(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 423 372 A1**

(12) # EUROPEAN PATENT APPLICATION published in accordance with Art. 158(3) EPC

(21) Application number: **90907382.7**

(51) Int. Cl.[5]: **E02F 9/22**

(22) Date of filing: **26.04.90**

(86) International application number: **PCT/JP90/00544**

(87) International publication number: **WO 90/12930 (01.11.90 90/25)**

(30) Priority: **27.04.89 JP 108422/89**

(43) Date of publication of application: **24.04.91 Bulletin 91/17**

(84) Designated Contracting States: **DE FR GB**

(71) Applicant: **KABUSHIKI KAISHA KOMATSU SEISAKUSHO**
3-6, Akasaka 2-chome
Minato-ku Tokyo 107(JP)

(72) Inventor: **NAKARAI, Nobuaki Komatsu Field Test Dept.**
2-5-1, Fuchinobe Sagamihara-shi
Kanagawa 229(JP)
Inventor: **TORIZUKA, Takayuki Komatsu Field Test Dept.**
2-5-1, Fuchinobe Sagamihara-shi
Kanagawa 229(JP)

(74) Representative: **Meissner, Peter E., Dipl.-Ing. et al**
Patentanwaltsbüro Meissner & Meissner,
Herbertstrasse 22
W-1000 Berlin 33(DE)

(54) **DRIVING CONTROL DEVICE FOR VEHICLE AND CONTROL METHOD THEREFOR.**

(57) A driving control device and a control method therefor suitable for industrial vehicles, particularly for construction vehicles such as a hydraulic power shovel, which makes it possible for a driver to drive a vehicle in a desired direction easily without any illusion. To accomplish this object, the method of the invention comprises tilting a driving lever in a desired driving direction, detecting the angle of the operation direction by a lever angle detector, detecting a relative angle of rotation between an upper swivelling member and a lower driving device by a car body swing encoder, sending these signals to a controller, judging the swinging direction of the lower driving device through the calculation by the controller, sending then the output signal to a driving operation valve to swing the lower driving device without travelling, stopping it when the lower driving device becomes parallel to the operation direction of the driving lever, and moving straight the lower driving device in the operation direction of the driving lever. The angle of the operation direction of the driving lever and its tilt angle may also be detected by the lever angle detector and then the lower driving device may be swung without travelling at a speed proportional to the tilt angle of the operation lever or may be moved straight. Furthermore, the lower driving device may be swung without travelling and driven by detecting the angle between an upper swing body and the direction of north of terrestrial magnetism by a gyrocompass.

EP 0 423 372 A1

VEHICLE TRAVEL CONTROLLER AND CONTROL METHOD FOR THE SAME

Background Art

This invention relates to a vehicle travel controller and a control method for the same and, more particularly, to a controller and a method for a controlling travel of an industrial vehicle, more specifically, a construction vehicle such as a hydraulic power shovel.

Technical Field

Conventionally, in a vehicle, such as that shown in Fig. 14, comprising an upper rotary body 1 having a cab 4, and a lower traveling unit 2 made up of a right track 6 having a right travel motor 7 and a left track 8 having a left travel motor 9, a right travel lever 51 and a left travel lever 52 linked to pilot pressure generating valves 53 are provided in the cab 4, and a right travel operation valve 12 and a left travel operation valve 13 mounted on the upper rotary body 1 are respectively connected to the right and left pilot pressure generating valves 53, the right travel motor 7 and the right travel operation valve 12, and the left travel motor 9 and the left travel operation valve 13 attached to the lower traveling unit 2 being connected respectively, as shown in Fig. 15. Pressure oil is supplied from an unillustrated hydraulic pressure generation source to these circuits. When the right travel lever 51 is inclined toward the front of the upper rotary body 1 (in the direction B), i.e., in the forward traveling direction, the pilot pressure generating valve 53 generates a pilot pressure to operate the right travel operation valve 12 and to thereby rotate the right travel motor 7 in the forward traveling direction. The right track 6 moves forward and the lower traveling unit 2 and the upper rotary body integrally turn counterclockwise. When the left travel lever 52 is inclined in the forward traveling direction, only the left track 8 moves forward and the vehicle turns clockwise. When the right and left travel levers 51 and 52 are simultaneously inclined in the forward traveling direction, the vehicle moves straight ahead. When the right and left travel levers 51 and 52 are simultaneously inclined in the rearward traveling direction, the vehicle moves straight backward. When the right travel lever 51 is inclined in the forward traveling direction while the left travel lever 52 is inclined in the rearward traveling direction, the right track 6 moves forward and the left track 8 moves rearward, so that the vehicle turns counterclockwise on a center of the lower traveling unit 2 without traveling.

However, during use of this apparatus and this control method, there is a possibility of a wrong operation with respect to the forward/rearward traveling directions owing to an operator's illusion. If as shown in Fig. 16 the upper rotary body 1 faces in the direction B, that is, the upper rotary body is rotated relative to the lower traveling unit 2 through 180°, and if in this state the right and left travel levers 51 and 52 are inclined in the forward traveling direction, i.e., in the direction B, the lower traveling unit 2 travels in the direction C and the vehicle travels backward as for the operator in the cab. In this case, if the operator has operated the travel levers with an intention of moving in the direction B, the operation is done under an illusion, which is very dangerous. Moreover, since there are two left and right travel levers, the operation of effecting the above-mentioned non-traveling turn is complicated and the time required for experience in this operation is long.

The present invention has been achieved in view of the above-described problems, and an object of the present invention is to provide a vehicle travel controller and a control method for the same which enable the operator to easily make the vehicle travel in any direction selected.

Disclosure of the Invention

A vehicle travel controller in accordance with the present invention has a travel lever mounted on the upper rotary body and serving to control the traveling direction, a lever angle detector for detecting the angle of the direction of operation of the travel lever, a vehicle body rotation encoder for detecting the relative rotation angle between the upper rotary body and the lower traveling unit, a controller for effecting arithmetic operation of signals supplied from the lever angle detector and the vehicle body rotation encoder, and a travel operation valve capable of operating by receiving a signal output from the controller.

For this arrangement, a travel lever mounted on the upper rotary and serving to control the traveling direction and the traveling speed may be provided together with a lever angle detector for detecting the angle of the direction of operation of the travel lever and the angle of inclination of the same. A gyro compass provided on the upper rotary body to always indicate the geomagnetic north and to detect the angle between the upper rotary body and the north direction may also be provided.

A vehicle travel control method in accordance with the present invention comprising inclining the travel lever in a desired traveling direction, detecting the angle of the direction of operation of the travel lever with the lever angle detector, detecting the relative rotation angle between the upper rotary body and the lower traveling unit with the vehicle body rotation encoder, supplying signals relating to these angles to the controller, effecting arithmetic operation with the controller to determine the direction of turning of the lower traveling unit, supplying a signal output therefrom to the travel operation valve to make the lower traveling unit perform non-traveling turning, stopping non-traveling turning when the lower traveling unit becomes parallel to the direction of travel lever operation, and controlling the travel operation valve to make the lower traveling unit travel straight in the direction of travel lever operation.

The arrangement may be such that the angle of the direction of operation of the travel lever and the angle of inclination of the same are detected with the lever angle detector; signals relating to them are supplied to the controller; a signal output from the controller is supplied to the travel operation valve to make the lower traveling unit perform non-traveling turning at a speed proportional to the inclination angle of the travel lever; this non-traveling turning is stopped when the lower traveling unit becomes parallel to the direction of travel lever operation; and the travel operation valve is controlled to make the lower traveling unit travel straight in the direction of operation of the travel lever at a speed proportional to the inclination angle of the same. Further, the arrangement may be such that the angle between the upper rotary body and the geomagnetic north is detected with a gyro compass; relating signals are supplied to the controller; a signal output from the controller is supplied to the travel operation valve to make the lower traveling unit perform non-traveling turning; the initial angle between the upper rotary body and the indicated north stored by the controller is compared with the corresponding angle during turning; a turning operation valve is controlled to turn the upper rotary body so that the initial angle is reached if the difference therebetween is larger than a predetermined angle; turning is stopped when the relative rotation angle between the direction of travel lever operation and the lower traveling unit is within a predetermined range and when the angle between the upper rotary body and the indicated north becomes within a predetermined range with respect to the corresponding initial angle; and the travel operation valve is controlled to make the lower traveling unit travel in the direction of travel lever operation.

According to these apparatus and method, the operator can incline the travel lever in a direction in which the operator wishes to make the the vehicle travel, and can make the vehicle travel in this direction. Also, the operator can incline the travel lever in a selected traveling direction according to a desired speed to make the vehicle travel in the same direction at a speed proportional to the inclination angle. Further, the operator can easily make the vehicle travel in a selected direction without changing the intermediate attitude only by inclining one travel lever in the selected traveling direction, and there is no possibility of illusion with respect to the traveling direction, thus ensuring safe traveling.

