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(54) METHOD FOR CONTROLLING AN ELEVATOR SYSTEM

VERFAHREN ZUR STEUERUNG EINES AUFZUGSSYSTEMS

METHODE POUR COMMANDER UN SYSTEME D'ASCENSEUR

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to control of an elevator group.

BACKGROUND OF THE INVENTION

[0002] An elevator system can be controlled by two different principal methods, of which the more traditional and more widely used method is up-down call buttons at the elevator landing floors and a car call panel inside the elevator car. This traditional call system requires that the elevator passenger give two successive calls: a landing call (ordering an elevator to the particular departure floor) and a car call (indicating the target floor to the elevator system). In this call system, the elevator to serve the call can be announced either immediately after the elevator control system has allocated the call (decided which elevator is to serve the call), or e.g. only after an arriving elevator starts braking to stop at the departure floor of the person having issued the call.

[0003] The other call system is so-called destination control, in which the elevator customer gives only one call. The call is given like a car call at the elevator landing floor by inputting destination floor information via a floor button panel or e.g. using a numeric keypad. In the destination call system, the allocation of elevators can be accomplished in a more sensible way because the system learns the information relating to each passenger (departure floor and destination floor) at an earlier stage and the passengers' destination floors can already be taken into account when a suitable elevator is being allocated. In the case of large elevator systems and large numbers of passengers, it is thus possible e.g. to assign the same elevator to customers traveling to the same floor.

[0004] One of the functions of the elevator system is to allocate elevators to calls in such a way that a desired cost function can be minimized. The cost function may comprise summed passenger waiting times, traveling times, electric energy consumption of the system, numbers of times the elevator car has stopped at different floors, or the aforesaid or other desired quantities may be weighted with desired weighting coefficients.

[0005] An effectively working elevator control algorithm required in large buildings is a very complicated optimization process. For example, the traditional collective control works in such manner that a given landing call is allocated to an elevator that is traveling towards the floor from which the landing call was input and is located closest to the call input floor. On the other hand, this leads to an accumulation of elevators with several elevators moving in the same direction as a front. As a further consequence of this, the overall performance of the elevator system deteriorates.

[0006] In prior art, the most optimal elevator is found e.g. by the ESP method (Enhanced Spacing Principle). In ESP, the issued calls are observed and the passenger waiting times are optimized. The number of passengers associated with each landing call and waiting on the floor in question is estimated as far as possible on the basis of statistical data. Those landing calls that the system assumes to be associated with the largest number of elevator customers are served fastest.

[0007] Another method for allocating elevators on the basis of calls is to use genetic algorithms, especially in large elevator systems. Genetic algorithms are described e.g. in patent specification FI112856B. Genetic algorithms do not guarantee that the absolutely most optimal value is found, but the results obtained in practical applications are quite close to it. In genetic algorithms the routes of the elevators in the system can be encoded in different chromosomes, in which one gene defines an elevator customer and the elevator to serve him/her. The system starts the process e.g. from a randomly selected route alternative and applies to it various genetic procedures, such as proliferation, crossbreeding and mutation. One generation at a time, a number of new chromosomes are generated via these genetic procedures and at the same time the chromosomes thus obtained are examined to determine whether they are viable for further processing. Viability may mean e.g. that the waiting time falls below a given value. Crossbreeding means that two route alternatives are combined at random to create one new route alternative. In mutation, the values of the genes of the chromosome are changed arbitrarily. The chromosome results given by the algorithm converge at some stage, and from the last processed set of chromosomes the one having the best viability is selected. The passengers are allocated to elevators according to the genes of the best chromosome.

[0008] In connection with the present invention, the starting point is optimization of total journey time. In prior art, an allocation principle is described in patent specification FI82917C. According to this method, the sum of so-called internal an external service costs is calculated. Internal service costs here refer to the waste time spent by passengers in the elevator car due to intermediate stops, and external service costs refer to the waiting time spent by passengers in an elevator lobby. Patent specification FI82917C mentions a cost function K:

$$K = t_v(P_m + k_1 \cdot R_E - k_2 \cdot R_C) + k_1[m \cdot t_m + t_v(R_E + R_C - R_{EC} + Z)], \qquad (1)$$

where t_v is delay time during an intermediate stop, P_m is instantaneous load at the instant of calculation, R_E is the number of intermediate floor calls issued between the floor of current location of the elevator and the floor where the customer is to be picked up, R_c is the number of car calls given between the floor of current location of the elevator and the floor where the customer is to be picked up, k_1 is the number of passengers entering the elevator for one landing call as estimated on the basis of the prevailing traffic situation, k_2 is the number of passengers leaving the elevator for one car call as estimated on the basis of the prevailing traffic situation, m is the number of floor-to-floor intervals between the floor of current location of the elevator and the floor where the customer is to be picked up, t_m is average journey time for one floor-to-floor interval, R_{EC} is the number of coincident car calls and landing calls between the floor of current location of the elevator and the floor where the customer is to be picked up, Z is a additional factor depending on the operational condition of the elevator car, and where the first term of the sum represents internal service costs and the second term represents external service costs. Thus, the cost function optimizes the waiting time, which is obtained as the sum of the waiting time spent in the lobby and the waste time spent in the elevator car due to stops. Coincident calls (which here means that an active landing call addressed to the elevator is simultaneously a destination floor given as an active car call) are taken into account in the method.

[0009] Patent specification US4991694 deals with immediate allocation of destination calls. This specification defines the cost function K as follows:

$$K = K_{rs} + K_{rz} + K_{ps} + K_{pz} + K_{ws} + K_{wz}, \qquad (2)$$

where K_{rs} is the waiting time of new passengers at the call input floor, K_{rz} is the traveling time of new passengers, K_{ps} is the length of the waste time spent by car passengers due to an intermediate stop caused by a landing call, K_{pz} is the length of the waste time spent by car passengers due to an intermediate stop caused by a car call, K_{ws} is the waiting time of all passengers entering the elevator between the call input floor and the destination floor, and K_{wz} is the waiting time of all passengers entering the elevator after arrival at a floor requested by an active destination floor call. In this method, the costs are optimized on the basis of passenger waiting times. As stated above, waiting time is accumulated from waiting in the elevator lobby and from intermediate stops due to landing calls and car calls.

