United States Patent [19]

Gottsching

[11] **3,807,196**

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[54] **ELECTRICAL PATTERNING DEVICE FOR MULTI-STATION KNITTING MACHINES HAVING A ROTATING NEEDLE CYLINDER**

[75] Inventor: **Herbert Gottsching,** Berlin, Germany

[73] Assignee: **Mayer & Cie Maschinenfabrik,** Tailfingen/Wuertt, Germany

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

[58] **Field of Search** ..... 66/50 R, 50 A, 50 B, 25, 66/154 A, 155

[56] **References Cited**

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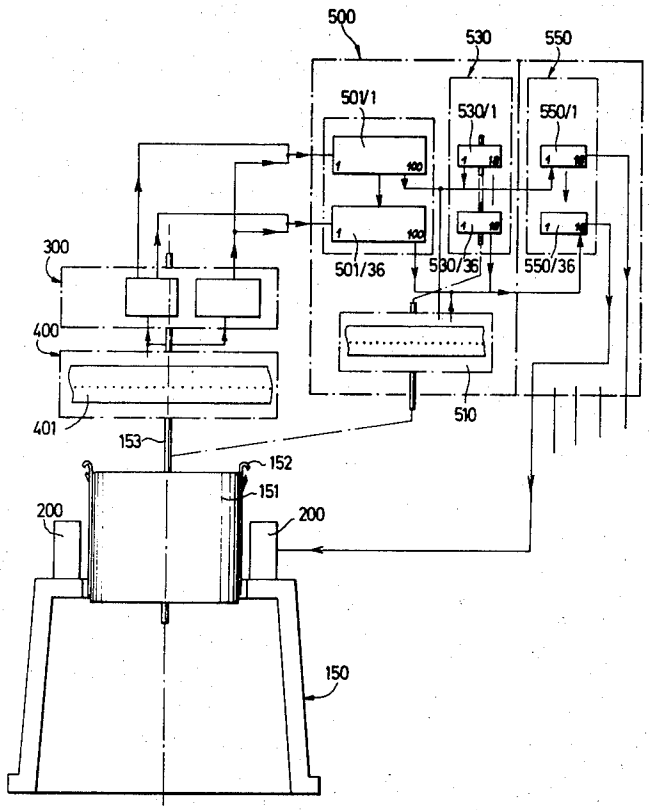
Primary Examiner—Wm. Carter Reynolds

Attorney, Agent, or Firm—Michael S. Striker

[57] **ABSTRACT**

A plurality of basic patterning stores, one for each knitting station, store the patterning signals "knit" and "not knit." A binary coded interrogator reads out these stores, and the resulting signals are sent, in dependence on signals from a respective binary coded needle actuators coordinating unit, to a respective actuator for operating the knitting needles.

