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(54) **Elevator**

Aufzug

Élévateur

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(56) References cited:
DE-T5- 10 392 710 JP-A- 2006 298 539

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an elevator that brakes an elevator car to a stop when the elevator car reaches an abnormal speed.

[0002] To deal with a case in which an abnormal condition is generated and the elevator cannot be stopped, a conventional elevator applies the brake (electric motor brake) to actuate the mechanical emergency stop device when the speed exceeds its rated speed. A buffer is also provided on the bottom of the shaft considering a case in which the brake and the emergency stop device cannot stop the elevator. Because the buffer size must be determined according to the rated speed of the elevator, a higher elevator rated speed requires a larger buffer which, in turn, requires a longer shaft.

[0003] To solve this problem, a technology is known that makes the buffer smaller and the shaft shorter by varying the speed, at which the brake and the emergency stop device are actuated, according to the position of the car and thereby decreasing the speed at which the elevator car hits the buffer at the bottom of the shaft. This technology is disclosed in WO2004/031064.

[0004] Another known technology is that the overspeed determination criterion is variably determined according to the car position to prevent the brake device from being actuated unnecessarily. This technology is disclosed in WO2004/028947.

SUMMARY OF THE INVENTION

[0005] According to the related art described above, as the car gets nearer to the lowest floor, the actuation speed of the electric motor brake (first brake device, electric motor brake) and the emergency stop device (second brake device, mechanical brake) gets lower and, at the same time, the difference between the speed at which the brake is actuated and the speed at which the emergency stop device is actuated gets smaller. Thus, the actuation time of the emergency stop device is reached within the time difference between the time the brake receives a command and the time the brake is actually actuated and, as a result, there is the possibility that, though the car can be stopped only by the brake, the emergency stop device is actuated.

[0006] In addition, because the actuation speed of the brake and the emergency stop device is low, a vibration in a car, if generated, causes the car to easily reach the actuation speed of the emergency stop device and sometimes causes the emergency stop device to be actuated. Thus, though the emergency stop device, which should not be actuated under normal circumstances, is actuated with the possibility that the guide rail is damaged.

[0007] According to the present invention, it is possible to provide an elevator brake system that solves the problems of the related art described above and that implements an elevator that reduces the wasteful actuations of the emergency stop device and makes the shaft shorter.

[0008] According to one aspect of the present invention, there is provided an elevator having a first setting speed that is set according to a position of an elevator car moving vertically along a guide rail in a shaft and a second setting speed that is set higher than the first setting speed wherein a first brake device is actuated when a speed of the car becomes higher than the first setting speed and a second brake device is actuated when the speed of the car becomes higher than the second setting speed, the elevator further having a third setting speed that is set higher than the second setting speed; and a vibration detector that detects a change in the speed of the car when the speed of the car exceeds the first setting speed and the first brake device is actuated wherein the second brake device is actuated based on the change in the speed of the car and on the second setting speed or the third setting speed.

[0009] According to the present invention, the electric motor brake that is the first brake device is actuated first and, based on the car position and the setting speed, a check is made if it is possible to brake the elevator only by the electric motor brake and, if necessary, the emergency stop device that is the second brake device is actuated. This structure prevents the emergency stop device from being actuated unnecessarily with no damage on the guide rail and makes the shaft shorter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1A is a schematic diagram showing the general configuration of one embodiment of the present invention, and FIG. 1B is a block diagram of the embodiment.

FIG. 2 is a graph showing the setting speeds at car positions in one embodiment.

FIGS. 3A and 3B are graphs showing a change in the car speeds.

FIG. 4 is a block diagram showing a car speed vibration analysis unit in one embodiment.

FIG. 5 is a graph showing the filter characteristics of a vibration detector in one embodiment.
 FIGS. 6A and 6B are graphs showing the waveforms after filtering processing in one embodiment.
 FIG. 7 is a flowchart showing the operation in one embodiment.
 FIG. 8 is a block diagram showing the general configuration of another embodiment.
 FIG. 9 is a flowchart showing the operation in another embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENT

[0011] FIGS. 1A and 1B are diagrams showing the configuration of an elevator brake system.

[0012] The above diagrams generally show an elevator in which a car 70 moves vertically in the shaft along a guide rail 75. A sheave 76 and a first brake device 11 are connected to an electric motor 73. A rope 77 is wound on the sheave 76, and the car 70 and a counterweight 78 are attached to the rope 77. A second brake device 13 is attached to the car 70. Sensors 71 and 72, which detect the position and the speed of the car 70, are provided on the car 70 and the electric motor 73. A first brake device controller 10 and a second brake device controller 20, though not shown, are built in a control device 74, and the first brake device 11 and the second brake device 13 are actuated by the information from the sensors 71 and 72.

[0013] A car position detector 1, a detector that measures the position of the car, is a device that reads the encoder, attached to the motor or the governor pulley, or reads the markers attached to the shaft. A car speed detector 2, which detects the speed of a moving car, calculates the speed from the signal of the encoder attached to the motor or the governor pulley or from the signal of the reader that reads the markers attached to the shaft at a fixed interval.

[0014] A first setting speed generator 3 sets the speed to a speed higher than the operating speed at a car position based on the generated car operating speed pattern, a second setting speed generator 4 generates a speed that is set higher than the speed generated by the first setting speed generator 3, and a third setting speed generator 5 generates a speed higher than the speed generated by the second setting speed generator 4.

[0015] A comparator 6 compares the car position detected by the car position detector 1, the car speed at the car position detected by the car speed detector 2, and the car setting speed generated by the first setting speed generator 3 and, when the car speed becomes higher than the first setting speed, outputs a signal to the first brake device controller 10 to actuate the first brake device 11.

[0016] A comparator 7 compares the car position, the car speed, and the car setting speed generated by the second setting speed generator 4. A comparator 9 compares the car position, the car speed, and the car setting speed generated by the third setting speed generator 5.

