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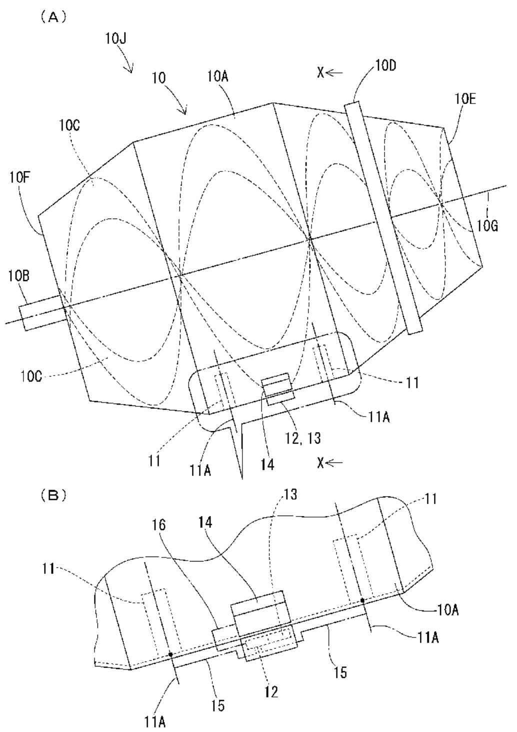
(54) **Title**: MIXER

(54) 発明の名称 : ミキサ



(57) **Abstract**: Provided is a mixer with which it is possible to satisfactorily find the slump value of ready-mixed concrete to be mixed in the mixer. This mixer (10J) comprises a mixer drum (10), an electrode (11), and a calculation unit (12). The mixer drum (10) has a rotation axis (10G) extending along the lateral direction, and ready-mixed concrete is introduced into the mixer drum while leaving a space on the upper side. The electrode (11) is provided inside the mixer drum (10), and measures a resistance value by moving in association with the rotation of the mixer drum (10) along a predetermined circumference about the rotation axis (10G) of the mixer drum (10). The calculation unit (12) finds a slump value corresponding to the rotation speed of the mixer drum (10) and the rate of change in the resistance value measured by employing the electrode (11).

(57) 要約: ミキサで攪拌するレディミクストコンクリートのスランプ値を良好に求めることができるミキサを提供する。 ミキサ（１０Ｊ）は、ミキサドラム（１０）、電極（１１）、及び演算部（１２）を備えている。ミキサドラム（１０）は、横方向に伸びた回転軸（１０Ｇ）を有し、上側に空間を残してレディミクストコンクリートが投入される。電極（１１）は、ミキサドラム（１０）内に設けられ、ミキサドラム（１０）の回転軸（１０Ｇ）を中心にした所定の円周上をミキサドラム（１０）の回転に伴って移動して抵抗値を測定する。演算部（１２）はミキサドラム（１０）の回転速度、及び電極（１１）を利用して測定した抵抗値の変化速度に対応するスランプ値を求める。

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— 国際調査報告（条約第 21 条(3)）

DESCRIPTION

Title of the Invention: MIXER

Technical Field

[0001] The present invention relates to a mixer.

Background Art

[0002] Patent Document 1 discloses a conventional mixer. This mixer includes a mixer drum, three types of electrodes, and an operation part. The mixer drum has two ends one of which is formed with an opening. The other end, which is an inner side as viewed from the one end, is closed by a closing part. The electrodes are provided on an inner peripheral surface of the mixer drum. The electrodes are capable of measuring a pressure which the inner peripheral surface of the mixer drum receives from ready-mixed concrete, a moisture content and a temperature of the ready-mixed concrete respectively. The electrodes are connected to the operation part. The operation part finds a slump value from values measured by the respective electrodes. Accordingly, in this mixer, the slump values can be found while the ready-mixed concrete is being agitated by the mixer drum.

Prior Art Document

Patent Documents

[0003] Patent Document 1: U.S. Patent Application Publication No. 2011/0077778

Summary of the Invention

Problem to Be Overcome By the Invention

[0004] In the mixer of patent document 1, however, three types of electrodes are provided in order to measure absolute values of the pressure which the inner peripheral surface of the mixer drum receives from ready-mixed concrete, the moisture content and the temperature of the ready-mixed concrete. As a result, when the ready-mixed concrete hardens while being adherent to the electrodes, there is a possibility that the absolute values of the pressure which the inner peripheral surface of the mixer drum receives from ready-mixed concrete, the moisture content and the temperature of the ready-mixed concrete cannot be measured properly. Accordingly, there is a possibility that an accurate slump value cannot be found in the mixer.

[0005] The present invention was made in view of the above-described circumstances in the conventional art and has an object to provide a mixer which can successfully find the slump value of the ready-mixed concrete agitated by the mixer drum.

Means for Overcoming the Problem

[0006] A mixer in accordance with the present invention includes a mixer drum, electrodes and an operation part. The mixer drum has a rotational axis extending in a lateral direction. Ready-mixed concrete is put into the mixer drum with a space remaining at an upper side in the mixer drum. The electrodes are provided in the mixer drum so as to be moved on respective predetermined circumferences about the rotational axis of the mixer drum with rotation of the mixer drum, thereby measuring a predetermined electrical characteristic. The operation part finds a slump value corresponding to a rotational speed of the mixer drum in a case where the ready-mixed concrete is agitated and a change rate of the electrical characteristic measured by use of the electrodes during the agitation.

[0007] In the mixer in accordance with the invention, the operation part may find the change rate of the electrical characteristic from a time period in which the electrical characteristic measured by the use of the electrodes changes from a minimum value to a maximum value or a time period in which the electrical characteristic measured by the use of the electrodes changes from a maximum value to a minimum value.

[0008] In the mixer in accordance with the invention, the operation part may find a rotational speed of the mixer drum from a one period of the electrical characteristic measured by the use of the electrodes.

[0009] The mixer in accordance with the invention may further include a recording part on which is recorded a database storing the rotational speed of the mixer drum, the change rate of the electrical characteristic and the slump value found from the rotational speed and the change rate. The operation part may find the slump value from the database recorded on the recording part.

[0010] In the mixer in accordance with the present invention, the change rate of the electrical characteristic from a state where the electrodes are buried in the ready-mixed concrete in the mixer drum until the electrodes are exposed in the space at the upper side over the ready-mixed concrete may be measured.

Brief Description of the Drawings

[0011] Fig. 1 is a diagrammatic view of a mixer truck of a first embodiment;

Fig. 2(A) is a schematic diagram of a mixer drum of a mixer of the mixer truck of the first embodiment, and Fig. 2(B) is an enlarged view of a major part where electrodes, an operation part, and a recording part are disposed;

Fig. 3(A) is a sectional view taken along line X-X in Fig. 2(A), and Fig. 3(B) is an enlarged view of the major part where the electrodes, the operation part, and the recording part are disposed;

Fig. 4 is a graph illustrating changes with time of resistance values measured by use of the electrodes upon rotation of the mixer drum in order to agitate ready-mixed concrete put into the mixer drum in the first embodiment;

Fig. 5 is a flowchart illustrating a step of determining a maximum value and a minimum value from the resistance values measured by the use of the electrodes in the first embodiment;

Fig. 6 is a flowchart illustrating a step of finding a rotational speed of the mixer drum and a change rate of the resistance value from the resistance values measured by the use of the electrodes in the first embodiment, thereby finding the slump value of the ready-mixed concrete;

Fig. 7 is a schematic diagram of the part where the electrodes, the operation part and the recording part are disposed in the second embodiment; and

Fig. 8 is a graph illustrating changes with time of electrostatic capacity values measured by the use of the electrodes upon rotation of the mixer drum in order to agitate the ready-mixed concrete put into the mixer drum in the second embodiment.

Best Mode for Carrying Out the Invention

[0012] First and second embodiments of the mixer truck with a mixer in accordance with the invention being mounted on a frame of the body will be described with reference to the drawings.

<First Embodiment>

Referring to Fig. 1, the mixer truck of the first embodiment includes a body 50, a hopper 50C, a chute 50D, and a mixer 10J.

[0013] The body 50 has a cabin 50A and a frame 50B. The cabin 50A is provided at the front side of the body 50 (a front-back direction corresponds to a left-right direction as viewed in Fig. 1. The same shall apply hereinafter.). The frame 50B is provided on the upper side of a mount 50F provided at the rear side of the cabin 50A. An engine (not illustrated) to run the body 50 is provided at a lower side of the cabin 50A (an up-down direction corresponds to an up-down direction as viewed in Fig. 1. The same shall apply hereinafter.).

[0014] The hopper 50C is formed with an inlet which is open while being upwardly spread. The hopper 50C has a lower end which is open forwardly downward thereby to be formed into an outlet. The outlet of the hopper 50C communicates with a central part of an opening 10E of a mixer drum 10 which will be described later. The hopper 50C is fixed to the upper part of the rear end of the frame 50B. Ready-mixed concrete put through the inlet into the hopper 50C is further put through the outlet into the mixer drum 10.

