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(71) Applicant: **HITACHI INDUSTRIAL EQUIPMENT SYSTEMS CO., LTD.**
Tokyo 101-0022 (JP)

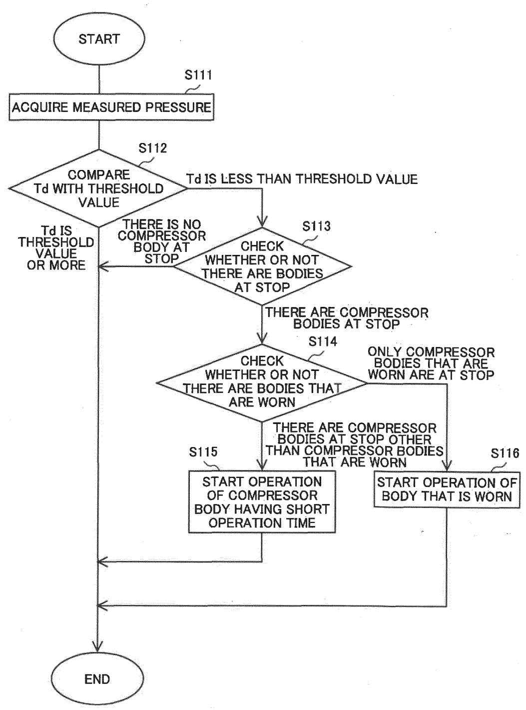
(72) Inventors:
- **YAMAMOTO, Akihiro**
  Tokyo 101-0022 (JP)
- **KANEMOTO, Yoshiyuki**
  Tokyo 101-0022 (JP)

(74) Representative: **MERH-IP Matias Erny Reichl Hoffmann**
Patentanwälte PartG mbB
Paul-Heyse-Strasse 29
80336 München (DE)

(54) **FLUID MACHINE DEVICE**

(57) A fluid machine device includes a plurality of fluid machines that discharge a fluid; a worn state detection unit that detects a worn state of the fluid machine; a pressure detection unit that measures a pressure from the fluid machines; and a control unit that controls the plurality of fluid machines. The control unit determines whether or not there is the fluid machine that is worn, and performs control to start operation of the fluid machine that is not worn when the pressure is insufficient.

FIG. 11



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Description

TECHNICAL FIELD

[0001] The present invention relates to a fluid machine device.

BACKGROUND ART

[0002] A gas compressor has been known which generates compressed gas to be used as a power source of a production line or as an air source of a machine tool, a press machine, an air blower, or the like. The gas compressor includes a compressor body that compresses gas in a compression chamber that a casing forms, and is configured to discharge the compressed gas from a discharge port to a gas tank via a discharge pipe.

[0003] A technique of Patent Document 1 has been known as a gas compressor. In Patent Document 1, when the temperature of a compressor body is higher than an upper limit temperature, no-load operation is performed to protect components from failure, deterioration, and the like caused by high temperature and to extend the life of the components, so that durability can be improved.

CITATION LIST

PATENT DOCUMENT

[0004] Patent Document 1: JP 2008-31965 A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] In the compressor described in Patent Document 1, no-load operation is performed when high temperature is detected in a package. The no-load operation has been described as an operation state in which a compression operation is not performed (refer to paragraph 0041).

[0006] When the air usage amount increases and pressure decreases, in the technique of Patent Document 1, no-load operation is performed, so that the pressure cannot be raised until the temperature of the compressor decreases.

[0007] In addition, a multi-compressor equipped with a plurality of compressor bodies, is a fluid machine device that increases or decreases the number of the compressor bodies to be operated according to a compressed air usage amount of a user to generate required compressed air. In such a fluid machine device, when an abnormality occurs in one compressor body, the compressor body in which the abnormality has occurred undergoes no-load operation as in Patent Document 1, so that the compressor body can be protected.

[0008] However, since the compressor body having an abnormality does not perform a compression operation, when the usage amount of a user increases, compressed air required by the user may not be able to be supplied, which is a concern.

[0009] An object of the present invention is to provide a fluid machine device capable of supplying required compressed air while protecting fluid machines.

SOLUTIONS TO PROBLEMS

[0010] As one preferred example of the present invention, there is provided a fluid machine device including: a plurality of fluid machines that discharge a fluid; a worn state detection unit that detects a worn state of the fluid machine; a pressure detection unit that measures a pressure from the fluid machines; and a control unit that controls the plurality of fluid machines.

[0011] The control unit determines whether or not there is the fluid machine that is worn, and performs control to start operation of the fluid machine that is not worn when the pressure is insufficient.

EFFECTS OF THE INVENTION

[0012] According to the present invention, required compressed air can be supplied while protecting the fluid machines.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a cross-sectional view of a compressor body of a first embodiment.

Fig. 2 is an internal structure of a fluid machine device of the first embodiment.

Fig. 3 is a conceptual graph of an operation in which a fluid machine is stopped at an expected reach time taken to reach a stop pressure.

Fig. 4 is a conceptual graph of operations during normal operation and when wear of one compressor is detected in the first embodiment.

Fig. 5 is a schematic graph of a pressure transition in the case of lengthening an expected reach time taken to reach a stop pressure.

Fig. 6 is a conceptual diagram of a configuration of the fluid machine in the first embodiment.

Fig. 7 is a conceptual graph of an operation in which a stop pressure is lowered and the fluid machine is stopped.

Fig. 8 is a flowchart illustrating a flow of a stop determination to be performed on pressure machine bodies when wear of the compressor bodies is not determined.

Fig. 9 is a flowchart illustrating a flow of a stop determination to be performed on pressure machine bodies when it is determined whether or not there are compressor bodies that are worn.

Fig. 10 is a flowchart illustrating a flow of an operation start determination to be performed on pressure machine bodies when wear of the compressor bodies is not determined.

Fig. 11 is a flowchart illustrating a flow of an operation start determination to be performed on pressure machine bodies when it is determined whether or not there are compressor bodies that are worn.

MODE FOR CARRYING OUT THE INVENTION

[0014] Hereinafter, embodiments will be described with reference to the drawings.

First Embodiment

[0015] In the present embodiment, as an example of a compression method of a compressor body, a fluid machine device will be described which is equipped with a plurality of scroll compressor bodies (fluid machines) in each of which a compression chamber is formed between a fixed scroll and an orbiting scroll and each of which undergoes orbital motion to compress air.

[0016] Fig. 1 is a cross-sectional view of a compressor body in a first embodiment. In this compressor, as illustrated in Fig. 1, power is transmitted from a motor including a stator 101 and a rotor 102 to a scroll compressor including an orbiting scroll 104 and a fixed scroll 105 via a shaft 103. Air compressed by the scroll compressor passes through a pipe from a discharge port 109, and passes through a fluid machine device such as an aftercooler.

[0017] The rotational speed of the motor changes with the frequency of a voltage to be output from an inverter 107. Power is transmitted from the shaft 103 to a cooling fan 106, and the cooling fan 106 sends generated cooling air to cooling fins of the orbiting scroll 104 and the fixed scroll 105 via a duct (not illustrated) to cool the compressor. A temperature sensor 108 is disposed at a tip of the cooling fin of the fixed scroll 105. The temperature sensor 108 serves as a worn state detection unit that detects a worn state of the compressor using measured temperature.

[0018] The orbiting scroll 104 and the fixed scroll 105 slide against each other, thereby causing a tip seal disposed in tip portions thereof to wear. In that case, since the temperature of the orbiting scroll 104 or the fixed scroll 105 rises, the present embodiment can be one example of a case where whether or not the compressor body is worn is determined by temperature.

[0019] Fig. 2 illustrates a perspective view of a package type fluid machine device equipped with a plurality of scroll type compressor bodies, as one example of a fluid machine device 200. A plurality (here, three) of scroll compressor bodies 201, 202, and 203 are housed in one package, and the number of the compressor bodies to be operated is changed according to an air usage amount to deal with a change in air amount.

[0020] Fig. 6 is an overall conceptual diagram of the fluid machine device 20.0 of the first embodiment. Here, a package type gas compressor will be described as an example. The package type gas compressor is a gas compressor which includes a motor that is a drive unit to drive a compressor body, and in which a single or a plurality of compressor bodies, a control circuit, an operation panel, and the like are integrally housed in a package to save space.

[0021] In the present embodiment, the package type gas compressor includes three stages of compression portions 4a, 4b, and 4c. An electrical wiring 9 is connected to inverters 2a, 2b, and 2c for controlling the compressor bodies and a dryer 14 from a terminal 10 that takes in a power source from the outside.

[0022] In addition, the electrical wiring 9 is connected to motors 3a, 3b, and 3c from the inverters or switches 2a, 2b, and 2c. The compression portions 4a, 4b, and 4c are driven by the motors 3a, 3b, and 3c, respectively.

[0023] Air 1 to be compressed is supplied through filters 5a, 5b, and 5c, and passes through the compression portions 4a, 4b, and 4c, check valves 6a, 6b, and 6c, first aftercoolers 7a, 7b, and 7c, and rubber hoses 8a, 8b, and 8c, and then is collected in one air line.

[0024] The rubber hoses 8a, 8b, and 8c are structured to be easily attachable and detachable. A pressure sensor 16 that measures a pressure of compressed air is disposed in a pipe 17 that sends the collected air. In addition, the air that has passed through the pipe 17 passes through a second aftercooler 12, a third aftercooler 13, and the dryer 14, and is supplied to the outside as compressed air 90.

