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(54) Method of and apparatus for controlling a knitting machine

(57) An apparatus for controlling a knitting machine (10) includes an plurality of needle selecting devices (20) for selectively actuating knitting needles of a circular machine. Each of the needle selecting devices (20) is provided with a drive circuit (25) for driving a pattern finger and a shift register (26). Knitting data a is sequentially supplied from a controller (30) to the shift register (26) in one of the needle selecting devices and then serially from this shift register to the remaining needle selecting devices (20). At the time the transfer of the knitting data completes, the knitting data is latched and retained in each of the shift registers (26) and the drive circuit (25) is activated based on the retained knitting data.

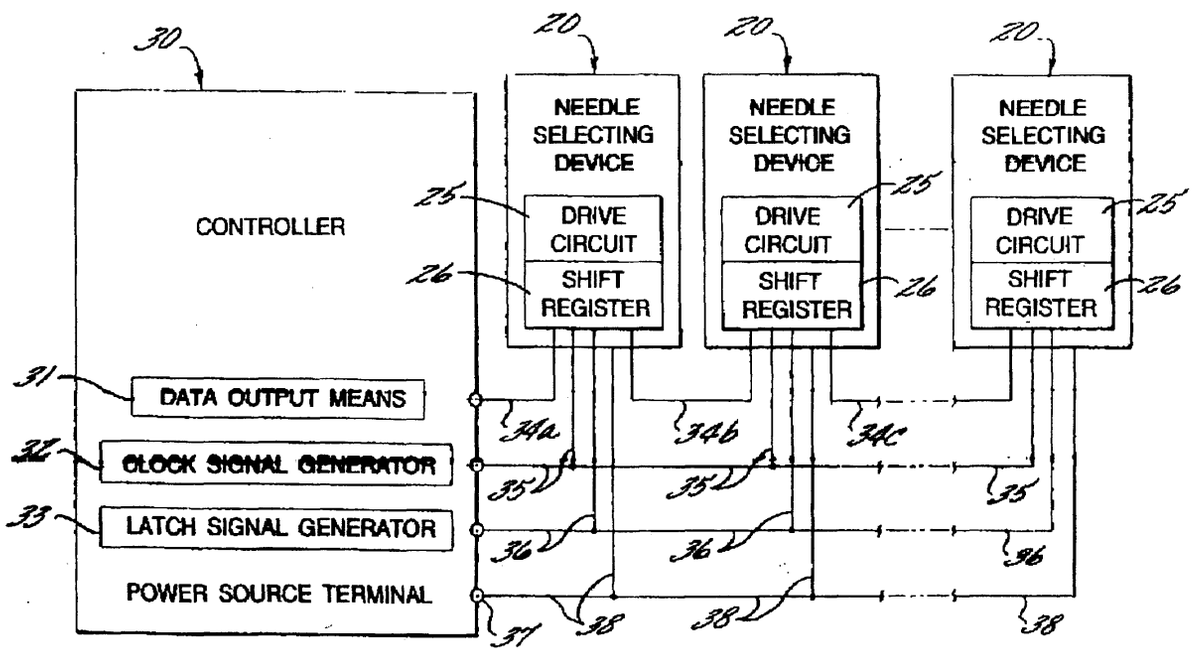

Fig. 1.

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Description

[0001] The present invention relates to knitting machines and, more particularly, to a method of and an apparatus for controlling a knitting machine in accordance with a preset pattern.

[0002] In knitting machines, various operating elements, such as knitting needles, sinkers stitch cams and yarn feeders, are actuated by electrically driven needle selecting devices. By way of example, a circular knitting machine conventionally includes a rotating cylinder having vertical grooves in its outer periphery in which knitting needles are slidably mounted for movement between knitting and non-knitting positions. A plurality of needle selecting devices are disposed around the knitting cylinder, typically one for each yarn feed, for selecting the knitting needles for movement to knitting and non-knitting positions to accomplish a patterned knitting in accordance with a preset pattern. These needle selecting devices are electrically connected with a controller in which the preset pattern is stored for performing a patterning control.

[0003] Heretofore, such needle selecting devices are quite complex, as is the electrical connection between such needle selecting devices and the controller, and maintenance thereof is difficult and costly. A typical arrangement of needle selecting devices and their controller is disclosed in JP-A-8-218255 and is illustrated in Figure 6 of this application. A plurality of needle selecting devices are connected in series to each other and to their controller by means of a plurality of signal lines. Each of the needle selecting devices has built therein, or is externally fitted with, a respective drive circuit and includes a plurality of stages (for example, upper and lower eight stages) of needle selecting fingers each having a piezoelectric element operable to cause the needles to be selected in response to a pulse voltage applied to such piezoelectric element.

[0004] The signal lines between the controller and the first needle selecting device and between the needle selecting devices include a plurality of address data lines which serve as paths of transmission of control data signals (knitting data signal) and address signals, that are parallel signals outputted from the controller for controlling the knitting operation, and a single strobe line which serves as a path of transmission of a strobe signal outputted from the controller. The number of address data lines is of a value sufficient to satisfy the number of bits of the knitting data and the number of bits of addresses of each needle selecting device.

[0005] More specifically, an address signal for selecting one of the needle selecting devices is transmitted from the controller to each needle selecting device through the address data lines contained in the signal lines, and one of the needle selecting devices assigned by such address signal is then specified at a timing in synchronism with the strobe signal transmitted from the controller through the strobe line. In such case, each needle selecting device is provided with a dip switch that is set to a combination of On and Off positions in correspondence with the address assigned thereto and, only when the address of the needle selecting device set by the dip switch matches with the address signal thus transmitted, the above described address selection is carried out. Thereafter, the knitting data signal associated with the above described needle selecting device is transmitted from the controller to each needle selecting device through the address data lines and is then stored in the address-selected needle selecting device at a timing synchronized with the strobe signal transmitted from the controller through the strobe line.