[0010] The indexing used in patent specifications FI82917C and US4991694 is a call-based arrangement, i.e. all calculation in the algorithm is performed on the basis of calls. This produces inaccurate results because it is possible that two or more passengers arrive in an elevator lobby at the same time but only one of them gives a landing call (up or down call) to the elevator system. In such a case the system assumes that only one passenger is arriving to the elevator and selects a suitable elevator accordingly. If the system knew that, for example, three passengers arrive to the elevator on a given floor, then, depending on whether the passengers are going to the same destination floor or whether they are all going to different floors, this would have an effect on the cost function and at the same time the allocation result would probably be different in these two example cases.

[0011] The US 2002/0112922 discloses a method for assigning hall calls in an elevator group. A call cost value for a hall call is calculated as a function of the estimated time to the desired destination of the passenger requesting the new hall call an of the delay that other passengers who are using the elevator car will experience. This method provides the option of using destination call allocation.

[0012] The WO 2004/031062 discloses a method for allocating calls in an elevator group. This document discloses the possibility of optimising the waiting time for the passengers in low traffic intensity conditions while in a more intensive traffic situation the travelling time for the passengers is optimised.

[0013] The problem with prior-art solutions is the limited flexibility of the elevator control system to cope with different needs based on different traffic conditions.

OBJECT OF THE INVENTION

[0014] The object of the present invention is to overcome some of the above-mentioned problems in elevator control. The aim is to create a control method in which both the waiting time and the traveling time of passengers are optimized.

BRIEF DESCRIPTION OF THE INVENTION

[0015] As for the features of the present invention, reference is made to the claims.

[0016] The present invention deals with a method for allocating elevators on the basis of call data, and the method is especially intended for use in a destination call system, wherein both the source floor and the destination floor of the customer are already known after the customer has given a call in an elevator lobby. Source floor refers to the floor where the customer gives a landing call or destination call and where the customer en-ters the elevator. The source

floor is thus the same as the customer's departure floor. Based on active calls and the location and operational condition of the elevators at the instant under consideration, all possible elevator route alternatives are calculated.

[0017] In the method, a cost function is calculated wherein passenger-specific average total traveling time, i.e. the time from the instant the person gives a destination floor call to the instant he/she leaves the elevator at the destination call floor, is minimized. The procedure takes into account the waiting time spent at the elevator landing floor, besides the traveling time spent in the elevator car as well as the delays caused by intermediate stops that, as far as known, are to be made during the journey. Intermediate stops may be due to active destination floor calls or source floor calls given by new passengers along the route of the elevator. Further delays arise in consequence of destination floor calls given by new customers boarding at intermediate stops. The calculation is performed taking into account the time it takes the elevator passenger to move from the DOP panel (Destination Operating Panel = device for inputting a destination floor call) to the elevator lobby, from the lobby to the elevator or vice versa, the time elapsing while the elevator door is being opened and closed, the waste time caused by the braking prior to stopping of the car and the acceleration after the stop, and additionally possible other waste time due to mechanical or electrical delays within the elevator system or guard times related to operational safety.

[0018] In intensive traffic conditions, elevators are reserved for passengers according to the route alternative that gives the shortest average traveling time, whereas in quiet traffic conditions the average passenger waiting time is optimized. Once the calculation result is obtained, the elevator customer is immediately informed as to the elevator allocated to serve him/her.

[0019] The method of the present invention can be combined with the use genetic algorithms to determine the most advantageous route alternative. However, the route alternatives processed by the algorithm can also be created in other ways.

[0020] If only traditional landing call buttons and a car call panel are in use, it is necessary to weight the traveling time associated with a given landing call by the relevant predicted number of passengers- Further, measured traffic statistics can be utilized to estimate passengers' destination floors at a given instant of time from a given source floor. The results of the forecast can be further utilized when the algorithm of the present invention is used.

[0021] A feature characteristic of the method of the present invention is that it employs passenger-specific calculation instead of call-specific calculation.

[0022] As traveling time is minimized and, in a preferred embodiment, the destination call system is used, the capacity of the elevator system can be better utilized as compared to the control algorithms used in the traditional up-down call system. Another significant advantage of the present invention is that the same control system can be used to control both systems using destination calls and systems using traditional up-down calls. In the destination call system, the traveling times are optimized and the serving elevator is immediately signaled to the customer. In this operating mode and in peak traffic conditions, the number of intermediate stops can be effectively reduced and the elevator capacity can be more efficiently utilized. Immediate signaling can also be used in a system comprising up-down call buttons. The signaling can be given automatically or it can be set manually to a suitable value with respect to usability.

[0023] The control system also permits the destination operating mode to be set into an active state e.g. only during peak traffic hours while at other times traditional call buttons are in operation. As anoth er alternative, the destination operating mode may be continuously in use.

LIST OF FIGURES

[0024] Fig. 1 presents the components of a cost function generated in elevator control according to the present invention, and

[0025] Fig. 2 presents the components of an elevator system associated with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0026] In a preferred embodiment, the present invention is applied in so-called destination call control, wherein the elevator system control receives the information regarding the customer's source and target floors at an early stage. However, the present invention is also applicable for use i n a traditional elevator system provided with up-down call buttons.

[0027] The cost function is first presented in the case of destination call control and then in the case of traditional call control. Fig. 1 presents in a simple form the time terms needed in the generation of the cost function.

[0028] In the present invention, the object of optimization 11 is the passenger's average traveling time. The traveling time contains the passenger's waiting time on his/her source floor 10, which means the time interval from the input of a landing call to the arrival of the elevator car. Further, the traveling time contains the ride time in the elevator car 12. In addition to these, it is necessary to take into account the landing and car calls 13 that the system knows of at the instant of input of the customer's destination call and that are to be allocated to be served by each elevator under consideration.

These are a source of delay in the time spent by the elevator customer in the elevator car. Moreover, the car calls 14 given by new passengers boarding the elevator car have to be taken into account in the traveling time (provided that the system already knows of these calls as destination calls), because they have a similar effect of increasing the traveling time of the passengers already in the car.

[0029] In the optimization method of the present invention, a cost function 11 is created which, based on the above considerations, can be expressed in a simple form e.g. as

$$J_{av} = \min(JT_{f_enter,lift} + JT_{inc,lift}), \qquad (3)$$

where J_{av} is the passenger's average traveling time when a new passenger uses the optimal elevator. $JT_{f_enter,lift}$ is the sum of passenger waiting times associated with a given destination floor or, in the case of a destination call, the traveling time of the person having input the call. $JT_{inc,lift}$ is the length of the waste time that, for different reasons, is summed in the traveling time of the passengers riding in the car.