5 Claims, 3 Drawing Figures



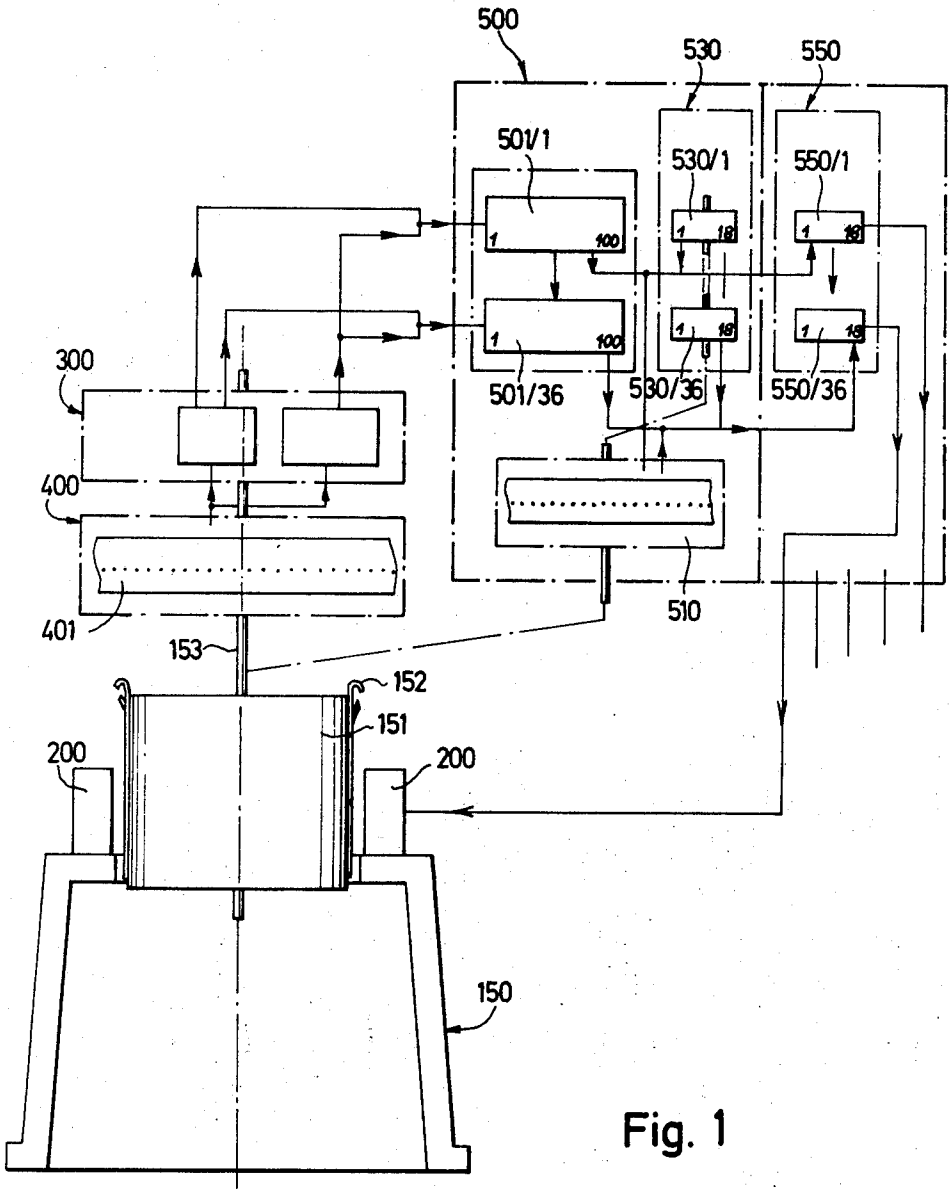


Fig. 1

INVENTOR.
HERBERT GOTTSCHING
BY Michael S. Striker
Attorney

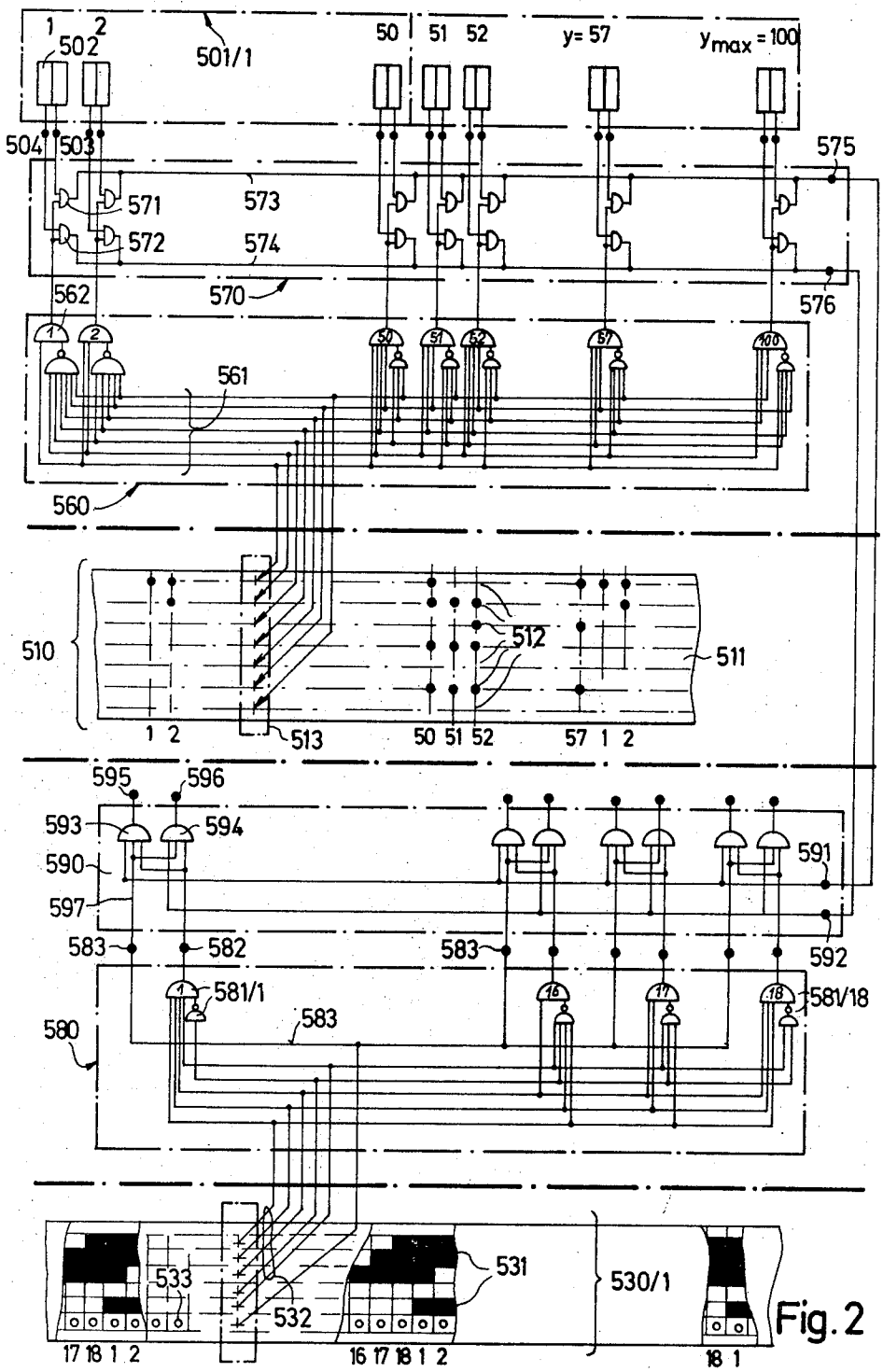


Fig. 2

INVENTOR.
HERBERT GÖTTSCHING
BY
Michael J. Hahn
Attorney

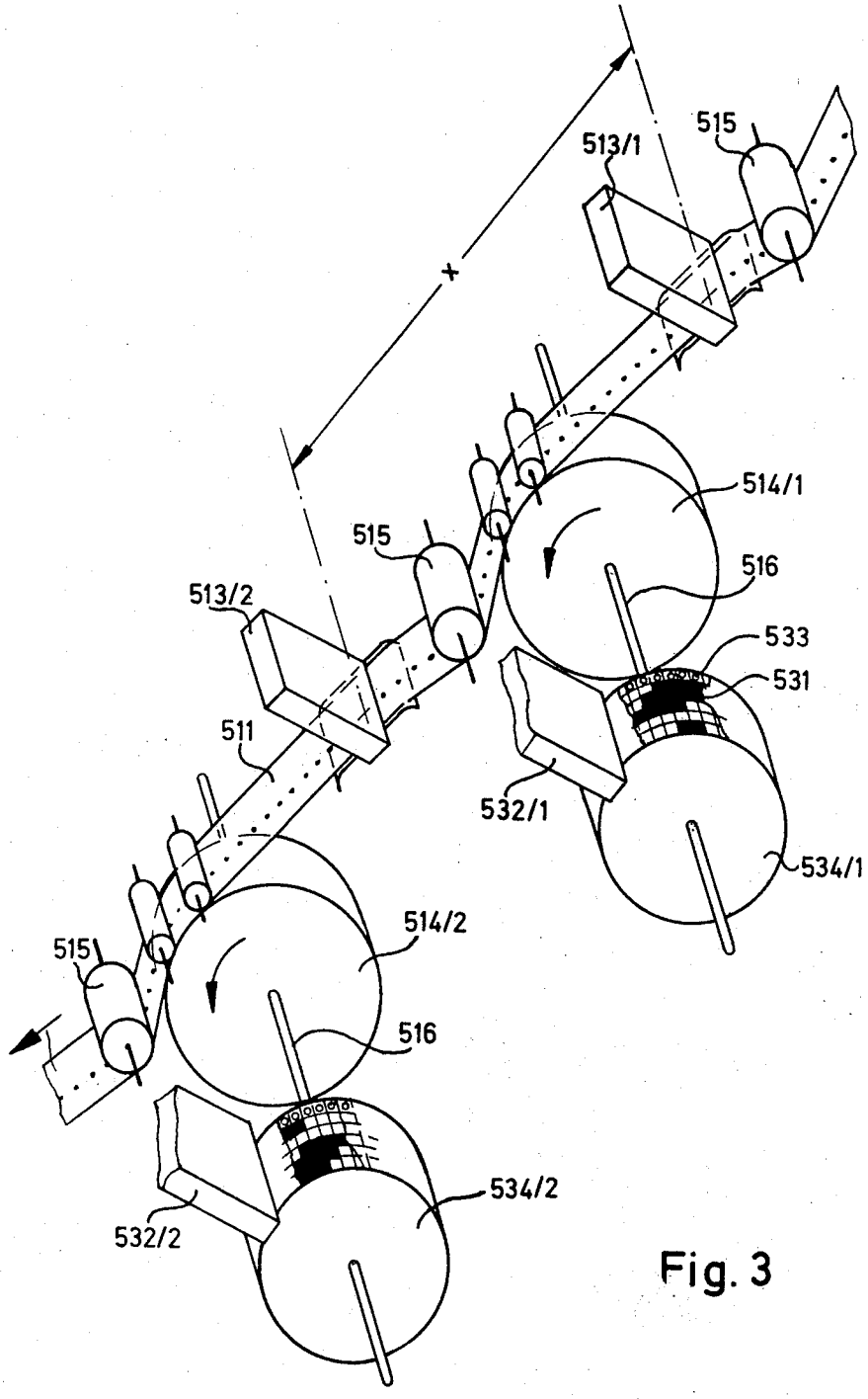


Fig. 3

INVENTOR.
HERBERT GÖTTSCHING

BY
Michael J. Striker
ATTORNEY

ELECTRICAL PATTERNING DEVICE FOR MULTI-STATION KNITTING MACHINES HAVING A ROTATING NEEDLE CYLINDER

BACKGROUND OF THE INVENTION

The invention relates to an electrical patterning device for circular knitting machines having a rotatable needle cylinder, the needles or jacks being controlled by electromagnetic actuators that are operated in accordance with the pattern to be knitted. The butts are staggered along the circumference of the needle cylinder. The electrical patterning device further comprises a permanent patterning store containing the knitting information, and read-out means for the store to produce corresponding patterning, or knitting, signals. Gates, bistable switches, stores, and amplifiers are provided for conducting the patterning signal in time with the rotation of the needle cylinder to the electromagnets of the actuators.

The British Patent No. 1,091,547 describes an electrical patterning device of the aforesaid kind, the patterning signals being stored in a magnetic core matrix. This known patterning device requires special personnel to set it up for a particular pattern that is to be knitted. It is impossible for the knitter himself to do this.

SUMMARY OF THE INVENTION

A fundamental object of the invention is an electrical patterning device for a multi-station circular knitting machine that can be set up by the operator of the knitting machine for a desired pattern.

