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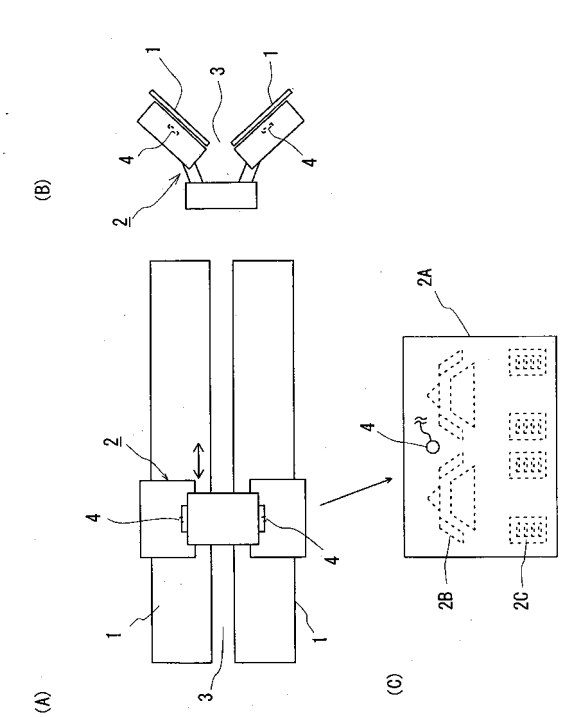
(54) WEFT KNITTING MACHINE, AND METHOD FOR DETECTING ABNORMAL VIBRATIONS IN THE WEFT KNITTING MACHINE

(57) To provide a flat knitting machine capable of detecting, at high sensitivity, the abnormal vibration involved in the abnormal contact of the carriage and the knitting needle, and a method of detecting abnormal vibration. The flat knitting machine includes a needle bed 1 in which a plurality of knitting needles is arranged in parallel, and a carriage 2 for moving the knitting needles forward and backward by reciprocating on the needle bed 1. The carriage 2 includes vibration detection means (vibration sensor 4), which vibration detection means detects vibration that occurs in a direction intersecting a traveling direction of the carriage 2. Error judgment means determines presence and absence of abnormal vibration by abnormal contact of the carriage 2 and the knitting needle based on such a detection result. The abnormal vibration can be detected distinguished from the vibration involved in the normal knitting even if the traveling speed of the carriage 2 is high.

Fig. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a flat knitting machine, and a method of detecting abnormal vibration in a flat knitting machine.

BACKGROUND ART

[0002] A flat knitting machine including a needle bed in which a plurality of knitting needles is arranged in parallel, and a carriage for moving the knitting needles forward and backward by reciprocating on the needle bed is conventionally known. The knitting needle includes a needle main body having a hook at a distal end, a needle jack, a select jack, and a selector, and each of such component members are sequentially engaged to each other and accommodated in a needle groove of the needle bed. The needle jack, the select jack, and the selector include a butt that projects out from the needle groove. Meanwhile, the carriage includes a knitting cam that engages each butt of the needle jack and the select jack, and a needle selecting cam that engages the butt of the selector. When the carriage is reciprocated on the needle bed, each butt is guided by the cams to slidably move the knitting needles in the needle groove thereby knitting a knitting fabric.

[0003] With such a flat knitting machine, a great force acts on each butt of the knitting needle in time of knitting since a traveling direction of the carriage and the forward/backward direction of the knitting needles are perpendicular. In particular, an operation load of the knitting needle may become large and the butt of the knitting needle may break when advancing the hook towards a needle bed gap side of the needle bed while leaving the stitches at needle stems, or when pulling a knitting yarn hooked at the hook in the needle bed gap to the side opposite to the needle bed gap by the knitting needle. Furthermore, the butt may similarly break when dust and the like accumulates in the needle groove. If knitting is continued with the butt broken, the broken fragments and the like may enter the knitting (needle selecting) cam or the needle groove and come into contact with other knitting needles thereby causing secondary damage of the flat knitting machine. The abnormal vibration involved in the abnormal contact of the carriage and the knitting needle such as breakage of the butt thus needs to be detected with a sensor, and the knitting operation needs to be immediately stopped.

[0004] The techniques described in Patent Documents 1 and 2 are known for the technique of detecting abnormal vibration described above.

[0005] The technique according to Patent Document 1 arranges a vibration sensor in a carriage, and detects the abnormal vibration that occurs in the traveling direction of the carriage with the sensor.

[0006] The technique according to Patent Document 2 attaches a plurality of vibration sensors 4 with an interval to a back surface of a needle bed 1 with a magnet, and detects the abnormal vibration that occurs in the traveling direction of the carriage 2 with the sensors 4 (Fig. 7).

[0007] In either case, in the vibrations that occur in the traveling direction of the carriage (lateral vibrations), the abnormal lateral vibration exceeding the lateral vibration involved in a normal knitting operation is detected.

[0008]

Patent Document 1: Japanese Laid-Open Utility Model Publication No. 54-139750

Patent Document 2: Japanese Laid-Open Utility Model Publication No. 56-146793

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0009] The above-described conventional techniques achieve a certain effect in detecting the abnormal vibration, but the detection of abnormal vibration may not be sufficient if the knitting speed (traveling speed of the carriage) is increased.

[0010] In other words, the above-described techniques are techniques for detecting all lateral vibrations, and the lateral vibration involved in the normal knitting becomes greater as the knitting speed becomes higher. As a result, the difference between the abnormal lateral vibration involved in the abnormal contact of the carriage and the knitting needle, and the lateral vibration involved in the normal knitting becomes small, and the abnormal vibration may become difficult to detect at high sensitivity while distinguishing such lateral vibrations.

[0011] In view of the above situations, it is an object of the present invention to provide a flat knitting machine capable of detecting, at high sensitivity, the abnormal vibration involved in the abnormal contact of the carriage and the knitting needle in distinction from the vibration involved in the normal knitting.

[0012] It is another object of the present invention to provide a method of detecting abnormal vibration in the flat knitting machine capable of detecting the abnormal vibration at high sensitivity.

MEANS FOR SOLVING THE PROBLEMS

[0013] The present inventors conducted various reviews on the detection of abnormal vibration involved in the abnormal contact of the carriage and the knitting needle, and came to complete the present invention with the finding that the vibration (longitudinal vibration) that occurs in the direction intersecting the traveling direction of the carriage is easier to detect in the abnormal vibration than the vibration that occurs in the traveling direction of the carriage.

[0014] The flat knitting machine of the present inven-

tion includes a needle bed in which a plurality of knitting needles is arranged in parallel, and a carriage for moving the knitting needles forward and backward by reciprocating on the needle bed. The flat knitting machine has a feature in including vibration detection means and error judgment means. The vibration detection means is arranged in the carriage, and detects vibration that occurs in a direction intersecting a traveling direction of the carriage. The error judgment means determines presence of abnormal vibration by abnormal contact of the carriage and the knitting needle based on a detection result of the vibration detection means.

[0015] In the flat knitting machine of the present invention, the error judgment means preferably determines the presence of the abnormal vibration according to whether or not the detection result of the vibration detection means is greater than or equal to a predetermined threshold value. In this case, the threshold value is suitably set so as to become greater the faster the traveling speed of the carriage.

