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Sweeney et al. SUBSTITUTE FOR MISSING XR

[11] **3,771,325**

[45] **Nov. 13, 1973**

[54] ELEMENT POSITION DETECTOR SYSTEM

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[52] **U.S. Cl.** ..... **66/50 R**, 66/157, 250/222 R, 250/227, 340/213 Q, 340/267 R, 340/282

[51] **Int. Cl.** **D04b 15/78**, D04b 35/18

[58] **Field of Search** ..... 66/50 R, 50 B, 25, 66/50 A, 154 A, 1 R, 157; 250/222 R, 221, 227; 340/213 Q, 267 R, 282

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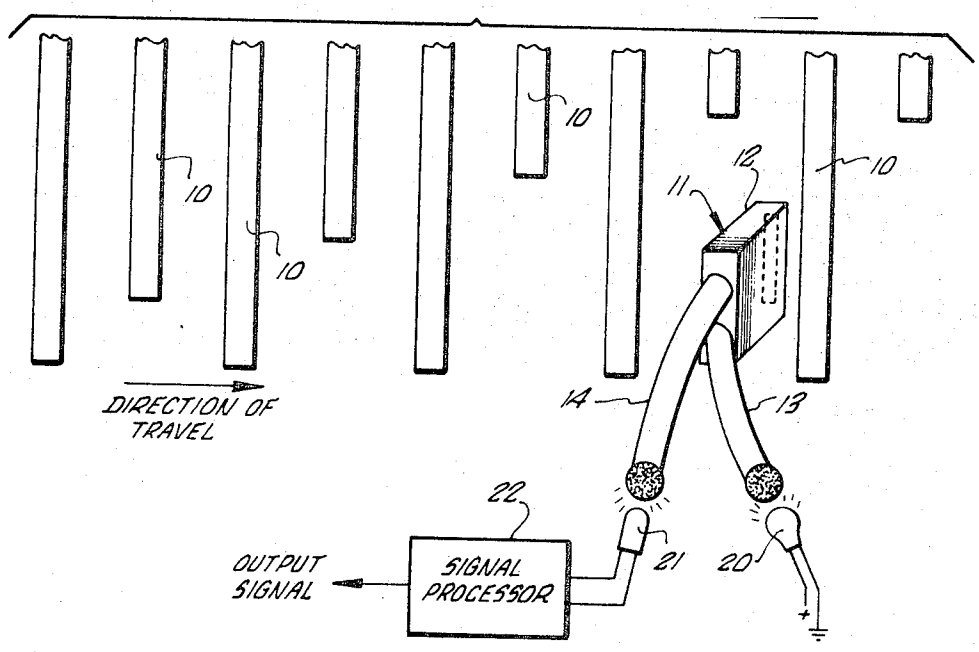
[57] **ABSTRACT**

An apparatus and detector system for sensing whether moving element of a series of elements are in a selected position which apparatus comprises sensor means mounted adjacent the path of travel of the series of elements, the sensor means being capable of projecting and receiving light, means for converting received, reflected light into a voltage pulse and means, including selected gating, for comparing the voltage pulse with other command or related derived signals.

