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(74) Representative: **Eisenführ Speiser
Patentanwälte Rechtsanwälte PartGmbH
Postfach 31 02 60
80102 München (DE)**

detects an abnormality state of the weaving-related device (10) based on a vibration signal from the vibration sensor (50).

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an abnormality diagnosing apparatus for diagnosing abnormality of a weaving-related device that is provided at a loom and that includes a drive member that is driven by driving means.

2. Description of the Related Art

[0002] Weaving-related devices, such as a weft retaining device, that are provided at a loom include a drive member, such as a retaining pin, that is driven by driving means, such as an actuator. Each weaving-related device includes a component that is related to the drive member and that deteriorates or wears in the long run as the drive member operates (such a component is hereunder called "deterioration component"). In the loom (the weaving-related devices), when such deterioration components deteriorate or wear, it becomes necessary to perform recovery, such as replacement or adjustment of the deterioration components.

[0003] However, regarding a period in which the deterioration components are replaced or adjusted (hereunder referred to as "recovery period"), in general, the recovery period is controlled by knowing the state of, for example, deterioration of the deterioration components (deterioration state) that is substituted by the operation time of the loom (the operation time of the weaving-related devices) or the number of operations of the weaving-related devices (the drive members).

[0004] However, even for the same weaving-related device, due to slight variations in the quality of the deterioration component itself or the operation state of the loom (for example, the continuous operation time or the number of stoppages), the deterioration state of the deterioration component may vary with respect to the operation time or the number of operations. Therefore, in controlling the recovery period mentioned above, for example, the recovery is sometimes not carried out even if the deterioration component needs to recover from the deterioration state. In this case, the deterioration state of the deterioration component may adversely affect the weaving-related device or the loom.

[0005] On the other hand, separately from the general method of controlling the recovery period mentioned above, Japanese Unexamined Patent Application Publication No. 5-156548 discloses a related art in which the state of a deterioration component itself is detected and used in controlling the recovery period. Specifically, in the related art disclosed in Japanese Unexamined Patent Application Publication No. 5-156548, by measuring the surface temperature of the deterioration component with a temperature sensor, the state of the deterioration com-

ponent is monitored, and, by comparing the measured temperature and a predetermined value with each other, the recovery period of the deterioration component is controlled.

[0006] The related art presupposes that the temperature of the deterioration component changes in accordance with the deterioration state of the deterioration component (the deterioration state and the temperature are mutually related). However, in such a related art above, depending upon the deterioration component, the deterioration state of the deterioration component cannot be known, as a result of which the recovery period sometimes cannot be controlled. For example, in the case of a weft retaining device, a shock-absorbing material that absorbs shock as a retaining pin, which is a drive member, advances and retreats corresponds to the deterioration component. However, since there is no definite mutual relationship between the deterioration state of the shock-absorbing material and temperature change, the deterioration state of the shock-absorbing material (the deterioration component) cannot be known from the temperature. Therefore, in this case, in the related art, the recovery period of the deterioration component cannot be controlled.

[0007] In addition, in the related art, the temperature of the deterioration component needs to be measured directly. However, depending upon the weaving-related device, when the temperature of the deterioration component included therein is directly measured, it is difficult to dispose the temperature sensor or the temperature sensor sometimes cannot be disposed. Therefore, the related art cannot even be used for such a weaving-related device.

SUMMARY OF THE INVENTION

[0008] Accordingly, it is an object of the present invention to provide an abnormality diagnosing apparatus that is for a weaving-related device and that allows a deterioration state to be known without relying on states other than the deterioration state of a deterioration component when the weaving-related device (drive member) operates or on the structure of the weaving-related device itself to thereby allow control of a recovery period of the deterioration component.

[0009] To this end, the present invention features an abnormality diagnosing apparatus such as that described above including a vibration sensor that is provided at a loom and that measures vibration of a weaving-related device, and an abnormality detecting device that detects an abnormality state of the weaving-related device based on a vibration signal from the vibration sensor.

[0010] The so-called "abnormality state" refers to a state in which, in a weaving-related device, a deterioration component deteriorates or wears and needs to be subjected to recovery, such as replacement or adjustment.

[0011] Such an abnormality detecting device accord-

ing to the present invention includes a storage unit that stores a diagnosis standard regarding a diagnosis factor related to the vibration, and a determining unit that determines whether or not the weaving-related device is in the abnormality state by comparing actual data regarding the diagnosis factor that is determined based on the vibration signal with the diagnosis standard.

[0012] According to the abnormality diagnosing apparatus of the present invention, the abnormality state of a weaving-related device is detected based on a vibration signal from the vibration sensor that measures the vibration of the weaving-related device. Therefore, it is possible to precisely control the recovery period of a deterioration component.

[0013] Specifically, in the loom, as the drive member of the weaving-related device operates, the device itself vibrates. Since the vibration also reaches a portion around the weaving-related device, this portion also vibrates in accordance with the vibration of the weaving-related device. Moreover, the results of assiduous study by the inventor of the present invention et al. showed that the vibration that is generated as the drive member operates and the deterioration state of the deterioration component are mutually related. Accordingly, by previously knowing the mutual relationship between the vibration and the deterioration state of the deterioration component and by measuring the vibration with the vibration sensor during weaving, it is possible to know the deterioration state of the deterioration component on the basis of the previously known mutual relationship and a vibration signal that is output from the vibration sensor. Consequently, compared to when the operation time or the number of operations mentioned above is used, it is possible to control the recovery period more precisely.

[0014] Moreover, the vibration occurs in the weaving-related device itself instead of in the deterioration component. Although the vibration is determined by measuring the vibration of the weaving-related device itself, it is not limited thereto. Since, as described above, the portion around the weaving-related device also vibrates in accordance with the vibration of the weaving-related device, it is also possible to measure the vibration of the portion around the weaving-related device and use this as a substitution. Therefore, the position where the vibration sensor that measures the vibration is provided may be set at an outer side portion of the weaving-related device or a portion around, for example, the position where the weaving-related device is set. Consequently, compared to the related art mentioned above, in the structure in which the deterioration state of the deterioration component is known on the basis of the measurement of the vibration, the problem that the sensor cannot be disposed due to the structure of the weaving-related device itself including the deterioration component does not occur.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

- 5 Fig. 1 illustrates an arrangement of a vibration sensor with respect to a weft retaining device of an embodiment according to the present invention;
 Fig. 2 is a sectional view of the weft retaining device of the embodiment according to the present invention; and
 10 Fig. 3 is a block diagram of an abnormality diagnosing apparatus of an embodiment according to the present invention.