Brief Description of Drawings

Figs. 1 to 6 are diagrams of a first embodiment of the present invention; Fig. 1 is a diagram of the overall construction; Fig. 2 is a diagram of the travel lever operating direction; Figs. 3, 4, and 6 are diagrams of the relationship between the relative turning angle and the operating direction angle; and Fig. 5 is a flow chart of the arithmetic processing program.

Figs. 7 to 9 are diagrams of a second embodiment of the present invention; Fig. 7 is a diagram of the overall construction; Fig. 8 is a diagram of the travel lever operating direction and the inclination angle; and Fig. 9 is a flow chart of the arithmetic processing program.

Figs. 10 to 13 are diagrams of a third embodiment of the present invention; Fig. 10 is a diagram of the overall construction; Figs. 11 and 12 are diagrams of the relationship between the relative turning angle, the operating direction angle and the north direction angle; and Fig. 13 is a flow chart of the arithmetic processing program.

Fig. 14 is a schematic diagram of the whole of a vehicle; Fig. 15 is a diagram of the construction of a conventional travel controller; and Fig. 16 is a diagram of the direction in which the conventional vehicle travels.

Best Mode for Carrying Out the Invention

Embodiments of the apparatus for controlling travel of a vehicle and the method of controlling the same in accordance with the present invention will be described below in detail with reference to the drawings.

Fig. 1 shows the overall construction of the first embodiment. A vehicle body rotation encoder 3 is mounted on the center of rotation of an upper rotary body 1 rotatably and axially connected to a lower traveling unit 2 comprising a right track 6 having a right travel motor 7 and a left track 8 having a left travel motor 9, and one travel lever 10, such as that shown in Fig. 2, which has at its lower end a lever angle detector 5 and which is capable of being inclined in each of directions X, Y and an intermediate direction is provided in a cab 4 fixed on the upper rotary body 1. The vehicle body rotation encoder 3, the lever angle detector 5 and a controller 11 fixed on the upper rotary body 1 are connected by wiring. The controller 11 and pilot portions of a right travel operation valve 12 and a left travel operation valve 13 of an electromagnetic hydraulic pilot type provided in the upper rotary body 1 are connected by wiring. The right travel motor 7 and the right travel operation valve 12, and the left travel motor 9 and the left travel operation valve 13 are connected by pressure pipe lines, and pressure oil is supplied from an unillustrated hydraulic pressure generation source to these pipe lines.

In the above arrangement, as shown in Fig. 1, the center line of the upper rotary body 1 is indicated by BE and the forward direction thereof is indicated by B, while the center line of the lower traveling unit 2 is indicated by CD and the forward direction thereof is indicated by C, and the relative rotation angle between the upper rotary body 1 and the lower traveling unit 2 is represented by α. As shown in Figs. 1 and 2, the angle between a straight line XX parallel to the center line BE of the upper rotary body 1 and passing through the center of the lever and the direction A in which the lever 10 is operated is represented by β. As shown in Fig. 3, the angle α is positive when measured clockwise based on a segment CN in the direction C of the center line CD of the lower traveling unit 2, or it is negative, that is, expressed as $-\alpha$ when measured counterclockwise, and the angle β is positive when measured clockwise based on a segment BN, or it is negative, that is, expressed as $-\beta$ when measured counterclockwise.

Next, the operation will be described below. When the travel lever 10 is inclined in a selected traveling direction, the vehicle body rotation encoder 3 reads the relative angle α between the upper rotary body 1 and the lower traveling unit 2 and sends a signal to the controller 11, and the lever angle detector 5 reads the angle β of the direction in which the travel lever 10 is operated, and sends a signal to the controller 11. The controller 11 effects arithmetic operation of these signals, determines a turning direction in which the lower traveling unit 2 can be turned by a minimum angle to face in the direction in which the traveling lever 10 is operated, and sends signals to the travel operation valves 12 and 13 to make the lower traveling unit 2 effect a non-traveling turn. When the lower traveling unit 2 starts non-traveling turning, the direction C of the center line of the lower traveling unit 2 before turning is changed to a direction C', as shown in Fig. 4. The direction A in which the operation lever 10 is operated is correspondingly changed to a direction A', and the operator therefore returns the traveling lever 10 operating direction to the position A. This operation is continued until the angle $\alpha + \beta$ between the direction C and the direction A reaches a predetermined angle K. When this angle is reached, the controller 11 sends signals for stopping non-traveling turning and for starting forward or rearward traveling to the travel operation valves 12 and 13, thereby making the vehicle travel straight.

The arithmetic processing program of the controller 11 will be described below with reference to the flow chart of Fig. 5.

If the travel lever 10 is not ON in step 100, commands are issued in steps 101 and 102 to stop forward/rearward traveling and non-traveling, so that the vehicle is stopped. If in step 100 the travel lever 10 is inclined in the selected traveling direction, the angles α and β are read in step 103, and examination is made in step 104 as to whether or not $-90^\circ \leqq \alpha + \beta \leqq 90^\circ$ is established. If YES, examination is made in step 105 as to whether or not the absolute value of $\alpha + \beta$ is smaller than the predetermined angle K. If $|\alpha + \beta| \leqq K$, it is determined that the direction C and the direction A coincide with each other, that is, the center line BE of the lower traveling unit and the direction NA in which the travel lever 10 is operated have become parallel to each other. In this case, a command is issued in step 106 to stop non-traveling turning, and another command is issued in step 107 to make the vehicle travel forward. If $|\alpha + \beta| > K$ in step 105, examination is made in step 108 as to whether or not $0 \leqq \alpha + \beta \leqq 90^\circ$ is established. If YES, a command is issued in step 109 to effect a rightward non-traveling turn by a minimum turning angle such that $|\alpha + \beta| \leqq K$ is established. Similarly, in the case of NO, a command is issued in step 110 to effect a leftward non-traveling turn by a minimum turning angle. When the vehicle starts turning, the travel lever 10 is corrected as mentioned above, α and β are read, and the same operation is repeated until $|\alpha + \beta| \leqq K$ is established. If in step 104 $-90^\circ \leqq \alpha + \beta \leqq 90^\circ$ is not established as shown in Fig. 6, examination is made in step 111 as to whether or not $180^\circ - |\alpha + \beta| \leqq K$ is established. If YES, a command is issued in step 112 to stop non-traveling turning. Then, in step 113, a rearward traveling direction command is issued to make the vehicle travel in the direction A because in this case the direction A in which the travel lever 10 is operated is opposite to the direction C of forward traveling of the lower traveling unit 2, that is, the angle therebetween is 180°. If NO in step 111, examination is made in step 114 as to whether or not $90^\circ < \alpha + \beta \leqq 180^\circ$ is established. If YES, a command is issued in step 115 to effect a leftward non-traveling turn by a minimum turning angle. If NO, a command is issued in step 116 to effect a rightward non-traveling turn, and the same operation is repeated until $180^\circ - |\alpha + \beta| \leqq K$ is established. In the above-described embodiment, rotation in the minimum turning direction is effected. However, needless to say, rotation in the opposite direction may be effected by changing the determination.

Thus, a vehicle travel controller and a control method for the same can be obtained whereby the operator can effect a non-traveling turn of the lower traveling unit to make the same face in the traveling direction by only inclining one travel lever in the traveling direction and can make the vehicle travel in the direction in which the travel lever is inclined, and which are improved in operation facility, free from occurrence of any illusion with respect to the traveling direction and therefore improved in terms of safety.

The second embodiment of the present invention will be described below in detail with reference to the accompanying drawings. Components having the same structures as those of the first embodiment are indicated by the same reference symbols and the description form them will not be repeated. Fig. 7 shows the overall construction of the second embodiment. One travel lever 8 such as that shown in Fig. 8 is provided in the cab 4 fixed on the upper rotary body 1. A variable capacity hydraulic pump 27 supplies pressure oil to the right travel motor 7 via a flow rate control type right travel operation valve 20, and return oil is returned to a hydraulic tank 29 via the right travel operation valve 20. The right travel operation valve 20 is composed of electromagnetic valves 22a and 22b, and poppet valves 23, 24, 25, and 26. The electromagnetic valve 22a controls the poppet valves 23 and 24 to control the flow rate of a pipe line 7a to the travel motor. The electromagnetic valve 22b controls the poppet valves 25 and 26 to control the flow rate of a pipe line 7b to the travel motor and, hence, the number of revolutions of the motor during reverse rotation. Pilot portions of the electromagnetic valves 22a and 22b and a controller 21 are connected by wiring. A left travel operation valve 29 and the left travel motor 9 are constructed in the same manner.