[0030] If the call data is available immediately in connection with the input of the landing call (in the case of a destination call), optimization 11 can be performed immediately and the most advantageous elevator obtained as a final result 15 of the optimization can be notified to the elevator customer. If the elevator is originally located at floor 'liftpos' (which is different from the elevator customer's source floor), the journey time for a passenger starting a ride on the elevator in question from floor 'f_enter' and giving floor 'f_exit' as the destination floor will be obtained as follows:

$$JT_{f_enter,lift} = ETA_{liftpos,f_enter,lift} + ETA_{f_enter,f_exit,lift} \quad = \text{journey time}, \qquad (4)$$

where ET $A_{liftpos,f_enter,lift}$ is the waiting time of the new passenger or passengers at the entry floor and $ETA_{f_enter,f_exit,lift}$ is the ride time from the entry floor to the destination floor.

[0031] $ETA_{x1,x2,lift}$ is the estimated journey time for the elevator (Estimated Arrival Time) from floor x_1 to floor x_2:

$$ETA_{x1,x2,lift} = T_{x1,x2,drive} + \sum_{i=x_1}^{x_2} F_{i,lift}\left(N_{i,in,lift} \cdot T_{pass} + N_{i,out,lift} \cdot T_{pass} + T_{door,lift} + T_{acc,dec}\right), \qquad (5)$$

where $T_{x1,x2,drive}$ is the elevator journey time at a constant travel speed from floor x_1 to floor x_2. The sum term represents the extra time resulting from stops due to landing and car calls, which is spent during the trip before floor x_2 is reached. $F_{i,lift} = 1$ if the elevator stops at floor i, otherwise $F_{i,lift} = 0$. $N_{i,in,lift}$ and $N_{i,out,lift}$ are the numbers of passengers entering and leaving the elevator, respectively. T_{pass} is the average time required for a passenger to step into or out of the elevator. $T_{door,lift}$ is the additional time consumed by the door opening and closing operations, and $T_{acc,dec}$ represents the delay resulting from the acceleration and braking of the elevator as compared to travel at an even travel speed.

[0032] The traveling time of the elevator customers already riding in the elevator car is increased by new elevator customers giving new landing calls (destination calls) on their entry floor and by the stops required to drop these new customers off at their destination floors when the destination floor is between x_1 ... x_2. The magnitude of this additional delay caused by new passengers to those already riding on the elevator is

$$JT_{inc,lift} = L_{f_enter,lift}\left(T_{pass} + Y_{f_enter,lift}\left(T_{door,lift} + T_{acc,dec}\right)\right) + L_{f_exit,lift}\left(T_{pass} + Y_{f_exit,lift}\left(T_{door,lift} + T_{acc,dec}\right)\right), \qquad (6)$$

where $L_{f_enter,lift}$ and $L_{f_exit,lift}$ are elevator's loads (=numbers of passengers) at the floors where a new passenger either boards or leaves the elevator. $Y_{i,lift} = 0$ if the elevator would have stopped at floor i without the new passenger giving a call, otherwise $Y_{i,lift} = 1$.

[0033] In formula (6), it is necessary to consider possible coincidences, i.e. cases where a destination call given by a first passenger and a landing call given by a new passenger have the same floor as a destination and are allocated to

the same elevator. In addition, in formula (6) the calculation of the traveling time is weighted by the number of passengers on the elevator in such manner that e.g. in a full elevator a significant extra delay is produced if a new landing call is allocated to be served by such a full elevator.

[0034] Let us now consider a traditional elevator system provided with up-down call buttons and a car call panel. In an elevator system provided with normal up-down call buttons, the traveling time can be calculated for example by assuming that each landing call corresponds to one elevator customer. The waiting times obtained by considering each call are summed. However, this produces quite unsatisfactory results when an allocation algorithm is used, because it is quite usual that the same landing call represents several elevator customers queuing up to enter the elevator. In a traditional elevator system like this, if the number of passengers associated with one call can be determined in some way, then this can be utilized in the calculation of the sum of waiting times.

[0035] In the estimation of traveling times, it is possible to use traffic statistics for the building in question. From the statistics it is possible to find out which floor the passenger most typically rides to at a given time on a given day of the week when additionally the source floor is known. Similarly, to assist the calculation, e.g. the average traveling time can be determined from the statistics when the time of the day and the source floor are known. In this way, the calculation can be executed efficiently immediately upon input of a landing call in a traditional system provided with up-down call buttons and it is not strictly necessary to await a destination call given by the customer in the elevator car.

[0036] The summed total journey time for passengers arriving to the elevator upon a single landing call is:

$$JT_{f_enter,lift,total} = \sum_{p=1}^{P}\left(ETA_{liftpos,f_enter,lift,p} + ETA_{f_enter,f_exit,lift,p}\right), \quad (7)$$

= total journey time

where P is the number of passengers departing from floor f_enter upon a single landing call.

[0037] The additional term $JT_{inc,lift}$ contains the additional time consumption caused by new passengers in the traveling time of the passengers already in the car:

$$JT_{inc,lift} = L_{f_enter,lift} P_{f_enter,lift} T_{pass} + Y_{f_enter,lift}\left(T_{door,lift} + T_{acc,dec}\right) + \sum_{i=f_enter}^{f_exit}\left[P_{i,lift} L_{i,lift} T_{pass} + K_{i,lift}\left(T_{door,lift} + T_{acc,dec}\right)\right] \quad (8)$$

where $P_{f_enter,lift}$ is the number of new passengers entering the elevator from a given floor and $P_{i,lift}$ is the number of passengers leaving the elevator from the number that boarded the elevator at floor f_enter. $K_{i,lift} = 1$ if at least one passenger having entered from an 'intermediate floor' leaves the elevator at floor i and the car had not yet stopped at this floor before. Otherwise $K_{i,lift} = 0$. Thus, in the sum term practically all destination call floors given by new passengers are considered and the delays occurring when these passengers leave the elevator are summed taking care that each door operation and braking/acceleration of the car is taken into account only once.

[0038] The cost function (3) has now been defined for both the destination call system and the traditional call system. During intensive traffic, the cost function minimizes the average passenger-specific traveling time, which comprises the time spent while waiting for an elevator, the actual ride time and additionally the delays caused by passengers subsequently entering the elevator. Once the minimum has been found, each passenger is directed to his/her right elevator according to the elevator allocation consistent with the shortest traveling time. The elevator system control naturally performs calculations continuously so that new calls entered and the continually changing positions of the elevators in the system are properly taken into account in the control of the elevators. Since the total traveling time is the object of optimization in the case of intensive traffic, the elevator capacity can be effectively reused after the customer's elevator trip.