[0025] In Fig. 6, the pressure sensor 16 is disposed in the pipe 17, but it does not matter that the pressure sensor 16 is disposed in another place as long as being capable of measuring pressure in the air line that collects the air compressed by the compression portions 4a, 4b, and 4c.

[0026] Although not illustrated in Fig. 6, but the fluid machine device 200 includes the control unit. The control unit receives temperature and pressure signals from the temperature sensor that measures the temperature of each of the compression portions 4a, 4b, and 4c, and the pressure sensor 16. The control unit controls the motor that drive the compressor body, or the switch based on information from the temperature sensor or the pressure sensor to control operation start or operation stop of the compressor body.

[0027] Fig. 3 illustrates an operation example of a fluid machine device equipped with three scroll type compressor bodies A, B, and C. The fluid machine device including a plurality of compressor bodies changes the number of the compressor bodies to be operated based on a transition of a pressure change to be generated by a change in air usage amount. The control unit of the fluid machine device performs control to reduce the number of the compressor bodies to be operated when the air usage amount is small, or to increase the number of the compressor bodies to.be operated when the air usage amount is large.

[0028] The control unit is configured to include a CPU or a microcomputer. In addition, the control unit may be formed of a field-programmable gate array (FPGA). When the number of the compressor bodies is increased, a determination is performed based on an expected reach time Td 304 taken, to reach a lower limit pressure 302, and when the expected reach time Td 304 is less than a threshold value, an operation number is added.

[0029] Regarding an expected lower limit pressure reach time Td, for example, when pressure decreases with respect to the axis of time, an interval from a determination time to the expected reach time Td 304 the lower limit pressure 302 is reached is calculated from a gradient of a pressure change between, a measured pressure P(k - 1) at one second earlier than the determination time and a measured pressure P(k) at the determination time.

[0030] When the number of the compressor bodies is reduced, a determination is performed based on an expected reach time Tu 303 taken to reach a stop pressure 301, and when the expected reach time Tu 303 is less than a threshold value, control is performed to reduce an operation number.

[0031] Regarding an expected stop pressure reach time Tu, for example, when pressure rises with respect to the axis of time, an interval from a determination time to the expected reach time Tu 303 the stop pressure 301 is reached is calculated from a gradient of a pressure change between a measured pressure P(k - 1) at one second earlier than the determination time and a measured pressure P(k) at the determination time.

[0032] Fig. 4 is a graph illustrating an example 401 in a normal state and an example 402 in which it is determined that one compressor body A is in a worn state in terms of a pressure transition and operation of three compressor bodies A, B, and C. In a normal state, the three compressor bodies operate in rotation according to a transition of pressure.

[0033] For example, when the compressor body A is greatly worn, a temperature measured by the temperature sensor 108 rises. The control unit receives data on the temperature sent from the temperature sensor 108, and when the temperature is more than a threshold value, the control unit determines that the compressor body A is worn, and controls the compressor body A to be stopped, and operation is continued with the other compressor bodies.

[0034] The compressor body A of which wear is detected is stopped, and is set as a spare machine. When the air supply amount is sufficient, a rotation is made to change an operating compressor, and the compressor bodies other than the compressor body A operate.

[0035] When the air consumption amount increases and pressure decreases, the compressor body A at stop is operated as indicated by reference sign 404, and when the air consumption amount is reduced and pressure rises, the compressor body A having a large wear is first stopped as indicated by reference sign 405. When wear of a compressor body is detected, an alarm is issued, and a user of the compressor body is notified of the wear to prompt maintenance of the compressor body.

[0036] In addition, when a compressor body of which wear is detected operates again, a stop pressure of the compressor body is set to a pressure 403 lower than those of the other compressor bodies to stop preferentially the compressor body and to reduce a load caused by high pressure, so that operation is continued while reducing a further wear of the compressor body.

[0037] Fig. 5 is a schematic graph of a pressure transition in the case of lengthening an expected reach time taken to reach a stop pressure at which a stop determination is performed on a compressor body. Fig. 5 is a schematic graph of a pressure transition in the case of lengthening a time Tu to determine that a stop pressure is reached, instead of lowering the stop pressure of a compressor body.

[0038] The compressor body that is worn can also be stopped in a low pressure state by setting an expected stop pressure reach time Tu' 501 obtained by lengthening a time to perform a stop determination on the compressor body instead of lowering the stop pressure of the compressor body.

[0039] Fig. 7 is a conceptual graph of an operation. Fig. 7 illustrates an example in which instead of lengthening an expected reach time taken to reach a stop pressure at which a stop determination is performed as in Fig. 5, control is performed such that a stop pressure of a compressor body that is worn is lowered more than a stop pressure of a compressor body that is not worn. Since a determination on the stop of the compression body that is worn is performed at a lower pressure than the compressor body that is not worn, temperature to be added to the compressor body can be lowered, and deterioration can be reduced.

[0040] Fig. 8 is a flowchart illustrating a flow of a stop determination to be performed on pressure machine bodies when wear of the compressor bodies is not determined.

[0041] As illustrated in Fig. 8, during operation of the compressor bodies, the pressure sensor 16 measures pressure at regular intervals, and sends measured pressure data to the control unit, and the control unit acquires a change over time in pressure (step S81).

[0042] The control unit calculates Tu based on the change over time in pressure, and compares Tu with a threshold value that is determined (step S82).

[0043] Here, Tu is an expected stop pressure reach time from a reference time (including the time of determination) to when the pressure reaches a stop pressure.

[0044] When Tu calculated in step S82 is less than the threshold value, the control unit executes control to stop one compressor body having a longest operation time (step S83).

[0045] When Tu calculated in step S82 is the threshold value or more, this determination flow ends (END).

[0046] Fig. 9 is a flowchart illustrating a flow of a stop determination to be performed on pressure machine bodies when it is determined whether or not there are compressor -bodies that are worn.

[0047] As illustrated in Fig. 9, during operation of the compressor bodies, the pressure sensor 16 measures pressure at regular intervals, and sends measured pressure data to the control unit, and the control unit acquires a change over time in pressure (step S91).

[0048] The control unit calculates Tu based on the change over time in pressure, and compares Tu with a threshold value that is determined (step S92).

[0049] When Tu calculated in step S92 is less than the threshold value (when pressure is sufficient), the control unit checks whether compressor bodies that are worn are in operation, or at stop (step S93).

[0050] When in step S93, it is confirmed that the compressor bodies that are worn are in operation, the control unit performs control to stop the operation of the compressor bodies that are worn (step S94).

[0051] When in step S93, it is confirmed that all compressor bodies that are worn are at stop, the control unit executes control to stop one compressor body that is not worn and has a longest operation time (step S95).

[0052] Fig. 10 is a flowchart illustrating a flow of an operation start determination to be performed on pressure machine bodies when wear of the compressor bodies is not determined.

[0053] As illustrated in Fig. 10, during operation of the compressor bodies, the pressure sensor 16 measures pressure at regular intervals, and sends measured pressure data to the control unit, and the control unit acquires a change over time in pressure (step S101).

[0054] The control unit calculates Td based on the change over time in pressure, and compares Td with a threshold value that is determined (step S102).

[0055] Here, Td is an expected lower limit pressure reach time from a reference time (including the time of determination) to when the pressure reaches a lower limit pressure.

[0056] When Td calculated in step S102 is less than a threshold value, the control unit checks whether or not there are compressor bodies at stop (step S103). When in step S103, it is confirmed that there are compressor bodies at stop, the control unit executes control to start operation of a compressor body having a shortest operation time (step S104).

[0057] When Td calculated in step S102 is the threshold value or more, and when in step S103, it is confirmed that there is no compressor body at stop, this determination flow ends (END).

[0058] Fig. 11 is a flowchart illustrating a flow in which the control unit determines operation start of pressure machine bodies when it is determined whether or not there are compressor bodies that are worn.

[0059] During operation of the compressor bodies, the pressure sensor 16 measures pressure at regular intervals, and sends measured pressure data to the control unit, and the control unit acquires a change over time in pressure (step S111). The control unit obtains Td based on the change over time in pressure, and compares Td with a threshold value that is determined (step S112).

[0060] When Td calculated in step S112 is less than a threshold value (when pressure is insufficient), it is checked whether or not there are compressor bodies at stop (step S113). When there are the compressor bodies at stop, the control unit checks whether or not the compressor bodies at stop include the compressor bodies that are worn, based on temperature information from the temperature sensor (step S114).

[0061] When the compressor bodies that are worn are at stop, and there are compressor bodies at stop that are not worn, the control unit executes control to start operation of one compressor body having a shortest operation time among the compressor bodies that are not worn (step S115).

[0062] When in step S114, it is confirmed that there is no compressor body at stop other than the compressor bodies that are worn, the control unit executes control to start operation of a compressor body that is worn (step S116).

[0063] When Td calculated in step S112 is the threshold value or more and in step S113, it is confirmed that there is no compressor body at stop, this determination flow ends (END).

[0064] When in step S114, it is confirmed that only the compressor bodies that are not worn are stopped, similarly to step S104 of Fig. 10, the control unit executes control to operate one compressor body having a shortest operation time among the compressor bodies at stop that are not worn.

[0065] Regarding compressor bodies that are worn, the control unit stores the number of times of determination of the compressor bodies detected as being worn, and when the number of times of determination is more than the specified number of times that is a threshold value for determining wear that is determined, the compressor body is stopped as a failure. In that case, even when a decrease in pressure or the like is detected because of insufficiency of the air supply amount, the compressor body is controlled not to operate. In such a manner, the compressor body is not allowed to stand by as a spare machine, but obtains an opportunity for repair or replacement, so that an abnormality having a large adverse effect such as the compressor body becoming inoperable can be avoided.