[0006] By sequentially carrying out the foregoing address selection and data writing operation subject to each of the needle selecting devices, the needle selecting devices can select the knitting needles necessary to accomplish the desired pattern knitting.

[0007] In such prior knitting machine control systems, the numerous address data lines for transmission of the knitting data signals and the address signals and the single strobe line utilized to electrically connect between the controller and the needle selecting devices causes the control circuit and drive circuits to be bulky in size and complicated in circuit design.

[0008] Also, because such conventional knitting machine control systems require that the address of the needle selecting devices is necessarily repeated each time a data signal is issued by the controller, excessive time is required to issue data signals to all of the needle selecting devices, particularly where the number of such needle selecting devices is large. For example, assuming that the number of the needle selecting devices is expressed by N and the time required to drive a drive circuit of a needle selecting device is expressed by t, then, the length of time expressed by N x t would be required to cause all of the needle selecting devices to perform the needle selecting operation. In other words, to activate a piezoelectric element, associated with the needle selecting fingers in one of the needle selecting devices, by supplying a pulse voltage from the associated drive circuit to such piezoelectric element would require a length of voltage applying time of typically 16 ƒÊs and, therefore, in order for all of the needle selecting devices to perform the needle selecting operation while the knitting cylinder rotates an angle corresponding to a circumferential width of the single knitting needle, at least the length of time expressed by N x 16 ƒÊs would be required. Accordingly, if the number of the needle selecting devices is relatively large, it may occur that the needle selecting operation would not be finished during the length of time in which the knitting cylinder rotates the angle corresponding to the width of the single knitting needle. In order to alleviate this problem, the length of time during which the piezoelectric element is activated must be reduced from 16 ƒÊs down to 8 ƒÊs or 4 ƒÊs (μmm), but a different electrical countermeasure is necessitated to sustain the reliability of operation.

[0009] In addition, such prior needle selecting devices tend to be complicated by the presence of the dip switches required for address specification of such needle selecting device. Moreover, in the event that replacement of the needle selecting device becomes necessary, the dip switch of a replacement needle selecting device must be set to the combination of On and Off positions which had been assigned to the dip switch of the replaced needle selecting device, requiring a complicated maintenance.

[0010] With the foregoing in mind, it is an object of the present invention to alleviate the above discussed problems and to provide a method of and an apparatus for controlling a knitting machine which is simplified in structure and easy to maintain.

[0011] This object of the present invention is accomplished by providing a method of and an apparatus for controlling a knitting machine in which control data is supplied to a plurality of needle selecting devices, each of which includes a drive circuit and a shift register. The shift registers in the needle selecting devices are connected in series with each other and, therefore, the control data supplied from the controller to the shift register of one of the needle selecting devices is sequentially transferred to the remaining needle selecting devices. The control data is latched and retained in each shift register when the transfer of the control data is completed, and the drive circuit of the indicated needles selecting device is actuated based on the retained control data.

[0012] Since according to this method and apparatus, the control data is outputted serially from the controller and is sequentially transferred through the respective shift registers in the remaining needle selecting devices and, when the transfer of the control data corresponding to the respective shift register in each needle selecting device completes, the control data is retained in the shift register, and the control data corresponding to each needle selecting device can be transmitted with no need to specify the address of any needle selecting device. Accordingly, the number of the signal lines necessary for the data transmission can be reduced considerably, and hence the drive circuit in each needle selecting device and the controller can be compacted, accompanied by simplification of the associated circuit designs.

[0013] Also, since the number of the signal lines necessary for the data transmission is thus reduced, making it possible to achieve a data transmission through a differential line comprised of two lines through which the data signal and an inverted signal of the data can be respectively transmitted simultaneously and, consequently, noises containing a relatively large amount of high frequency components can advantageously be suppressed considerably, it is possible to accomplish a high-speed data transmission with the frequency of the data signal increased. For this reason, even though the number of the needle selecting devices is increased, the length of time required for all of the needle selecting devices to perform the needle selecting operation will not increase significantly. Furthermore, this leads to the length of the voltage applying time being reduced and a high reliability of operation can be maintained. In addition, since all of the needle selecting devices can be actuated at the time the control data are retained in those needle selecting devices, the present invention can be applied not only to a piezoelectric control devices in which piezoelectric elements are employed to drive the pattern fingers, but also to an electromagnetic control device in which electromagnetic elements requiring a relatively long voltage applying time are employed.

[0014] In addition, since the needle selecting devices need not be specified by respective addresses, no dip switches are needed and in the event of replacement of one of the needle selecting devices, no complicated and time-consuming job of setting a combination of the On and Off positions to render the dip switch to match with the address is necessary, rendering the maintenance to be easy to accomplish.

[0015] In order that the present invention may be more readily understood, reference will now be made to the accompanying drawings, in which:-

Fig. 1 is a block diagram illustrating a preferred embodiment of the invention for controlling a circular knitting machine;

Fig. 2 is a diagram illustrating a needle selecting device suitable for use with the embodiment of Fig. 1;

Fig. 3 is a longitudinal sectional view showing one of the actuators employed in the needle selecting device;

Fig. 4 is a chart showing waveforms of signals supplied from a controller of the needle selecting device referred to above;

Fig. 5 is a schematic diagram showing the structure of the circular knitting machine; and

Fig. 6 is a block diagram illustrating a conventional control system.

[0016] Referring now more particularly to the drawings and specifically to Figure 5, there is illustrated schematically a circular knitting machine, generally indicated at 10, including a rotating cylinder 11. Cylinder 11 has a multiplicity of vertical grooves in its outer periphery (not shown) in which knitting needles 12 and other cooperating operating elements are mounted. A more complete description of these conventional knitting machine components is provided in US-A-5,647,230 owned by this proprietor. Such operating elements include selector jacks 13 (Figure 3) positioned in the cylinder grooves beneath the needles 12 for moving the needles 12 between knitting and non-knitting positions in accordance with a preset pattern.

