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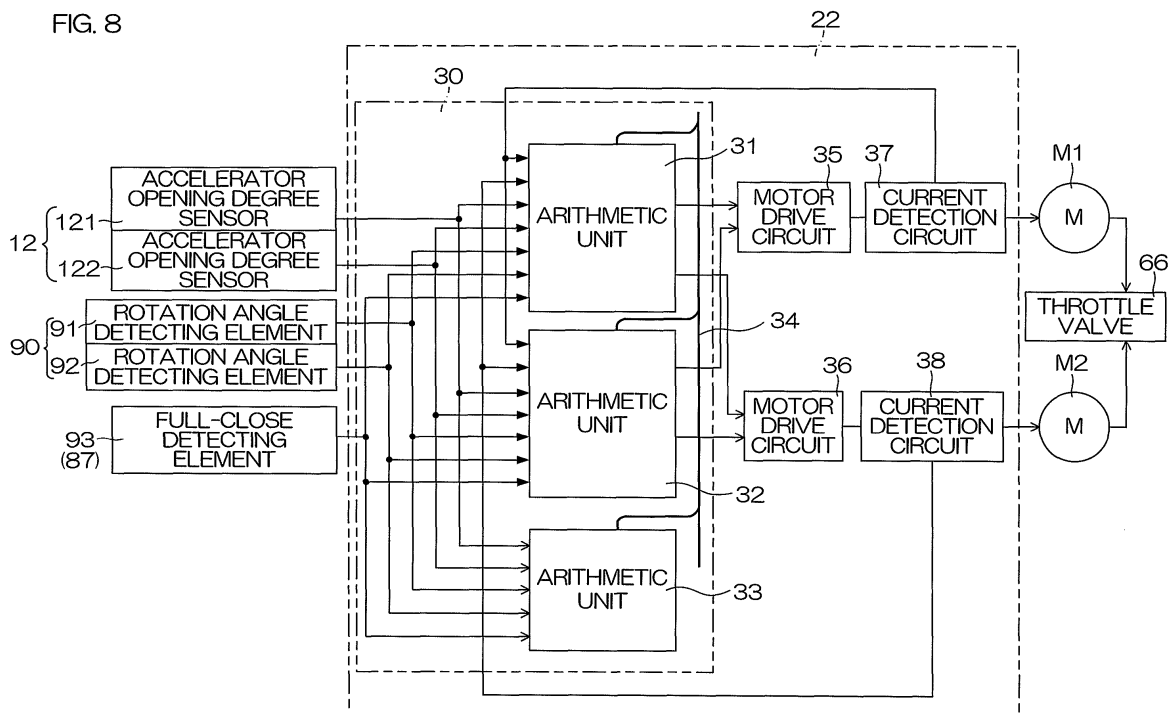
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(54) **Throttle device and motorcycle including the same**

(57) A throttle device (60) includes a throttle valve (66) to be provided in an air-intake passage of an engine (3), a drive means (70) for driving the throttle valve (66), a throttle opening degree detecting means (90), an accelerator opening degree detecting means (12) for detecting an accelerator opening degree indicating an operation amount of an accelerator operation member (11), and a control means (30) for controlling the drive means (70) so that a throttle opening degree corresponds to an accelerator opening degree. The control means (30), at

occurrence of an abnormality, operates as follows. If a throttle opening degree corresponding to an accelerator opening degree is smaller than a detected throttle opening degree, the control means (30) drives the drive means (70) so that a throttle opening degree corresponds to the accelerator opening degree. If a throttle opening degree corresponding to an accelerator opening degree is equal to or more than a detected throttle opening degree, the control means (30) drives the drive means (70) at a predetermined speed so that a throttle opening degree becomes a predetermined value.

FIG. 8



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a throttle device that adjusts the throttle opening degree by driving a throttle valve and a motorcycle including the same.

2. Description of Related Art

[0002] It has been proposed to mount an electronically-controlled throttle device on a motorcycle. For example, a device according to a related art disclosed in Japanese Unexamined Patent Publication No. 2002-256903 includes a throttle grip sensor that detects the operation amount of a throttle grip, a drive motor that drives to open and close a throttle valve, and a controller. This device further includes a throttle sensor that detects the rotation angle of a valve shaft of the throttle valve (throttle shaft). The controller feedback-controls the drive motor based on a detection value of the throttle grip sensor and a detection value of the throttle sensor.

SUMMARY OF THE INVENTION

[0003] When a sensor for detecting the throttle opening degree has failed, it is preferable to lead the throttle valve to a full-close position. In a typical technique for this purpose, a return spring is used. More specifically, a return spring for urging in a full-close direction is fitted to the throttle shaft. When a failure of the throttle opening degree sensor is detected, power supply to the motor is shut down. The return spring then returns the throttle valve to the full-close position at a stroke.

[0004] Although this technique is effective for a four-wheeled vehicle where deceleration due to a fully closed throttle relatively slowly occurs, it is not preferable to apply the technique as it is to a motorcycle. This is because a rapid deceleration occurs as a result of fully closing the throttle valve at a stroke, and thus the rider may feel a great sense of discomfort.

[0005] It is therefore considered to drive the throttle shaft by the motor slowly at a constant speed to the full-close position in the case of a failure of the throttle opening degree sensor.

[0006] However, if such a motor control is uniformly applied to all cases of a failure of the throttle opening degree sensor, a response can no longer be made for a rapid deceleration by a rider's will.

[0007] On the other hand, it is considered to connect the throttle grip and the throttle device via a wire cable to prepare a configuration for mechanically transmitting an operation of the throttle grip to the throttle valve in case of a failure of the throttle opening degree sensor. However, with such a configuration, not only is the mechanism increased in size, but it is also necessary to secure

a space for routing the wire cable. Further, exposure of the wire cable may spoil the design of the motorcycle.

[0008] A throttle device of the present invention includes:

a throttle valve to be provided in an air-intake passage of an engine; a drive means for driving the throttle valve to change a throttle opening degree; a throttle opening degree detecting means for detecting the throttle opening degree; an accelerator opening degree detecting means for detecting an accelerator opening degree indicating an operation amount of an accelerator operation member; and a control means for controlling the drive means so that a throttle opening degree which the throttle opening degree detecting means detects corresponds to an accelerator opening degree to be detected by the accelerator opening degree detecting means. The control means, at occurrence of an abnormality where there is an abnormality in any of the drive means, the throttle opening degree detecting means, the accelerator opening degree detecting means, and the control means, operates as follows. More specifically, the control means, at the occurrence of an abnormality, if a throttle opening degree corresponding to an accelerator opening degree detected by the accelerator opening degree detecting means is smaller than a throttle opening degree detected by the throttle opening degree detecting means, drives the drive means so that a throttle opening degree to be detected by the throttle opening degree detecting means corresponds to the accelerator opening degree. Moreover, the control means, at the occurrence of an abnormality, if a throttle opening degree corresponding to an accelerator opening degree detected by the accelerator opening degree detecting means is equal to or more than a throttle opening degree detected by the throttle opening degree detecting means, drives the drive means at a predetermined speed so that a throttle opening degree becomes a predetermined value.

[0009] According to this configuration, when the accelerator operation member is operated, the operation amount thereof is detected by the accelerator opening degree detecting means. The drive means is controlled, according to the detected operation amount, by the control means, and the throttle valve is accordingly displaced within the air intake passage. This changes the opening degree of the throttle valve (throttle opening degree). The throttle opening degree is detected by the throttle opening degree detecting means. A control of the drive means by the control means is performed so that the throttle opening degree to be detected corresponds to the operation amount of the accelerator operation member.

[0010] When an abnormality occurs in any of the drive means, the throttle opening degree detecting means, the accelerator opening degree detecting means, and the

control means, the control means controls the drive means so as to lead the throttle opening degree to a predetermined value (for example, a full-close value). At this time, when the throttle opening degree corresponding to the accelerator opening degree is smaller than the actual throttle opening degree, the control means controls the drive means so that the throttle opening degree corresponds to the accelerator opening degree. Therefore, when an operator quickly decreases the accelerator opening degree with the intention of rapidly decelerating the engine, the throttle opening degree quickly decreases in accordance therewith. More specifically, an operator's will is reflected, while the throttle opening degree can be led to a predetermined value. On the other hand, when the throttle opening degree corresponding to the accelerator opening degree is equal to or more than the actual throttle opening degree, the operator has no intention of a rapid deceleration. Therefore, in this case, the control means drives the drive means at a predetermined speed to thereby lead the throttle opening degree to a predetermined value. Accordingly, determining the predetermined speed appropriately allows leading the throttle opening degree to a predetermined value without making the operator feel an excessively great sense of discomfort.

[0011] The "predetermined speed" means a drive speed of the drive means such that the vehicle speed decreases at a predetermined ratio (for example, -2.0m/s^2).

[0012] Preferably, at the occurrence of an abnormality, if a throttle opening degree corresponding to an accelerator opening degree detected by the accelerator opening degree detecting means is equal to or more than a throttle opening degree detected by the throttle opening degree detecting means, the control means accelerates the drive means at a predetermined acceleration until it reaches the predetermined speed. The "accelerates" means that the absolute value of the drive speed of the drive means increases, and the rate of change of the absolute value is "acceleration."

[0013] As described above, unless the operator performs an accelerator operation with the intention of rapidly decelerating the engine, the drive means is driven at a predetermined speed to decrease the throttle opening degree. At this time, in a period before reaching the predetermined speed, the drive means is driven at a predetermined acceleration. Accordingly, setting the predetermined acceleration appropriately allows reducing a sense of discomfort when the throttle valve begins to move and it accelerates up to the predetermined speed.

[0014] It suffices that the predetermined speed and the predetermined acceleration are determined in consideration of the influence of a decrease in the engine rotation speed due to a decrease in the throttle opening degree. For example, if the engine is to be mounted on a vehicle (for example, a motorcycle), it is preferable to determine the predetermined speed and the predetermined acceleration so that a deceleration of the vehicle due to a de-

crease in the engine rotation speed becomes as high as not to make a rider who is not willing to decelerate feel an excessively great sense of discomfort. For example, the predetermined speed may have a value equivalent to 8.5 deg/sec in terms of a rotation speed of the throttle valve. Moreover, the predetermined acceleration may be, for example, a rate of speed change such that a time required to be a predetermined speed from a current speed is 500 milliseconds.

[0015] Preferably, at the occurrence of an abnormality, if a throttle opening degree corresponding to an accelerator opening degree detected by the accelerator opening degree detecting means is equal to or more than a throttle opening degree detected by the throttle opening degree detecting means, the control means decelerates the drive means at a predetermined deceleration from the predetermined speed until a throttle opening degree reaches the predetermined value. The "decelerates" means that the absolute value of the drive speed of the drive means decreases, and the rate of change of the absolute value is "deceleration."

[0016] According to this configuration, immediately before the throttle opening degree reaches the predetermined value, the drive means is driven at a predetermined deceleration to lead to operation stoppage. Accordingly, setting the predetermined deceleration appropriately allows reducing a sense of discomfort in a period before the throttle valve decelerates from the predetermined speed to stop. The predetermined deceleration may be, for example, a rate of speed change such that the speed equals zero in 500 milliseconds.

[0017] Preferably, at least one of the drive means, the throttle opening degree detecting means, the accelerator opening degree detecting means, and the control means is provided as a multiple system of a double or higher order system, and the control means, when an abnormality has occurred in any system component of the multiple system, specifies a normally operable system component of the multiple system, and controls the drive means by use of the normally operable system component.

[0018] According to this configuration, even if an abnormality occurs in any system component of the multiple system, by using a remaining normal system component, the multiple-system configuration is capable of continuing operation. Accordingly, using a normal system component allows driving the drive means at a predetermined speed until the throttle opening degree reaches a predetermined value.

[0019] For example, the control means may be arranged to compare outputs of the multiple system, and if there is a predetermined output difference or more, to judge that an abnormality has occurred.

[0020] For example, the drive means includes at least two motors, and preferably, the control means, when an abnormality has occurred in either of the motors, specifies a normally drivable motor, and drives the drive means by means of the normally drivable motor.