In the above arrangement, as shown in Fig. 7, the center line of the upper rotary body 1 is indicated by BE and the forward direction is indicated by B, while the center line of the lower traveling unit 2 is indicated by CD and the forward direction is indicated by C, and the relative rotation angle between the upper rotary body 1 and the lower traveling unit 2 is represented by α. As shown in Fig. 8, the angle between a straight line XX parallel to the center line BE of the upper rotary body 1 and passing through the center of the lever and the direction A in which the lever 10 is operated is represented by β, and the angle of inclination of the travel lever 10 is represented by γ.

Next, the operation will be described below. When the travel lever 10 is inclined in a selected traveling direction by an angle corresponding to a desired speed, the vehicle body rotation encoder 3 reads the relative angle α between the upper rotary body 1 and the lower traveling unit 2 and sends a signal to the controller 21, and the lever angle detector 5 reads the angle β of the direction in which the travel lever 10 is operated and the inclination angle γ, and sends a signal to the controller 21. The controller 21 effects arithmetic operation of these signals, determines a turning direction in which the lower traveling unit 2 can be turned by a minimum angle to face in the direction in which the traveling lever 10 is operated, determines a control flow rate from the inclination angle γ, and sends signals to the electromagnetic valves 22a and 22b of the right and left travel operation valves 20 and 29, and the electromagnetic valves 22a and 22b control the poppet valves 23, 24, 25, and 26 in response to these signals to rotate the travel motors 7 and 9 in designated directions at designated speeds, thereby making the lower traveling unit effect a non-traveling turn. When the lower traveling unit 2 starts non-traveling turning, the direction C of the center line of the lower traveling unit 2 before turning is changed to a direction C', as shown in Fig. 4. The direction A in which the operation lever 10 is operated is correspondingly changed to a direction A', and the operator therefore returns the travel lever 10 operating direction to the position A. This operation is continued until the angle $\alpha + \beta$ between the direction C and the direction A reaches a predetermined angle K. When this angle is reached, the controller 21 sends signals for stopping non-traveling turning and for starting forward or rearward traveling and control flow rate signals to the travel operation valves 20 and 29, thereby making the lower traveling unit 2 travel straight at the designated speed and in the designated direction.

The arithmetic processing program of the controller 21 will be described below with reference to the flow chart of Fig. 9. If the travel lever 10 is not ON in step 200, commands are issued in steps 201 and 202 to stop forward/rearward traveling and non-traveling, so that the vehicle is stopped. If in step 200 the travel lever 10 is inclined in the selected traveling direction by the inclination angle γ, the angles α, β, γ are read in step 203, and examination is made in step 204 as to whether or not $-90^\circ \leqq \alpha + \beta \leqq 90^\circ$ is established. If YES, examination is made in step 205 as to whether or not the absolute value of $\alpha + \beta$ is smaller than the predetermined angle K. If $|\alpha + \beta| \leqq K$, it is determined that the direction C and the direction A coincide with each other, that is, the center line BE of the lower traveling unit and the direction NA in which the travel lever 10 is operated have become parallel to each other. In this case, a command is issued in step 206 to stop non-traveling turning, and a forward direction command and a control flow rate command are issued in step 207 to make the vehicle travel forward at the designated speed. If $|\alpha + \beta| > K$ in step 205, examination is made in step 208 as to whether or not $0 \leqq \alpha + \beta \leqq 90^\circ$ is established. If YES, a command for a rightward non-traveling turn by a minimum turning angle such that $|\alpha + \beta| \leqq K$ is established and a control flow rate command are issued in step 209. When the vehicle starts turning, α, β, g corrected with respect to the direction in which the operation lever 10 is operated are read as described above, and the same operation is repeated until $|\alpha + \beta| \leqq K$ is established. If in step 204 $-90^\circ \leqq \alpha + \beta \leqq 90^\circ$ is not established, examination is made in step 211 as to whether or not $180^\circ - |\alpha + \beta| \leqq K$ is established. If YES, a command is issued in step 212 to stop non-traveling turning. Then, in step 213, a rearward traveling direction command and a control flow rate command are issued to make the vehicle travel in the direction A at the designated speed because in this case the direction A in which the travel lever 10 is operated is opposite to the direction C of forward traveling of the lower traveling unit 2, that is, the angle therebetween is 180°. If NO in step 211, a command for a leftward non-traveling turn by a minimum turning angle and a control flow rate command are issued in step 215. If NO, a rightward non-traveling turn command and a control flow rate command are issued in step 116, and the same operation is repeated until $180^\circ - |\alpha + \beta| \leqq K$ is established. In the above-described embodiment, rotation in the minimum turning direction is effected. However, needless to say, rotation in the opposite direction may be effected by changing the determination. According to the second embodiment, a vehicle travel controller and a control method for the same can be obtained whereby the operator can make the lower traveling unit to effect non-traveling turning at the desired speed so as to face the traveling direction by only inclining one travel lever in the traveling direction according to the desired speed and can make the vehicle travel at the desired speed in the direction in which the travel lever is inclined, and which controller and method are improved in operation facility, free from occurrence of any illusion with respect to the traveling direction and therefore improved in terms of safety.

The third embodiment of the present invention will be described below in detail with reference to the drawings. The same components as those of the first and second embodiments are indicated by the same reference symbols and the description form them will not be repeated. Fig. 10 shows the overall construction of this embodiment. A gyro compass 30 always indicating the geomagnetic north and serving to detect the angle of the upper rotary body 1 from the forward direction B is mounted on the upper rotary body 1. The vehicle body encoder 3, the lever angle detector 5 and the gyro compass 30 are respectively connected by wiring to a controller 31 mounted on the upper rotary body 1. A rotating operation valve 34, a right travel operation valve 12 and a left travel operation valve 13 of an electromagnetic hydraulic pilot type mounted on the upper rotary body 1 are respectively connected to the controller 31 by wiring. The right travel operation valve 12 and the left travel operation valve 13 are respectively connected by pressure pipe lines to the right travel motor 7 and the left travel motor mounted in lower travel unit 2, the rotating operation valve 34 and a rotating motor 33 are also connected, and pressure oil is supplied from an unillustrated hydraulic pressure generation source to these pipe lines.

In the above arrangement, as shown in Fig. 10, the center line of the upper rotary body 1 is indicated by BE and the forward direction is indicated by B, while the center line of the lower traveling unit is indicated by CD and the forward direction is indicated by C, and the angle between BE and CD, i.e., the relative rotation angle between the upper rotary body 1 and the lower traveling unit 2 is represented by α. The north direction indicated by the gyro compass 30 is indicated by N, and the angle between N and BE is represented by δ. The angle between a straight line XX parallel to the center line BE of the upper rotary body 1 and passing through the center of the lever angle detector 5 and the traveling direction A of the travel lever 10 is represented by β. These relationships are as shown in Fig. 11. The angle α is positive when measured clockwise based on a segment CO in the direction C of the center line CD of the lower traveling unit 2, the angle β is positive when measured clockwise based on a segment BO, the angle δ is positive when measured clockwise based on NO in the north direction indicated by the gyro compass 30.

Next, the operation will be described below. When the travel lever 10 is inclined in a selected traveling direction, the vehicle body rotation encoder 3 detects the relative angle α between the upper rotary body 1 and the lower traveling unit 2 and sends a signal to the controller 31, the lever angle detector 5 detects the angle β of the direction in which the travel lever 10 is operated, and sends a signal to the controller 31, and the gyro compass 30 detects the angle δ between the upper rotary body 1 and the indicated north and sends a signal to the controller 30. The controller 31 stores the initial angle as δ_0 and effects arithmetic operation to determine a turning direction in which the lower traveling unit 2 can be turned by a minimum angle to face in the direction in which the traveling lever 10 is operated, and sends signals to the travel operation valves 12 and 13 to make the lower traveling unit 2 effect a non-traveling turn. When the lower traveling unit 2 starts non-traveling turning, the upper rotary body 1 is turned integrally therewith, so that the angle δ_t between the upper rotary body 1 and the indicated north becomes different from the initial angle δ_0. The controller 31 receives the signal from the gyro compass 30 and calculates the difference between δ_t and δ_0, and, if this value is larger than a predetermined value K_2, sends a signal to the rotating operation valve 34 to rotate the upper rotary body 1 in a direction such that δ_t is reduced to δ_0. That is, the upper rotary body 1 is rotated in the direction opposite to the direction of rotation of non-traveling turning of the lower traveling unit 2. When, as operation is repeated, the angle $|\alpha + \beta|$ between traveling direction of the travel lever 7 and the center line of the lower traveling unit 2 becomes smaller than a predetermined value K_1, non-traveling turning of the lower traveling unit 2 is stopped. When the value $|\delta_t - \delta_0|$ becomes smaller than the value K_2, turning of the upper rotary body 1 is stopped and a signals is sent to the travel operation valves to perform forward or rearward traveling in the direction in which the operation lever 10 is operated. When the target position is reached by the vehicle and when the travel lever 10 is returned to the home position, the controller 31 issues commands to stop all operations including traveling and turning, thereby stopping the vehicle.