[0017] Knitting of fabric items, such as socks, is performed by the needles 12 which, in cooperation with other stitch forming instrumentalities (not shown), knit yarns 14 (only one of which is shown) fed to the needles

12. Typically, a plurality of yarn feeds, usually four to eight, are provided around the periphery of the cylinder 11.

[0018] Needle selection in accordance with the desired pattern is accomplished by a plurality of needle selecting devices 20 arranged around the cylinder 11, with the number of needle selecting devices **20** equaling the number of yarn feeds. The needle selecting devices **20** are positioned in advance of the yarn feeds for selecting the appropriate needles **12** to be moved to the knit position and thereby to receive yarn **14** from a yarn feed. Each needle selecting device **20** is the same and therefore only one will be described.

[0019] Needle selecting device **20** is preferably an electrically controlled and actuated device. More preferably, needle selecting device **20** includes a plurality of actuating elements or piezoelectric elements **21** that are fixedly mounted at a medial location on a shaft **22** which in turn is rotatably mounted on a stay **23a** of a housing **23**. One end of each piezoelectric element **21** is received in a cavity in a block or stay **23b** of housing **23** at one end thereof and the other end thereof moves up or down upon the application of a pulse of electrical energy of either positive or negative polarity (Figures 2 and 3). Piezoelectric elements **21** are operatively connected at their other ends to pattern fingers **24** by a bifurcated end portion **24a**. Fingers **24** are mounted for limited pivotal movement on a stay **23c** of housing **23** and have their other end portions **24b** projecting through openings in the housing **23**. The piezoelectric elements **21** and pattern fingers **24** are preferably arranged in a multi-tier stack and may include eight tiers of stages and each tier or stage may include two rows.

[0020] To actuate the piezoelectric elements **21**, each needle selecting device **20** includes a drive circuit **25**. Needle selecting device **20** also includes a shift register **26** for receiving, transferring and retaining knitting data which serves as control data for the drive circuit **25**.

[0021] A controller **30** is connected to one of the needle selecting devices **20** and the remaining needle selecting devices **20** are connected in series to the one needle selecting device **20**. Controller **30** has a built-in data output means **31**, a clock signal generating means **32** and a latch signal generating means **33**. The knitting data for controlling and actuating the needle selecting devices **20** is outputted as serial signals from the data output means **31**.

[0022] The data output means **31** is connected to the shift register **26** of the first in line needle selecting device **20** by a data transmission line **34a** and the shift registers **26** of the remaining needle selecting devices **20** are connected together in series by data transmission lines **34b, 34c,** etc. The clock signal generating means **32** is connected to the shift registers **26** of the needle selecting devices **20** by a data transmission line **35**. Similarly, the latch signal generating means **33** is connected to the shift registers **26** of the needle selecting devices 20 by a data transmission line 36 and a power source terminal 37 of controller 30 is connected to each needle selecting device 20 by a power line 38 to complete the control circuits to the needle selecting devices 20.

[0023] The drive circuit 25 of each needle selecting device 20 is connected to the piezoelectric elements 21. The piezoelectric elements 21 are generally of a rectangular plate-like configuration and may be formed of a bimorph ceramic material or any other piezoelectric material known to persons skilled in this art. When a positive or negative pulse voltage is applied to the piezoelectric elements 21 by the drive circuit 25, they will flex up or down and cause the pattern fingers 24 to pivot up or down as is illustrated in Figure 3.

[0024] Each pattern finger 24 has a slant or sloping cam surface and a linear surface (not shown) on its outer end of end portion 24b which engages a pattern butt 13a on the selector jack 13 when the pattern finger 24 is pivoted upward by the application of a positive pulse voltage to the piezoelectric element 21. The pattern finger 24 pushes the selector jack 13 inwardly of cylinder 11 and out of the path of a raising cam 15. Therefore, the needle 12 will not be raised to the knit position, but will remain in the non-knit or welt position. Conversely, when a negative pulse of voltage is applied by the drive circuit 25 to the piezoelectric element 21, the pattern finger 24 will be pivoted downwardly and the outer end thereof will be moved out of the path of the pattern butt 13 a of the selector jack 13 and the selector jack 13 will be engaged and moved upwardly by the raising cam 15 to move the needle 12 to the knit position to receive yarn 14 and thereafter form a stitch.

[0025] To place the present invention in perspective, Figure 6 illustrates a typical control system, generally indicated at 50, for a previously used knitting machine (See JP-A-8-21855). In this conventional control system 50, a controller 51 is connected in series to a plurality of actuators or needle selecting devices 52, having drive circuits 53 therein, by a plurality of signal lines 54. The signal lines 54 include a plurality of address lines which serve as paths of transmission of control data signals (knitting data signals) and address signals, that are parallel signals outputted from the controller 51 for controlling the knitting operation, and a single strobe line which serves as a path for transmission of a strobe signal outputted from the controller 51. The number of address lines is of a value sufficient to satisfy the number of bits of the knitting data and the number of bits of addresses of each actuator or needle selecting device 52.

[0026] In the above described needle selecting device, an address signal for selecting one of the needle selecting devices **52** is transmitted from the controller **51** to each needle selecting device **52** through the address data lines contained in the signal lines **54**, and one of the needle selecting devices **52** assigned by such address signal is then specified at a timing in synchronism with the strobe signal transmitted from the controller **51** through the strobe line. In such case, each needle selecting device **52** is provided with a dip switch that is

set to a combination of On and Off positions in correspondence with the address assigned thereto and, only when the address of the actuator set by the dip switch matches with the address signal thus transmitted, the above described address selection is carried out. Thereafter, the knitting data signal associated with the above described needle selecting device **52** at a timing synchronized with the strobe signal transmitted from the controller **51** through the strobe line.