15 DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] On the basis of Figs. 1 to 3, an embodiment (a practical example) of an abnormality diagnosing apparatus of a weaving-related device for a loom to which the present invention is applied is described below.

[0017] As shown in Figs. 1 and 2, a loom 1 includes a weft measuring-and-storing device 3 including a weft retaining device 10 serving as a weaving-related device. Specifically, the weft measuring-and-storing device 3 includes a storage drum 20, a drive motor 40 for rotationally driving a rotary yarn guide 30 that winds a weft Y on the storage drum 20, and the weft retaining device 10 for controlling the storage of the weft Y onto the storage drum 20 and the unwinding of the weft Y from the storage drum 20.

[0018] The weft retaining device 10 includes a retaining pin 12 serving as a drive member and a solenoid 14 serving as driving means for driving the retaining pin 12 in an advancing and retreating manner, the retaining pin 12 and the solenoid 14 being accommodated in a holder 11 a of a solenoid case 11. The solenoid 14 includes a retaining solenoid 14a for driving the retaining pin 12 in an advancing manner and an unwinding solenoid 14b for driving the retaining pin 12 in a retreating manner. The retaining solenoid 14a and the unwinding solenoid 14b are provided so as to be wound at respective solenoid holders 13 and 13 having the form of bobbins, and are arranged in a column so as to be spaced apart from each other with a ring-shaped space 15 therebetween in the holder 11a. A through hole having a hole diameter that is larger than the hole diameter of through holes formed in the respective solenoid holders 13 and 13 is formed in the spacer 15.

[0019] The retaining pin 12 is provided so as to be inserted in the through holes formed in both of the solenoid holders 13 and 13 and the through hole formed in the spacer 15. The retaining pin 12 includes a ring-shaped stopper 12a at a central portion thereof in an axial direction. However, the stopper 12a is formed with a thickness that is smaller than the thickness of the spacer 15 and with an outside diameter that is larger than the hole diameters formed in the solenoid holders 13 and that is smaller than the hole diameter of the spacer 15. Moreo-

ver, the retaining pin 12 is provided so that its stopper 12a is positioned between both of the solenoid holders 13 and 13 (in the through hole of the spacer 15), and is displaceable in the axial direction. When the retaining pin 12 is driven in an advancing and retreating manner by the solenoids 14a and 14b, a tip end portion thereof advances/retreats with respect to a through hole 11b having an opening in a bottom surface of the solenoid case 11.

[0020] The position of the retaining pin 12 in the axial direction when the retaining pin 12 advances and retreats as described above is regulated by causing the stopper 12a to come into contact with each solenoid holder 13. That is, as the retaining pin 12 is driven in an advancing and retreating manner as described above, the stopper 12a collides with the solenoid holders 13. Accordingly, in order to reduce shock generated during such a collision, for example, shock-absorbing materials 16 made of rubber are mounted on spacer-15-side end surfaces.

[0021] In the weft measuring-and-storing device 3, by causing the rotary yarn guide 30 to be rotationally driven with the retaining pin 12 having advanced with respect to the storage drum 20, the weft Y that has been drawn out from a weft supply package 7 is wound on the storage drum 20 and stored. By causing the retaining pin 12 to be driven in a retreating manner and causing a compressed fluid for weft insertion to be ejected from a weft insertion nozzle 5, the weft Y is unwound from the storage drum 20 and the weft Y is inserted into a warp shed.

[0022] The abnormality diagnosing apparatus according to the present invention is a device for diagnosing abnormality of a weaving-related device for the loom 1 mentioned above, and includes a vibration sensor that measures the vibration of the weaving-related device to be diagnosed and an abnormality detecting device that detects that the state of the weaving-related device has become an abnormal state (abnormality state) on the basis of a vibration signal from the vibration sensor. However, the so-called "abnormality state" refers to a state in which a deterioration component deteriorates or wears and needs to be subjected to recovery, such as replacement or adjustment.

[0023] Moreover, the present practical example is an example in which the weaving-related device to be diagnosed is the weft retaining device 10 of the weft measuring-and-storing device 3 mentioned above and in which the abnormality state caused by the deterioration of the shock-absorbing materials 16, which are deterioration components, is detected. The present practical example is an example in which the abnormality detecting device is provided not in a weaving factory, where looms are installed, but at, for example, a service center of a manufacturer of the looms (hereunder simply referred to as "manufacturer") and in which the weaving factory and the manufacturer are connected to each other by a communication line. In the present invention, the abnormality state of the weaving-related device is detected by the abnormality detecting device on the basis of a diagnosis factor related to vibration, and in the present practical

example, the diagnosis factor is the acceleration of the vibration. The abnormality diagnosing apparatus of the present practical example is described below on the basis of, for example, Fig. 3.

[0024] First, regarding a vibration sensor 50, in the present practical example, the vibration sensor 50 is not provided at the weft retaining device 10 itself serving as the weaving-related device, but is provided at a portion around the weft retaining device 10. However, the portion around the weft retaining device 10 needs to be situated at a position where the vibration that is generated as the weft retaining device 10 operates can be measured. Accordingly, in the present practical example, as shown in Fig. 1, the vibration sensor 50 is mounted on a motor case 40a of the drive motor 40 of the weft measuring-and-storing device 3. The vibration sensor 50 is a so-called acceleration sensor that measures the magnitude of the acceleration of the vibration of an object to be detected and outputs a signal in accordance with a measured value thereof.

[0025] The loom 1 is configured to allow the signal (the vibration signal) related to the vibration and output from the vibration sensor 50 to be input to a loom controlling device 60, which is a main controlling device of the loom 1. In the weaving factory, as is well known, a plurality of looms 1 are generally set; and a host computer 70 for controlling, for example, the operation state of each loom 1 is set to connect each loom 1 to the host computer 70. Moreover, the loom controlling device 60 is configured to transmit the vibration signal output from the vibration sensor 50 as described above to the host computer 70.

[0026] The host computer 70 includes a memory 70a serving as a storage unit connected to the loom controlling device 60 and is configured to receive the vibration signal that is transmitted from the loom controlling device 60 as described above and to successively store the magnitude of the acceleration of the vibration indicated by the vibration signal as vibration data. The host computer 70 also includes a central processing unit (CPU) 70b, and the memory 70a is connected to the CPU 70b. Further, the host computer 70 includes a display unit 70c, and the display unit 70c is also connected to the CPU 70b. The display unit 70c also functions as an input unit and is configured to make it possible to, for example, read out data and input a set value.

[0027] In the host computer 70, the CPU 70b includes a converter 70b1 that functions as a part of the abnormality diagnosing apparatus. The converter 70b1 performs conversion processing in which the vibration data stored in the memory 70a as the measured value is converted to determine actual data regarding the diagnosis factor (acceleration).