[0015] The chute 50D is supported by the rear end of the frame 50B so that a distal end thereof is rotatable about a proximal end thereof in a horizontal direction and in an up-down direction. In this case, the horizontal direction should not mean a strict horizontal direction but includes a state deviated somewhat from the strict horizontal direction. Thus, the ready-mixed concrete discharged from the mixer drum 10 is guided by the chute 50D to a desired location.

[0016] The mixer 10J includes the mixer drum 10, two electrodes 11, an operation part 12, a recording part 13, and a power supply 14, as illustrated in Figs. 2(A), 2(B), 3(A) and 3(B).

[0017] The mixer drum 10 includes a drum body 10A, a drive shaft 10B, two drum blades 10C, and a roller ring 10D. The drum body 10A is formed into a cylindrical shape. The drum body 10A has two ends one of which is provided with an opening 10E. The other end of the drum body 10A located at the inner side as viewed from the one end is closed by a closure 10F. The drive shaft 10B is connected to a central part of the closure 10F and extends outward from the drum body 10A. The drive shaft 10B extends on a rotational axis 10G of the mixer drum 10.

[0018] The drive shaft 10B is connected to a speed reducer (not illustrated). The speed reducer is connected to a hydraulic motor (not illustrated). The hydraulic motor is connected via piping (not illustrated) to a hydraulic pump (not illustrated). The hydraulic pump is connected to the engine (not illustrated) mounted on the body. Thus, a rotative force produced by the engine is transmitted to the drive shaft 10B via the hydraulic pump, piping, the hydraulic motor, and the speed reducer so that the mixer drum 10 is rotated.

[0019] The drum blades 10C are fixed along an inner peripheral surface of the drum body 10A in a spiral manner with a predetermined space from each other. In other words, the drum blades 10C are rotated together with the drum body 10A. The roller ring 10D is circularly annular in shape and is provided so as to go round an outer surface of the drum body 10A at the opening

10E side.

[0020] The mixer drum 10 is rotatably mounted on the frame 50B in a forwardly inclined posture in which the opening 10E is located above and raised higher than the closure 10F, as illustrated in Fig. 1. In more detail, in the mixer drum 10, the roller ring 10D is supported on a plurality of rollers 50E from below, which rollers are rotatably provided on an upper part of the rear end of the frame 50B. In other words, the mixer drum 10 is rotatably mounted on the frame 50B while a rotational axis 10G of the mixer drum 10 laterally extends in an inclined state.

[0021] The electrodes 11 can measure a resistance value which is a predetermined electrical characteristic between one electrode and another, as illustrated in Figs. 2(A), 2(B), 3(A), and 3(B). The electrodes 11 are each formed to extend into a cylindrical shape and provided on a middle part of the inner peripheral surface of the mixer drum 10 in the front-back direction, that is, inside of the mixer drum 10. In more detail, the electrodes 11 are arranged at a predetermined interval in the front-back direction of the mixer drum 10. Each electrode 11 has a proximal end abutting against the inner peripheral surface of the mixer drum 10 and a distal end directed toward the rotational axis 10G of the mixer drum 10. Each electrode 11 is provided so that a center line 11A thereof is perpendicular to the rotational axis 10G. In other words, the electrodes 11 are provided so that the center lines 11A are parallel with each other. Electric wires 15 have respective one ends which are connected to the proximal ends of the electrodes 11 through respective through-holes watertightly formed through a side surface of the mixer drum 10, as illustrated in Fig. 2(B).

[0022] The operation part 12 and the recording part 13 are provided on the outer peripheral surface of the mixer drum 10. The operation part 12 and the recording part 13 are disposed adjacent to each other and are electrically connected to each other. The operation part 12 and the recording part 13 are located in the middle between two adjacent electrodes 11. The other ends of the electric wires 15 are electrically connected to the operation part 12. A power supply 14 is provided on the outer peripheral surface of the mixer drum 10. The power supply 14 is located adjacent to the operation part 12 and the recording part 13. The power supply 14 is connected via an electric wire 16 to the operation part 12, so that the operation part 12 is supplied with electrical power necessary for operation from the power supply 14 via the electric wire 16. Furthermore, the electrodes 11 and the recording part 13 are supplied with electrical power necessary for operation from the power supply 14 via the electric wire 16 and the operation part 12. The recording part 13 is a read only memory (ROM), a flash memory, or the like and can record a database that will be described later.

[0023] The working of the mixer 10J of the mixer truck will now be described. The rotational axis 10G of the mixer 10J extends at a slant in the lateral direction. As a result, when ready-mixed concrete is put into the mixer drum 10, a space remains over the put ready-mixed concrete in the mixer drum 10. The mixer 10J is rotated about the rotational axis 10G so that the ready-mixed concrete put into the mixer drum 10 is agitated.

[0024] Each electrode 11 provided on the inner peripheral surface of the mixer drum 10 is moved on a circumference (a predetermined circumference) located near the inner peripheral surface of the mixer drum 10 about the rotational axis 10G of the mixer drum 10 with rotation of the mixer drum 10. Thus, the electrodes 11 are moved between the ready-mixed concreate put into the mixer drum 10 and the space remaining over the ready-mixed concrete in the mixer drum 10.

[0025] The resistance value assumes a minimum value Min1 when the electrodes 11 are moved while being completely buried in the ready-mixed concrete (T1-T2), and the resistance value assumes a maximum value Max1 when the electrodes 11 are moved while being completely exposed in the space over the ready-mixed concrete (T3-T4), as illustrated in Fig. 4. The resistance value is gradually increased from the minimum value Min1 to the maximum value Max1 during the time period (T2-T3) in which the electrodes 11 change from the state where the electrodes 11 are completely buried in the ready-mixed concrete to the state where the electrodes 11 are completely exposed in the space over the ready-mixed concrete. Furthermore, the resistance value is gradually decreased from the maximum value Max1 to the minimum value Min1 during the time period (T4-T5) in which the electrodes 11 change from the state where the electrodes 11 are completely exposed in the space over the ready-mixed concrete to the state where the electrodes 11 are completely buried in the ready-mixed concrete. In other words, the resistance value periodically transits between the minimum value Min1 and the maximum value Max1 when each electrode 11 is moved on the circumference located near the inner peripheral surface of the mixer drum 10 with rotation of the mixer drum 10. That is to say, the resistance value has one period between time T1 and time T5. The mixer drum 10 is rotated one turn in this period.

[0026] Next, a manner of finding a slump value will be described. The slump value represents the flowability of the ready-mixed concrete. The slump value becomes larger as a moisture content of the ready-mixed concrete is rendered large, and the slump value becomes smaller as the moisture content of the ready-mixed concrete is rendered small.

[0027] For example, the ready-mixed concrete is less likely to stick to the inner peripheral surface of the mixer drum 10 and the electrodes 11 when the slump value is large (the flowability is high). In more detail, the ready-mixed concrete is less likely to stick to the inner peripheral surface of the mixer drum 10 and less likely to be lifted along the inner peripheral surface of the mixer drum 10 even when the rotational speed of the mixer drum 10 is high (even when the period between time T1 and time T5 is short). As a result, a moving distance of each electrode 11 in the ready-mixed concrete becomes short. Furthermore, the ready-mixed concrete is less likely to stick to the electrodes 11, so that the electrodes 11 can easily move in the ready-mixed concrete in a short period of time. For the foregoing reasons, a change rate of the resistance value becomes fast (the period between time T2 and time T3 becomes short) when the slump value of the ready-mixed concrete becomes large.

[0028] In reverse, the ready-mixed concrete is likely to stick to the inner peripheral surface of the mixer drum 10 and the electrodes 11 when the slump value is small (the flowability is low). In more detail, the ready-mixed concrete is likely to stick to the inner peripheral surface of the mixer drum 10 and likely to be lifted along the inner peripheral surface of the mixer drum 10 when the rotational speed of the mixer drum 10 is high (when the time period between time T1 and time T5 is short). As a result, the moving distance of each electrode 11 in the ready-mixed concrete becomes long. Furthermore, the ready-mixed concrete is likely to stick to the electrodes 11, so that the electrodes 11 cannot easily to move in the ready-mixed concrete in a short period of time. For the foregoing reasons, a change rate of the resistance value becomes slow (the period between time T2 and time T3 becomes long) when the slump value of the ready-mixed concrete becomes small.

[0029] Thus, the slump value has an influence on the rotational speed of the mixer drum 10 (hereinafter, "rotational speed") and the change rate of the resistance value (hereinafter, "change rate") according to its value. TABLE 1 indicates slump values corresponding to respective rotational speeds and change rates obtained from the experiments. The recording part 13 records a database storing the slump values corresponding to these rotational speeds and the change rates.