2 Claims, 6 Drawing Figures



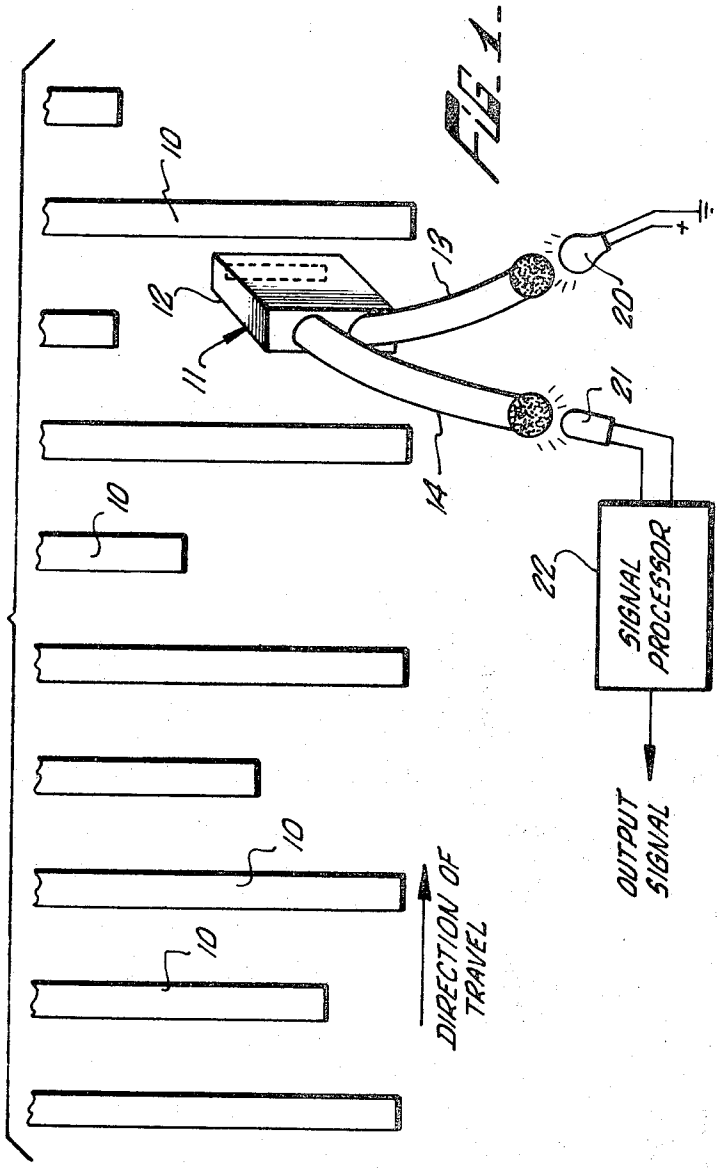


FIG. 1.

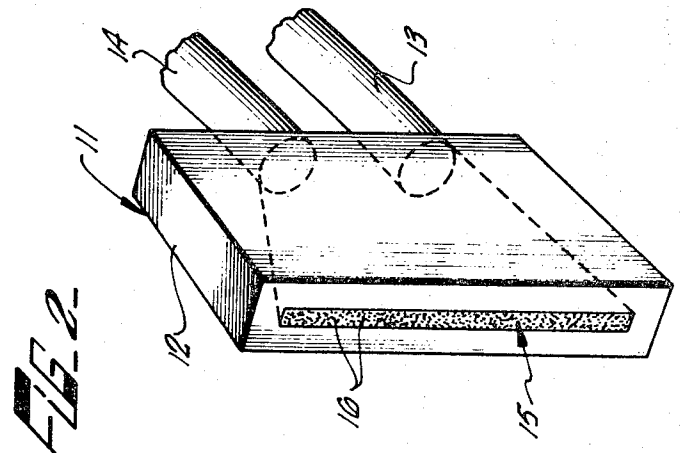


FIG. 2.

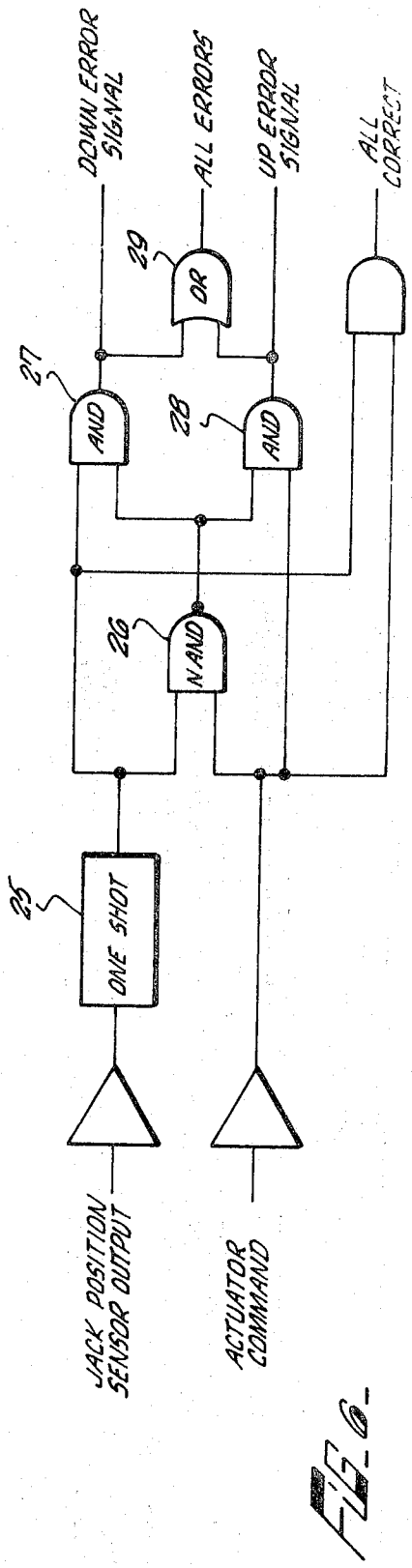


FIG. 6.