[0027] By sequentially carrying out the foregoing address selection and data writing operation subject to each of the needle selecting devices **52**, the needle selecting devices **52** can select the knitting needles necessary to accomplish the desired pattern knitting.

[0028] In the needle selecting device of the structure described above, the numerous address data lines for transmission of the knitting data signals and the address signals which are the parallel signal and the single strobe line are utilized to electrically connect between the controller **51** and one of the needle selecting devices **52** and between the neighboring needle selecting devices **52**. For this reason, although the time required to transmit the knitting data signal and the address signal to each of the actuators **52** may be reduced, a relatively large number of signal lines for the transmission of the parallel signals, the signal lines **54** corresponding in number to the number of bits of the signals are required, hence rendering the drive circuit **53** for each actuator **52** and the controller **51** to be bulky in size accompanied by complication of circuit designs.

[0029] Also, in the above described needle selecting device, the operation of specifying the address of one of the needle selecting devices **52** and subsequently driving the drive circuit **53** after the data signal is retained in the needle selecting device **52** specified by such address is necessarily repeated each time the address of the needle selecting device **52** is expressed by **N** and the time required to drive one drive circuit **53** is expressed by **t**, then, the length of time expressed by **N** x **t** would be required to cause all of the needle selecting devices **52** to perform the needle selecting operation. In other words, to activate the piezoelectric element associated with the needle selecting fingers in one of the needle selecting devices **52**, by supplying a pulse voltage from the associated drive circuit **53** to such piezoelectric element,would require a length of voltage applying time of typically **16** μs and, therefore, in order for all of the needle selecting devices **52** to perform the needle selecting operation while the knitting cylinder rotates an angle corresponding to a circumferential width of the single knitting needle, at least the length of time expressed by N x 16 μs would be required. Accordingly, if the number of the actuators **52** is relatively large, it may occur that the needle selecting operation would not be finished during the length of time in which the knitting cylinder rotates the angle corresponding to the width of the single knitting needle. In order to alleviate this problem, the length of time during which the piezoelectric element is activated must be reduced from 16 μm down to 8μs or 4μs, but a different electrical countermeasure is necessitated to sustain the reliability of operation.

[0030] In addition, in the above described needle selecting device, each of the needle selecting devices **52** tends to be complicated in structure in the presence of the dip switch required for address specification of such actuator **52**. Moreover, in the event that replacement of the actuator **52** occurs as a result of failure of such actuator **52** to operate properly, the dip switch of a replacement actuator **52** must be set to the combination of On and Off positions which has been assumed by the dip switch of the replaced needle selecting device **52**, requiring a complicated maintenance.

[0031] The operation of the circular knitting machine **10** will now be described. At the outset, the knitting data **a** corresponding to each of the needle selecting devices **20** is outputted from the data output means **31** of the controller **30** (Fig. 1) as a serial signal (as shown in Fig. 4). A single unit of the knitting data **a** corresponding to one needle selecting device **20** comprises a signal having bits, the number of which is equal to the number of the selector jacks **13**, which is also the number of the piezoelectric elements **21**. In the illustrated embodiment, there are **16** bits. The sequential arrangement of the knitting data **a** is set to match with the sequential arrangement of the needle selecting devices **20**. The serial signal representative of the knitting data **a** so outputted is supplied to the shift register **26** in the first stage needle selecting device **20** (Fig. 1) and is then sequentially transferred to the shift register **26** in the last-stage needle selecting device **20** through the shift registers **26** in the intermediate stage needle selecting devices **20**. The transfer of the knitting data **a** is carried out bit by bit in synchronism with the clock signal **b** (shown in Fig. 4) which is supplied parallel from the clock signal generating means **32** of the controller **30** to all of the shift registers **26**.

[0032] When the transfer of the knitting data **a** completes, the knitting data **a** is latched in the shift registers **26** in response to the latch signal **c** (shown in Fig. 4) which is outputted from the latch signal generating means **33** of the controller **30**. In other words, in the case where the single unit of the knitting data **a** for each of the needle selecting devices **20** is comprised of 16 bits, and assuming that the total number of the needle selecting devices **20** is expressed by N, the latch signal **c** is outputted each time the clock signals **b**, (the number of which is equal to 16 x N) are outputted, so that the knitting data **a** can be latched in each of the shift registers **26**. Since as hereinabove described, the knitting data **a** is supplied to the respective shift registers **26** of the needle selecting devices **20** and at the time of completion of the transfer of the knitting data **a**, the corresponding knitting data **a** is stored in the shift registers **26** in response to the above described latch signal **c**.

[0033] The drive circuits **25** of the respective needle selecting devices **20** are activated in response to the

latch signal **c** which serves as a timing signal for initiating the pulse voltages that activate the piezoelectric elements **21**. In other words, the drive circuit **25** of the respective needle selecting device **20** is activated by the utilization of the knitting data **a**, retained in the shift register **26** in such needle selecting device **20**, as a control signal to thereby apply a positive or negative pulse voltage to the piezoelectric element **21** to move the pattern finger **24** in the stage corresponding to the knitting data **a**, allowing the corresponding pattern finger **24** to move upwards or downwards. By this action, as hereinbefore described, the knitting needle **12** is shifted upwards or held standstill to thereby accomplish the desired pattern knitting.

