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Gottschall et al.

[11] **3,896,638**

[45] **July 29, 1975**

[54] **PROGRAMME CONTROL DEVICES**

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[52] **U.S. Cl.** .... **66/50 R;** 66/157; 250/219 DD

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

[58] **Field of Search** .... 66/50 R, 154 A, 157; 250/219 DD, 233, 210

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Primary Examiner—Wm. Carter Reynolds

[57] **ABSTRACT**

A programme control device for the working parts of a machine having operational sequences such as a knitting machine, comprising a store, means for reading out a new information word from the store for controlling the working parts in response to a reading clock signal, means for generating for each machine operation a different code signal, and means for generating a reading clock signal when the code signal coincides with a predetermined expected code signal.

19 Claims, 5 Drawing Figures

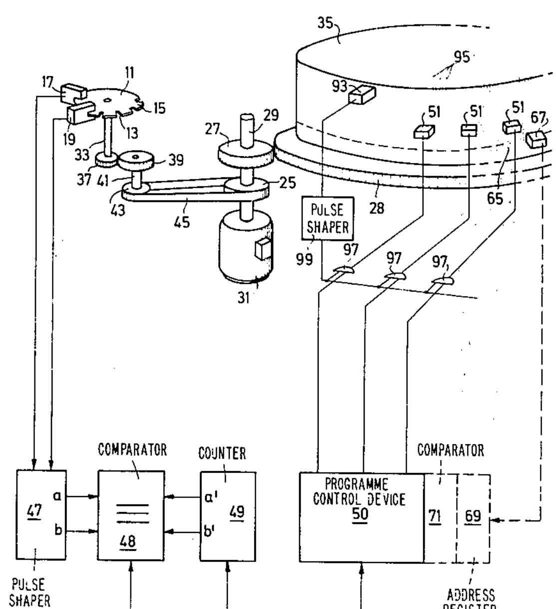


Fig. 1

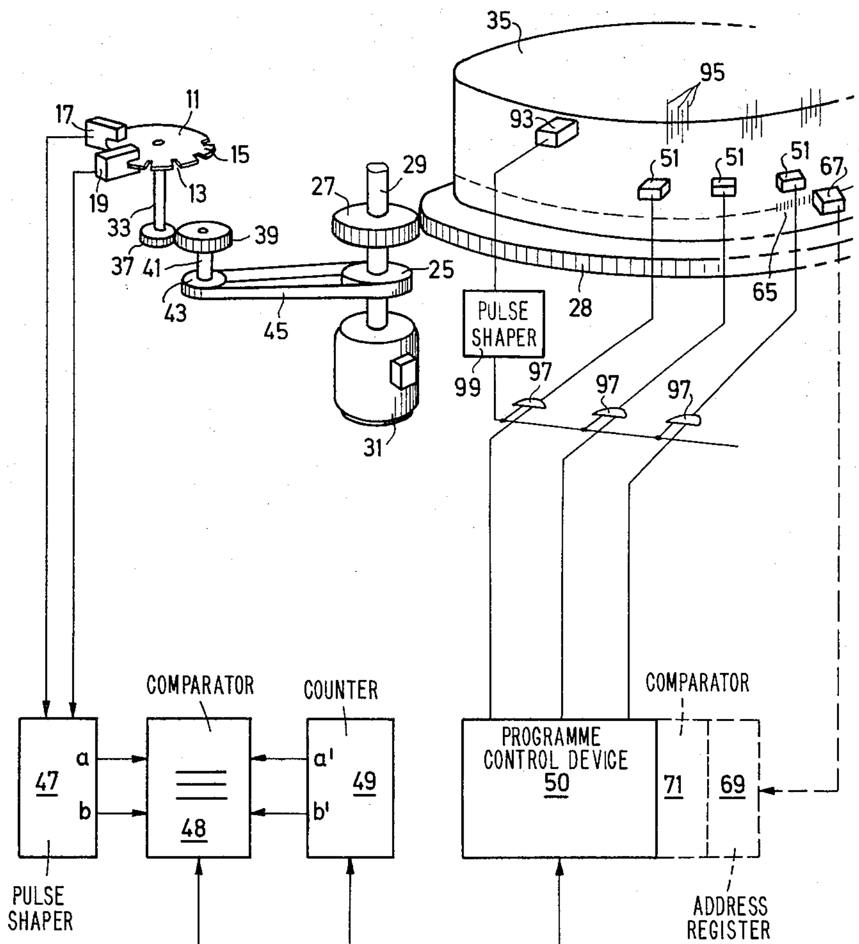

PULSE SHAPER
COMPARATOR
COUNTER
PROGRAMME CONTROL DEVICE
COMPARATOR
PULSE SHAPER
ADDRESS REGISTER

Fig. 2

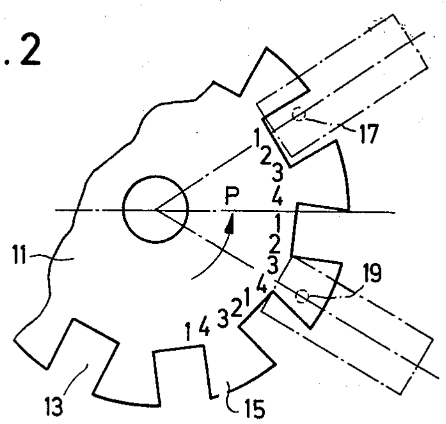


Fig. 3

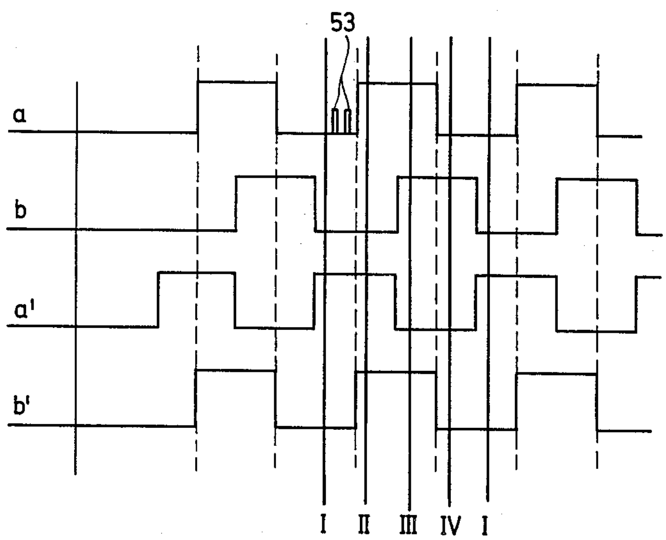


Fig. 4

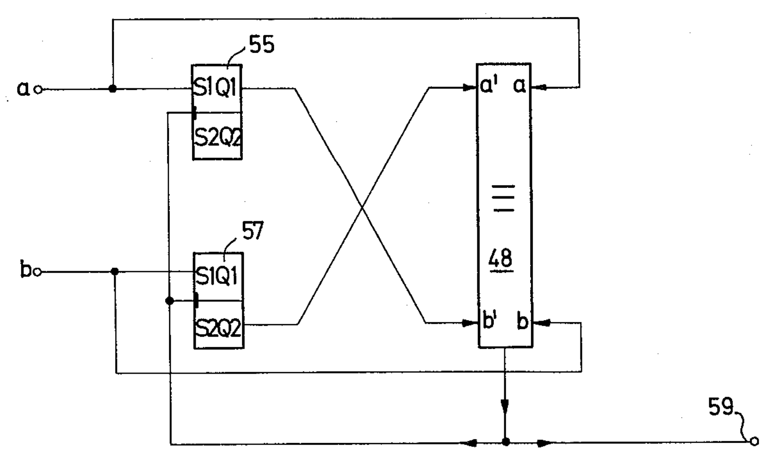
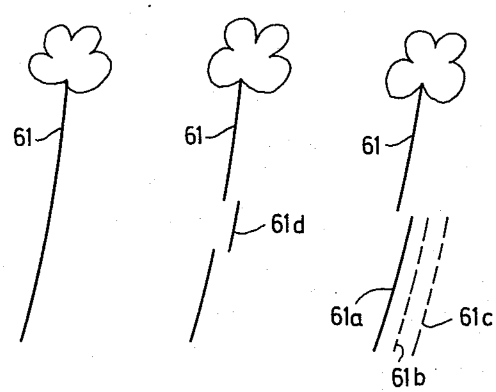