[0039] During quiet traffic, the algorithm minimizes passenger-specific average waiting time. In quite traffic conditions, the elevator arrives quickly to the call input floor, but the elevator is allowed to make even several intermediate stops if necessary.

[0040] The car loads are balanced by the algorithm so that the given car load limits are not exceeded. The control method allows the cars to be filled to the upper limit of the number of persons if people enter the elevator from the same source floor. In practice, this limit is only reached when a special peak traffic condition prevails in the system. Peak traffic again can be identified e.g. from measured statistical traffic data or from traffic forecasts made.

[0041] Fig. 2 presents an example of an actual elevator system employing the above-described method, showing the

essential parts of the system. The building is provided with an elevator system comprising elevators 20. The call input equipment 21 includes both traditional up-down call buttons and a car call panel placed in the car. Furthermore, the call input equipment 21 contains the buttons required in a destination call system on each floor. The intelligence of the system is located in a control system 22 comprising a microprocessor (not shown in the figures) as an essential part of it. The microprocessor contains a memory, in which a computer program capable of executing the method of the present invention (or a part of it) is stored. The memory may also be implemented as an external part connected to the computer. The microprocessor runs the program code comprised in the computer program, thus executing the various stages of the method of the present invention (or part of them).

[0042] In the form of the program code executed in the microprocessor, the traveling time is calculated by a time counter 23. The control system 22 performs the required optimization operations by using the input data and method of the present invention. Previously measured traffic statistics 24 can be utilized when an optimization algorithm is used. The traffic statistics 24 may be stored in a separate memory block. As a final result, the control system 22 calculates the optimal elevator route alternative that minimizes the average traveling time.

[0043] The invention is not limited to the embodiment examples described above; instead, many variations are possible within the scope of the inventive concept defined in the claims.

Claims

1. A method for the allocation of elevators to passengers in an elevator system in which method the source and destination floors of each passenger is made known to the elevator system via a call input equipment, which method comprises the steps of: forming the possible elevator route alternatives on the basis of active calls and the state of the elevators at the instant under consideration; determining for the elevator route alternatives a waiting time from the input of the source floor call to the arrival, of the elevator at the call floor and a ride time in the elevator car from the source floor to the destination floor; determining for the elevator route alternatives a first delay caused by intermediate stops to bye between the source and destination floors of the passengers; determining for the elevators route alternatives a second delay caused by intermediate stops to be made due to destination floor calls given by customers having boarded the elevator between the source and destination floors of the passengers; determining for the elevator route alternatives a passenger travelling time based on the waiting time, the ride time, the first and the second delays; and allocating the elevators to the passenger according to traffic intensity in accordance with the route alternative that gives the shortest waiting or travelling time, **characterised in that** said elevator system has a control system for destination calls and traditional up-down calls, whereby in intensive traffic conditions the passenger's average travelling time is optimized and the destination operating mode is activated and in quiet traffic conditions the passengers' average waiting time is optimize and the traditional, up-down call system is used.

2. A method according to clam 1, **characterized in that** the aforesaid first delay results from landing calls allocated to the elevator and car calls gives the elevator car.

3. A method according to any one of the preceding claims 1- 2, **characterized in that** the method further comprises the step of: determining the first and second delays by humming the average time it takes for each elevator to move from the floor to the elevator or vice versa, the waste time caused by opening and closing of the elevator door, the waste time caused by breaking and acceleration of the any the waste time caused by the operation of the system.

4. A method according to any one of the preceding claims 1-3, **characterized in that** genetic algorithms are used in the allocation of the elevator.

5. A method according to any one of the preceding claims 1-4, **characterized in that** the aforesaid source and destination floor data are given to the system via a destination call system (DOP).

6. A method according to any one of the preceding claims 1-5, **characterized in that** the aforesaid source floor data is given to the system via landing call buttons and the destination floor data via a car call panel.

7. A method according to claim 6, **characterized in that** the method further comprises the steps of: calculating the travelling time associated with one landing call by multiplying the defined travelling time by a predicted number of associated with one landing call; and predicting the passengers' destination floors on the bas of traffic statistics.

8. A system for the allocation of elevators to passengers in elevator system, said system comprising at least one elevator (20); a call input equipment(21) comprising the buttons required in a destination call system own each floor

for making the source and destination floors of each passenger known to the elevator systems as well as up-down call buttons and a car call panel placed in the car; an elevator control system (22) for forming the possible elevator route alternatives on the basis of the calls active and the state of the elevators at the instant under consideration, which control system is constituted to handle a destination call system as well as a traditional up-down call system; a time counter (23) for determining for then elevator route alternatives a waiting time elapsing from the input of the source floor call to the arrival of the elevator at the call input floor and a ride time elapsing in the elevator car from the source floor to the destination floor; a time counter (23) determining for the elevator route alternatives a first delay caused by intermediate stops to be made between the source and destination floors of the passengers; a time counter (23) fo determining for the elevator route alternatives a second delay caused by intermediate stops to be made due to destination floor calls given by customers having boarded the elevator between the source and destination floors of the passengers; a time counter (23) for determining for the elevator route alternatives a passenger travelling time obtained on the basis of the waiting g time, the ride time, the first and the second delays; and an elevator control system (22) for allocating the elevators to the passengers according to traffic intensity in accordance with the route alternative that gives the Shortest waiting or travelling time, whereby the system is designed to optimize in intensive traffic conditions the passenger's average travelling time an an destination operating mode is set into an active state and in quiet traffic conditions, the average waiting time and the traditional call buttons are in operation.

9. A system according to claim 8, **characterized in that** in the time counter (23) the aforesaid first delay is caused by the landing calls allocated to the elevator and the car calls given in the elevator car.

10. A system according to any one of the preceding claims 8-9, **characterized in that** the system further comprises: a time counter (23) for the average time it takes for each elevator passenger to move from the floor to the elevator or vice versa, the waste time caused by opening and closing of the elevator door, the time caused by braking and acceleration of the elevator and the waste time caused by operation of the systems, determining the first and second delays.

11. A system according to any one of the preceding claims 8-10, **characterized in that** in the elevator control system (22) genetic algorithms are used for the allocation of the elevators.

