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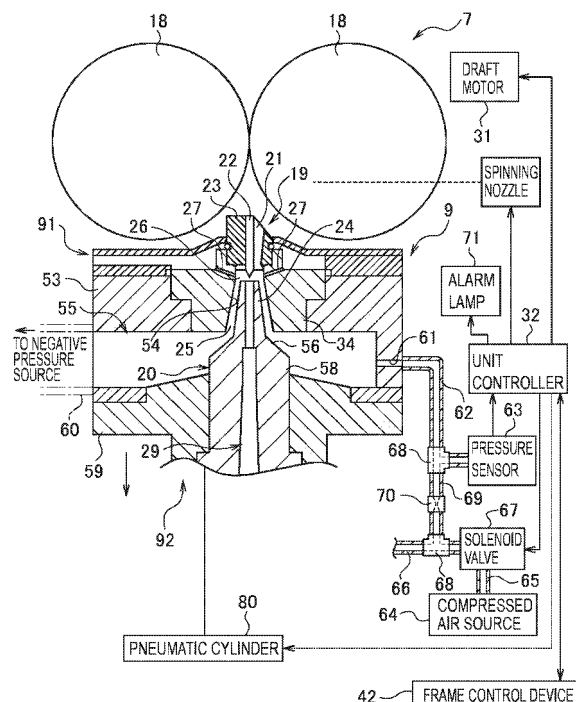
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(54) **Spinning apparatus**

(57) The present invention provides a spinning apparatus that collectively manages pressures in a plurality of air spinning units (2). A spinning machine (1) includes a plurality of spinning units (2), and a unit controller (32) and a frame control device (42) which serve as a pressure collective management device. Each of the air spinning units (2) includes a whirling flow generating chamber (25) and a pressure sensor (63). The whirling flow generating chamber (25) internally generates a whirling air flow to twist fibers. The pressure sensor (63) detects pressure inside the whirling flow generating chamber (25). The unit controller (32) includes a receiving section (28) and a pressure abnormality determining section (37). The receiving section (28) can receive a pressure value signal from each of the pressure sensors (63). The pressure abnormality determining section (37) compares the pressure value with a predetermined threshold value to determine whether or not the pressure in each of the air spinning units (2) is abnormal.

FIGURE 3



Description

Field of the Invention

[0001] The present invention relates to a spinning apparatus including a plurality of air spinning units.

Background of the Invention

[0002] The Unexamined Japanese Patent Application Publication (Tokkai) No. 2006-132035 discloses a spinning apparatus (spinning machine) that twists fibers by means of a whirling air flow generated through an air spinning nozzle. In this configuration, a pressure sensor detects the pressure in an air discharging space that is connected to a hollow chamber for spinning. When a pressure detection value exceeds a threshold value preset for the pressure sensor, the spinning apparatus in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2006-132035 determines that a fiber accumulation state has been reached and stops a spinning operation. This configuration allows easy detection of a condition in which a spun yarn is likely to become defective.

[0003] The spinning apparatus in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2006-132035 includes a large number of air spinning units. The pressure sensor is provided in each of the air spinning units. The threshold value is preset for each of the pressure sensors. Each pressure sensor individually detects the fiber accumulation state through a comparison of the pressure detection value with the threshold value.

[0004] However, the above-described configuration needs to set the threshold value for each of the pressure sensors, and this operation is cumbersome. The configuration thus has difficulty in collectively changing the threshold values of the plurality of spinning units or appropriately setting the threshold values taking individual differences among the spinning units into account to improve product quality. Furthermore, the configuration in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2006-132035 fails to perform collective management of the spinning apparatus as a whole, including recording of changes in the detection value from each pressure sensor and determination of states. The configuration further requires configuration for setting the threshold values and detecting the fiber accumulation state, for each pressure sensor (each spinning unit). This increases the number of components of the spinning apparatus as a whole and thus the costs of the spinning apparatus.

Summary of the Invention

[0005] An object of the present invention is to provide a spinning apparatus that collectively manages the pressures in a plurality of air spinning units provided in the

spinning apparatus.

[0006] According to an aspect of the present invention, a spinning apparatus includes a plurality of air spinning units and a pressure collective management device. Each of the air spinning units includes a hollow chamber and a pressure sensor. The hollow chamber internally generates a whirling air flow to twist fibers. The pressure sensor detects pressure inside the hollow chamber. The pressure collective management device includes a pressure detection value receiving section and a pressure abnormality determining section. The pressure detection value receiving section is capable of receiving a pressure value signal from each of the pressure sensors. The pressure abnormality determining section compares the pressure value with a predetermined threshold value to determine whether or not the pressure in each of the air spinning units is abnormal.

[0007] Accordingly, the spinning apparatus can collectively detect pressure abnormality in the plurality of air spinning units. The air spinning units can thus be easily managed. Furthermore, each air spinning unit is not required to be provided with an individual configuration for determining whether or not the pressure is abnormal. Consequently, the configuration of the spinning apparatus can be simplified, thus reducing the costs of the spinning apparatus.

[0008] In the spinning apparatus, the pressure collective management device includes a storage section and a threshold value setting section. The storage section is capable of storing the threshold value for each of the air spinning units.

The threshold value setting section determines the threshold value based on the pressure value detected by the pressure sensor and stores the threshold value in the storage section.

[0009] This configuration enables the appropriate threshold value to be set depending on the individual differences among the air spinning units and among the pressure sensors. Thus, the abnormality can be adequately detected. Furthermore, the pressure collective management device collectively sets and stores the threshold values, allowing each of the air spinning units to be more easily managed.

[0010] In the spinning apparatus, the threshold value setting section preferably utilizes the pressure value of at least one of the air spinning units obtained during idle running, to set the threshold value for each of the air spinning units.

[0011] This configuration allows the tendency of the pressures in the air spinning units to be taken into account in setting the threshold values. Compared to a case in which the same threshold value is used for all the air spinning units, the above-described configuration can set a more suitable threshold value for each of the air spinning units.

[0012] In the spinning apparatus, the threshold value setting section preferably sets the threshold value for each of the air spinning units by multiplying the pressure

value of the air spinning unit obtained at a predetermined point in time during spinning, by a predetermined coefficient.

[0013] According to this configuration, even with the centralized management, suitable threshold values can be set for the individual air spinning units with variations, that is, individual differences, among the air spinning units taken into account. Thus, detection of a defective yarn and prevention of erroneous detection can be more accurately performed.

[0014] In the spinning apparatus, the threshold value setting section preferably can switch between a first mode and a second mode. In the first mode, the pressure value obtained when at least one of the air spinning units is idly operated is utilized to set the threshold value for each of the air spinning units. In the second mode, the threshold value of the air spinning unit is set by multiplying the pressure value of each of the air spinning unit obtained at the predetermined point in time during spinning, by the predetermined coefficient.

[0015] This configuration enables an operator to appropriately change the setting and thus set the appropriate threshold value depending on the situation. Thus, detection of a defective yarn and prevention of erroneous detection can be more accurately achieved.

[0016] In the spinning apparatus, the pressure collective management device includes a calibration executing section capable of calibrating each of the pressure sensors.

[0017] This configuration enables calibration to be collectively carried out for the pressure sensors in the plurality of air spinning units. Thus, each of the air spinning units can be more easily managed. Furthermore, the accuracy of the pressure detection value can always be maintained constant.

[0018] The spinning apparatus preferably further includes an information display section which can display information on the pressure sensor or the detection value from the pressure sensor.

[0019] This configuration can collectively or intensively display information on the pressures in the plurality of air spinning units. The operator can thus easily understand the situation of the spinning apparatus as a whole.

[0020] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

Brief Description of the Drawings

[0021]

Figure 1 is a front view of a spinning machine according to an embodiment of the present invention. Figure 2 is a longitudinal cross-sectional side view of a spinning machine according to an embodiment of the present invention.

Figure 3 is a longitudinal cross-sectional front view of a spinning section.

Figure 4 is a device block diagram of a pressure collective management device.

Figure 5 is a longitudinal cross-sectional front view of the spinning section when the spinning section is open.

Figure 6 is a drawing showing the spinning section during a spinning operation.

Figure 7 is a graph showing the pressure values of spinning units of the spinning apparatus obtained during idle running of the spinning units according to an embodiment of the present invention.

Figure 8 is a graph showing the pressure values of spinning units of a spinning apparatus obtained during spinning operation of the spinning units according to another embodiment of the present invention.

Detailed Description of the Preferred Embodiments

[0022] Preferred embodiments of the present invention will be described below with reference to the drawings.

[0023] As shown in Figure 1, a spinning machine 1 as a spinning apparatus includes a large number of spinning units (air spinning units) 2 arranged in a line. In the present embodiment, spinning unit groups 2G each including four spinning units 2 are provided. Furthermore, each of the spinning unit groups 2G includes one unit controller 32 described below. The spinning machine 1 includes a yarn splicing vehicle 3, a blower box 4, and a motor box 5. The yarn splicing vehicle 3 can travel in a direction in which the spinning units 2 are arranged.

[0024] The motor box 5 includes a frame control device 42. The frame control device 42 includes a control panel (information display section) 38. The control panel 38 has a color liquid crystal monitor 48. The control panel 38 can display information on the operational state of each of the spinning units 2 and yarn quality using texts, numerical values, charts, or graphs, in response to an appropriate operation of an operator. An input section 47 is provided in the vicinity of the color liquid crystal monitor 48. The input section 47 includes a plurality of input keys. The operator uses the input section 47 to select information that is to be displayed on the color liquid crystal monitor 48. Moreover, the input section 47 is used to transmit appropriate instructions to each of the spinning units 2 and to set various conditions.

[0025] As shown in Figure 1, each of the spinning units 2 includes a draft device 7, a spinning section 9, a yarn feeding device 11, and a winding device 12 as main components. The draft device 7 is provided in the upper portion of a housing 6 of the spinning machine 1. The spinning section 9 spins a fiber bundle 8 fed from the draft device 7. A spun yarn 10 discharged from the spinning section 9 is fed by the yarn feeding device 11. The spun yarn 10 is then wound by the winding device 12 to form a package 45.