Fig. 5



PROGRAMME CONTROL DEVICES

In programme control devices for the electronic control of machines it is known to compare the machine operation pulses present in the form of short rectangular or needle pulses to the programme pulses developed by the programme control device in such a way that the grogramme pulses can be fed to the machine only at well defined moments in time (see British Patent No. 934,041).

If the programme control device contains as a store instead of a perforated tape, a film or the like, the drive of which is synchronized with the machine drive, for example, a core store or a magnetic tape operated by the start-stop method, the information being fed to the machine directly or via intermediate stores, then it is convenient to use the machine operation pulses mentioned above also for the internal clock of the programme control device and, in particular, as reading clock signals, with the aid of which the information required for the following machine operation is read out from the store and kept ready in its output register (see British Patent No. 1,273,661). This applies also to the case where a perforated tape or film driven by a stepping motor is used as store (see British Patent No. 1,264,601), because the film has to be advanced by one step for every machine operation and the pulses fed to the stepping motor correspond to the reading clock pulses.

The use of the machine clock pulses for reading out from the store may have disadvantageous consequences. Due to interference in the generator generating the machine clock pulses or due to external interference which take effect in the comparatively long transmission lines from the generator to the store, machine operation pulses may be simulated which lead to a change of the information word in the output register of the store or to a premature advance of the control film, although the machine operation which would logically follow is not yet reached or completed. If prolonged sequences of interfering signals occur, this results in substantial deviations from the desired programme sequence without the possibility of correcting these deviations or transforming them into a temporary disturbance.

This disadvantage makes itself felt particularly in the electronic control of machines which have to carry out a very great number of operative steps in order to produce an article. If, for example, the machine operation signals in the control of knitting machines are generated by electro-magnetic scanning of the knitting needles or of the bars present between them, and if a knitting needle or a bar is arrested in the immediate area of the scanning organ when the knitting machine is stopped, or if the scanned part of the knitting machine carries out slight pendulum movements while it is running out, then the machine operations simulated by the scanning organ as a result lead to permanent shifts of the pattern in the whole of the subsequent knitted fabric.

The invention is therefore based on the task of providing a device in which this disadvantage is removed and, in particular, permanent deviations from the programme sequence or permanent shifts of the pattern can be obviated, or the shifts of patterns caused by interferring signals can be restricted to a few machine operations.

According to the invention there is provided a programme control device for the working parts of a machine, comprising a store, means for reading out a new information word from the store for controlling the working parts in response to a reading clock signal, means for generating for each machine operation a different code signal, and means for generating a reading clock signal when the code signal coincides with a predetermined expected code signal.

In the case of machines operating periodically, each sequence of machine operations may correspond to a full period, e.g. a revolution of the needle cylinder of a circular knitting machine, or to a fraction of a full period, e.g. four subsequent machine operations.

For the derivation of the code signals there are preferably used devices which are provided with markings and which can be scanned in synchronism with the machine operation and for this purpose, for example, can be moved past stationary scanning devices. To produce four different markings, it suffices to scan a number of markings with the aid of two staggered scanning devices in such a way that the two resultant scanned signals are in phase quadrature. (See co-pending application No. 143,135 filed May 13, 1971 of Gottschall et al, now abandoned.