[0030] TABLE 1

Rotational speed	Change rate 0.5 sec	Change rate 1 sec	Change rate 1.5 sec
0.5 rpm	5 cm	8 cm	15 cm
1 rpm	7 cm	12 cm	23 cm
1.5 rpm	10 cm	15 cm	28 cm

[0031] The rotational speed of the mixer drum 10 in the case of agitating the ready-mixed concrete is an inverse of one period (from time T1 to time T5) of the resistance value that is measured by the use of the electrodes 11 moved with rotation of the mixer drum 10 and periodically changes, as illustrated in Fig. 4. In other words, the rotational speed is found by the operation part 12 from the one period (T1-T5) of the resistance value measured by the use of the electrodes 11.

[0032] The change rate is a time period (from T2 to T3) from the time (T2) when the periodically changing resistance value measured by the use of the electrodes 11 moved with rotation of the mixer drum 10 starts to increase from the minimum value Min1, to the time (T3) when the resistance value reaches the maximum value Max1. In other words, the operation part 12 finds the time period (T2-T3) when the resistance value measured by the use of the electrodes 11 changes from minimum value Min1 to the maximum value Max1, thereby finding the change rate. In further other words, the change rate of the resistance value from the state where the electrodes 11 are completely buried in the ready-mixed concrete until the electrodes 11 are completely exposed in the space over the ready-mixed concrete in the mixer drum 10 is measured. Thus, the rotational speed and the change rate can be found by the operation part 12 from the resistance value measured by the use of the electrodes 11.

[0033] The operation part 12 finds from the database recorded in the recording part 13 the value corresponding to the rotational speed and the change rate both found by the operation part 12, thereby finding the slump value. For example, as presented in TABLE 1, when the rotational speed is 1.5 rpm and the change rate is 0.5 sec, the slump value of the ready-mixed concrete is 10 cm.

[0034] Next, the following will describe the control in the operation part 12 to determine the minimum value Min1 and the maximum value Max1 from the resistance value measured by the use of the electrodes 11. The flowchart as indicated in Fig. 5 is repeatedly carried out at a predetermined time interval in the operation part 12. Accordingly, the operation part 12 can repeatedly obtain a current resistance value measured by the use of the electrodes 11, at the predetermined time interval.

[0035] Firstly, a provisional minimum value and a provisional maximum value are collected from the current resistance value measured by the use of the electrodes 11 with rotation of the mixer drum 10 (step S1). In more detail, the current resistance value measured by the use of the electrodes 11 is compared with a first boundary value and a second boundary value (both boundary values are previously recorded in the recording part 13). In this case, the current resistance value is collected as a provisional minimum value when smaller than the first boundary value. The current resistance value is collected as a provisional maximum value when larger than the second boundary value.

[0036] Subsequently, it is determined whether or not the provisional minimum and maximum values collected at step S1 are stable (step S2). The operation part 12 repeatedly carries out the flowchart of Fig. 5 at the predetermined time interval. Accordingly, the operation part 12 can repeatedly collect the provisional minimum and maximum values at the predetermined time interval from the current resistance value measured by the use of the electrodes 11. In more detail, it is determined whether or not the difference between the provisional minimum and maximum values collected at step S1 is larger than a predetermined value. Furthermore, it is determined whether or not the provisional minimum and maximum values remain within respective predetermined ranges for respective predetermined time periods (the predetermined values, the predetermined ranges and the predetermined time periods are previously recorded in the recording part 13). Thereafter, when it is determined that the provisional minimum and maximum values are stable, the flowchart proceeds to step S3. Alternatively, when it is determined that the provisional minimum and maximum values are not stable, the operation is finished and provisional minimum and maximum values are collected again from the resistance value in the next operation repeated in the operation part 12.

[0037] Next, the minimum value Min1 and the maximum value Max1 for comparison purpose (step S3) are determined. In more detail, when it is determined at step S2 that the provisional minimum and maximum values are stable, these provisional minimum and maximum values are stored as the minimum value Min1 and the maximum value Max1 for comparison purpose respectively.

[0038] Next, the following will describe the control in the operation part 12 to find the rotational speed and the change rate. The flowchart of Fig. 6 is repeatedly carried out in the operation part 12 at a predetermined time interval. Accordingly, the operation part 12 can repeatedly compare the current resistance value measured by the use of the electrodes 11 with the minimum value Min1 and maximum value Max1 for comparison purpose both of which have been stored at step S3 (refer to Fig. 5), at the predetermined time interval.

[0039] Firstly, the current resistance value is measured by the use of the electrodes 11 with rotation of the mixer drum 10 (step S11). Subsequently, it is determined whether or not the current resistance value measured by the use of the electrodes 11 has reached the minimum value Min1 for comparison purpose at time T1 (step S12). When it is determined that the current resistance value measured by the use of the electrodes 11 has reached the minimum value Min1 for comparison purpose at time T1, the flowchart proceeds to step S13. Alternatively, when it is determined that the current resistance value measured by the use of the electrodes 11 has not reached the minimum value Min1 for comparison purpose at time T1, the flowchart proceeds to step S14.

[0040] When the flowchart proceeds to step S13, the rotational speed of the mixer 10J one period before is found and measurement of the rotational speed of the mixer 10J in a subsequent one period is started. In more detail, a first counter is provided which is added with +1 every time the flowchart as indicated in Fig. 6 is repeatedly carried out in the operation part 12 at the predetermined time interval. The first counter is reset to 0 at a time (T1, T5) when the current resistance value has reached the minimum value Min1 for comparison purpose. In other words, the first counter is reset to 0 every time the mixer drum 10 is rotated one turn. Accordingly, the rotational speed of the mixer drum 10 is found as an inverse of the result of multiplication of the count value immediately before reset of the first counter to 0, by a time period where the flowchart of Fig. 6 is carried out repeatedly in the operation part 12 at the predetermined time interval. After having been reset to 0, the first counter repeats addition of +1 at the predetermined time interval to start measurement of the rotational speed of the mixer 10J in a subsequent one period.

[0041] When the flowchart proceeds to step S14, it is determined whether or not the current resistance value has started to increase from the minimum value Min1 for comparison purpose at time T2. When it is determined that the current resistance value measured by the use of the electrodes 11 has started to increase from the minimum value Min1 for comparison purpose at time T2, the flowchart proceeds to step S15. Alternatively, when it is determined that the current resistance value measured by the use of the electrodes 11 has not started to increase from the minimum value Min1 for comparison purpose at time T2, the flowchart proceeds to step S16.

[0042] When the flowchart proceeds to step S15, measurement of a time period until time (T3) when the current resistance value measured by the use of the electrodes 11 has reached the maximum value Max1 for comparison purpose. In more detail, a second counter is provided which is added with +1 every time the flowchart of Fig. 6 is repeatedly carried out in the operation part 12, for the time period (T2−T3) from the time (T2) when the current resistance value has started to increase from the minimum value Min1 for comparison purpose until the time (T3) when the current resistance value has reached the maximum value Max1 for comparison purpose. In other words, the addition of +1 to the second counter starts at step S15.

[0043] When the flowchart proceeds to step S16, it is determined whether or not the current resistance value has reached the maximum value Max1 for comparison purpose at time T3. When it is determined that the current resistance value measured by the use of the electrodes 11 has reached the maximum value Max1 for comparison purpose at time T3, the flowchart proceeds to step S17. Alternatively, when it is determined that the current resistance value measured by the use of the electrodes 11 has not reached the maximum value Max1 for comparison purpose at time T3, the operation is finished and the operation is carried out again from step S11 in the subsequent operation repeated in the operation part.

[0044] When the flowchart proceeds to step S17, the change rate is found. In more detail, operation is carried out to obtain the time period (T2−T3) from the time (T2) when the current resistance value measured by the use of the electrodes 11 has started to increase from the minimum value Min1 for comparison purpose to the time (T3) when the current resistance value measured by the use of the electrodes 11 has reached the maximum value Max1 for comparison purpose. In other words, the change rate can be found by multiplying the current value of the second counter which has started addition of +1 at step S15, by a time period where the flowchart of Fig. 6 is carried out repeatedly in the operation part 12 at the predetermined time interval. The second counter is then reset to 0.

[0045] Next, a slump value corresponding to the rotational speed and the change rate is found (step S18). In more detail, the slump value corresponding to the rotational speed found at step S13 and the change rate found at step S17 is found from the database recorded in the recording part 13.

[0046] Thus, when the slump value is to be found in the mixer truck of the first embodiment, the change rate of the resistance value just need to be measured by the use of one type of electrodes 11. Accordingly, a plurality of types of electrodes 11 need not be provided. Furthermore, the slump value is found by the use of the change rate of the resistance value in this mixer truck. Even if the ready-mixed concrete should harden while being adherent to the electrodes 11 and the absolute value of the measured resistance value should be influenced, there would be almost no influence on the change rate of the resistance value. As a result, this mixer truck can find the slump value without influence from the condition around the electrodes 11.

