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(54) **Method and system for automatically adjusting the stopping position of an elevator car**

Automatisches Einstellverfahren und -system für Haltestellung einer Aufzugskabine

Méthode et système pour ajuster automatiquement la position d'arrêt d'une cabine d'ascenseur

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(56) References cited:
EP-A- 0 382 933
GB-A- 2 061 559
US-A- 4 256 203

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Description

[0001] The present invention concerns a system for automatically adjusting the stopping position opposite the hall doors.

[0002] Currently, the information which defines the stopping height at the level of the hall door is obtained from the coinciding of magnetic sensors mounted on the elevator car and magnets fixed in the hoistway at each landing. Such an assembly is known in the field as a position reference system PRS. The information gathered by the magnetic sensors is transmitted to the control logic with which the elevator installation is provided, which, in turn, provides stopping commands to the elevator car drive means.

[0003] Such a PRS is shown in the attached Figure 1. This Figure shows an elevator car 10 mounted in a hoistway 12 located at the level of a hall door 16. The hoistway is provided with a magnet 18, while the car has two magnetic sensors 20, 22 fixed at two different levels on a vertical strut 24. The upper sensor 20 provides level information during descent and the lower sensor 22 provides level information on ascending.

[0004] The PRS may be used in hydraulic elevators and also in electric elevators of the type comprising a two speed reduction motor having two separate rotors, one for moving the car at high speed and the other for moving at low speed before stopping. The PRS should allow the car to stop at all landings opposite the hall doors such that the gap between the threshold of the car and that of the landing is as small as possible, preferably zero.

[0005] During assembly, the magnetic sensors and the magnet are positioned with the theoretical assembly dimensions. These are calculated as a function of the nominal speed of movement of the car, the response time of the control logic, the parameters of detection of the magnets by the magnetic sensors and the theoretical regulation of the brake of the reduction motor.

[0006] Nevertheless, it has been seen that the theoretical values of assembly almost never correspond to reality, for the following reasons:

- the control of the brake of the reduction motor is not precise and is reset for each installation as a function of the desired comfort;
- the magnetic sensors detecting the magnets have different positions of the function of the distance between them and it is very difficult to keep this value constant at all levels;
- observance of the theoretical dimensions is difficult to realise to the millimetre;
- the actual speed of movement of the car does not correspond exactly to the nominal value.

[0007] It is as a function of these parameters that the magnetic sensors provide the stopping information to the control logic which transmits the signals as stopping commands, leading to the motor power supply being cut off and the release of the brake shoes for electric elevators or the closing of the gates for hydraulic elevators. For this reason, if no precaution is taken, the precision of stopping obtained with such an SPR is poor. Currently, on stopping, the threshold of the elevator is out of line with the landing by several centimetres.

[0008] To reduce this discrepancy, it is necessary to carry out a manual control at each level around the theoretical value of the position of the magnetic sensors, in both displacement directions. However, these adjustments take much time because they require measurements of the stopping precision at each level in both directions of displacement, climbing on the roof of the car to displace the magnets in the correct direction, verifying the results and repeating if necessary. The time taken to carry out these adjustments is estimated at ten minutes per landing.

[0009] The solution which is currently used to resolve this problem consists in replacing the PRS by an apparatus capable of providing information on the actual height of the car continuously. One can thus determine the exact height of the stopping commands and activate the stopping commands by a program, however the disadvantage of this solution is that the apparatuses capable of giving an absolute position (telemetry laser, steel sensor, tape encoder etc.) are very bulky and are not, therefore, suitable for standard two speed or hydraulic elevators, even if they save time during maintenance.

[0010] The present invention seeks to remedy these disadvantages by proposing an elevator car stopping position adjusting system which no longer requires manual adjustment of the magnet.

[0011] Another object of the invention is to provide a adjusting system of this type which allows a precise stopping position to be obtained.