The expected code signals can be formed, for example, by address signals which are permanently allocated to the information words stored in the store, or by modifications of the code signal generated during the preceding machine operation.

In a preferred embodiment of the invention, not every interfering pulse is capable of leading to a change of the information at the output of the store; this can only be brought about by an interfering pulse which has a shape corresponding to the expected code signal. Also, even in the case where an interfering signal has caused a disturbance in the normal programme sequence, this disturbance can be corrected by a suitable variation of the expected code signal in the following machine operations.

The invention will now be described in more detail, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 diagrammatically illustrates one embodiment of the invention, and shows in broken lines a possible modification thereof.

FIG. 2 illustrates a detail of the device required for generating the code signals in the embodiment of FIG. 1.

FIG. 3 diagrammatically illustrates the phase positions of the code signals and of the expected code signals in the device of FIG. 1.

FIG. 4 illustrates a detail of one embodiment of FIG. 1.

FIG. 5 diagrammatically illustrates the advantages of the programme control device embodying the invention.

For generating code signals, there is provided in FIG. 1 a light barrier comprising a rotary disc **11** with markings in the shape of uniformly spaced slots **13** and bars **15** on its edge. The slots **13** and bars **15** are scanned by two scanning devices **17, 19** which are arranged side by side and each of which consists, for example, of a light source and a photocell the light source and the photocell being arranged on different sides of the disc **11**. The scanning devices **17, 19** are mounted on a stationary plate (not shown) and are adjustable.

The disc **11** is fixed to a rotary shaft **33** which is mounted in a stationary part of a circular knitting machine and has on its lower part a gear wheel **37** which engages with a gear wheel **39** mounted on a shaft **41** which is likewise pivoted in a stationary part of the machine and carries a further gear wheel **43**. This gear wheel **43** is driven by a motor **31** via a backlash-free chain drive **45** and a further gear wheel **25** situated on a driving shaft **29**.

Via a further gear wheel **27** on the driving shaft **29**, the motor **31** also drives a gear wheel **28** fixed to the needle cylinder **35** of a circular knitting machine. Due to these driving connections, the disc **11** and the needle cylinder **35** are rotated in synchronism with each other. Instead of the gear wheels **37, 39, 43, 25** and **27**, there may also be used rolls, and the chain drive **45** may be replaced with a belt transmission provided it permits of a non-slip drive.

A pulse shaper **47** for generating uniform rectangular pulses is connected to the outlets of the scanning devices **17, 19**.

The distance between the scanning devices **17, 19** is illustrated in FIG. **2**. It is assumed that the slots **13** and bars **15** on the edge of the disc **11** have approximately the same width in the sense of rotation of the disc **11**, and that each slot **13** and each bar **15** is subdivided into two sections which have approximately the same width in the sense of rotation, so that the slots **13** consist of slot sections **1, 2** and the bars **15** consist of bar sections **3, 4** and the sections **1, 2, 3** and **4** are situated side by side in the same order. On this assumption, the scanning devices **17, 19** are arranged above the disc **11** in such a way that, with the disc **11** in the angular position shown in FIG. **2**, the scanning device **17** scans the section **1** of one slot while the other scanning device **19** simultaneously scans the section **4** of a bar. When the disc **11** rotates in the direction of the arrow P, the outlets of the pulse shaper **47** therefore give off pulses *a* and *b* (FIG. 3) the widths of which correspond to the width of a slot **13**, whereas the intervals between two pulses have the width of a bar **15**.

As can be seen in FIG. 3 the pulses *a* and *b* are moreover offset in time by half a pulse width. The values of the pulses *a* and *b* appearing at the outlet of the pulse shaper **47** form at any moment in time a so-called code signal.