In accordance with the invention, those parts of the patterning device which must be changed when the pattern is changed are so designed that the knitter, using conventional equipment, can himself undertake the necessary changes.

In accordance with the aforesaid fundamental object of the invention, certain parts of the patterning device are mechanical in construction, so as to simplify checking of the operation of the device and to improve reliability. These mechanical parts operate in conjunction with electronic circuits.

Another object of the invention is an interrogator for the basic patterning stores of a buffer store, which interrogator is easily altered for the different basic pattern widths by the knitter and which ensures that the patterning signals of the basic patterning stores are conducted to the correct ones of the actuators.

The invention consists essentially of a buffer store comprising for each of the knitting stations a respective basic patterning store for storing for each rotation of a needle cylinder the patterning signal "knit" or "not knit" for the actuators of the corresponding knitting stations for each of the wales to be knitted for the respective course, and interrogator means for interrogating the basic patterning stores in dependence on the rotation of the needle cylinder and on the width in wales of the basic pattern for obtaining therefrom the patterning signal.

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 schematically shows the patterning device of the invention in relation to a circular knitting machine;

FIG. 2 is a wiring diagram of the electrical part of the buffer store for one knitting station; and

FIG. 3 schematically shows the mechanical construction of the buffer store and interrogator for two knitting stations.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the Figures, similar parts are denoted by the same reference numerals.

FIG. 1 schematically shows the entire electrical patterning device for a circular knitting machine **150**, the machine comprising a needle cylinder **151**, which carries the needles **152**, and a drive shaft **153** coupled to the needle cylinder.

Surrounding the needle cylinder **151** at the positions of the various knitting stations are groups **200** of actuators for the needles or jacks. In a known manner, the individual actuators operate, in accordance with the pattern to be knitted, a series of stepped butts of successive jacks or needles.

The shaft **153** denotes symbolically that an electromechanical coordinating switching unit **300** and a permanently programmed store and read-out unit **400** are driven in dependence on the rotation of the needle cylinder **151**. The store and read-out unit **400** comprises a patterning store tape **401**. The electro-mechanical coordinating switching unit **300**, which does not form a part of the present invention and therefore will not be further described, ensures the correct sequential conduction of the patterning signals from the permanent patterning store **401** to the respective basic patterning stores **501/1 . . . 501/36.**

There is provided in the buffer store and interrogator **500** an individual basic patterning store for each of the assumed 36 knitting stations of the circular knitting machine **150.** The number after the solidus denotes the individual knitting system to which the basic patterning store corresponds.