[0047] Accordingly, the mixer truck of the first embodiment can successfully find the slump value of the ready-mixed concrete agitated by the mixer drum 10.

[0048] In this mixer truck, furthermore, the operation part 12 finds the change rate of the resistance value from the time period (T2-T3) in which the resistance value measured by the use of the electrodes 11 changes from the minimum value Min1 to the maximum value Max1. As a result, since the minimum value Min1 and the maximum value Max1 of the resistance value are easy to measure by the use of the electrodes 11 in this mixer truck, the change rate of the resistance value can easily be found.

[0049] In this mixer truck, furthermore, the operation part 12 finds the rotational speed of the mixer drum 10 from one period

(T1–T5) of the resistance value measured by the use of the electrodes 11. As a result, since the rotational speed of the mixer drum 10 can be measured by the use of the electrodes 11 provided for finding the change rate of the resistance value, a speed indicator or the like need not be provided separately in this mixer truck.

[0050] In this mixer truck, furthermore, the recording part 13 records the database storing the rotational speed of the mixer drum 10, the change rate of the electrical characteristic, and the slump value found from the rotational speed and the change rate. Furthermore, the operation part 12 finds the slump value from the database stored in the recording part 13. As a result, this mixer truck can easily find the slump value by measuring the rotational speed of the mixer drum 10 and the change rate of the electrical characteristic by the use of the electrodes 11 and further by making the measured values correspond to the rotational speed of the mixer drum 10 and the change rate of the electrical characteristic recorded in the recording part 13.

[0051] In this mixer truck, furthermore, the change rate of the electrical characteristic from the state where the electrodes 11 are buried in the ready-mixed concrete until the electrodes 11 are exposed in the space over the ready-mixed concrete is measured. Accordingly, upon rotation of the mixer drum 10, the ready-mixed concrete put into the mixer drum 10 is lifted up along the inner peripheral surface of the mixer drum 10. As a result, a time period required for the electrodes 11 rotated with rotation of the mixer drum 10 to be exposed in the space over the ready-mixed concrete from the inside of the ready-mixed concrete is longer than a time period required for the electrodes 11 to be buried into the ready-mixed concrete from the space over the ready-mixed concrete. In other words, the longer time period can be measured where the electrical characteristic changes. Accordingly, more accurate change rate of the electrical characteristic can be found.

[0052] <Second Embodiment>

The mixer drum of a second embodiment differs from that of the first embodiment in the structure of two electrodes 111 and in that an electrostatic capacity value between the electrodes 111 is measured. The other construction of the mixer truck of the second embodiment is identical with that of the first embodiment. Identical or similar parts in the second embodiment are labeled by the same reference symbols as those in the first embodiment and detailed description of these parts will be eliminated.

[0053] Each electrode 111 has a conductor part 60 and an insulating member 61 as shown in Fig. 7. The conductor part 60 is formed to extend into a cylindrical shape. A surface of the conductor part 60 of the electrode 111 is covered by the insulating member 61 in order that the surface of the conductor part 60 may be prevented from direct contact with the ready-mixed concrete. The electrodes 111 are each formed to extend into a cylindrical shape and provided on the middle part of the inner peripheral surface of the mixer drum 10 in the front-back direction (not illustrated). Each electrode 111 has a proximal end abutting against the inner peripheral surface of the mixer drum 10 and a distal end directed toward the rotational axis 10G of the mixer drum 10. Each electrode 111 is provided so that a center lines 11A thereof is perpendicular to the rotational axis 10G of the mixer drum 10. In other words, the electrodes 111 are provided so that the center lines 11A are parallel with each other.

[0054] The electrodes 111 can measure an electrostatic capacity value therebetween as shown in Fig. 8. The electrostatic capacity value measured by the use of the electrodes 111 assumes a minimum value Min2 when the electrodes 111 are moved while being completely exposed in the space over the ready-mixed concrete (T13–T14). The electrostatic capacity value measured by the use of the electrodes 111 further assumes a maximum value Max2 when the electrodes 111 are moved while being completely buried in the ready-mixed concrete (T11–T12). Furthermore, the electrostatic capacity value is gradually increased from the minimum value Min2 toward the maximum value Max2 during the time period (T14–T15) in which the electrodes 111 change from the state where the electrodes 111 are completely exposed in the space over the ready-mixed concrete to the state where the electrodes 111 are completely buried in the ready-mixed concrete. Furthermore, the electrostatic capacity value is gradually decreased from the maximum value Max2 toward the minimum value Min2 during the time period (T12–T13) in which the electrodes 111 change from the state where the electrodes 111 are completely buried in the ready-mixed concrete to the state where the electrodes 111 are completely exposed in the space over the ready-mixed concrete. In other words, the electrostatic capacity value periodically transits between the minimum value Min2 and the maximum value Max2 when each electrode 111 is moved on the circumference located near the inner peripheral surface of the mixer drum 10 with rotation of the mixer drum 10. Thus, the electrostatic capacity value has one period of T11–T15, in which period the mixer drum 10 is rotated one turn.

[0055] In the case where the mixer drum 10 is rotated to agitate the ready-mixed concrete, the rotational speed of the mixer drum 10 is an inverse of one period (T11–T15) of the electrostatic capacity value that is measured by the use of the electrodes 111 moved with rotation of the mixer drum 10 and periodically changes, as illustrated in Fig. 8. In other words, the rotational speed is found by the operation part 12 from the one period (T11–T15) of the electrostatic capacity value that is a predetermined electrical characteristic measured by the use of the electrodes 111.

[0056] The change rate is a time period (T12–T13) from the time (T12) when the periodically changing electrostatic capacity value measured by the use of the electrodes 111 moved with rotation of the mixer drum 10 starts to decrease from the maximum value Max2 to the time (T13) when the electrostatic capacity value reaches the minimum value Min2. In other words, the operation part 12 finds the time (T12–T13) when the electrostatic capacity value measured by the use of the electrodes 111 changes from the maximum value Max2 to the minimum value Min2, thereby finding the change rate. In further other words, the change rate of the electrostatic capacity value from the state where the electrodes 111 are completely buried in the ready-mixed concrete until the electrodes 111 are completely exposed in the space over the ready-mixed concrete is measured. Thus, the rotational speed and the change rate can be found by the operation part 12 from the electrostatic capacity value measured by the use of the electrodes 111. The slump value can be found by the operation part 12 from the rotational speed and the found change rate found by the operation part 12 by the use of the database recorded in the recording part 13.

[0057] Thus, in the mixer truck of the second embodiment, too, when the slump value is to be found, the change rate of the electrostatic capacity value just need to be measured by the use of the one type of electrodes 111. Accordingly, a plurality of types of electrodes 111 need not be provided. Furthermore, the slump value is found by the use of the change rate of the electrostatic capacity value in this mixer truck. Even if the ready-mixed concrete should harden while being adherent to the electrodes 111 and the absolute value of the measured resistance value should be influenced, there would be almost no influence on the change rate of the electrostatic capacity value. As a result, this mixer truck can find the slump value without influence from the condition around the electrodes 111.

[0058] Accordingly, the mixer truck of the second embodiment, too, can successfully find the slump value of the ready-mixed concrete agitated by the mixer drum 10.

[0059] In the mixer truck of the second embodiment, furthermore, the operation part 12 finds the change rate of the electrostatic capacity value from the time period (T12-T13) in which the electrostatic capacity value measured by the use of the electrodes 11 changes from the maximum value Max2 to the minimum value Min2. As a result, since the minimum value Min2 and the maximum value Max2 of the electrostatic capacity value are easy to measure by the use of the electrodes 111 in this mixer truck, the change rate of the electrostatic capacity value can easily be found.

[0060] In the mixer truck of the second embodiment, furthermore, the operation part 12 finds the rotational speed of the mixer drum 10 from the one period (T11–T15) of the electrostatic capacity value measured by the use of the electrodes 111. As a result, since the rotational speed of the mixer drum 10 can be found by the use of the electrodes 111 provided for finding the change rate of the electrostatic capacity value, a speed indicator or the like need not be provided separately in this mixer truck.

[0061] In this mixer truck, furthermore, the recording part 13 records the database storing the rotational speed of the mixer drum 10, the change rate of the electrical characteristic, and the slump value found from the rotational speed and the change rate. Furthermore, the operation part 12 finds the slump value from the database stored in the recording part 13. As a result, this mixer truck can easily find the slump value by measuring the rotational speed of the mixer drum 10 and the change rate of the electrical characteristic by the use of the electrodes 111 and further by making the measured values correspond to the rotational speed of the mixer drum 10 and the change rate of the electrical characteristic recorded in the recording part 13.