[0028] Regarding the converter 70b1, specifically, the converter 70b1 performs the conversion processing every preset period (for example, every 24 hours). The period is set with respect to the CPU 70b by the display unit 70c. In addition, in the CPU 70b, a conversion command that causes the converter 70b1 to perform the conversion

processing every such period is generated. When the conversion command is generated, the converter 70b1 performs processing in which the vibration data stored in the memory 70a is read out and the vibration data is converted into acceleration data (actual data) for each frequency by performing frequency analysis (for example, a FFT analysis). When the converter 70b1 has read out the vibration data from the memory 70a, the CPU 70b performs processing in which the vibration data stored in the memory 70a is reset.

[0029] In the present practical example, as described above, an abnormality detecting device 90 is installed at a manufacturer, and the host computer 70 is connected to the abnormality detecting device 90, installed at the manufacturer, via a server 80. Moreover, when the converter 70b1 has completed the conversion processing, the CPU 70b outputs the actual data determined on the basis of the vibration data to the abnormality detecting device 90, installed at the manufacturer, via the server 80.

[0030] The abnormality detecting device 90 includes a determining unit 90a connected to the CPU 70b of the host computer 70, a storage unit 90b connected to the determining unit 90a, and a setting unit 90c connected to the storage unit 90b. A specific structure of the abnormality detecting device 90 is described in detail below.

[0031] First, the determining unit 90a is connected to the CPU 70b as described above, and the actual data that is transmitted from the CPU 70b is input to the determining unit 90a. The determining unit 90a is configured to, when the actual data has been input from the CPU 70b, perform processing (determination processing) in which whether or not the weft retaining device 10 is in the abnormality state is determined. The determining unit 90a is configured to output a signal to the CPU 70b in accordance with the processing results of the determination processing. The determination processing is performed by using a set value stored in the storage unit 90b connected to the determining unit 90a.

[0032] The set value is set by the setting unit 90c connected to the storage unit 90b. The setting unit 90c has, for example, an inputting function, and is configured to be capable of inputting and setting the set value and to set the set value with respect to the storage unit 90b. The set value is as follows in detail.

[0033] First, as described above, in the weft retaining device 10, the shock-absorbing materials 16 provided at the solenoid holders 13 are subjected to the advancing and retreating movements of the retaining pin 12. Although the shock-absorbing materials 16 are deterioration components, when the shock-absorbing materials 16 are not deteriorated, the shock-absorbing materials 16 are capable of absorbing shock generated by the collision between the retaining pin 12 and the solenoid holders 13 (the shock-absorbing materials 16). Therefore, in this state, the vibration that occurs in the weft retaining device 10 itself due to the collision is extremely small. However, as the weft retaining device 10 operates, the shock-absorbing materials 16 gradually deteriorate. In

addition, when the shock-absorbing materials 16 deteriorate, the degree of absorption of the shock compared to that when the shock-absorbing materials 16 are not deteriorated is reduced. Therefore, in the weft retaining device 10, vibration caused by the collision between the solenoid holders 13 and the retaining pin 12 (hereunder referred to as "abnormality vibration") occurs.

[0034] As described above, the abnormality vibration occurs due to the collision between the solenoid holders 13 and the retaining pin 12 and hardly occurs when the shock-absorbing materials 16 are not deteriorated. Therefore, the abnormality vibration results from a cause that differs from the cause of other types of vibration occurring in the weft retaining device 10 in a state in which the shock-absorbing materials 16 are not deteriorated, and occurs as a vibration having a different frequency.

[0035] More specifically, vibration that occurs in the motor case 40a of the weft measuring-and-storing device 3 where the vibration sensor 50 is provided is not only a vibration that occurs due to the operation of the weft retaining device 10 but also, for example, a vibration caused by the operation of the drive motor 40, and is, thus, a vibration that is a combination of vibrations caused by a plurality of causes. Therefore, the vibration data stored in the memory 70a as a vibration measurement value obtained by the vibration sensor 50 includes data regarding all types of the vibrations resulting from different causes. However, each vibration is basically a vibration having a frequency in accordance with the cause of the vibration. In other words, the abnormality vibration that occurs in the weft retaining device 10 is a vibration included in a frequency band in accordance therewith.

[0036] Accordingly, it is previously determined which vibration band the abnormality vibration is included in, and the frequency band is set as the set value mentioned above. Therefore, since it is possible to identify a part of the actual data that corresponds to the abnormality vibration and that is to be the object of determination of the abnormality state, the set value is used in the determination processing. Such a part that is identified is a part of the actual data and is also in itself the actual data.

[0037] Since the abnormality vibration is caused by the deterioration of the shock-absorbing materials 16 as described above, the acceleration of the vibration gradually increases due to the progress of the deterioration of the shock-absorbing materials 16. Therefore, the degree of deterioration of the shock-absorbing materials 16 can be determined by using the acceleration of the vibration.

[0038] Accordingly, in order to detect the abnormality state (a state in which the shock-absorbing materials 16 are deteriorated by an unallowable degree and need to be replaced), how large the acceleration of the abnormality vibration is is previously determined with the shock-absorbing materials 16 being deteriorated by a degree causing the abnormality state. Moreover, on the basis of the magnitude of the determined acceleration, an allowable value (threshold value) of the acceleration is determined to set this value as the set value mentioned

above.

[0039] The frequency band that the abnormality vibration is included in and the magnitude of the acceleration causing the abnormality state can be determined by, for example, tests by the loom (or a loom of the same specification). The threshold value of the acceleration for the aforementioned set value corresponds to the so-called "diagnosis standard" in the present invention.

[0040] The determining unit 90a of the abnormality detecting device 90 performs the determination processing by using the actual data from the CPU 70b and the set values (frequency band and the threshold value of the acceleration) that are set as described above. Regarding the determination processing, specifically, when the actual data has been input from the CPU 70b of the host computer 70 via the server 80, the determining unit 90a reads out the set values (the frequency band that the abnormality vibration is included in and the threshold value of the acceleration) stored in the storage unit 90b. Then, the determining unit 90a compares the maximum value of the acceleration in the acceleration data for the frequency band of the aforementioned set values in the acceleration data for the plurality of frequency bands that are included in the actual data with the threshold value of the acceleration (determination standard).