[0066] According to the first embodiment, a compressor body that is detected as' being worn among a plurality of compressor bodies is protected. Further, since normally there is a compressor body at stop that is not worn, the operation of the compressor body that is not worn is preferentially started. Therefore, the fluid machine device can be realized which supplies required compressed air to a user.

[0067] In addition, when only compressor bodies that are worn are compressor bodies at stop, and pressure is insufficient, the operation of the compressor bodies that are worn can be started to supply air of a required pressure to a user.

[0068] In addition, when there are a plurality of compressor bodies that are worn, only the, bodies that are worn are compressor bodies at stop, and pressure is insufficient, the operation of the compressor bodies that are worn can be started in order of detection of wear to supply air of a required pressure to a user.

Second Embodiment

[0069] A second embodiment is different from the first embodiment in that the worn state detection unit is a current detector that measures a current of a motor; Namely, regarding a determination of wear, the current detector measures a current value of a motor that drives each compressor body, and when the measured current value is more than a determination value that is determined, the control unit performs control to set the compressor body as a spare machine and to stop the compressor body.

[0070] In addition, the control unit performs control to operate a compressor body that is determined as being in a worn state only when air amount insufficiency is generated. According to the present embodiment, when the current detector that measures a current of a motor is already provided, there is no need to set a sensor such as a temperature sensor for each compressor body.

Third Embodiment

[0071] A third embodiment is different from the first embodiment in that the worn state detection unit is an electric power detector that measures an electric power of a motor. Namely, regarding a determination of wear, the electric power detector measures an input electric power of a motor that drives each compressor body, and when a measured electric power value is more than a determination value that is determined, the control unit performs control to set the compressor body as a spare machine and to stop the compressor body.

[0072] In addition, the control unit performs control to operate a compressor body that is determined as being in a worn state only when air amount insufficiency is generated. According to the present embodiment, when the electric power detector that measures an electric power of a motor is already provided, there is no need to set a sensor such as a temperature sensor for each compressor body.

Fourth Embodiment

[0073] A fourth embodiment is different from the first embodiment in that the worn state detection unit is a vibration detector that measures vibration of a compressor body. Namely, regarding a determination of wear, the vibration detector measures vibration of each compressor body, and when a measured vibration value is more than a determination value that is determined, the control unit performs control to set the compressor body as a spare machine and to stop the compressor body.

[0074] In addition, the control unit performs control to operate a compressor body that is determined as being in a worn state only when air amount insufficiency is generated. According to the present embodiment, when the vibration detector that measures vibration of a compressor is already provided, there is no need to set a sensor such as a temperature sensor for each compressor body.

Fifth Embodiment

[0075] A fifth embodiment is different from the first embodiment in that the worn state detection unit is an air amount detector that measures an amount of a compressor body. Namely, regarding a determination of wear, the air amount detector measures a discharge air amount of each compressor body, and when a measured air amount value is less than a determination value that is determined, it is determined that the air amount is insufficient, and the control unit performs control to set the compressor body as a spare machine and to stop the compressor body.

[0076] In addition, the control unit performs control to operate a compressor body that is determined as being in a worn state only when air amount insufficiency is generated. According to the present embodiment, when the air amount detector that measures an air amount of a compressor body is already provided, there is no need to set a sensor such as a temperature sensor for each compressor body.

Sixth Embodiment

[0077] A sixth embodiment is different from the first embodiment in that the worn state detection unit is a noise detector that measures noise of a compressor body. Namely, regarding a determination of wear, the noise detector measures noise of each compressor body, and when a measured noise value is more than a determination value that is determined, the control unit performs control to set the compressor body as a spare machine and to stop the compressor body.

[0078] In addition, the control unit performs control to operate a compressor body that is determined as being in a worn state only when air amount insufficiency is generated. According to the present embodiment, when the noise detector that measures a noise value of a compressor body is already provided, there is no need to set a sensor such as a temperature sensor for each compressor body.

Seventh Embodiment

[0079] A seventh embodiment is different from the first embodiment in that the worn state detection unit is an operation time detector that measures an operation time of a compressor body. Namely, regarding a determination of wear, the noise detector measures an operation time of each compressor body, and when a measured operation time is more than a determination value that is determined, the control unit performs control to set the compressor body as a spare machine and to stop the compressor body.

[0080] In addition, the control unit performs control to operate a compressor body that is determined as being in a worn state only when air amount insufficiency is generated.

Eighth Embodiment

[0081] In the embodiments, a compression body that is worn may be set as a spare machine, and operated when the air amount is insufficient. However, the compressor body may be determined as a failure. When such a determination is performed, a second threshold value is provided which is a level that is higher than a first threshold value for determining wear which is determined by temperature, current, input electric power, or the like as described in the first to seventh embodiments, or that can be determined as a failure.

[0082] When the measured value is more than the second threshold value, the control unit determines that there is an abnormality due to a failure, stops the compressor body as a failure, and performs control not to operate the compressor body even when a decrease in pressure or the like is detected because of insufficiency of the air supply amount.

[0083] Since an abnormality of the compressor body is determined as a failure, and the compressor body is stopped, maintenance, repair, or the like of the compressor body can be reliably executed.

REFERENCE SIGNS LIST

[0084]

108	Temperature sensor
301	Stop pressure
302	Lower limit pressure
303	Expected stop pressure reach time Tu
304	Expected lower limit pressure reach time Td

Claims

1. A fluid machine device comprising:

a plurality of fluid machines that discharge a fluid;
a worn state detection unit that detects a worn state of the fluid machine;
a pressure detection unit that measures a pressure from the fluid machines; and
a control unit that controls the plurality of fluid machines,
wherein the control unit determines whether or not there is the fluid machine that is worn, and performs control to start operation of the fluid machine that is not worn when the pressure is insufficient.

2. The fluid machine device according to claim 1, wherein when there is the fluid machine in operation that is worn, and the pressure is sufficient, the control unit performs control to stop operation of the fluid machine that is worn.

3. The fluid machine device according to claim 1, wherein when only the fluid machine that is worn is the fluid machine at stop, and the pressure is insufficient, the control unit performs control to start operation of the fluid machine that is worn.

4. The fluid machine device according to claim 1, wherein the control unit determines when the pressure is insufficient, based on a lower limit pressure, and determines when the pressure is sufficient, based on a stop pressure.

5. The fluid machine device according to claim 3, wherein when there are a plurality of the fluid machines that are worn, and the pressure is insufficient, the control unit performs control to start operation of the fluid machines that are worn.

6. The fluid machine device according to claim 4,

wherein the stop pressure of the fluid machine that is worn is set to a pressure lower than the stop pressure of the fluid machine that is not worn, and
the control unit determines when the pressure is sufficient, based on the stop pressure.

7. The fluid machine device according to claim 4, wherein the control unit calculates an expected stop pressure reach time taken to reach the stop pressure, and determines that the pressure is sufficient, when the expected stop pressure reach time is shorter than a time that is determined.

8. The fluid machine device according to claim 4, wherein the control unit calculates an expected lower limit pressure reach time taken to reach the lower limit pressure, and determines that the pressure is insufficient, when the expected lower limit pressure reach time is shorter than a time that is determined.

9. The fluid machine device according to claim 1,

wherein the control unit stores the number of times of determination of the fluid machines that are determined as being worn, and when the number of times of determination is more than the number of times that is determined, the fluid machines are stopped as a failure.

10. The fluid machine device according to claim 1, wherein the worn state detection unit is a temperature sensor that measures a temperature of the fluid machine.

11. The fluid machine device according to claim 1, wherein the worn state detection unit is a current detector that measures a current flowing through an electric motor that drives the fluid machine.

12. The fluid machine device according to claim 1, wherein the worn state detection unit is an electric power detector that measures an electric power to be consumed by an electric motor that drives the fluid machine.

13. The fluid machine device according to claim 1, wherein the worn state detection unit is a vibration detector that measures vibration of the fluid machine.

14. The fluid machine device according to claim 1, wherein the worn state detection unit is an air amount detector that measures a discharge air amount of the fluid machine.

15. The fluid machine device according to claim 1, wherein the worn state detection unit is a noise detector that measures noise of the fluid machine.

16. The fluid machine device according to claim 1, wherein the worn state detection unit is an operation time detector that measures an operation time of the fluid machine.

17. The fluid machine device according to claim 1, wherein in a case of an abnormality in which a measured value from the worn state detection unit is more than a second threshold value higher than a first threshold value for determining whether or not there is wear, the control unit causes the fluid machine, which is detected as having an abnormality, to stop as a failure.