[0062] In this mixer truck, furthermore, the change rate of the electrical characteristic from the state where the electrodes 111 are buried in the ready-mixed concrete until the electrodes

111 are exposed in the space over the ready-mixed concrete is measured. Accordingly, upon rotation of the mixer drum 10, the ready-mixed concrete put into the mixer drum 10 is lifted up along the inner peripheral surface of the mixer drum 10. As a result, a time period required for the electrodes 111 rotated with rotation of the mixer drum 10 to be exposed in the space over the ready-mixed concrete from the inside of the ready-mixed concrete is longer than a time period required for the electrodes 111 to be buried into the ready-mixed concrete from the space over the ready-mixed concrete. In other words, the longer time period can be measured where the electrical characteristic changes. Accordingly, more accurate change rate of the electrical characteristic can be found.

[0063] <Other Embodiments>

The present invention should not be limited to the first and the second embodiments described above with reference to the drawings, but the technical scope of the invention encompasses the following embodiments, for example.

(1) Although the recording part records the database storing a plurality of slump values corresponding to the rotational speeds and the change rates in the first embodiment, the recording part may record the database storing slump values corresponding to three types of values, that is, the rotational speed, the change rate, and a loading amount of ready-mixed concrete. In this case, the loading amount of ready-mixed concrete is found on the basis of a ratio of the time when the electrodes are moved in the space over the ready-mixed concrete to the time when the electrodes are moved in the ready-mixed concrete. In more detail, when the

loading amount of ready-mixed concrete differs, an angle changes which angle is made between an imaginary line connecting a lower end of the mixer drum to the rotational axis and an imaginary line connecting each electrode to the rotational axis at the time when each electrode is completely exposed in the space over the ready-mixed concrete from the inside of the ready-mixed concrete. As a result, the resistance value and the change rate of the electrostatic capacity value change even if the slump value of the ready-mixed concrete does not change. Accordingly, a more accurate slump value can be found by the use of the database added with data of the loading amount of ready-mixed concrete.

(2) Although the operation part finds the rotational speed in the first and the second embodiments, the operation part may not find the rotational speed, and a speed indicator or the like may be provided to find the rotational speed.

(3) The time period when the resistance value measured by the use of the electrodes changes from the minimum value to the maximum value is used as the change rate in the first embodiment. The change rate should not be limited to this. An intermediate time period between the time when the resistance value increases from the minimum value and the time when the resistance value reaches the maximum value may be used as the change rate.

(4) The time period in which the electrostatic capacity value measured by the use of the electrodes changes from the maximum value to the minimum value is used as the change rate in the second embodiment. The change rate should not be limited to this. An intermediate time period between the time when the electrostatic capacity value decreases from the maximum value and the time when

the electrostatic capacity value reaches the minimum value may be used as the change rate.

(5) The time period in which the resistance value measured by the use of the electrodes changes from the minimum value to the maximum value is used as the change rate in the first embodiment. The change rate should not be limited to this. The time period in which the resistance value measured by the use of the electrodes changes from the maximum value to the minimum value may be used as the change rate.

(6) The time period in which the electrostatic capacity value measured by the use of the electrodes changes from the maximum value to the minimum value is used as the change rate in the second embodiment. The change rate should not be limited to this. The time period in which the electrostatic capacity value measured by the use of the electrodes changes from the minimum value to the maximum value may be used as the change rate.

(7) Although the rotative force obtained from the engine serving as a power source of the mixer truck is transmitted to the mixer drum in the first embodiment, the power source should not be limited to the engine. The rotative force derived from an electric motor or the like may serve as the power source.

(8) Although the first embodiment is directed to the mixer truck, the embodiment should not be limited to the mixer truck. The embodiment may be directed to a mixer including a mixer drum which is rotatably mounted on a frame installed at work site. In this case, the rotative force to rotate the mixer drum may be derived from an electric motor or the like.

Explanation of Reference Symbols

[0064] 10G … rotational axis, 10 … mixer drum, 11 … electrode, 12 … operation part, 13 … recording part, Min1, Min2 … minimum value (for comparison purpose), and Max1, Max2 … maximum value (for comparison purpose).

CLAIMS

1. A mixer comprising:

a mixer drum which has a rotational axis extending in a lateral direction and into which ready-mixed concrete is put with a space remaining at an upper side therein;

electrodes provided in the mixer drum so as to be moved on respective predetermined circumferences about the rotational axis of the mixer drum with rotation of the mixer drum, thereby measuring a predetermined electrical characteristic; and

an operation part finding a slump value corresponding to a rotational speed of the mixer drum in a case where the ready-mixed concrete is agitated and a change rate of the electrical characteristic measured by use of the electrodes during the agitation.

2. The mixer according to claim 1, wherein the operation part finds the change rate of the electrical characteristic from a time period in which the electrical characteristic measured by the use of the electrodes changes from a minimum value to a maximum value or a time period in which the electrical characteristic measured by the use of the electrodes changes from a maximum value to a minimum value.

3. The mixer according to claim 1, wherein the operation part finds a rotational speed of the mixer drum from a one period of the electrical characteristic measured by the use of the electrodes.

4. The mixer according to any one of claims 1 to 3, further comprising a recording part on which is recorded a database storing the rotational speed of the mixer drum, the change rate of the electrical characteristic and the slump value found from the rotational speed and the change rate,

wherein the operation part finds the slump value from the database recorded on the recording part.

5. The mixer according to claim 4, wherein the change rate of the electrical characteristic from a state where the electrodes are buried in the ready-mixed concrete until the electrodes are exposed in the space at the upper side over the ready-mixed concrete is measured.