The arithmetic processing program of the controller 31 will be described below with reference to the flow chart of Fig. 13. If the travel lever 10 is ON in step 300, α, β, and δ_t (the value of δ at an arbitrary time) are read in step 311. If this is a first operation (step 312), δ_t is set to δ_0 (the value of δ at an initial stage of travel lever operation) and stored, and examination is made in step 314 as to whether or not the value of $\alpha + \beta$ is 0 to 90° or 270 to 360°. Fig. 11 shows an example in which $0 \leqq \alpha + \beta \leqq 90°$ or $270° \leqq \alpha + \beta \leqq 360°$. If YES, determination is made in step 315 as to whether or not $|\alpha + \beta|$ is not larger than K_1. If NO, determination is made in step 320 as to whether a rightward non-traveling turn or a leftward non-traveling turn should be selected based on whether or not $\alpha + \beta$ is 0 to 90°, and a non-traveling turn is designated in step 321 or 325. Next, in step 322 or 326, determination is made as to whether or not the value $|\delta_t - \delta_0|$ is equal to or smaller than K_2. As described above, when the vehicle starts non-traveling turning during proceeding of operation, the value $|\delta_t - \delta_0|$ becomes larger than than K_2. A command is thereby issued in step 324 or 328 to turn the upper rotary body 1 so that δ_t becomes closer to δ_0. The above operations are repeated and, if it is determined in step 315 that $|\alpha + \beta| \leqq K_1$, non-traveling turning is stopped in step 330. In step 331, determination is made as to whether or not the value $|\delta_t - \delta_0|$ is equal to or smaller than than K_2. If it is larger than K_2, the turning direction is determined in step 333 according to $0 \leqq \alpha + \beta \leqq 90°$, and the upper rotary body 1 is further turned in step 334 or 335. When $|\delta_t - \delta_0| \leqq K_2$ is established, forward traveling is started in step 332. When the vehicle reaches the destination, the travel lever 10 is made OFF and commands are issued in steps 302, 303 and 304 to stop traveling and turning, thereby completing the process (step 305). Fig. 12 shows an example in which $0 \leqq \alpha + \beta \leqq 90°$ or $270° \leqq \alpha + \beta \leqq 360°$ is not established in step 314. In this case, the operations of steps 250 to 358 and steps 360 to 364 subsequent to step 340 are the same as in the above, and description for them will not be repeated.

According to the third embodiment, a vehicle travel controller and a control method for the same can be obtained whereby the operator can easily perform turning in a selected direction without changing the intermediate attitude only by inclining one travel lever in the selected traveling direction, and which are improved in operation facility, free from occurrence of any illusion with respect to the traveling direction and therefore improved in terms of safety.

Industrial Applicability

The present invention is effective as a vehicle travel controller and a control method for the same whereby the operator can easily make the vehicle travel in any direction selected without any illusion, and is suitable for a controller and a method for controlling travel of an industrial vehicle, more specifically, a construction vehicle such as a hydraulic power shovel.

Claims

1. A vehicle travel controller having an upper rotary body, a lower traveling unit, a travel lever for operating a travel operation valve, and a travel motor controlled with the travel operation valve, said vehicle travel controller being

characterized by comprising a travel lever mounted on the upper rotary body and serving to control the traveling direction, a lever angle detector for detecting the angle of the direction of operation of the travel lever, a vehicle body rotation encoder for detecting the relative rotation angle between the upper rotary body and the lower traveling unit, a controller for effecting arithmetic operation of signals supplied from the lever angle detector and the vehicle body rotation encoder, and a travel operation valve capable of operating by receiving a signal output from the controller.

2. A vehicle travel controller according to claim 1, comprising a travel lever mounted on the upper rotary body and serving to control the traveling direction and the traveling speed, a lever angle detector for detecting the angle of the direction of operation of the travel lever and the angle of inclination of the same, a vehicle body rotation encoder for detecting the relative rotation angle between the upper rotary body and the lower traveling unit, a controller for effecting arithmetic operation of signals supplied from the lever angle detector and the vehicle body rotation encoder, and a travel operation valve capable of operating by receiving a signal output from the controller.

3. A vehicle travel controller according to claim 1, comprising a travel lever mounted on the upper rotary body and serving to control the traveling direction, a lever angle detector for detecting the angle of the direction of operation of the travel lever, a vehicle body rotation encoder for detecting the relative rotation angle between the upper rotary body and the lower traveling unit, a gyro compass provided on the upper rotary body to constantly indicate the geomagnetic north and to detect the angle between the upper rotary body and the indicated north, a controller for effecting arithmetic operation of signals supplied from the lever angle detector, the vehicle body rotation encoder and the gyro compass, and a travel operation valve and a rotating operation valve capable of operating by receiving signals output from the controller.

4. A vehicle travel control method comprising inclining a travel lever in a desired traveling direction, detecting the angle of the direction of operation of the travel lever with a lever angle detector, detecting the relative rotation angle between an upper rotary body and a lower traveling unit with a vehicle body rotation encoder, supplying signals relating to these angles to a controller, effecting arithmetic operation with the controller to determine the direction of turning of the lower traveling unit, supplying a signal output therefrom to a travel operation valve to make the lower traveling unit perform non-traveling turning, stopping non-traveling turning when the lower traveling unit becomes parallel to the direction of travel lever operation, and controlling the travel operation valve to make the lower traveling unit travel straight in the direction of travel lever operation.

5. A vehicle travel control method according to claim 4, comprising inclining the travel lever in a desired traveling direction, detecting the angle of the direction of operation of the travel lever and the angle of inclination of the same with the lever angle detector, detecting the relative rotation angle between the upper rotary body and the lower traveling unit with the vehicle body rotation encoder, supplying signals relating to these angles to the controller, effecting arithmetic operation with the controller to determine the direction of turning of the lower traveling unit, supplying a signal output therefrom to the travel operation valve to make the lower traveling unit perform non-traveling turning at a speed proportional to the inclination angle of the travel lever, stopping non-traveling turning when the lower traveling unit becomes parallel to the direction of travel lever operation, and controlling the travel operation valve to make the lower traveling unit travel straight in the direction of operation of the travel lever at a speed proportional to the inclination angle of the same.

6. A vehicle travel control method according to claim 4, comprising inclining a travel lever in a desired traveling direction, detecting the angle of the direction of operation of the travel lever with the lever angle detector, detecting the relative rotation angle between the upper rotary body and the lower traveling unit with the vehicle body rotation encoder, detecting the angle between the upper rotary body and the geomagnetic north with a gyro compass, supplying signals relating to these angles to the controller, effecting arithmetic operation with the controller to determine a turning direction such that the direction of travel lever operation and the lower traveling unit become parallel to each other by turning though a minimum angle, supplying a signal output therefrom to the travel operation valve to make the lower traveling unit perform non-traveling turning, comparing the initial angle between the upper rotary body and the indicated north stored by the controller with the corresponding angle during turning, controlling a turning operation valve to turn the upper rotary body so that the initial angle is reached if the difference therebetween is larger than a predetermined angle, stopping turning when the relative rotation angle between the direction of travel lever operation and the lower traveling unit is within a predetermined range and when the angle between the upper rotary body and the indicated north becomes within a predetermined range with respect to the corresponding initial angle, and controlling the travel operation valve to make the lower traveling unit travel in the direction of travel lever operation.