[0041] As a result of the comparison, when the aforementioned maximum value of the acceleration does not exceed the threshold value, the determining unit 90a determines that the weft retaining device 10 is not in the abnormality state and ends the determination processing. On the other hand, when the maximum value of the acceleration exceeds the threshold value, the determining unit 90a determines that the weft retaining device 10 is in the abnormality state, and outputs a signal to the CPU 70b, the signal informing that the weft retaining device 10 is in the abnormality state (recovery signal). Due to the output of the recovery signal, the determining unit 90a ends the determination processing.

[0042] When the recovery signal is input, the CPU 70b causes a message urging recovery of the weft retaining device 10 (the shock-absorbing materials 16) on a screen of the display unit 70c of the host computer 70. Therefore, an operator confirms the message displayed on the screen of the display unit 70c to know that the weft retaining device 10 is in the abnormality state, that is, the shock-absorbing materials 16 of the weft retaining device 10 are in a state requiring replacement.

[0043] In this way, according to an abnormality diagnosing apparatus 100 of the present practical example, the abnormality state of the weft retaining device 10 is detected on the basis of the vibration signal from the vibration sensor 50. Therefore, the abnormality diagnosing apparatus 100 is capable of controlling the replacement period of deterioration components (the shock-absorbing materials 16) more precisely compared to when it is determined that the weft retaining device 10 is in the abnormality state by using the operation period or the number of operations as in the related art.

[0044] However, in the present practical example, the vibration sensor 50 is mounted at a position on the motor case 40a of the weft measuring-and-storing device 3. The mounting position is not a position where it is difficult to, for example, mount the vibration sensor 50, but a position where the vibration that is generated as the weft retaining device 10 operates can be measured as described above. In addition, due to such a structure, the abnormality diagnosing apparatus 100 of the present practical example is such that, in detecting the abnormality state of the weft retaining device 10 as described above, the structure of, for example, the vibration sensor 50 can be easily realized.

[0045] In the foregoing description, an embodiment of the abnormality diagnosing apparatus of the weaving-related device for the loom to which the present invention has been applied has been described (hereunder referred to as "the aforementioned practical example"). However, the present invention is not limited to the aforementioned practical example and can also be carried out by way of different embodiments (modifications).

[0046] (1) Regarding the weaving-related device for the loom to be diagnosed by the abnormality diagnosing apparatus, in the aforementioned practical example, the weft retaining device 10 of the weft measuring-and-storing device 3 is the weaving related device. However, in the present invention, the weaving-related device to be diagnosed by the abnormality diagnosing apparatus is not limited thereto. Other types of weaving related devices, such as a driving mechanism for driving the loom or a planetary selvage device that forms a leno selvage construction at a selvage of a cloth to be woven, may be objects of diagnosis. When the loom is a water jet loom, a flow-path switching device for switching a flow path in a supply flow path for supplying a compressed fluid to a weft-insertion nozzle may be a weaving-related device to be diagnosed. The details are as follows.

[0047] (1-1) The so-called "driving mechanism" mentioned above is a mechanism that rotationally drives a main shaft of the loom and has a structure in which a driving motor, which serves as driving means, and a transmission mechanism that transmits rotation to the main shaft are connected to each other by a V belt. In the driving mechanism, the V belt extends between a transmission-mechanism-side driven pulley and a drive pulley (drive member) mounted on an output shaft of the driving motor and rotationally driven by the driving motor; and, by setting the tension of the V belt to a proper tension, the rotation is properly transmitted. The tension of the V belt is adjusted by, for example, adjusting the interval between the pulleys or adjusting the position of a tension adjusting member that applies a tension to the V belt by coming into contact with the V belt between the pulleys.

[0048] As the loom operates for a long time, the V belt may stretch and be brought into a state in which its tension is reduced. Therefore, in the driving mechanism, the V belt is a deterioration component, and its stretched

state is a deteriorated state (deterioration state). When the tension is reduced in this way, in particular, when the loom starts, sliding occurs between the belt and each pulley, and the time taken to increase the number of rotations of the main shaft to the steady number of rotations that is set with respect to weaving is longer than that when the sliding does not occur.

[0049] In looms of recent years, the period until the number of rotations of the main shaft reaches the steady number of rotations after the start-up (transition period) is short. However, the transition period is longer than the period of rotation of the main shaft. In addition, depending upon, for example, the weaving condition, there may also be a case in which the weft insertion is performed in the transition period. In this case, since the number of rotations of the main shaft in the transition period is smaller than the steady number of rotations, depending upon this difference, the weft may be inserted under a weft-insertion operational condition that differs from the weft-insertion operational condition during a steady operation.

[0050] However, when sliding occurs between the belt and each pulley and the transition period becomes long in terms of time, for example, in a first weft insertion after the start-up, the number of rotations of the main shaft becomes smaller compared to the number of rotations of the main shaft when the sliding does not occur. Therefore, the weft is inserted in a state in which the number of rotations is smaller than the number of rotations assumed when determining the weft-insertion operational condition used in the weft insertion. Depending upon the case, the inserted weft is woven in a loose state, as a result of which the quality of a cloth that is woven is reduced.

[0051] Accordingly, in order to know the deterioration state of the V belt (deterioration component) mentioned above, the abnormality diagnosing apparatus of the present invention is applied. In addition, in this case, the driving mechanism becomes a weaving-related device to be diagnosed and vibration is measured in the driving mechanism. The details of the diagnosis are as follows.

[0052] First, in the driving mechanism, as the driving motor operates, the driving mechanism, itself, vibrates. The magnitude of the vibration during the transition period, which is during accelerated operation immediately after the start-up of the loom, differs from the magnitude of the vibration during the steady operation, which is when operation is continued with the number of rotations of the main shaft being substantially maintained at the steady number of rotations. In addition, the magnitude of the vibration during the transition period is larger than that during the steady operation. That is, although, after the start-up of the loom, a large vibration occurs in the driving mechanism during the transition period, when the number of rotations of the main shaft reaches the steady number of rotations and the operation state switches over to the steady operation state, the vibration occurring in the driving mechanism changes so as to become smaller than that during the transition period.

[0053] Accordingly, it is possible to measure the vibration of the driving mechanism, and to know when the number of rotations of the main shaft has reached the steady number of rotations after the start-up of the loom. By knowing this time, it is possible to determine the length of the transition period from the start-up (the length of the transition period). Moreover, the length of the transition period is increased due to the sliding as the V belt deteriorates as described above. In addition, as the deterioration state progresses, the sliding is increased in accordance with the deterioration state, that is, the length of the transition period is increased. Therefore, it is possible to know the deterioration state of the V belt with the length of the transition period when the sliding does not occur (the V belt is not deteriorated) being a standard.

[0054] The vibration of the driving mechanism is such that a fixed portion of the driving mechanism, such as a housing portion of the driving motor, can be measured. Therefore, the vibration sensor is mounted on a fixed portion of the driving motor, such as the housing portion.