[0021] According to this configuration, because the drive means includes at least two motors, when an abnormality has occurred in either motor, operating a remaining normal motor at the predetermined speed allows leading the throttle opening degree to the predetermined value.

[0022] For example, the throttle opening degree detecting means includes at least two throttle opening degree sensors, and preferably, the control means, when an abnormality has occurred in either of the throttle opening degree sensors, specifies a normally operable throttle opening degree sensor, and drives the drive means based on a detection result of the normally operable throttle opening degree sensor.

[0023] According to this configuration, because the throttle opening degree detecting means includes at least two throttle opening degree sensors, when an abnormality has occurred in either throttle opening degree sensor, the drive means can be controlled by use of a remaining normal throttle opening degree sensor.

[0024] For example, the accelerator opening degree detecting means includes at least two accelerator opening degree sensors, and preferably, the control means, when an abnormality has occurred in either of the accelerator opening degree sensors, specifies a normally operable accelerator opening degree sensor, and drives the drive means based on a detection result of the normally operable accelerator opening degree sensor.

[0025] According to this configuration, because the accelerator opening degree detecting means includes at least two accelerator opening degree sensors, when an abnormality has occurred in either accelerator opening degree sensor, the drive means can be controlled by use of a remaining normal accelerator opening degree sensor.

[0026] Preferably, the control means includes at least two motor drive circuits to be connected to the at least two motors, respectively, and the control means, when an abnormality has occurred in either of the motor drive circuits, specifies a normally operable motor drive circuit, and drives the drive means by means of the normally operable motor drive circuit.

[0027] According to this configuration, because at least two motor drive circuits are provided corresponding to at least two motors, even when an abnormality has occurred in either motor drive circuit, a corresponding motor can be driven by means of a remaining normal motor drive circuit. Accordingly, the throttle opening degree can be led to the predetermined value.

[0028] Preferably, the control means includes at least three arithmetic units to which detection results of the throttle opening degree detection means are input, respectively, and the control means, when an abnormality has occurred in any of the arithmetic units, specifies a normally operable arithmetic unit, and drives the drive means by means of the normally operable arithmetic unit.

[0029] According to this configuration, the control means includes at least three arithmetic units, and thus,

when an abnormality has occurred in any arithmetic unit, arithmetic unit in which the abnormality has occurred can be specified. In addition, by a normal remaining arithmetic unit, the control means can perform a control of the drive means according to a detection result of the throttle opening degree detecting means.

[0030] The plurality of arithmetic units may be, for example, arithmetic units that execute the same arithmetic processing, and each one monitors calculation results by other arithmetic units. In this case, normal and abnormal arithmetic units may be specified based on a majority decision of calculation results.

[0031] A motorcycle according to the present invention includes: an engine; a wheel to which a driving force of the engine is transmitted; and the throttle device having the above-described characteristics that adjusts an amount of intake air to the engine.

[0032] According to this configuration, at occurrence of an abnormality, the control means controls the drive means so as to lead the throttle opening degree to a predetermined value (for example, a full-close value). At this time, when the throttle opening degree corresponding to the accelerator opening degree is smaller than the actual throttle opening degree, the control means controls the drive means so that the throttle opening degree corresponds to the accelerator opening degree. Therefore, when a rider quickly decreases the accelerator opening degree with the intention of rapidly decelerating the engine, the throttle opening degree quickly decreases in accordance therewith. More specifically, a rider's will is reflected, while the throttle opening degree can be led to a predetermined value. On the other hand, when the throttle opening degree corresponding to the accelerator opening degree is equal to or more than the actual throttle opening degree, the rider has no intention of a rapid deceleration. Therefore, in this case, the control means drives the drive means at a predetermined speed to thereby lead the throttle opening degree to a predetermined value. Accordingly, determining the predetermined speed appropriately allows leading the throttle opening degree to a predetermined value without making the rider feel an excessively great sense of discomfort.

[0033] Other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] Fig. 1 is an illustrated side view showing a configuration of a motorcycle according to an embodiment of the present invention.

[0035] Fig. 2 is a view for explaining a configuration related to an engine of the above motorcycle.

[0036] Fig. 3 is an illustrated configuration view of a throttle device.

[0037] Fig. 4 is a perspective view for explaining a

structure of a drive mechanism for throttle valves and an arrangement of a sensor assembly.

[0038] Fig. 5 is an exploded perspective view of a configuration shown in Fig. 4.

[0039] Fig. 6 is an enlarged perspective view for explaining an arrangement of a rotation angle detecting magnet and a full-close detecting magnet.

[0040] Fig. 7 is a plan view for explaining a configuration of a sensor assembly.

[0041] Fig. 8 is a block diagram for explaining an electrical configuration related to control of a throttle device.

[0042] Fig. 9 is a flowchart for explaining a processing by a control unit.

[0043] Figs. 10A and 10B are diagrams showing time changes of the accelerator opening degree and the throttle opening degree at the occurrence of a failure.

[0044] Fig. 11 is a flowchart for explaining an abnormality determination processing.

[0045] Fig. 12 is a perspective view for explaining a configuration of a throttle device according to a second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0046] Fig. 1 is an illustrated side view showing a configuration of a motorcycle according to an embodiment of the present invention. The motorcycle 1 includes a vehicle body frame 2, an engine 3, a front wheel 4, and a rear wheel 5. The engine 3 is mounted on the vehicle body frame 2. In a front portion of the vehicle body frame 2, a head pipe 6 is provided. On the head pipe 6, a front fork 7 is supported so as to be pivotal laterally. The front wheel 4 is axially supported at a lower end of the front fork 7. In a rear portion of the vehicle body frame 2, a rear arm 8 is supported. The rear wheel 5 is supported at a rear end portion of the rear arm 8.

[0047] At an upper end of the front fork 7, a handlebar 10 for steering the motorcycle 1 is fixed. At both ends of the handlebar 10, a pair of grips that a rider holds with his/her left and right hands are provided. One of these (normally, the right grip) is an accelerator grip 11 (accelerator operation member) to be operated to turn about a steering shaft by the rider. The accelerator grip 11 is fitted with an accelerator opening degree detecting unit 12 (accelerator opening degree detecting means) for detecting the operation amount thereof. The operation amount of the accelerator grip 11 will be hereinafter referred to as an "accelerator opening degree." More specifically, the accelerator opening degree detecting unit 12 detects the accelerator opening degree. A throttle opening degree of the engine 3 is adjusted according to output of the accelerator opening degree detecting unit 12, that is, the accelerator opening degree. Accordingly, the rider can adjust the rotation speed of the engine 3 by an operation of the accelerator grip 11.

[0048] The engine 3 is, for example, a water-cooled four-cylinder four-stroke engine. The engine 3 has in a

lower portion thereof a crank case 15 in which a crankshaft is accommodated. A cylinder block 16 is connected to a front portion on the crank case 15. A cylinder head 17 is fixed on the cylinder block 16.

[0049] In the crank case 15, a transmission gear mechanism (not shown) is incorporated. Between an output shaft of the transmission gear mechanism and a sprocket 18 fixed to the rear wheel 5, a chain 19 is wound therearound. The transmission gear mechanism and the chain 19 transmit a driving force of the engine 3 to the rear wheel 5.

[0050] Disposed above the engine 3 is a fuel tank 20, which is supported on the vehicle body frame 2. A seat 21 is disposed rearward of the fuel tank 20. An ECU (Electronic Control Unit) 22 serving as a control unit is provided in a lower portion of the seat 21.

[0051] In a front wall of the cylinder head 17 of the engine 3, an exhaust port is opened. This exhaust port is connected with an exhaust pipe 23. The exhaust pipe 23 is curved rearward, and connected to a muffler 24 disposed lateral to the rear wheel 5.

[0052] In a rear wall of the cylinder head 17, an air intake port is opened. The air intake port is connected with a throttle device 60.

[0053] Fig. 2 is a view for explaining a configuration related to the engine 3. The engine 3 includes a crank case 15, a cylinder block 16 communicating with the crank case 15, a cylinder head 17 connected to a head portion of the cylinder block 16, and a piston 26 accommodated in the cylinder block 16. In the crank case 15, a crankshaft 27 is rotatably axially supported. The crankshaft 27 is connected with a rotor of a generator (ACM) 41.

[0054] The cylinder head 17 is connected with an air intake pipe 42 and an exhaust pipe 23, and these pipes communicate with a combustion chamber 43 above the piston 26. The cylinder head 17 is attached with an ignition plug 44, and a discharge portion of the ignition plug 44 is located within the combustion chamber 43. A discharging voltage is applied from an ignition coil 45 to the ignition plug 44.

[0055] An injector 40 is attached to an intermediate portion of the air intake pipe 42. The injector 40 is supplied with a fuel retained in the fuel tank 20 by a fuel pump 47. The air intake pipe 42 is intervened with a throttle device 60. The throttle device 60 includes a throttle valve 66. The air intake pipe 42 is further attached with an intake air temperature sensor 52 and an intake air pressure sensor 53. The throttle device 60 is a device for adjusting the amount of intake air to the engine 3 by changing the opening degree (throttle opening degree) of an air intake passage according to an accelerator operation of the rider. The throttle device 60 is disposed further at an upstream side in an intake air inflow direction than the injector 40. The intake air temperature sensor 52 detects the temperature of air introduced in the air intake pipe 42. The intake air pressure sensor 53 is disposed between the throttle device 60 and the injector 40, and de-

tests the pressure of intake air within the air intake pipe 42.

[0056] Further, the cylinder block 16 is attached with a coolant temperature sensor 54, and the crank case 15 is attached with a crank angle sensor 55. The coolant temperature sensor 54 detects the temperature of coolant that cools the engine 3. The crank angle sensor 55 detects a rotation angle of the crank shaft 27.

[0057] Output signals of the aforementioned sensors are given to the ECU 22 (see Fig. 1). The ECU 22 executes a control (ignition control) of an ignition coil 45, a control (fuel injection control) of the injector 40, a control (fuel supply control) of the fuel pump 47, and a control (intake air amount control) of the throttle device 60.

[0058] Fig. 3 is an illustrated configuration view of the throttle device 60. The throttle device 60 is designed for a four-cylinder engine in the present embodiment. The throttle device 60 includes four throttle bodies 62 that define four air intake passages 61 to be connected to four air intake ports, respectively. The four throttle bodies 62 are supported while being connected to the frame 63 in a linearly arranged state. The air intake passages 61 are thereby linearly arranged. Between two pairs of throttle bodies 62 of both sides, spacers 64 are intervened, respectively, to coordinate the interval between the throttle bodies 62 with the interval between the air intake ports. In a manner penetrating through the four throttle bodies 62 and the two spacers, a throttle shaft (throttle valve shaft) 65 is disposed. The throttle shaft 65 is supported, by, for example, bearings (not shown) provided on the throttle bodies 62, so as to be freely turnable about an axis thereof.

[0059] To an intermediate portion of the throttle shaft 65, four throttle valves 66 are connected spaced from each other. The four throttle valves 66 are located in the four air intake passages 61, respectively. The throttle valve 66, by turning the throttle shaft 65 about its axis, can take an arbitrary angular position between a full-close position and a full-open position. The full-close position is a position where the throttle valve 66 takes a position almost orthogonal to a gas circulation direction (axial direction of the air intake passage 61) of the air intake passage 61. The full-open position is a position where the throttle valve 66 takes a position almost parallel to a gas circulation direction of the air intake passage 61. If, for example, the angular position of the throttle valve 66 is expressed on the basis of a direction perpendicular to a gas circulation path of the air intake passage 61, the full-close position can be expressed as 0 degrees, and the full-open position can be expressed as, for example, 90 degrees. The angular position of the throttle valve 66 indicates the throttle opening degree, that is, the degree of opening of the air intake passage 61 that is adjusted by the throttle valve 66. The four throttle valves 66 are fixed to the throttle shaft 65 in postures parallel to each other. Accordingly, by a turn of the throttle shaft 65, the throttle opening degrees of the four air intake passages 61 can be simultaneously adjusted to the same value.