FIG. 1

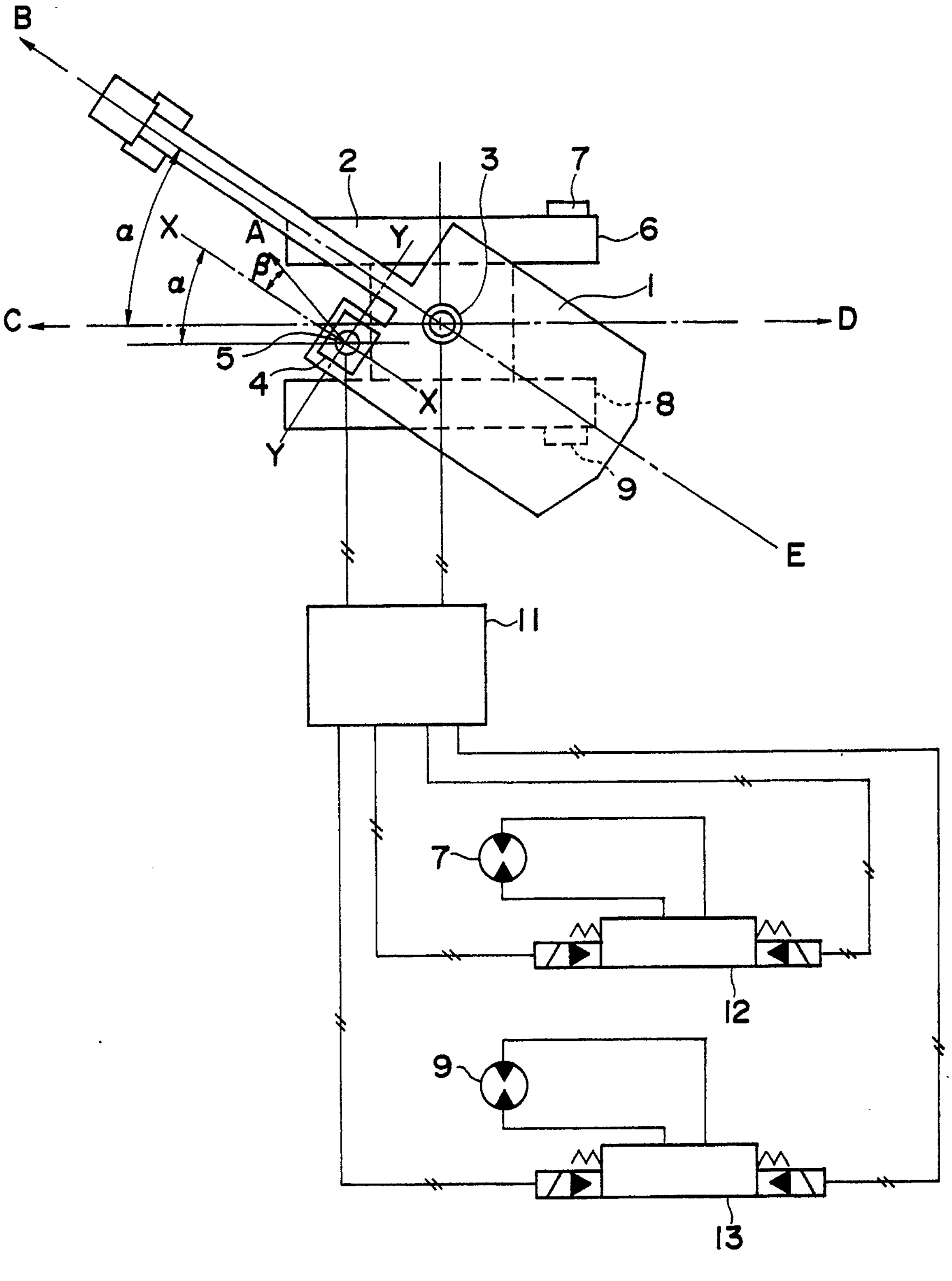


FIG. 2

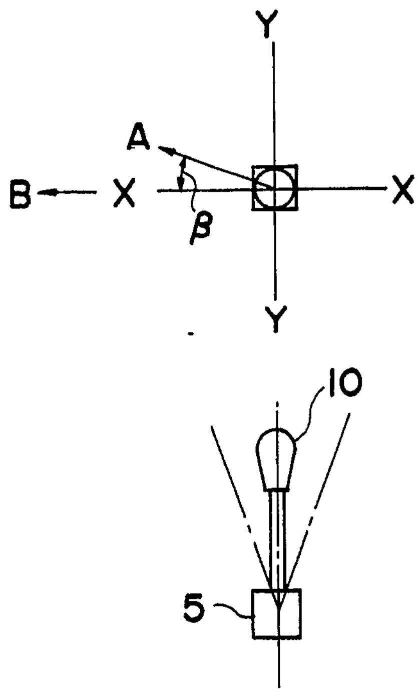


FIG. 3

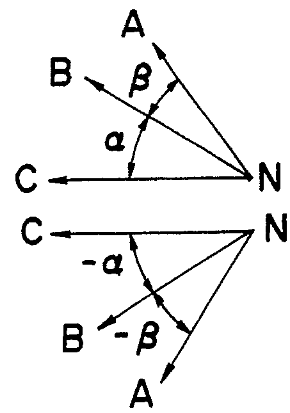


FIG. 4

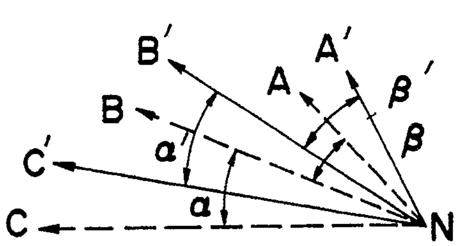


FIG. 6

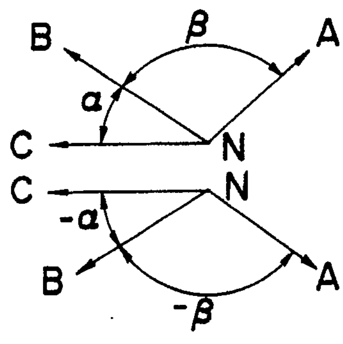


FIG. 5

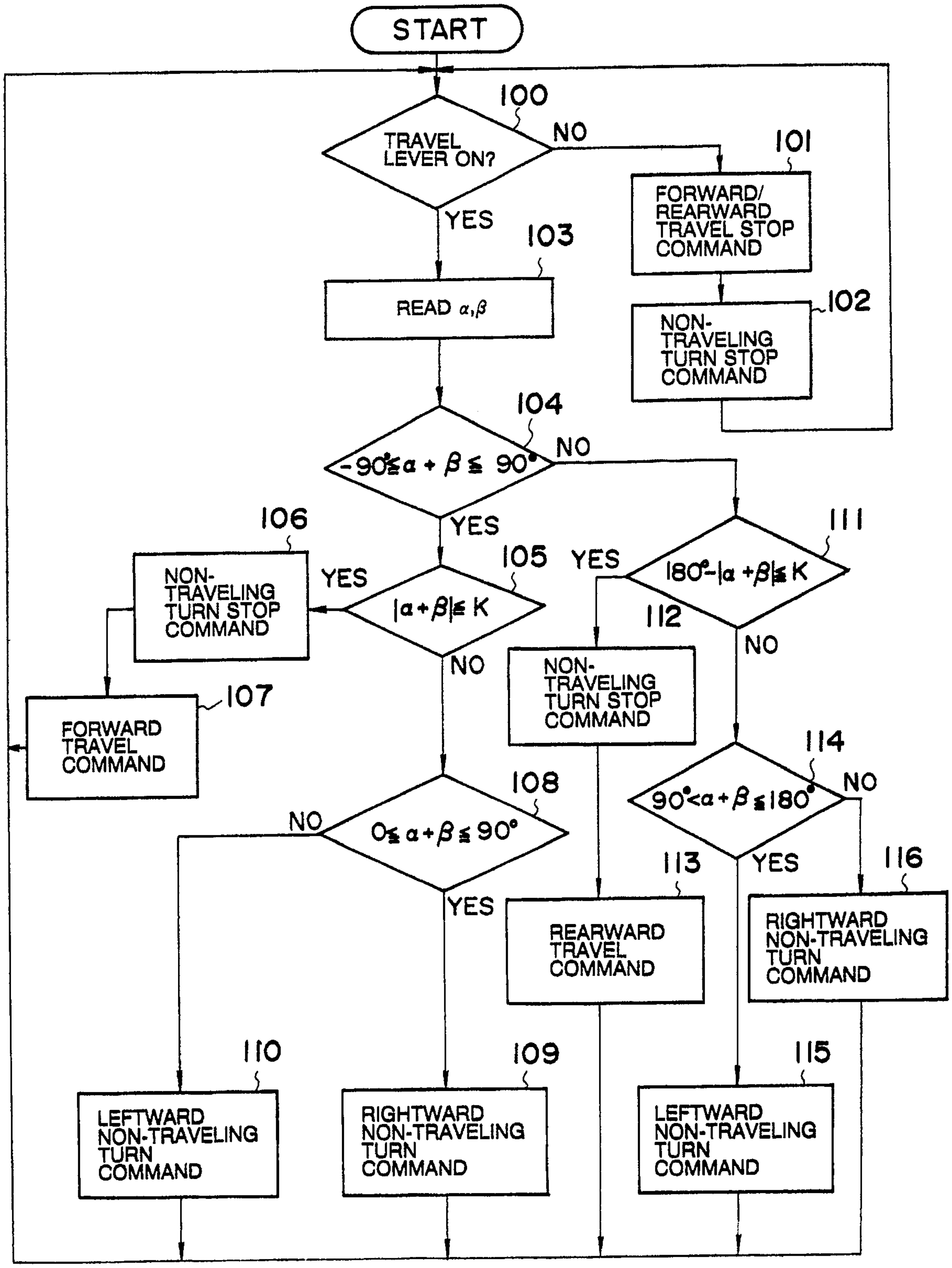

START
100
TRAVEL LEVER ON?
NO
YES
101
FORWARD/ REARWARD TRAVEL STOP COMMAND
102
NON-TRAVELING TURN STOP COMMAND
103
READ α,β
104
-90°≤α+β≤90°
NO
YES
105
|α+β|≤K
YES
106
NON-TRAVELING TURN STOP COMMAND
107
FORWARD TRAVEL COMMAND
NO
108
0≤α+β≤90°
NO
YES
109
RIGHTWARD NON-TRAVELING TURN COMMAND
110
LEFTWARD NON-TRAVELING TURN COMMAND
111
180°-|α+β|≤K
YES
NO
112
NON-TRAVELING TURN STOP COMMAND
113
REARWARD TRAVEL COMMAND
114
90°<α+β≤180°
NO
YES
115
LEFTWARD NON-TRAVELING TURN COMMAND
116
RIGHTWARD NON-TRAVELING TURN COMMAND