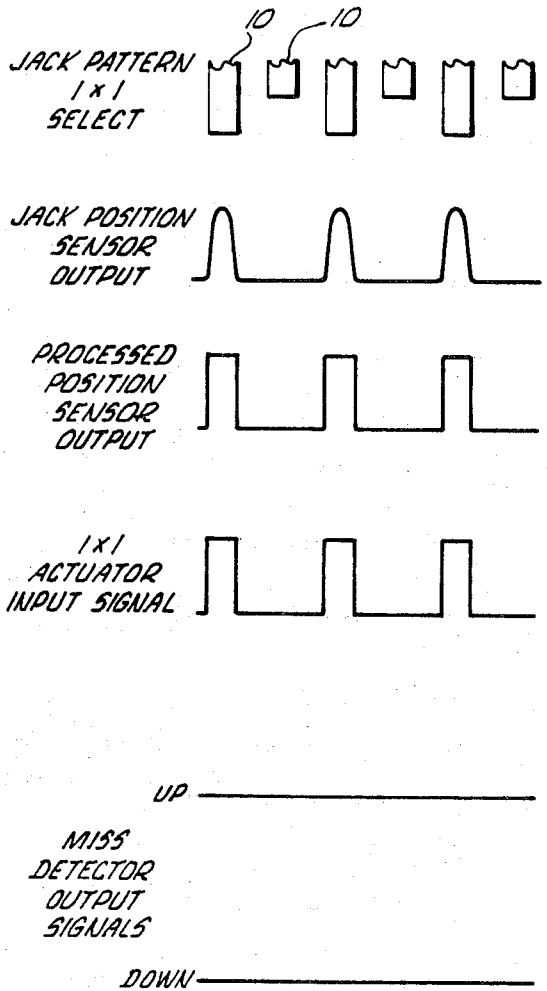


FIG. 3

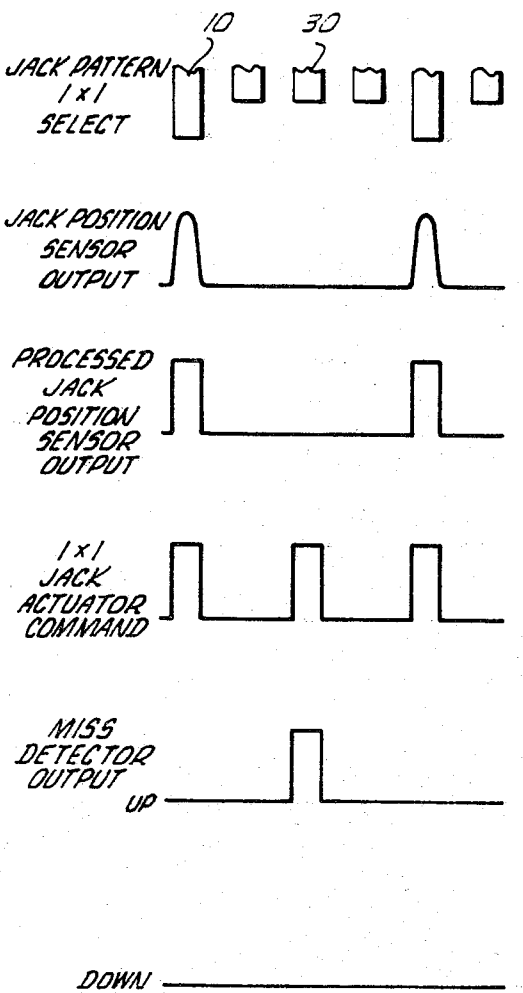


FIG. 4

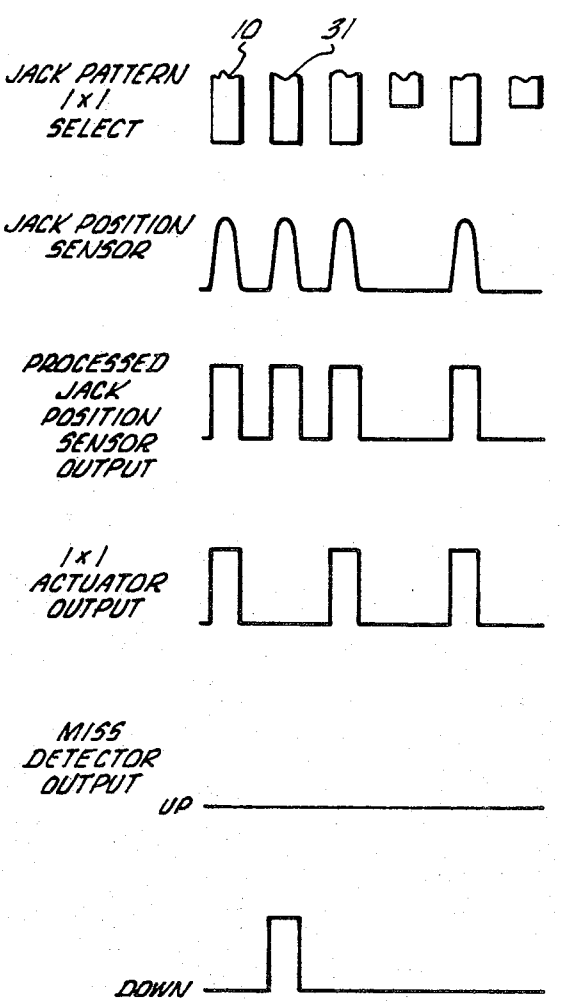


FIG. 6

ELEMENT POSITION DETECTOR SYSTEM

BACKGROUND OF THE INVENTION

While this invention relates broadly to a sensing apparatus or system, for detecting the relative positioning of individual elements of a series of elements, it will be discussed in connection with a specific environment. Specifically, in the operation of various types of rotary knitting machines, particularly those in which pattern changes are to be effected by other than mechanical alteration of the equipment, malfunctioning of pattern jacks many times occurs. These errors result primarily from variations in cylinder eccentricity, speed of cylinder rotation, and, where the electro-magnetic or similar actuating means is used, from variations in electromagnetic phasing or in permanent magnet field strength. Obviously, if these variations result in the production of imperfect fabric due to improper knitting, loss of both time and money results. It is therefore desirable for the machine user to have some instant or ready indication that there is malfunctioning in the pattern jack operation.

SUMMARY OF THE INVENTION

As noted earlier the detector system of this invention is particularly applicable for use in conjunction with circular knitting machines in which the pattern jacks can be automatically changed through the application of an appropriately applied magnetic field, although the concept is applicable with other types of equipment where similar sensing is of value and should, therefore, not be narrowly interpreted. The detector system utilizes a sensor element, capable of projecting and receiving light which is located on the knitting machine with one face operably adjacent the tricks of the needle cylinder so that light projected from the emitter and receptor face will strike the edges of the pattern jacks as they move past the sensing site. At least a pair of light conducting fibre cables one of which transmits light from a suitable source to the emittor-receiver face of the element and the other of which is operably joined to a light receiving