multiple of repeated stitches for increasing the width of the basic pattern; and further switch means for selectively controlling the outputs of said OR gates to said buffer stores for applying interrogating signals thereto.

8. A patterning system for a circular knitting machine having a plurality of knitting stations, knitting needles, and electrically operated actuators for directly or indirectly controlling the needles, in combination, a permanent patterning store including a stationary switch matrix having information locations arranged in rows and columns representing courses and wales of knitted fabric, each information location having n selectable states, the states representing different pattern characteristics; means for generating coded signals for controlling knitting at the knitting stations; counting means controlled by said means for generating coded signals for scanning said matrix to produce patterning signals; program logic switch means connected to said matrix for passing said patterning signals from said matrix in dependence upon the pattern characteristic represented by said patterning signals; main program switch means connected to said program logic means and controlled by said means for generating coded signals for coordinating said patterning signals from said matrix with the individual knitting stations; at least one buffer store for each knitting station, each buffer store being connected to said program logic means to receive therefrom said patterning signals; and groups of needle actuators connected to each of said buffer stores for controlling the knitting at the respective knitting stations, wherein said matrix has a plurality of wale outputs, each buffer store having as many information locations as said matrix has wale outputs, each buffer store including an address counter that can be operated in either direction to select different information locations of the buffer store, and logic gate means connected to respective outputs of said address counter; and further including additional program switch means connected between said means for generating coded signals and each of the buffer stores for controlling the read out of each of said buffer stores by said address counter in dependence on coded signals from said means for generating coded signals; a counting pulse generator for controlling the reading in of information into each buffer store by the respective address counter, each buffer store including an addressing store containing said information locations of the buffer.
9. A patterning system for a circular knitting machine having a plurality of knitting stations, knitting needles, and electrically operated actuators for directly or indirectly controlling the needles, in combination, a permanent patterning store including a stationary switch matrix having information locations arranged in rows and columns representing courses and wales of knitted fabric, each information location having a different selectable state, the states representing different pattern characteristics; means for generating coded signals for controlling knitting at the knitting stations; counting means controlled by said means for generating coded signals for scanning said matrix to produce patterning signals; program logic switch means connected to said matrix for passing said patterning signals from said matrix in dependence upon the pattern characteristic represented by said patterning signals: main program switch means connected to said program logic means and controlled by said means for generating coded signals for coordinating said patterning signals from said matrix with the individual knitting stations; at least one buffer store for each knitting station, each buffer store being connected to said program logic means to receive therefrom said patterning signals; and groups of needle actuators connected to each of said buffer stores for controlling the knitting at the respective knitting stations, wherein each information location of said matrix includes encoding switch means comprised of m encoding switches capable of jointly assuming n = 2m different switching combinations, each encoding switch having a first part and a second part, said matrix having a plurality of course inputs and a plurality of wale outputs, each wale output being formed by m conductors, a respective diode connecting one part of each encoding switch to a common course input and the other part to a respective one of said m conductors of a wale output.

10. A patterning system as defined in claim 9, wherein said matrix has the form of a plug board having plugs for individually operating each of said encoding switch means to store the basic pattern in said plug board, there being n different kinds of plugs to obtain n different switching combinations.

11. A patterning system as defined in claim 10, including holding plate means into which said plugs can be inserted according to a prearranged pattern that corresponds to the basic pattern to be stored in said plug board so that said plugs for causing storing of a pattern can be simultaneously inserted into said plug board.

12. A patterning system as defined in claim 11 wherein said holding plate is transparent.