[0012] These objects are achieved thanks to the adjusting system according to the invention which comprises:

[0013] A system for automatically adjusting the stopping position of an elevator car, comprising:

- two magnetic sensors fixed on the car, one above the other, to respectively provide stopping information on descent and stopping information on ascent,
- a magnet fixed in the hoistway,
- and a stopping command logic which receives the stopping information from said sensors and provides a stopping command to the car drive means, characterised in that said system further comprises:
- speed measuring means to measure the speed of displacement of the car before each stop at different levels,
- a microprocessor in which are stored in memory all of the values of the stopping precision (P_A) measured empirically at each level, in both directions of displacement of the car,
- a stopping management program adapted to calcu-

late a delay T using the formula $T = P_A/v$ in which P_A is the stopping precision at a level and in a given direction of displacement, whose value is stored in the microprocessor memory, and v is the actual speed of the elevator car measured by the speed measuring means at said level and in said direction of displacement,
- and a delay module which includes said delay in the stopping information provided by the corresponding magnetic sensor, such that the stopping of the car will be delayed by said delay to occur at a time when the stopping precision is substantially zero.

[0014] The invention also concerns a method of adjusting the stopping position of an elevator car, characterised in that it comprises:

a) integrating in the control logic of the elevator a microprocessor in which are stored the stopping precision values (P_A) for all levels and in both directions of displacement of the car,
b) installing the magnetic sensors on the car and the magnet in the hoistway,
c) mounting on the cabin and in the hoistway a speed measuring means which measures the speed of the car at an instant when it is constant before the car stops at a landing,
d) calculating the delay $T = P_A/v$ from the value of the stopping precision P_A for the level and the direction of displacement under consideration, stored in the memory of said microprocessor and the actual speed v before arrival at said level,
e) including this delay in the stopping information that the sensors provide to the control logic, such that stopping is delayed by said delay and occurs at a time when a stopping precision is substantially zero.

[0015] Thanks to the invention, considerable time is saved on site when installing the elevator, since it avoids climbing on the roof of the elevator and controlling the height of the magnets by trial and error. It is estimated that the saving in time is 8 minutes per level.

[0016] Another advantage of the invention lies in the fact that the sensors and the magnets can be positioned in a very approximate manner then errors can be corrected easily. The supports of the sensors and the magnets can moreover be simplified by eliminating their adjustment possibility.

[0017] The saving in time thus realised is 5 more minutes per level.

[0018] The adjusting apparatus according to the invention can be realised at low cost, integrating the microprocessor in the control logic with which all elevator installations are normally provided and using, as an apparatus for measuring speed, the optical fork speed detector which is the subject of French Patent Application No. 95 08428, filed in the name of the present applicants.

[0019] The present invention will be better understood from reading the following description of one way of carrying out the invention, given by way of example only, with reference to the accompanying drawings in which:

Fig. 1 schematically shows an elevator provided with magnetic sensors and magnets, as known in the art;

Fig. 2 is a schematic view of an elevator equipped with the same sensors and magnets and also an optical fork speed measuring system and a stopping position adjusting system according to the present invention; and

Fig. 3 is a flow chart showing the operation of the adjustment system according to the invention.

[0020] Fig. 1 having already been described, we will pass directly to the description of Figure 2. This Figure again shows the elevator car 10, the magnet 18 fixed thereon and the magnetic sensors 20, 22 fixed on the elevator car.

[0021] At the instant when the magnetic sensors 20, 22 meet a magnet 18, they emit logic signals which are transmitted via conductors, such as 24, to a stopping command unit which, preferably, may be integrated in the control logic 26, with which the elevator installation is normally provided. The control logic 26 comprises an input 28 which receives from the magnetic sensors 20, 22, information about their meeting with the magnets 18 and an output 30 at which a stopping command is provided and sent to the elevator drive means.

[0022] According to the invention, the elevator is also equipped with an apparatus for measuring the speed of displacement of car, for example an optical fork apparatus which is well known in the field. As is known, such a system comprises an optical fork 32 comprising two crossed arms housing respectively an infra-red emitter and an infra-red receiver, the fork being fixed to the elevator car 10 such that the arms are in a horizontal plane and the infra-red beam 34 horizontally traverses the space between the arms.

[0023] The speed measuring apparatus also comprises a number of flags 36, 38 comprising plates which are opaque to infra-red radiation, the flags being fixed vertically in the hoistway at heights where it is desired to measure the speed of displacement of the car, being disposed in a manner such that they cut the infra-red beam 34 each time the optical fork passes their level. In Figure 2, only two flags associated with the level are shown. The upper flag 36 serves to measure the speed during descent, while the lower flag 38 serves to measure the speed during ascent.