As shown in FIG. **1,** the buffer store and interrogator **500** also comprises an interrogator **510** that is common to all of the basic patterning stores **501** and a needle actuators coordinating apparatus **530,** which latter comprises a respective needle actuator coordinating unit **530/1** . . . 530/36 for each of the knitting stations. A respective needle actuators coordinating unit **530** is connected to each of the basic patterning stores **501.** The connecting lines and arrows within the boxes symbolize the fact that the individual patterning stores, which are freshly stored with patterning signals for each rotation of the needle cylinder, are interrogated by the interrogator **510.** The resulting patterning signals from the basic patterning stores are conducted, in dependence on the signals from the corresponding needle actuators coordinating units, to the magnetic amplifiers **550/1 . . . 550/36.** which are connected to the electromagnetic actuator groups **200.**

The construction and the operation of the buffer store and interrogator **500** will be described in connection with FIG. **2,** which shows in detail that part of the unit **500** that controls the operation of the first knitting station. FIG. 2 shows the basic patterning store 501/1,

the programmed interrogator **510**, which is common to all of the basic patterning stores and has an interrogator store in the form of a perforated tape **511** constituting a first information carrier, and the programmed tape **531** (constituting a first information carrier) of the needle actuators coordinating unit **530/1**. The interrogator, with the perforated tape **511**, is connected by a logic circuit **560** and by AND gates **570** to the respective basic patterning store **501**. The needle actuators corrdinating unit **530/1** is connected by the logic circuit **580**, a set of AND gates **590**, and the magnetic amplifier **550/1** to the actuators group **200** of the first knitting station. The programmed tapes **511** and **531** can be made, or at least replaced, at the knitting mill by the operating of the knitting machine, simply by following printed instructions.

As a rule, only the width of the basic pattern, which is repeated in the knitted goods, is stored in the permanent patterning store, such as a tape or a switch plugboard. The basic, or repeated, pattern appears repeatedly in the tubular knitting, and the patterning signals held in the permanent patterning store for the individual repeats are, in the case of a slant element in the knitted pattern, for example, required during each rotation of the cylinder as often as the number of times that the wales of the repeated pattern are contained in the number of used needles of the cylinder. Since the width of the basic pattern is usually different from the number of electromagnetic actuators per knitting station, the wales patterning signals for a slanted element must be read out from the permanently patterning store and stored in the basic patterning store **501** of each knitting station for each needle cylinder rotation.

Each of the 36 stores **501/1** . . . **501/36** is repatterned once per needle cylinder revolution. This repatterning commences at each store **501** as a needle cylinder reference point passes the correlated knitting station, so that the stores **501/1** . . . **501/36** are repatterned in succession. The successive information locations (flip-flops **502**) within each store are set in succession, at the needle-passing frequency, i.e., at the frequency with which cylinder needles pass an arbitrarily selected stationary reference point adjacent the needle-cylinder periphery.

Each basic patterning store **501** must be read out in the correct sequence, so that the stored patterning signals are conducted in the correct sequence to the magnetic amplifiers **550** and thence to the magnets of the individual actuators. When bistable reversing solenoids are used to operate the actuators, as is the case in the present example, two different active patterning signals appear in the patterning device, namely a patterning signal knit and a patterning signal not knit, which, for example, are formed by positive and negative pulses.

The needle actuators coordinator **530** ensures that the signals from a basic patterning store **501** are sent in the correct order to the individual magnets of the actuators of the respective knitting station. Each of the coordinating units **530/1** . . . 530/36 continuously scans and rescans the actuator magnets of its knitting station, and determines the correct order in which the knitting signals, obtained by the interrogator **510**, are to be conducted to the corresponding magnetic amplifier **550**.

In the example shown in FIG. **2**, the maximum capacity of the basic patterning store **501/1** is $y_{max} = 2 \times 50 = 100$ wales, to which number of wales the maximum width of the basic pattern is limited. It is assumed, however, that the width of the basic pattern of the knitted goods is only $y = 57$ wales. The wales patterning signals for the course to be knitted are stored in 57 of the 100 available locations of the basic patterning store **501/1**. Since two different patterning signals must be stored, these locations consist of bistable multivibrators **502**, each of which has a knit output **503** and a not knit output **504**. It will be assumed that the needle cylinder holds **2232** needles, and that the knitting machine has **36** knitting stations and $a = 18$ actuators per knitting system.

The interrogator **510** reads out each of the basic patterning stores **501**, the interrogator **510** having a programmed, perforated, tape **511**, which in the illustrated example has seven parallel perforated tracks. The tape **511** is moved in time with the needle cylinder, so that the movement from one perforation to the next on the tape corresponds to one needle step of the needle cylinder. The numbers 1–57, which correspond to the number of wales in the width of the basic pattern, are transversely binary encoded, in numerical sequence, in the total of the seven tracks. Each information location **512** of each track of the tape **511** thus corresponds to one bit of a binary number, and each perforation, symbolized in FIG. **2** by a dark dot, is equivalent to a binary 1 with 57 wales knitted per course. The perforated tape **511** begins a new series of **57** information locations after the **57**th information location of the previous series has been read out; and after **2232** information locations have been read out (there being **2232** needles on the cylinder) the read-out begins again with the first series. If a conventional perforated tape is used, having a spacing between perforations of 2.54 mm (one-tenth inch), the entire length of the tape is 5.67 m for the 2,232 information locations. Since differently programmed tapes are required for different widths of the basic pattern, the tapes are made so that they can be replaced by the knitter.