[0060] Between two throttle bodies 62 arranged near the center, that is, between two air intake passages 61 arranged near the center, a drive mechanism 70 is disposed. The drive mechanism 70 is arranged to turn the throttle shaft 65 to cause the throttle opening degree to change. The drive mechanism 70 includes a pair of motors M1 and M2, a reduction mechanism 72, a return spring 73, and a bracket 74 holding these components. A sensor assembly 75 is further supported on the bracket. The sensor assembly 75 is arranged to detect the throttle opening degree and a fully closed throttle.

[0061] Fig. 4 is a perspective view for explaining a structure of the drive mechanism 70 and an arrangement of the sensor assembly 75, and Fig. 5 is an exploded perspective view thereof.

[0062] The first and second motors M1 and M2 share a drive shaft 71 disposed parallel to the throttle shaft 65. Although shown in a manner divided into left and right halves for the sake of convenience in Fig. 5, the drive shaft 71 is a single shaft. The first and second motors M1 and M2 are coaxially disposed, and a motor pinion gear 76 is fixed to the common drive shaft 71. In this manner, there is provided a double system of driving sources that generate driving forces to drive the throttle valves 66. The reduction mechanism 72 includes an intermediate gear 77 and a throttle gear 78.

[0063] The intermediate gear 77 has a large-diametrical wheel gear portion 77A engaging with the motor pinion gear 76 and a small-diametrical pinion gear portion 77B provided integrally with the large-diametrical wheel gear portion 77A. The intermediate gear 77 is fixed to an intermediate gear shaft 80 disposed parallel to the throttle shaft 65. The intermediate gear shaft 80 is supported on the bracket 74 (see Fig. 3) so as to be able to turn about its axis with the intermediate gear 77.

[0064] The throttle gear 78 is fixed to the throttle shaft 65 between the two throttle bodies 62 (see Fig. 3) near the center. The throttle gear 78 has at a peripheral portion thereof a wheel gear portion 78A engaging with the pinion gear portion 77B of the intermediate gear 77. The wheel gear portion 78A is composed of a row of teeth over an angular range of almost 90 degrees corresponding to from a full-close position to a full-open position of the throttle valve 66.

[0065] Due to this configuration, when the motor pinion gear 76 fixed to the drive shaft 71 rotates as a result of driving of the motor M1, M2, this rotation is transmitted to the wheel gear portion 77A of the intermediate gear 77. Accordingly, the intermediate gear shaft 80 rotates with the intermediate gear 77. The rotation of the intermediate gear 77 is transmitted from the pinion gear portion 77B to the wheel gear portion 78A of the throttle gear 78 to cause a rotation of the throttle gear 78. Accordingly, the throttle shaft 65 fixed to the throttle gear 78 is turned about its axis. As a result, the throttle valve 66 rotates within the air intake passage 61 to change the throttle opening degree.

[0066] The number of teeth of the motor pinion gear

76 is smaller than that of the wheel gear portion 77A of the intermediate gear 77. Accordingly, rotation of the motor M1, M2 is reduced and transmitted to the intermediate gear 77. Further, the number of teeth of the pinion gear portion 77B of the intermediate gear 77 is smaller than that of the wheel gear portion 78A of the throttle gear 78. Accordingly, rotation of the intermediate gear 77 is reduced and transmitted to the throttle gear 78. Thus, the rotation of the motor M1, M2 is reduced by the reduction mechanism 72 and transmitted to the throttle shaft 65. It should be noted that the number of teeth of the wheel gear portion 78A is an equivalent value when it is assumed that the wheel gear portion 78A is formed across the entire circumference of the throttle gear 78.

[0067] As shown in an enlarged manner in Fig. 6, a magnet fixing portion 78B is formed on the throttle gear 78, and a full-close detecting magnet 81 (permanent magnet piece) is embedded in the magnet fixing portion 78B. The magnet fixing portion 78B is disposed in the vicinity of one end portion of the wheel gear portion 78A, and formed in a pillar shape projecting toward one side in a direction parallel to the throttle shaft 65. A front end portion of the magnet fixing portion 78B is embedded with the full-close detecting magnet 81. The full-close detecting magnet 81 is fixed to the magnet fixing portion 78B in a posture with its magnetic pole direction (direction passing through an N-pole and an S-pole) parallel to the throttle shaft 65.

[0068] On the other hand, to a pinion gear portion 77B-side front end portion of the intermediate gear shaft 80, a magnet fixing member 83 is fixed so as to rotate integrally with the intermediate gear shaft 80. The magnet fixing member 83 is embedded with a rotation angle detecting magnet 82 (permanent magnet piece). The rotation angle detecting magnet 82 is embedded in the magnet fixing member 83 in a posture with its magnetic pole direction orthogonal to the intermediate gear shaft 80.

[0069] As shown in Fig. 4, the sensor assembly 75 is disposed so as to face the rotation angle detecting magnet 82 provided in the front end portion of the intermediate gear shaft 80. The sensor assembly 75 is disposed so as to face the rotation angle detecting magnet 82 at all times and to be able to face the full-close detecting magnet 81 when the throttle valve 66 is at a full-close position. The sensor assembly 75 is held on the bracket 74 (see Fig. 3), so that a relative positional relationship of the sensor assembly 75 with the intermediate gear shaft 80 and the throttle gear 78 is maintained.

[0070] The return spring 73 is formed of a torsion spring wound around the throttle shaft 65. One end of the return spring 73 is held on a predetermined portion of the bracket 74, and the other end thereof is fixed to the wheel gear portion 78A of the throttle gear 78. A torsion is imparted in advance to the return spring 73, and thereby, the return spring 73 elastically urges the throttle shaft 65 via the throttle gear 78 in a direction to lead the throttle valve 66 to a full-close position. The return spring 73 functions mainly for eliminating backlash between gears. That is,

by the function of the return spring 73, the motor pinion gear 76 and the wheel gear portion 77A, and the pinion gear portion 77B and the wheel gear portion 78A are engaged therebetween while being urged in one direction at all times, respectively. Therefore, a rotation of the intermediate gear shaft 80 accurately corresponds to a rotation of the throttle shaft 65. Accordingly, detecting a rotation angle of the intermediate gear shaft 80 allows accurately detecting an angular position of the throttle valve 66 fixed to the throttle shaft 65.

[0071] Fig. 7 is a plan view for explaining a configuration of the sensor assembly 75. The sensor assembly 75 is formed by mounting a rotation angle detecting unit 90 and a full-close detecting unit 87 on a common substrate 88.

[0072] The rotation angle detecting unit 90 is formed by sealing a pair of rotation angle detecting elements 91 and 92 in a common resin package. A lead terminal of the rotation angle detecting unit 90 is soldered to a wiring pattern on the substrate 88. The rotation angle detecting elements 91 and 92 are each formed of a Hall IC that detects the magnetic pole direction (direction of a magnetic field) of the rotation angle detecting magnet 82. As such a Hall IC, for example, a magnetic field vector detecting sensor MLX90316 (Rotary Position Sensor IC) supplied from Melexis Corp. can be used. The rotation angle detecting elements 91, 92 each formed of such a Hall IC are for detecting the direction of a magnetic field, not the size of a magnetic field, and thus can accurately detect the rotation angle of the intermediate gear shaft 80, regardless of the size of a gap between the same and the rotation angle detecting magnet 82.

[0073] On the other hand, the full-close detecting unit 87 is formed by sealing a full-close detecting element 93 formed of a Hall IC that detects the intensity of a magnetic field in a resin package. A lead terminal of the full-close detecting unit 87 is soldered to a wiring pattern on the substrate 88. The full-close detecting unit 87 is disposed in proximity to a course along which the full-close detecting magnet 81 moves when the throttle shaft 65 is turned, and designed so as to face the full-close deselecting magnet 81 when the throttle valve 66 is at a full-close position. The full-close detecting element 93 is used for detecting whether the full-close detecting magnet 81 is facing. More specifically, if the full-close detecting element 93 has detected a strong magnetic field (for example, a magnetic field of a size equal to or more than a threshold value), the full-close detecting magnet 81 is located at a facing position, and accordingly it can be recognized that the throttle valve 66 is at a full-close position. In contrast thereto, when a magnetic field detected by the full-close detecting element 93 is weak (for example, less than the threshold value) or zero, the full-close detecting magnet 81 is not located at a facing position, and accordingly it can be recognized that the throttle valve 66 is not at a full-close position. Thus, unlike the rotation angle detecting elements 91, 92, the full-close detecting element 93 is not for detecting the direction of

a magnetic field, but for detecting the intensity of a magnetic field, and can thus be formed of a Hall IC of lower price than that of the rotation angle detecting elements 91, 92.

[0074] Because the rotation angle detecting elements 91, 92 are for detecting the direction of a magnetic field, the rotation angle detecting magnet 82 is arranged on a rotation shaft of the intermediate gear shaft 80. Because the full-close detecting element 93 is on the other hand for detecting the intensity of a magnetic field, the full-close detecting magnet 81 is disposed at a position offset from a rotation shaft of the throttle gear 78. That is, the full-close detecting magnet 81 is disposed so as to approximate and separate from the full-close detecting element 93. More specifically, the full-close detecting magnet 81 is fixed to the throttle gear 78 so as to be located at a position in proximity to the rotation angle detecting magnet 82 when the throttle valve 66 is located at a full-close position. This allows disposing the rotation angle detecting unit 90 and the full-close detecting unit 87 in proximity, and thus the substrate 88 on which these are commonly mounted can be downsized.

[0075] Fig. 8 is a block diagram for explaining an electrical configuration related to control of the throttle device 60. Output signals of the pair of rotation angle detecting elements 91 and 92 provided in the rotation angle detecting unit 90 are input to the ECU 22. Further, an output signal of the full-close detecting element 93 provided in the full-close detecting unit 87 is also input to the ECU 22. Still further, an output signal (accelerator opening degree) of the accelerator opening degree detecting unit 12 for detecting the operation amount of the accelerator grip 11 is input to the ECU 22. The accelerator opening degree detecting unit 12 is provided as a double system including a pair of accelerator opening degree sensors 121 and 122 in the present embodiment.

[0076] The ECU 22 includes a control unit 30, a pair of motor drive circuits 35 and 36 corresponding to the first and second motors M1 and M2, respectively, and a pair of current detection circuits 37 and 38 corresponding to the first and second motors M1 and M2, respectively. The motor drive circuits 35 and 36 supply motor currents to the first and second motors M1 and M2, respectively. The current detection circuits 37 and 38 detect motor currents respectively supplied from the motor drive circuits 35 and 36 to the corresponding first and second motor M1 and M2. The motor drive circuits 35 and 36 supply currents according to control signals from the control unit 30 to the first and second motors M1 and M2, respectively. The current detection circuits 37 and 38 feedback detection signals indicating detected motor currents to the control unit 30.

[0077] The control unit 30 includes a first arithmetic unit 31, a second arithmetic unit 32, and a third arithmetic unit 33. These first to third arithmetic units 31, 32, and 33 each include a microcomputer. The first to third arithmetic units 31, 32, and 33 are structured to be able to mutually exchange data via a communication line 34.

[0078] The first arithmetic unit 31 can give control signals to the motor drive circuits 35 and 36, and can receive detection signals from the current detection circuits 37 and 38. Further, to the first arithmetic unit 31, output signals of the accelerator opening degree sensors 121 and 122 are input, and output signals of the rotation angle detecting elements 91 and 92 are input. An output signal of the full-close detecting element 93 is also input to the first arithmetic unit 31.

[0079] Likewise, the second arithmetic unit 32 can give control signals to the motor drive circuits 35 and 36, and can receive detection signals from the current detection circuits 37 and 38. Further, to the second arithmetic unit 32, output signals of the accelerator opening degree sensors 121 and 122 are input, and output signals of the rotation angle detecting elements 91 and 92 are input. An output signal of the full-close detecting element 93 is also input to the second arithmetic unit 32.