The outlets of the pulse shaper **47** are connected to the two inlets of a comparator **48**. Two further inlets of the comparator **48** are connected with the two outlets of a counter **49** supplying a so-called expected code signal *a'*, *b'* and having as many counting states as there are possible code signals. When the code signal *a*, *b* supplied by the pulse shaper **47** coincides with the expected code signal *a'*, *b'* supplied by the counter **49**, the comparator gives off an output signal which is fed, on the one hand, to the clock inlet of the counter **49**, and, on the other hand, as a reading clock signal to a programme control device **50**.

The programme control device **50** has a plurality of outlets which are connected via AND gates **97** to the working parts of the machine to be controlled. In FIG. **1** the working parts consist, for example, of the electromagnetic systems **51** of the circular knitting machine required for the selection of the needles, the knitting needles being indicated at the points **95** of the needle cylinder **35**. The knitting needles or the bars between them are scanned by an electromagnetic generator **93** the output signals of which are transformed by a pulse shaper **99** into rectangular machine operation signals and applied to the second inlets of the AND gates **97**. In this way the information values which are statically kept ready, in the output register of the programme control device are fed to the electromagnetic systems **51** when, and only when, a machine operation pulse appears.

The programme control device **50** contains as its essential constituent any programme carrier or store. This may consist of a core store, of a plurality of shift register stages, or also of a store which has a magnetic disc, a magnetic drum, a magnetic or perforated tape or the like, and where the tapes, discs, drums etc. are not driven in mechanical synchronism with the needle cylinder or the working parts to be controlled. Where stores of this kind are used, it has hitherto been common practice to use the machine pulse generator **93** also as internal pulse generator for the reading clock of the programme control device, in order to ensure that after one information word has been digested, the information word required for the subsequent machine operation is read out from the store and kept ready for subsequent scanning by the next machine clock pulse. In this way, the machine operation controls not only the readingout process which as such is independent of the working rhythm of the machine, but it also ensures a phase-locking synchronous operation of the electromagnetic systems **51**.

In accordance with the invention, on the other hand, the signals derived from the comparator **48** are fed to the programme control device **50** as internal reading clock signals which are always generated when the comparator finds that the code signals *a*, *b* coming from the pulse shaper **47** coincide with the code signal *a'*, *b'* coming from the counter **49**. Preferably, the counter **49** is constructed in such a way that the expected code signals *a'* and *b'* appearing at its outlets always have the value which the code signals *a* and *b* will acquire during the following machine operation.

In binary rotation, the logical table for the signals *a* and *b* or *a'* and *b'* respectively, appears as follows; for example:

	a	b	a'	b'
I	0	0	1	0
II	1	0	1	1
III	1	1	0	1
IV	0	1	0	0

At the moment I the signals *a* and *b* both have the value 0 to which also the signals *a'* and *b'* of the counter **49** have been adjusted during the preceding machine operation. When these signals *a* and *b* appear, the comparator gives off an output signal which adjusts the counter **49** to the following step so that at its outlet the signal *a'* acquires the value 1 and the signal *b'* acquires the valve 0, as indicated in the above logical Table for the moment I. At the moment II the signals *a* and *b* then have the values 1 and 0, i.e. the values to which the counter **49** has been adjusted at the moment I. Consequently, the comparator **48** again gives off a pulse signal by which the counter is adjusted to its next step and the signals *a'* and *b'* both acquire the value 1. At the moment III the signals *a* and *b* then both have the value 1 so that the comparator **48** adjusts the counter **49** to the last step where the signal a' has the value 0 and the signal b' has the value 1 so that at the moment IV identity is again indicated and the counter **49** is readjusted to its first step (a' and b' both being equal to 0). In the absence of interference, the expected code signal therefore corresponds at any moment to the code signal generated during the following machine operation.