[0016] Furthermore, the flat knitting machine of the present invention also preferably includes detection control means. The detection control means extracts a non-detection zone in which a predetermined vibration occurs in the direction intersecting the traveling direction of the carriage by a normal knitting operation from knitting data, and disables the detection of the vibration by the vibration detection means while the carriage is in the non-detection zone.

[0017] Meanwhile, a method of detecting an abnormal vibration in a flat knitting machine of the present invention relates to a method of detecting an abnormal vibration involved in an abnormal contact of a carriage and a knitting needle when knitting a knitted fabric with a flat knitting machine including a needle bed in which a plurality of knitting needles is arranged in parallel, and a carriage for moving the knitting needles forward and backward by reciprocating on the needle bed. The detection method includes the steps of: detecting vibration that occurs in a direction intersecting a traveling direction of the carriage; determining presence of abnormal vibration by abnormal contact of the carriage and the knitting needle based on a detection result of the vibration; and commanding stop of the carriage by the detection of the abnormal vibration.

EFFECTS OF THE INVENTION

[0018] According to the flat knitting machine of the present invention, the detection of the longitudinal vibration is carried out by the vibration detection means. The longitudinal vibration involved in the normal knitting operation is small compared to the lateral vibration, and is less likely to become large compared to the lateral vibration even if the traveling speed of the carriage becomes high. The abnormal longitudinal vibration involved in the abnormal contact of the carriage and the knitting needle, on the other hand, has a sufficient magnitude compared to the longitudinal vibration involved in the normal knitting operation. Thus, the abnormal longitudinal vibration can be detected clearly distinguished from the longitudinal vibration involved in the normal knitting operation by detecting the longitudinal vibration by the vibration detection means.

[0019] Many vibration detection means do not need to be arranged in the needle bed by arranging the vibration detection means in the carriage, and the vibration detection characteristics of the vibration detection means do not depend on the position on the needle bed where butt breakage occurred.

[0020] Furthermore, the detection overlooked and the false detection of the abnormal vibration can be effectively avoided by having the threshold value used for the determination in the error judgment means greater the faster the traveling speed of the carriage. The magnitude of the longitudinal vibration involved in the normal knitting operation and the abnormal longitudinal vibration involved in the abnormal contact of the carriage and the knitting needle changes by the traveling speed of the carriage. Thus, the detection overlooked and the false detection of the abnormal vibration can be prevented by varying the threshold value used for the determination in the error judgment means in accordance with the traveling speed of the carriage.

[0021] The abnormal longitudinal vibration and the longitudinal vibration involved in the normal knitting operation can be more clearly distinguished by arranging the detection control means in the flat knitting machine of the present invention. For instance, the switching of the knitting cam and a projection and retraction of a yarn carrier catching pin from the carriage are normal operations involved in the knitting, but cause a relatively large vibration in a direction intersecting the traveling direction of the carriage. Thus, the period of performing the switching of the knitting cam and the projection and retraction operation of the yarn carrier catching pin is extracted as a non-detection zone from the knitting data by the detection control means, and the detection of the vibration by the vibration detection means during the period is disabled, whereby false detection as the abnormal vibration is not made even if the longitudinal vibration involved in the normal knitting is large.

[0022] According to the method of detecting an abnormal vibration in a flat knitting machine of the present invention, the detection of the abnormal longitudinal vibration is carried out similar to the flat knitting machine of the present invention. The detection of the abnormal longitudinal vibration is made at high sensitivity in distinction from the normal longitudinal vibration, and thus the knitting operation can be reliably stopped when the abnormal vibration involved in the abnormal contact of the carriage and the knitting needle occurred.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

Fig. 1 shows a flat knitting machine of the present invention according to a first embodiment, where (A) is a plan view of the flat knitting machine, (B) is a side view thereof, and (C) is an enlarged schematic view of a cam plate used in the flat knitting machine.

Fig. 2 is a functional block diagram of the flat knitting machine of the present invention according to the first embodiment.

Fig. 3 is a flowchart showing the procedures for detecting the abnormal vibration with the flat knitting machine of the present invention according to the first embodiment.

Fig. 4(A) is an explanatory view showing a signal waveform of a detected vibration of a comparative example, (B) is an explanatory view showing a signal waveform of a detected vibration of a reference example, and (C) is an explanatory view showing a signal waveform of a detected vibration of the first embodiment.

Fig. 5 is a functional block diagram of a flat knitting machine of the present invention according to a second embodiment.

Fig. 6 is a flowchart showing the procedures for detecting the abnormal vibration with the flat knitting machine of the present invention according to the second embodiment.

Fig. 7 shows an outline of a conventional flat knitting machine, where (A) is a plan view of the flat knitting machine, and (B) is a side view thereof.

DESCRIPTION OF SYMBOLS

[0024]

1	needle bed
2	carriage
2A	cam plate
2B	knitting cam
2C	needle selecting cam
3	needle bed gap
4	vibration sensor
5	filter means
6	error judgment means
7	detection control means
7A	non-detection zone extracting means
7B	disable determination means

DETAIL DESCRIPTION OF THE PREFERRED EMBODIMENT

[0025] Embodiments of the present invention will be hereinafter described with reference to the drawings.

<First Embodiment>

[0026] Fig. 1 schematically shows a needle bed 1 and a carriage 2 of a flat knitting machine of the present invention. A so-called two-bed flat knitting machine, that is, a flat knitting machine having a pair of needle beds 1 extending in a transverse direction and disposed opposite to each other in a cross direction will be described by way of example. The configurations of the needle bed 1 (knitting needle) and the carriage 2 are basically similar to the known configurations. That is, the needle bed 1 has a great number of knitting needles (not shown) arranged in parallel in the transverse direction and is accommodated in the needle groove. The carriage 2 has a structure in which a pair of cam plates 2A arranged to cover one part of each front and back needle bed 1 is coupled above a needle bed gap 3, and can reciprocate on the needle bed 1 in the transverse direction. The cam plate 2A includes a knitting cam 2B and a needle selecting cam 2C, where each cam 2B, 2C guides the butt of the knitting needle when the carriage 2 reciprocates to cause the knitting needle to move forward and backward along the needle groove.

[0027] Vibration detection means is arranged on one surface of the cam plate 2A, that is, the surface on the side opposite to the surface the knitting cam 2B and the like project out. A vibration sensor 4 that uses a piezoelectric element is suitably used for the vibration detection means. The attachment of the vibration sensor 4 to the cam plate 2A is preferably fixation with appropriate means such as screwing. The number of sensors is only few if the vibration sensor 4 is arranged at the carriage 2 compared to when the vibration sensor 4 is arranged at the needle bed 1, and the vibration detection characteristics of the vibration sensor 4 does not depend on the position of the carriage 2 on the needle bed 1. Furthermore, since the wiring of the vibration sensor 4 merely needs to be a small amount of wiring for the carriage, excellent workability is realized in time of assembling of the vibration sensor 4 and the wiring and in time of maintenance. The vibration can be detected with substantially similar magnitude even if one of the knitting (needle selecting) cam 2B (2C) of the cam plate 2A causes butt breakage by arranging the vibration sensor 4 between the plurality of knitting cams 2B in the cam plate 2A. In a two-cam machine in which a pair of knitting (needle selecting) cams 2B (2C) is arranged in parallel in the transverse direction as in the present example, one vibration sensor 4 merely needs to be arranged between the knitting cams 2B in each front and back cam plate 2A. In a so-called three-cam machine, two vibration sensors merely need be arranged between three knitting cams in each front and back cam plate. Needless to say, the attachment position and the number of vibration sensors 4 are not limited to the above configurations. One vibration sensor 4 each may be arranged in each front and back cam plate of the three-cam machine. The vibration sensor 4 normally has a flat shape and is attached

with the detection surface of the vibration sensor 4 parallel to the cam plate 2A, so that the vibration (orthogonal vibration) that occurs in a direction orthogonal to the traveling direction of the carriage 2 and orthogonal to the cam plate 2A can be detected with the vibration sensor 4. The vibration detected by the vibration sensor 4 is converted to a detection signal by the action of the piezoelectric element, and then outputted.