[0034] A line through which the knitting data **a** is transferred by means of the shift registers **26** is a differential line having a pair of two lines capable of transferring the data signal and an inverted signal simultaneously and, therefore, any adverse influence which would be brought about by noises can be suppressed to improve the S/N ratio of the knitting data. In the case of the above described needle selecting device, since without the needle selecting devices having to be specified by the respective addresses as in the conventional case, the knitting data **a** corresponding to the respective needle selecting device **20** can be supplied serially, the number of signal lines for the data transmission can be reduced considerably. As a result thereof, an electric circuit for each needle selecting device **20** and the controller **30** can be made compact with the circuit simplified in structure. In particular, the use of the differential line comprised of a pair of two lines has hitherto been considered impossible since the number of the signal lines may double, but has been made possible in the present invention in which the number of the signal lines is reduced considerably.

[0035] Also, since the data transfer is possible with such a differential line, the noises containing a relatively large amount of high frequency components can be suppressed considerably and, therefore, it is possible to accomplish a high-speed data transfer by increasing the frequency of the data signal a while any possible adverse influence which would be brought about by the noises is avoided. For this reason, even though the number of the needle selecting devices **20** is increased, the length of time required for all of the needle selecting devices **20** to perform the needle selecting operation will not increase significantly. In addition, in view of this, no effort is necessary to reduce particularly the voltage applying time for actuating the pattern fingers **24** in each of the needle selecting devices **20**, securing a high reliability of operation.

[0036] Again, since at the time the knitting data **a** is retained in all of the needle selecting devices **20**, all can be actuated at a time, no effort is necessary to specifically reduce the voltage applying time towards the pattern fingers **24** for accomplishment of a high speed operation and, therefore, the present invention can be equally applied to an electromagnetic needle selecting device in which actuating elements that require a relatively long voltage applying time are employed for actuating the pattern fingers by the effect of an electromagnetic force developed by an electromagnetic coil.

[0037] It is to be noted that in the control system of this invention, the length of time required to transmit the knitting data **a** to all of the needle selecting devices **20** would be 16 x N x T, wherein "N" represents the number of the needle selecting devices **20** used, "**16**" represents the number of bits of the single unit of the knitting data **a** and the "T" represents the cycle of the clock signal **b**. However, if the clock signal **b** has a cycle "T" which is 125 nanoseconds (a frequency of 8 MHz), the transmission of the knitting data **a** to all of the needle selecting devices **20** can be achieved stably and at a high speed and, during the period in which the knitting cylinder **11** rotates the angle corresponding to the width of a single knitting needle **12**, the needle selecting operation can be performed. By way of example, even where N = 64, 16 x 64 x 125 nanoseconds = 128 microseconds and, hence, the length of time required for the knitting cylinder **11** to rotate the angle corresponding to the width of one of the 3,000 knitting needles **12** is sufficiently smaller than 1 millisecond.

[0038] In addition, since the above described needle selecting devices **20** need not be specified by the corresponding address, no dip switch is required, as in the conventional case, for each needle selecting device and the needle selecting device **20** can be correspondingly simplified in structure. Also, even if as a result of one of the needle selecting devices **20** failing to operate properly, replacement of the damaged needle selecting device **20** is required, no complicated and time-consuming job of setting a combination of the On and Off positions to cause the new dip switch to match with the address is necessary, rendering the maintenance easy to accomplish.

[0039] The present invention is not limited to the needle selecting device for selecting the knitting needles of the type shown in the above described embodiment, but may be applied to a control method and a control apparatus wherein electrically driven needle selecting devices are used to drive various driven members in the knitting machine such as a stitch cam for adjusting the knitting stitch of each knitting needle and a yarn guide for changing the path of travel of a thread.

Claims

1. A method of controlling a knitting machine (10) by supplying control data to a plurality of needle selecting devices (20) having drive circuits (25) for driving the selector devices, characterised by the steps of:

   providing the needle selecting devices (20) with shift registers (26) connected in series with

each other;
supplying the control data from a controller (30) to the shift register (26) of one of the needle selecting devices (20) and sequentially transferring it to the remaining needle selecting devices (20);
latching and retaining the control data in each shift register (26) when the transfer of the control data completes; and
actuating the drive circuit based on the retained control data.

2. The method according to Claim 1, wherein the needle selecting devices (20) have a plurality of actuating elements (21) and pattern fingers (24) for selecting and actuating knitting needles (12) for movement between knitting and non-knitting positions to accomplish pattern knitting, and each actuating element comprises a piezoelectric element (21) arranged to actuate its associated pattern finger (24).

3. The method according to Claim 1 or 2, wherein the needle selecting devices (20) are of a type capable of actuating a plurality of knitting needles retained by a knitting cylinder.

4. Apparatus for controlling a knitting machine, in which a controller (30) is arranged to supply control data to a plurality of needle selecting devices (20) to control said devices, and each of the needle selecting devices (20) includes a drive circuit for driving the associated device based on the control data, characterized in that

each needle selecting device (20) includes a shift register (26) for sequentially transferring the control data, inputted from the controller (30), to the remaining needle selecting devices (20); and in that
the controller (30) includes a latch means (33) for causing the control data to be retained in each of the shift registers (26) at the time the transfer of the control data is completed.

5. The apparatus according to Claim 4, wherein each needle selecting device (20) includes a piezoelectric element for actuating a selector jack (13) associated with the device.

6. The apparatus according to Claim 4 or 5, wherein each needle selecting device (20) is of a type capable of actuating a plurality of knitting needles (12) retained by a knitting cylinder (11).