The values for the signals a and b and, respectively, a' and b' and the moments I to IV corresponding to the logical Table are diagrammatically illustrated in FIG. **3.** Be it assumed, for example, that between the moments I and II, i.e. at a time when the signals a and b both should still have the value 0, positive interfering signals **53** (FIG. **3**) in the line carrying the signal a already simulate the state which should occur only at the moment II. In this case the counter **49** is prematurely brought into the state which it should acquire only at the moment II and where the signals a' and b' both have the value 1. When the signals a and b (1 and 0, respectively) intended for the moment II now appear at this same moment, the comparator is unable to indicate identity and, consequently, cannot give off an output signal so that the counter **49** is not readjusted again at this moment but remains in the state where a' and b' both are equal to 1. Only in the third clock step, when a and b actually have the value 1, the comparator generates a further signal which advances the counter **49** so that the shift of the pattern is corrected. If, on the other hand, negative interfering signals are generated in the line carrying the signal a at the moment indicated in FIG. **3,** then these have no effect at all, because they lead to a code signal which does not correspond to the expected code signal and therefore does not generate a reading clock signal.

Since the signals generated by the comparator are also fed to the programme control device **50** as reading clock pulses, the following method of operation results: Any interference pulses appearing in any line transmitting the signals a or b from the machine to the comparator **48** lead only under certain conditions to an advance of the counter **49** or to a premature advance of the programme control device to the following information word. If, however, this case arises and no further interfering signals are generated, then the disturbance is removed in the next machine operation but one, because one machine operation does not generate a reading clock signal and, consequently, the counter **49** is not advanced.

FIG. **4** illustrates a simple circuit for the counter **49,** in which the expected code signals a', b' are derived from the code signals a, b. The signals a and b are conducted directly to one pair of inputs of the comparator **48,** on the one hand, and to the inputs S1 of two flip-flops **55** and **57,** on the other hand. The outlet Q1 of the flip-flop **55** is connected to the input of the comparator **48** provided for the signal b', whereas the input allocated to the signal a' is connected to the outlet Q2 of the flip-flop **57.** The outlet of the comparator **48** is moreover connected to the clock inputs of the flip-flops **55** and **57** and to an outlet terminal **59** via which the reading pulse of the programme control device is supplied.

Due to the circuit illustrated in FIG. **4** and in accordance with the logical Table given above by way of example, the signal a is transformed into the identical signal b' and the signal b into the inverted signal a' after each comparison carried out by the comparator **48,** so that $a \equiv b'$ and $\bar{b} \equiv a'$.

The advantages of the device are indicated in FIG. **5** which shows a flower with a stem **61** forming part, for example, of a pattern produced by a programme-controlled circular knitting machine. When the machine clock pulses given off by the pulse shaper **99** (FIG. **1**) are fed to the programme control device as reading clock pulses, then the stem **61** is a continuous line if there are no interfering signals. If, however, one, two, three etc. interfering signals occur, a permanent shift of the pattern **61***a*, *b* or *c* results for the whole of the subsequent pattern. When the reading clock pulses according to the invention are used, one shift of the pattern **61***d* may, admittedly, likewise result, but this will virtually only have an effect over the length and width of one stitch wale formed during one machine stroke.

It will normally suffice to define four states of the working parts of the machine in accordance with the above logical Table, in order to reduce the shifts of the pattern **61***d* shown in FIG. **5** or to reverse them in one of the subsequent clock steps. In some cases, however, it may be necessary to form the code signals and the expected code signals from more than two signals a, b, a' and b' in order to be able to allocate different code signals to a sequence of more than four machine operations.

In cases where an extremely high absence of faults is desired, there is allocated to each clock step of the machine to be controlled or to each possible position of the working parts, a different code signal or a different address which must coincide with a corresponding address stored in the programme carrier, if the word required for a certain machine operation is to be conveyed to the output register of the programme control device.