[0028] The processing means of the detection signal will be described below with reference to Fig. 2. Fig. 2 is a functional block diagram related to vibration detection in the flat knitting machine of the present invention.

[0029] As shown in Fig. 2, filter means 5 and error judgment means 6 are configured in a main body (not shown) of the flat knitting machine. The filter means 5 removes the component of high frequency of the detection signal. A low pass filter is suitably used for the filter means 5. The filter means 5 can remove the signal component of a resonance point (e.g., between 1 KHz and 2 KHz) of the vibration sensor 4, and effectively remove the signal component of the orthogonal vibration involved in the normal knitting operation. As a result of the review by the present inventors, it is found that the signal component of the orthogonal vibration involved in the normal knitting vibration is contained in great amount in a relatively high frequency band, and that the signal component of the orthogonal vibration in time of butt breakage can be sufficiently detected in a low frequency band. Thus, the signal component of the orthogonal vibration involved in the normal knitting operation can be effectively removed by removing the high frequency component from the detection signal by the filter means 5. The filter means 5 is obviously not essentially in the present invention.

[0030] The error judgment means 6 determines whether or not the abnormal orthogonal vibration involved in the abnormal contact of the carriage 2 and the knitting needle according to whether or not the signal component passed through the filter means 5 is greater than or equal to a predetermined threshold value.

[0031] In addition, although not shown, the flat knitting machine of the present invention includes a display panel for displaying the operation abnormality with the operation information, and a warning lamp for warning the worker when the abnormality vibration such as butt breakage is detected.

[0032] The procedures for detecting the abnormal vibration such as butt breakage with the above flat knitting machine will be described with reference to Fig. 3.

[0033] The signal component in which the high frequency component is removed by the filter means from the detection signal of the vibration sensor is acquired (step S1).

[0034] Whether or not the signal component is greater than or equal to a predetermined threshold value is then determined (step S2). The threshold value may be set by finding the signal value that occurs in the normal knitting operation from experience. Generally, the longitudinal vibration involved in the normal knitting operation and the abnormal longitudinal vibration involved in the abnormal contact of the carriage and the knitting needle become large when the traveling speed of the carriage becomes fast, and such longitudinal vibrations become small when the traveling speed of the carriage becomes slow. That is, if the threshold value is determined based on the longitudinal vibration involved in the normal knitting operation and the abnormal longitudinal vibration in time of high speed knitting, the abnormal longitudinal vibration in time of low speed knitting sometimes becomes smaller than the threshold value and the detection overlooked of the abnormal vibration may occur. If the threshold value is determined based on the longitudinal vibration involved in the normal knitting operation and the abnormal longitudinal vibration in time of low speed knitting, the longitudinal vibration involved in the normal knitting operation in time of high speed knitting sometimes becomes greater than the threshold value and the false detection of the abnormal vibration may occur. Thus, the detection overlooked and the false detection can be prevented by varying the threshold value used for the determination by the error judgment means in accordance with the traveling speed of the carriage. In particular, the traveling speed (knitting speed) of the carriage in each course of the knitted fabric can be extracted from the knitting data, and thus the threshold value is suitably changed according to the knitting speed extracted from the knitting data.

[0035] If the signal component is greater than or equal to the threshold value as a result of the determination, the warning signal is outputted (step S3). The warning signal is a signal for commanding at least the stop of the knitting operation (operation stop of the carriage). The lighting of the warning lamp, and the abnormal display to the display panel are preferably performed by the warning signal in accordance with the stop of the knitting operation.

[0036] If the signal component is smaller than the threshold value in step S2, the process again returns to step S1 and the procedures after the acquisition of the signal component are performed.

[0037] The principle in which the flat knitting machine effectively detects the abnormality vibration such as butt breakage will be described with reference to Fig. 4 in comparison with the comparative example/reference example. In each partial view of Fig. 4, the solid waveform schematically shows the detection signal of the vibration involved in the normal knitting operation, and the broken waveform schematically shows the detection signal of the abnormal vibration involved in butt breakage.

[0038] Comparative example (Fig. 4(A)): Three vibration sensors 4 are arranged at equal interval on the back surface of the needle bed 1, and the vibration (lateral vibration) in the traveling direction of the carriage is detected with each vibration sensor 4. The detection surface of the vibration sensor 4 is arranged perpendicular to the back surface of the needle bed 1 (correspond to Fig. 7 and prior art of Patent Document 2). In this case,

the vibration detection characteristics of each vibration sensor 4 depend on the position of the carriage. That is, the signal value of the lateral vibration involved in the normal knitting operation and the signal value of the abnormal vibration are greater the more the carriage is closer to the vibration sensor 4, and are the smallest when the carriage is at the intermediate of the vibration sensors 4. Thus, a difference D1 between the signal value in the case where the lateral vibration involved in the normal knitting operation is large and the signal value in the case where the abnormal vibration is small is very small, and the setting range of the threshold is greatly limited. In particular, the lateral vibration involved in the normal knitting operation becomes greater as the carriage travels at higher speed, and the setting range of the threshold inevitably becomes smaller. This easily leads to frequent false detection and oversight of the detection as a result.

[0039] Reference example (Fig. 4(B)): The detection surface of one vibration sensor is attached perpendicularly with respect to the cam plate of the carriage, and the vibration (lateral vibration) in the traveling direction of the carriage is detected. In this case, the signal value of the lateral vibration involved in the normal knitting operation is substantially a constant value irrespective of the position of the carriage. However, in such a case as well, a difference D2 between the signal value of the lateral vibration involved in the normal knitting operation and the signal value of the abnormal lateral vibration involved in butt breakage is small, and the setting range of the threshold value is not as improved compared to the comparative example.

[0040] First embodiment 1 (Fig. 4(C)): The detection surface of one vibration sensor is attached in parallel with respect to the cam plate of the carriage, and the vibration (orthogonal vibration) perpendicular to the traveling direction of the carriage and the cam plate is detected.

In this case, the signal value of the orthogonal vibration involved in the normal knitting operation is substantially constant irrespective of the position of the carriage, and is a signal value significantly smaller than the lateral vibration of the reference example. On the other hand, the signal value of the orthogonal vibration in time of butt breakage is significantly greater than the signal value of the orthogonal vibration involved in the normal knitting operation. Thus, a difference D3 between the signal value of the orthogonal vibration involved in the normal knitting operation and the signal value of the orthogonal vibration in time of butt breakage becomes a sufficiently large value. In the prior art, the vibration involved in the traveling of the carriage is mainly the lateral vibration as it is generated when the knitting (needle selecting) cam continuously hits the butt, and thus the vibration to detect (include vibration involved in the normal knitting and abnormal vibration) is obviously assumed as the lateral vibration. However, the abnormal vibration by the abnormal contact of the carriage and the knitting needle is found to be a magnitude that can be sufficiently detected even with the orthogonal vibration by the verification of the inventors of this time. In butt breakage, the butt curves when pressed by the knitting cam, so that the knitting cam rides on the curved butt, or the knitting cam rides on the remaining portion of the butt or the broken piece even after the butt breakage, and hence a relatively large orthogonal vibration is estimated to occur with the riding of the knitting cam. The signal value of the orthogonal vibration involved in the normal knitting operation is small compared to the change in the signal value of the lateral vibration even if the traveling speed of the carriage is raised. Thus, a wide setting range of the threshold value can be obtained in the example, and the abnormal vibration can be detected at high sensitivity.