FIG. 7

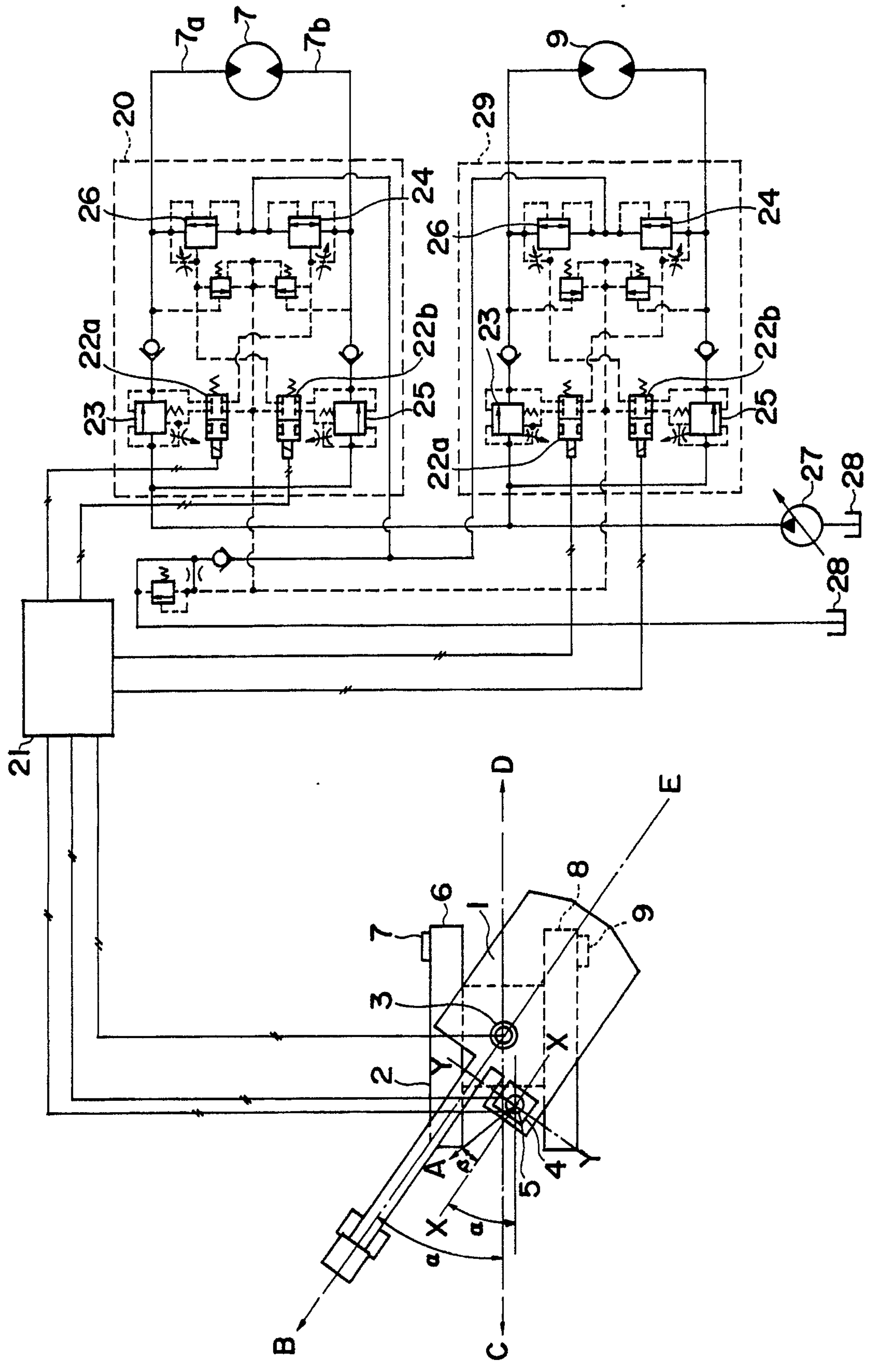


FIG. 9

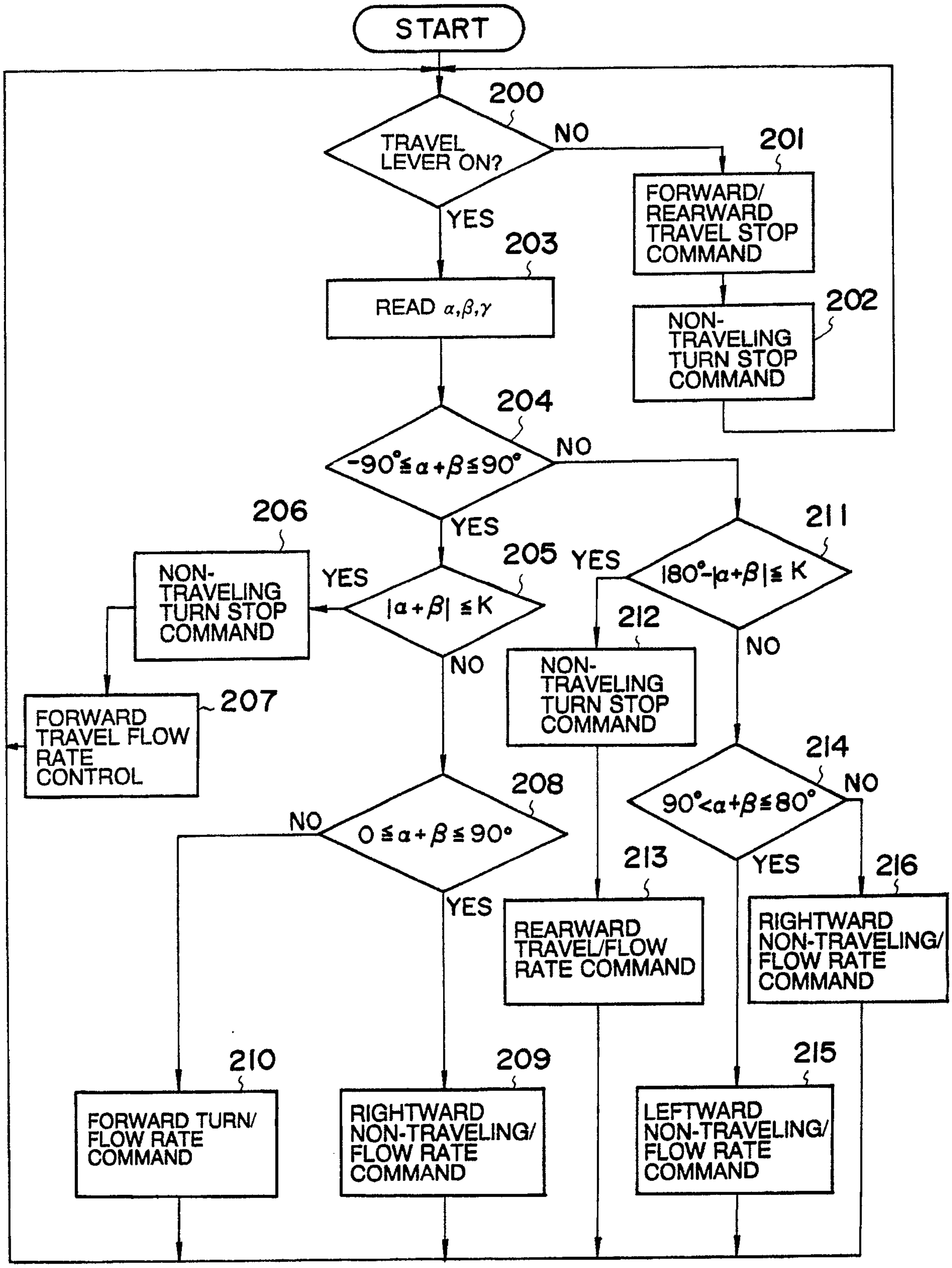

START
200
TRAVEL LEVER ON?
NO
YES
201
FORWARD/ REARWARD TRAVEL STOP COMMAND
202
NON-TRAVELING TURN STOP COMMAND
203
READ α,β,γ
204
-90°≤α+β≤90°
NO
YES
205
|α+β| ≤K
YES
NO
206
NON-TRAVELING TURN STOP COMMAND
207
FORWARD TRAVEL FLOW RATE CONTROL
208
0≤α+β≤90°
NO
YES
209
RIGHTWARD NON-TRAVELING/ FLOW RATE COMMAND
210
FORWARD TURN/ FLOW RATE COMMAND
211
180°-|α+β|≤K
YES
NO
212
NON-TRAVELING TURN STOP COMMAND
213
REARWARD TRAVEL/FLOW RATE COMMAND
214
90°<α+β≤80°
NO
YES
215
LEFTWARD NON-TRAVELING/ FLOW RATE COMMAND
216
RIGHTWARD NON-TRAVELING/ FLOW RATE COMMAND