[0017] A vibration detector 8 extracts a vibration component from the signal detected by the car speed detector 2 to check for a change in the car speed and, more particularly, to check whether the car is vibrating. A second brake device controller 12 drives the second brake device 13 based on the output from the comparator 7, comparator 9, and vibration detector 8.

[0018] The following describes the basic operation of the brake device with reference to FIG. 2.

[0019] FIG. 2 shows an example of setting speed patterns generated by the first setting speed generator 3, second setting speed generator 4, and third setting speed generator 5. The target speed of a car when it moves from the lowest floor to the highest floor or from the highest floor to the lowest floor is set by a target speed 20 that is indicated by the dotted line.

[0020] The actuation speed of the electric motor brake, which is the first brake device, is set to a first setting speed 21 that is higher than the target speed 20, and a second setting speed 22 is set to a value higher than the first setting speed 21.

[0021] More specifically, the second setting speed 22 is set by the following expression so that the electric motor brake is actuated to stop the car before it hits the buffer at the bottom of the shaft.

[Expression 1]

$$V_2 = \sqrt{2a_b h} + \alpha \quad (1)$$

[0022] V_2 is the second setting speed, a_b is the average deceleration speed when the electric motor brake is actuated, h is the car position from the top face of the buffer installed at the bottom of the shaft, and α is the margin speed.

[0023] A third setting speed 23, which is a speed still higher than the second setting speed 22, is set by the following expression so that the emergency stop device is actuated to stop the car before it hits the buffer at the bottom of the shaft.

[Expression 2]

$$V_3 = \sqrt{2ash} + \beta \quad (2)$$

[0024] V_3 is the third setting speed, as is the average deceleration speed when the emergency stop device is actuated, and β is the margin speed. The constant speed of the second setting speed 22 and the third setting speed 23 is set to a speed that is 1.4 times as high as the constant speed line of the car target speed 20.

[0025] The setting speed for actuating the emergency stop device, the second brake device, should be changed depending upon whether or not a large vibration component is included in the signal from the car speed detector 2. For example, a large vibration component, though not included in the car speed signal when the car speed is increased because of a rope slippage, a rope breakage, or an insufficient power of the first brake device, is included in the car speed signal when the car is strongly swung out of mischief.

[0026] In addition, when the car speed is increased because of a rope slippage or a rope breakage, the emergency stop device, that is, the second brake device, must be actuated immediately; on the other hand, when a strong vibration in the car is generated by a mischief, the emergency stop device need not always be actuated because the vibration will stop soon.

[0027] The signal output from the car speed detector 2 is input to the vibration detector 8 to check if a large vibration is included. If a large vibration component is not included, the second brake device is actuated when the car speed exceeds the second setting speed. If it is determined that a large vibration component is included in the signal received from the car speed detector 2, the second brake device is actuated when the car speed exceeds the third setting speed.

[0028] The cause of the abnormal speed of the car is checked to see whether the abnormal speed is caused by a rope slippage, a rope breakage, or an insufficient power of the electric motor brake or by a large vibration generated by a mischief and, based on the checking result, the actuation speed of the second brake device is selected. Selecting the actuation speed of the second brake device in this way prevents the emergency stop device from being actuated if the car can be stopped simply by actuating the electric motor brake, and this operation mode makes the shaft shorter.

[0029] Next, the following describes the analysis to check if the car speed includes a vibration component.

[0030] The speed waveform generated when a passenger wobbles the car is, for example, as shown by the numeral 24 in FIG. 3A. When the wobbling frequency is near the characteristic frequency of the car, the vibration gets larger as shown by the numeral 24.

[0031] The speed waveform generated when the car speed is increased because of a rope slippage, a rope breakage, or an insufficient power of the electric motor brake is indicated by the numeral 25 in FIG. 3B. To distinguish between those two types of waveform, the signal of the car speed detector 2 is input to the vibration detector 8 shown in FIG. 4.

[0032] The vibration detector 8 comprises a filter 8a and a determiner 8b. The filter 8a extracts the value of the vibration component, which is the difference between the minimum and the maximum of the signal from the car speed detector 2 when the signal has changed. The value of the vibration component is compared with the threshold stored in the determiner 8b in advance. If the value of the vibration component is larger than the threshold, it is determined that there is a vibration component and that the abnormal speed is caused by a mischief. If the value of the vibration component is smaller than the threshold, it is determined that the abnormal speed is caused by a rope slippage, a rope breakage, or an insufficient power of the electric motor brake.

[0033] FIG. 5 is a diagram showing an example of the characteristic of the filter 8a, and the numeral 26 indicates the gain characteristic of the filter. A large vibration is generated in the car when the disturbance source has a frequency component near the characteristic frequency of the car and a resonance is generated. So, it is desirable that the filter 8a have the gain of 1.0 near the characteristic frequency of the car and have a low gain in other frequency bandwidths. In addition, the characteristic frequency of the car varies according to a change in the load capacity and the rope length and so, to cover this variation, the filter 8a should have the gain of 1.0 in the bandwidth at least from the minimum characteristic frequency f_1 to the maximum characteristic frequency f_2 .

[0034] FIG. 6 is a diagram showing the concept of the result generated by passing the waveforms 24 and 25 shown in FIGS. 3A and 3B through the filter 8a having the characteristics 26 shown in FIG. 5. A waveform 27 shown in FIG. 6A is the result generated by passing the waveform 24 shown in FIG. 3A through the filter 8a and, in this case, the vibration component is extracted. A waveform 28 shown in FIG. 6B is the result generated by passing the waveform 25 shown in FIG. 3B through the filter 8a and, in this case, a little or no output is generated.