<Second Embodiment>

[0041] An embodiment of detecting only the abnormal vibration even when a shocking and large orthogonal vibration occurs while being a vibration involved in the normal knitting operation will be described below with reference to Fig. 5. The present embodiment differs from the first embodiment only in that detection control means 7 is arranged, and other configurations are common with the first embodiment, and thus the differing point will be mainly described below.

[0042] The detection control means 7 of the present embodiment extracts a case in which a shocking and large orthogonal vibration occurs while being the vibration involved in the normal knitting operation as a non-detection zone, and disables the detection of the vibration by the vibration detection sensor 4 in the non-detection zone. Here, "disables the detection of the vibration" includes (1) a case where the vibration detection sensor 4 stops the operation and does not perform the vibration detection itself, (2) a case where the vibration detection is performed but the abnormality determination by the error judgment means 6 is not performed, and (3) a case where the vibration detection and the abnormality determination are performed but the abnormality determination result is not outputted. In summary, the stopping process and the like of the knitting operation merely need to be suppressed from being performed even if a large orthogonal vibration involved in the normal knitting operation occurs. In this case, the detection control means 7 includes non-detection zone extracting means 7A and disable determination means 7B.

[0043] The non-detection zone extracting means 7A extracts the non-detection zone from the knitting data. The knitting data is set in storage means of the flat knitting machine according to the knitting conditions such as the size, color, pattern, and knitting method of the knitted fabric. The operation procedures of the flat knitting machine necessary for knitting the knitted fabric such as, of course, the traveling/stopping of the carriage, and also the operation of the knitting (needle selecting) cam can be grasped from the knitting data. For instance, when switching the knitting cam or projecting and retracting the yarn carrier catching pin from the carriage at the outer

side of the knitting width, a relatively large orthogonal vibration generates at the carriage. In this case, false detection as the orthogonal vibration involved in the butt breakage might be made unless the detection of the orthogonal vibration involved in the switching of the knitting cam and the like is disabled. Thus, in the present embodiment, the non-detection zone extracting means 7A extracts the non-detection zone from the knitting data. In the non-detection zone extracting means 7A, the condition is set in advance in which an orthogonal vibration large enough to be falsely detected as the abnormal vibration exceeding the threshold value of the error judgment means 6 occurs, for example, when projection and retraction of a plurality of yarn carrier catching pins is simultaneously performed, and the non-detection zone is extracted depending on presence or absence of a zone that matches such a condition exists in the knitting data.

[0044] The disable determination means 7B determines whether or not the signal component obtained through the vibration sensor 4 and the filter means 5 is the signal component of the extracted non-detection zone. If the disable determination means 7B determines that the signal component is not the signal component of the extracted non-detection zone, the error judgment means 6 determines whether such a signal component is due to abnormal vibration.

[0045] The detection procedure of the abnormal vibration in the present embodiment will be described with reference to Fig. 6.

[0046] First, a signal component in which the high frequency component is removed by the filter means from the detection signal of the vibration sensor is acquired (step S11).

[0047] The detection control means determines whether or not the signal component is the signal of the non-detection zone (step S12). Step S12 and the next step S13 may be reversed. If determined as the signal of the non-detection zone as a result of the determination in step S12, the process again returns to step S11, and the procedures after the acquisition of the signal component are performed.

[0048] If determined as not the signal of the non-detection zone, the error judgment means determines whether or not the signal component is greater than or equal to a predetermined threshold value (step S13).

[0049] If the signal component is greater than or equal to the threshold value as a result of the determination, a warning signal is outputted (step S14). The aspect in that the stopping of the carriage, the lighting of the warning lamp, and the like are performed by the output of the warning signal is similar to the first embodiment.

[0050] On the other hand, if the signal component is smaller than the threshold value in step S13, the process again returns to step S11, and the procedures after the acquisition of the signal component are performed.

[0051] According to the present embodiment described above, the orthogonal vibration is not falsely detected as the abnormal vibration even if a large orthogonal vibration involved in the normal knitting operation occurs, in addition to the abnormal vibration detection of high sensitivity according to the first embodiment. In particular, according to the present embodiment, the large orthogonal vibration involved in the normal knitting operation will not be falsely detected as the abnormal vibration even if the carriage is positioned other than at the end of the needle bed. For instance, in the case of intarsia knitting, projection and retraction of the yarn carrier catching pin, and the like is sometimes performed even if the carriage is positioned on the inner side of the knitting width. A large orthogonal vibration occurs in this case as well, but false detection as the abnormal vibration will not be made since a period of performing the projection and retraction of the yarn carrier catching pin and the like is recognized as the non-detection zone from the knitting data.

[0052] The present invention is not limited to the above embodiments, and various modifications may be made. For instance, the present invention can be used for a four-bed flat knitting machine. The vibration detected with the vibration sensor may be the vibration in the direction non-perpendicularly intersecting the cam plate if not the vibration in the traveling direction of the carriage (direction along the cam plate).

INDUSTRIAL APPLICABILITY

[0053] The flat knitting machine and the method of detecting abnormal vibration in the flat knitting machine of the present invention can be suitably used in the flat knitting machine used to knit the tubular knitted fabric, and the like. In particular, the use as the flat knitting machine in which the traveling speed of the carriage is high speed is expected.

Claims

1. A flat knitting machine including a needle bed in which a plurality of knitting needles is arranged in parallel, and a carriage for moving the knitting needles forward and backward by reciprocating on the needle bed, the flat knitting machine comprising:

   vibration detection means, arranged in the carriage, for detecting vibration that occurs in a direction intersecting a traveling direction of the carriage; and
   error judgment means for determining presence of abnormal vibration by abnormal contact of the carriage and the knitting needle based on a detection result of the vibration detection means.

2. The flat knitting machine according to claim 1, wherein
   the error judgment means determines the presence of the abnormal vibration according to whether or

not the detection result of the vibration detection means is greater than or equal to a predetermined threshold value; and
the threshold value is set so as to become greater the faster the traveling speed of the carriage.

3. The flat knitting machine according to claim 1 or 2, further comprising:

detection control means; wherein
the detection control means extracts a non-detection zone in which a predetermined vibration occurs in the direction intersecting the traveling direction of the carriage in a normal knitting operation from knitting data, and disables the detection of the vibration by the vibration detection means while the carriage is in the non-detection zone.

4. A method of detecting an abnormal vibration in a flat knitting machine for detecting the abnormal vibration involved in an abnormal contact of a carriage and a knitting needle when knitting a knitted fabric with the flat knitting machine including a needle bed in which a plurality of knitting needles is arranged in parallel, and the carriage for moving the knitting needles forward and backward by reciprocating on the needle bed, the method comprising the steps of:

detecting vibration that occurs in a direction intersecting a traveling direction of the carriage;
determining presence of abnormal vibration by abnormal contact of the carriage and the knitting needle based on a detection result of the vibration; and
commanding stop of the carriage by the detection of the abnormal vibration.