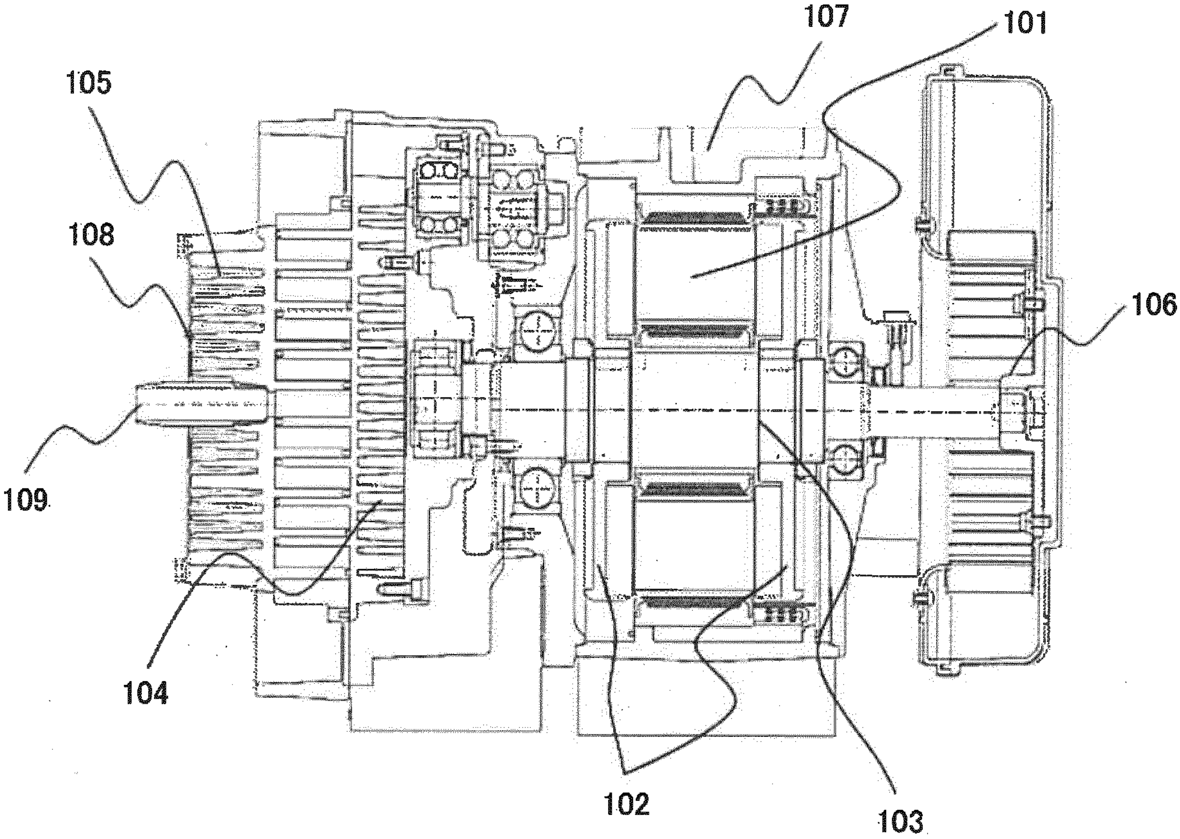
18. The fluid machine device according to claim 1,

wherein when all the fluid machines at stop are the fluid machines that are not worn, and the pressure is insufficient, the control unit preferentially causes the fluid machine having a shortest operation time to start operating among the fluid machines at stop, and
when all the fluid machines in operation are the fluid machines that are not worn, and the pressure is sufficient, the control unit preferentially causes the fluid machine having a longest operation time to stop operating among the fluid machines in operation.

19. The fluid machine device according to claim 1,

wherein the fluid machine is a scroll compressor, and
a drive unit that drives the scroll compressor and an operation unit are housed in a package.

F I G. 1



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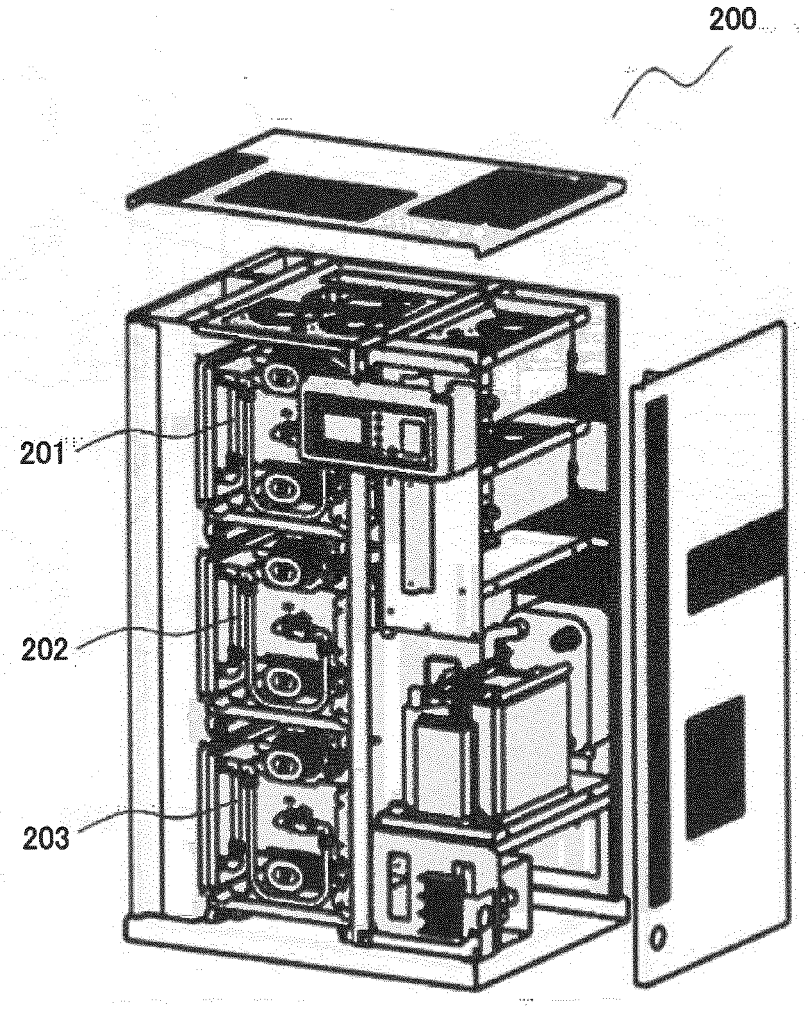
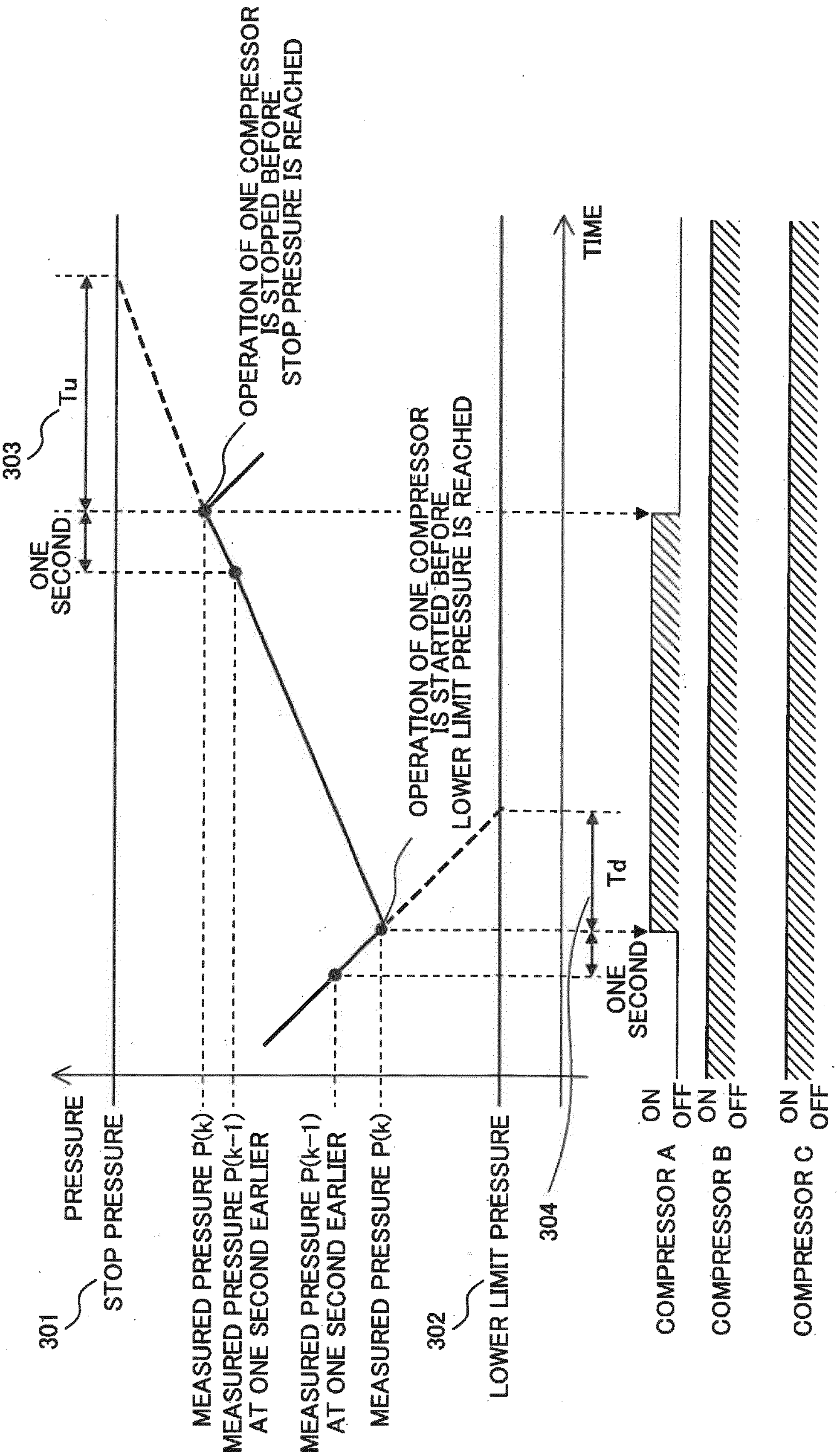
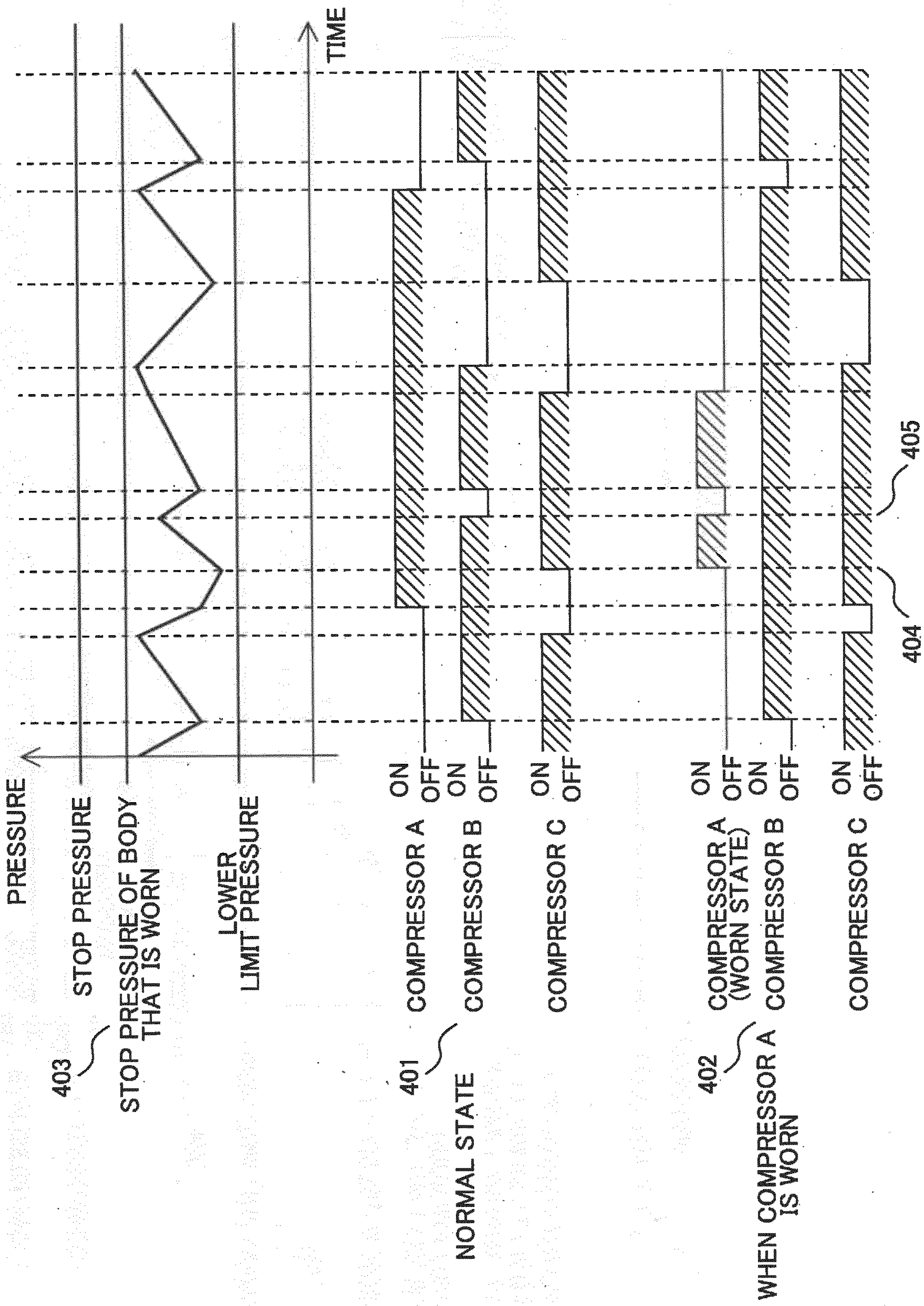