For each of the basic patterning stores **501** there is provided an individual multi-track read-out head for the tape **511**. The multi-track read-out head **513** constituting part of reading means for the basic patterning store **501/1** is denoted symbolically by the seven arrows directed at the seven parallel tracks of the tape **511**. The seven electrical outputs of the read-out head **513** are connected to respective ones of the leads **561** of the logic circuit **560**. When the multi-track head **513** simultaneously reads out the transverse group of bits on the tape **511** that correspond to the first wale, the signal at the output of the AND gate **562** appears on one input of the two first AND gates **571** and **572** of the series of AND gates **570**. The AND gates **571** and **572** have their other inputs connected to the respective outputs of the bistable multivibrator corresponding to the first wale knitting by the first knitting station. This bistable multivibrator is the first information location **502** of the first patterning store **501/1**. Depending upon whether the information location **501** stores a knit or a not knit signal, there appears a signal on the knit common line **573** or a signal on the not knit common line **574** of the AND gates. This signal is conducted to the knit output terminal **575** or to the not knit output terminal **576** of the AND gates **570**, from where it is conducted to the input terminal **591** or **592** of the AND gates **590**.

It will be noted that logic circuit **560** has only seven input lines, cooperating with seven detectors in the bank **513** which read the seven parallel tracks of the

tape **511.** Each transverse row read by detectors **513** will be provided with one or more perforations representing in binary encoded form one of the integers from 1 to 127 inasmuch as $2^7 = 128$. Actually, only one hundred such integers are required, at the most.

Each of the 100 AND-gates **562** is associated with a particular one of the binary-encoded integers on the tape **511.** An output signal will appear on the output of a particular AND-gate **562** only if the binary-encoded integer being read by head **513** is the one corresponding to the AND-gate **56** in question.

It will be noted that each AND-gate **562** has one or more inputs directly connected to feelers **513,** and that each AND-gate **562** furthermore has another input connected to the output of an associated NAND-gate. The inputs of the associated NAND-gate are connected to those of the feelers **513** not directly connected to one or more inputs of the respective AND-gate **562.**

When the set of feelers **513** detects the binary-encoded integer associated with a particular AND-gate, those feelers which detect perforations will apply logical 1 signals to the one or more inputs of the AND-gate that are directly connected to those feelers. The feelers which are detecting the absence of perforations apply logical 0 signals to all the inputs of the associated NAND-gate, which latter accordingly applies a logical 1 signal to the remaining input of the respective AND-gate **562.** Thus, there is a logical 1 signal at each and every one of the inputs of the respective AND-gate **562,** and a logical 1 signal accordingly appears at the output of such AND-gate **562.** In this manner, a one-to-one correspondence is achieved between the reading of a particular binary-encoded integer on the tape **513** and the appearance of a signal at a particular one of the one hundred AND-gates **562.**

The AND gates **590** evaluate the patterning signals together with the control signals from the needle actuators coordinating unit **530.** The programmed means of this unit is also a binary coded tape **531** having a plurality of parallel tracks (in the present example five) which form a transversely extending code that is read out by a multitrack head **532** constituting together with reading head **513** reading means in this embodiment. Since each actuators group **200** has 18 actuators, the tape **531** encodes the numbers 1–18. This is in correspondence to the provision of eighteen needle actuators in each group **200.** If the number of actuators is in general designated *a*, then the tape **531** encodes the numbers 1 to *a*, with a in the present example being equal to 18. The tape **531** may be a closed loop bearing the integers 1 to 18, in succession, either once only, or an integral number of times. After the encoded number 18 is read out, the same series of encoded numbers is again read out, so that the resulting train of pulses is repeated over and over again, Inasmuch as the number of actuators per knitting station, as a rule, is fixed, the needle actuators coordinating unit can be constructed, for example, as permanent drums, as shown in FIG. **3.** The programmed means of each drum is so coded that in reading out successive transversely extending information locations there is only a single change in the group of pulses at the output of the multi-track read-out head **532.** A code of this kind is unambiguous and ensures the correct operation of the actuators group **200.** The tape **531** has to be changed only when the number of actuators per knitting station is changed. It will be noted that tape **531** is depicted as being provided with rows and columns of rectangular areas, some of which contain a circular perforation **533.** It is to be understood that the region within each such rectangle actually constituting a perforation, or the region within an empty rectangle at which a perforation would have been made, constitutes an information location, the remaining area of each such rectangle containing no information whatsoever. It should be noted that the tape **531** is read in synchronism with needle-cylinder rotation and that the spacing between successive information locations on tape **531** corresponds to the spacing between adjacent needle-cylinder needles. The tape **511** can be a closed loop bearing the binary-encoded integers 1–57, in succession, repeated 39 times, followed by the integers 1 to 9.