Fig. 1

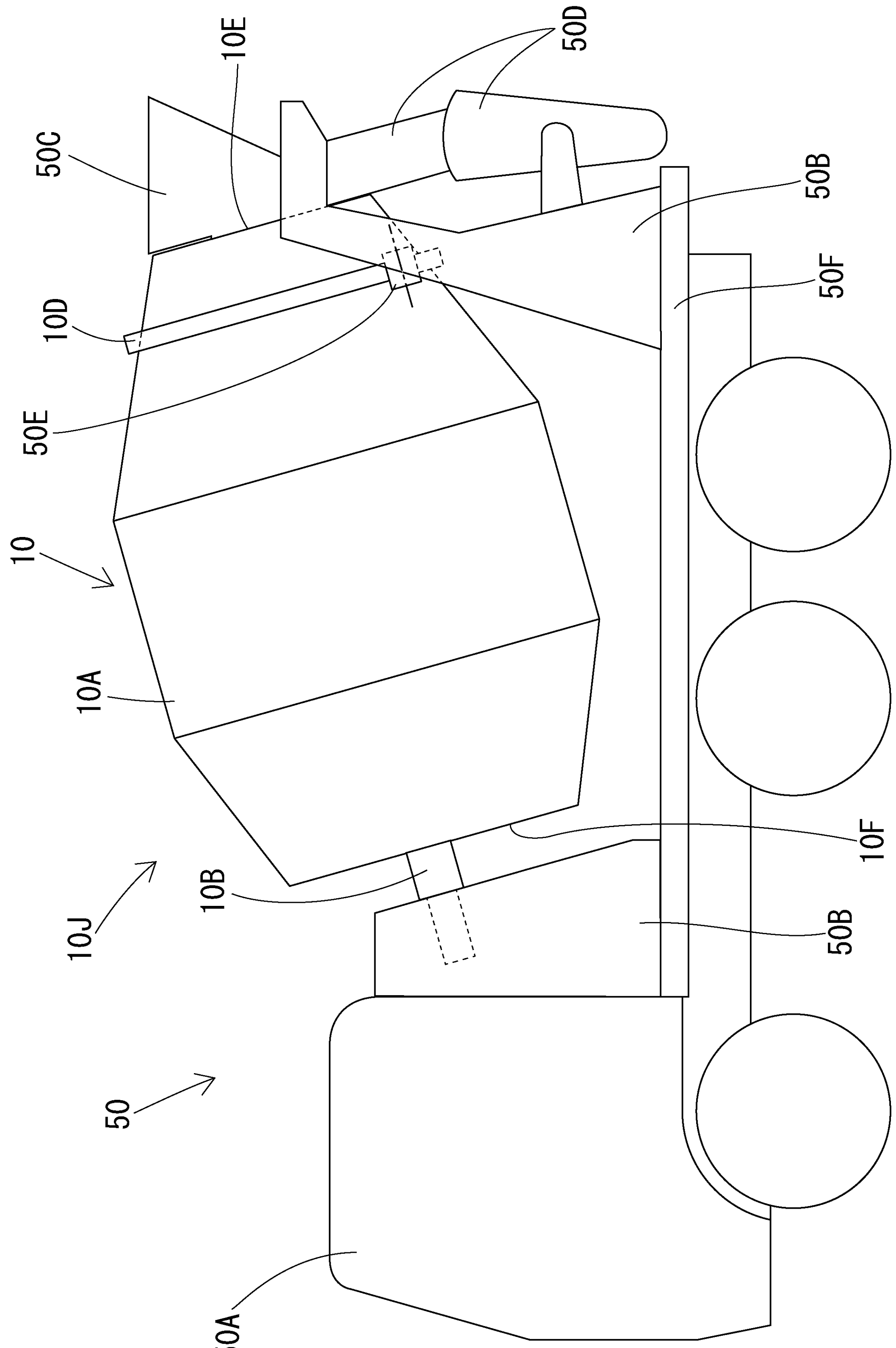


Fig. 2

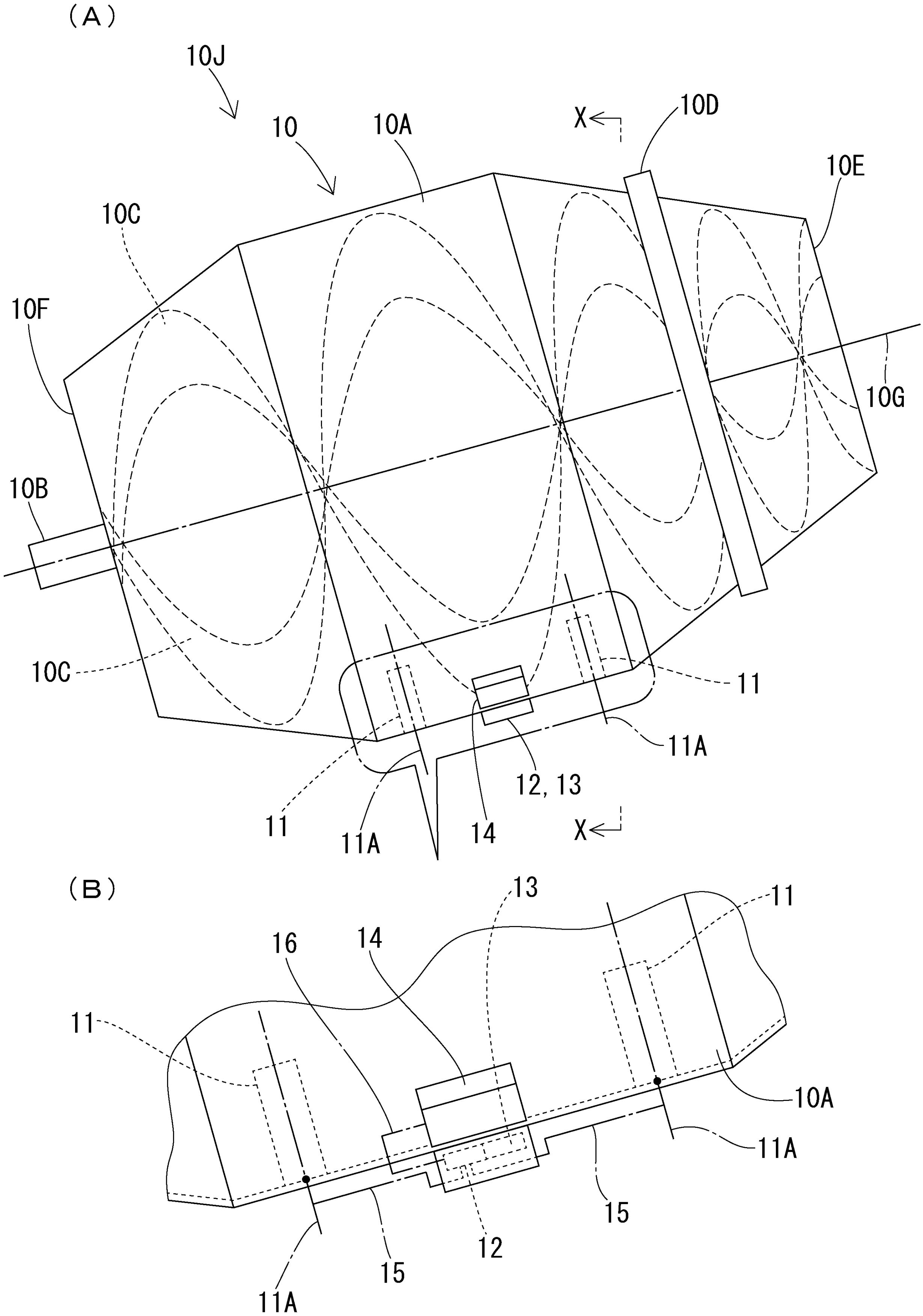
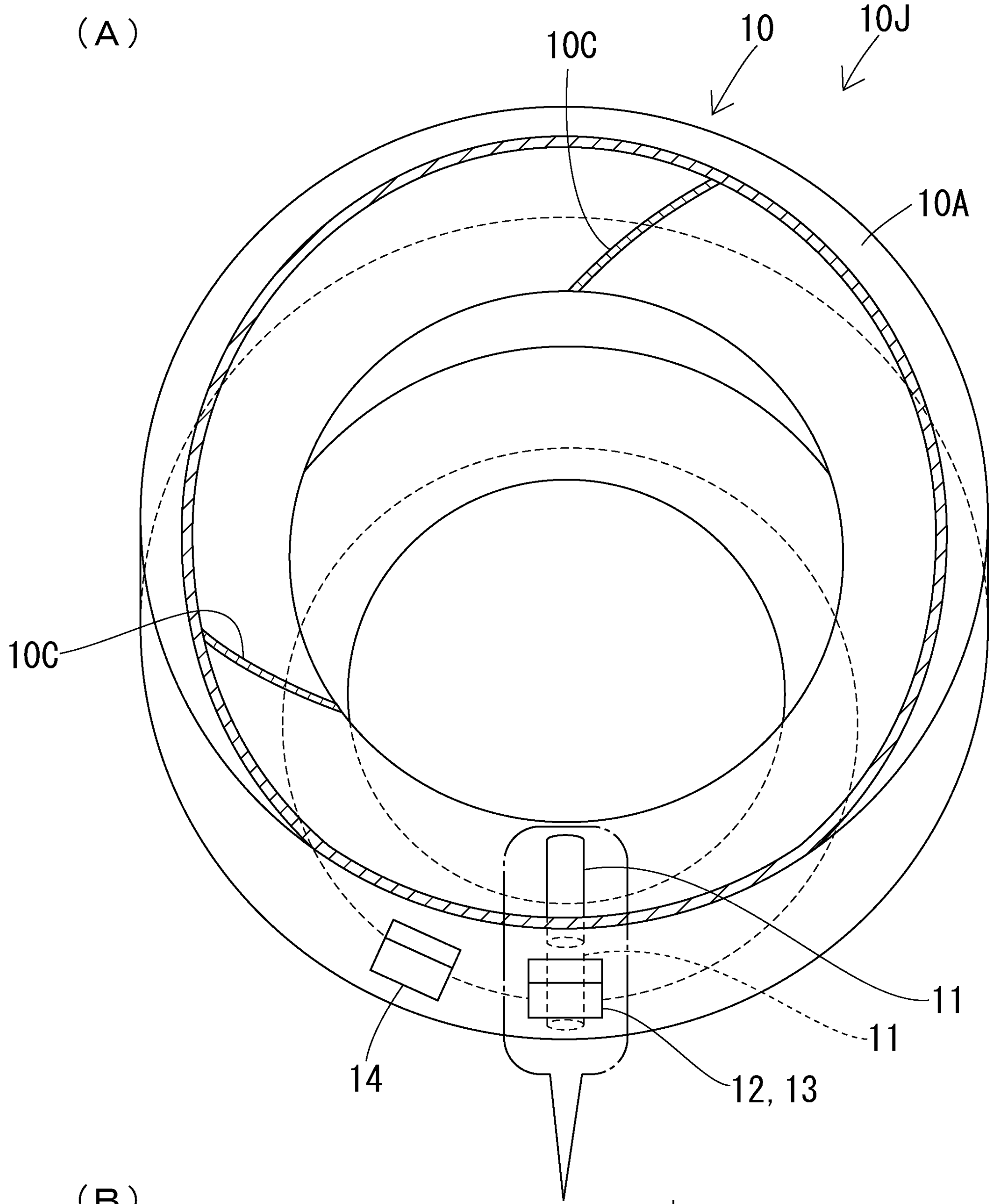

(A)
10J
10
10A
X
10D
10E
10C
10F
10G
10B
10C
11
11A
12, 13
11
11A
14
X
(B)
13
11
16
14
11
10A
11A
15
12
15
11A

Fig. 3

(A)



(B)