voltage generator. The signal derived from the voltage generator is appropriately shaped and amplified so that a usable signal can be fed to a comparator logic system. In the logic system the signal derived from the voltage generator is compared with the signal from the jack actuator command to determine the presence of any malfunctioning. The system also provides for comparison between the command output and other signals derived from the voltage generator output to determine what particular type of malfunctioning has occurred.

It is a principal object of this invention to provide a new sensor device for sensing the relative positioning of individual elements in a series of elements as they pass a sensing site.

Another object of this invention is to provide a sensor device for use in conjunction with electro-magnetically operated jack positioning devices on rotary knitting equipment.

It is an additional object of this invention to provide an improved sensing device in which light is reflected from the edges of the pattern jacks and the received reflected light is converted into a signal that can be used to determine the presence or absence of machine malfunctioning.

Another object of this invention is to provide an improved detector system which can determine whether a pattern jack has passed its operating stage in either a knit or a non-knit position erroneously.

Other objects and advantages of this invention will, in part, be obvious and in part explained by reference to the accompanying specification and drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view showing the general relationship between the edges of the pattern jacks, the light emitting and receiving sensor and associated reflected light receiving voltage generating means.

FIG. 2 is an enlarged perspective showing the general construction of the light emitting and receiving sensor of FIG. 1.

FIG. 3 is a schematic diagram illustrating the manner in which the output sensed from the moving elements can be compared with a command input signal.

FIG. 4 is a series of graphs showing the relationship between proper jack positioning and the various derived outputs on a 1×1 select jack pattern.