F I G. 3

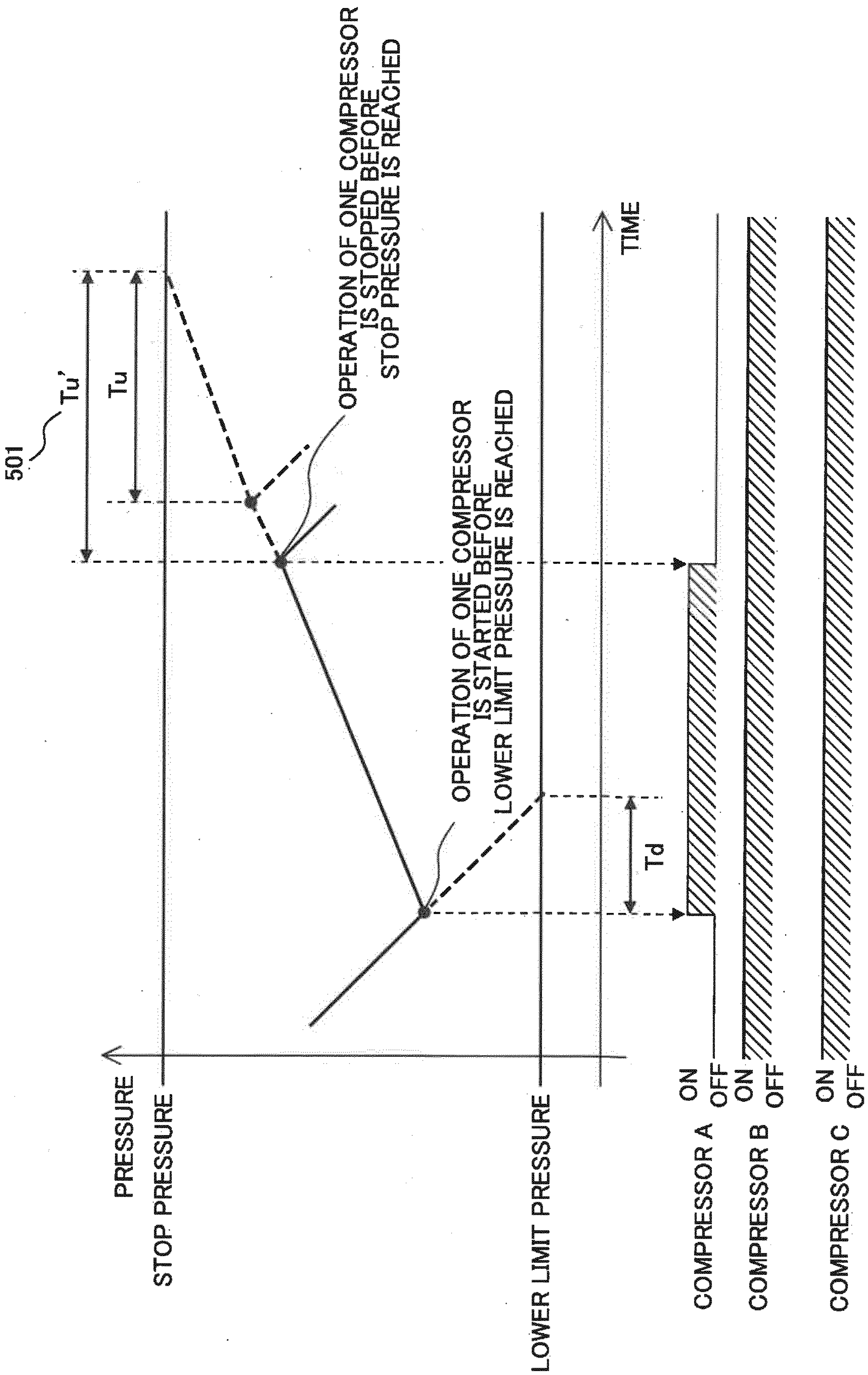


301
STOP PRESSURE
PRESSURE
MEASURED PRESSURE P(k)
MEASURED PRESSURE P(k−1) AT ONE SECOND EARLIER
MEASURED PRESSURE P(k−1) AT ONE SECOND EARLIER
MEASURED PRESSURE P(k)
302
LOWER LIMIT PRESSURE
304
COMPRESSOR A
ON
OFF
COMPRESSOR B
ON
OFF
COMPRESSOR C
ON
OFF
303
Tu
ONE SECOND
OPERATION OF ONE COMPRESSOR IS STOPPED BEFORE STOP PRESSURE IS REACHED
OPERATION OF ONE COMPRESSOR IS STARTED BEFORE LOWER LIMIT PRESSURE IS REACHED
Td
ONE SECOND
TIME