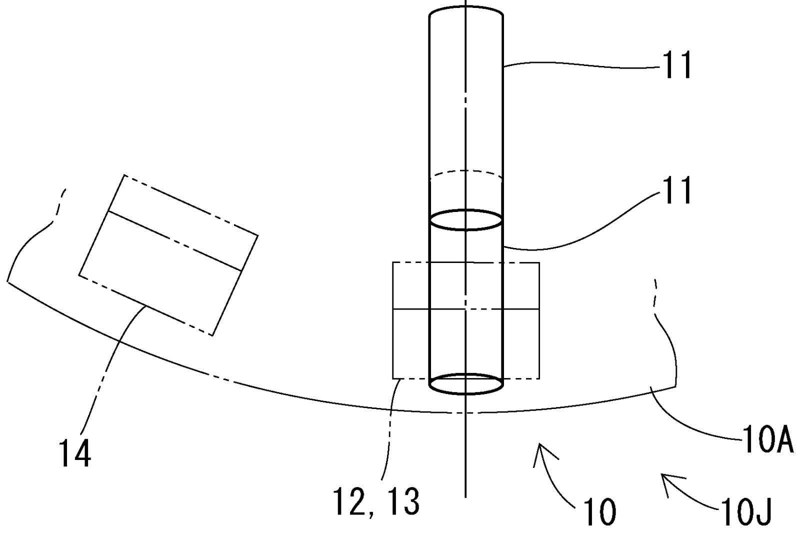


Fig. 4

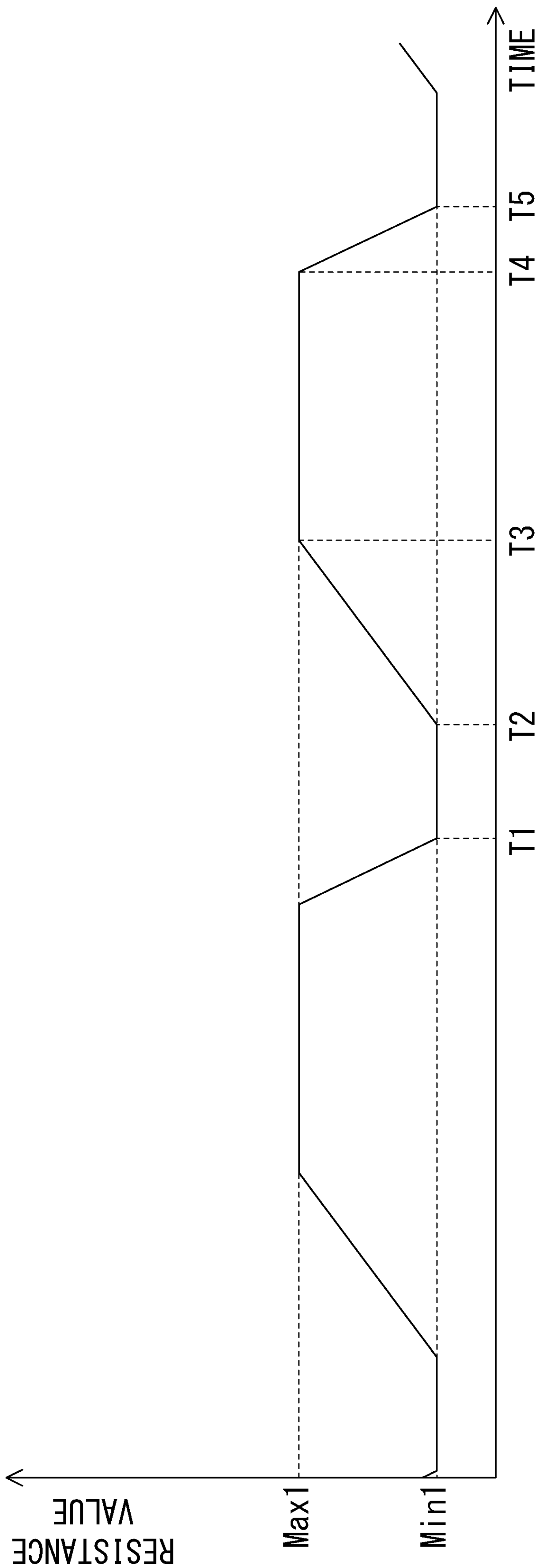


Fig. 5

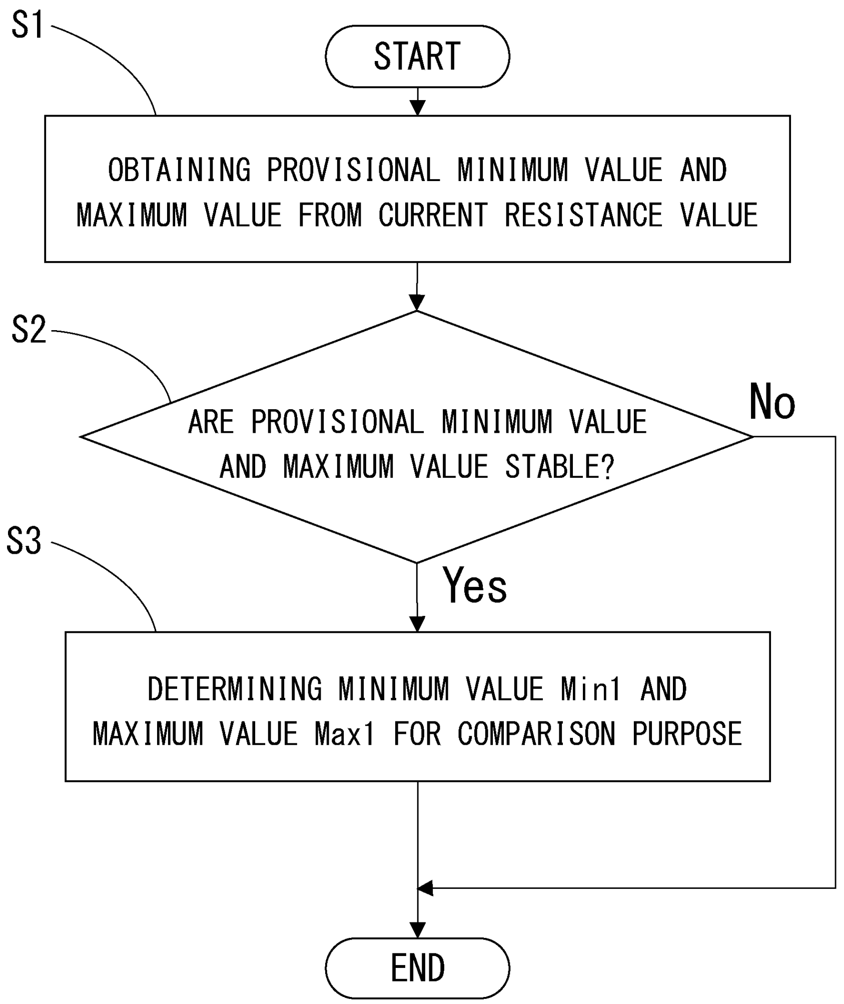

S1
START
OBTAINING PROVISIONAL MINIMUM VALUE AND MAXIMUM VALUE FROM CURRENT RESISTANCE VALUE
S2
ARE PROVISIONAL MINIMUM VALUE AND MAXIMUM VALUE STABLE?
No
Yes
S3
DETERMINING MINIMUM VALUE Min1 AND MAXIMUM VALUE Max1 FOR COMPARISON PURPOSE
END