Fig. 1

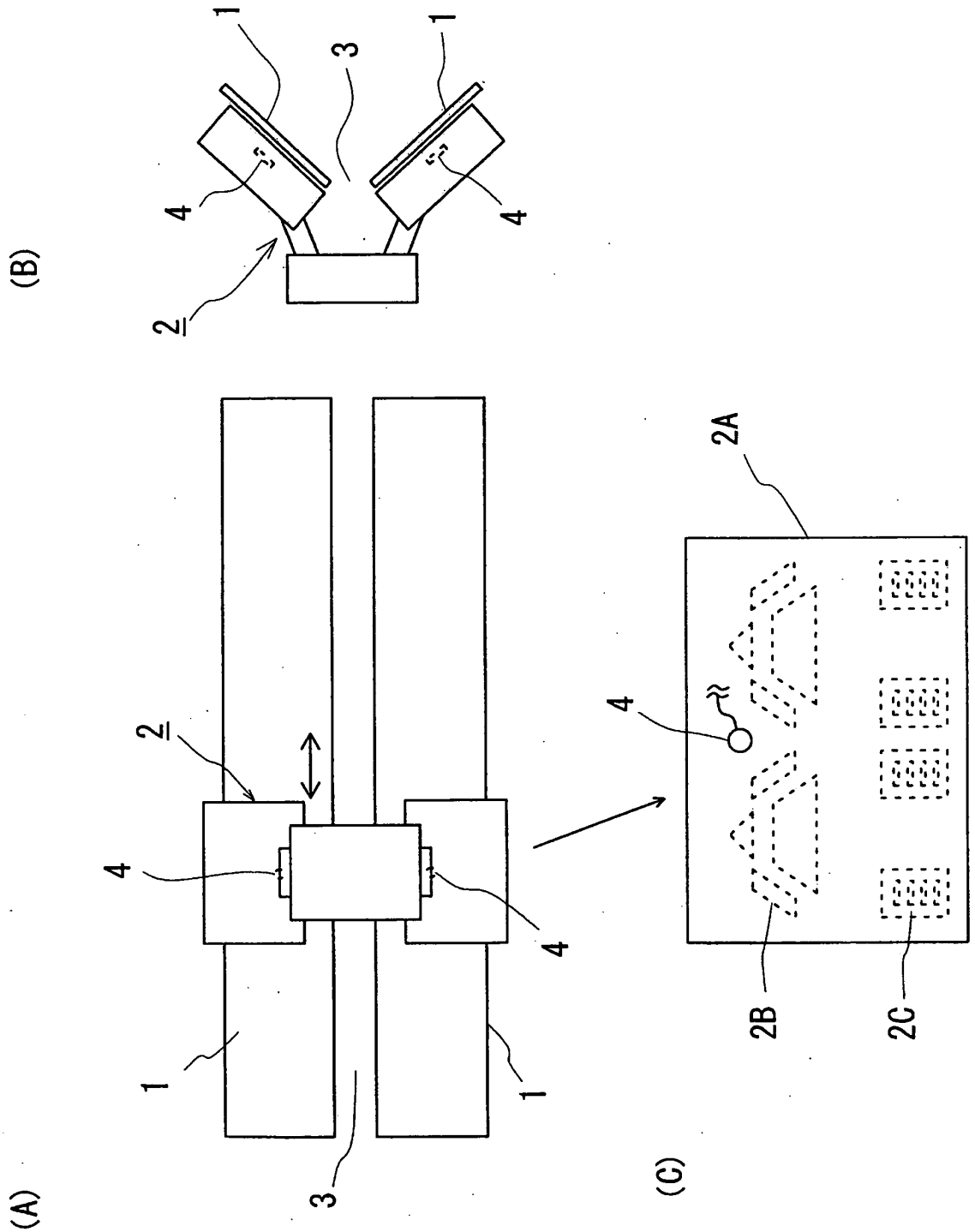


Fig. 2

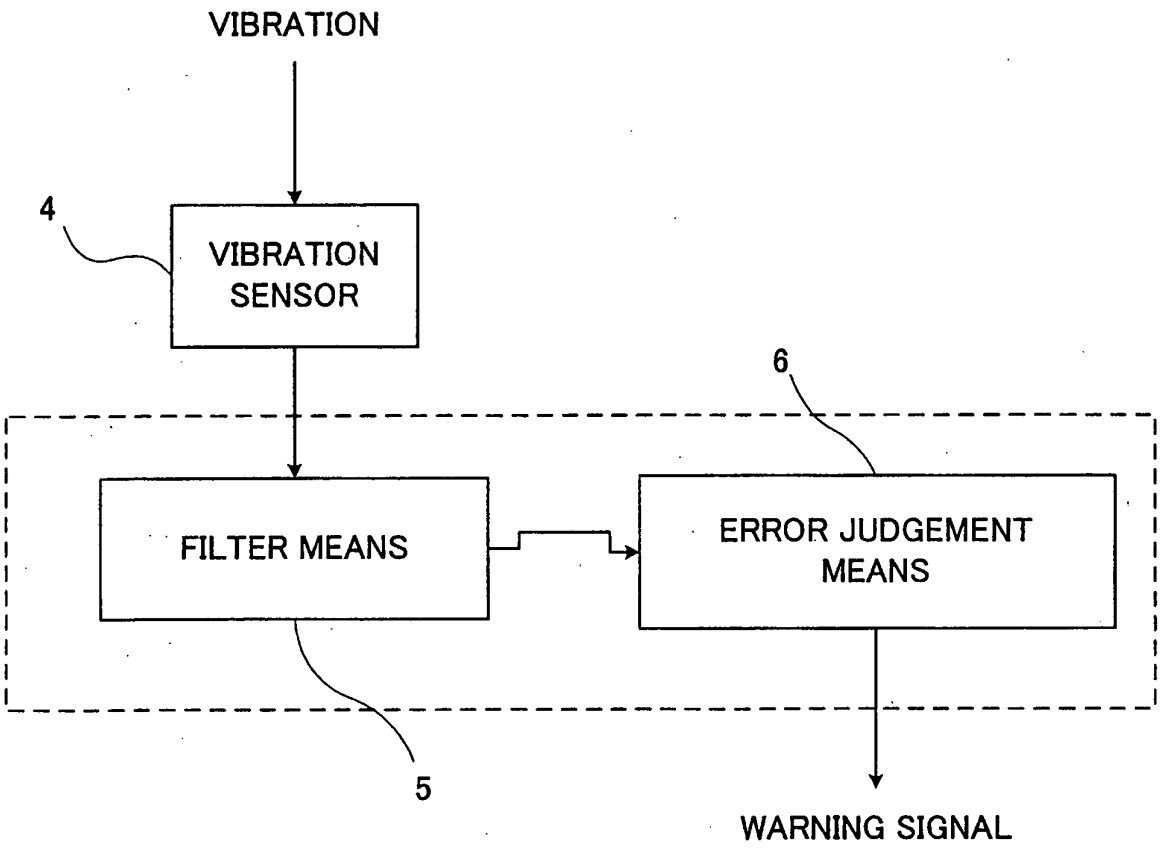

VIBRATION
4
VIBRATION SENSOR
6
FILTER MEANS
ERROR JUDGEMENT MEANS
5
WARNING SIGNAL

Fig. 3