[0080] To the third arithmetic unit 33, output signals of the accelerator opening degree sensors 121 and 122 are input, and output signals of the rotation angle detecting elements 91 and 92 are input. An output signal of the full-close detecting element 93 is also input to the third arithmetic unit 33. However, the third arithmetic unit 33 does not give a control signal to the motor drive circuit 35 or 36. Moreover, the third arithmetic unit 33 is also not designed so as to receive a detection signal from the current detection circuit 37 or 38.

[0081] The first to third arithmetic units 31, 32, and 33 are configured so as to execute an arithmetic processing in accordance with the same algorithm based on output signals of the accelerator opening degree sensors 121, 122, the rotation angle detecting elements 91, 92, and the full-close detecting element 93. In addition, each one of the arithmetic units 31 to 33 operates so as to monitor the operation of two other arithmetic units via the communication line 34.

[0082] Fig. 9 is a flowchart for explaining a processing that the control unit 30 repeatedly executes for every predetermined control cycle. The control unit 30 executes an abnormality determination processing (step S1). In this abnormality determination processing, it is determined whether an abnormality has occurred in any of the accelerator opening degree detecting unit 12, the rotation angle detecting unit 90, the arithmetic units 31, 32, and 33, the motor drive circuits 35 and 36, and the motors M1 and M2. Further, if an abnormality has occurred, an element in which the abnormality has occurred and a normal element(s) are specified.

[0083] If an abnormality has not occurred (step S2: NO), an ordinary control is performed (step S3). The ordinary control is a feedback-control on the motors M1, M2 so as to cause a throttle opening degree (actual opening degree) determined from output values of the rotation angle detecting elements 91, 92 to be coincident with a target throttle opening degree corresponding to the accelerator opening degree. With this step, the throttle opening degree is controlled according to an accelerator

operation of the rider. The feedback-control may be performed by a proportional-integral-derivative (PID) control.

[0084] If it is determined that an abnormality has occurred (step S2: YES), a fail-safe process is executed. Concretely, first, it is judged with reference to output signals of the rotation angle detecting elements 91, 92 (an output signal of a normal element if the other element is abnormal) whether the throttle valve 66 is located at a full-close position (step S4). If the throttle valve 66 is located at a full-close position, power supply to the motor M1 and M2 is stopped (step S5) to end the process.

[0085] If the throttle valve 66 is not at a full-close position (step S4: NO), the control unit 30 judges whether an abnormality has occurred in any of the motors M1, M2 and the motor drive circuits 35, 36 (step S6). If an abnormality has occurred in any of the motors M1, M2 and the motor drive circuits 35, 36 (step S6: YES), power supply to a motor of the abnormal side is stopped (step S7). Accordingly, the subsequent operation is executed by driving only a motor of the normal side. If all of the motors M1, M2 and the motor drive circuits 35, 36 are normal and an abnormality has occurred in other elements (step S6: NO), a process of step S7 is skipped, and the subsequent operation is executed by using both of the two motors M1 and M2. In addition, when power supply to a motor of the abnormal side is stopped, it is preferable to bring a power supply line of the motor into an open state. This allows reducing the power consumption of a normal motor in order to prevent the motor from serving as a load.

[0086] The control unit 30 next generates a throttle opening degree command (throttle opening degree command in case of a failure) for driving the normal motor M1, M2 (both or either one that is normal) at a predetermined full-close speed to lead the throttle opening degree to a full-close value (step S8). This throttle opening degree command indicates a target throttle opening degree to be generated in accordance with a time series so as to lead a throttle opening degree (detection value of the normal rotation angle detecting element 91, 92) at the occurrence of an abnormality to a fully closed throttle at the full-close speed. The full-close speed is determined in consideration of a deceleration of the motorcycle 1 due to a decrease in the throttle opening degree. That is, the full-close speed is determined according to specifications of the motorcycle 1 so that the deceleration does not make the rider who is not willing to decelerate feel an excessively great sense of discomfort.

[0087] Next, the control unit 30 (either the arithmetic unit 31, 32 that is normal) compares the throttle opening degree command and an accelerator opening degree (step S9). In this case, the accelerator opening degree means a target throttle opening degree corresponding to an accelerator opening degree that is detected by the accelerator opening degree detecting unit 12 (normal accelerator opening degree sensor 121, 122). The accelerator opening degree is smaller than the throttle opening

degree command (step S9: YES) when the rider is quickly closing the throttle valve 66 at his/her will. Therefore, the control unit 30 controls the normal motor M1, M2 in accordance with the accelerator opening degree (step S10). That is, the control of the normal motor M1, M2 is performed in order to cause the throttle opening degree to be obtained from an output value of the normal rotation angle detecting element 91, 92 to be coincident with the accelerator opening degree. This allows quickly leading the throttle valve 66 to a full-close position in accordance with the rider's will. An example of time changes of the accelerator opening degree and the throttle opening degree in such a situation is shown in Fig. 10A. The dashed line corresponds to the case where the throttle valve 66 is fully closed at the full-close speed in accordance with the throttle opening degree command value.

[0088] On the other hand, the accelerator opening degree is equal to or more than the throttle opening degree command (step S9: NO) when the rider is not willing to quickly close the throttle valve 66. Therefore, the control unit 30 controls the normal motor M1, M2 based on the throttle opening degree command (throttle opening degree command in case of a failure) (steps S11 to S15). With these steps, the normal motor M1, M2 is driven at the full-close speed, and the throttle valve 66 is driven toward a full-close position. An example of time changes of the accelerator opening degree and the throttle opening degree in such a situation is shown in Fig. 10B.

[0089] In greater detail, the control unit 30 judges whether the speed of the motor M1, M2 has reached a full-close speed (step S11). When the speed of the motor M1, M2 has not reached a full-close speed (step S11: NO), the control unit 30 corrects the throttle opening degree command value so that the normal motor M1, M2 accelerates at a predetermined acceleration (step S12). With this step, the normal motor M1, M2 is accelerated at the predetermined acceleration until its speed reaches a full-close speed. After the speed of the motor M1, M2 reaches the full-close speed (step S11: YES), a process of step S12 is skipped. That is, the normal motor M1, M2 is driven at a constant full-close speed. The predetermined acceleration is preferably determined according to specifications of the motorcycle 1 and the like so that the rider of the motorcycle 1 does not feel an excessively great sense of discomfort as a result of a change in the engine rotation speed due to a change in the throttle opening degree.

[0090] Further, the control unit 30 judges whether the throttle opening degree is equal to or less than a predetermined opening degree (step S13). If the throttle opening degree is equal to or less than a predetermined opening degree (step S13: YES), the control unit 30 corrects the throttle opening degree command so that the motor M1, M2 decelerates at a predetermined deceleration until the throttle valve reaches a fully closed throttle and the speed of the motor M1, M2 reaches zero. This allows preventing the motor M1, M2 from quickly stopping when the throttle valve reaches a fully closed throttle, thereby

to reduce a change in throttle opening degree immediately before a fully closed throttle. If the throttle opening degree exceeds the predetermined opening degree (step S13: NO), a process of step S14 is skipped. That is, the normal motor M1, M2 is driven in accordance with the throttle opening degree command set in step S8 and corrected in step S12 according to necessity. The predetermined deceleration is preferably determined according to specifications of the motorcycle 1 and the like so that the rider of the motorcycle 1 does not feel an excessively great sense of discomfort as a result of a change in the engine rotation speed due to a change in the throttle opening degree.

[0091] Thus, the normal motor M1, M2 is driven in accordance with the throttle opening degree command set in step S8 and corrected in step S12 and/or S14 according to necessity (step S15). As a result, the throttle opening degree can be changed as exemplified in Fig. 10B to lead it to a fully closed throttle state.

[0092] Fig. 11 is a flowchart for explaining the contents of an abnormality determination processing (step S1 of Fig. 9). The abnormality determination processing includes a process (step S101) for determining an abnormality in the accelerator opening degree detecting unit 12, a process (step S102) for determining an abnormality in the rotation angle detecting unit 90, a process (step S103) for determining an abnormality in the arithmetic units 31, 32, 33 provided in the control unit 30, a process (step S104) for determining an abnormality in the motor drive circuits 35, 36, and a process (step S105) for determining an abnormality in the motors M1, M2. In the following, each abnormality determination process will be explained.

[Abnormality determination for accelerator opening degree detecting unit (step S101)]

[0093] The arithmetic units 31, 32, and 33 each execute a process for determining whether an abnormality is present in the accelerator opening degree sensors 121, 122. Concretely, the arithmetic units 31, 32, and 33 each have an analytical model for an ordinary accelerator opening degree sensor. This analytical model generates an accelerator opening degree output signal in accordance with a pre-stored, standard pattern of a rider's accelerator operation. The arithmetic units 31, 32, and 33 judge whether a deviation between output signals of the accelerator opening degree sensors 121 and 122 (sensor-to-sensor deviation) is equal to a predetermined threshold value or more. If the sensor-to-sensor deviation is equal to or more than the threshold value, a deviation between the output signal of each sensor 121, 122 and the output signal of the analytical model is determined. It is judged that an abnormality has occurred in an accelerator opening degree sensor where the deviation is larger, and the other accelerator opening degree sensor is specified to be a normal side.

[0094] Abnormalities to be determined include a dis-

connection failure and a short-circuit failure in wiring between the accelerator opening degree detecting unit 12 and the ECU 22, besides a failure of the accelerator opening degree sensor 121, 122 itself.

[0095] It can also be considered to provide three or more accelerator opening degree sensors to provide the accelerator opening degree detecting unit as a triple or higher order system. In this case, by a majority decision of output signals of the three or more accelerator opening degree sensors, an abnormality in any of the accelerator opening degree sensors can be determined, and the remaining accelerator opening degree sensors can be specified to be normal sensors. In this case, the "majority decision" is a processing for determining a predetermined width of distribution area to which a majority of sensor outputs belong. If there is any sensor output that does not belong to such distribution area, it is judged that an abnormality has occurred in the corresponding accelerator opening degree sensor.

[0096] When a plurality of accelerator opening degree sensors are normal, it suffices to control the throttle opening degree using the accelerator opening degree detected by one of these accelerator opening degree sensors. As a matter of course, it also suffices to determine an average value of the accelerator opening degrees detected by the plurality of normal accelerator opening degree sensors, respectively, and use the average value for a control of the throttle opening degree.

[Abnormality determination for rotation angle detecting unit 90 (step S102)]

[0097] The arithmetic units 31, 32, and 33 each execute a process for determining whether an abnormality is present in the rotation angle detecting elements 91, 92. Concretely, the arithmetic units 31, 32, and 33 each have an analytical model for an ordinary rotation angle detecting element. This analytical model generates an estimated output signal of the rotation angle detecting element for the current calculation cycle based on output signals of the rotation angle detecting elements 91, 92 and the current detection circuits 37, 38 of the previous calculation cycle. The arithmetic units 31, 32, and 33 judge whether a deviation between output signals of the rotation angle detecting elements 91 and 92 (element-to-element deviation) is equal to a predetermined threshold value or more. If the element-to-element deviation is equal to or more than the threshold value, a deviation between the output signal of each rotation angle detecting element 91, 92 and the output signal of the analytical model is determined. It is judged that an abnormality has occurred in a rotation angle detecting element where the deviation is larger, and the other rotation angle detecting element is specified to be a normal side.

[0098] Abnormalities to be determined include a disconnection failure and a short-circuit failure in wiring between the rotation angle detecting unit 90 and the ECU 22, besides a failure of the rotation angle detecting ele-

ment 91, 92 itself.

[0099] It can also be considered to provide three or more rotation angle detecting elements to provide the rotation angle detecting unit as a triple or higher order system. In this case, by a majority decision of output signals of the three or more rotation angle detecting elements, an abnormality in any of the rotation angle detecting elements can be determined, and the remaining rotation angle detecting elements can be specified to be normal elements. In this case, the "majority decision" is a process for determining a predetermined width of distribution area to which a majority of element outputs belong. If there is any element output that does not belong to such distribution area, it is judged that an abnormality has occurred in the corresponding rotation angle detecting element.

[0100] When a plurality of rotation angle detecting elements are normal, it suffices to control the throttle opening degree using the rotation angle (throttle opening degree) detected by one of these rotation angle detecting elements. As a matter of course, it also suffices to determine an average value of the rotation angles detected by the plurality of normal rotation angle detecting elements, respectively, and use the average value for a control of the throttle opening degree.