[0035] Evaluating the amplitude of the vibration waveform with the threshold set as shown in FIGS. 6A and 6B makes it possible to determine if the signal from the car speed detector 2 includes a vibration component. Although the amplitude is used for this determination in this example, the waveform area can also be used. The absolute value of the waveform

generated after the first brake device is actuated is added up and, if the added value exceeds the threshold, it is determined that the speed has reached an abnormal speed caused by a mischief. The FFT(Fast Fourier Transform) processing may also be performed for the signal from the car speed detector 2 to extract the vibration component. The FFT processing gives the frequency and the power spectrum of a prominent vibration component that makes it possible to determine that, when the frequency of the prominent component is near the characteristic frequency and the power spectrum exceeds the threshold, the speed has reached an abnormal speed caused by a mischief.

[0036] FIG. 7 is a flowchart showing the general processing of the operation described above.

[0037] When the destination floor of the car is set and the car operation pattern is generated in step 30, the first, second, and third setting speed patterns are generated in step 31 based on the operation pattern generated in step 30. When the car starts moving, the car position and the car speed are detected to monitor for an abnormal condition.

[0038] In step 33, a check is made if the car speed exceeds the first setting speed to determine if there is an abnormal condition. If the car speed exceeds the first setting speed, the first brake device is actuated in step 34.

[0039] The car position and the car speed are monitored even after the first brake device is actuated (step 35) and, in step 36, an analysis is made to determine if the car speed includes a vibration component.

[0040] If a vibration component larger than the pre-set numeric value is not included (step 37), a check is made in step 38 if the car speed has reached the second setting speed. If the car speed has not reached the second setting speed, control is passed back to step 35 to continue monitoring the car position and the car speed and, if the car speed has reached the second setting speed, the second brake device is actuated.

[0041] If a vibration component larger than the pre-set numeric value is included in step 37 and if the car speed has not reached the third setting speed, control is passed back to step 35. If the car speed has reached the third setting speed, the second brake device is actuated.

[0042] Another embodiment will be described with reference to FIG. 8.

[0043] The car acceleration is detected and, using the detected information, a second brake device 13 is controlled. To detect the car acceleration, it is possible to attach an acceleration pickup to the car as a car acceleration detector 40 or to calculate the acceleration from the signal received from a car speed detector 2.

[0044] After the car speed has reached the first setting speed and a first brake device 11 is actuated, the car acceleration speed information is used to quickly detect an abnormal acceleration caused by a rope breakage. If the acceleration is continuously increased, the second brake device is actuated to stop the car.

[0045] FIG. 9 is a general flowchart in which the flow to step 54 is the same as that in FIG. 7.

[0046] After the first brake device 11 is actuated in step 54, the car position, speed, and acceleration are monitored (step 55) and, when the car acceleration has exceeded the pre-set numeric value, the car speed is analyzed for a vibration (step 57). If a vibration component equal to or larger than the setting value is detected, the second brake device is actuated. On the other hand, if a vibration component equal to or larger than the setting value is not detected, control is passed to step 60 and, if the car speed has reached the third setting speed, the second brake device is actuated.

Claims

1. An elevator having a first setting speed that is set according to a position of an elevator car (70) moving vertically along a guide rail (75) in a shaft and a second setting speed that is set higher than the first setting speed wherein a first brake device (11) is actuated when a speed of the car (70) becomes higher than the first setting speed and a second brake device (13) is actuated when the speed of the car (70) becomes higher than the second setting speed, **characterised in that** said elevator further having:

a third setting speed that is set higher than the second setting speed; and
a vibration detector (8) that detects a change in the speed of the car (70) when the speed of the car (70) exceeds the first setting speed and said first brake device (11) is actuated wherein
said second brake device (13) is actuated based on the change in the speed of the car (70) and on the second setting speed or the third setting speed.

2. The elevator according to claim 1 wherein said vibration detector (8) extracts a vibration component as the change in the speed of the car (70).

3. The elevator according to claim 1 wherein said second brake device (13) is actuated when the change in the speed of the car (70) is equal to or lower than a threshold and the speed of the car (70) exceeds the second setting speed.

4. The elevator according to claim 1 wherein said vibration detector (8) extracts a vibration component as the change in the speed of the car (70) and said second brake device (13) is actuated when the vibration component exceeds

a threshold and, in addition, the speed of the car (70) exceeds the third setting speed.

- 5 5. The elevator according to claim 1 wherein said vibration detector (8) detects acceleration as the change in the speed of the car (70).
6. The elevator according to claim 1, further having a buffer at a bottom of said shaft wherein the third setting speed is set so that the car (70) can be stopped without hitting the buffer when the speed of the car (70) exceeds the third setting speed and said second brake device (13) is actuated.
- 10 7. The elevator according to claim 1, further having a buffer at a bottom of said shaft wherein the second setting speed is set so that the car (70) can be stopped without hitting the buffer when said first brake device (11) is actuated.
8. The elevator according to claim 1 wherein
15 said vibration detector (8) extracts a vibration component as the change in the speed of the car (70)
said second brake device (13) is actuated when the vibration component is equal to or lower than a threshold and the speed of the car (70) exceeds the second setting speed, and
said second brake device (13) is actuated when the vibration component exceeds the threshold and the speed of the car (70) exceeds the third setting speed.