In the case of a circular knitting machine, there may be allocated for this purpose on one part of the needle cylinder (FIG. **1**) to each individual knitting needle a different scannable marking **65** which is scanned by a scanning organ **67** and fed to an address register **69.** The address signal formed in this address register **69** from the markings **65** are then compared in the sense of the above description by means of a comparator **71** with the signals stored in the address register of the programme control device **50.** In this case, it is almost impossible that, due to undesired pendulum movements of the machine or to interfering signals, a position of the working parts of the machine is simulated which has actually not yet been reached.

It is possible to modify the embodiments described above. In particular, it is not necessary to generate the signal sequences a and b shown in FIG. **3** by means of a light barrier as in FIG. **1.** On the contrary, any pulse generators to which suitable markings have been allocated on the disc **11** or on another structural part synchronized with the machine, e.g. the needle cylinder **35,** are suitable for generating these signal sequences. For example, the embodiment shown in FIG. **1** could be modified by leaving out the light barrier and substituting two electromagnetic generators (such as **93**) which scan magnetic markings on the disc **11.** According to a further embodiment, it would also be possible to derive the two signals a and b from the same generator and subsequently to shift their phase in relation to each other. To generate the signals, holes may also be provided in the needle cylinder, as is already known for other purposes from British Patent No. 1,088,413; or several staggered rows of markings may be arranged on the disc **11**, which are scanned by non-staggered scanning devices. Finally, it is also possible to generate more than two signals *a* and *b*, in order to be able to allocate a specific coding to **8, 16** etc. machine positions; or to compare the code signals generated by means of the light barrier **11** to **19** with two control bits corresponding to the expected code signal *a'*, *b'* and allocated to each stored information word.

The reading clock signals are preferably shifted in phase in relation to the machine operation signals generated by the generator **93** in such a way that the new information words are read out a short time before the appearance of a machine operation signal, the period of time being determined by the maximum preparation or access time of the computer or store.

Finally, it is also possible to exclude mistakes which do not arise from the occurrence of an interfering signal but from the failing of a correctly generated machine operation or reading clock signal. This would have the result that all information words following the mistake would be read out late by one machine operation sequence, i.e. by **4, 8, 16** etc. operations and that permanent shifts of the pattern (to the left, instead of to the right in FIG. **5**) would consequently occur because the comparator **48, 71** only gives off reading clock pulses again when the code signals coincide with the expected code signals after one machine operation sequence.

In order to obviate mistakes of this kind, the comparator **48** can be constructed in such a way that, where the expected code signals lead the code signals in the way described above, it temporarily suppresses the reading clock signals, whereas in the case where the code signal leads the expected code signal, it generates an alarm signal which, for example, stops the machine. In this way the operator can manually supply the computer or store with clock signals while the machine is stopped, until the information word present below the reading head is again exactly coordinated with the subsequent machine operation and the shift of the pattern is removed.

What is claimed is:

1. A programme control device for the working parts of a periodically operated machine, said machine having machine operation sequences, each sequence having the same number of machine strokes, comprising in combination: a storage means for storing information for controlling the working parts; reading means for reading out and feeding information words from said storage device to the working parts; reading clock means for producing reading clock signals, said reading clock signals being fed to said reading means such that new information words are only fed to said working parts after feeding a reading clock signal to said reading means; means for generating for each machine stroke of said machine operation sequences a different code signal; and means for deriving different expected code signals from said code signals, said expected code signals having the same code as said code signals but being generated in an order prescribed by the function of said machine; said reading clock means including means for comparing each generated code signal with each generated expected code signal so that a reading clock signal and a new expected code signal are only generated

when said code signal corresponds to an expected code signal.

2. A device according to claim **1**, wherein said machine is a circular knitting machine having a rotatable needle cylinder and wherein each machine operation sequence corresponds to a full revolutioln of said needle cylinder.

3. A device according to claim **1**, wherein said machine is a circular knitting machine having a rotatable needle cylinder and wherein each machine operation sequence corresponds to a fraction of a full revolution of said needle cylinder.