[0026] The draft device 7 draws the sliver 13 into the fiber bundle 8. As shown in Figure 2, the draft roller 7 includes four rollers, that is, a back roller 14, a third roller 15, a middle roller 17, and a front roller 18. An apron belt 16 is provided on the middle roller 17.

[0027] A draft motor 31, which is an electric motor, is installed at an appropriate position in the housing 6. The back roller 14 and the third roller 15 are coupled to the draft motor 31 via a belt. The draft motor 31 is controllably driven and stopped by a control section 72 of the unit controller 32. In the spinning machine 1 in the present embodiment, an electric motor that drives the middle roller 17 and the front roller 18 is also provided in the housing 6 but is not shown in the drawings.

[0028] The yarn feeding device 11 includes a delivery roller 39 and a nip roller 40. The delivery roller 39 is supported by the housing 6 of the spinning machine 1. The nip roller 40 is located in contact with the delivery roller 39. The spun yarn 10 discharged from the spinning section 9 is sandwiched between the delivery roller 39 and the nip roller 40. The delivery roller 39 is then rotationally driven by an electric motor (not shown in the drawings) to feed the spun yarn 10 toward the winding device 12.

[0029] An alarm lamp (alarm means) 71 is provided on the front surface of the housing 6. The alarm lamp 71 can inform the operator whether or not an error is occurring in the spinning section 9. The alarm lamp 71 is connected to the unit controller 32.

[0030] As shown in Figures 1 and 2, the yarn splicing vehicle 3 includes a splicer (yarn splicing device) 43, a suction pipe 44, and a suction mouth 46. As shown in Figure 1, the yarn splicing vehicle 3 travels on a rail 41 provided in the housing 6 of a main frame of the spinning machine 1. When yarn breakage or cutting occurs in one of the spinning units 2, the yarn splicing vehicle 3 travels to and stops at such spinning unit 2. A suction pipe 44 moves pivotally around a shaft in a vertical direction, while sucking a yarn end discharged from the spinning section 9. The suction pipe 44 thus catches and guides the yarn end to the splicer 43. A suction mouth 46 moves pivotally around a shaft in the vertical direction, while sucking a yarn end from a package 45, which is rotatably supported by the winding device 12. The suction mouth 46 thus catches and guides the yarn end to the splicer 43. The splicer 43 then splices the guided yarn ends.

[0031] As shown in Figures 2 and 3, the spinning section 9 includes two divisional blocks, that is, a first block 91 and a second block 92. In a traveling direction of fiber bundle 8, the second block 92 is provided on the downstream side of the first block 91. As shown in Figure 3, the first block 91 includes an air spinning nozzle 19. The second block 92 includes a hollow guide shaft 20. While the fiber bundle 8 fed from the front roller 18 is being inserted through the air spinning nozzle 19, the air spinning nozzle 19 allows a whirling flow to act on the fiber bundle 8. The hollow guide shaft 20 is located so that a tip portion of the hollow guide shaft 20 can be inserted into the air spinning nozzle 19 with the axes of the hollow

guide shaft 20 and the air spinning nozzle 19 aligned with each other.

[0032] The air spinning nozzle 19 includes a needle holder 23 and a nozzle block 34. The first block 91 includes a nozzle section casing 53. The first block 91 supports the nozzle block 34 via the nozzle section casing 53. A guide hole 21 is formed in the needle holder 23. The fiber bundle 8 drafted by the draft device 7, which is located on the upstream side of the needle holder 23, is introduced into the guide hole 21. The needle holder 23 holds a needle 22 located on a travelling path of the fiber bundle 8 discharged from the guide hole 21.

[0033] A taper hole 54 is formed in the nozzle block 34 on the downstream side of the needle holder 23. A tip portion 24 of the hollow guide shaft 20 is inserted into the taper hole 54 with the axes of the hollow guide shaft 20 and the taper hole 54 aligned with each other. The tip portion 24 is tapered. The taper angle of the tip portion 24 is almost equal to that of the taper hole 54. A circular spinning chamber 26 is formed between the tip surface of the hollow guide shaft 20 and the needle holder 23. The tip of the needle 22 projects into the spinning chamber 26. The tip of the needle 22 is located facing the tip surface of the hollow guide shaft 20.

[0034] The tip portion 24 of the hollow guide shaft 20 is located to form a predetermined gap between the tip portion 24 and the taper hole 54. Thus, a whirling flow generating chamber (hollow chamber) 25 is formed. The whirling flow generating chamber 25 is connected to the spinning chamber 26. An air discharging space 55 is formed in the nozzle section casing 53. The air discharging space 55 is connected to the whirling flow generating chamber 25. A negative pressure source (suction means; not shown in the drawings) located in the blower box 4 is connected to the air discharging space 55 through a line 60.

[0035] A plurality of whirling flow generating nozzles 27 are formed in the nozzle block 34. The outlet end of each of the whirling flow generating nozzles 27 is open to the spinning chamber 26. The whirling flow generating nozzle 27 is formed of an elongate hole formed in the nozzle block 34. The holes of the whirling flow generating nozzles 27 are formed in the tangential direction of the spinning chamber 26. The longitudinal direction of the hole of each of the whirling flow generating nozzles 27 is slightly inclined to a yarn-feeding downstream side. The whirling flow generating nozzle 27 ejects compressed air fed from a compressed air source (not shown in the drawings) into the spinning chamber 26 to generate a whirling flow flowing counterclockwise in a plan view, in the spinning chamber 26 (see Figure 6). The whirling flow flows spirally to the downstream side along the whirling flow generating chamber 25 and is then discharged from the air discharging space 55, which is formed in the nozzle section casing 53.

[0036] The hollow guide shaft 20 includes a cylinder 56. The tapered tip portion 24 is formed at one end of the cylinder 56. A yarn passage 29 is formed in an axial

portion of the hollow guide shaft 20. After the yarn passes through the yarn passage 29, the spun yarn 10 is discharged via an outlet hole located on the downstream side (not shown in the drawings).

[0037] The cylinder 56 includes a larger diameter portion 58 formed on the downstream side of the tip portion 24. The larger diameter portion 58 is exposed to the air discharging space 55. The second block 92 includes a shaft holding member 59. The larger diameter portion 58 is insertingly fixed to the shaft holding member 59.

[0038] The shaft holding member 59 is coupled to a pneumatic cylinder 80. Driving the pneumatic cylinder 80 allows the second block 92 to move away from the first block 91 as shown by an arrow in Figure 3. Fibers may become stuck in the spinning chamber 26 or the whirling flow generating chamber 25 or accumulated in the air discharging space 55 and may be hindered from being sucked and removed by the negative pressure source. In this case, the stuck fibers can be easily removed by separating the shaft holding member 59 from the nozzle section casing 53 (that is, separating the second block 92 from the first block 91) and opening the air discharging space 55, the whirling flow generating chamber 25, and the spinning chamber 26. The pneumatic cylinder 80 is controlled by the unit controller 32 and can be actuated via an appropriate driving signal.

[0039] A penetrating pressure detecting hole 61 is formed in the nozzle section casing 53. The pressure detecting hole 61 is connected to a pressure sensor 63 via a tube 62. The pressure sensor 63 detects the pressure value of the air discharging space 55 and the pressure value of interior of the whirling flow generating chamber 25, which is connected to the air discharging space 55. The pressure sensor 63 transmits a pressure detection value to the unit controller 32. The unit controller 32 monitors the pressure detection value to detect whether or not fibers are accumulated in the air discharging space 55 and the whirling flow generating chamber 25. The detection of accumulation of fibers will be described below.

[0040] The spinning chamber 1 according to the present embodiment includes the appropriate compressed air source 64. The compressed air source 64 is connected to a cleaning line 66 via a compressed air tube 65. The cleaning line 66 allows compressed air to be ejected to, for example, the periphery of the guide hole 21 of the air spinning nozzle 19 for cleaning. A solenoid valve 67 is provided at the compressed air tube 65. The solenoid valve 67 is controllably opened and closed via an actuation signal from the unit controller 32. The cleaning line 66 is coupled to the tube 62 via a joint 68 and a relay pipe 69. An orifice 70 is provided in a middle portion of the relay pipe 69.

[0041] Next, with reference to the block diagram in Figure 4, the configuration of the pressure collective-management device according to the present embodiment will be described. As shown in Figure 4, in the present embodiment, one unit controller 32 is provided for one spinning unit group 2G composed of four spinning units

2. Each of the unit controllers 32 mainly includes a receiving section 28, a calculation executing section 30, an offset value storage section 33, a threshold value setting section 35, a storage section 36, and a pressure abnormality determining section 37. The frame control device 42 mainly includes the control panel 38. The unit controller 32 can transmit and receive information to and from the frame control device 42. Figure 4 shows only one spinning unit group 2G and one unit controller 32. However, the actual spinning machine 1 includes a plurality of the spinning unit groups 2G, and the number of the unit controllers 32 corresponds to the number of the spinning unit groups 2G provided. Each of the unit controllers 32 can transmit and receive information to and from the frame control device 42.

[0042] The receiving section 28 can receive analog pressure value signals from the plurality of pressure sensors 63. The receiving section 28 subjects a received pressure value signal to an A/D conversion and transmits the converted pressure value signal to the pressure abnormality determining section 37 and the like.

[0043] The calibration executing section 30 calibrates the pressure sensor 63 provided in each of the spinning units 2 at an appropriate timing or in response to an instruction input via the control panel 38 by the operator. The unit controller 32 includes the offset value storage section 33 that stores offset values determined during the calibration. The offset value storage section 33 is composed of, for example, a random access memory (RAM). The calibration and the offset value will be described below in detail.

