(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 091 034 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
11.04.2001 Bulletin 2001/15

(51) Int. Cl.[7]: **D04B 15/66**

(21) Application number: **00121244.8**

(22) Date of filing: **02.10.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **07.10.1999 IT MI992100**

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(54) Method and device for self-learning the position of electromechanical actuators, particularly for circular textile machines and the like

(57) A method for self-learning the position of electromechanical actuators, particularly for circular textile machines provided with a needle cylinder with multiple circumferentially arranged actuators for actuating heels of flexible elements arranged at each needle of the needle cylinder, each one of the actuators being provided with a plurality of levers which are actuated electronically, each one of the levers being suitable to pass from an inactive position to a position for engagement with a corresponding heel of the needle cylinder, consisting in:

- sending a command to each one of the actuators in order to arrange all of the levers except one in the inactive position, inducing a contact between the lower lever and the heel of a flexible element, to generate an electrical signal;
- starting the rotation of the needle cylinder;
- measuring, by way of signals generated by an encoder which is rigidly coupled to the needle cylinder, and electrical signals generated by the contact between the lower lever of each actuator and a corresponding heel, the angle between the zero position of the encoder and each heel that makes contact with the corresponding lever.

The device includes the actuators (1), supported on an insulating element, and arranged around the needle cylinder (3).

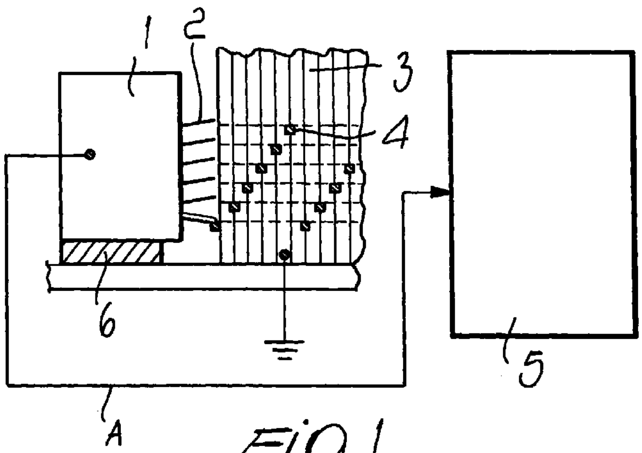

Fig.1

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Description

[0001] The present invention relates to a method and a device for self-learning the position of electromechanical actuators, particularly for circular textile machines.

[0002] More particularly, the invention relates to a method for self-learning the position of electromechanical actuators, for performing particular kinds of knitting on circular knitting machines, in order to obtain particular types of pattern or mesh.

[0003] It is known that multiple yarns are used to provide knitting with particular designs in circular textile machines, which must be woven in each instance according to the intended kind of knitting.

[0004] Insertion of one or more yarns in the knitting must occur in a synchronized fashion, in accordance with the intended type of knitting.

[0005] Currently, therefore, electronically-controlled needle selection devices must be timed or synchronized with respect to the needle cylinder so as to be able to select the intended needle in each instance.

[0006] This synchronization or timing is usually performed manually, with evident difficulty in synchronizing the electromechanical actuators with respect to the rotating needle cylinder.

[0007] Moreover, the mechanical synchronization of the electromechanical actuators is never sufficiently precise, especially if performed on site.

[0008] The aim of the present invention is to provide a method for self-learning the position of electromechanical actuators, particularly for circular textile machines, which allows to automatically detect the angular position of the electromechanical actuators arranged around the rotating needle cylinder with respect to a reference point of said needle cylinder.

[0009] Within the scope of this aim, an object of the present invention is to provide a method for self-learning the position of electromechanical actuators in which said reference can be any point of the rotating cylinder.

[0010] Another object of the present invention is to provide a method for self-learning the position of electromechanical actuators which allows to use, as sensor, sensors which are typically already present in said circular machine.

[0011] Another object of the present invention is to provide a method for self-learning the position of electromechanical actuators which allows, after determining the positions of the axes of the actuators with respect to a reference point, to precisely generate the synchronization or timing signals for driving the electromagnets of the actuators, in order to achieve selection of the needles and thus provide a particular type of pattern or knitting.

[0012] Another object of the present invention is to provide a method for self-learning the position of electromechanical actuators which is highly reliable, relatively simple to provide and at competitive costs.