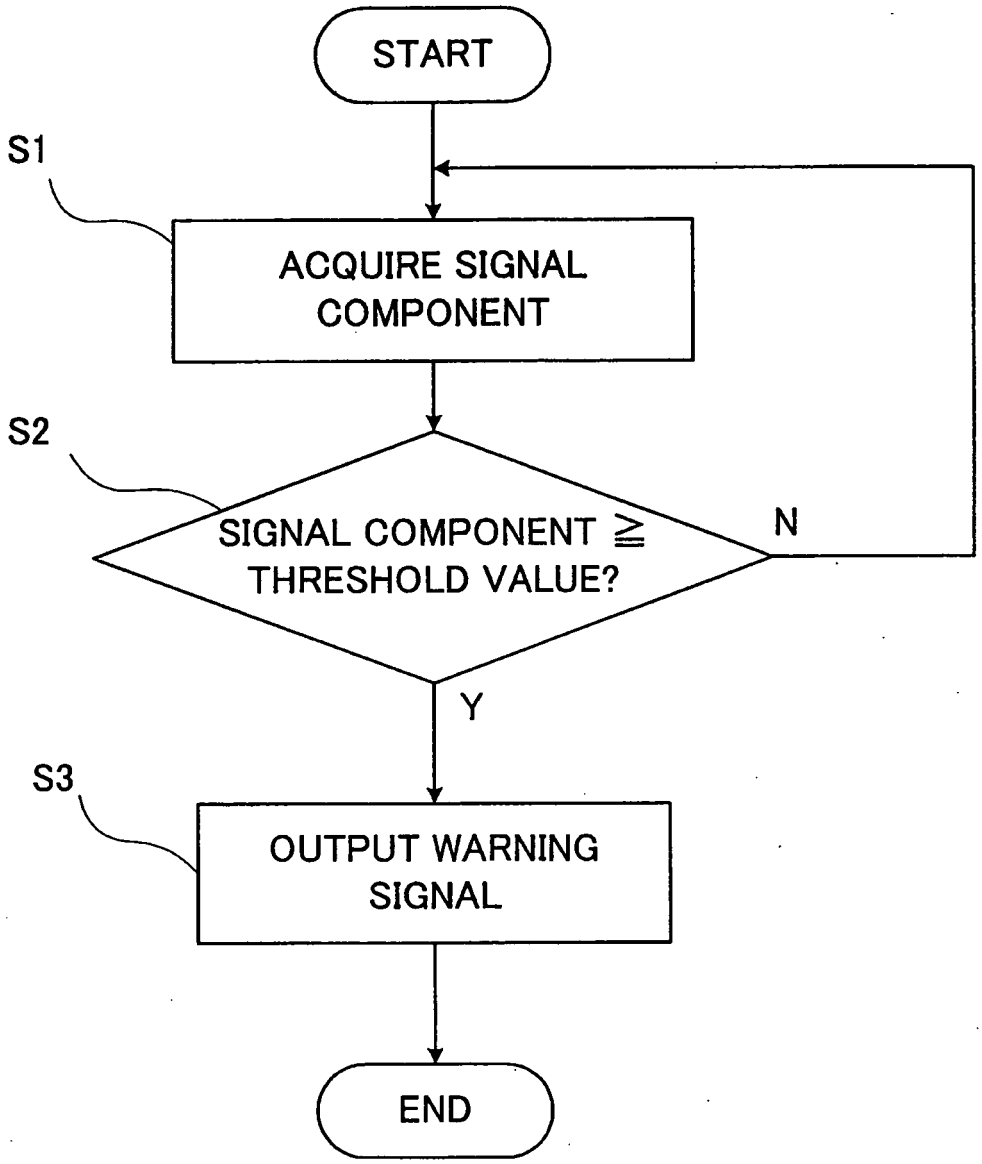

START
S1
ACQUIRE SIGNAL COMPONENT
S2
SIGNAL COMPONENT ≧ THRESHOLD VALUE?
N
Y
S3
OUTPUT WARNING SIGNAL
END

Fig. 4

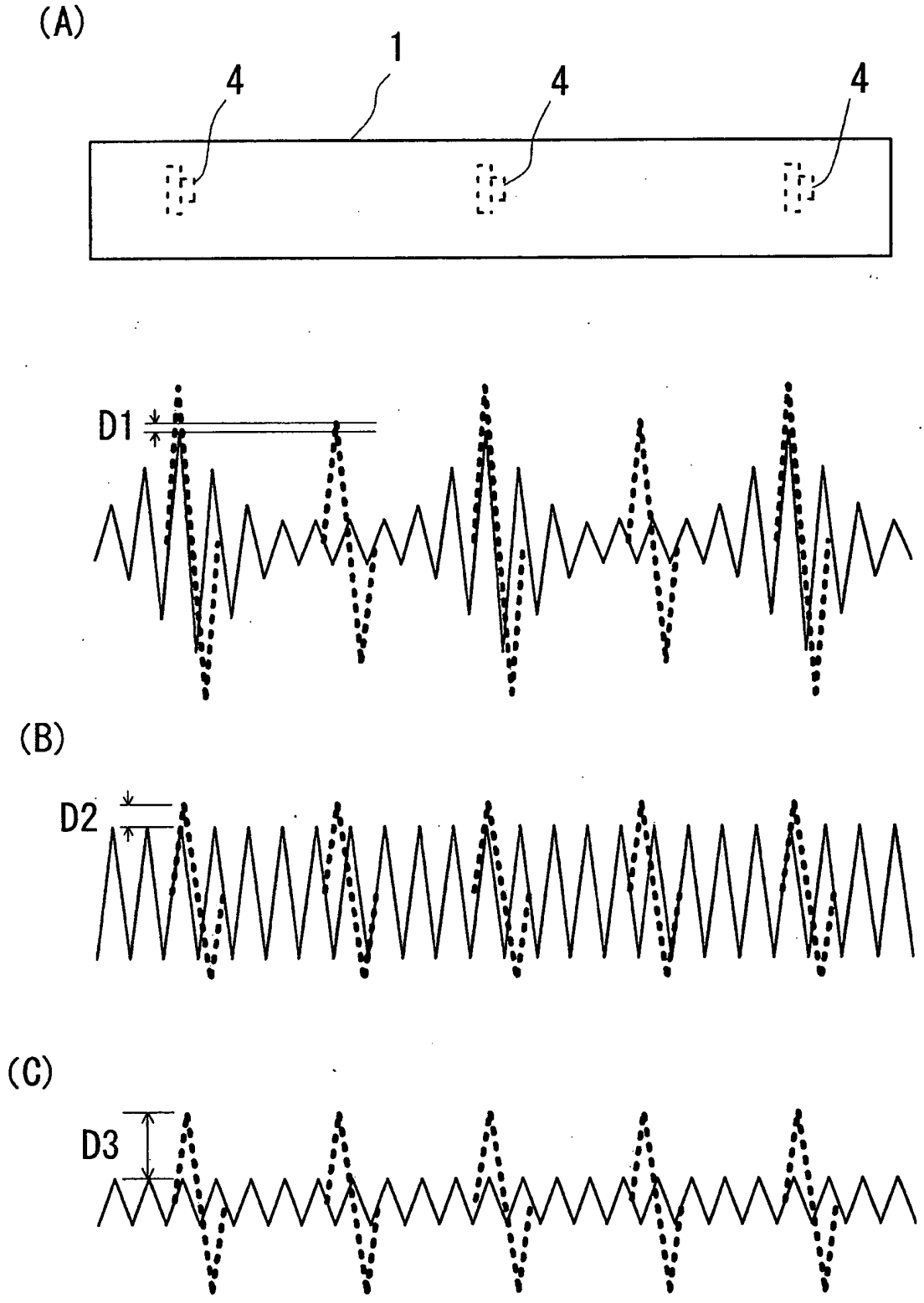


Fig. 5

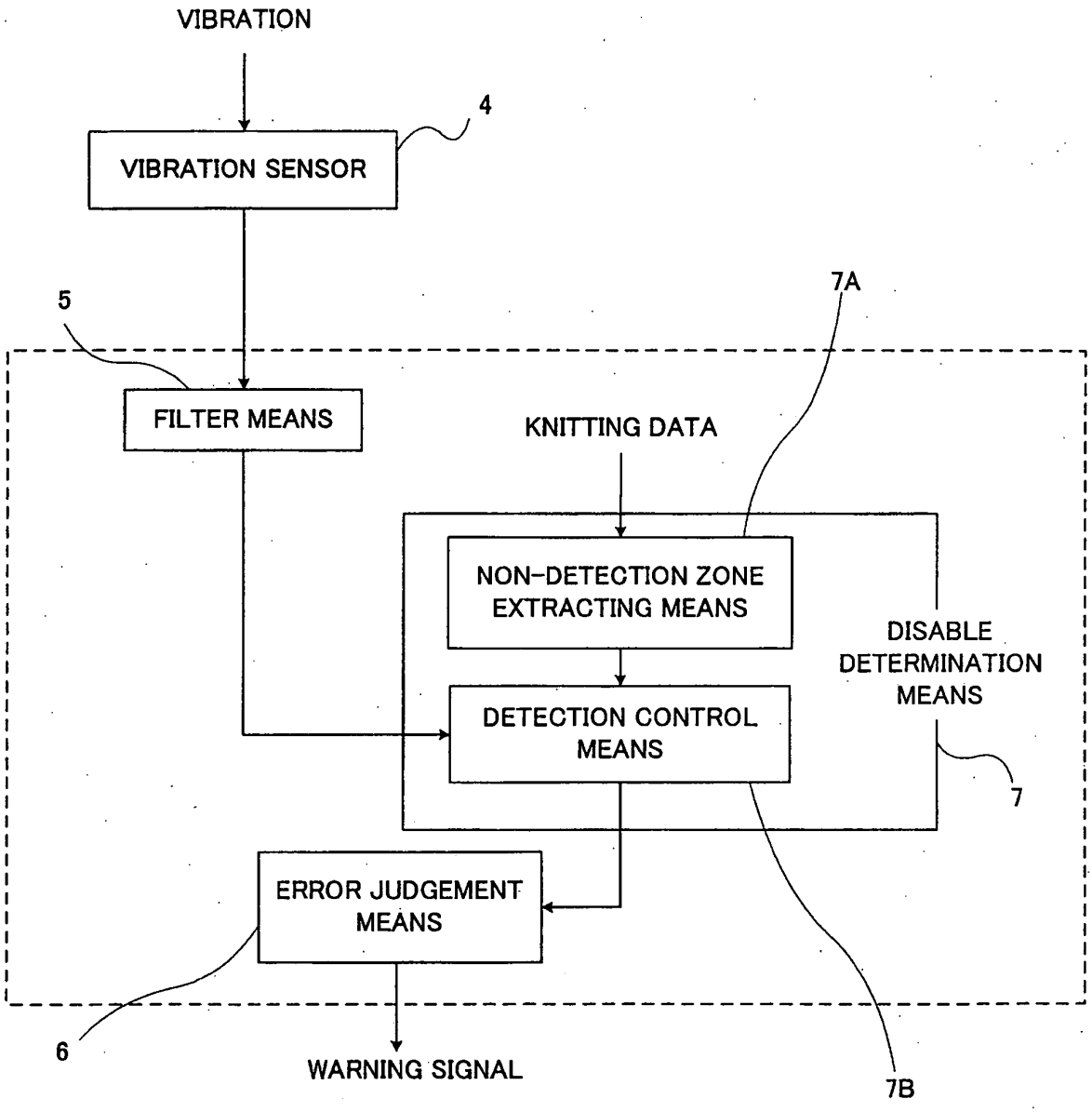

VIBRATION
4
VIBRATION SENSOR
5
7A
FILTER MEANS
KNITTING DATA
NON-DETECTION ZONE EXTRACTING MEANS
DISABLE DETERMINATION MEANS
DETECTION CONTROL MEANS
7
ERROR JUDGEMENT MEANS
6
WARNING SIGNAL
7B