[0044] The threshold value setting section 35 sets a threshold value that is used when the pressure abnormality determining section 37 determines that the pressure value from the pressure sensor 63 is abnormal. The unit controller 32 has the storage section 36 that stores the threshold values. The storage section 36 is composed of, for example, a RAM. The abnormal-pressure determination and the threshold value setting will be described below.

[0045] The control panel 38 includes the color liquid crystal monitor 48 as described above. The color liquid crystal monitor 48 can visually display information managed by the unit controller 32, for example, the pressure value, average pressure value, offset value, and threshold value of each of the pressure sensors 63, and an abnormality notification.

[0046] In the present embodiment, as described above, the unit controller 32 and the frame control device 42 can cooperate with each other in managing the pressure sensor 63 of each of the spinning units 2 (the management includes calibration, threshold value setting, and information display). Thus, the unit controller 32 and the frame control device 42 function as a pressure collective management device for the spinning machine 1.

[0047] Next, the calibration of the pressure sensor 63 will be described. First, the operator operates the input section 47 to specify the spinning unit 2 to which the

calibration will be carried out. At this time, the operator may specify all or only some of the plurality of spinning units 2. Once the operator specifies the spinning unit 2, a predetermined signal is transmitted to the calibration executing section 30. In response to the signal, the calibration executing section 30 calibrates the pressure sensor 63 of the specified spinning unit 2.

[0048] Specifically, the unit controller 32 activates the pneumatic cylinder 80 to retract the second block 92 from the first block 91. Thus, as shown in Figure 5, the air discharging space 55, the whirling flow generating chamber 25, and the spinning chamber 2 are opened. The pressure detecting hole 61 is opened to the atmospheric pressure. The pressure sensor 63 detects the pressure value of the atmospheric pressure. The resulting pressure value signal corresponds to the offset value of each of the pressure sensors 63.

[0049] The receiving section 28 receives the pressure value signal for the atmospheric pressure from each of the pressure sensors 63. The receiving section 28 then subjects the received pressure value signal to an A/D conversion. The receiving section 28 transmits the converted pressure value to the calibration executing section 30. The calibration executing section 30 stores the pressure value in a storage area in the offset value storage section 33 for each of the pressure sensors 63 as the offset value of the pressure sensor 63.

[0050] When the acquired offset value is much different from the normally expected detection value for the atmospheric pressure, the calibration executing section 30 determines that the pressure sensor 63 is abnormal (defective). The unit controller 32 lights the alarm lamp 71 of the spinning unit 2 having such pressure sensor 63 to notify the operator of the abnormality (defect) of the pressure sensor 63. Moreover, the calibration executing section 30 transmits a signal to the control panel 38 to display a sensor abnormality notification on the color liquid crystal monitor 48. As described above, by thus calibrating each of the pressure sensors 63 using the pressure detection values obtained when the air discharging space 55, the whirling flow generating chamber 25, and the spinning chamber 26 are open, a possible abnormality of the pressure sensor 63 can be reliably detected without being affected by the condition of any other portion (for example, a defect in the negative pressure source).

[0051] Meanwhile, when carrying out a doffing operation of a package 45 or when a yarn clearer (not shown in the drawings) detects a yarn defect, the spinning section 9 is temporarily stopped and the doffing operation or yarn splicing operation is started. While the spinning section 9 is thus stopped, the spinning chamber 26 can be opened, thus enabling the calibration and the abnormality detection to be performed.

[0052] Even when the pressure sensors 63 are collectively calibrated in response to the instruction of the operator or when the timing is right to open the spinning chamber 26 of the spinning unit 2, the calibration exe-

cuting section 30 automatically performs the calibration and abnormality detection on each of the pressure sensors 63. By thus automatically calibrating each of the spinning units 2 at the corresponding timing, the corresponding pressure sensor 63 can always be maintained in the appropriate state.

[0053] The operations of calibrating the pressure sensor 63 and checking the pressure sensor 63 for operation are completed as described above. Thereafter, the unit controller 32 activates the pneumatic cylinder 80. Thus, the shaft holding member 59 advances to the nozzle section casing 53 to close the spinning chamber 26, whirling flow generating chamber 25, and air discharging space 55 again as shown in Figure 3.

[0054] Next, the operation of the spinning machine 1 during spinning will be described below. First, at the beginning of the spinning operation, the unit controller 32 keeps the solenoid valve 67 open for a predetermined time to supply compressed air to the cleaning line 66. The periphery of the guide holes 21 of the air spinning nozzles 19 is thus cleaned.

[0055] At this time, the compressed air from the compressed air source 64 is fed to the pressure detecting hole 61 through the relay pipe 69. The compressed air is then ejected from the pressure detecting hole 61 to the air discharging space 55. As a result, even if fibers (described below in detail) are stuck in the pressure detecting hole 61, the stuck fibers can be blown away from the pressure detecting hole 61. The pressure sensor 63 can thus accurately measure the pressure in the opening portion of the pressure detecting hole 61. The amount of compressed air supplied is adjusted by the orifice 70 so as to prevent the pressure in the pressure detecting hole 61 from increasing sharply to deviate from an allowable measurement range of the pressure sensor 63.

[0056] Thereafter, the spinning section 9 starts the spinning operation. During the spinning operation, the fiber bundle 8 or the spun yarn 10 extends continuously from the front roller 18 through the guide hole 21, the spinning chamber 26, and the yarn passage 29 to the yarn feeding device 11. The yarn feeding device 11 applies a downstream side feeding force to the fiber bundle 8 or the spun yarn 10 to apply tension to the yarn.

[0057] As shown in Figure 6, the fiber bundle 8 discharged from the front roller 18 of the draft device 7 is fed from the guide hole 21 into the spinning chamber 26. In the spinning chamber 26, the fiber bundle 8 is subjected to the action of a whirling flow from the whirling flow generating nozzles 27. Thus, one end of each of the short fibers contained in the fiber bundle 8 is separated from the long fibers in the fiber bundle 8 that are to be the core fiber. The short fibers are thus opened. The short fibers are swung around and twisted in the whirling flow generating chamber 25. The twisting starts to propagate toward the front roller 18. However, the propagation is hindered by the needle 22. Consequently, the fiber bundle 8 fed from the front roller 18 is prevented from being twisted by the propagating twisting. Thus, the needle 22

functions as a twisting propagation preventing means. Most of the fibers twisted as described above are sequentially generated into a true twist yarn composed of wound fibers. The yarn passes through the yarn passage 29 and is discharged from the outlet hole (not shown in the drawings). The spun yarn 10 is fed via the yarn feeding device 11 and wound by the winding device 12.

[0058] Some fibers may be broken during the opening and twisting of the short fibers and fail to be twisted into the spun yarn 10. These fibers are fed from the whirling flow generating chamber 25 to the air discharging space 55 by the whirling flow generated through the whirling flow generating nozzle 27. The fibers are then sucked by the negative pressure source and thus discharged from the air discharging space 55 via the line 60.

[0059] Meanwhile, the fibers to be discharged via the line 60 as described above may form loops around the large diameter portion 58 and be accumulated in the air discharging space 55 as shown by reference numeral 90 in Figure 6. A possible cause of the accumulation is that the fibers are caught by a certain member inside the air discharging space 55 and fail to be discharged even with the suction flow from the negative pressure source. In this case, as the spinning operation progresses, the fibers are entangled with other fibers to grow gradually. The size of the fibers then exceeds the outer peripheral length of the larger diameter portion 58. Another possible cause is as follows. In the present embodiment, the shaft holding member 59 can be separated from the nozzle section casing 53 in order to facilitate a maintenance operation and to allow the pressure sensor 63 to be calibrated. After the maintenance operation or calibration, when attaching the shaft holding member 59 to a predetermined position where the shaft holding member 59 is located close to the nozzle section casing 53 as shown in the drawing, the fibers may be caught in the attaching portion. The caught fibers may be entangled with other fibers without being discharged to grow into the looped fibers 90.

[0060] As described above, when the fibers 90 grow to some degree in the air discharging space 55 to become like fly waste, the fibers 90 may hinder air from flowing from the whirling flow generating chamber 25 to the air discharging space 55. This may in turn hinder the normal whirling flow in the whirling flow generating chamber 25, reducing the strength of the yarn. Furthermore, when being swung around in the whirling flow generating chamber 25, the short fibers opened during the spinning operation may come into contact with the fibers accumulated around the periphery of the larger diameter portion 58 to hinder the twisting. Also in this sense, the strength of the yarn is reduced.

[0061] The pressures in the whirling flow generating chamber 25 and the air discharging space 55 are normally kept at appropriate negative values by the suction flow from the negative pressure source. However, when the fibers 90 are accumulated around the periphery of the hollow guide shaft 20, the accumulated fibers 90 may hinder the suction flow. As a result, the pressures in the

whirling flow generating chamber 25 and the air discharging space 55 may rise gradually to approach the atmospheric pressure. Thus, in the present embodiment, the pressure sensor 63 monitors the pressure in the opening portion of the pressure detecting hole 61 (the pressure in the air discharging space 55, which is connected to the whirling flow generating chamber 25) to detect the accumulation of the fibers 90.

[0062] Specifically, the above-described operation is as follows. That is, during the spinning operation, the pressure abnormality determining section 37 monitors changes in the detection value received from each of the pressure sensors 63 by the receiving section 28. When the detection value exceeds a preset threshold value, the pressure abnormality determining section 37 determines that the strength of the yarn is likely to be reduced. The pressure abnormality determining section 37 then automatically transmits an operation stop signal to the spinning unit 2.

[0063] Then, the driving of the draft motor 31 and the supply of the fiber bundle 8 to the spinning section 9 are immediately stopped. Moreover, the supply of compressed air to the air spinning nozzles 19 is stopped and the spinning operation is stopped. Then, the alarm lamp 71 is lighted to notify the operator that the fibers 90 are accumulated in the air discharging space 55. The pressure abnormality determining section 37 transmits a signal to the control panel 38 to enable a fiber accumulation notification to be displayed on the color liquid crystal monitor 48.