[0055] As in the aforementioned practical example, a vibration signal that is output from the vibration sensor is input to the loom controlling device 60 and is transmitted to the host computer 70 from the loom controlling device 60. However, since the deterioration state of the V belt can be known from the length of the transition period as described above, the vibration signal that is transmitted to the host computer 70 from the loom controlling device 60 is a signal of a period including at least the transition period. Accordingly, the period including the transition period (referred to as "set period" below) is set in the loom controlling device 60. However, regarding the set period, since the transition period is increased as the V belt deteriorates, the set period is a period that is set in terms of time, and is set longer than a period that is in accordance with the deterioration state requiring replacement of the V belt and that is previously determined by, for example, a test.

[0056] The loom controlling device 60 successively stores the vibration signal that is output from the vibration sensor each time a start-up signal of the loom is generated, and when the elapsed time has reached the set period, the vibration signal that has been stored up to this time (the vibration signal for the set period) is transmitted to the host computer 70. Therefore, the loom controlling device 60 includes a timer that starts operating due to the generation of the start-up signal when an operation button of the loom is operated and that generates a signal (an execution signal) when a measurement time thereof has reached the set period. The loom controlling device 60 is configured to start a storage operation of storing the vibration signal that is input when the start-up signal has been generated and to end the storage operation as the timer generates the execution signal and to execute the transmission when the storage operation ends. The vibration signal that has been stored in the loom controlling device 60 is reset when the transmission has been completed (the loom controlling device

60 is configured in this way).

[0057] As in the aforementioned practical example, the vibration signal that is transmitted from the loom controlling device 60 is stored in the memory 70a of the host computer 70 with the magnitude of the acceleration of the vibration that is indicated by the vibration signal being vibration data. In the host computer 70, the converter 70b1 of the CPU 70b connected to the memory 70a performs the conversion processing in which the vibration data stored in the memory 70a is converted to determine the actual data regarding the diagnosis factor (acceleration).

[0058] However, in this example, the deterioration state of the V belt is determined on the basis of the length of the transition period, and it is possible to know the length of the transition period on the basis of a change in the vibration after the start-up of the loom as described above. Therefore, the actual data that is determined by the conversion is not acceleration data for each frequency as in the aforementioned practical example, but acceleration data for each period (elapsed time) that is previously determined and that is sufficiently shorter than the set period. When the converter 70b1 has completed the conversion processing, the CPU 70b outputs the actual data determined from the vibration data to the abnormality detecting device 90, installed at a manufacturer, via the server 80. As in the aforementioned practical example, when the converter 70b1 has read out the vibration data from the memory 70a, the CPU 70b performs the processing in which the vibration data stored in the memory 70a is reset.

[0059] When the actual data is transmitted from the CPU 70b, the determining unit 90a of the abnormality detecting device 90 performs the determination processing in which whether or not the V belt of the driving mechanism is in the deterioration state requiring replacement is determined, that is, whether or not the V belt is in the abnormality state is determined. The details of the determination processing are as follows.

[0060] First, when the actual data has been input, the determining unit 90a determines the length of the transition period on the basis of the actual data (the acceleration data for each period above). Then, after the length of the transition period has been determined, the determining unit 90a reads out the set value stored in the storage unit 90b. However, the set value in this example is set in terms of time, and is an allowable value (threshold value) of the length of the transition period that is determined on the basis of the length of the transition period previously determined by, for example, a test, the length of the transition period being one when the loom has been started by using the V belt in the abnormality state requiring replacement. In this example, the threshold value of the length of the transition period corresponds to the so-called "diagnosis standard" in the present invention.

[0061] The determining unit 90a compares the length of the transition period determined from the actual data

and the set value (the threshold value of the length of the transition period) with each other as described above. As a result of the comparison, when the length of the transition period determined from the actual data does not exceed the threshold value, the determining unit 90a determines that the driving mechanism is not in the abnormality state and ends the determination processing. On the other hand, when the length of the transition period determined from the actual data exceeds the threshold value, as in the aforementioned practical example, the determining unit 90a determines that the driving mechanism is in the abnormality state, and outputs a recovery signal to the CPU 70b. Due to the output of the recovery signal, a message urging recovery of the driving mechanism (the V belt) is displayed on the display unit 70c of the host computer 70.

[0062] (1-2) A planetary selvage device is a device that forms a leno selvage construction at a selvage of a woven cloth as described above, and includes a sun gear that is provided inside the device so as to be nonrotatable, a disk-shaped planetary carrier that is coaxially disposed with the sun gear and that is rotationally driven by a driving shaft, and a pair of planetary gears that are symmetrically disposed on the planetary carrier with respect to a center of rotation of the planetary carrier and that are rotatably supported with respect to the planetary carrier by support shafts. Each planetary gear engages with the sun gear via an intermediate gear. A bobbin holder that holds a selvage bobbin on which a selvage is wound is mounted on the other end of each support shaft that supports its corresponding planetary gear. In the planetary selvage device, by rotationally driving the planetary carrier, the bobbin holders undergo a revolving planetary motion while rotating.

[0063] When the driving shaft that rotationally drives the planetary carrier is such that a main shaft (a driving motor) of the loom is a driving source, vibration occurs inside the planetary selvage device due to variations in the rotational speed of the main shaft (rotation variations). Specifically, the main shaft of the loom is not always rotating at a constant speed even in a steady operation state, so that variations occur during one rotation caused by a load that is exerted upon the main shaft due to a beating operation of a reed or a shedding motion of a shedding device, with the main shaft of the loom being the driving source. Therefore, in the planetary selvage device in which the main shaft is the driving source, a backlash (play) existing between each gear including the sun gear, the planetary gears, and the intermediate gear may cause vibration in a rotation direction (rotational vibration) to occur in the planetary carrier due to the rotation variations in the main shaft as described above.

[0064] Moreover, in the planetary selvage device, the existence of backlash or rotational vibration mentioned above causes wear to occur between tooth surfaces of the gears that engage each other due to long use. In addition, as the gears wear, the backlash between the gears is increased, as a result of which the rotational

vibration is increased. When the rotational vibration is increased in this way, for example, the bobbin holders may become damaged. When the rotational vibration is increased in this way, improper selvage formation in which the leno selvage construction is not properly formed may occur. Therefore, in the planetary selvage device, for example, the state of high probability with which the bobbin holders are damaged or the state of high probability with which improper selvage formation occurs is the abnormal state. The components (deterioration components) that deteriorate (wear) and that cause the abnormal state are the gears described above.