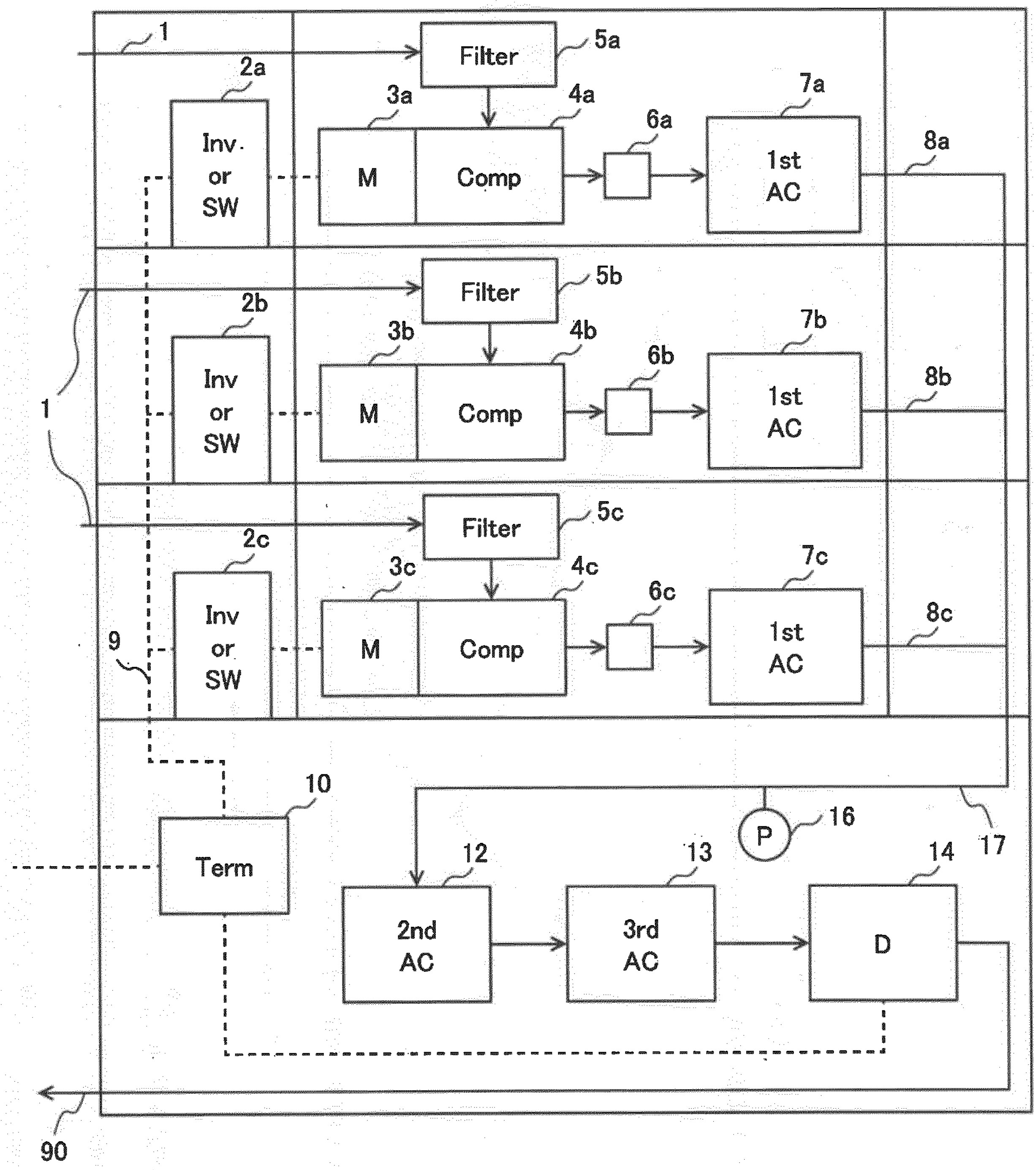
FIG. 4


PRESSURE
STOP PRESSURE
403
STOP PRESSURE OF BODY THAT IS WORN
LOWER LIMIT PRESSURE
TIME
401
NORMAL STATE
COMPRESSOR A
COMPRESSOR B
COMPRESSOR C
ON
OFF
402
WHEN COMPRESSOR A IS WORN
COMPRESSOR A (WORN STATE)
COMPRESSOR B
COMPRESSOR C
404
405

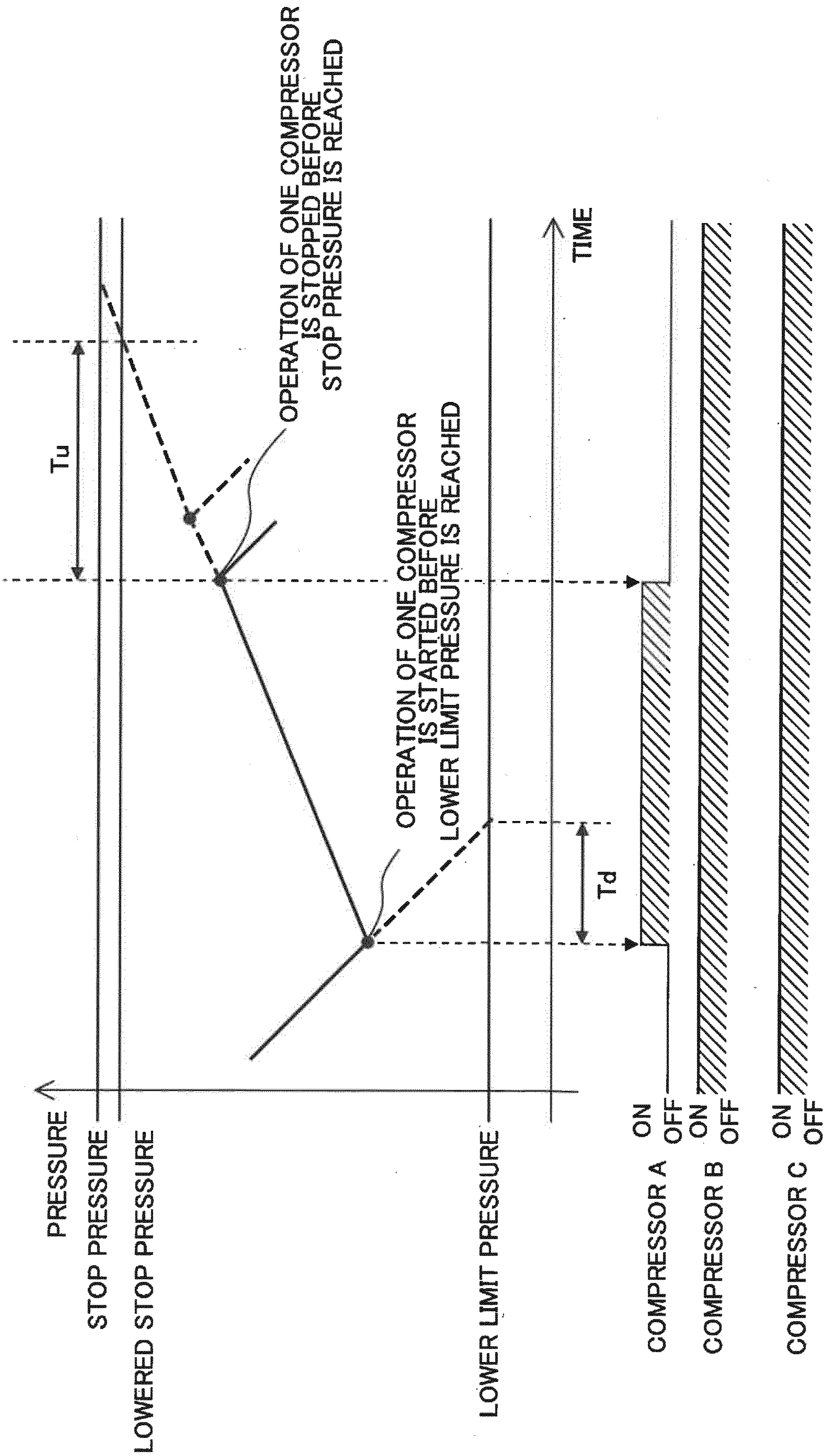
F I G. 5


PRESSURE
STOP PRESSURE
LOWER LIMIT PRESSURE
TIME
501
Tu'
Tu
Td
OPERATION OF ONE COMPRESSOR IS STOPPED BEFORE STOP PRESSURE IS REACHED
OPERATION OF ONE COMPRESSOR IS STARTED BEFORE LOWER LIMIT PRESSURE IS REACHED
COMPRESSOR A
COMPRESSOR B
COMPRESSOR C
ON
OFF
ON
OFF
ON
OFF

F I G. 6


1
Filter
5a
2a
3a
4a
7a
6a
Inv
or
SW
M
Comp
1st
AC
8a
Filter
5b
2b
3b
4b
7b
6b
Inv
or
SW
M
Comp
1st
AC
8b
1
Filter
5c
2c
3c
4c
7c
6c
9
Inv
or
SW
M
Comp
1st
AC
8c
10
Term
16
P
17
12
13
14
2nd
AC
3rd
AC
D
90

F I G. 7


OPERATION OF ONE COMPRESSOR
IS STOPPED BEFORE
STOP PRESSURE IS REACHED
OPERATION OF ONE COMPRESSOR
IS STARTED BEFORE
LOWER LIMIT PRESSURE IS REACHED
Tu
Td
TIME
PRESSURE
STOP PRESSURE
LOWERED STOP PRESSURE
LOWER LIMIT PRESSURE
COMPRESSOR A
ON
OFF
COMPRESSOR B
ON
OFF
COMPRESSOR C
ON
OFF