[0024] The infra-red receiver emits signals having a first logic state when the infra-red beam passes and a second logic state when the beam is cut. The signals are transmitted by a conductor 40 to a calculation unit 42 which, preferably, can be integrated in the control logic 26.

[0025] From these signals, the calculation unit calculates the period Δt of interruption of the infra-red beam by a flag, then the speed of displacement v of the car using the formula $v = h/\Delta t$, h being the height of the flag which has cut the beam.

[0026] The adjustment system according to the invention comprises a microprocessor 44 which stores in memory, all of the values of the stopping precision at the different levels where stopping is effected, in the two directions of displacement, and with an equilibrium load on board the elevator (about 45% of the nominal load). These values have been previously measured during installation.

[0027] The adjustment system also comprises a stopping management program 46 arranged to calculate a delay T using the formula $T = P_A/v$ in which:

P_A is the value of the stopping precision stored in the microprocessor 44 and corresponds to the level where stopping will be effected with the equilibrium load and for a displacement of the cabin in the direction of displacement under consideration,

and v is the speed of displacement of the car, measured just before stopping. It is important to use the actual speed as, if the nominal speed given by the constructor is used, the precision is worsened while the delay is increased.

[0028] If the elevator has a tendency to want to stop before the landing, the delay T is added to that which separates the stopping information and the stopping command, such that the stopping command is delayed and the final height of stopping is adjusted.

[0029] If, on the other hand, the elevator has a tendency to want to stop after the landing, one cannot anticipate the stop as it is not possible to add a negative delay. To remedy this, it is sufficient to position the sensors and the magnet in a manner such that the stopping information will always be given well before the stopping command such that one may always integrate a minimum delay.

[0030] It should be noted that the system according to the invention does not allow the variation in the stopping position to be corrected as a function of the load. The correction of the stopping position which is obtained is only valid for the same load condition in which the values stored in the microprocessor were measured. In other load cases, the system will correct the stopping height as if the load was nominal and it will then be necessary to carry out an adjustment of the stopping position as a function of the load in the car. This adjustment will be made as for the manual adjustment of the magnets.

[0031] The set of operations carried out by the control logic 26 is summarised by the flow diagram of Figure 3.

[0032] At stage 50, the magnetic sensors detect if the elevator car has arrived at a stopping level and if the speed has become equal to the minimum speed before stopping. If this is not the case, the program is not initialised. If YES, at stage 52, the calculating unit 42 calculates the period Δt and the actual speed of the displacement of the car.

[0033] Once the speed is calculated, the system can, at that stage 54, look up the correction stopping precision value for the landing and the direction of displacement under consideration from the data stored in the microprocessor 54. This value of stopping precision and the speed previously registered in the preceding stage are put into the equation $T = P_A/v$, and this formula is then executed. This result is stored in memory and its value is input into a delay module 48 placed between the stopping information given by the sensors 20, 22 and the stopping command.

[0034] At stage 56, the system checks if the detection of the stopping information has taken place. If this is the case, the delay module is initiated in stage 58.

[0035] At stage 60, the system checks if the delay is completed. If YES, the stopping information is transferred to the stopping management program at stage 62.

[0036] The applicant has tested the system according to the present invention and, in order to do that, the magnets were placed to give the stopping heights well before the assumed landings (about 100 mm minimum) and at different values for each level. For a car with the equilibrium load, the correction carried out by the system restored the stopping precision to a value less than 2 mm. In varying the load a variation of the stopping precision identical to the measured value before installation of the system was recorded, i.e. the system has no influence on the stopping precision in the case of a loaded car.

Claims

1. A system for automatically adjusting the stopping position of an elevator car, comprising:

   - two magnetic sensors (20, 22) fixed on the car (10), one above the other, to respectively provide stopping information on descent and stopping information on ascent,
   - a magnet (18) fixed in the hoistway (12),
   - and a stopping command logic (26) which receives the stopping information from said sensors and provides a stopping command to the car drive means, characterised in that said system further comprises:

     - speed measuring means (32, 36, 38) to measure the speed of displacement of the car before each stop at different levels,

- a microprocessor (44) in which are stored in memory all of the values of the stopping precision (P_A) measured empirically at each level, in both directions of displacement of the car,
- a stopping management program (46) adapted to calculate a delay T using the formula $T = P_A/v$ in which P_A is the stopping precision at a level and in a given direction of displacement, whose value is stored in the microprocessor memory, and v is the actual speed of the elevator car measured by the speed measuring means at said level and in said direction of displacement,
- and a delay module (48) which includes said delay in the stopping information provided by the corresponding magnetic sensor, such that the stopping of the car will be delayed by said delay to occur at a time when the stopping precision is substantially zero.