[0065] Accordingly, in order to know the deterioration state of the gears (the deterioration components), the abnormality diagnosing apparatus of the present invention is used. Specifically, since the rotational vibration is increased as the wear of the gears progresses as described above, it is possible to know the deterioration state of the gears on the basis of the magnitude of the vibration that is generated in the planetary selvage device itself due to the rotational vibration. The vibration of the planetary selvage device is such that a fixed portion of the planetary selvage device, such as a gear cover that accommodates each gear, can be measured. Therefore, the vibration sensor is mounted on a fixed portion, such as the gear cover.

[0066] Since the deterioration state is known on the basis of the magnitude (change in) the vibration as described above, as in the example above, the actual data regarding the diagnosis factor (acceleration) in this example is also the acceleration data for each elapsed time. However, in this example, the memory 70a of the host computer 70 not only stores vibration data for a predetermined period from the start-up, but also, as in the aforementioned practical example, successively stores vibration data during weaving, the vibration data being based on the vibration signal that is output whenever necessary from the loom controlling device 60. Therefore, in this example, as in the aforementioned practical example, the conversion processing in which the actual data is determined by the host computer 70 (the CPU 70b) and the transmission of the actual data to the abnormality detecting device 90 (the determining unit 90a) are performed every preset period (for example, 24 hours).

[0067] Moreover, although the determining unit 90a performs the determination processing in which whether or not the planetary selvage device is in the abnormality state is determined, the set value that is used in the determination processing is an allowable value (threshold value) of the acceleration that is determined on the basis of the acceleration of the vibration previously determined by, for example, a test, the vibration being one when weaving has been performed by using the gears in the abnormality state requiring replacement. The determination processing is performed by comparing the maximum value of the acceleration in the acceleration data included in the actual data with the set value (the threshold value

of the acceleration) and by determining whether or not the maximum value of the acceleration exceeds the threshold value. When the maximum value of the acceleration exceeds the threshold value, the determining unit 90a determines that the planetary selvage device is in the abnormality state, and outputs a recovery signal to the CPU 70b. In this example, the threshold value of the acceleration corresponds to the so-called "diagnosis standard" in the present invention.

[0068] (1-3) The flow-path switching device is a device in a multi-color water jet loom that selectively inserts a weft at a plurality of weft-insertion nozzles, is provided in a supply flow path for supplying pressured water to the weft-insertion nozzles, and switches a flow path to supply the pressured water to the selected weft-insertion nozzle. The flow-path switching device includes a switching valve that switches a flow path in this way and driving means (such as a rotary solenoid) that drives the switching valve. The switching valve includes a valve body that slidably rotates in a valve main body that is fixedly provided. When the valve body is rotated by a predetermined angle by the driving means, a flow path is switched as described above.

[0069] In the flow-path switching device, since the valve body rotates while sliding with respect to the valve main body each time the flow path is switched as described above, the valve body may wear due to long use. When such wear occurs, the pressured water leaks between the valve body and the valve main body and may cause problems, such as weft insertion no longer being properly performed. Therefore, it is necessary to detect the wear (deterioration) of the valve body before the valve body is in the abnormality state that causes such problems to occur, and to replace the switching valve.

[0070] In the switching valve, when such wear above occurs, as the pressured water is supplied, the valve body vibrates and the entire switching valve vibrates. The vibration increases as the wear of, for example, the valve body mentioned above progresses. Accordingly, in order to know the deterioration state of the switching valve, the abnormality diagnosing apparatus of the present invention is used. In the case of this example, the valve body (the switching valve) that wears (deteriorates) as described above is the so-called "deterioration component" in the present invention, and the state in which the wear has progressed by a degree requiring replacement is the abnormality state.

[0071] Even in this example, as in the example of the planetary selvage device mentioned above, it is possible to know the deterioration state of the switching valve on the basis of the magnitude of the vibration. Moreover, the determination processing in which whether or not the switching valve is in the abnormality state is determined is also performed as in the example of the planetary selvage device mentioned above. However, the set value that is used in the determination processing is an allowable value (threshold value) of the acceleration that is determined on the basis of the acceleration of the vibra-

tion previously determined by, for example, a test, the vibration being generated when weaving has been performed by using the switching valve in the deterioration state requiring replacement. The vibration can be measured at a fixed portion of the flow-path switching device, such as a holder portion where the driving means mentioned above is mounted. Therefore, the vibration sensor is mounted on a fixed portion, such as the holder portion.

[0072] (2) The aforementioned practical example is an example in which the abnormality diagnosing apparatus 100 includes the converter 70b1 that performs the conversion processing for determining the actual data regarding the diagnosis factor, and in which the converter 70b1 is provided in the CPU 70b of the host computer 70. That is, the aforementioned practical example is an example in which the actual data that is used in the determination processing, in which whether or not a weaving-related device is in the abnormality state is determined, is determined in the host computer, which is installed in a weaving factory, separately from the abnormality detecting device. However, a portion of, for example, the converter for determining the actual data may be provided in the abnormality detecting device.

[0073] In this case, the data that is transmitted to the abnormality detecting device is not actual data as that in the aforementioned practical example, but is vibration data. In the abnormality detecting device, as in the CPU of the host computer of the example mentioned above, the actual data regarding the diagnosis factor is determined on the basis of the vibration data.

[0074] (3) The aforementioned practical example is an example in which the abnormality detecting device that performs the determination processing is provided at a manufacturer. However, in the present invention, the abnormality detecting device may be provided in a weaving factory instead of at the manufacturer. In this case, the abnormality device may be provided separately from the host computer in the weaving factor, or may be provided so as to be included in the host computer (the host computer functions as the abnormality detecting device). When the abnormality detecting device is included in the host computer, the memory of the host computer can be used as the storage unit of the abnormality detecting device. Further, each loom installed in the weaving factory may include the abnormality diagnosing apparatus.

[0075] (4) Regarding the diagnosis factor and the diagnosis standard regarding the vibration for the determination process, in the examples described above, the diagnosis factor is the acceleration of the vibration and the diagnosis standard is the magnitude of the acceleration. However, in the present invention, it is possible to perform the determination processing with the diagnosis factor being the amplitude of the vibration. In this case, the diagnosis standard is set as a value regarding the magnitude of the amplitude. The actual data regarding the amplitude can be determined by, for example, calculation using the acceleration data of the aforementioned practical example, or on the basis of a vibration signal

from a displacement sensor serving as the vibration sensor.