12. A system according to any one of the preceding claims 8 - 11, **characterized in that** the call input equipment(21) is a destination call equipment (DOP) for the input of source and destination floor data to the system.

13. A system according to any one of the preceding claims 8 - 12, **characterized in that** the call input equipment(21) consists of landing call buttons and car call buttons for the input of source and destination floor data to the system.

14. A system according to claim 13, **characterized in that** the system further comprises:

a time counter (23) for calculating the travelling time associated with one landing call by multiplying the defined travelling time by a predicted number of passengers associated with one landing call; and traffic statistics (24) for predicting the passengers destination floors.

Patentansprüche

1. Verfahren für die Zuweisung von Aufzügen zu Passagieren in einem Aufzugsystem, in welchem Verfahren dem Aufzugssystem die Abfahrt- und Zielstockwerke jedes Passagiers über eine Rufeingabeeinrichtung mitgeteilt werden, welches Verfahren folgende Schritte enthält: Bilden der möglichen Aufzugwegalternativen auf der Basis aktiver Rufe und des Status der Aufzüge zum Zeitpunkt der Betrachtung; Bestimmen einer Wartezeit für die Aufzugswegalternativen von der Eingabe des Abfahrtstockwerkrufs bis zur Ankunft des Aufzugs an dem Rufeingabestockwerk und einer Fahrzeit der Aufzugskabine von dem Abfahrtsstockwerk bis zum Zielstockwerk; Bestimmen einer erste Verzögerung für die Aufzugwegalternativen, die durch Zwischenstops zwischen dem Abfahrtstockwerk und dem Zielstockwerk der Passagiere verursacht wird; Bestimmen einer zweiten Verzögerung für die Aufzugwegalternativen, die durch Zwischenstops aufgrund Zielstockwerkrufen verursacht wird, die von Passagieren abgegeben wurden, die den Aufzug zwischen dem Abfahrt- und dem Zielstockwerk des Passagiers betreten haben; Bestimmen einer Passagierwegzeit für die Aufzugswegalternativen basierend auf der Wartezeit, der Fahrzeit, der ersten und zweiten Verzögerung; und Zuweisen der Aufzüge zu den Passagieren gemäß der Verkehrsintensität in Übereinstimmung mit der Wegalternative, welche die kürzeste Warte- oder Wegzeit ergibt, **dadurch gekennzeichnet, dass** das Aufzugssystem ein Steuerungssystem für Zielrufe und traditionelle Auf-/Abwärts-Rufe aufweist, wobei in intensiven

Verkehrssituationen die durchschnittliche Wegzeit des Passagiers optimiert wird und der Zielstockwerksbetriebsmodus aktiviert wird, und in ruhigen Verkehrssituationen die durchschnittliche Wartezeit des Passagiers optimiert wird und das traditionelle Auf-/Abwärts-Rufsystem verwendet wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die oben genannte erste Verzögerung aus Stockwerkrufen, die dem Aufzug zugewiesen werden und aus Kabinenrufen resultiert, die in der Aufzugskabine abgegeben werden.

3. Verfahren nach einem der vorhergehenden Ansprüche 1 - 2, **dadurch gekennzeichnet, dass** das Verfahren weiterhin folgende Schritte umfasst: Bestimmen der oben genannten ersten und zweiten Verzögerung durch Aufsummieren der Durchschnittszeit, die jeder Passagier benötigt, um sich von dem Stockwerk zum Aufzug zu bewegen oder vice versa, der Zeit, die das Öffnen und Schließen der Aufzugstüre erfordert, der Zeit, die das Abbremsen und Beschleunigen des Aufzugs erfordert, und der Zeit die der den Betrieb des Systems erfordert.

4. Verfahren nach einem der vorhergehenden Ansprüche 1 - 3, **dadurch gekennzeichnet, dass** genetische Algorithmen bei Zuweisung der Aufzüge verwendet werden.

5. Verfahren nach einem der vorhergehenden Ansprüche 1 - 4, **dadurch gekennzeichnet, dass** die vorgenannten Abfahrt- und Zielstockwerkdaten dem System über ein Zielstockwerkrufsystem (DOP) gegeben werden.

6. Verfahren nach einem der vorhergehenden Ansprüche 1 - 5, **dadurch gekennzeichnet, dass** die vorgenannten Abfahrtsstockwerkdaten dem System über Stockwerkrufknöpfe und die Zielstockwerkdaten über ein Kabinenrufpanel gegeben werden.

7. Verfahren nach Anspruch 6, **dadurch gekennzeichnet, dass** das Verfahren weiterhin folgende Schritte umfasst: Errechnen der Wegzeit, die mit einem Stockwerkruf assoziiert ist, durch Multiplizieren der definierten Wegzeit mit einer vorhergesagten Anzahl an Passagieren, die mit einem Stockwerkruf assoziiert sind; und Vorhersagen der Zielstockwerke der Passagiere auf der Basis von Verkehrsstatistiken.

8. System für die Zuweisung von Aufzügen zu Passagieren in einem Aufzugssystem, welches System folgende Merkmale umfasst: Wenigstens einen Aufzug (20), eine Rufgabeeinrichtung (21), welche die in einem Zielstockwerkrufsystem auf jedem Stockwerk erforderlichen Knöpfe aufweist, um dem Aufzugssystem das Abfahrtsstockwerk und das Zielstockwerk jedes Passagiers mitzuteilen, als auch traditionelle Auf-/Abrufknöpfe und ein Kabinenrufpanel, das in der Kabine angeordnet ist; ein Aufzugssteuerungssystem (22) zum Bilden der möglichen Aufzugwegalternativen auf der Basis der aktiven Rufe und des Status der Aufzüge zum Zeitpunkt der Betrachtung, welches Steuerungssystem konzipiert ist, um sowohl ein Zielrufsystem als auch ein traditionelles Auf/Abrufsystem zu handhaben; einen Zeitzähler (23) zum Bestimmen einer Wartezeit für die Aufzugwegalternativen, die sich ergibt aus der Eingabe des Abfahrtstockwerkrufes bis zur Ankunft des Aufzugs an dem Rufeingabestockwerk, und einer Fahrzeit in der Aufzugskabine von dem Abfahrtstockwerk bis zum Zielstockwerk; einen Zeitzähler (23) zum Bestimmen einer ersten Verzögerung für die Aufzugwegalternativen, die durch Zwischenstops zwischen dem Abfahrts- und dem Zielstockwerk der Passagiere verursacht wird; einen Zeitzähler (23) zum Bestimmen einer zweiten Verzögerung für die Aufzugwegalternativen, die durch Zwischenstops verursacht wird, welche aus Zielstockwerkrufen resultieren, die von Passagieren abgegeben werden, welche den Aufzug zwischen dem Abfahrt- und dem Zielstockwerk des Passagiers betreten haben; einen Zeitzähler (23) zum Bestimmen einer Passagierwegzeit für die Aufzugswegalternativen, die erhalten wird auf der Basis der Wartezeit, der Fahrzeit, und der ersten und zweiten Verzögerung; und ein Aufzugssteuerungssystem (22) zum Zuweisen der Aufzüge zu den Passagieren entsprechend der Verkehrsintensität in Übereinstimmung mit den Wegalternativen, welche die kürzeste Warte- oder Fahrzeit ergeben, wobei das System konzipiert ist, in intensiven Verkehrssituationen die durchschnittliche Passagierfahrzeit zu optimieren und ein Zielrufbetriebssystem in den aktiven Status zu setzen, und in ruhigen Verkehrssituationen die durchschnittliche Passagierwartezeit zu optimieren und die traditionellen Rufknöpfe in Betrieb zu setzen.