2. A system according to claim 1, characterised in that said speed measuring apparatus comprises an optical fork (32) fixed on the car (10) and a plurality of flags (36, 38) fixed in the hoistway (12).

3. A method of automatically controlling the stopping position of an elevator car using the system of claims 1 or 2, characterised in that it comprises:

a) integrating in the control logic (26) of the elevator a microprocessor (44) in which are stored the stopping precision values (P_A) for all levels and in both directions of displacement of the car,
b) installing the magnetic sensors (20, 22) on the car and the magnet (18) in the hoistway,
c) mounting on the cabin and in the hoistway a speed measuring means (32, 36, 38) which measures the speed of the car at an instant when it is constant before the car stops at a landing,
d) calculating the delay $T = P_A/v$ from the value of the stopping precision P_A for the level and the direction of displacement under consideration, stored in the memory of said microprocessor and the actual speed v before arrival at said level,
e) including this delay in the stopping information that the sensors provide to the control logic, such that stopping is delayed by said delay and occurs at a time when a stopping precision is substantially zero.

Patentansprüche

1. System zum automatischen Einstellen der Stopp-Position einer Aufzugkabine, das folgendes aufweist:

- zwei Magnetsensoren (20, 22), die einer über dem anderen an der Kabine (10) befestigt sind, um jeweils Stopp-Information bei der Abwährtsfahrt und Stopp-Information bei der Aufwärtsfahrt zu liefern,
- einen in dem Aufzugschacht (12) angebrachten Magneten (18),
- und eine Stopp-Befehlslogik (26), die die Stopp-Information von den Sensoren erhält und einen Stopp-Befehl an die Kabinen-Antriebseinrichtung liefert,

dadurch gekennzeichnet, daß das System ferner folgendes aufweist:

- eine Geschwindigkeitsmeßeinrichtung (32, 36, 38) zum Messen der Verlagerungsgeschwindigkeit der Kabine vor jedem Stopp auf verschiedenen Niveaus,
- einen Mikroprozessor (44), in dem alle der auf jedem Niveau empirisch und in beiden Verlagerungsrichtungen der Kabine gemessenen Stoppgenauigkeitswerte (P_A) in einem Speicher gespeichert sind,
- ein Stopp-Management-Programm (46), das dazu ausgelegt ist, eine Verzögerung T unter Verwendung der Formel $T = P_A/v$ zu berechnen, wobei P_A die Stoppgenauigkeit auf einem Niveau und in einer bestimmten Verlagerungsrichtung ist, deren Wert in dem Mikroprozessor-Speicher gespeichert ist, und wobei v die tatsächliche Geschwindigkeit der Aufzugkabine ist, wie diese von der Geschwindigkeitsmeßeinrichtung auf dem jeweiligen Niveau und in der jeweiligen Verlagerungsrichtung gemessen wird,
- und einen Verzögerungsmodul (48), der die Verzögerung in die von dem entsprechenden Magnetsensor gelieferten Stopp-Information einbezieht, so daß das Stoppen der Kabine um die Verzögerung verzögert wird und somit zu einem Zeitpunkt stattfindet, zu dem die Stoppgenauigkeit im wesentlichen Null ist.

2. System nach Anspruch 1,
dadurch gekennzeichnet, daß die Geschwindigkeitsmeßeinrichtung eine an der Kabine (10) angebrachte optische Gabel (32) sowie eine Mehrzahl von in dem Aufzugschacht (12) angebrachten Flags (36, 38) aufweist.