[0013] These and other objects which will become better apparent hereinafter are achieved by a method for self-learning the position of electromechanical actuators, particularly for circular textile machines provided with a needle cylinder with multiple circumferentially arranged actuators for actuating heels of flexible elements arranged at each needle of the needle cylinder, each one of said actuators being provided with a plurality of levers which are actuated electronically, each one of said levers being suitable to pass from an inactive position to a position for engagement with a corresponding heel of said needle cylinder, characterized in that it comprises the steps that consist in:

sending a command to each one of said actuators to arrange all of said levers except one in the inactive position, so as to induce a contact between said one lever and the heel of a flexible element, for generating an electrical signal;
starting the rotation of said needle cylinder;
measuring, by way of signals generated by an encoder which is rigidly coupled to said needle cylinder, and electrical signals generated by the contact between said one lever of each actuator and a corresponding heel, the angle between the zero position of said encoder and each heel that makes contact with the corresponding lever.

[0014] Further characteristics and advantages of the invention will become better apparent from the description of preferred but not exclusive embodiments of the method according to the invention, illustrated only by way of non-limitative example with reference to a portion of a circular knitting machine, illustrated in the accompanying drawings, wherein:

Figure 1 is a schematic view of an electromechanical actuator coupled to a needle cylinder and connected to an electronic unit for performing the method according to the present invention;
Figure 2 is a schematic view of a plurality of actuators arranged around a needle cylinder and connected to the electronic unit;
Figure 3 is a chart which plots the behavior of a plurality of signals in the self-learning method according to the present invention; and
Figure 4 is a chart which plots the behavior of the signals of Figure 3, together with the signals for determining an absolute position of the electromechanical actuators.

[0015] With reference to the figures, an electromechanical actuator and its coupling to a needle cylinder are described initially.

[0016] Figure 1 illustrates an electromechanical actuator 1 which is formed by special electromagnets (not shown) which move upward and downward a plurality of levers 2. Each lever can be moved and arranged downward by means of the activation of the corresponding electromagnet, and in this case makes mechanical contact with a heel 4 of a flexible element which is rigidly coupled to a rotating needle cylinder 3 of the machine. Each flexible element is arranged at each needle of the cylinder. The heels of the flexible elements are arranged sequentially at different heights, as shown in Figure 1, with the same center distance provided is between the levers 2 and with a modulus of repetition which is equal to the number of levers 2 of the actuator 1. In practice, one has a diagonal arrangement of the heels 4 of the flexible elements.

[0017] The mechanical contact of each lever 2 with a heel 4 is utilized to obtain an electrical contact as well. The needle cylinder 3 is in fact typically in contact with the structure of the circular knitting machine and is therefore connected to the same electrical ground as the machine. For the self-learning method according to the invention, a single lever 2 is arranged downward and generates the electrical signal. The chosen lever must be the same for each actuator.

[0018] The actuator 1 is conveniently supported on an electrically insulating supporting element 6, which is meant to electrically insulate the actuator 1 from the electrical ground to which the machine is connected.

[0019] Each lever 2, by means of its metallic supporting systems, is in electrical contact with the body of the actuator 1, which is in turn connected to an input channel of an electronic unit 5 which controls the circular knitting machine.

[0020] During the rotation of the needle cylinder 3, every time the lever 2 arranged downward (one for each actuator) makes contact with a heel 4 of a flexible element, each input to which each one of the actuators 1 (designated by 1a...1n in Figure 2) is connected makes contact with the electrical ground and, by means of appropriate electronic circuits, generates a digital signal which can have, for example, the following meaning:

1 = input in contact with the electrical ground.
0 = input not in contact with the electrical ground.

[0021] Each actuator arranged around the needle cylinder 3 therefore acts as a sensor (or better still as a transducer) in order to generate an item of electrical information whenever it interferes mechanically with the heels 4 of the flexible elements that correspond to each needle of the cylinder 3.

[0022] This allows to activate a self-learning procedure which is described hereinafter.

[0023] Figure 2 is a plan view of the needle cylinder 3, connected to the electronic unit 5, on which multiple actuators, designated in this case by 1a...1n, are arranged radially, and with an encoder 8 which is rigidly coupled to the needle cylinder 3 and is in turn connected to the electronic unit 5.

[0024] Conveniently, the encoder 8 is of the incremental type and is characterized by a zero signal (encoder zero) which is generated only once per revolution, a signal ch1 and a signal ch2 which is generated, for each revolution, a number of times which is sufficient to obtain a resolution of a fraction of a degree on the position of the needle cylinder 3.