The group of pulses from the head **532** is conducted to **18** gates **581/1 . . . 581/18** of the logic circuit **580.** These gates are so designed that each of the 18 possible groups of pulses causes an output to appear at only that gate **581** corresponding to the coded number. The output **582** of each gate **581** is connected to the respective first input of two AND gates **593** and **594,** the two AND gates together being associated with one actuator of the respective knitting station. The second of the three inputs of these AND gates is connected either to the input terminal **591** or **592.** The third input of the AND gates **593** and **594** are connected to a common control pulse line **597** that receives pulses from a line **583** connected to the head **532** to obtain pulses from a control track **533.** These control pulses occur in step with the information locations of the tape **531.** When signals appear at all the inputs of the AND gates **593** or **594,** the respective output **595** or **596** delivers a patterning signal knit or not knit, which is conducted by the magnetic amplifier **550/1** to a winding of the bistable reversing solenoid of the first actuator of the group **200** of the first knitting station. The illustrated logic circuits **560, 570, 580** and **590** constitute routing means in this embodiment.

The control pulses from the track **533** are desirable, because the correct read-out of a perforated tape, such as the tapes **511,** can pose certain difficulties. The transverse coding of the tape is reliably read out only if all of the information locations are read out simultaneously, which is virtually impossible. The coded tracks **533** enables the production of a selection pulse for choosing the correct AND gate. This pulse appears when the read-out head **513** and the read-out head **532** read out all of the transversely extending information locations. The buffer store and interrogator **500** have a high degree of accuracy, because if a pulse fails to appear, the knitted goods are defective at only a single spot.

As previously explained, each knitting station requires a basic patterning store **501** and a needle actuators coordinating unit **530.** The interrogator **510** can be constructed in the form of a single perforated tape **511,** which is read out by a plurality of multi-track read-out heads, there being one head for each store **501.**

FIG. **3** shows the mechanical details of the programmed tape **511** and **531,** and the drive means and read-out means therefor. The arrangement is shown for the distance of two successive knitting stations. The tape **511** is moved by drive rollers **514/1, 514/2,** and so on, these rollers rotating in time with the needle cylinder and there preferably being as many rollers as there are knitting stations. Each of these rollers is connected

by a shaft **516** to a respective drum **534**/1, 534/2, and so on. The cylindrical surface of each drum carries the multi-track code of the respective needle actuators coordinating unit **530.** A multi-track read-out head **532/1, 532/2,** and so on, is mounted to read out the code on each of the drums.

The movement of the perforated tape **511** in time with the needle cylinder is assisted by the pressure rollers **515.** Between each of the drive rollers **514** is mounted a multi-track read-out head **513/1, 513/2,** and so on, for the respective knitting stations. The heads **513** are spaced apart a distance *x*, where *x* is the number of information locations equal to the number of needle steps between successive knitting stations. The tape **511** can be removed and replaced by another tape differently coded. The tape **511** can be coded so that with slanted butts all desired elements or inserts, such as slanted elements, roof-shaped pattern elements, single or double or triple pattern elements, or pattern elements of other kinds, can be knitted.

The desired sequence of needles can be read out of the basic patterning stores **501** by the tape **511.** For example, with a roof-shaped pattern element, the sequence 2 . . . *y*/*y*-1 . . . ½ . . . *y*/*y*-1 . . . *y*/ and so forth, can be read out, or, for example, the sequence 2 . . . *k*/*k*-1 . . . ½ . . . *n*/*n*-1 . . . 1, and so forth.

In accordance with the invention the programmed means of the interrogator **510** need not be a perforated tape **511,** but can, for example, be a magnetic tape, a coded disk, or a film. The same considerations hold true for the programmed means of the needle actuators coordinating unit **530.** The programmed means of the interrogator **510** can also be a stationary unit, such as a switch plug board, or it can be controller barrel incorporating various basic pattern widths and butt pattern elements.