Patentansprüche

1. Aufzug, bei dem eine erste festgelegte Geschwindigkeit entsprechend einer Position einer Aufzugskabine (70) festgelegt ist, die vertikal entlang einer Führungsschiene (75) in einem Schacht sich bewegt und bei der eine zweite festgelegte Geschwindigkeit auf einen höheren Wert eingestellt ist als die erste festgelegte Geschwindigkeit, wobei eine erste Bremsvorrichtung (11) betätigt wird wenn die Geschwindigkeit der Kabine (70) größer wird als die erste festgelegte Geschwindigkeit und eine zweite Bremsvorrichtung (13) wird betätigt, wenn die Geschwindigkeit der Kabine (70) größer wird als die zweite festgelegte Geschwindigkeit, **dadurch gekennzeichnet, dass** der Aufzug ferner aufweist:
30 eine dritte festgelegte Geschwindigkeit, die höher ist als die zweite festgelegte Geschwindigkeit; und einen Vibrationsdetektor (8), der eine Geschwindigkeitsänderung der Kabine (70) erfasst, wenn die Geschwindigkeit der Kabine (70) die erste festgelegte Geschwindigkeit überschreitet und die erste Bremsvorrichtung (11) betätigt wird, wobei die zweite Bremsvorrichtung (13) betätigt wird auf der Grundlage einer Änderung der Geschwindigkeit der Kabine (70) und auf der Grundlage der zweiten festgelegten Geschwindigkeit oder der dritten festgelegten Geschwindigkeit.
35
2. Aufzug nach Anspruch 1, wobei der Vibrationsdetektor (8) aus einer Vibrationskomponente die Geschwindigkeitsänderung der Kabine (70) extrahiert.
40
3. Aufzug nach Anspruch 1, wobei die zweite Bremsvorrichtung (13) betätigt wird wenn die Geschwindigkeitsänderung der Kabine (70) kleiner oder gleich einem Schwellenwert ist und die Geschwindigkeit der Kabine (70) die zweite festgelegte Geschwindigkeit überschreitet.
- 45 4. Aufzug nach Anspruch 1, wobei der Vibrationsdetektor (8) aus einer Vibrationskomponente die Geschwindigkeitsänderung der Kabine (70) extrahiert und die zweite Bremsvorrichtung (13) betätigt wird wenn die Vibrationskomponente einen Schwellenwert überschreitet und zusätzlich die Geschwindigkeit der Kabine (70) die dritte festgelegte Geschwindigkeit überschreitet.
- 50 5. Aufzug nach Anspruch 1, wobei der Vibrationsdetektor (8) die Beschleunigung als die Geschwindigkeitsänderung der Kabine (70) erfasst.
6. Aufzug nach Anspruch 1, ferner aufweisend einen Puffer am Boden des Schachtes, wobei die dritte festgelegte Geschwindigkeit so festgesetzt ist, dass die Kabine (70) gestoppt werden kann ohne den Puffer zu berühren wenn die Geschwindigkeit der Kabine (70) die dritte festgelegte Geschwindigkeit überschreitet und die zweite Bremsvorrichtung (13) betätigt wird.
55
7. Aufzug nach Anspruch 1, ferner aufweisend einen Puffer am Boden des Schachtes, wobei die zweite festgelegte

Geschwindigkeit so festgesetzt ist, dass die Kabine (70) gestoppt werden kann ohne den Puffer zu berühren, wenn die erste Bremsvorrichtung (11) betätigt wird.

8. Aufzug nach Anspruch 1, wobei der Vibrationsdetektor (8) die Änderung der Geschwindigkeit der Kabine (70) aus einer Vibrationskomponente extrahiert, wobei die zweite Bremsvorrichtung (13) betätigt wird wenn die Vibrationskomponente kleiner oder gleich einem Schwellenwert der Geschwindigkeit der Kabine (70) ist, der die zweite festgelegte Geschwindigkeit übersteigt und wobei die zweite Bremsvorrichtung (13) betätigt wird, wenn die Vibrationskomponente den Schwellenwert überschreitet und die Geschwindigkeit der Kabine (70) die dritte festgelegte Geschwindigkeit überschreitet.

Revendications

1. Ascenseur possédant une première vitesse de réglage qui est réglée selon une position d'une cabine d'ascenseur (70) se déplaçant verticalement le long d'un rail de guidage (75) dans une cage et une seconde vitesse de réglage qui est réglée de manière à être supérieure à la première vitesse de réglage, un premier dispositif de freinage (11) étant actionné quand une vitesse de la cabine (70) devient supérieure à la première vitesse de réglage et un second dispositif de freinage (13) étant actionné quand la vitesse de la cabine (70) devient supérieure à la seconde vitesse de réglage, **caractérisé en ce que** ledit ascenseur possède en outre :

une troisième vitesse de réglage qui est réglée de manière à être supérieure à la seconde vitesse de réglage ; et un détecteur de vibrations (8) qui détecte un changement de vitesse de la cabine (70) quand la vitesse de la cabine (70) dépasse la première vitesse de réglage et que ledit premier dispositif de freinage (11) est actionné, dans lequel

ledit second dispositif de freinage (13) est actionné en fonction du changement de vitesse de la cabine (70) et en fonction de la seconde vitesse de réglage ou de la troisième vitesse de réglage.

2. L'ascenseur selon la revendication 1, dans lequel ledit détecteur de vibrations (8) extrait une composante vibratoire en tant que changement de vitesse de la cabine (70).

3. L'ascenseur selon la revendication 1, dans lequel ledit second dispositif de freinage (13) est actionné quand le changement de vitesse de la cabine (70) est égal ou inférieur à un seuil et que la vitesse de la cabine (70) dépasse la seconde vitesse de réglage.

4. L'ascenseur selon la revendication 1, dans lequel ledit détecteur de vibrations (8) extrait une composante vibratoire en tant que changement de vitesse de la cabine (70) et ledit second dispositif de freinage (13) est actionné quand la composante vibratoire dépasse un seuil et que, en plus, la vitesse de la cabine (70) dépasse la troisième vitesse de réglage.

5. L'ascenseur selon la revendication 1, dans lequel ledit détecteur de vibrations (8) détecte l'accélération en tant que changement de vitesse de la cabine (70).

6. L'ascenseur selon la revendication 1, possédant en outre un amortisseur au niveau de la partie inférieure de ladite cage, la troisième vitesse de réglage étant réglée de manière à ce que la cabine (70) puisse être arrêtée sans heurter l'amortisseur quand la vitesse de la cabine (70) dépasse la troisième vitesse de réglage et que ledit second dispositif de freinage (13) est actionné.