[Abnormality determination for arithmetic unit (step S103)]

[0101] When an abnormality occurs in any one of the arithmetic units, calculation results by the remaining two arithmetic units coincide with each other (have an error equal to or less than a predetermined threshold value), whereas a calculation result by the arithmetic unit in which the abnormality has occurred does not coincide with the calculation results of the two other arithmetic units (has an error exceeding the predetermined threshold value). Therefore, a majority of the calculation results by the three arithmetic units 31, 32, and 33 is decided. Then, if there is an arithmetic unit that has generated a calculation result not conforming to the calculation result in accordance with the majority decision, it is judged that an abnormality has occurred in the arithmetic unit. Thus, normal and abnormal arithmetic units can be separately specified.

[0102] In a normal time where an abnormality is present in none of the arithmetic units, it suffices to control the motor drive circuits 35, 36 by the first arithmetic unit 31, for example. When an abnormality has occurred in the first arithmetic unit 31, it suffices to cancel a control by the first arithmetic unit 31 and to control the motor drive circuits 35, 36 by the second arithmetic unit 32.

[Abnormality determination for motor drive circuit (step S104)]

[0103] Whether an abnormality is present in the motor drive circuits 35, 36 is determined by using an output

signal of the current detection circuits 37, 38. When there is no output from any of the current detection circuits 37, 38, it can be determined that a disconnection has occurred in the motor drive circuit corresponding to the current detection circuit with no output. When there is an output from both of the current detection circuits 37 and 38, the first arithmetic unit 31 determines a deviation of motor current values (current deviation) detected by the current detection circuits 37 and 38, respectively. When the current deviation is over a predetermined threshold value, the first arithmetic unit 31 judges that an abnormality has occurred in either of the motor drive circuits 35, 36. Further, the first arithmetic unit 31, by use of an analytical model of a motor drive circuit, determines which motor drive circuit is abnormal and which motor drive circuit is normal. The analytical model is input with a control signal to be given to the motor drive circuit, and generates an estimated motor current value corresponding to the control signal. The first arithmetic unit 31 compares a detection value of each current detection circuit 37, 38 with the estimated motor current value. If a deviation of the detection value and the estimated motor current value is over a predetermined threshold value, the first arithmetic unit 31 judges that an abnormality has occurred in the motor drive circuit corresponding to the detection value. Moreover, the first arithmetic unit 31 determines that the motor drive circuit having a deviation between the detection value and the estimated motor current value equal to or less than the threshold value is normal.

[0104] Although it is sufficient that this operation is performed in either one of the first and second arithmetic units 31, 32, the operation may be performed in both the arithmetic units 31 and 32. As a matter of course, when an abnormality has occurred in either of the first and second arithmetic units 31 and 32, the above-described processing is performed in an arithmetic unit of the normal side.

[0105] If the three arithmetic units are normal, the first arithmetic unit 31 compares outputs of the two motor drive circuits 35 and 36 to make a judgment. The second arithmetic unit 32 performs a comparison when the first arithmetic unit 31 is determined to be abnormal.

[Abnormality determination for motor (step S105)]

[0106] Whether an abnormality is present in any of the motors M1, M2 is determined by using motor-applied voltages to be applied from the motor drive circuits 35, 36 to the motors M1, M2, motor currents to be detected by the current detection circuits 37, 38, and a motor rotation speed. The motor rotation speed is calculated from a difference between a rotation angle detected by the rotation angle detecting unit 90 in the previous control cycle and a rotation angle detected by the rotation angle detecting unit 90 in the present control cycle. More specifically, provided in the first arithmetic unit 31 is an analytical model that is input with a motor-applied voltage and

a motor rotation speed to estimate a motor current value. This analytical model determines a motor-induced voltage based on the motor rotation speed. The analytical model further determines a difference between the motor-applied voltage and the motor-induced voltage, and estimates the motor current value based on a value of the difference and a coil resistance of the motor M1, M2. The first arithmetic unit 31 compares the motor current estimation value thus determined and a motor current detection value detected by the current detection circuits 37, 38. If a deviation between the motor current estimation value and the motor current detection value is equal to or more than a predetermined threshold value, the first arithmetic unit 31 judges that an abnormality has occurred in the motor corresponding to the deviation. If a deviation between the motor current estimation value and the motor current detection value is less than a predetermined threshold value, the motor corresponding to the deviation is judged to be normal. Thus, the first arithmetic unit 31 has a function to detect that an abnormality has occurred in either of the motors M1, M2, and specify a motor where an abnormality has occurred and a normal motor.

[0107] It should be noted that, as the motor applied voltage, a voltage command value that is calculated by the first arithmetic unit 31 may be used. Alternatively, it may also be possible to provide voltage detectors for detecting voltages to be respectively applied from the motor drive circuits 35, 36 to the motors M1, M2, and to use detection values of the voltage detectors as a "motor-applied voltage."

[0108] Moreover, it is preferable, also in the second arithmetic unit 32, to perform the same calculation as in the first arithmetic unit 31 for performing an abnormality determination processing for the motors M1, M2. However, an abnormality determination processing for the motors M1, M2 may not be performed in the second arithmetic unit 32. If the three arithmetic units are normal, the first arithmetic unit 31 compares outputs of the two motor drive circuits 35 and 36 to make a judgment. The second arithmetic unit 32 performs a comparison when the first arithmetic unit 31 is determined to be abnormal.

[0109] According to the present embodiment as in the above, at the occurrence of an abnormality, the throttle valve 66 is not fully closed at one stroke by a spring force of the return spring 73, but by driving the motors M1, M2 at a predetermined full-close speed, the throttle valve 66 is led to a full-close position. Because this prevents the rotation speed of the engine 3 from quickly decreasing, the motorcycle 1 does not rapidly decelerate, thus allowing to suppress a sense of discomfort to be given to the rider. On the other hand, when leading the throttle valve 66 to a full-close position as a result of the occurrence of an abnormality, if it is desired by a rider's will to quickly close the throttle valve 66, the motors M1, M2 are controlled so as to accord with the rider's will. This enables a quick full-close control in accordance with the rider's will.

[0110] Moreover, when driving the motors M1, M2 at a full-close speed, the motors M1, M2 are accelerated at a predetermined acceleration until the full-close speed. Moreover, immediately before the throttle valve 66 reaches the full-close position, the motors M1, M2 are decelerated at a predetermined deceleration from the full-close speed. This reduces a sense of discomfort due to a change in the throttle opening degree.

[0111] Still moreover, the accelerator opening degree detecting unit 12, the rotation angle detecting unit 90, the motor drive circuits 35, 36, and the motors M1, M2 are provided as double systems, and the control unit 30 is configured as a triple system. This allows, even if an abnormality has occurred in any system component of the multiple system, to reliably lead the throttle opening degree to a full-close value by use of a normal remaining system component. This allows realizing a highly reliable throttle device 60.

[0112] Fig. 12 is a perspective view for explaining a configuration of a throttle device according to a second embodiment of the present invention. In Fig. 12, corresponding portions to the above-described sections shown in Fig. 4 described above are shown with the same reference numerals and signs.

[0113] In the present embodiment, a drive shaft 171 of the second motor M2 is disposed offset with respect to the drive shaft 71 of the first motor M1. In addition, the drive shaft 171 of the second motor M2 is fixed with a motor pinion gear 176. The motor pinion gear 176 is engaged, with the wheel gear portion 77A of the intermediate gear 77, at a position different from that of the motor pinion gear 76. Due to this configuration, the first and second motors M1 and M2 can both give torque to the intermediate gear 77, and can drive the throttle shaft 65 via the intermediate gear 77.

[0114] While two embodiments of the present invention have been explained in the above, the present invention may be embodied in other ways. For example, the accelerator operation member may have a form of an accelerator lever or an accelerator pedal, without limitation to the accelerator grip.

[0115] Although, in the above-described embodiments, a motorcycle has been mentioned as an example, the throttle device of the present invention can also be applied to engines used as driving sources of vehicles other than motorcycles and other mechanical devices. As a matter of course, the number of cylinders of the engine is not limited to four.

[0116] The correspondence between the components described in the claims and the components in the above-described embodiments is shown below:

Engine: Engine 3

Throttle device: Throttle device 60

Air intake passage: Air intake passage 61

Throttle valve: Throttle valve 66

Drive means: Drive mechanism 70

Throttle opening degree detecting means: Rotation

angle detecting unit 90

Accelerator operation member: Accelerator grip 11

Accelerator opening degree detecting means: Accelerator opening degree detecting unit 12

Control means: Control unit 30

Motor: Motor M1, M2

Throttle opening degree sensor: Rotation angle detecting element 91, 92

Accelerator opening degree sensor: Accelerator opening degree sensor 121, 122

Motor drive circuit: Motor drive circuit 35, 36

Arithmetic unit: Arithmetic unit 31, 32, 33

Wheel : Rear wheel 5

[0117] While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

[0118] The present application corresponds to Japanese Patent Application No. 2008-307727 filed in the Japan Patent Office on December 2, 2008, and the entire disclosure of the application is incorporated herein by reference.

Claims

1. A throttle device (60) **characterized by** comprising:

a throttle valve (66) to be provided in an air-intake passage of an engine (3);

a drive means (70) for driving the throttle valve (66) to change a throttle opening degree;

a throttle opening degree detecting means (90) for detecting the throttle opening degree;

an accelerator opening degree detecting means (12) for detecting an accelerator opening degree indicating an operation amount of an accelerator operation member (11); and

a control means (30) for controlling the drive means (70) so that a throttle opening degree detected by the throttle opening degree detecting means (90) corresponds to an accelerator opening degree to be detected by the accelerator opening degree detecting means (12), wherein

the control means (30), at occurrence of an abnormality where there is an abnormality in any of the drive means (70), the throttle opening degree detecting means (90), the accelerator opening degree detecting means (12), and the control means (30), if a throttle opening degree corresponding to an accelerator opening degree detected by the accelerator opening degree detecting means (12) is smaller than a throttle

opening degree detected by the throttle opening degree detecting means (90), drives the drive means (70) so that a throttle opening degree to be detected by the throttle opening degree detecting means (90) corresponds to the accelerator opening degree, and if a throttle opening degree corresponding to an accelerator opening degree detected by the accelerator opening degree detecting means (12) is equal to or more than a throttle opening degree detected by the throttle opening degree detecting means (90), drives the drive means (70) at a predetermined speed so that a throttle opening degree becomes a predetermined value.

2. The throttle device (60) according to claim 1, **characterized in that** the control means (30), at the occurrence of an abnormality, if a throttle opening degree corresponding to an accelerator opening degree detected by the accelerator opening degree detecting means (12) is equal to or more than a throttle opening degree detected by the throttle opening degree detecting means (90), accelerates the drive means (70) at a predetermined acceleration until the speed of the drive means (70) reaches the predetermined speed.

3. The throttle device (60) according to claim 1 or 2, **characterized in that** the control means (30), at the occurrence of an abnormality, if a throttle opening degree corresponding to an accelerator opening degree detected by the accelerator opening degree detecting means (12) is equal to or more than a throttle opening degree detected by the throttle opening degree detecting means (90), decelerates the drive means (70) at a predetermined deceleration from the predetermined speed until a throttle opening degree reaches the predetermined value.

4. The throttle device (60) according to any one of claims 1 to 3, **characterized in that** at least one of the drive means (70), the throttle opening degree detecting means (90), the accelerator opening degree detecting means (12), and the control means (30) is provided as a multiple system of a double or higher order system, and the control means (30), when an abnormality has occurred in any system component of the multiple system, specifies a normally operable system component of the multiple system, and drives the drive means (70) by use of the normally operable system component.

5. The throttle device (60) according to claim 4, **characterized in that** the control means (30) compares outputs of the multiple system, and if there is a predetermined output difference or more, judges that an abnormality has occurred.