[0064] Thus, the operator can be quickly notified that the fibers 90 are accumulated in the air discharging space 55. As a result, the operator is urged to remove the fibers 90 from the air discharging space 55. The spinning unit 2 can thus be recovered to a condition in which the spinning unit 2 can perform the spinning operation.

[0065] The pressure sensor 63 is configured to output a pressure value within a predetermined pressure detection range. The present embodiment uses the pressure sensor 69 that can sufficiently measure variation in the pressure in the pressure detecting hole 61 using only a narrow middle portion of the pressure detection range. Thus, when the detection value from the pressure sensor 63 indicates a lower or upper limit value of the pressure detection range, this means that the pressure sensor 63 is defective. By monitoring whether or not the detection value from the pressure sensor 63 has reached the lower or upper limit value of the pressure detection range, the pressure abnormality determining section 37 determines whether or not the pressure sensor 63 is abnormal. When the pressure abnormality determining section 37 detects defect in the pressure sensor 63, the unit controller 32 notifies the operator of the defect via the alarm lamp 71. Moreover, the pressure abnormality determining section 37 transmits a signal to the control panel 38 to display a sensor defect notification on the color liquid crystal monitor 48.

[0066] As described above, the control panel (informa-

tion display section) 38 of the frame control device 42 can collectively or individually display information on the fiber accumulation state of each of the spinning units 2, a defect in the pressure sensor 63, and the like. In particular, various pieces of information on the plurality of spinning units 2 are collectively displayed to allow the operator to easily determine the state of the whole spinning apparatus to appropriately maintain and manage the spinning apparatus.

[0067] Next, the setting of the threshold value will be described. As a method for setting the threshold value, for example, a predetermined value can be uniformly set for all the spinning units 2. However, due to the individual differences among the pressure sensors 63 and among the spinning sections 9, varying the threshold value based on which the pressure is determined to be abnormal in each spinning unit 2 is advantageous in terms of determination accuracy.

[0068] The threshold value setting section 35 can set an individual threshold value for each spinning unit 2. The threshold value setting section 35 can use a first threshold value setting method or a second threshold value setting method as described below to set the threshold value.

[0069] First, the first threshold value setting method will be described. The first threshold value setting method sets the threshold value based on the pressure value obtained while each of the spinning units 2 runs idly. The term "idle running" as used herein means that with the draft device 7 stopped to stop the supply of the fiber bundle 8 and with the supply of compressed air from the compressed air source to the whirling flow generating nozzle 27 stopped, the spinning section 9 is not performing spinning. Even during the idle running, the negative pressure source connected to the line 60 continues the suction, thus maintaining the interior of the whirling flow generating chamber 25 at a negative pressure.

[0070] Figure 7 is a graph showing the results of measurement on a spinning machine including 80 spinning units 2, as an example of the pressure value of each of the spinning units 2 during the idle running. The spinning units 2 are provided so as to lie in a line in a lateral direction between the motor box 5 and the blower box 4 as shown in Figure 1. The serial numbers of the spinning units 2 are shown on the axis of abscissa in Figure 7; the serial numbers start from 1 for the spinning unit 2 located closest to the motor box 5 side. As shown in Figure 7, during the idle running, the pressure values of the pressure sensor 63 of the spinning units 2 exhibit a specific tendency such that the pressure value increases consistently with the distance from the blower box 4 (decreasing spinning unit number). This is because the negative pressure source is located in the blower box 4 and because a pressure loss occurs which is of a magnitude corresponding to the distance from the blower box 4.

[0071] As described above, during the idle running, the pressure value varies among the spinning units 2. Thus, setting the threshold value with the variation taken into

account enables detection of a decrease in yarn strength and abnormal pressure. For example, the threshold value of each of the spinning units 2 is set by multiplying the pressure value of the spinning unit 2 during the idle running by a prescribed coefficient (for example, 0.5) or offsetting the pressure value by a prescribed amount (the value obtained with variation in pressure during spinning taken into account, for example, +1.0 kPa).

[0072] As shown in the graph in Figure 7, the pressure values of the spinning units 2 exhibit the specific tendency during the idle running. Thus, for example, when the spinning apparatus is installed, all the spinning units 2 are idly operated so that the values corresponding to the inclination of the graph in Figure 7 can be stored in the pressure value storage section 73 provided in the frame control device 42. Thus, based on the pressure value of one spinning unit 2 during the idle running, the pressure values of the other spinning units 2 during the idle running can be calculated.

[0073] To set the threshold value for each of the spinning units 2, the spinning machine 1 according to the present embodiment detects, instead of the pressure values of all the spinning units 2, only the pressure value of the spinning unit 2 No. 80, which is provided closest to the negative pressure source. Further, any of the spinning units 2 can be selected for detecting the pressure value. For example, the pressure value of the spinning unit 2 (spinning unit 2 No. 1) located furthest from the negative pressure source may be detected during the idle running and stored.

[0074] Specifically, to set the threshold value for each of the spinning units 2 by the first threshold value setting method, the following operation is performed. First, the pressure value of, for example, the spinning unit 2 No. 80 is measured during the idle running. Then, such pressure value is multiplied by a coefficient, or such pressure value is offset by a given value. The operator then inputs the resulting value to the control panel 38 of the frame control device 42 as the threshold value of the spinning unit 2 No. 80.

[0075] The frame control device 42 transmits the threshold value input by the operator and the preset abnormality determination correction values to the threshold value setting section 35 of the unit controller 32. Further, the abnormality determination correction values are the values that have been determined based on the inclination of the graph of the pressure values of the spinning units 2 measured during the idle running. The threshold value setting section 35 newly calculates the threshold value of each of the spinning units 2 based on the received threshold value and the abnormality determination correction values. The threshold value setting section 35 then stores the calculated threshold values in the storage section 36.

[0076] Thus, the threshold values can be set with the original tendency of the pressures in the spinning units 2 taken into account. As a result, compared to the case in which the same threshold value is set for all the spin-

ning units 2, the threshold values can be set more reliably. The setting is based on the pressure values during the idle running and is thus unlikely to be affected by possible noise. As a result, stable threshold values can be set on every required occasion.

[0077] The threshold value of each of the spinning units 2 may be calculated, for example, as follows instead of using the method in which the operator presets the threshold value of the spinning unit 2 No. 80 as described above. That is, first, based on the pressure value of the spinning unit 2 No. 80 during the idle running and the inclination of the graph, the pressure value of each of the spinning units 2 during the idle running is calculated. The calculated value of each of the spinning units 2 is multiplied by a coefficient or offset by a given value to calculate the threshold value of each of the spinning units 2. This method allows the threshold values to be set with the tendency of the pressures in the spinning units 2 taken into account as described above.

[0078] Next, the second threshold value setting method will be described. The second threshold value setting method multiplies the pressure value of each of the air spinning units 2 measured at a predetermined point in time during the spinning, by a predetermined coefficient to obtain the threshold value of the air spinning unit 2.

[0079] Figure 8 is a graph for a spinning machine having 24 spinning units 2, showing a plot of the pressure values of the spinning units 2 measured during operation of the spinning apparatus. As shown in Figure 8, a clear tendency such as the one obtained during the idle running is not observed during the operation of the spinning apparatus. This is expected to be largely due to the individual differences among the spinning sections 9, for example, a difference in the direction of the whirling flow generating nozzle 27, in addition to the distance from the negative pressure source. The abnormality can be more accurately determined by setting the threshold value taking into account the individual differences among the spinning units 2, which are observed during the operation of the spinning apparatus.

[0080] However, when the threshold value is set based on the pressure value obtained during the operation of the spinning apparatus as described above, the appropriate threshold value cannot be determined unless the determination is based on the pressure in the normal condition (specifically, the condition in which the fibers 90 are not accumulated and the pressure sensor 63 is not defective). Furthermore, since no such specific tendency as obtained during the idle running is observed among the spinning units 2, the threshold value needs to be determined based on the pressure value detected in each of the spinning units 2.

[0081] Thus, the threshold value setting section 35 detects the pressure value of each of the spinning units 2 at a predetermined timing, for example, the beginning of the spinning operation, and multiplies the detected pressure value by a predetermined coefficient (for example, 0.5 to 0.6). The threshold value setting section 35 stores

the resulting value in a storage area of the storage section 36.

[0082] Thus, the suitable threshold value can be set for each of the spinning units 2 by a simple process of multiplying the pressure value by the given coefficient while eliminating the individual differences among the pressure sensors 63 and among the spinning sections 9. Furthermore, the collective management is facilitated by using the same coefficient for all the spinning units 2. Thus, detection of a defective yarn and prevention of erroneous detection can be accurately performed in an easily manageable manner.

[0083] The threshold value setting section 35 according to the present embodiment can switch between the first threshold value setting method and the second threshold value setting method in response to the instruction of an operator. Specifically, the color liquid crystal monitor 48 of the control panel 38 displays a switching setting screen for the operator to select the threshold setting method. The operator appropriately operates the input section 47 to switch the threshold value setting method for the threshold value setting section 35. Thus, a suitable threshold value setting method can be selected according to the type of the spun yarn, the operational status of the spinning apparatus, and the like.

[0084] As described above, the spinning machine 1 according to the present embodiment includes the plurality of spinning units 2, and the frame control device 42 and the unit controller 32, which serve as the pressure collective management device. Each of the air spinning units 2 includes the whirling flow generating chamber 25 and the pressure sensor 63. The whirling flow generating chamber 25 internally generates a whirling air flow to twist the fibers. The pressure sensor 63 detects the pressure inside the whirling flow generating chamber 25. The unit controller 32 includes the receiving section 28 and the pressure abnormality determining section 37. The receiving section 28 can receive the pressure value signal from each of the pressure sensors 63. The pressure abnormality determining section 37 compares the pressure value with the predetermined threshold value to determine whether or not the pressure in each of the air spinning units 2 is abnormal.