Fig. 6

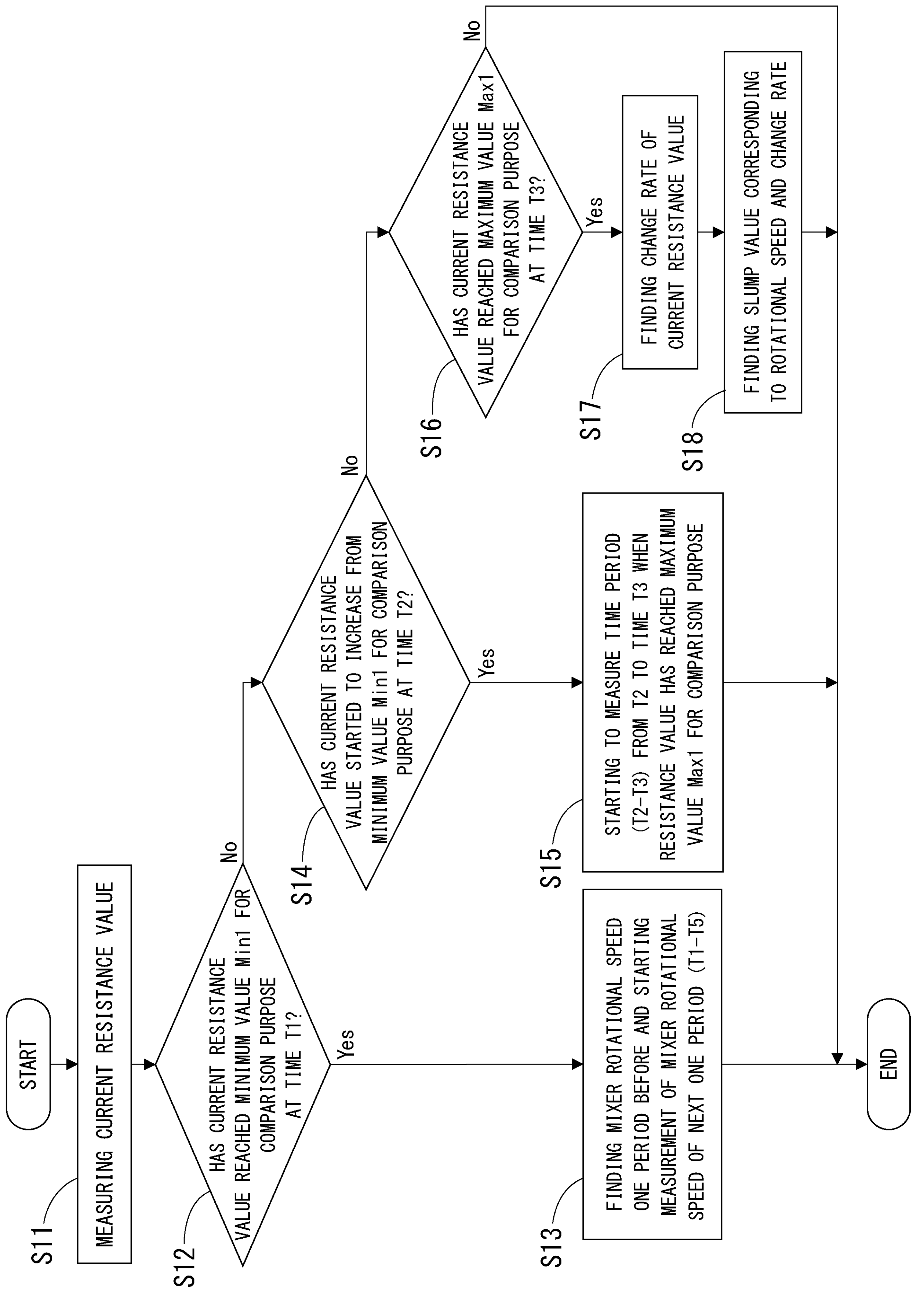

START
S11
MEASURING CURRENT RESISTANCE VALUE
S12
HAS CURRENT RESISTANCE VALUE REACHED MINIMUM VALUE Min1 FOR COMPARISON PURPOSE AT TIME T1?
Yes
No
S13
FINDING MIXER ROTATIONAL SPEED ONE PERIOD BEFORE AND STARTING MEASUREMENT OF MIXER ROTATIONAL SPEED OF NEXT ONE PERIOD (T1-T5)
S14
HAS CURRENT RESISTANCE VALUE STARTED TO INCREASE FROM MINIMUM VALUE Min1 FOR COMPARISON PURPOSE AT TIME T2?
Yes
No
S15
STARTING TO MEASURE TIME PERIOD (T2-T3) FROM T2 TO TIME T3 WHEN RESISTANCE VALUE HAS REACHED MAXIMUM VALUE Max1 FOR COMPARISON PURPOSE
S16
HAS CURRENT RESISTANCE VALUE REACHED MAXIMUM VALUE Max1 FOR COMPARISON PURPOSE AT TIME T3?
Yes
No
S17
FINDING CHANGE RATE OF CURRENT RESISTANCE VALUE
S18
FINDING SLUMP VALUE CORRESPONDING TO ROTATIONAL SPEED AND CHANGE RATE
END

Fig. 7

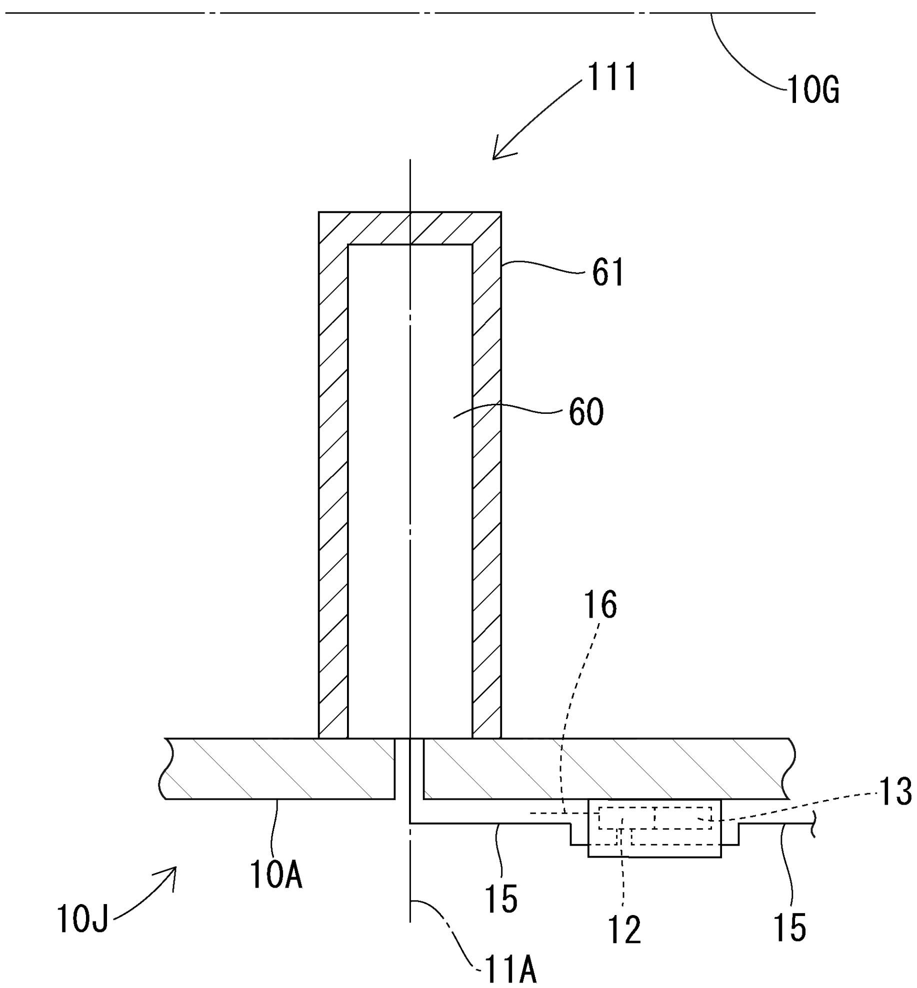
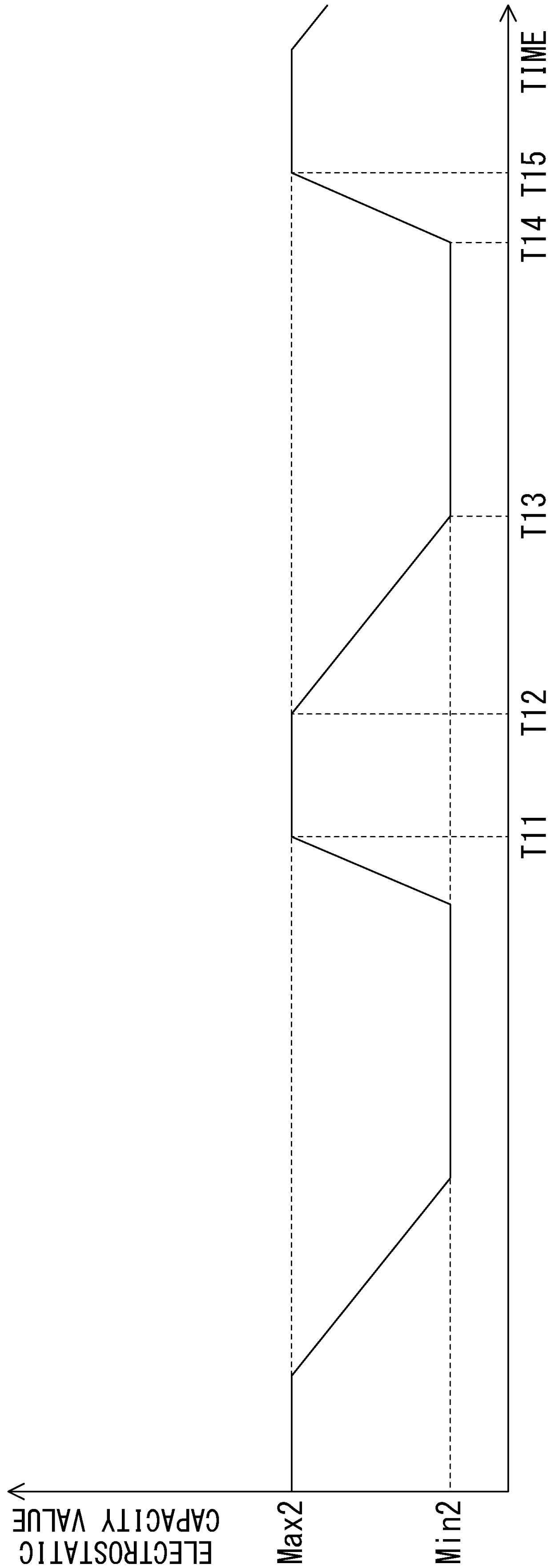


Fig. 8


TIME
T15
T14
T13
T12
T11
Max2
Min2
ELECTROSTATIC
CAPACITY VALUE