3. Verfahren zum automatischen Steuern der Stopp-

Position einer Aufzugkabine unter Verwendung des Systems nach Anspruch 1 oder 2,
dadurch gekennzeichnet, daß das Verfahren folgende Schritte aufweist:

a) Integrieren eines Mikroprozessors (44) in der Steuerlogik (26) des Aufzugs, in dem die Stoppgenauigkeitswerte (P_A) für alle Niveaus und beide Verlagerungsrichtungen der Kabine gespeichert sind,
b) Installieren der Magnetsensoren (20, 22) an der Kabine und des Magneten (18) in dem Aufzugschacht,
c) an der Kabine und in dem Aufzugschacht erfolgende Anbringung einer Geschwindigkeitsmeßeinrichtung (32, 36, 38), die die Geschwindigkeit der Kabine in einem Moment mißt, wenn diese konstant ist, bevor die Kabine auf einem Stockwerk stoppt,
d) Berechnen der Verzögerung $T = P_A/V$ anhand des Stoppgenauigkeitswertes P_A für das betreffende Niveau und die betreffende Verlagerungsrichtung, die in dem Speicher des Mikroprozessors gespeichert sind, sowie anhand der tatsächlichen Geschwindigkeit v vor Ankunft auf dem Niveau,
e) Einbeziehen dieser Verzögerung in die Stopp-Information, die die Sensoren an die Steuerlogik liefern, so daß das Stoppen um die Verzögerung verzögert wird und zu einem Zeitpunkt stattfindet, zu dem eine Stoppgenauigkeit im wesentlichen Null ist.

Revendications

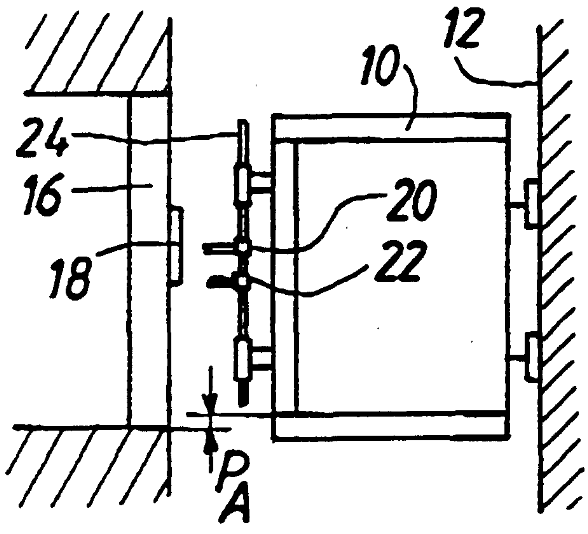
1. Système pour ajuster automatiquement la position d'arrêt d'une cabine d'ascenseur, comprenant :

- deux capteurs magnétiques (20, 22) fixés sur la cabine (10), l'un au-dessus de l'autre, pour fournir respectivement des informations d'arrêt en descente et des informations d'arrêt en montée,
- un aimant (18) fixé dans la cage (12),
- et une logique de commande d'arrêt (26) qui reçoit les informations d'arrêt provenant desdits capteurs et fournit une commande d'arrêt aux moyens d'entraînement de la cabine, caractérisé en ce que ledit système comprend en outre :
- des moyens de mesure de la vitesse (32, 36, 38) pour mesurer la vitesse de déplacement de la cabine avant chaque arrêt à des niveaux différents,
- un microprocesseur (44) dans lequel sont stockées en mémoire toutes les valeurs de la précision d'arrêt (P_A) mesurées par voie empirique à chaque niveau, dans les deux sens de déplacement de la cabine,
- un programme de gestion de l'arrêt (46) conçu pour calculer un délai T à l'aide de la formule $T = P_A/v$, dans laquelle P_A est la précision d'arrêt à un niveau et dans un sens de déplacement donné, dont la valeur est stockée dans la mémoire du microprocesseur, et v est la vitesse effective de la cabine d'ascenseur mesurée par les moyens de mesure de la vitesse audit niveau et dans ledit sens de déplacement,
- et un module de délai (48) qui incorpore ledit délai dans lesdites informations d'arrêt fournies par le capteur magnétique correspondant, de façon à ce que l'arrêt de la cabine soit retardé dudit délai pour se produire à un instant auquel la précision d'arrêt est essentiellement nulle.

2. Système selon la revendication 1, caractérisé en ce que lesdits moyens de mesure de la vitesse comprennent une fourche optique (32) fixée sur la cabine (10) et une pluralité de repères (36, 38) fixés dans la cage.