[0085] Accordingly, the generation of the pressure abnormality in the plurality of spinning units 2 can be detected at once. The spinning units 2 can thus be easily managed. Furthermore, each air spinning unit 2 need not individually include a configuration for determining whether or not the pressure is abnormal. Consequently, the configuration of the spinning apparatus as a whole can be simplified, thus reducing the costs of the spinning apparatus.

[0086] The unit controller 32 according to the present embodiment includes the storage section 36 and the threshold value setting section 35. The storage section 36 can store the threshold value for each of the air spinning units 2. The threshold value setting section 35 determines the threshold value based on the pressure value

detected by the pressure sensor 63 and stores the threshold value in the storage section 36.

[0087] Accordingly, an appropriate threshold value can be set according to the individual differences among the air spinning units 2 and among the pressure sensors 63. Thus, the abnormality can be adequately detected. Furthermore, the unit controller 32 and the frame control device 42 cooperatively and collectively sets and stores the threshold values, allowing each of the spinning units 2 to be more easily managed.

[0088] The threshold value setting section 35 according to the present embodiment utilizes the pressure value of at least one of the spinning units 2 obtained during idle running, to set the threshold value for each of the spinning units 2 (first threshold value setting method).

[0089] Accordingly, the threshold values can be set by taking into account the tendency of the pressure in the spinning units 2. Compared to a case in which the same threshold value is used for all the spinning units 2, a more suitable threshold value can be set for each of the spinning units 2.

[0090] The threshold value setting section 35 according to the present embodiment can set the threshold value for each of the spinning units 2 by multiplying the pressure value of the spinning unit 2 obtained at the predetermined point in time during the spinning, by the predetermined coefficient (second threshold value setting method).

[0091] According to this configuration, even with the centralized management, the suitable threshold values can be set for the individual spinning units 2 with variations caused by individual differences, among the spinning units 2 taken into account. Thus, detection of a defective yarn and prevention of erroneous detection can be more accurately performed.

[0092] The threshold value setting section 35 according to the present embodiment can switch between the mode in which the threshold value is set by the first threshold value setting method and the mode in which the threshold value is set by the second threshold value setting method.

[0093] This configuration enables the operator to appropriately change the threshold value setting method and thus set the appropriate threshold value depending on the situation. Thus, detection of a defective yarn and prevention of erroneous detection can be more accurately achieved.

[0094] The unit controller 32 according to the present embodiment includes the calibration executing section 30 that can calibrate the pressure sensors 63 of the plurality of spinning units 2.

[0095] Accordingly, calibration can be collectively carried out on the pressure sensors 63 of the plurality of spinning units 2. Furthermore, the pressure sensors 63 of the spinning units 2 can be individually calibrated at appropriate timings. Thus, each of the spinning units 2 can be more easily managed. Additionally, the accuracy of the pressure detection value can always be maintained

constant.

[0096] The spinning machine 1 according to the present embodiment includes the control panel (information display section) 38 that can display information on the pressure sensor 63 or the detection value from the pressure sensor 63.

[0097] Accordingly, information on the pressures in the plurality of spinning units 2 can be displayed collectively or intensively. The operator can thus easily understand the situation of the spinning machine 1 as a whole.

[0098] The preferred embodiment of the present invention has been described above. However, the above-described configuration can be modified as described below. A single detection value may be utilized as the offset value of the pressure sensor 63. However, the offset value may be an average pressure value calculated by the calibration executing section 30 from a predetermined number of pressure values sampled and received from the pressure sensor 63 by the receiving section 28 each time when the whirling flow generating chamber 25 is opened. In this case, the use of the average value means the use of a more reliable value, thus enabling more accurate calibration. As the frequency of the sampling or the number of sampling operations performed, any numerical value can be appropriately set by operating the input section 47.

[0099] The first threshold value setting method may be modified as follows. That is, the pressure value may be sampled a plurality of times during the idle running. The threshold value setting section 35 may then determine the average value of the plurality of sampled pressure values. Based on the average value, the threshold value may be set. Thus, an appropriate threshold value can be set without being affected by possible noise during the measurement. The second threshold value setting method can also exert similar effects by modifying as follows. That is, the threshold value may be set based on the average value of the pressure values obtained during the operation of the spinning apparatus. The pressure value varies more significantly during the operation of the spinning apparatus than during the idle running. Thus, the second threshold value setting method is particularly preferable to use the average value.

[0100] The pressure abnormality determining section 37 may use an average value of a predetermined number of sampled pressure values (for example, a moving average value) as the pressure value of each of the spinning units 2 to be compared with the threshold value. Thus, the abnormality determination can be accurately performed without being affected by possible noise.

[0101] The method by which the control panel 38 displays information is not limited to the color liquid crystal monitor. The information can be displayed by appropriate means such as a monochromatic liquid crystal or a light emitting diode (LED) display.

[0102] The configuration in which the threshold value setting section 35 automatically sets the threshold value can be changed to a configuration in which the operator

can individually designate threshold values for the respective spinning units 2. In this case, for example, the operator instructs the color liquid crystal monitor 48 of the control panel 38 to display the switching setting screen for selecting the threshold value setting method. The operator appropriately operates the input section 47 to input numerical values, and a desired threshold value is stored in a predetermined storage area of the storage section 36. Thus, for example, a particular spinning unit 2 can be exclusively operated under different conditions.

[0103] The frame control device 42 can be implemented by, for example, a personal computer (PC) externally connected to the spinning machine 1 and software, instead of being provided in the motor box 5.

[0104] Alternatively, the control panel 38 can also be used to view and set various other pieces of information on the spinning machine 1. For example, the control panel 38 can be configured to enable accesses to information such as yarn quality information on each of the spinning units 2, the history of past pressure values, and the sampling period (frequency) of the pressure sensor 63. With this configuration, for example, the operator can check the historical information to easily determine that maintenance needs to be performed on a particular spinning unit 2 because the fibers 90 are likely to be accumulated in such a particular spinning unit 2.

[0105] The position of the pressure detecting hole 61 can be changed provided that the pressure detecting hole 61 is open to a wall surface of the whirling flow generating chamber 25 or the air discharging space 55. The pressure detecting hole 61 may be formed in, for example, the shaft holding member 59.

[0106] Various conditions can be used to determine that the fibers 90 are accumulated in the air discharging space 55 (in other words, the condition for determining that the pressure in the air discharging space 55 has risen). For example, the determination condition may be that the detection value from the pressure sensor 63 has exceeded the above-described threshold value even for a moment or that a period of time for which the detection value exceeds the threshold value has lasted longer than a predetermined period of time.

[0107] The position where the alarm lamp 71 is provided and how the alarm lamp 71 is lighted on or turned off are not limited to the above-described embodiment. During normal state, the alarm lamp 71 may be lighted on. When a determination is made that the fibers 90 are accumulated in the air discharging space 55, the alarm lamp 71 may be turned off. The alarm means is not limited to the alarm lamp 71. The alarm means may be a buzzer or the like. The alarm means may be other forms as long as the alarm means can visually or acoustically notify the operator of the fiber accumulation state.

[0108] The pressure sensor 63 and the pressure detecting hole 61 are applicable not only to the spinning section 9 using the hollow guide shaft 20 but also to a spinning section of a different configuration.

[0109] The configuration for separating and contacting

the first block 91 and the second block 92 from and with each other may be changed from the pneumatic cylinder 80 to, for example, a combination of a cam and an electric motor or a solenoid.

[0110] An appropriate calculating formula may be used for calculating the average of measured pressure values. For example, a simple moving average, a weighted moving average, or an index weighted moving average may be used for the calculation.

[0111] The pneumatic cylinder 80 is adapted to separate and contact the second block 92 from and with the first block 91. However, the pneumatic cylinder 80 may be provided on the first block 91 side so that the first block 91 is separated from and contacted with the second block 92.

[0112] Alternatively, possible noise may be removed by attaching a mechanical damper or the like between the joint 68 and the pressure sensor 63 or to the tube 62 between the pressure detecting hole 61 and the joint 68.

[0113] In the above-described embodiment, one spinning unit group 2G is composed of four spinning units 2. However, the number of spinning units provided in each spinning unit group 2G may be one or any plural number.

[0114] In the above-described embodiment, the pressure collective management device includes the unit controller 32 and the frame control device 42. The unit controller 32 mainly includes the calibration executing section 30, the threshold value setting section 35, and the pressure abnormality determining section 37. The frame control device 42 mainly includes the control panel 38. The functions of the pressure collective management device are divided between the unit controller 32 and the frame control device 42 so that the unit controller 32 provides the control function, whereas the frame control device 42 provides the monitor function and the setting function. However, the pressure collective management device may be configured such that the functions are not divided between the unit controller 32 and the frame control device 42 but for example, the frame control device 42 includes the configuration of the unit controller 32 according to the above-described embodiment.

[0115] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the scope of the invention.

Claims

1. A spinning apparatus comprising:

a plurality of air spinning units (2) and a pressure collective management device (32, 42),

wherein each of the air spinning units (2) includes:

a hollow chamber (25) that internally generates a whirling air flow to twist fibers, and a pressure sensor (63) that detects pressure inside the hollow chamber (25), and the pressure collective management device (32, 42) includes:

a pressure detection value receiving section (28) that can receive a signal of a pressure value from each of the pressure sensors (63); and a pressure abnormality determining section (37) that compares the pressure value with a predetermined threshold value to determine whether or not pressure in each of the air spinning units (2) is abnormal.

2. The spinning apparatus according to Claim 1, **characterized in that** the pressure collective management device (32, 42) includes:

a storage section (36) that can store the threshold value for each of the air spinning units (2), and a threshold value setting section (35) that determines the threshold value based on the pressure value detected by the pressure sensor (63) and stores the threshold value in the storage section (36).

3. The spinning apparatus according to Claim 2, **characterized in that** the threshold value setting section (35) utilizes the pressure value of at least one of the air spinning units (2) obtained during idle running, to set the threshold value for each of the air spinning units (2).