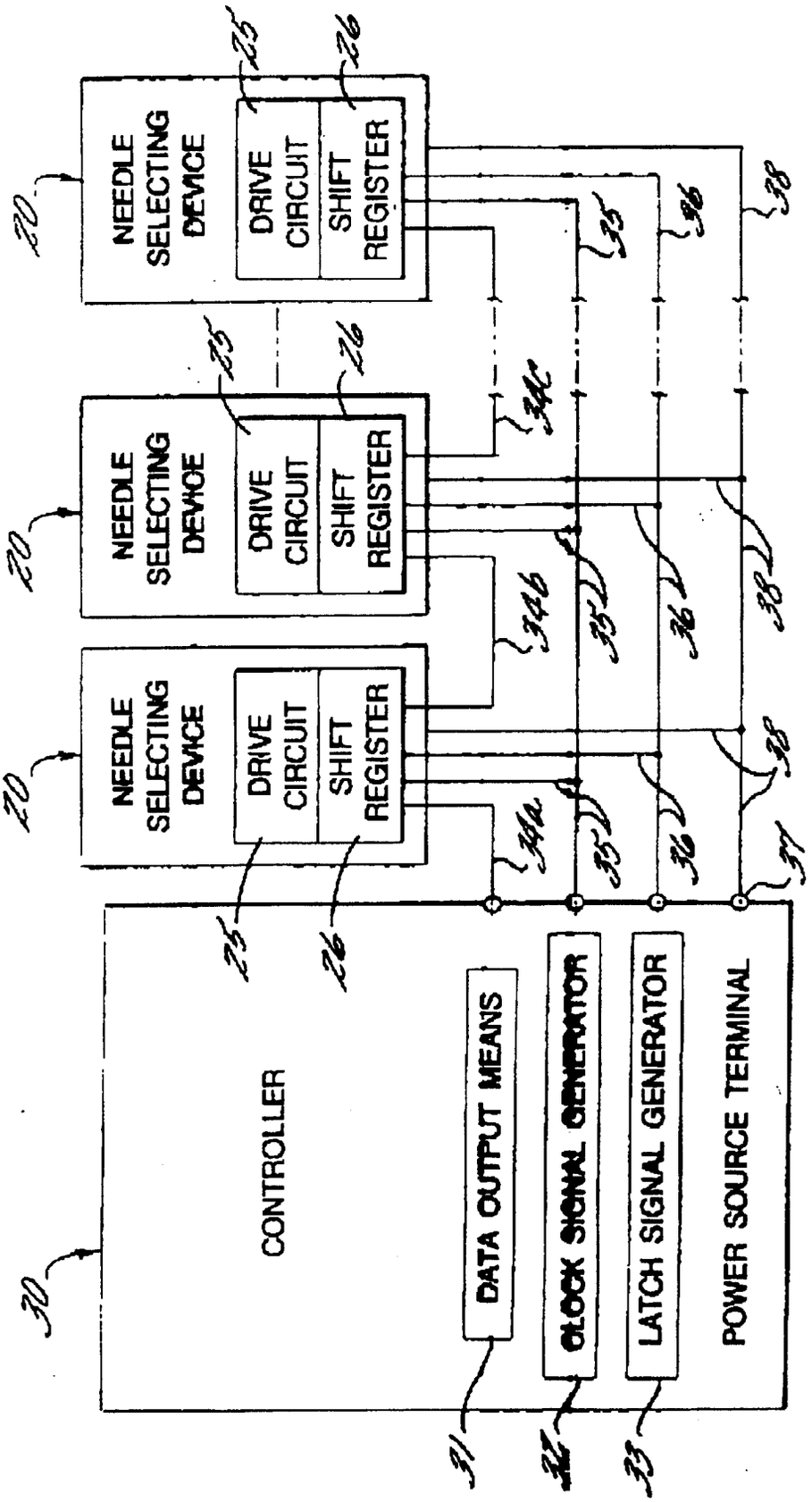
NEEDLE SELECTING DEVICE
DRIVE CIRCUIT
SHIFT REGISTER
CONTROLLER
DATA OUTPUT MEANS
CLOCK SIGNAL GENERATOR
LATCH SIGNAL GENERATOR
POWER SOURCE TERMINAL

FIG. 1.