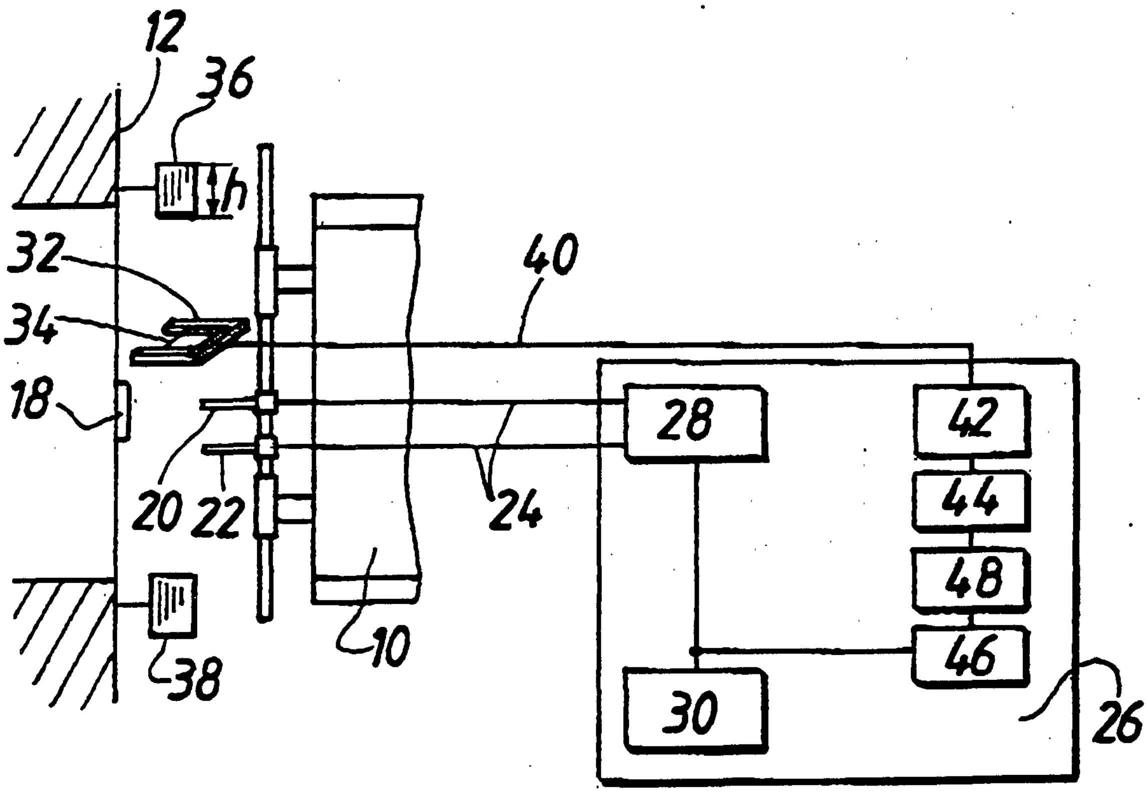
3. Méthode de commande automatique de la position d'arrêt d'une cabine d'ascenseur utilisant le système selon les revendications 1 ou 2, caractérisée en ce qu'elle comprend :

a) l'intégration, dans la logique de commande (26) de l'ascenseur, d'un microprocesseur (44) dans lequel sont stockées les valeurs de précision d'arrêt (P_A) pour tous les niveaux et dans les deux sens de déplacement de la cabine,
b) l'installation des capteurs magnétiques (20, 22) sur la cabine et de l'aimant (18) dans la cage,
c) le montage sur la cabine et dans la cage de moyens de mesure de la vitesse (32, 36, 38) mesurant la vitesse de la cabine à un instant auquel elle est constante avant que la cabine ne s'arrête à un palier,
d) le calcul du délai $T = P_A/v$ à partir de la valeur de précision d'arrêt P_A pour le niveau et le sens de déplacement considérés, stockée dans la mémoire dudit microprocesseur et de la vitesse effective v avant l'arrivée audit niveau,
e) l'incorporation de ce délai dans les informations d'arrêt fournies par les capteurs à la logique de commande, de façon à ce que l'arrêt soit retardé dudit délai pour se produire à un instant auquel la précision d'arrêt est essentiellement nulle.