FIG. 5 is a schematic similar to that of FIG. 4 showing the signals derived when a jack passes the sensing site at an erroneous elevated level.

FIG. 6 is a schematic similar to that of FIG. 5 but showing the outputs derived when a jack passes the sensing site below the selected level.

It was ealier mentioned that the detector system of this invention is useful in determining the relative positioning of any sort of element moving past a detecting site. However, in outlining the invention, it will be described with particular application to a rotary knitting machine.

The type of knitting machine with which this invention is most applicable is one in which the pattern jacks can be automatically adjusted to either a position where it will cause the knitting needles to knit or not to knit. This is accomplished through the use of an electro-magnetic control system including an electromagnetically functioning jack actuator which is operated by a command system, specifically a computer input. Machines of this type generally comprise a large number of knitting stations or feeds, although it would also be applicable to relatively small diameter machines with a small number of yard feed stations. In the co-pending application of R. G. Wolfshagen, Ser. No. 135,319, filed Apr. 19, 1971, (docket 1676) there is described a complete jack actuator system as used on a machine having 48 feed stations and therefore 48 jack actuator arrays. In this sort of knitting machine the electromagnetic jack actuators are positioned reasonably critically with respect to the edges of the pattern jacks as they pass by a selecting site. If during the course of operation misalignment should occur it opens the possibility of jack actuation not occurring as it should in response to a command input. When this happens it is of course essential that the malfunctioning be located promptly and the cause for the malfunctioning appropriately corrected.

To describe the invention in greater detail, reference is made to FIG. 1 of the drawings where the numeral 10 illustrates diagrammatically the edges of pattern jacks as they would be in a 1×1 select position. That is at the given site only every other one of the needles will be caused to move to the knit position and the alternate needles will remain in the non-knit position. Situated

operably adjacent the edges of the pattern jacks **10** is a sensor **11** which comprises a head **12** and a pair of fibre optic cables **13** and **14** which are capable of transmitting or conducting light from and to the head **12.** On the side of the head **12** adjacent the edges of the pattern jacks **10** is an emitter-receiving face **15** where the ends of the light conducting fibres terminate. The ends of the fibres are best seen in FIG. **2** of the drawings and are indicated by the numeral **16.**

Also in FIG. **1** there is illustrated diagrammatically a light source **20** which is to supply light to the lowermost of the fibre optic cables **13** and conduct the light to the emittor-receiver face **15** of head **12.** Immediately and operably adjacent the other of the optic fibre cables (**14**) is a receiver **21** for the light which is being emitted from the cable **14.** This receiver **21** may appropriately be a photocell which will take the light being conducted to it and convert it into a voltage pulse. The photocell **21** is connected to a signal processor **22** which serves to sharpen and improve the nature of the voltage pulse received from photocell **21.** Signal processer **22** may advantageously be a saturating amplifier which will shape the analog signal and square it to deliver a cleaner signal. The signal processer **22** then delivers an output signal which is connected to additional apparatus.

The operation of that part of the sensor described thus far is as follows. Light from source **20** is displayed to the fibre cable **13** and this light is emitted from the face **15** of head **12,** so that it will strike any of the jacks **10** which are in the lowered or non-knit position, as viewed in FIG. **1.** When light strikes one of the pattern jacks, a certain percentage of it is reflected back and is transmitted through the fibres that are contained in the uppermost cable **14** to then activate the photocell **21.** The photocell **21** then delivers a voltage pulse to the signal processer for subsequent application. When there is no jack present opposite the emittor-receptor face of head **12** then insufficient light will be reflected back to activate the voltage generating photocell **21.** In the case of knitting equipment the light reflected from the emittor-receptor face can be adjusted to strike the needle or jack butts so that reflection from the needle cylinder is not a significant factor. The system can then differentiate between the presence or absence of any given jack (or other type of passing element) by means of determining whether or not light is being reflected back to result in the generation of a voltage pulse.

Since malfunctioning may occur by having a jack actuator in either an erroneous knit or an erroneous non-knit position, that is, in a raised or lowered position as shown in the drawings, it is obvious that means should be provided to determine the specific nature of the malfunctioning that is occurring. This is accomplished by means of the circuit illustrated in the diagram shown in FIG. **6** of the drawings. Here the output signal derived from signal processor **22** in FIG. **1** is fed into the jack position sensor output and then connected to a one-shot multivibrator **25** that will deliver a pulse of constant amplitude and length regardless of machine speed. The other input to the comparator system of FIG. **6** is the actuator command, which comes from the central command system that controls the actuation or pulsing of the individual jack actuator mechanisms at each yarn feed station.