9. System nach Anspruch 8, **dadurch gekennzeichnet, dass** in dem Zeitzähler (23) die erste Verzögerung verursacht wird durch Stockwerkrufe, die dem Aufzug zugewiesen werden, und Kabinenrufe, die in der Aufzugskabine abgegeben werden.

10. Ein System nach einem der vorhergehenden Ansprüche 8 - 9, **dadurch gekennzeichnet, dass** das System weiterhin folgende Merkmale enthält: Einen Zeitzähler (23) zum Aufsummieren der Durchschnittszeit, die jeder Passagier benötigt, um von dem Stockwerk zu dem Aufzug oder vice versa zu gelangen, der Zeit, die durch das Öffnen und

Schließen der Aufzugstüre verursacht wird, der Zeit die durch das Abbremsen und die Beschleunigung des Aufzugs verursacht wird, und der Zeit, die durch den Betrieb des Systems verursacht wird, welches die erste und zweite Verzögerung bestimmt.

11. System nach einem der vorhergehenden Ansprüche 8 - 10, **dadurch gekennzeichnet, dass** in dem Aufzugssteuerungssystem (22) genetische Algorithmen für die Zuweisung der Aufzüge verwendet werden.

12. System nach einem der vorhergehenden Ansprüche 8 - 11, **dadurch gekennzeichnet, dass** die Rufeingabeeinrichtung (21) eine Zielrufeinrichtung (DOP) für die Eingabe von Abfahrt- und Zielstockwerkdaten in das System ist.

13. System nach einem der vorhergehenden Ansprüche 8 - 12, **dadurch gekennzeichnet, dass** die Rufeingabeeinrichtung (21) aus Stockwerkrufknöpfen und Kabinenrufknöpfen die Eingabe von Abfahrts- und Zielstockwerkdaten in das System besteht.

14. System nach Anspruch 13, **dadurch gekennzeichnet, dass** das System weiterhin umfasst: Einen Zeitzähler (23) zum Errechnen der Wegzeit, die mit einem Stockwerkruf assoziiert ist, durch Multiplizieren der definierten Wegzeit mit einer vorhergesagten Anzahl von Passagieren, die mit einem Stockwerkruf verknüpft sind; und Verkehrsstatistiken (24) zum Vorhersagen der Zielstockwerke der Passagiere.

Revendications

1. Procédé d'attribution d'ascenseurs à des passagers dans un système d'ascenseurs, dans lequel procédé les étages de départ et de destination de chaque passager sont reconnus par le système d'ascenseurs par l'intermédiaire d'un équipement d'entrées d'appel, le procédé comprenant les étapes de formation d'itinéraires alternatifs possibles des ascenseurs sur la base d'appels actifs et de l'état des ascenseurs à l'instant considéré ; de détermination pour les itinéraires alternatifs des ascenseurs d'un temps d'attente à partir de l'entrée de l'appel à l'étage de départ jusqu'à l'arrivée de l'ascenseur à l'étage d'entrée de l'appel et d'une durée de trajet dans la cabine d'ascenseur de l'étage de départ à l'étage de destination ; de détermination pour les itinéraires alternatifs des ascenseurs d'un premier retard causé par les arrêts intermédiaires devant être effectués entre les étages de départ et de destination des passagers ; de détermination pour les itinéraires alternatifs des ascenseurs d'un second retard causé par les arrêts intermédiaires devant être effectués en raison des appels entrés par les clients étant montés à bord de l'ascenseur entre les étages de départ et de destination des passagers ; de détermination pour les itinéraires alternatifs des ascenseurs d'une durée de transport des passagers basée sur le temps d'attente, la durée de trajet, les premier et second retards ; et d'attribution des ascenseurs au passager en fonction de conditions de transport intenses selon l'itinéraire alternatif offrant les plus courts temps d'attente et de transport, **caractérisé par le fait que** ledit système d'ascenseurs dispose d'un système de commande pour les appels de destination et les appels bidirectionnels classiques, la durée de transport moyen des passagers étant optimisée et le mode de fonctionnement de la destination étant activé dans des conditions de transport intenses et le temps d'attente moyen des passagers étant optimisé et le système d'appels bidirectionnels classique étant utilisé dans des conditions de transport calmes.

2. Procédé selon la revendication 1, **caractérisé par le fait que** le premier retard susmentionné résulte d'appels paliers attribués aux appels d'ascenseur et de cabine effectués dans la cabine d'ascenseur.

3. Procédé selon l'une quelconque des revendications précédentes 1 à 2, **caractérisé par le fait que** le procédé comporte en outre l'étape de : détermination des premier et second retards susmentionnés en additionnant le temps moyen nécessaire à chaque passager d'ascenseur pour se déplacer de l'étage à l'ascenseur ou vice versa, le temps perdu à cause de l'ouverture et de la fermeture de la porte d'ascenseur, le temps perdu à cause du freinage et de l'accélération de l'ascenseur et le temps perdu à cause du fonctionnement du système.

4. Procédé selon l'une quelconque des revendications précédentes 1 à 3, **caractérisé par le fait que** des algorithmes génétiques sont utilisés dans l'attribution des ascenseurs.

5. Procédé selon l'une quelconque des revendications précédentes 1 à 4, **caractérisé par le fait que** les données des étages de départ et de destination susmentionnées sont transmises au système par l'intermédiaire d'un système d'appel de destination (DOP).