7. L'ascenseur selon la revendication 1, possédant en outre un amortisseur au niveau de la partie inférieure de ladite cage, la seconde vitesse de réglage étant réglée de manière à ce que la cabine (70) puisse être arrêtée sans heurter l'amortisseur quand ledit premier dispositif de freinage (11) est actionné.

8. L'ascenseur selon la revendication 1, dans lequel ledit détecteur de vibrations (8) extrait une composante vibratoire comme changement de vitesse de la cabine (70), ledit second dispositif de freinage (13) est actionné quand la composante vibratoire est égale ou inférieure à un seuil et que la vitesse de la cabine (70) dépasse la seconde vitesse de réglage, et ledit second dispositif de freinage (13) est actionné quand la composante vibratoire dépasse le seuil et que la vitesse de la cabine (70) dépasse la troisième vitesse de réglage.

FIG.1A

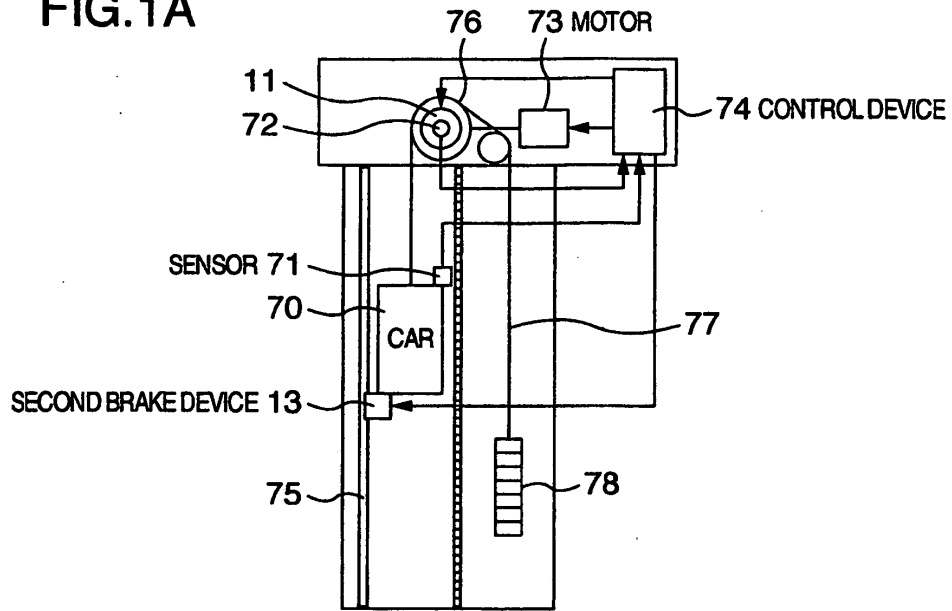


FIG.1B

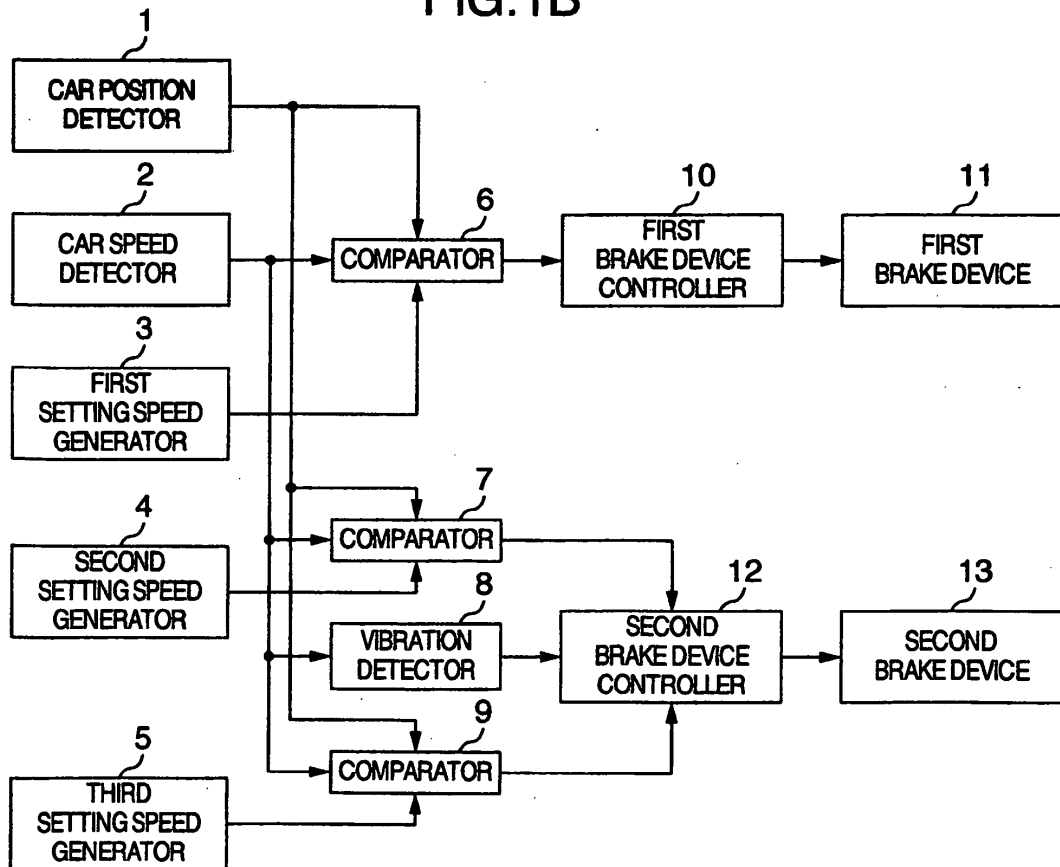


FIG.2

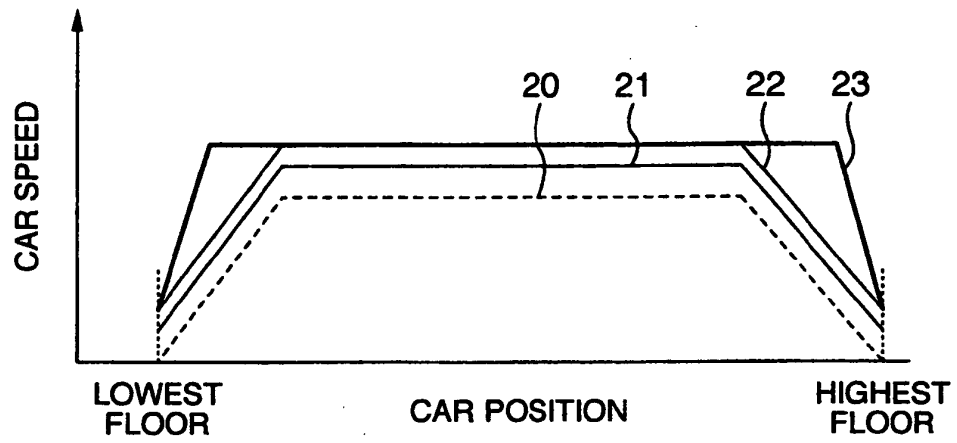


FIG.3A

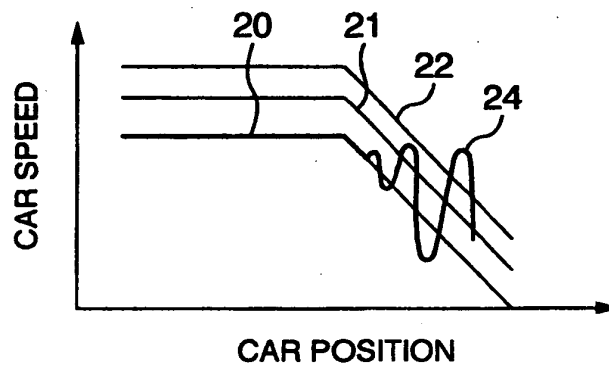


FIG.3B

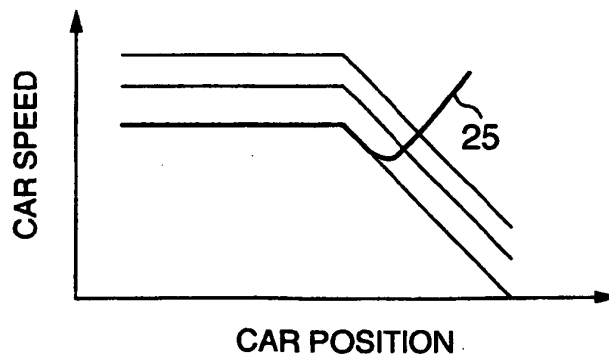


FIG.4

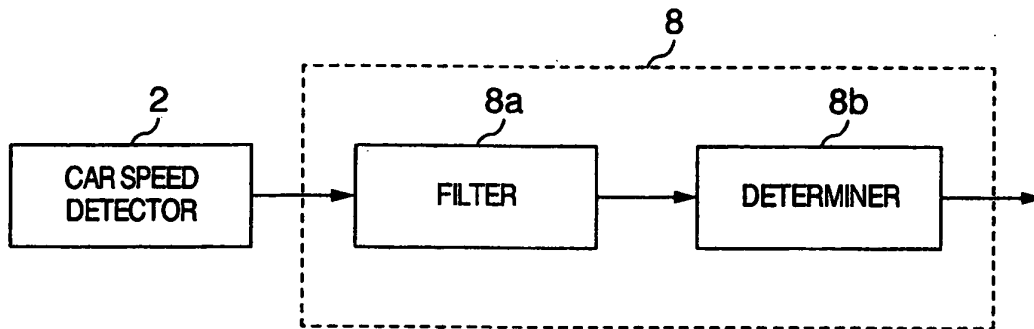