Fig. 6

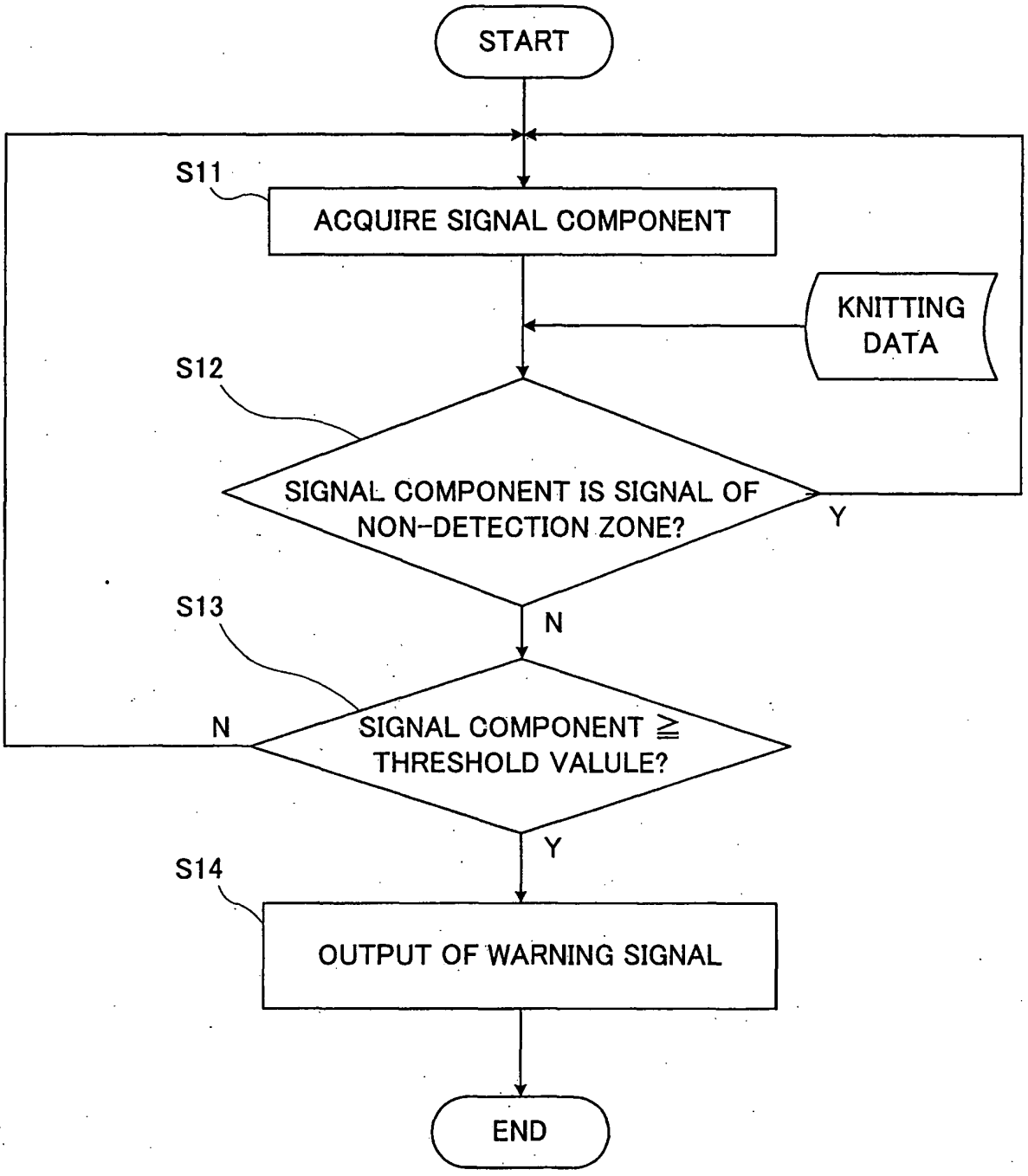
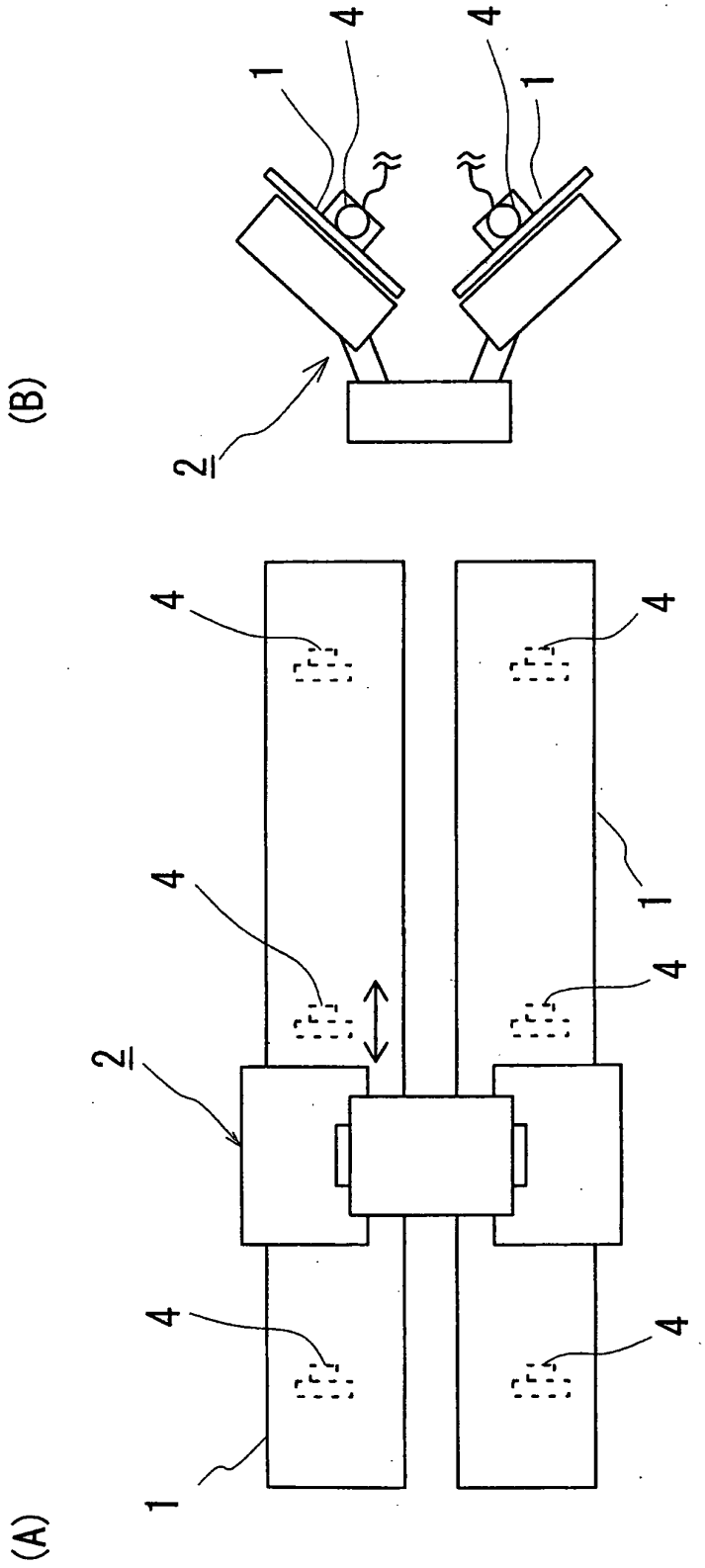

START
S11
ACQUIRE SIGNAL COMPONENT
KNITTING DATA
S12
SIGNAL COMPONENT IS SIGNAL OF NON-DETECTION ZONE?
Y
N
S13
N
SIGNAL COMPONENT ≧ THRESHOLD VALULE?
Y
S14
OUTPUT OF WARNING SIGNAL
END

Fig. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/003721

A. CLASSIFICATION OF SUBJECT MATTER
D04B35/18(2006.01)i, *D04B15/96*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D04B15/94-15/99, 35/10-35/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 3719061 A (W.HADAM ET AL), 06 March, 1973 (06.03.73), Column 4, lines 16 to 66; Figs. 1 to 3, 7 & JP 49-40025 B & GB 1312023 A & DE 2120824 A & FR 2114438 A & CH 525317 A & ES 396928 A	1,4 2,3
Y A	JP 2900159 B2 (H. Stoll GmbH & Co.), 19 March, 1999 (19.03.99), Column 8, line 32 to column 9, line 4; column 11, lines 6 to 23; column 12, lines 25 to 46; column 14, lines 15 to 28 & US 4790153 A & GB 2197348 A & DE 3645099 C & FR 2607156 A & CH 677507 A & ES 2005678 A & IT 1223076 B	2,3 1,4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 January, 2009 (15.01.09)	27 January, 2009 (27.01.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/003721

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 90/09476 A1 (UNIVERSAL MASCHINENFABRIK DR RUDOLFSCHIEBER GMBH & CO. KG.), 23 August, 1990 (23.08.90), & EP 458793 A & DE 3904306 A	1-4
A	JP 57-4157 Y2 (Shima Idea Center Co., Ltd.), 26 January, 1982 (26.01.82), (Family: none)	1-4
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 42978/1980(Laid-open No. 146793/1981) (Shima Idea Center Co., Ltd.), 05 November, 1981 (05.11.81), (Family: none)	1-4
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 70020/1975(Laid-open No. 151758/1976) (Gunze Ltd.), 03 December, 1976 (03.12.76), (Family: none)	1-4
A	JP 63-9063 B2 (Atelier de Construction Steiger S.A.), 25 February, 1988 (25.02.88), & US 4505135 A & EP 97386 A1 & ES 523171 A & DD 209862 A	1-4
P,A	WO 2008/152815 A1 (Shima Seiki Mfg., Ltd.), 18 December, 2008 (18.12.08), (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 54139750 A **[0008]**
- JP 56146793 A **[0008]**