[0076] The diagnosis factor is not limited to parameters regarding individual vibrations, such as the acceleration of the vibration and the amplitude of the vibration, and can be determined by, for example, calculation (group of calculations) using a plurality of the parameters. In this case, the diagnosis standard is related to the determined diagnosis factor and is determined on the basis of, for example, a calculated value for the actual deterioration state. Further, when the diagnosis factor and the diagnosis standard are determined in this way, they may be determined using AI (artificial intelligence), and the determination processing may also be performed by using AI. That is, AI may be installed in the abnormality detecting device. In this case, using information that is obtained from actual weaving and that is accumulated, it is possible to automatically update the diagnosis factor and the diagnosis standard to an optimal diagnosis factor and an optimal diagnosis standard.

[0077] The present invention is not limited to the embodiments mentioned above and can be variously changed without departing from the spirit of the present invention.

Claims

1. An abnormality diagnosing apparatus (100) for diagnosing abnormality of a weaving-related device (10) that is provided at a loom (1) and that includes a drive member (12) that is driven by driving means (14), the abnormality diagnosing apparatus (100) comprising:

a vibration sensor (50) that is provided at the loom (1) and that measures vibration of the weaving-related device (10); and
an abnormality detecting device (90) that detects an abnormality state of the weaving-related device (10) based on a vibration signal from the vibration sensor (50).

2. The abnormality diagnosing apparatus (100) according to Claim 1, wherein the abnormality detecting device (90) includes

a storage unit (90b) that stores a diagnosis standard regarding a diagnosis factor related to the vibration, and
a determining unit (90a) that determines whether or not the weaving-related device (10) is in the abnormality state by comparing actual data regarding the diagnosis factor that is determined based on the vibration signal with the diagnosis standard.