FIG. 8

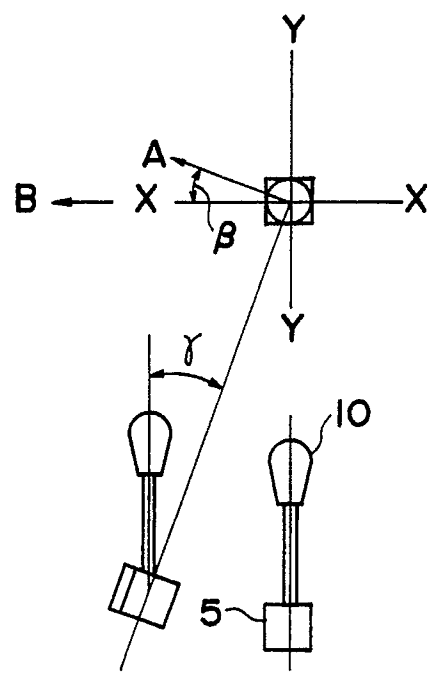


FIG. 11

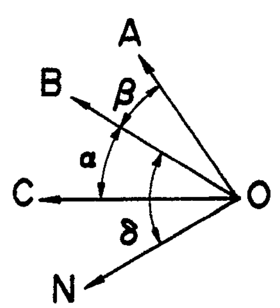


FIG. 12

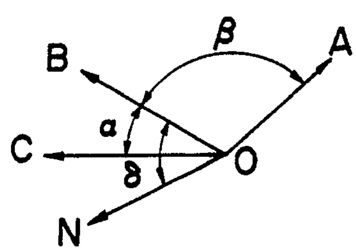
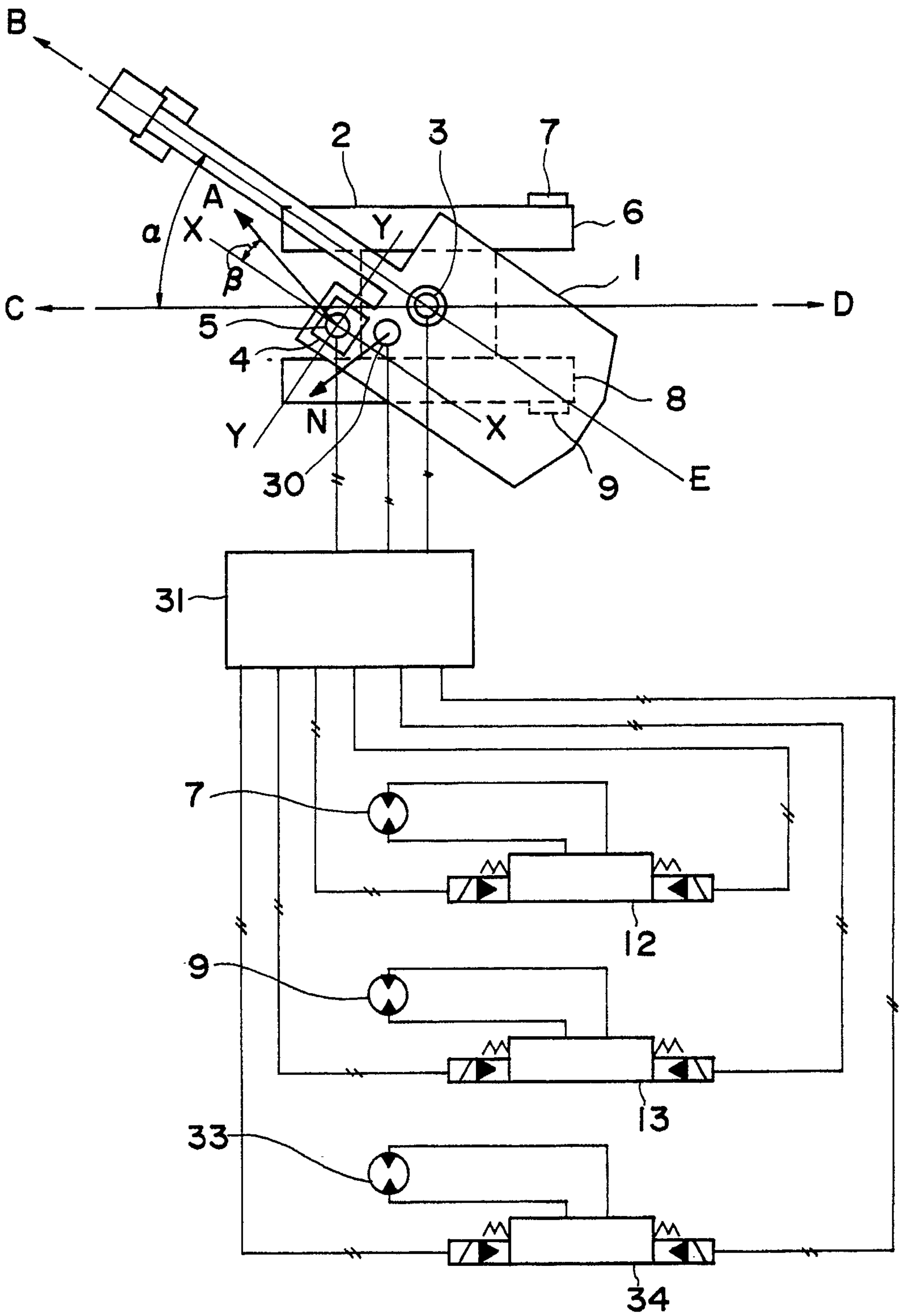