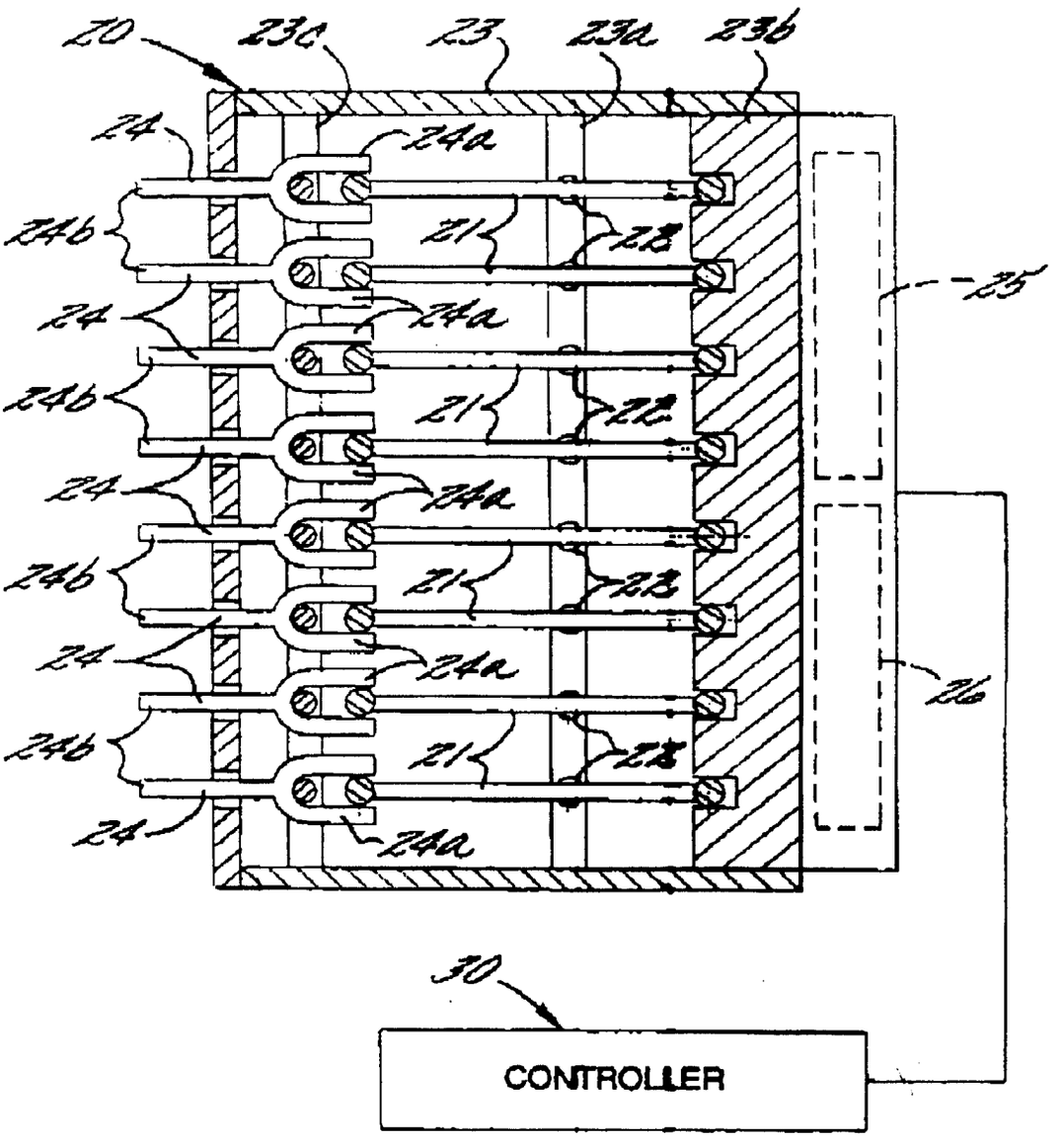

Fig. 2.

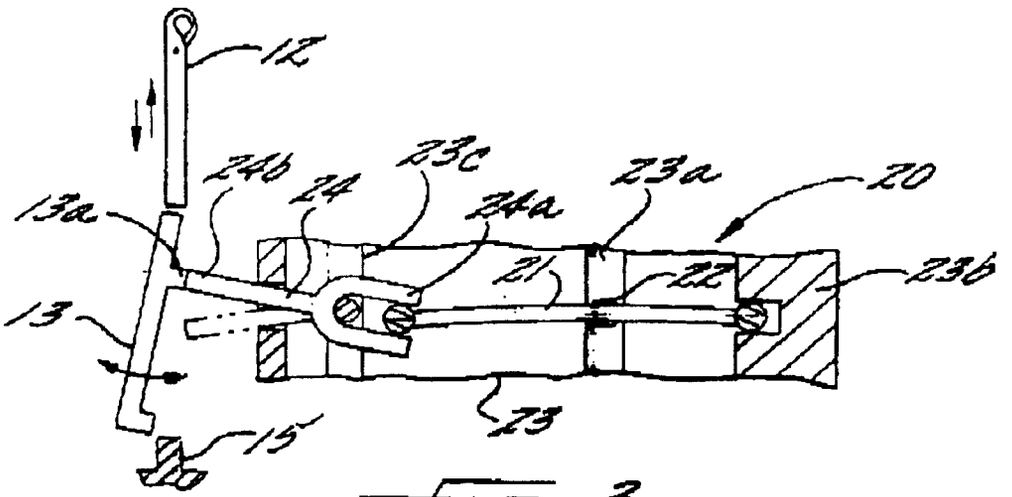
12
24b
23c
24
24a
23a
20
13a
21
22
23b
13
15
23

Fig. 3.

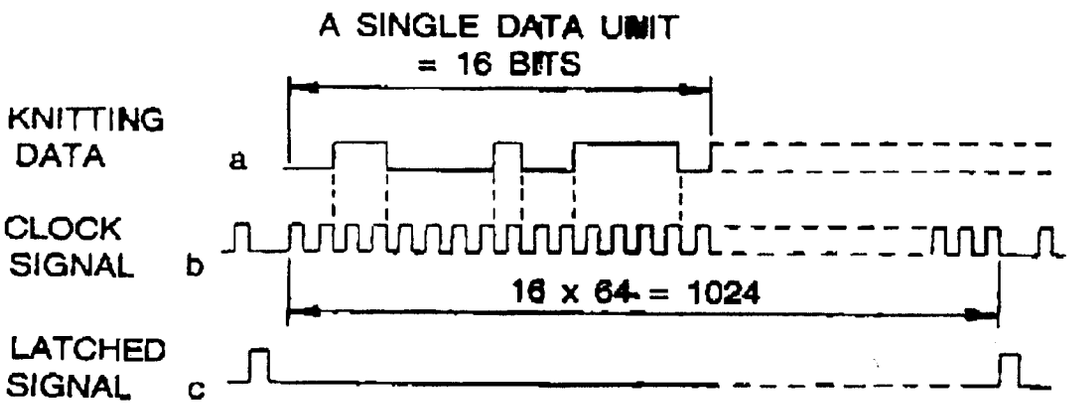
A SINGLE DATA UNIT
= 16 BITS
KNITTING
DATA
a
CLOCK
SIGNAL
b
16 x 64 = 1024
LATCHED
SIGNAL
c

Fig. 4.