6. The throttle device (60) according to any one of claims 1 to 5, **characterized in that** the drive means (70) includes at least two motors (M1, M2), and the control means (30), when an abnormality has occurred in either of the motors (M1, M2), specifies a normally drivable motor (M1, M2), and drives the drive means (70) by means of the normally drivable motor (M1, M2). 5
7. The throttle device (60) according to any one of claims 1 to 6, **characterized in that** the throttle opening degree detecting means (90) includes at least two throttle opening degree sensors (91, 92), and the control means (30), when an abnormality has occurred in either of the throttle opening degree sensors (91, 92), specifies a normally operable throttle opening degree sensor (91, 92), and drives the drive means (70) based on a detection result of the normally operable throttle opening degree sensor (91, 92). 10 15 20
8. The throttle device (60) according to any one of claims 1 to 7, **characterized in that** the accelerator opening degree detecting means (12) includes at least two accelerator opening degree sensors (121, 122), and the control means (30), when an abnormality has occurred in either of the accelerator opening degree sensors (121, 122), specifies a normally operable accelerator opening degree sensor (121, 122), and drives the drive means (70) based on a detection result of the normally operable accelerator opening degree sensor (121, 122). 25 30 35
9. The throttle device (60) according to claim 6, **characterized in that** the control means (30) includes at least two motor drive circuits (35, 36) to be connected to the at least two motors (M1, M2), respectively, and the control means (30), when an abnormality has occurred in either of the motor drive circuits (35, 36), specifies a normally operable motor drive circuit (35, 36), and drives the drive means (70) by means of the normally operable motor drive circuit (35, 36). 40 45
10. The throttle device (60) according to any one of claims 1 to 9, **characterized in that** the control means (30) includes at least three arithmetic units (31, 32, 33) to which detection results of the throttle opening degree detection means (90) are input, respectively, and the control means (30), when an abnormality has occurred in any of the arithmetic units (31, 32, 33), specifies a normally operable arithmetic unit (31, 32, 33), and drives the drive means (70) by means of the normally operable arithmetic unit (31, 32, 33). 50 55
11. A motorcycle **characterized by** comprising:

an engine (3);
 a wheel (5) to which a driving force of the engine (3) is transmitted; and
 the throttle device (60) according to any one of claims 1 to 10 that adjusts an amount of intake air to the engine (3).