[0025] The connection between each actuator 1a...1n and the electronic unit 5 is of the bidirectional type, since the actuators receive from the electronic unit the control signals for the electromagnets which are rigidly coupled to the levers 2, and in turn send to the electronic unit, over the appropriately provided input channels designated by INPUT 1a...INPUT 1n, the information related to the operation of the actuators as sensors for detecting the position of the needle cylinder 3.

[0026] The connection between the incremental encoder 8 and the electronic unit 5 is provided by means of a bus H which is meant to send to the electronic unit 5 the three signals of the encoder, i.e., the encoder zero signal, the Ch1 signal and the Ch2 signal.

[0027] The electronic unit 5 furthermore drives the motor of the needle cylinder 3, not shown in the figures.

[0028] The method for self-learning the position of the needle cylinder 3 is started by an appropriate command on the keyboard of the circular knitting machine and activates the following actions:

first of all, commands are sent to the electromagnets of all the actuators 1a...1n in order to initially arrange upward all the levers 2 except for the lowermost lever, which accordingly will be the only one to make contact with the heel 4 of the flexible element and therefore generate the corresponding electrical signal, as described earlier.

[0029] This is followed by a step in which the needle cylinder 3 is turned at a rate which is convenient to ensure reading of the signals of interest with sufficient precision.

[0030] This is followed by a measurement step, performed by means of the signals generated by the encoder (encoder zero, Ch1, Ch2) and the signals generated by the contact between the lowermost lever 2 of each actuator 1a...1n and each heel 4, which makes contact with the corresponding lever.

[0031] Assuming, with reasonable approximation, that all the levers lie on the same axis, it is thus possible to determine the precise position, given by the angles x1 - x2 -...xn shown in Figure 3, of the actuators with respect to the encoder zero, which is indicated in Figure 2 by a downward arrow.

[0032] Figure 3 is a chart which plots the timings of the various signals.

[0033] A precise position of the actuators with respect to the encoder zero has therefore been calculated.

[0034] However, in order to be able to determine which one of the heels 4 has actually generated the electrical signal (produced by mechanical contact) and therefore be able to automatically calculate the absolute position of the actuators 1a...1n (axis of the actuators) with respect to the encoder zero, it is necessary to identify a specific heel 4.

[0035] In this regard, this operation can occur in different manners, for example by adding appropriate sensors at a specific position on the needle cylinder 3 or by arranging the cylinder by manual rotation at a specific angle or by means of a procedure which allows to simplify the operation and have assurance of reliability.

[0036] This procedure entails, in a step which precedes the activation of the self-learning method, the removal of a heel 4 which corresponds to a reference position chosen by the operator.

[0037] The signals INPUT 1a... INPUT 1n obtained during the self-learning method have an evident gap, indicated by a dashed line in Figure 4, at the missing heel 4. Since the number of needles and therefore of flexible elements and heels is known for each circular knitting machine, since it is a design specification, and most of all since the number of needles that composes each diagonal is known, it is easy to determine the position of the missing heel 4 and accordingly it is also easy to calculate the angles a1, a2, a3...an between the zero of the encoder and the reference needle on the axis of each one of the actuators 1a...1n that are present. In practice, it is therefore possible to detect the absolute position of the actuators 1a...1n with respect to the zero of the encoder 8.

[0038] From the measurement of the angle a1, and knowing the angle b1 (defined as the position of the zero of the needle cylinder 3 and the position of the axis of the axis of the actuator 1), it is possible to calculate the phase shift between the zero of the encoder 8 and the position of the zero of the needle cylinder 3. It is in fact sufficient to subtract b1 from a1, or add b1 to a1, depending on whether the zero position of the needle cylinder lies ahead or after the position of the actuator 1. The calculation can also be performed by considering all the other actuators, but of course with the corresponding angles.

[0039] The self-learned positions of the axes of the actuators 1 with respect to the zero of the encoder 8 allow to precisely generate the synchronization signals for driving the electromagnets and therefore the levers 2 of each actuator in order to obtain needle selection and therefore provide a particular type of pattern or knitting.

[0040] The self-learned position of the zero of the needle cylinder 3 with respect to the zero of the encoder 8 allows to precisely calculate the angular position of the needle cylinder 3 and therefore to activate all the actuations programmed to specific positions of said cylinder, for example: electric valves for pneumatic actuations, movement of step motors, halting and reversal of the motion of said cylinder, enabling of sensors, revolution counting, etcetera.