F I G. 8

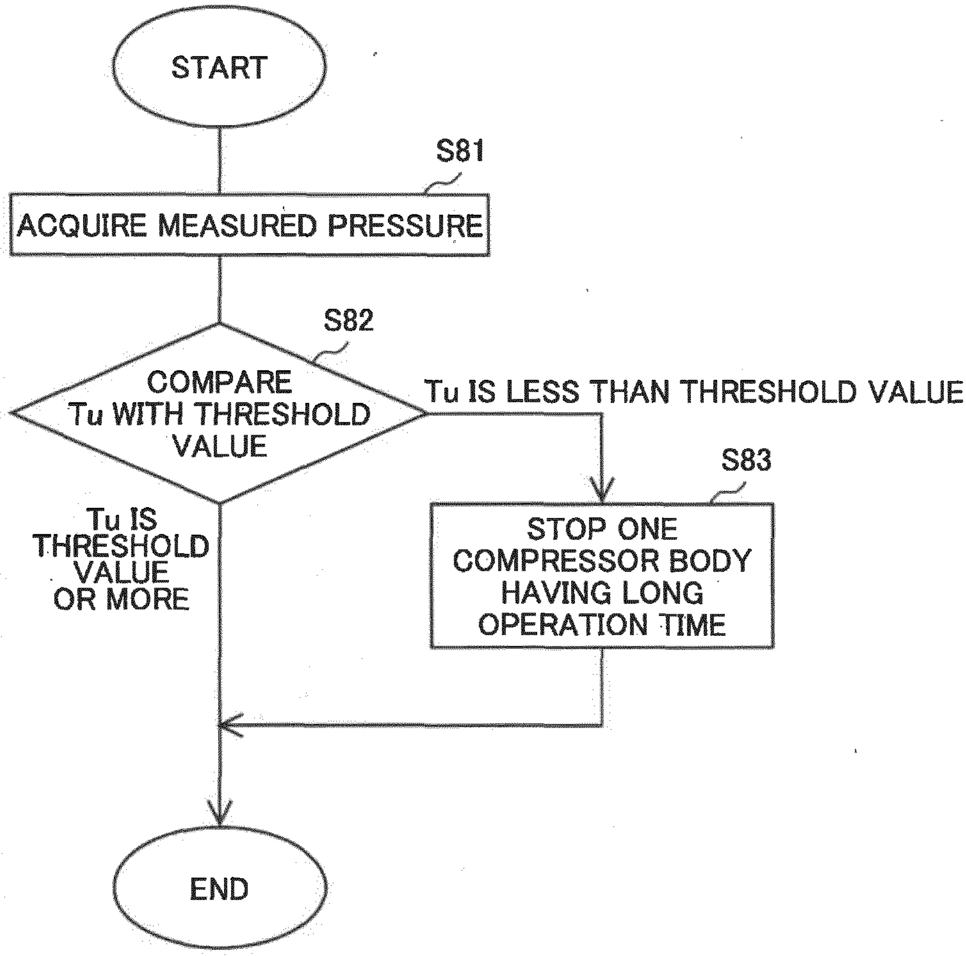

START
S81
ACQUIRE MEASURED PRESSURE
S82
COMPARE
Tu WITH THRESHOLD
VALUE
Tu IS LESS THAN THRESHOLD VALUE
S83
STOP ONE
COMPRESSOR BODY
HAVING LONG
OPERATION TIME
Tu IS
THRESHOLD
VALUE
OR MORE
END

FIG. 9

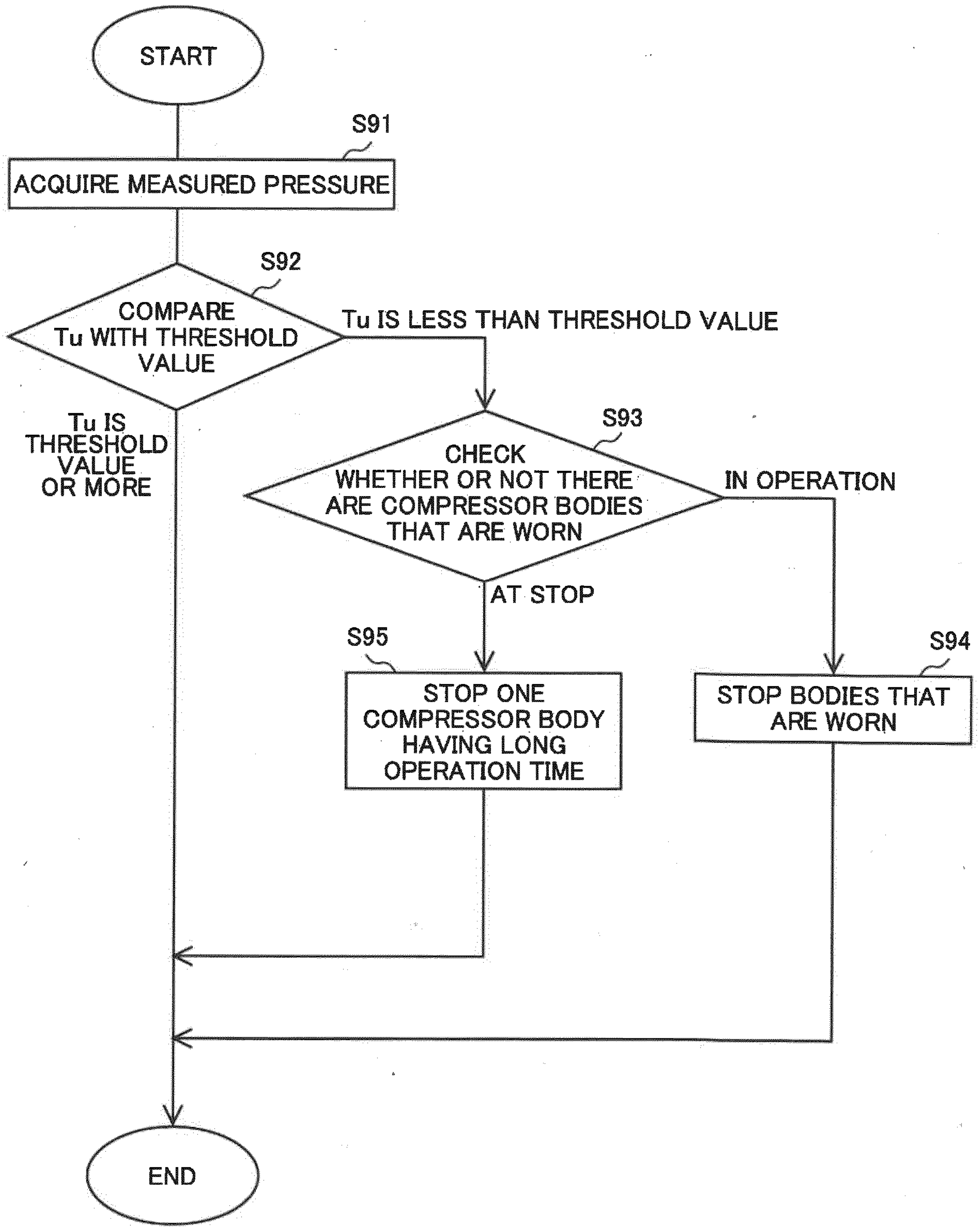
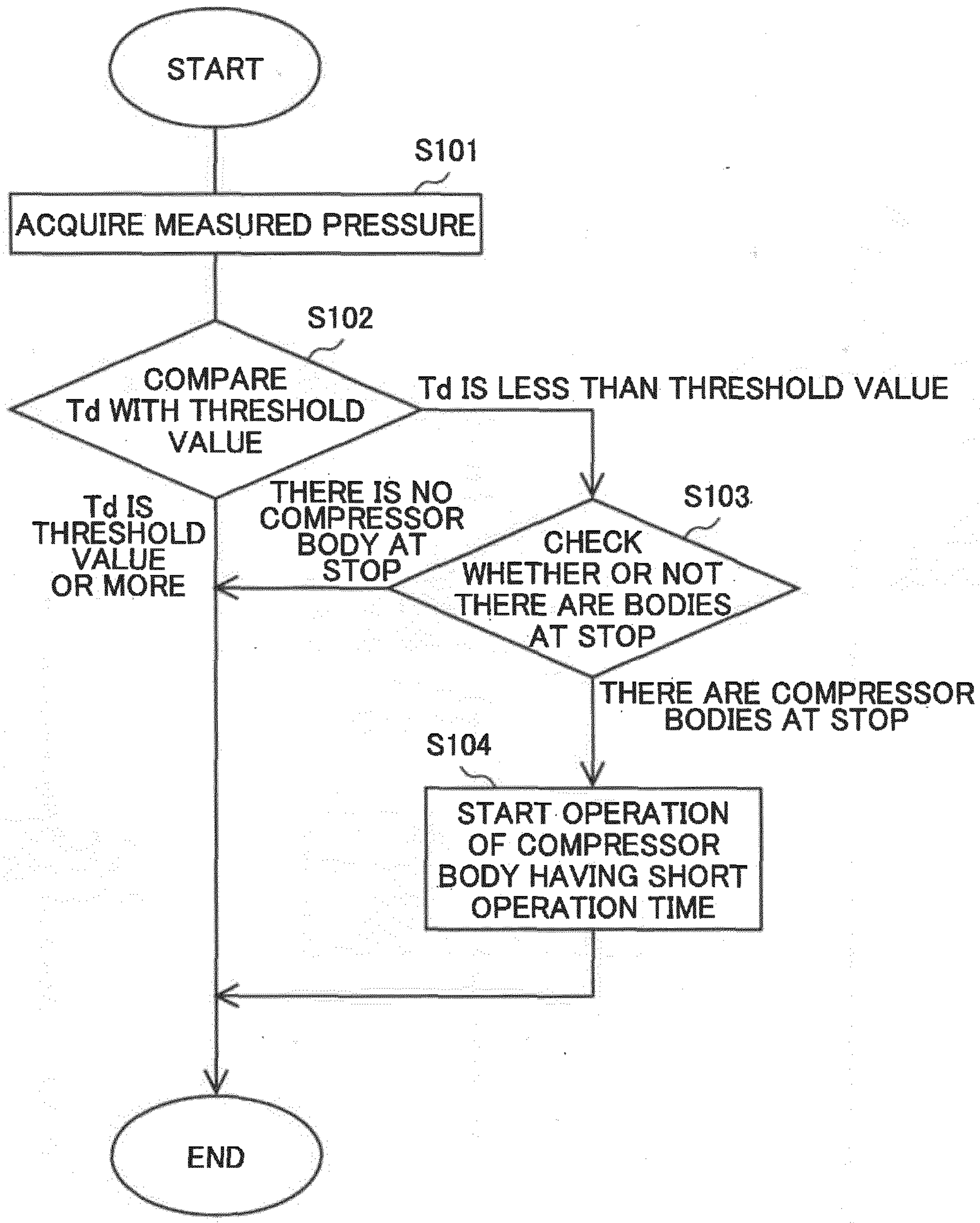
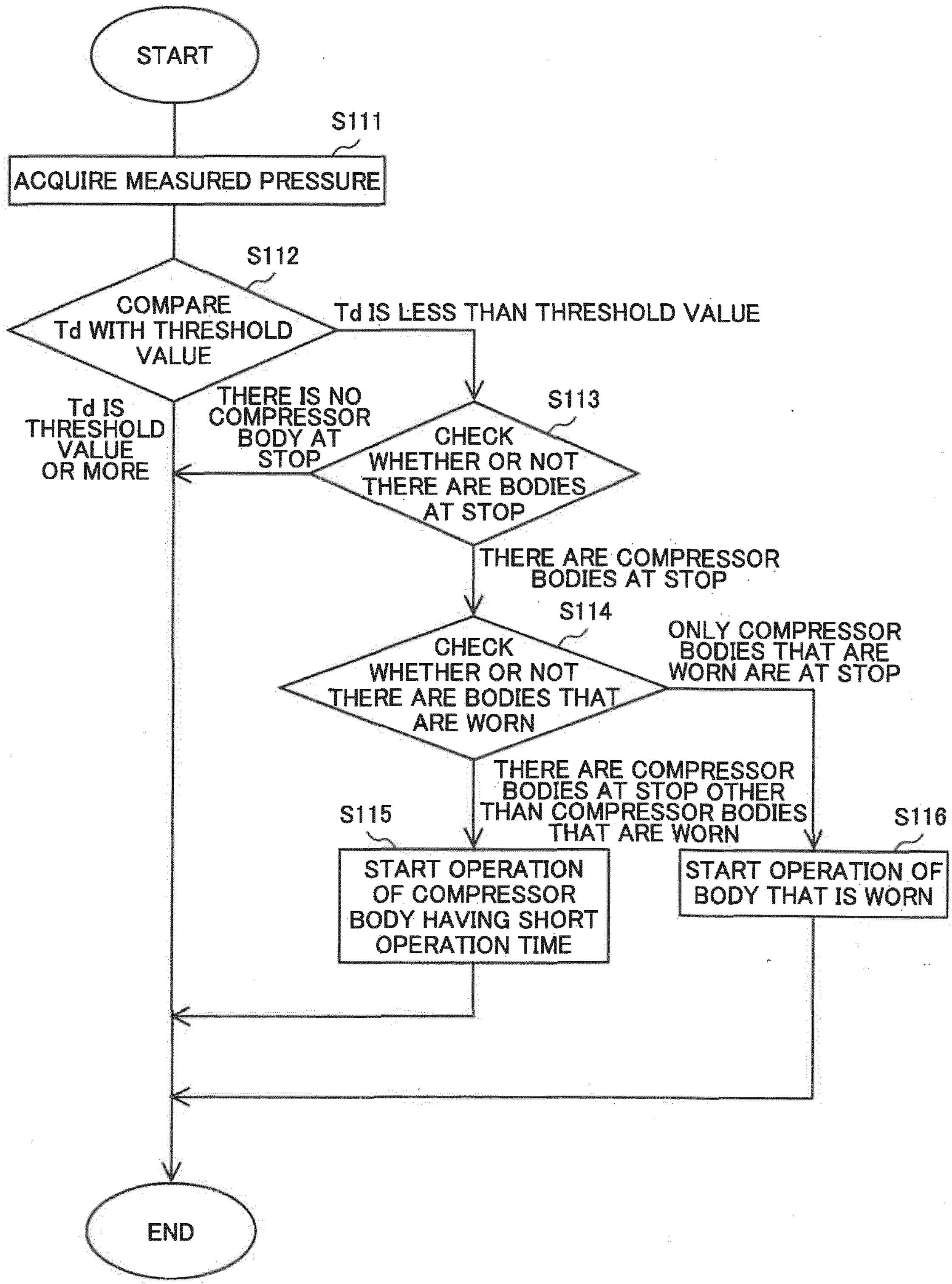