FIG. 1

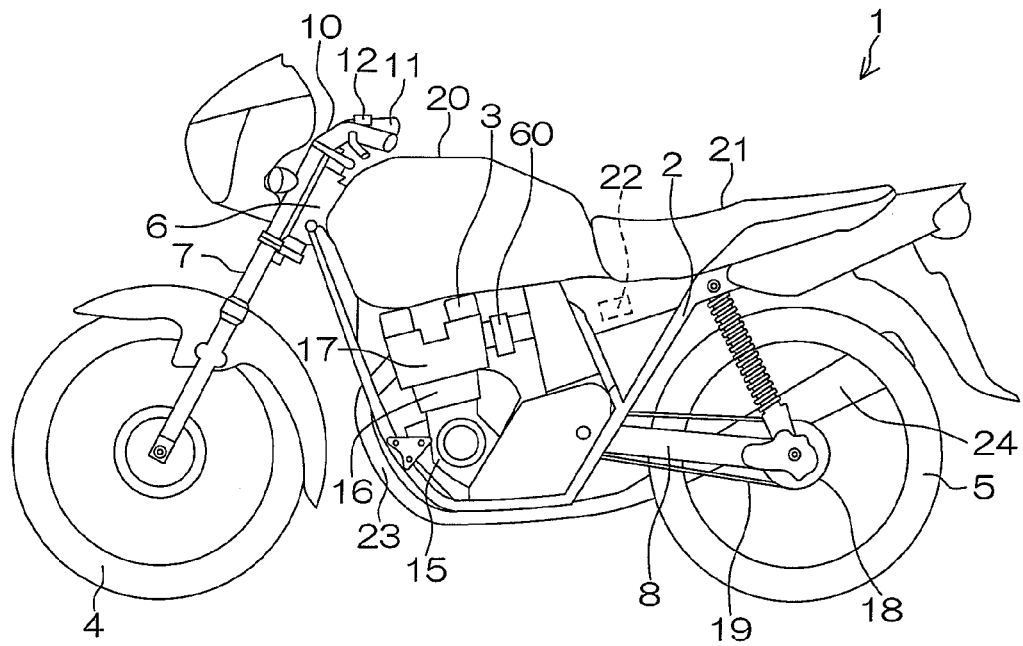


FIG. 2

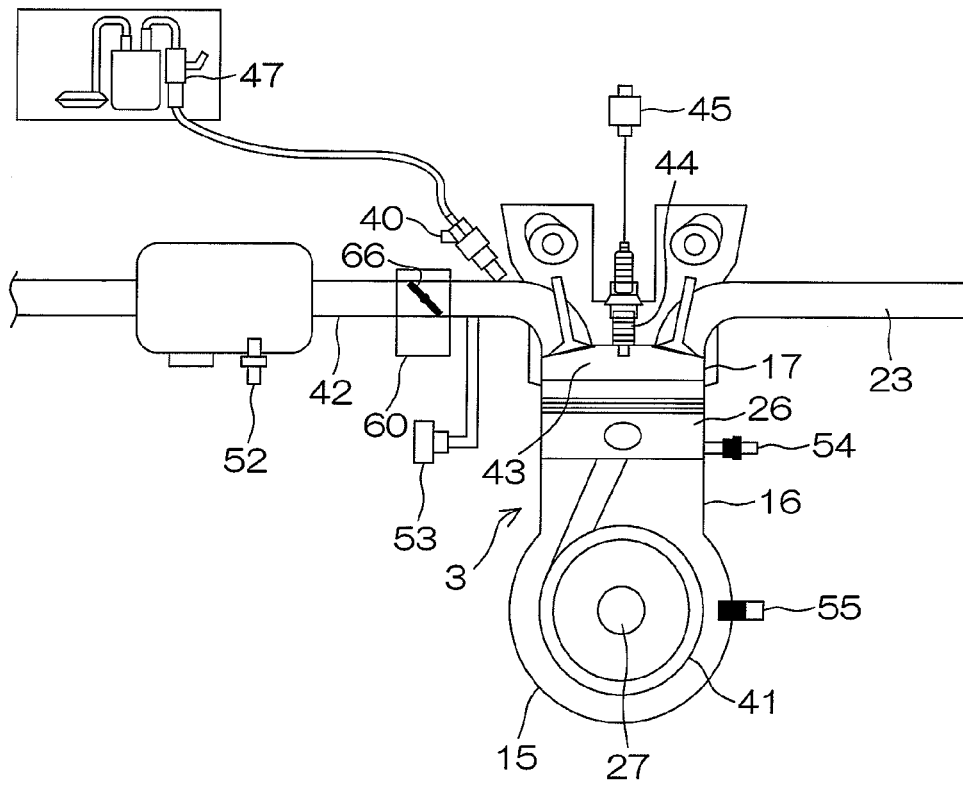


FIG. 3

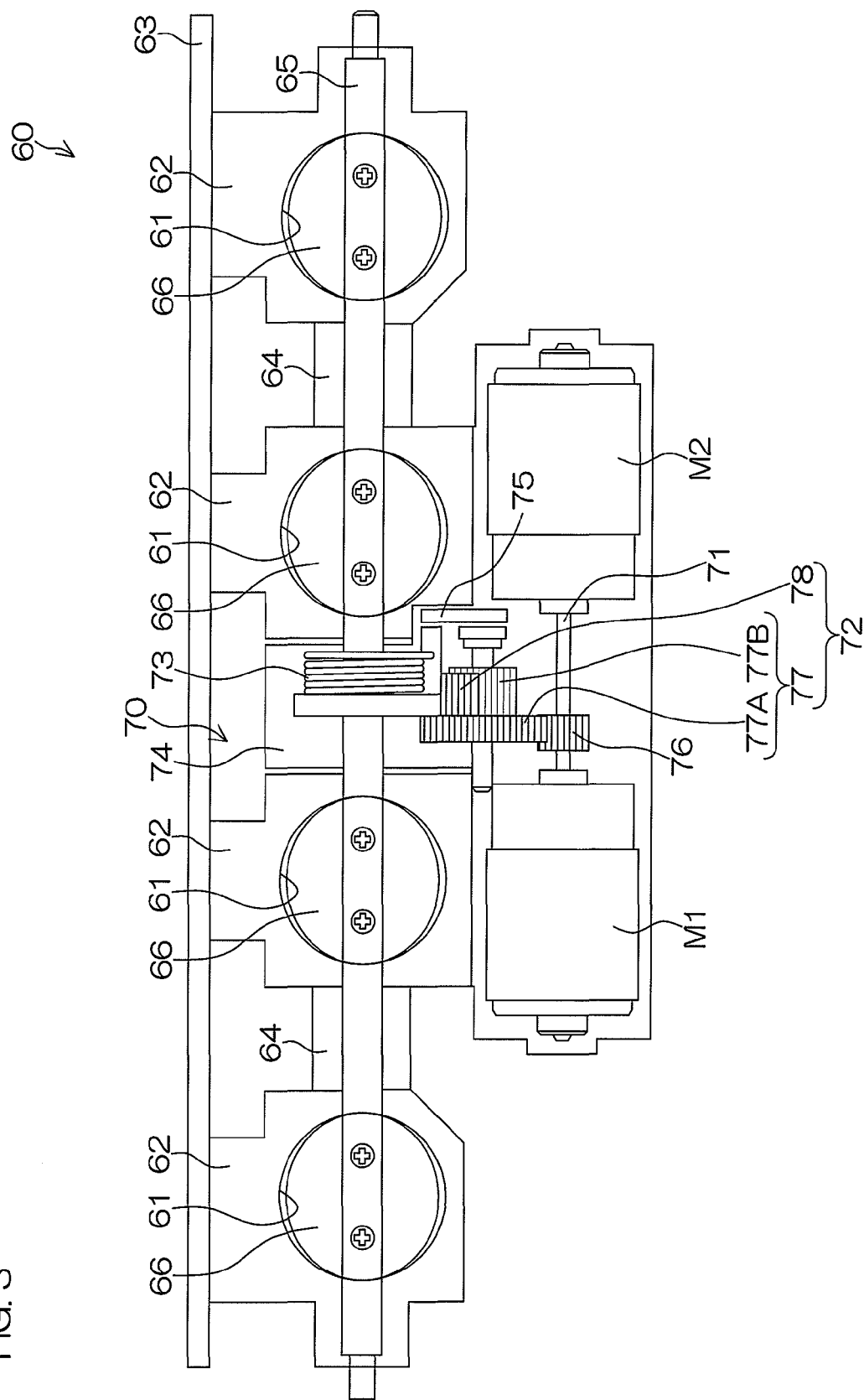


FIG. 4

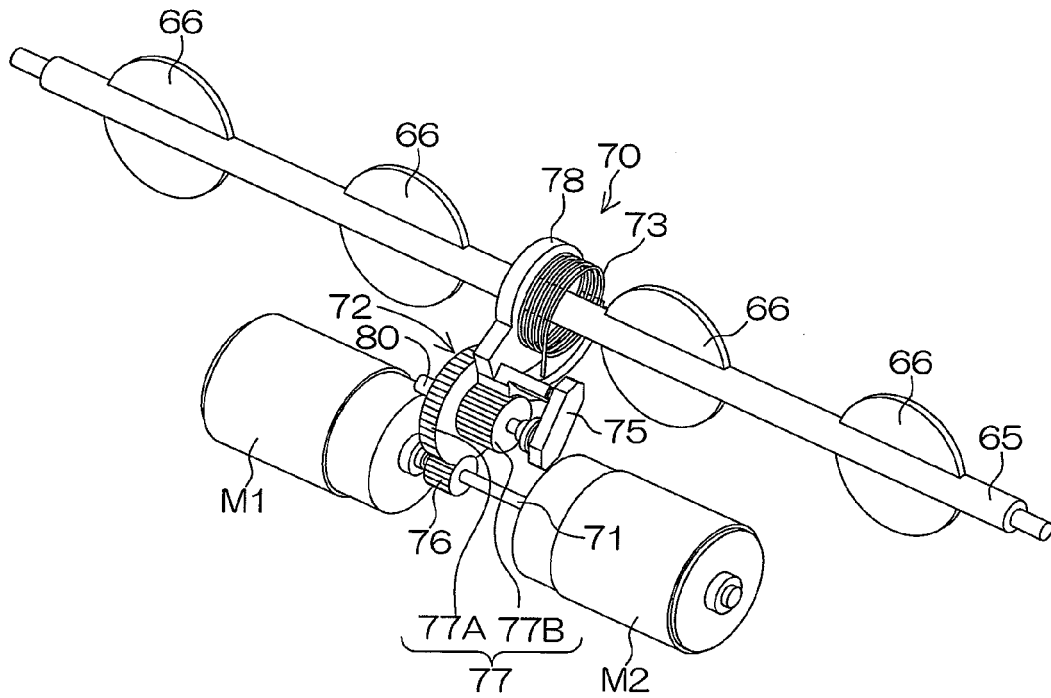


FIG. 5

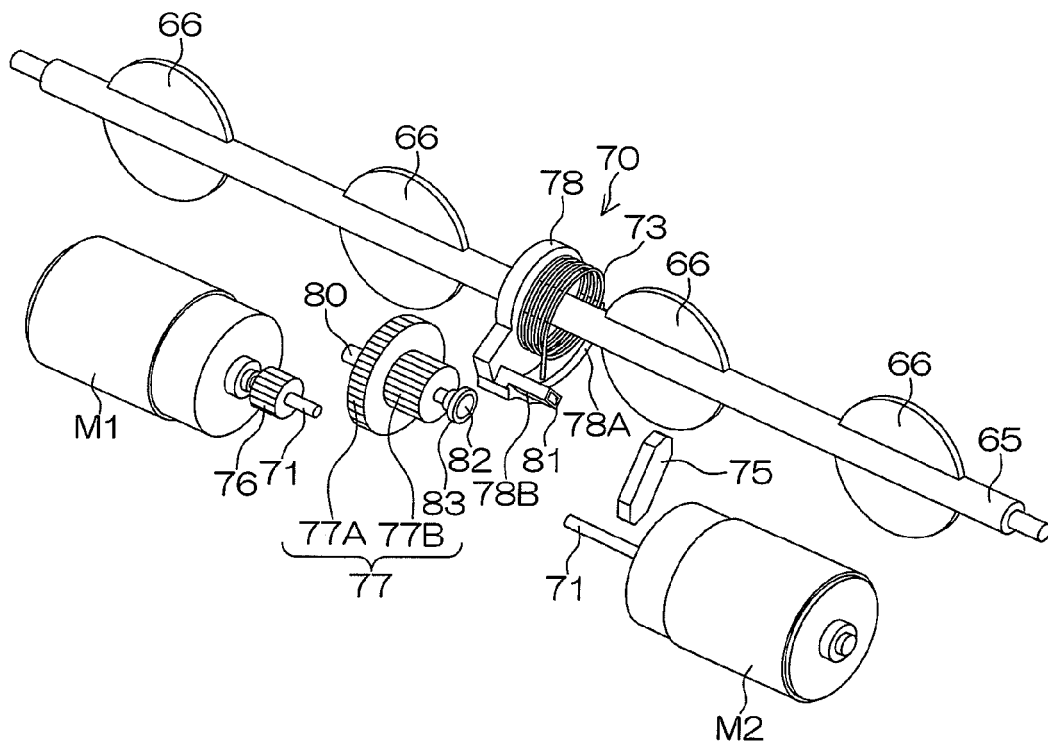


FIG. 6

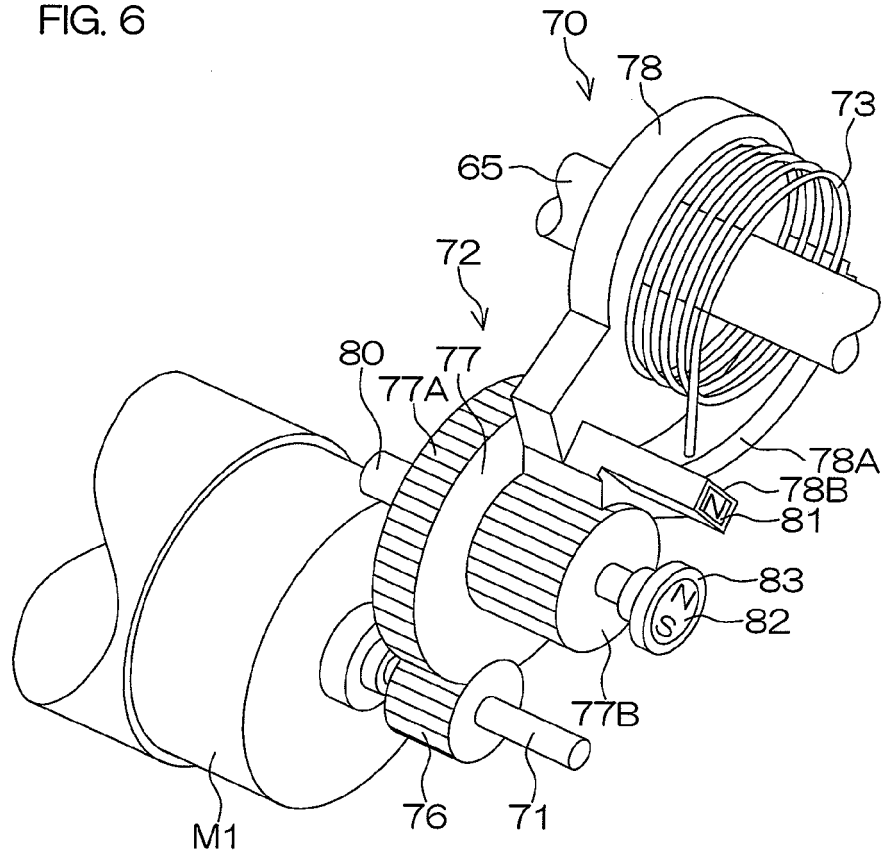


FIG. 7

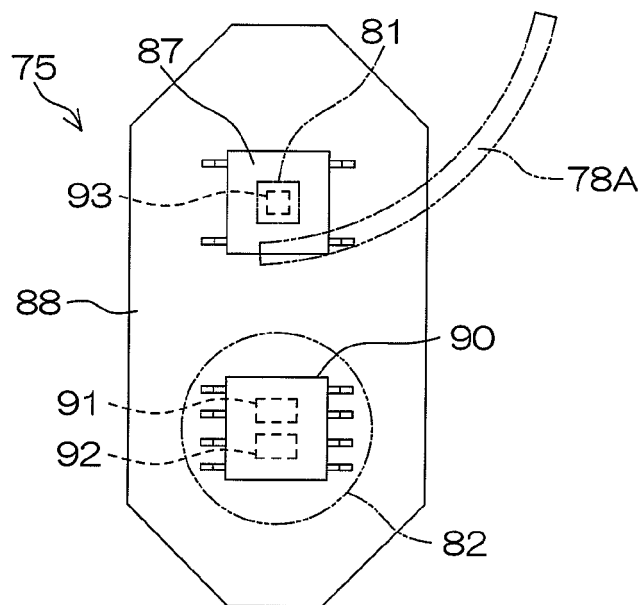


FIG. 8