4. A device according to claim **1** wherein each machine operation sequence comprises at least four machine strokes.

5. A device according to claim **1**, wherein said means for generating said code signals comprise a marking carrier means, a marking scanning means and means for scanning said markings in synchronism with said machine strokes.

6. A device according to claim **5** wherein said generating means includes a light barrier.

7. A device according to claim **1**, wherein said machine is a knitting machine having a needle cylinder with knitting needles; and wherein the working parts include actuating means for selecting knitting needles for knitting; and further comprising means for producing relative motion between said knitting needles and said actuating means; each machine stroke corresponding to the time necessary for the relative movement of a knitting needle past an actuating means.

8. A device according to claim **7**, wherein each machine operation sequence includes at least four successive machine strokes.

9. A device according to claim **7**, wherein said means for generating said code signals comprise markings movable with said needle cylinder and means for scanning said markings.

10. A device according to claim **9**, wherein said markings are provided on a separate structural part which is driven in synchronism with said needle cylinder.

11. A device according to claim **7**, wherein said code signal generating means includes a light barrier.

12. A device according to claim **11**, wherein said light barrier comprises a disc which is rotated in synchronism with said machine strokes and has alternating circumferential slots and bars, and staggered optical-electrical scanning means.

13. A device according to claim **12**, wherein said scanning means includes two scanning devices whose output signals are approximately in phase quadrature.

14. A programme control device for the working parts of a periodically operated machine, said machine having machine operation sequences, each sequence having the same number of machine strokes, comprising in combination: A storage means for storing information for controlling the working parts; reading means for reading out and feeding information words from said storage device to the working parts; reading clock means for producing reading clock signals, said signals being fed to said reading means such that new information words are only fed to said working parts after feeding a reading clock signal to said reading means; means for generating for each machine stroke of said machine operation sequences a different code signal; and means for deriving different expected code signals from said code signals, said expected code signals having the same code as said code signals but being generated in an order prescribed by the function of said machine; said reading clock means including means for comparing each generated code signal and each generated expected code signal such that a reading clock signal is only generated when said code signal corresponds to said expected code signal and said means for comparing including a comparator to the inputs of which the code signals and the expected code signals are applied, and the output signals of which constitute the reading clock signals.

15. A device according to claim **14,** wherein said means for deriving said different expected code signals are controlled by the output signals of said comparing means.

16. A device according to claim **1** wherein said expected code signals are stored in a counter which is controlled by the output signals of said comparator and has as many counting stages as there are code signals.

17. A device according to claim **14,** wherein one part of the expected code signal is obtained by inversion of one part of said code signal, and the other part of the expected code signal corresponds to the other part of the code signal.

18. A device according to claim **14,** wherein said comparator includes two flipflops, the code signals being applied to one pair of inputs of said comparator and to the inputs of said two flipflops, the outputs of which are connected crosswise with the other inputs of the comparator, an inversion of the input signal being carried out at the input of one flipflop, and the output of the comparator being connected to the clock inputs of the two flipflops.

19. A programme control device for the working parts of a periodically operated machine, said machine having machine operation sequences, each sequence having the same number of machine strokes, comprising in combination: a storage means for storing information for controlling the working parts; reading means for reading out and feeding information words from said storage device to the working parts; means for generating for each machine stroke of said machine operation sequences a different code signal, said code signal generating means including scanning means for scanning markings moving past said scanning means in correspondence with the operation of said working parts; means for deriving different expected code signals from said code signals, said expected code signals having the same code as said code signals but being generated in an order prescribed by the function of said machine, and each information word stored in said storing means being identified by a predetermined expected code signal; reading clock means for producing reading clock signals, said reading clock signals being fed to said reading means such that new information words are only fed to said working parts after feeding a reading clock signal to said reading means, said reading clock means including comparator means for comparing each generated code signal and each generated expected code signal such that a reading clock signal and a new expected code signal are only generated when said code signal corresponds to said expected code signal.

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