[0041] In practice it has been found that the method according to the invention allows to utilize an actuator for actuating the selection of the needles also as a sensor, without necessarily having to add external sensors.

[0042] Moreover, the above described method allows to determine both a precise position of each actuator and an absolute position thereof, in this case also without the addition of additional sensors.

[0043] The method and the device thus conceived are susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept; all the details may furthermore be any according to requirements and to the state of the art.

[0044] In practice, the materials, so long as they are compatible with the specific use, as well as the dimensions, may be any according to requirements and to the state of the art.

[0045] The disclosures in Italian Patent Application No. MI99A002100 from which this application claims priority are incorporated herein by reference.

[0046] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A method for self-learning the position of electromechanical actuators, particularly for circular textile machines provided with a needle cylinder with multiple circumferentially arranged actuators for actuating heels of flexible elements arranged at each needle of the needle cylinder, each one of said actuators being provided with a plurality of levers which are actuated electronically, each one of said levers being suitable to pass from an inactive position to a position for engagement with a corresponding heel of said needle cylinder, characterized in that it comprises the steps that consist in:

sending a command to each one of said actuators in order to arrange all of said levers except one in said inactive position, in order to induce a contact between said one lever and the heel of a flexible element, in order to generate an electrical signal;

starting the rotation of said needle cylinder;

measuring, by way of signals generated by an encoder which is rigidly coupled to said needle cylinder, and electrical signals generated by the contact between said one lever of each actuator and a corresponding heel, the angle between the zero position of said encoder and each heel that makes contact with the corresponding lever.

2. The method according to claim 1, characterized in that it comprises a preliminary step which consists in removing one of said heels which corresponds to a reference position chosen arbitrarily by the operator.

3. The method according to claim 2, characterized in that said step that consists in removing said heel that corresponds to the reference position comprises the steps that consist in:

detecting the electrical signals that indicate contact between said one lever of each actuator and a corresponding heel;
calculating the angles between the zero position of said encoder and said reference position on the axis of each one of said actuators, in order to determine the absolute position of said actuators with respect to the zero position of said encoder;
calculating the phase shift between the zero position of said encoder and the zero position of said needle cylinder.

4. The method according to claim 3, characterized in that the step that consists in calculating the phase shift between the zero position of said encoder and the zero position of said needle cylinder consists in subtracting the angle between the zero position of said needle cylinder and the position of the axis of each actuator from the measurement of the angle between the zero position of said encoder and the position of said reference on the axis of each one of said actuators, if the zero position of said needle cylinder lies ahead of the position of said actuator.

5. The method according to claim 3, characterized in that said step that consists in calculating the phase shift between said zero position of said encoder and the zero position of said needle cylinder comprises the step that consists in adding said angle between the zero position of said needle cylinder and the position of the axis of said actuator and the angle between the zero position of said encoder and said reference position on the axis of said actuator, if the zero position of said needle cylinder lies after the position of said actuator.

6. A device for self-learning the position of electromechanical actuators arranged around a rotating needle cylinder (3) with respect to a reference point of said cylinder, particularly for circular textile machines, each one of said actuators (1) being supported on an insulating supporting element (6), so as to electrically insulate each one of said actuators (1) from the electrical ground of said circular machine to which said needle cylinder (3) is connected.

7. The device according to claim 6, characterized in that it comprises an electronic unit (5) which is adapted to drive each one of said actuators (1) and to detect its measurement signals, said needle cylinder (3) being provided with a motor which is in turn connected to said electronic unit (5).

8. The device according to claim 6, characterized in that it comprises an encoder (8) which is rigidly coupled to said needle cylinder (3) and is connected to said electronic unit (5).