4. The spinning apparatus according to Claim 2, **characterized in that** the threshold value setting section (35) sets the threshold value for each of the air spinning units (2) by multiplying the pressure value of each of the air spinning units (2) obtained at a predetermined point in time during spinning, by a predetermined coefficient.

5. The spinning apparatus according to Claim 2, **characterized in that** the threshold value setting section (35) can switch between:

a first mode in which the threshold value for each of the air spinning units (2) is set by utilizing the pressure value obtained when at least one of the air spinning units (2) is idly operated, and a second mode in which the threshold value of each of the air spinning units (2) is set by multiplying the pressure value of each of the air spin-

ning units (2) obtained at a predetermined point in time during spinning, by a predetermined coefficient.

6. The spinning apparatus according to any one of Claims 1 to 5, **characterized in that** the pressure collective management device (32, 42) includes a calibration executing section (30) that can calibrate each of the pressure sensors (63).

7. The spinning apparatus according to any one of Claims 1 to 6, **characterized by** further comprising an information display section (38) that can display information on the pressure sensor (63) or a detection value from the pressure sensor (63).

FIGURE 1

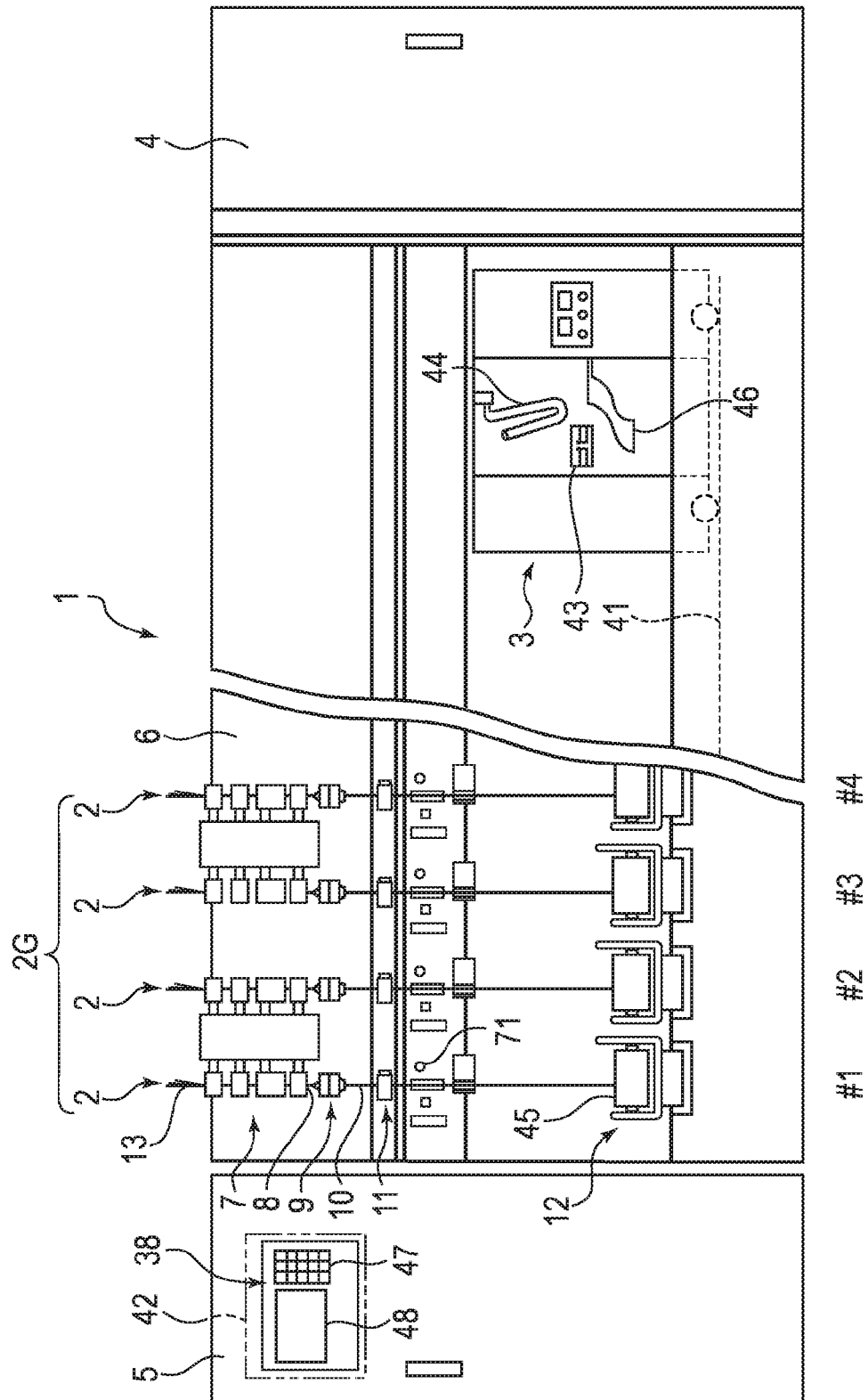


FIGURE 2

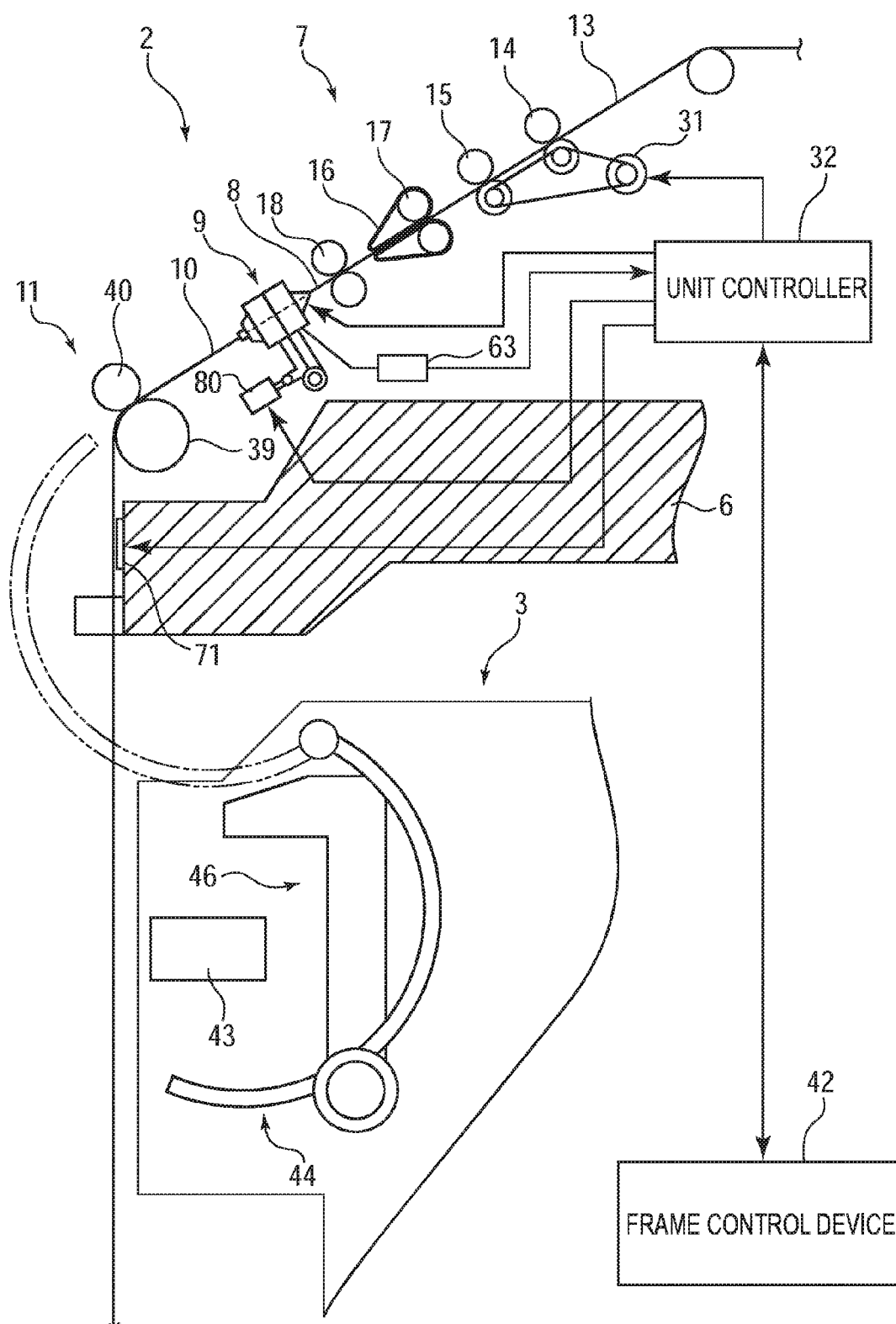


FIGURE 3

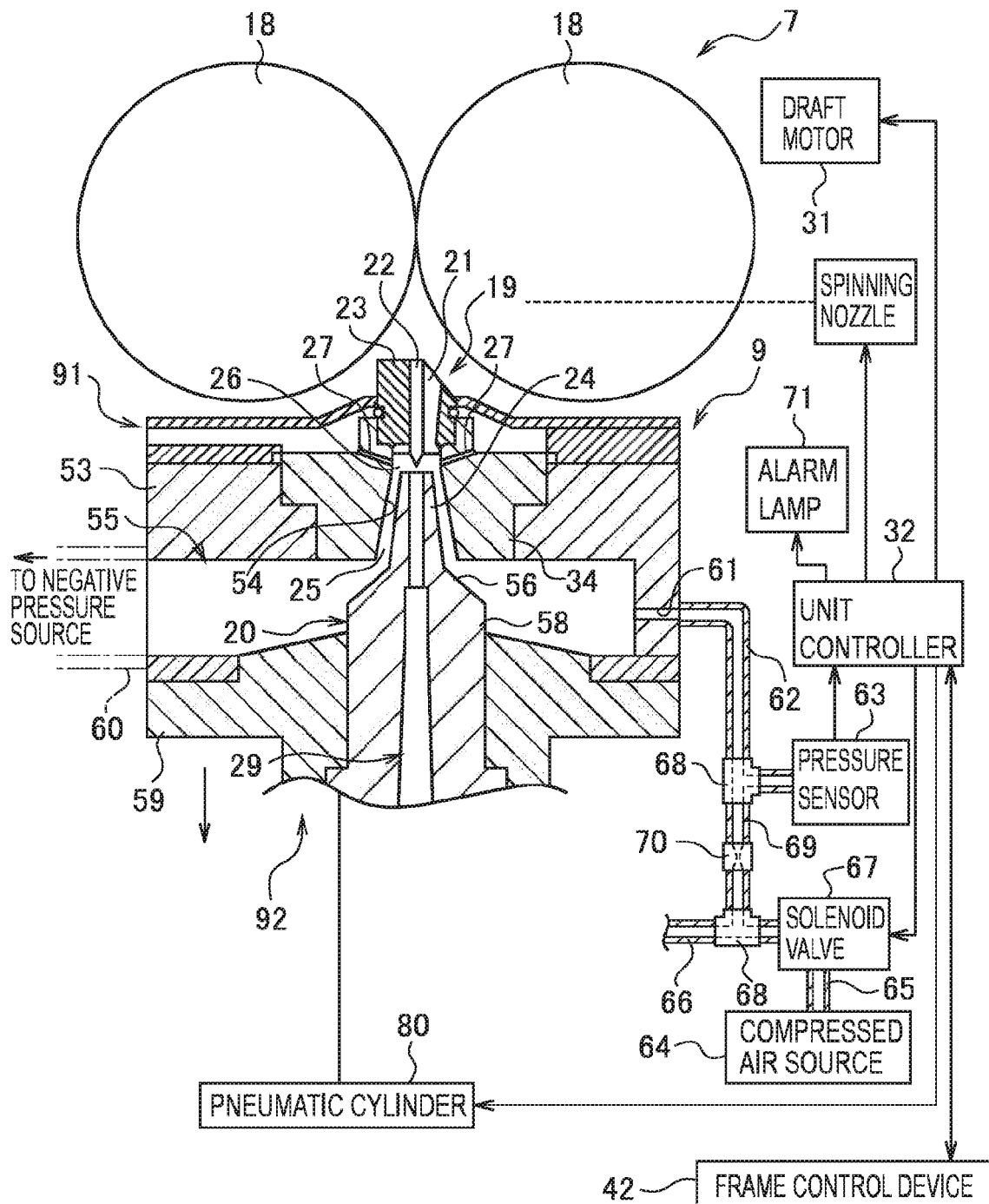


FIGURE 4

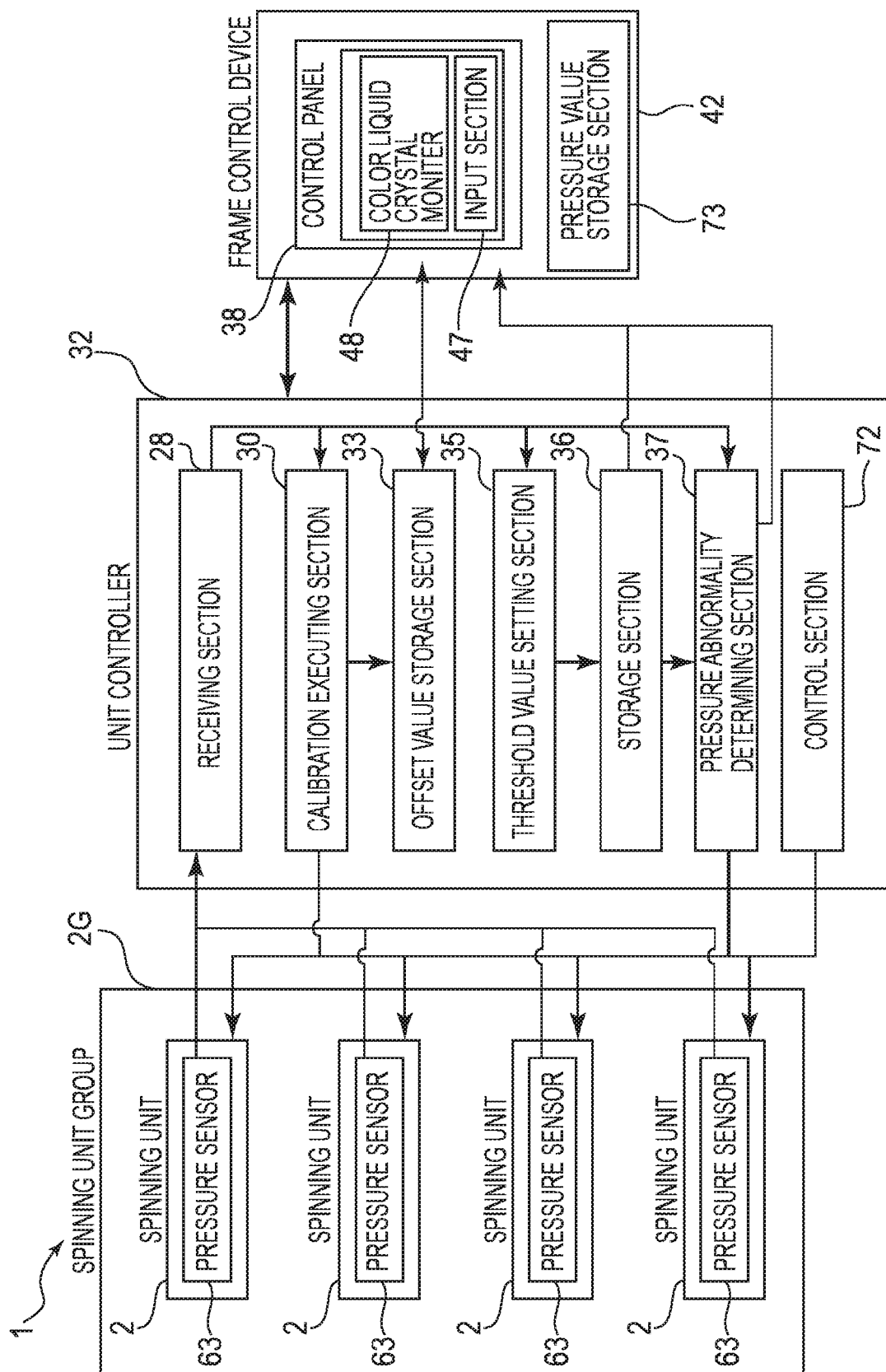


FIGURE 5

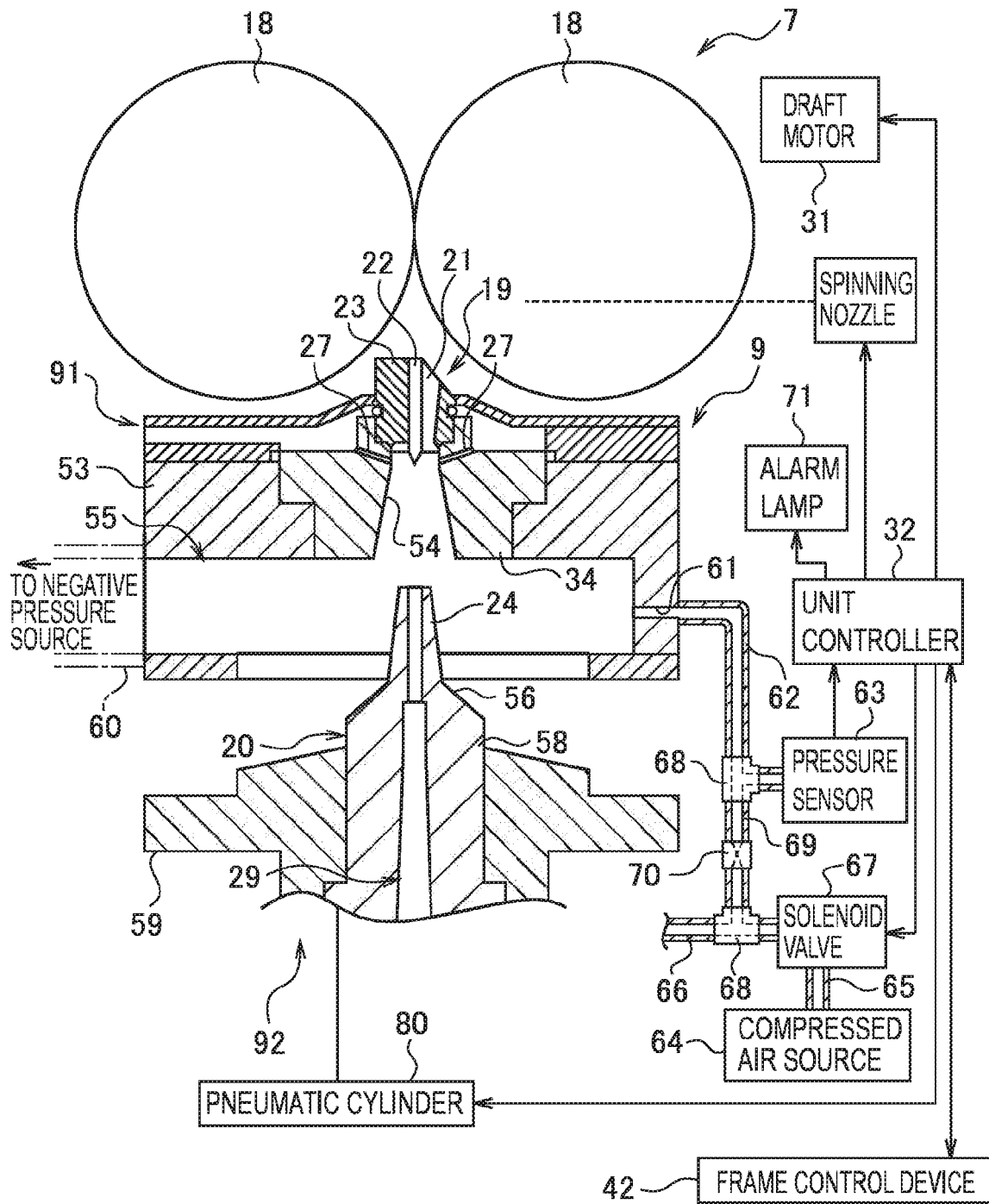


FIGURE 6

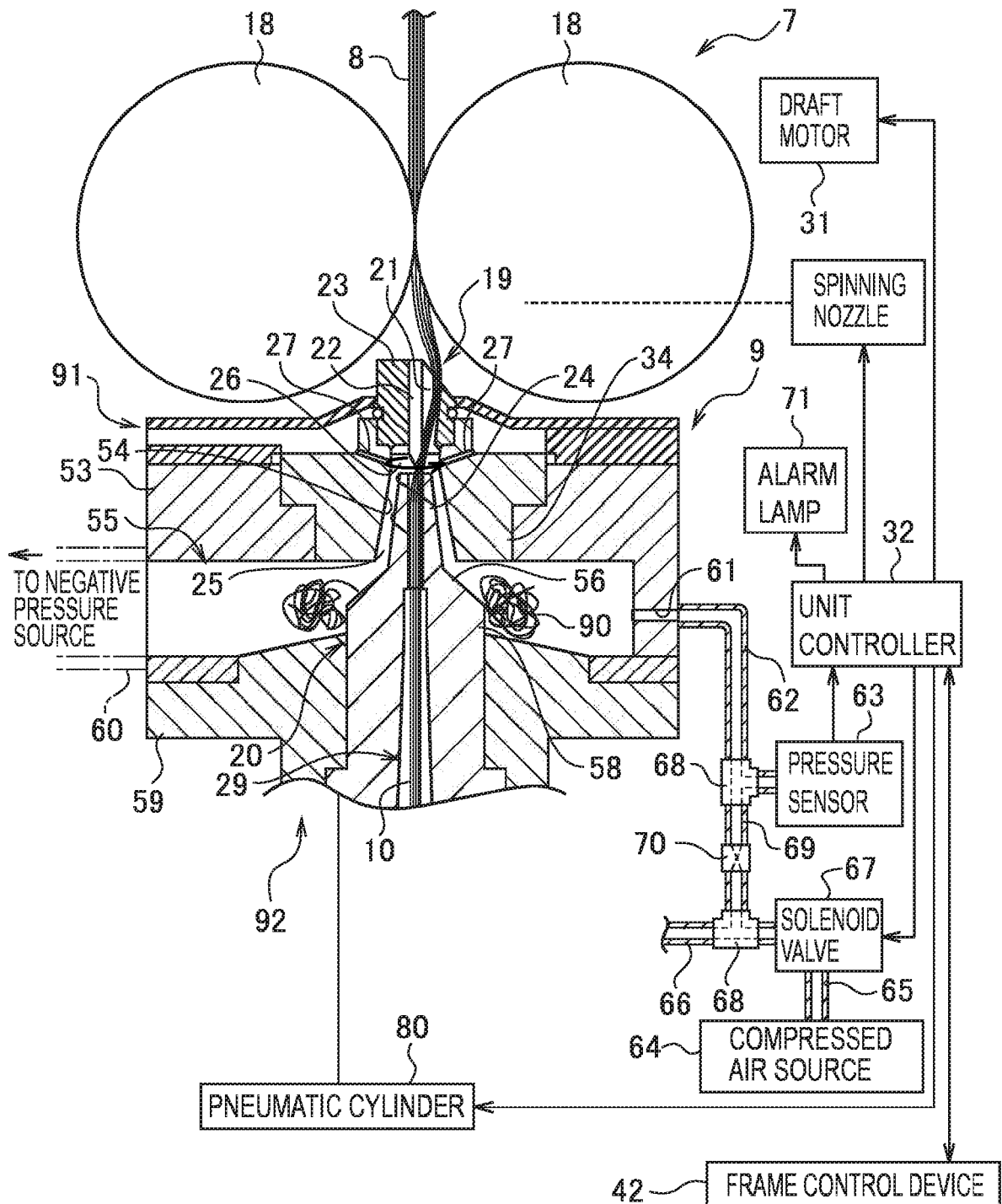


FIGURE 7

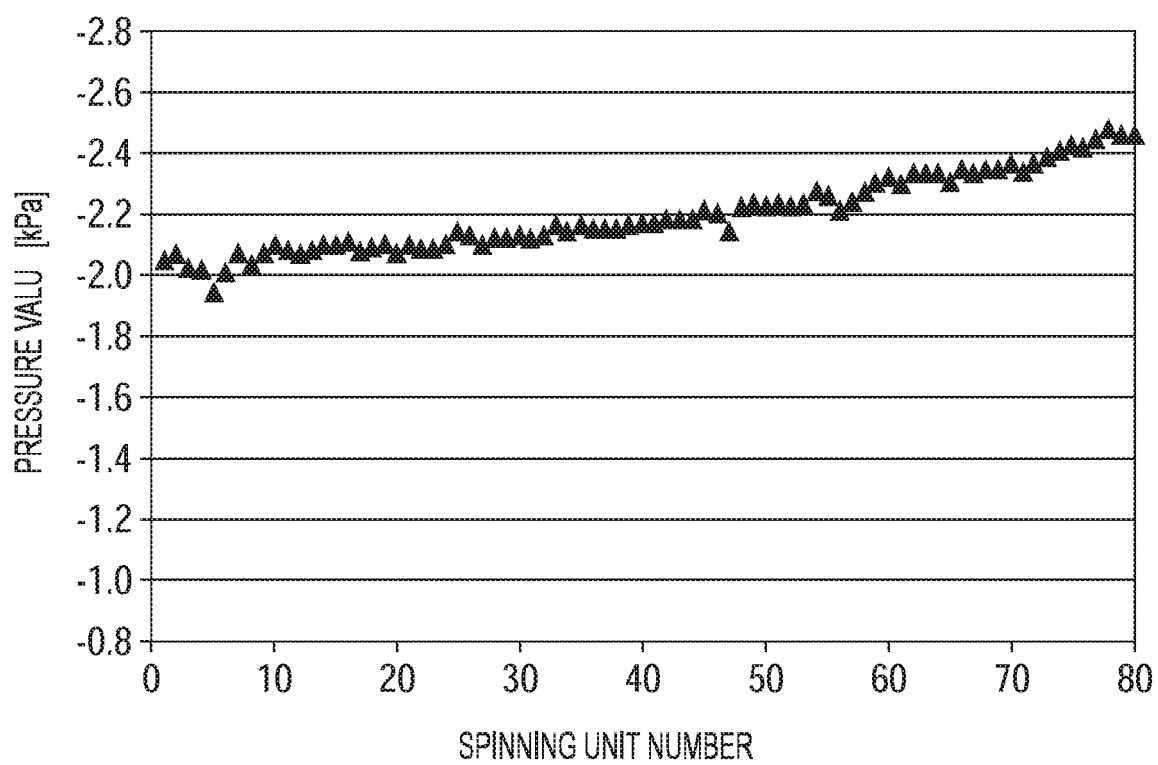
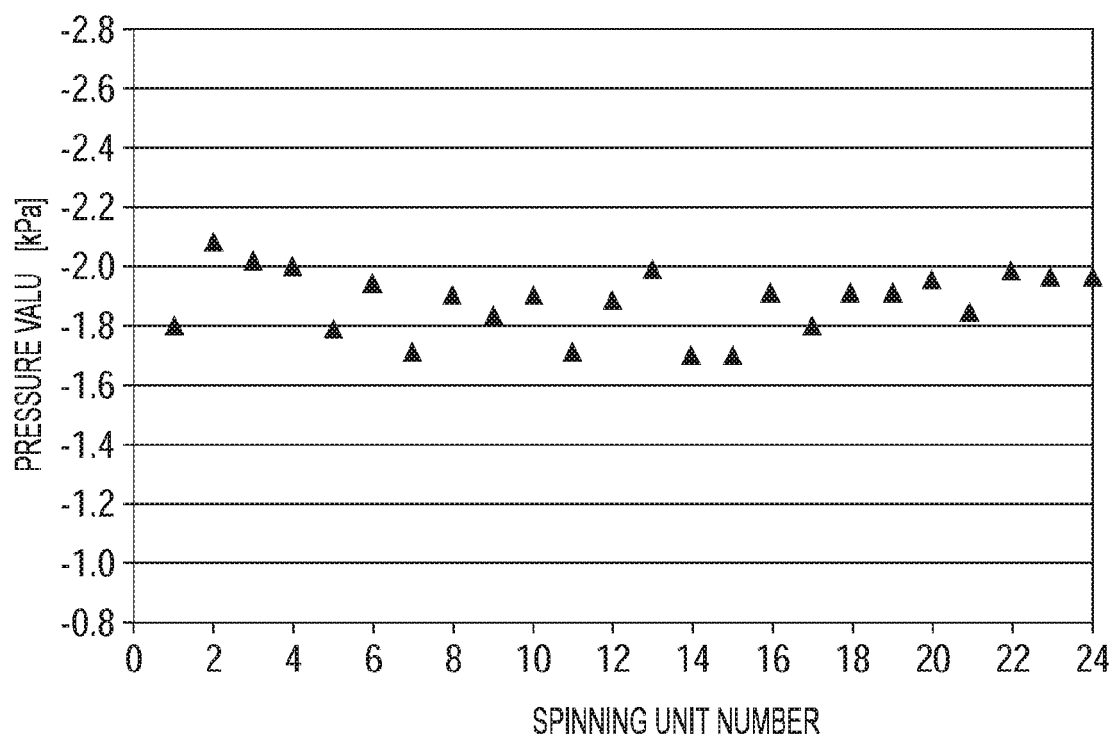


FIGURE 8



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006132035 A [0002] [0002] [0003] [0004]