12
10
24
16
20
18
22
P
A

FIG.1



12
36
h
32
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44
20
22
24
48
46
10
38
30
26

FIG.2

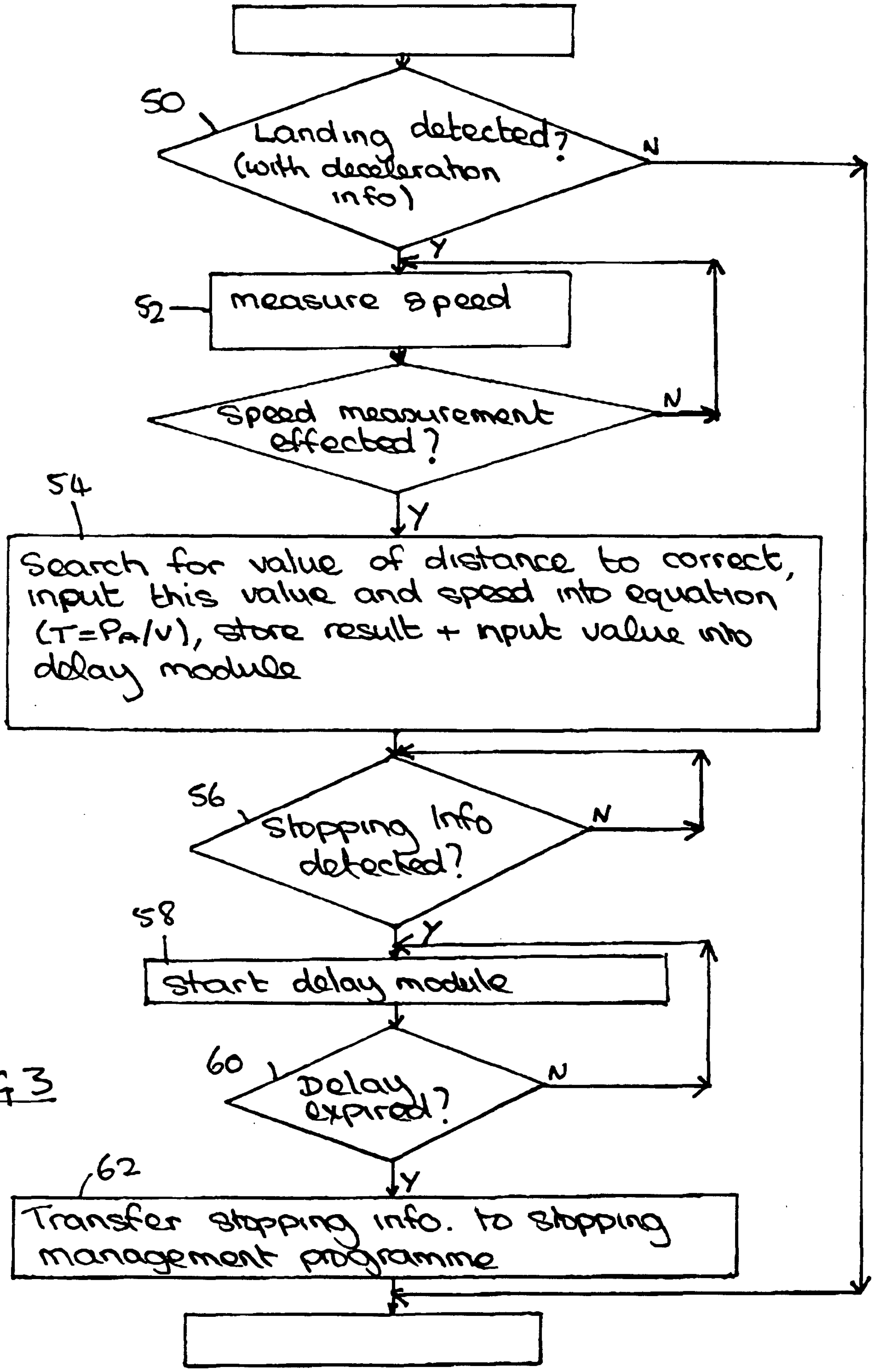
50
Landing detected? (with deceleration info)
N
Y
52
measure speed
speed measurement effected?
N
Y
54
Search for value of distance to correct, input this value and speed into equation (T=PA/V), store result + input value into delay module
56
Stopping Info detected?
N
Y
58
start delay module
60
Delay expired?
N
Y
62
Transfer stopping info. to stopping management programme

FIG 3