6. Procédé selon l'une quelconque des revendications précédentes 1 à 5, **caractérisé par le fait que** les données

de l'étage de départ susmentionnées sont transmises au système par l'intermédiaire des boutons d'appel de palier et les données de l'étage de destination par l'intermédiaire d'un tableau d'appel de cabine.

7. Procédé selon la revendication 6, **caractérisé par le fait que** le procédé comporte en outre les étapes : de calcul de la durée de transport associée à un appel palier en multipliant la durée de transport par un nombre prévu de passagers associé à un appel palier ; et de prévision des étages de destination des passagers sur la base des statistiques de transport.

8. Système destiné à l'attribution d'ascenseurs dans un système d'ascenseurs, ledit système comprenant au moins un ascenseur (20) ; un équipement d'entrée d'appel (21) comprenant les boutons nécessaires dans un système d'appel de destination à chaque étage pour communiquer les étages de départ et de destination de chaque passager au système d'ascenseurs ainsi que des boutons d'appel bidirectionnels classiques et un tableau d'appel de cabine placé dans la cabine ; un système de commande d'ascenseurs (22) destiné à former les itinéraires alternatifs possibles des ascenseurs sur la base des appels actifs et de l'état des ascenseurs à l'instant considéré, lequel système de commande étant constitué pour traiter un système d'appel de destination ainsi qu'un système d'appel bidirectionnel classique ; un compteur de temps (23) destiné à déterminer pour les itinéraires alternatifs des ascenseurs un temps d'attente s'écoulant de l'entrée de l'appel à l'étage de départ jusqu'à l'arrivée de l'ascenseur à l'étage d'entrée de l'appel et une durée de trajet s'écoulant dans la cabine d'ascenseur de l'étage de départ jusqu'à l'étage de destination ; un compteur de temps (23) destiné à déterminer pour les itinéraires alternatifs des ascenseurs un premier retard causé par les arrêts intermédiaires devant être faits entre les étages de départ et de destination des passagers ; un compteur de temps (23) destiné à déterminer pour les itinéraires alternatifs des ascenseurs un second retard causé par les arrêts intermédiaires devant être faits en raison des appels entrés par les clients étant montés à bord de l'ascenseur entre les étages de départ et de destination des passagers ; un compteur de temps (23) destiné à déterminer pour les itinéraires alternatifs des ascenseurs une durée de transport des passagers basée sur le temps d'attente, la durée de trajet, les premier et second retards ; et un système de commande d'ascenseurs (22) destiné à attribuer les ascenseurs aux passagers en fonction des conditions de transport selon l'itinéraire alternatif offrant le temps d'attente et de transport le plus court, le système étant conçu pour optimiser la durée de transport moyenne des passagers et un mode de fonctionnement de la destination étant activé dans des conditions de transport intenses et le temps d'attente moyen des passagers et les boutons d'appel classiques étant en fonctionnement dans des conditions de transport calmes.

9. Système selon la revendication 8, **caractérisé par le fait que** dans le compteur de temps (23) le premier retard susmentionné résulte des appels paliers attribués aux appels d'ascenseur et de cabine effectués dans la cabine d'ascenseur.

10. Système selon l'une quelconque des revendications précédentes 8 à 9, **caractérisé par le fait que** le système comprend en outre : un compteur de temps (23) destiné à additionner la durée moyenne nécessaire à chaque passager d'ascenseur pour se déplacer de l'étage à l'ascenseur ou vice versa, le temps perdu à cause de l'ouverture et la fermeture de la porte d'ascenseur, le temps perdu à cause du freinage et de l'accélération de l'ascenseur et le temps perdu à cause du fonctionnement du système, déterminant les premier et second retards.

11. Système selon l'une quelconque des revendications précédentes 8 à 10, **caractérisé par le fait que** des algorithmes génétiques sont utilisés dans le système de commande d'ascenseurs (22) pour l'attribution des ascenseurs.

12. Système selon l'une quelconque des revendications précédentes 8 à 11, **caractérisé par le fait que** l'équipement d'entrée d'appel (21) est un équipement d'appel de destination (DOP) pour l'entrée des données des étages de départ et de destination dans le système.

13. Système selon l'une quelconque des revendications précédentes 8 à 12, **caractérisé par le fait que** l'équipement d'entrée d'appel (21) est constitué de boutons d'appel palier et de boutons d'appel de cabine pour l'entrée de données d'étage de départ et de destination dans le système.

14. Système selon la revendication 13, **caractérisé par le fait que** le système comprend en outre : un compteur de temps (23) destiné à calculer la durée de transport associée à un appel palier en multipliant la durée de transport par un nombre prévu de passagers associé à un appel palier ; et des statistiques de transport (24) destinées à prévoir les étages de destination des passagers.