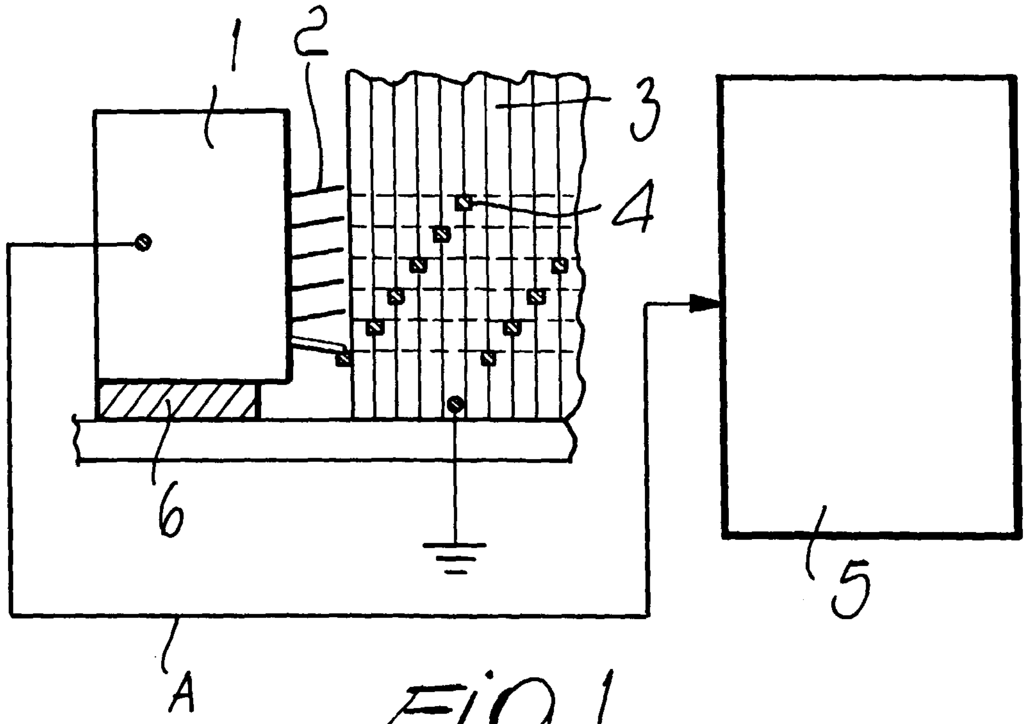
1
2
3
4
5
6
A

Fig.1

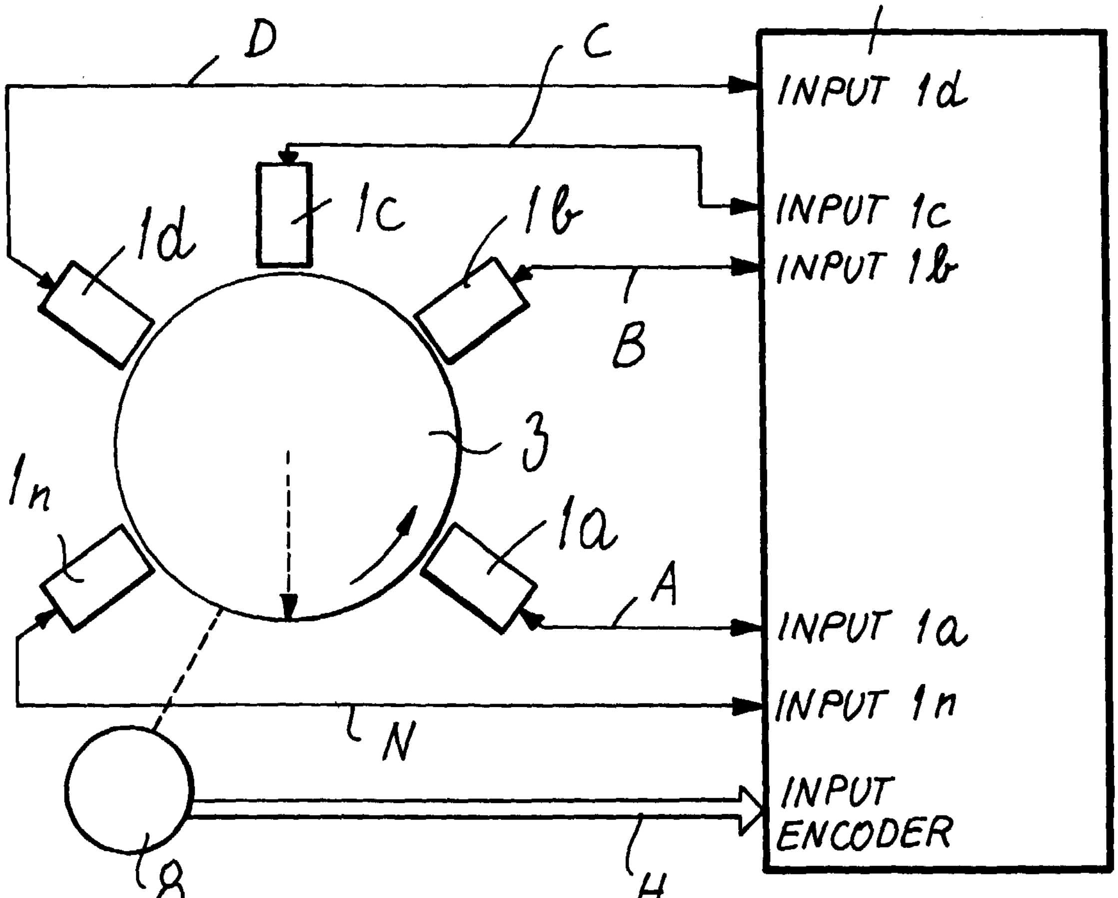
5
D
C
INPUT 1d
INPUT 1c
INPUT 1b
1d
1c
1b
B
3
1n
1a
A
INPUT 1a
INPUT 1n
N
INPUT
ENCODER
8
H