FIG. 10



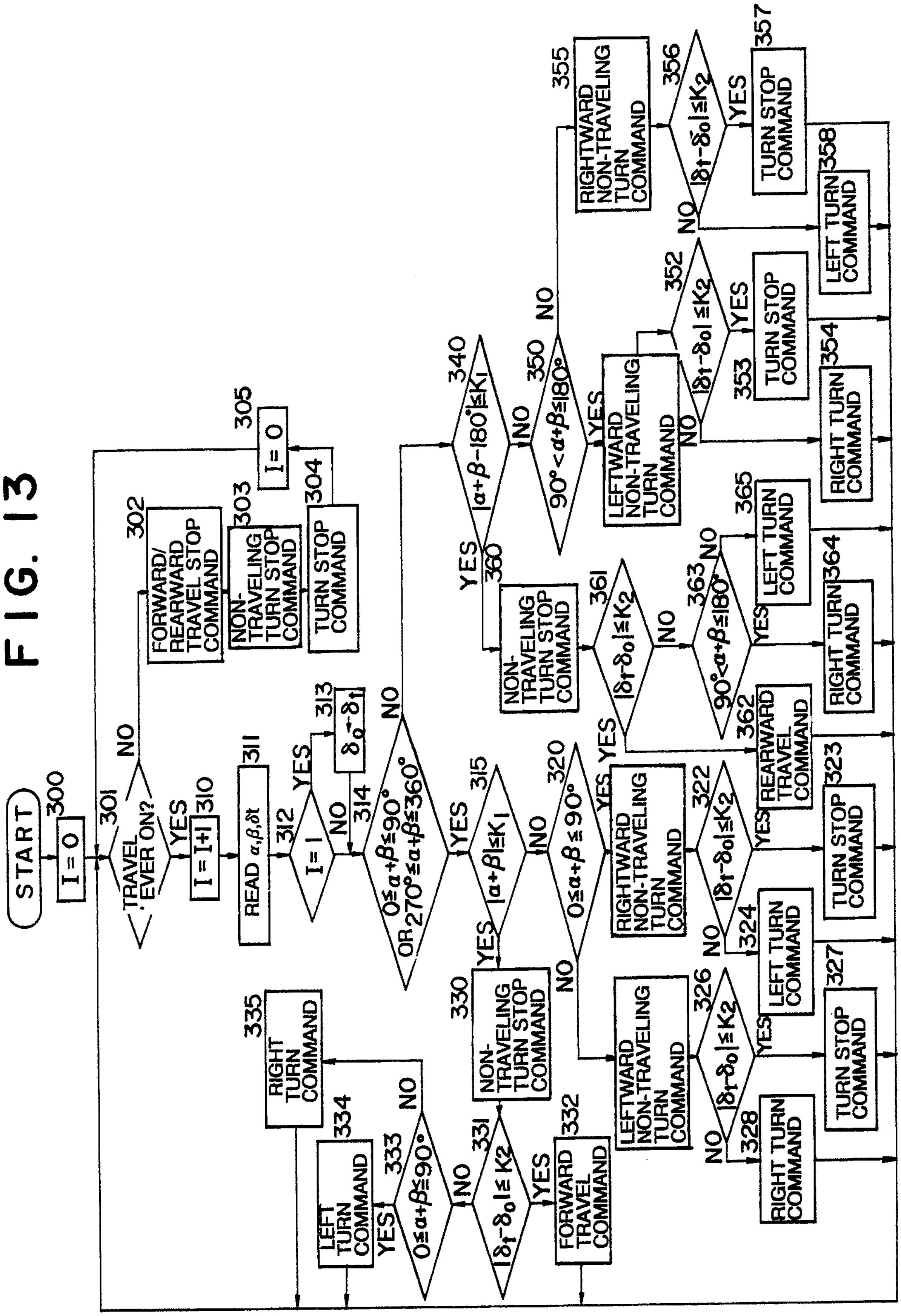

START
300
I = 0
301
TRAVEL EVER ON?
YES
NO
302
FORWARD/ REARWARD TRAVEL STOP COMMAND
303
NON-TRAVELING TURN STOP COMMAND
304
TURN STOP COMMAND
305
I = 0
310
I = I+1
311
READ α,β,δt
312
I = 1
313
δo ← δt
314
0≤α+β≤90° OR 270°≤α+β≤360°
315
|α+β|≤K1
320
0≤α+β≤90°
321
RIGHTWARD NON-TRAVELING TURN COMMAND
322
|δt−δo|≤K2
323
TURN STOP COMMAND
324
LEFT TURN COMMAND
325
LEFTWARD NON-TRAVELING TURN COMMAND
326
|δt−δo|≤K2
327
TURN STOP COMMAND
328
RIGHT TURN COMMAND
330
NON-TRAVELING TURN STOP COMMAND
331
|δt−δo|≤K2
332
FORWARD TRAVEL COMMAND
333
0≤α+β≤90°
334
LEFT TURN COMMAND
335
RIGHT TURN COMMAND
340
|α+β−180°|≤K1
350
90°<α+β≤180°
351
LEFTWARD NON-TRAVELING TURN COMMAND
352
|δt−δo|≤K2
353
TURN STOP COMMAND
354
RIGHT TURN COMMAND
355
RIGHTWARD NON-TRAVELING TURN COMMAND
356
|δt−δo|≤K2
357
TURN STOP COMMAND
358
LEFT TURN COMMAND
360
NON-TRAVELING TURN STOP COMMAND
361
|δt−δo|≤K2
362
REARWARD TRAVEL COMMAND
363
90°<α+β≤180°
364
RIGHT TURN COMMAND
365
LEFT TURN COMMAND

FIG. 13

FIG. 14

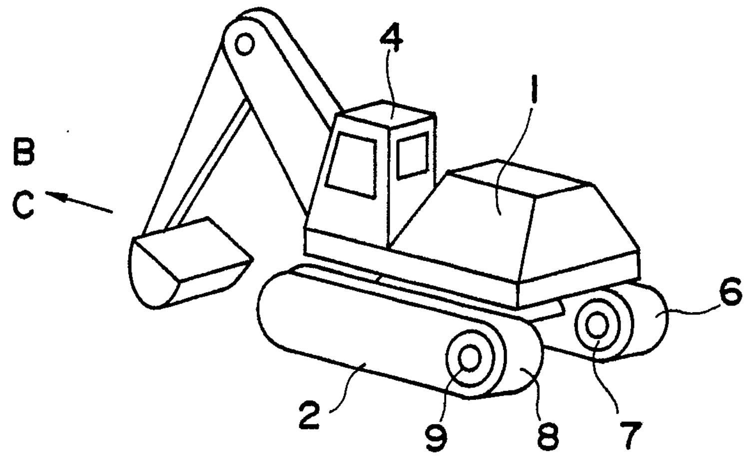


FIG. 15 (PRIOR ART)

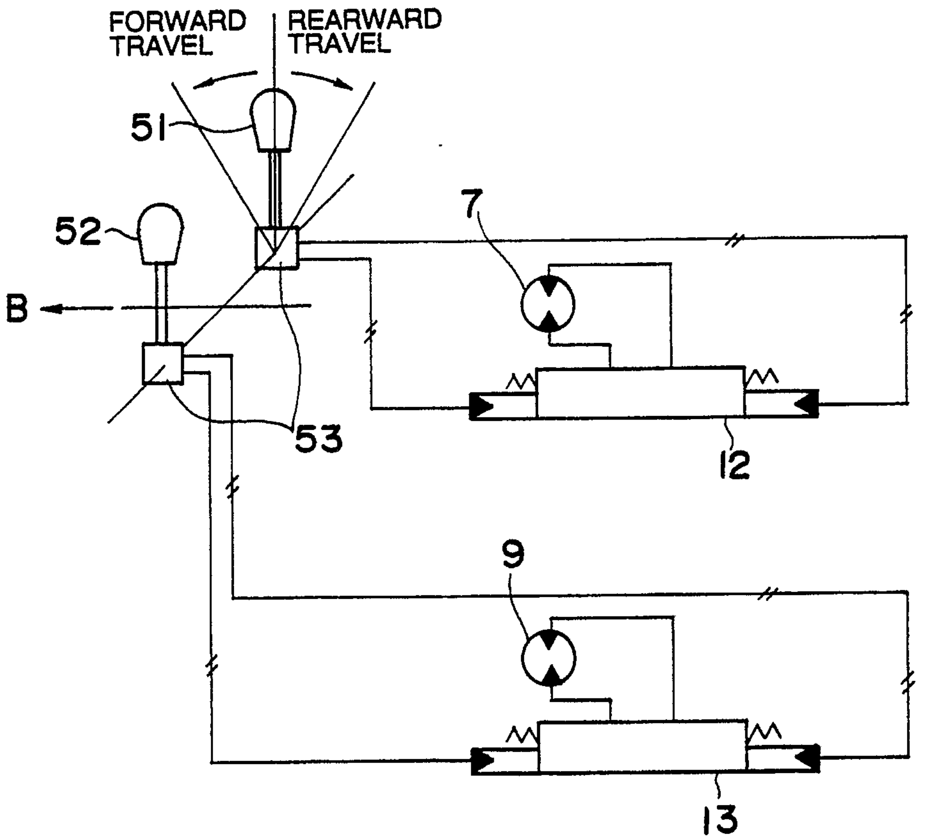
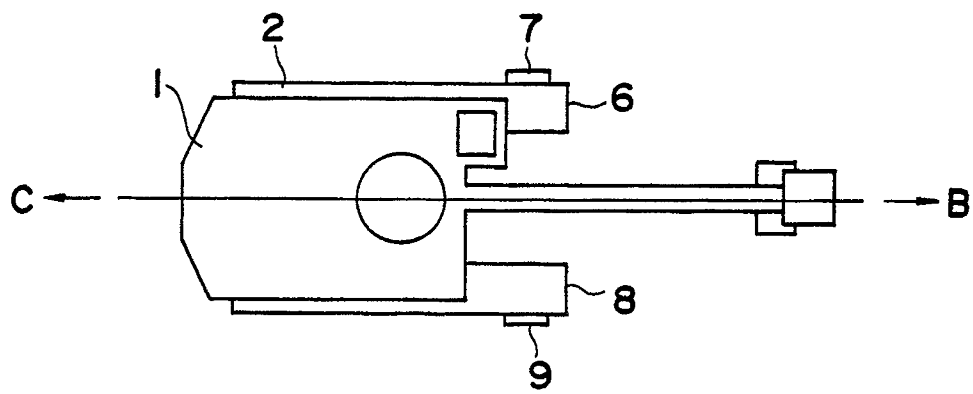


FIG. 16 (PRIOR ART)



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP90/00544

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[5] E02F9/22

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	E02F3/42, 3/43, 3/84, 3/85, 9/20, 9/22

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho	1966 - 1989
Kokai Jitsuyo Shinan Koho	1972 - 1989

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	JP, A, 62-211431 (Seirei Kogyo K.K.), 17 September 1987 (17. 09. 87)	1 - 6
A	JP, A, 62-106515 (Hitachi Construction Machinery Co., Ltd.), 18 May 1987 (18. 05. 87)	1 - 6
A	JP, U, 61-141365 (Nippon Spindle Seizo K.K.), 1 September 1986 (01. 09. 86)	1 - 6

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
June 19, 1990 (19. 06. 90)	July 23, 1990 (23. 07. 90)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	