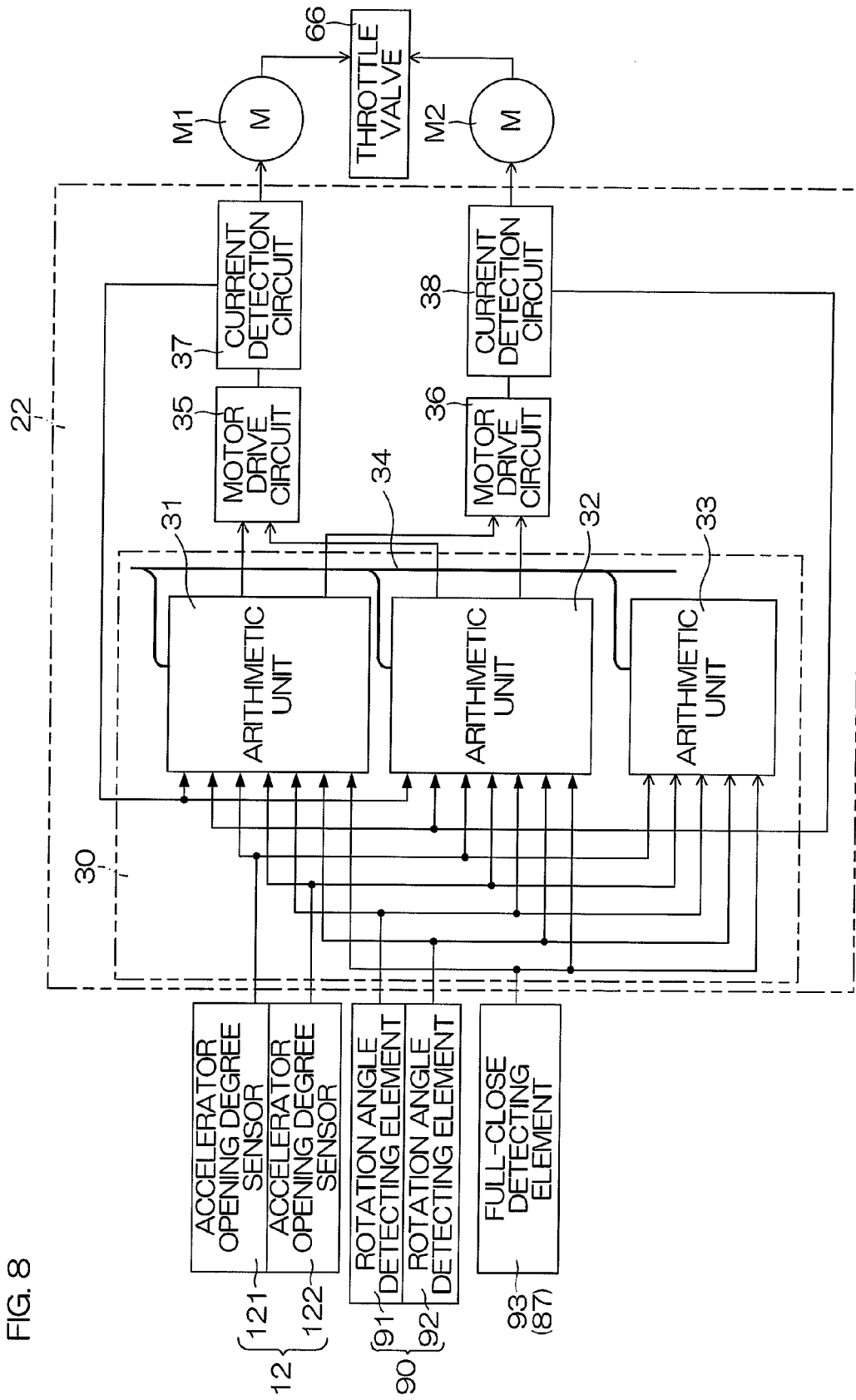


FIG. 9

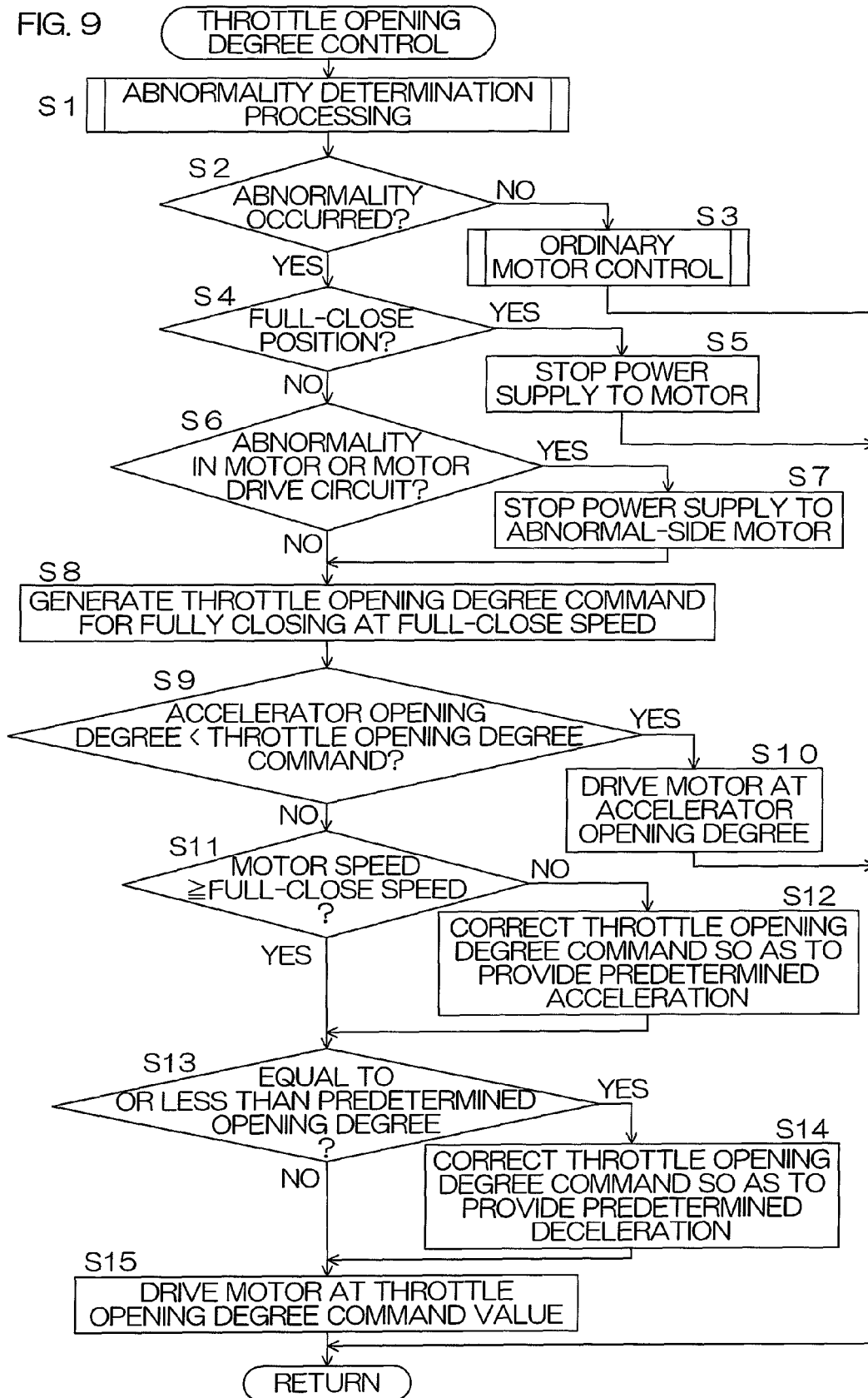


FIG. 1 OA

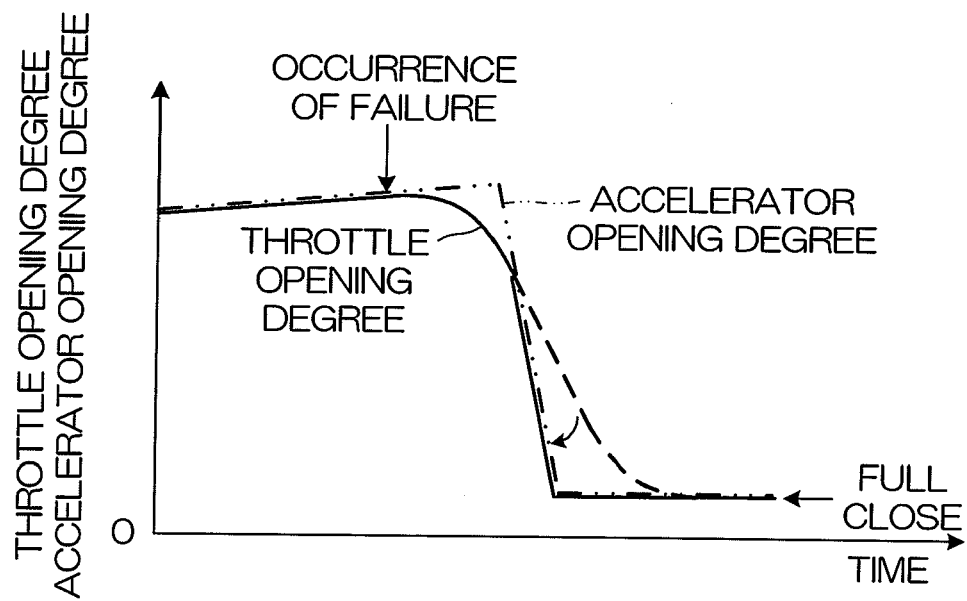


FIG. 1 OB

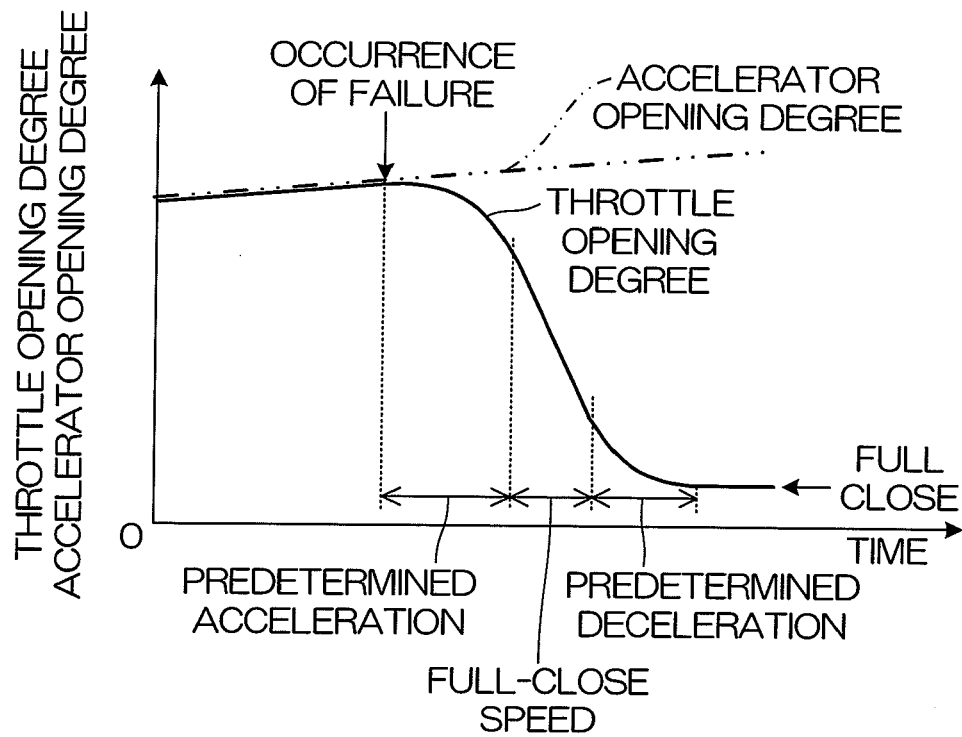


FIG. 1 1

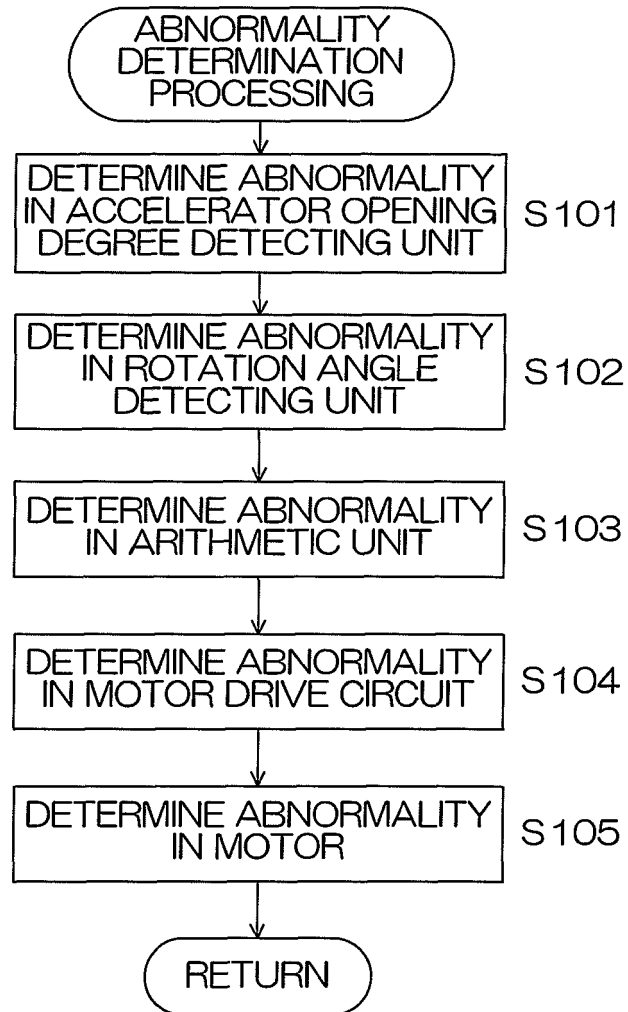
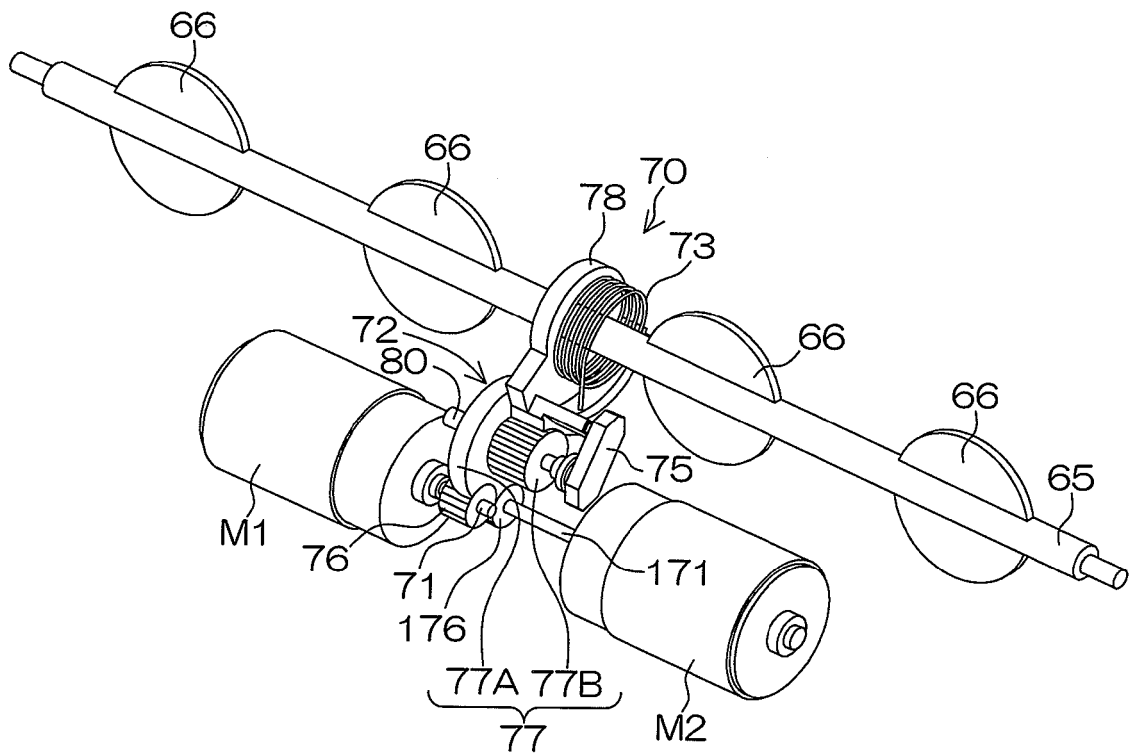


FIG. 12



REFERENCES CITED IN THE DESCRIPTION

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