FIG.5

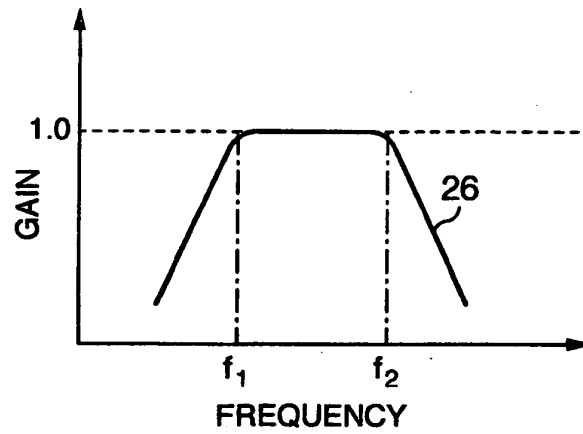


FIG.6A

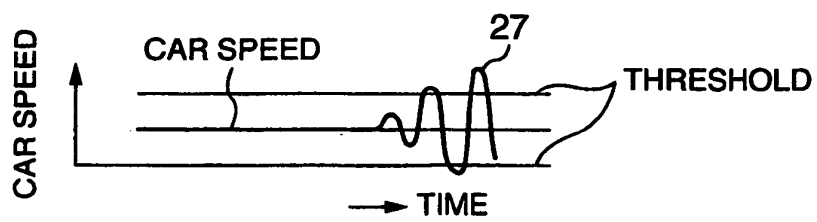


FIG.6B

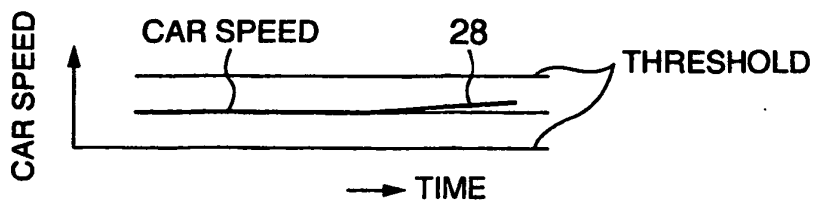


FIG.7

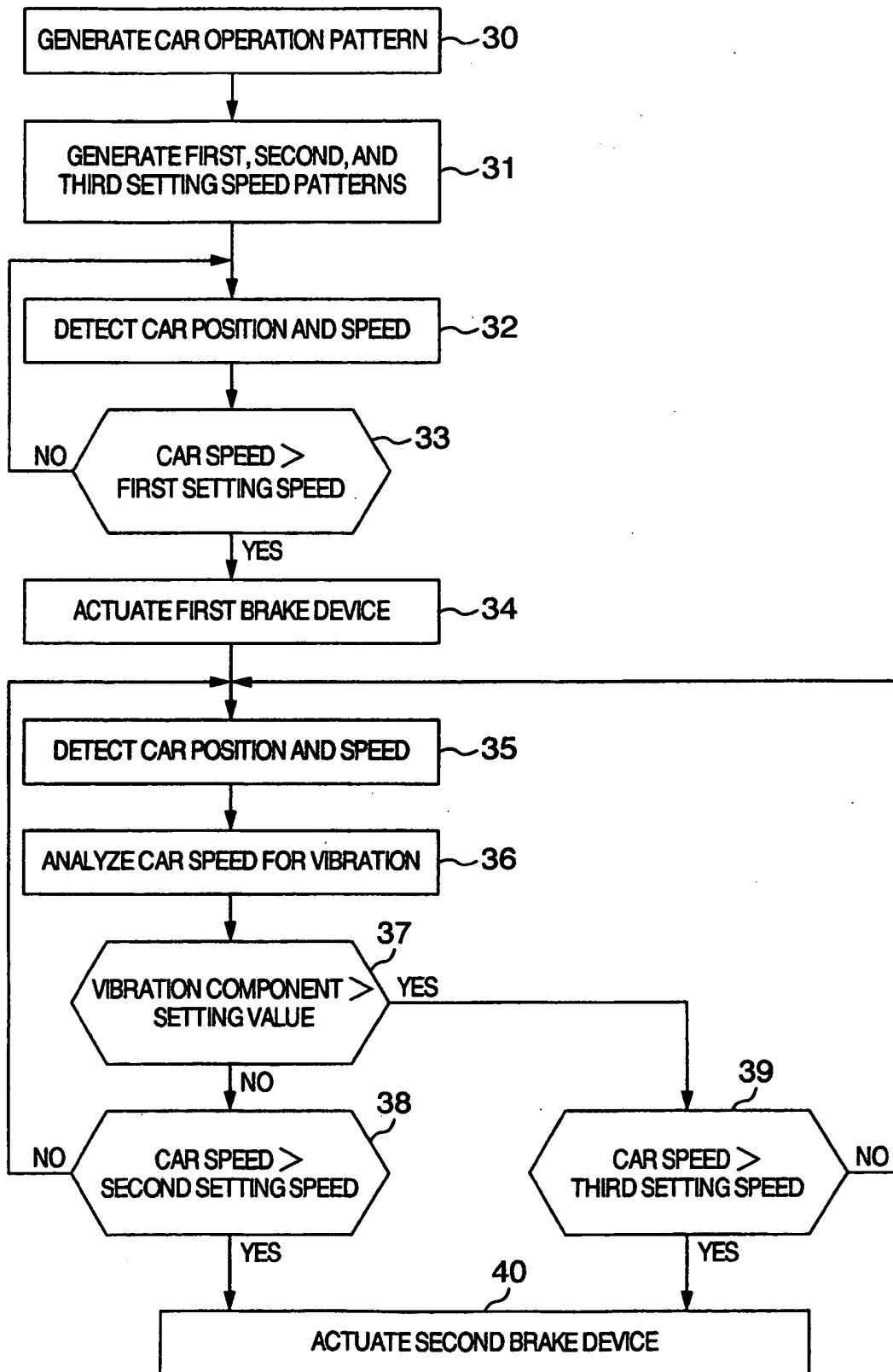


FIG.8

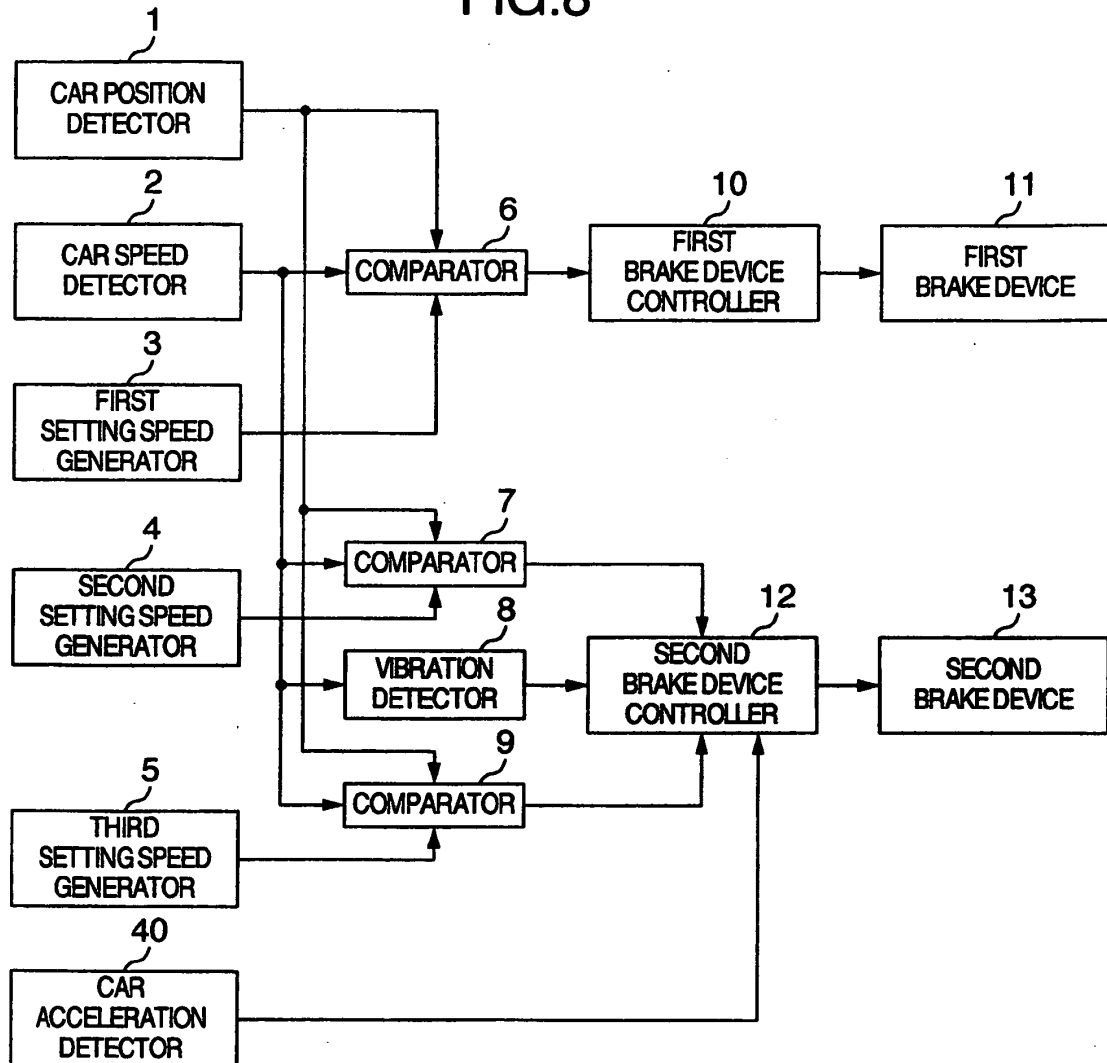
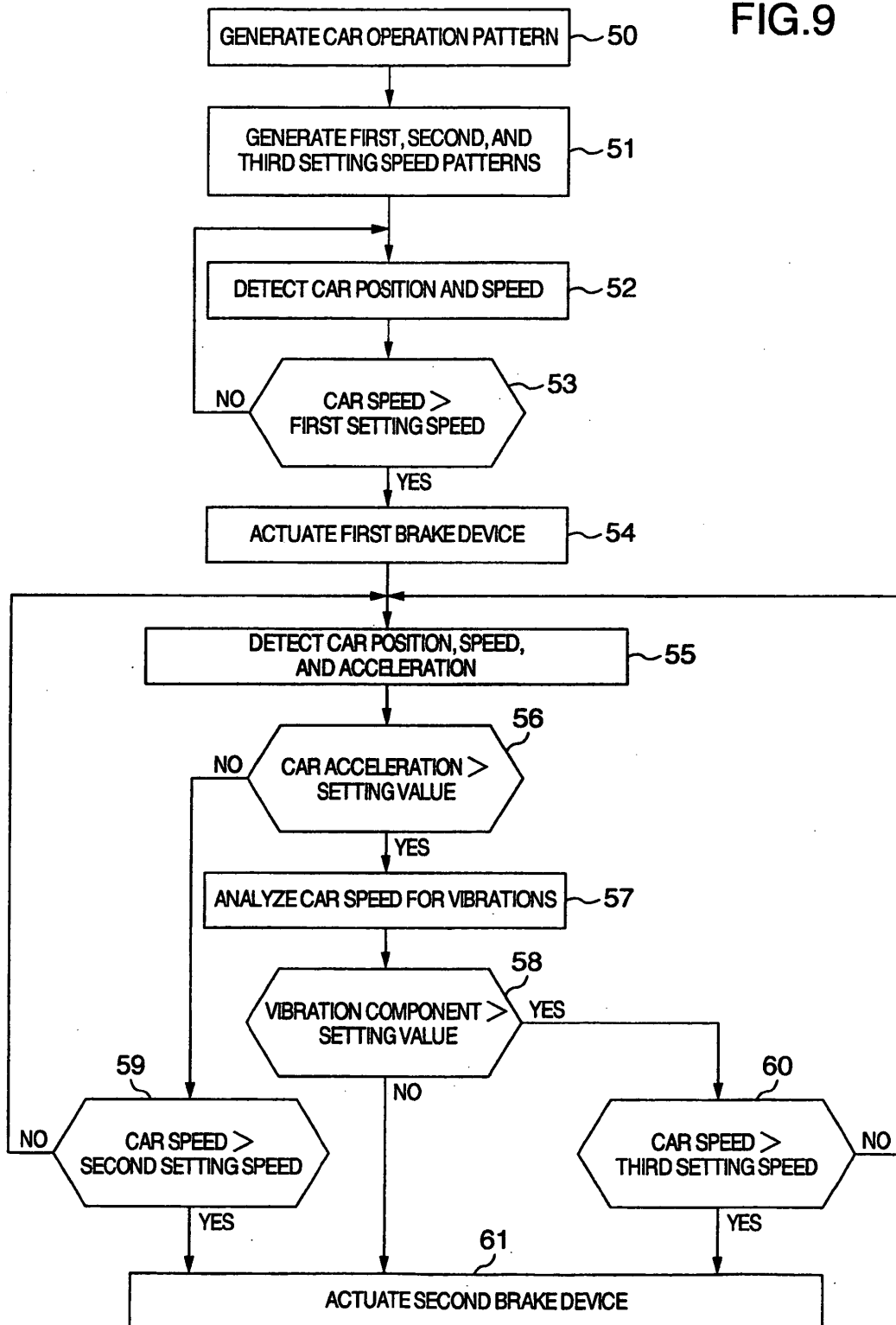


FIG.9



REFERENCES CITED IN THE DESCRIPTION

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