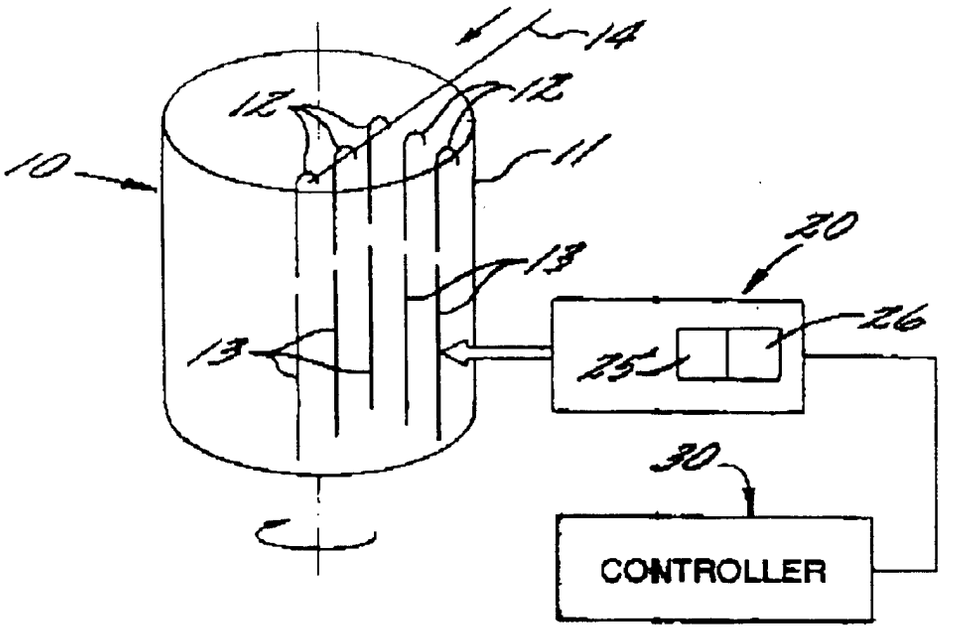

Fig. 5.

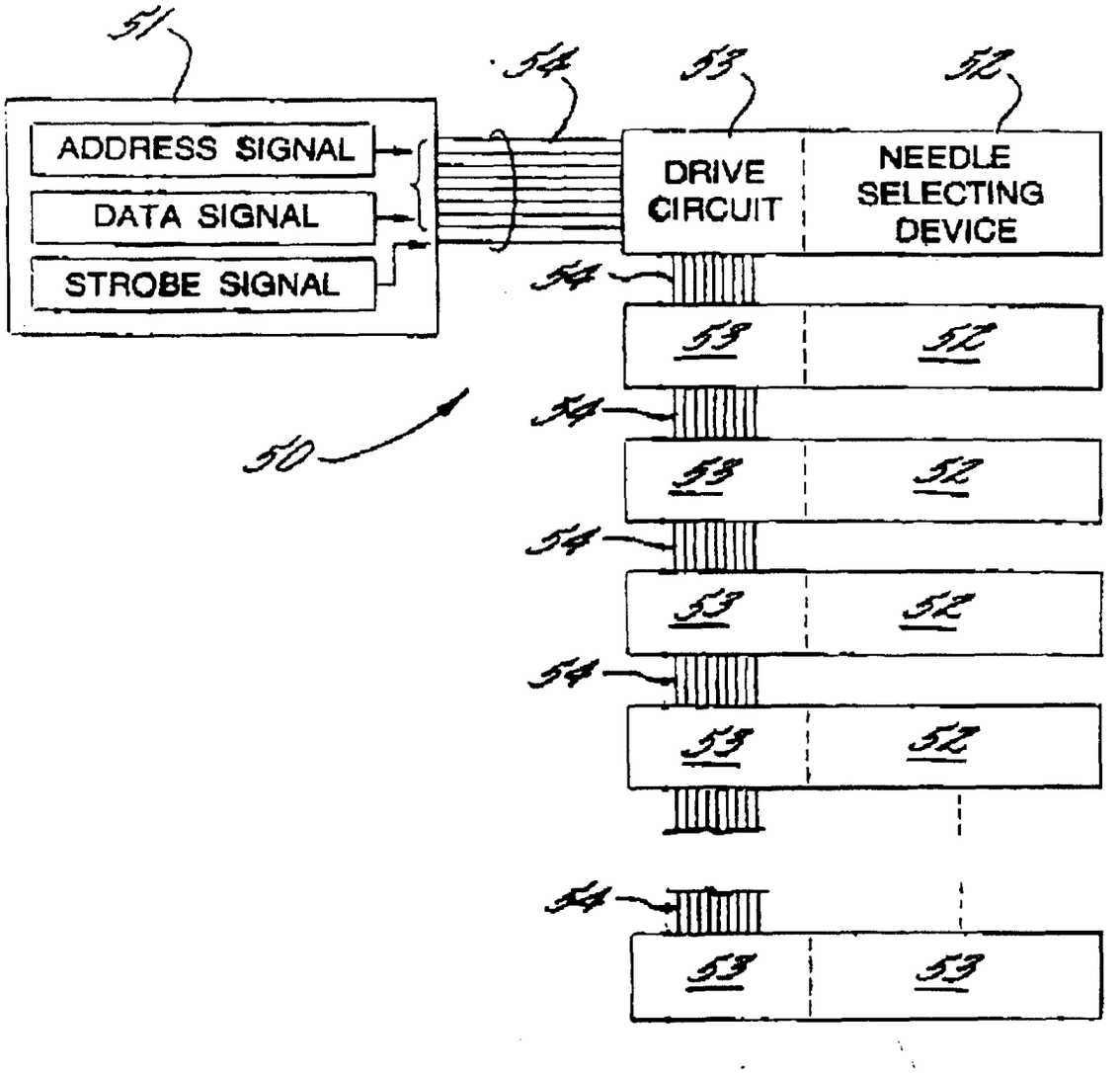
51
54
53
52
ADDRESS SIGNAL
DATA SIGNAL
STROBE SIGNAL
DRIVE CIRCUIT
NEEDLE SELECTING DEVICE
50

Fig. 6.