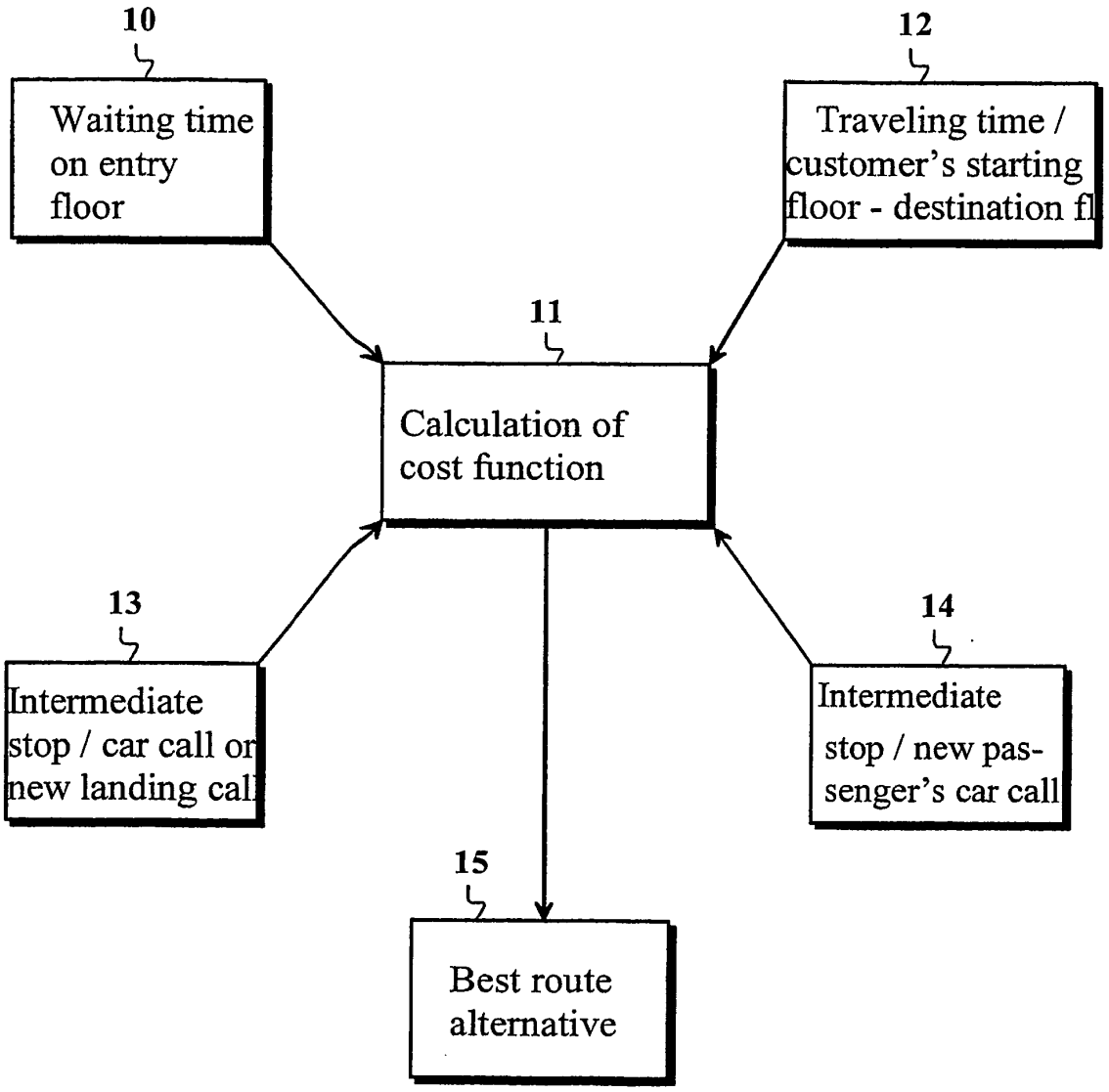

10
Waiting time on entry floor
12
Traveling time / customer's starting floor - destination fl
11
Calculation of cost function
13
Intermediate stop / car call or new landing cal
14
Intermediate stop / new passenger's car call
15
Best route alternative

Figure 1

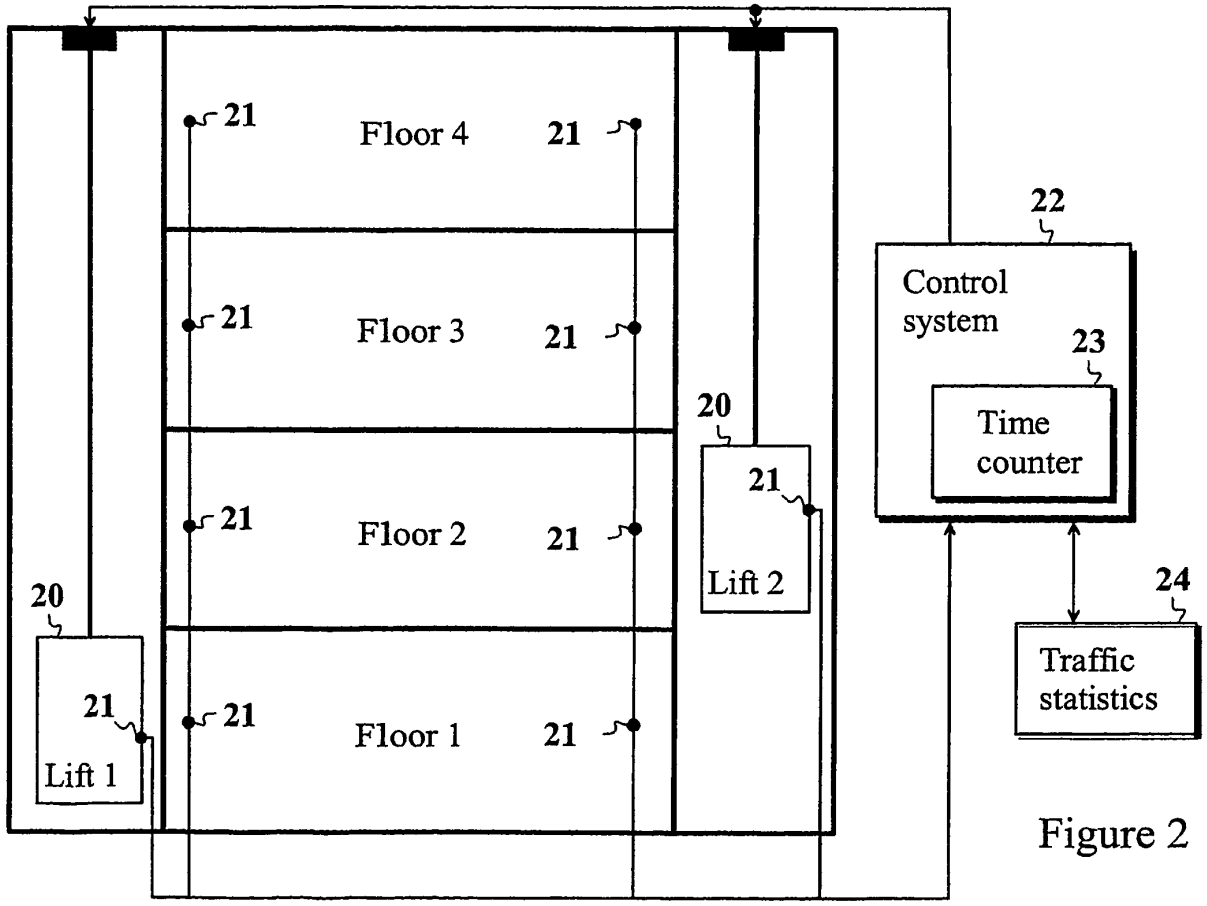

21
Floor 4
21
22
Control system
23
Time counter
21
Floor 3
21
20
21
Lift 2
21
Floor 2
21
24
Traffic statistics
20
21
Lift 1
21
Floor 1
21

Figure 2

REFERENCES CITED IN THE DESCRIPTION

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