START
S91
ACQUIRE MEASURED PRESSURE
S92
COMPARE Tu WITH THRESHOLD VALUE
Tu IS LESS THAN THRESHOLD VALUE
Tu IS THRESHOLD VALUE OR MORE
S93
CHECK WHETHER OR NOT THERE ARE COMPRESSOR BODIES THAT ARE WORN
IN OPERATION
AT STOP
S95
STOP ONE COMPRESSOR BODY HAVING LONG OPERATION TIME
S94
STOP BODIES THAT ARE WORN
END

FIG. 10


START
S101
ACQUIRE MEASURED PRESSURE
S102
COMPARE Td WITH THRESHOLD VALUE
Td IS LESS THAN THRESHOLD VALUE
Td IS THRESHOLD VALUE OR MORE
THERE IS NO COMPRESSOR BODY AT STOP
S103
CHECK WHETHER OR NOT THERE ARE BODIES AT STOP
THERE ARE COMPRESSOR BODIES AT STOP
S104
START OPERATION OF COMPRESSOR BODY HAVING SHORT OPERATION TIME
END

F I G. 1 1


START
S111
ACQUIRE MEASURED PRESSURE
S112
COMPARE Td WITH THRESHOLD VALUE
Td IS LESS THAN THRESHOLD VALUE
Td IS THRESHOLD VALUE OR MORE
THERE IS NO COMPRESSOR BODY AT STOP
S113
CHECK WHETHER OR NOT THERE ARE BODIES AT STOP
THERE ARE COMPRESSOR BODIES AT STOP
S114
CHECK WHETHER OR NOT THERE ARE BODIES THAT ARE WORN
ONLY COMPRESSOR BODIES THAT ARE WORN ARE AT STOP
THERE ARE COMPRESSOR BODIES AT STOP OTHER THAN COMPRESSOR BODIES THAT ARE WORN
S115
START OPERATION OF COMPRESSOR BODY HAVING SHORT OPERATION TIME
S116
START OPERATION OF BODY THAT IS WORN
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/032420

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F04B49/06(2006.01)i
FI: F04B49/06321B

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F04B49/00-51/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2007-120497 A (HITACHI, LTD.) 17 May 2007 (2007-05-17), paragraphs [0028]-[0036], [0043]-[0065], fig. 1, 4	1-2, 4, 6-8, 19 3, 5, 9-18
Y	JP 6-249151 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 06 September 1994 (1994-09-06), paragraph [0030], fig. 3	3, 5
Y	JP 56-132486 A (TOKYO SHIBAURA ELECTRIC CO., LTD.) 16 October 1981 (1981-10-16), page 2, upper left column, line 18 to upper right column, line 3	3, 5
Y	JP 2003-343449 A (TOKICO, LTD.) 03 December 2003 (2003-12-03), paragraphs [0018], [0019], [0083]-[0086]	9-16
Y	JP 59-145619 A (NIPPON DENSO CO., LTD.) 21 August 1984 (1984-08-21), page 3, upper left column, lines 9-12	9-16

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 October 2020	27 October 2020

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2020/032420

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 57-8383 A (MITSUBISHI ELECTRIC CORPORATION) 16 January 1982 (1982-01-16), page 2, lower left column, lines 1-6	9-16
Y	JP 10-63301 A (NEW COSMOS ELECTRIC CO., LTD.) 06 March 1998 (1998-03-06), paragraph [0018]	9-16
Y	JP 2002-98061 A (OYODO DIESEL KK) 05 April 2002 (2002-04-05), paragraphs [0018]-[0020]	9-16
Y	JP 2009-264301 A (HITACHI, LTD.) 12 November 2009 (2009-11-12), paragraphs [0022]-[0030]	9-16
Y	JP 2004-116311 A (HITACHI HOME AND LIFE SOLUTIONS INC.) 15 April 2004 (2004-04-15), paragraph [0051]	9-16
Y	JP 2018-31335 A (HITACHI INDUSTRIAL EQUIPMENT SYSTEMS CO., LTD.) 01 March 2018 (2018-03-01), paragraphs [0018]-[0020]	17
Y	JP 61-178584 A (DAIKIN INDUSTRIES, LTD.) 11 August 1986 (1986-08-11), page 3, lower right column, lines 2-5	18

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/032420

JP 2007-120497 A	17 May 2007	US 2007/0077151 A1 paragraphs [0030]-[0038], [0045]-[0064], fig. 1, 4 CN 1940294 A
JP 6-249151 A	06 September 1994	(Family: none)
JP 56-132486 A	16 October 1981	(Family: none)
JP 2003-343449 A	03 December 2003	(Family: none)
JP 59-145619 A	21 August 1984	(Family: none)
JP 57-8383 A	16 January 1982	(Family: none)
JP 10-63301 A	06 March 1998	(Family: none)
JP 2002-98061 A	05 April 2002	(Family: none)
JP 2009-264301 A	12 November 2009	(Family: none)
JP 2004-116311 A	15 April 2004	(Family: none)
JP 2018-31335 A	01 March 2018	(Family: none)
JP 61-178584 A	11 August 1986	(Family: none)

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2008031965 A **[0004]**