FIG. 1

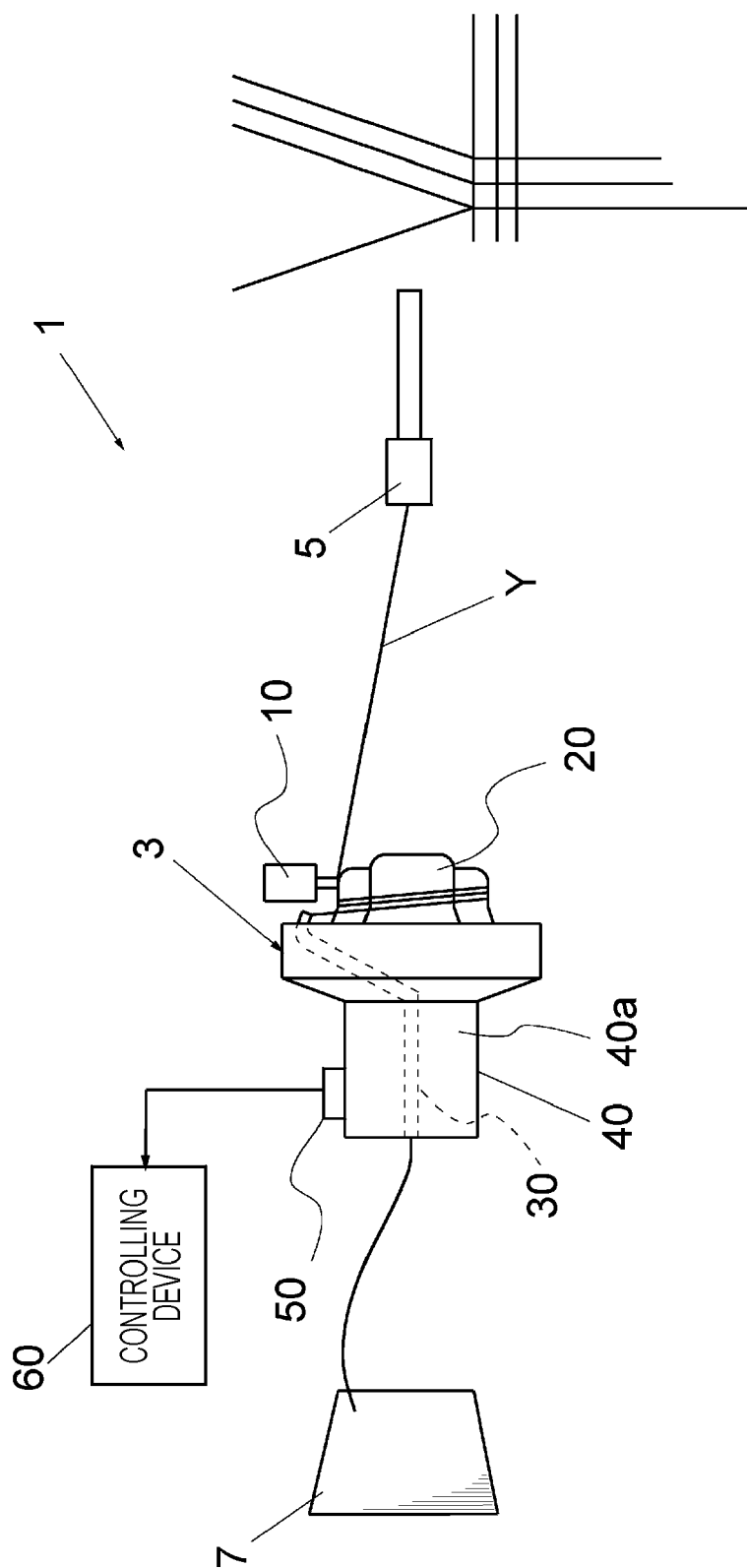


FIG. 2

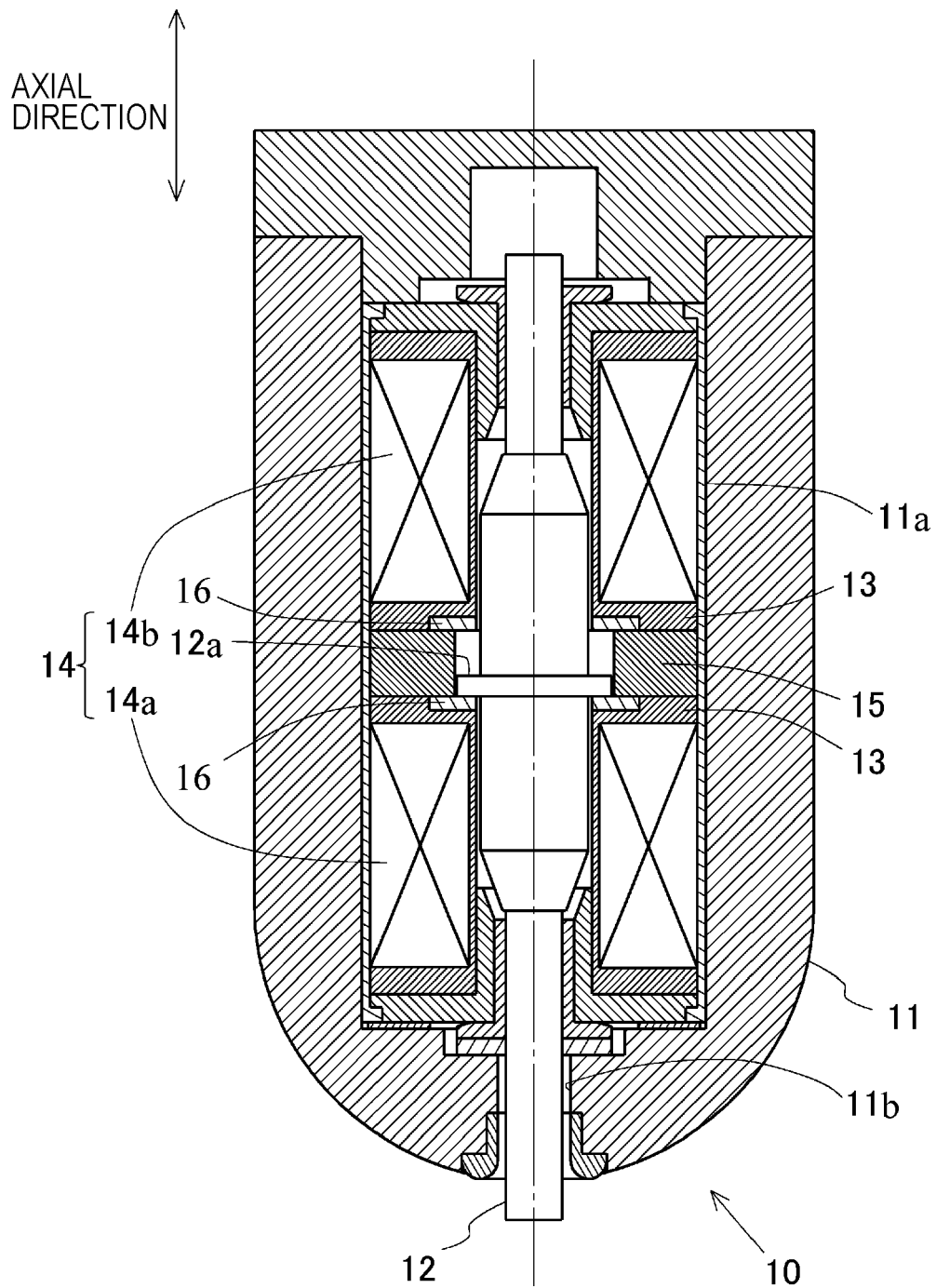
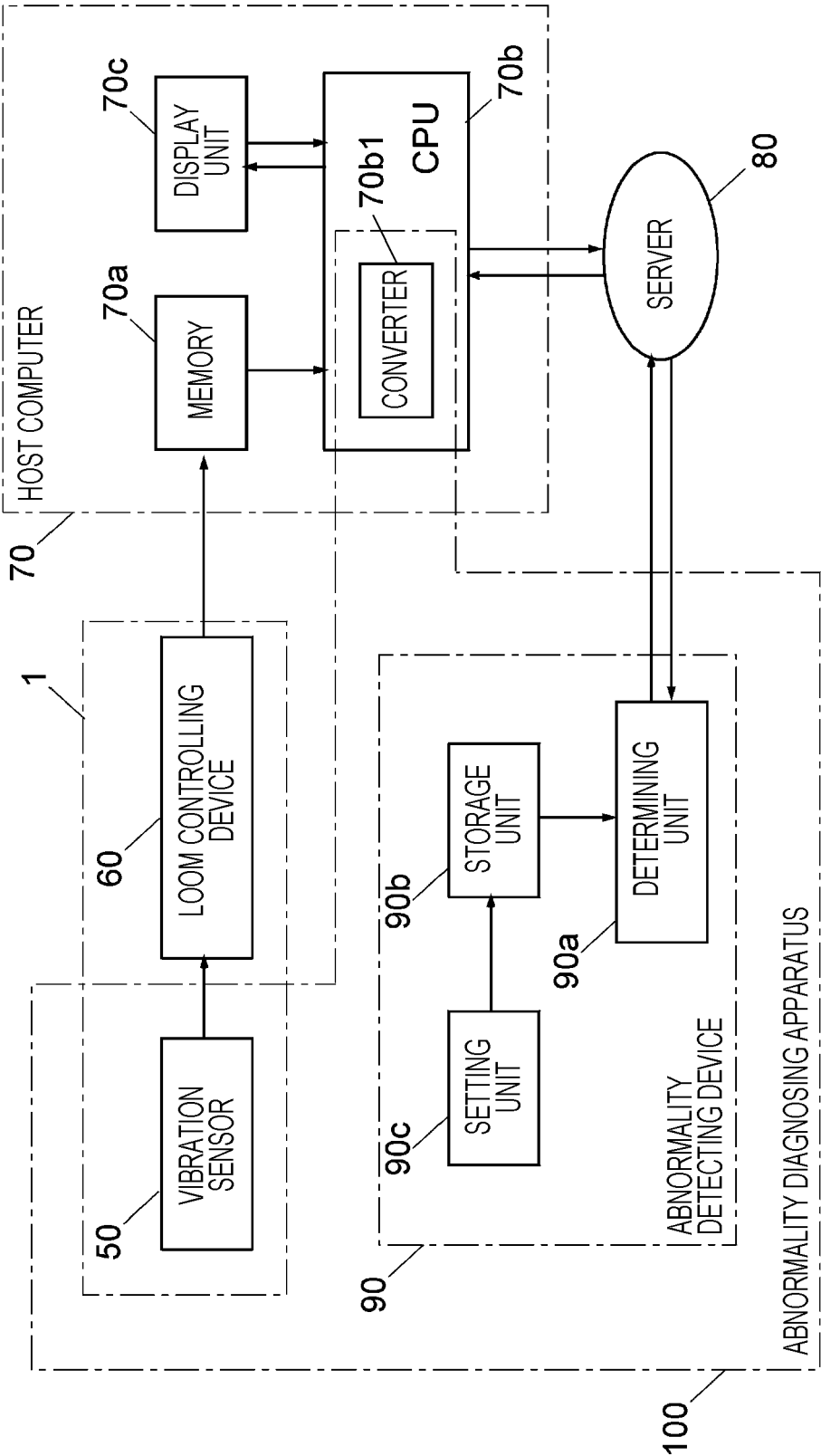


FIG. 3





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