Fig.2

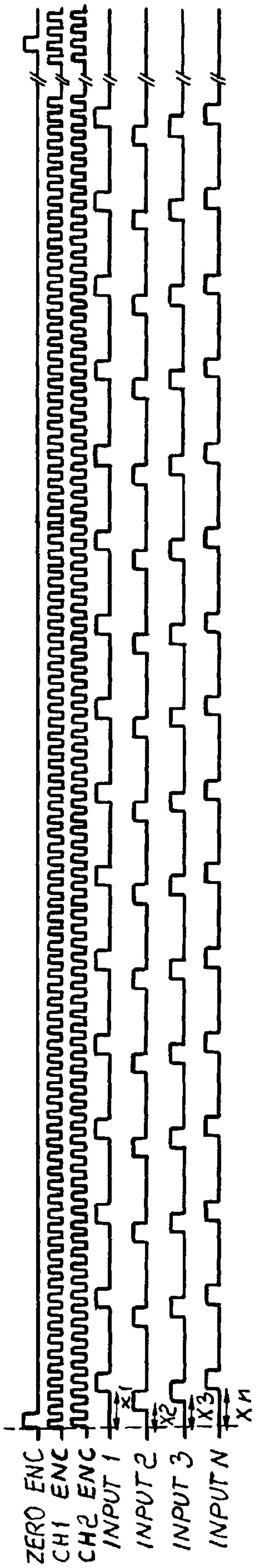
ZERO ENC
CH1 ENC
CH2 ENC
INPUT 1
INPUT 2
INPUT 3
INPUT N
x1
X2
X3
Xn

Fig. 3

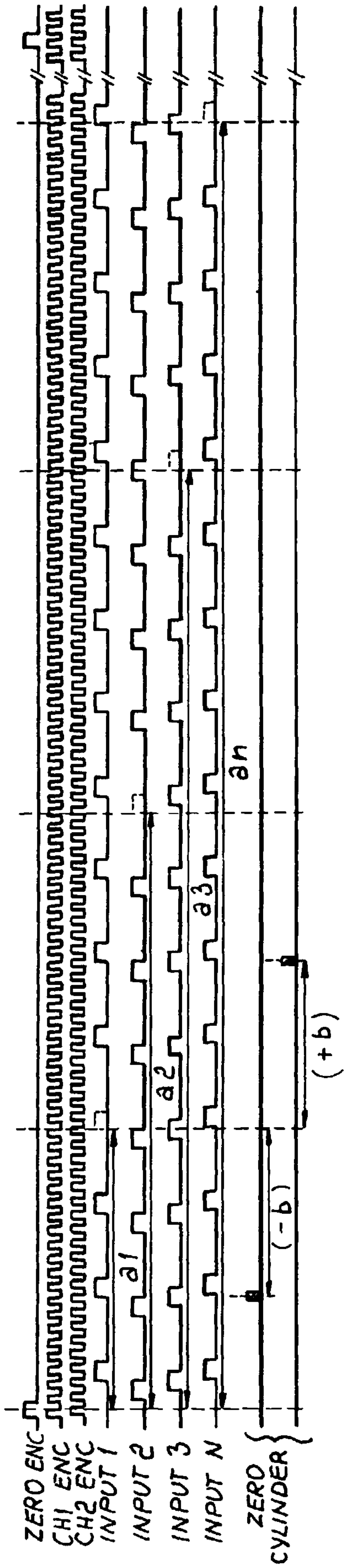
ZERO ENC
CH1 ENC
CH2 ENC
INPUT 1
INPUT 2
INPUT 3
INPUT N
ZERO
CYLINDER
a1
a2
a3
an
(-b)
(+b)

Fig. 4