In any case, the patterning signals for the wales of the pattern width are stored in the basic patterning stores **501** for each rotation of the needle cylinder, and are read out by means of the interrogator **510.** The programmed means (such as the tape **511**) of the interrogator **510** is coded in dependenoe on the width of the pattern and the kind of patterned elements. This programmed means has one read-out head for each of the knitting stations. The needle actuators coordinating unit for each knitting station operates in time ith the programmed means of the interrogator **510.** If the programmed means is stationary, then these units operate in time with the associated coder. The needle actuators coordinating unit continuously scans and rescans the individual actuators. As a consequence of all this, the signals from each basic patterning store **501** together with the signals from the associated needle actuators coordinating units are conducted in the correct sequence to the magnetic amplifiers **550** for controlling the actuators.

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 differing from the types described above.

While the invention has been illustrated and described as embodied in an electrical patterning device for multi-station knitting machines having a rotating needle cylinder, it is not intended to be limited to the details shown, since various modifications and circuit 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 be 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 claims:

1. In an electrical patterning device for a circular knitting machine having a plurality of knitting stations, a rotatable needle cylinder, knitting needles, electrically operated actuators for directly or indirectly operating the needles, a permanent patterning store containing the patterning information, and read-out means for reading out the store to produce patterning signals, in combination, a buffer store comprising for each of the knitting stations a respective basic patterning store for storing for each rotation of the needle cylinder the patterning signals "knit" or "not knit" for the actuators of the corresponding station for each of the wales to be knitted for the respective course; and interrogator means for interrogating the basic patterning stores in dependence on the rotation of the needle cylinder and on the width in wales of the basic pattern to obtain patterning signals therefrom, further including a needle actuators coordinating unit for each of said basic patterning stores; for each said unit movable individual programmed store means moved in time with the needle cylinder, said store means having a binary code encoding the numbers 1 to a in succesion, where a is the number of actuators per knitting station, and wherein the distance between successive information locations in said store means corresponds to one needle step of the needle cylinder, said interrogator means including a replaceable, programmed multi-track, endless tape; as many spaced tape drive rollers as there are knitting stations for moving said tape in time with the needle cylinder so that one complete passage of said tape corresponds to one complete rotation of the needle cylinder; a multi-track read-out head located between each of said drive rollers for reading out said tape, and wherein said programmed store means includes individual drum means rigidly coupled to each of said tape drive rollers, the cylindrical surface of said drum means having thereon said binary code, and individual read-out means for reading out said code on each said drum means.

2. In an electrical patterning device as defined in claim **1,** further including read-out means; AND gate means having at least two inputs, one of said inputs connected to receive the output of said read-out means, another of said inputs being connected to receive the patterning signal from the corresponding basic patterning store, the output of said AND gate means being connected to control a respective actuator,

3. In an electrical patterning device as defined in claim **1,** wherein said programmed store means comprises a control track having as many information locations as there are used needles of the needle cylinder.

4. In an electrical patterning device for a circular knitting machine having a plurality of knitting stations, a rotatable needle cylinder, knitting needles, a perma-

nent patterning store containing patterning information, and read-out means for reading out the store to produce patterning signals, in combination, electrically operated actuators for directly or indirectly operating the needles; a buffer store comprising for each of the knitting stations a respective basic patterning store for storing for each rotation of the needle cylinder the patterning signals knit or not knit for the actuators of the corresponding station for each of the wales to be knitted for the respective course; and interrogator means for interrogating the basic patterning stores in dependence on the rotation of the needle cylinder and on the width in wales of the basic pattern to obtain patterning signals therefrom, said interrogator means including a replaceable programmed interrogation store means that moves in time with the needle cylinder, said programmed interrogation store means having a binary code encoding the numbers 1 to *y*, where *y* is the number of wale patterning signals stored in a respective basic patterning store, and is the number of wales in the basic pattern, said programmed interrogation store means having at least one read-out head for each of said basic patterning stores, said read-out head reading out one of said binary coded numbers 1 to *y* per needle step of the needle cylinder; an AND-gate means having at least two inputs, one input being connected to receive the output of said read-out head and the other input being connected to the corresponding basic patterning store containing the patterning signal knit or not knit so that the stored patterning signal appears at the output of said AND-gate means, said programmed interrogation store means comprising a single endless coded tape storing said binary code, and further wherein there is one read-out head for each of said basic patterning stores, said read-out heads being successively spaced along the longitudinal direction of said tape a distance corresponding to the distance between successive knitting stations as expressed in the number of needle steps.

5. In an electrical patterning device as defined in claim **4,** wherein said tape comprises a plurality of binary coded tracks that are simultaneously read out by the read-out heads, each of said tracks comprising as many of said information locations as there are used needles of the needle cylinder and each information location containing a bit that together with the bits of the corresponding information location of the other said tracks define a binary number.

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