The overall system then comprises first gating means **26** for receiving as input signals the actuator command signal and the output signal from the sensor means, that is, the signal derived from processor **22.** If a signal is received from the output sensor and the actuator command coincidentally, then no output signal will come from gating means **26** and proper operation of the apparatus will be indicated. Second gating means **27** receives the output signal from gate **26** and the actuator command signal to give a first error signal indicating that a jack has passed the sensor means **11** in an improper position. Specifically, it identifies the error as one where a jack is in the non-knit wrongly.

Third gating means **28** receives the output signal from gate **26** and the output signal from the command system to indicate that a jack has passed the sensor means **11** in the knit or uppermost position erroneously. The output of the gating elements **27** and **28** are indicated in FIG. **6** to deliver a down error signal and an up error signal, respectively. An additional gate **29** is provided which receives as input signals those derived from gate elements **27** and **28** and has been labelled as an OR gate **29.** As indicated, this gate will give a positive indiction of all errors that have occurred, whether up or down.

Describing the operation of the system of FIG. **6** slightly differently, the actuator command signal is fed into NAND gate **26** with the jack position sensor output so that no signal occurs at pulse coincidence but signals do occur for all other combinations. The output signal from NAND gate **26** is then forwarded to AND gate **27** with the jack position input pulse to yield a down error signal. The output signal from NAND gate **26** is also forwarded to AND gate **27** with the actuator command signal and from this is derived the up error signal. By forwarding the signals from AND gate **27** and **28** to OR gate **29** all errors are detected, as noted earlier.

The manner in which the pulses interact to deliver the indication of malfunction can best be described by referring to FIGS. **3, 4** and **5** of the drawings. Referring first to FIG. **3** there is shown a vertical series of five outputs which occur at various edges of the detecting operation. The uppermost of the six vertical elements present in FIG. **3** is representative of the positions the jacks should correctly assume in a **1×1** pattern select. In this case it can be seen that every other jack is in the down or non-knit position with alternating jacks being in the upper or knit position. When the jacks are in the non-knit lowered position the light being emitted and received through sensor head **12** will cause the photocell **21** to generate pulses which coincide with the passage of a lower jack past the detecting site. Again, as earlier described, the voltage pulse coming from the photocell **21** goes through signal processor **22** and is processed to deliver an improved signal. The fourth vertical line from the top of the vertical series of curves represents the input derived from the actuator command or input signal system. It can be seen that the pulses received, as generated by photocell **21,** coincide with the clocking pulses received from the command system. When this occurs the lower two lines indicate that there are no detector output signals that would indicate any sort of machine malfunction. Comparing the curves of FIG. **3** with those of FIG. **4** it will be noted that the jack numbered "**30**" is in a raised position, whereas to be properly located it should be in a lower position. This, of course, results in the absence of a pulse from the jack position sensor output while the

jack actuator command as indicated with a pulse should be present. Operating through the system of FIG. 6 then, the inputs would result in NAND gate 26 and AND gate 28 combining to produce an up error signal.

Conversely the curves of FIG. 5 demonstrate what the condition of the system is when a jack 31 is in a lower or down position erroneously. Here an extra pulse is produced by the jack position sensor while one is not called for the command system. When this occurs, NAND gate 26 and AND gate 27 should deliver an indication of a down error.

This detector is far less sensitive to cylinder eccentricity and cylinder to detector spacing than the conventional magnetic sensors which are adversely affected by cylinder velocity and jack to sensor distance and the presence of magnetic fields.

Although the present invention has been described in connection with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and the appended claims.

We claim:

1. A detector system for use with a circular knitting machine on which the pattern jacks carried within the tricks of the needle cylinder are selected by electronically regulated jack actuators controlled by an actuator command system to be either raised to a knit position by jack raising cams or left in a lower non-knit position, as desired, said detector system comprising:

sensor means for positioning operably adjacent the needle cylinder for projecting light against the edges of jacks in the non-knit position and for collecting a portion of the light reflected by the edges; and

means associated with said sensor means to generate a voltage output signal indicative of the passage of a jack in the non-knit position past said sensor means.

2. A detector system as described in claim 1 wherein said sensor means comprises at least two light conducting fibre cables terminating in an emitter and receptor face for positioning adjacent the edges of said jacks, one of said cables being operably connected to a source of light and the other of said cables being operably joined to a light responsive voltage generator.

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