
(12) PATENT ABRIDGMENT (11) Document No. AU-B-17783/88
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 606426

(54) Title
METHOD FOR SUB-ZONING OF AN ELEVATOR GROUP

International Patent Classification(s)
(51)⁴ **B66B 001/18 B66B 001/20**

(21) Application No. : **17783/88** (22) Application Date : **17.06.88**

(30) Priority Data

(31) Number (32) Date (33) Country
872706 17.06.87 FI FINLAND

(43) Publication Date : **22.12.88**

(44) Publication Date of Accepted Application : **07.02.91**

(71) Applicant(s)
KONE ELEVATOR GMBH

(72) Inventor(s)
RALF EKHOLM; RIITTA PARTANEN-JOKELA

(74) Attorney or Agent
COLLISON & CO, 117 King William Street, ADELAIDE SA 5000

(56) Prior Art Documents
AU 507366 32345/78 B66B 1/20
AU 473947 85618/75
AU 503881 15097/76

(57) Claim

1. A method for increasing the transportation capacity of elevators in a building by dividing the elevators into two or more groups, each comprising one or more elevators, in such a manner that in certain loading conditions said groups will temporarily serve different zones of said building and wherein an upward peak traffic elevator condition is detected and the boundaries between said zones are determined and maintained by the following steps:

- (a) detecting a peak traffic condition mainly on the basis of elevator loading time and/or the number of people arriving in an elevator lobby of said building.
- (b) calculating an initial optimal zone boundary value, mainly on the basis of traffic statistics and existing transportation capacity.
- (c) effecting transition of elevator operation to sub-zoning during upward peak traffic.
- (d) re-calculating the optimal zone boundary value mainly on the basis of short-term traffic statistics, the number of people in the

(11) AU-B-17783/88
(10) 606426

-2-

elevator lobby and the available transportation capacity.

- (e) sensing the need for change in the zone boundary and effecting the change thereof as calculated in section (d) hereof.
- (f) cancelling the sub-zoning upon completion of the upward peak passenger period or when the volume of upward traffic has fallen below a predetermined limit.

COMMONWEALTH OF AUSTRALIA

Form 10

Patents Act 1952-1969

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE:

Class

Int. Class

60 642 6

Application Number :
Lodged :

Complete Application No. ;
Specification Lodged ;
Published :

Priority:

Related art:

TO BE COMPLETED BY APPLICANT

Name of Applicant:

KONE ELEVATOR GmbH

Address of Applicant:

Rathausstrasse 1, CH-6340 Baar, SWITZERLAND

Actual Inventor:

Ralf EKHOLM and
Riitta PARTANEN-JOKELA

Address for Service: COLLISON & CO., Patent Attorneys, 117 King William Street, Adelaide, South Australia, 5000.

Complete Specification for the invention entitled: "METHOD FOR SUB-ZONING OF AN ELEVATOR GROUP"

The following statement is a full description of this invention, including the best method of performing it known to us:

METHOD FOR SUB-ZONING OF AN ELEVATOR GROUP

The present invention relates to a method for increasing the transportation capacity of the elevators in a building by dividing the the elevators into two or more groups, each

5. comprising one or more elevators, in such manner that in certain loading situations the groups will temporarily serve different zones of the building.

It is most desirable that the control system of an elevator group be so designed that the group, dimensioned according

10. to the general practice, is able to provide the required transportation to all passengers even in the hours of heavy upward peak traffic without any queues being built up on the floors where people wait for elevators.

In a known method, the building is divided into two fixed

15. zones during heavy upward traffic, about half of the elevators exclusively serving the upper zone and the rest the lower zone. Using methods of statistical mathematics as employed in the dimensioning of elevator groups, it can be

20. proved that the additional capacity thus achieved is of the order of 20 - 40 %, depending on the size of the elevator group, the type of elevators used, the traffic characteristics and the number of sub-zones.

However, this solution has several drawbacks, one of the worst being that during the upward rush the traffic is not

25. equally distributed between all floors of the building but may instead be concentrated in different parts of the building in different phases of the upward rush. In these circumstances the service quality significantly deteriorates for those parts of the building to which there is more than an

30. average amount of traffic.

Another notable disadvantage is that when one or more elevators must for some reason be set out of normal service, the elevator control system has no provision for re-zoning, with the result that queues are built up for the rest of the elevators of the group concerned. This applies to the cases of goods and VIP transport, which may take up a significant portion of the transportation capacity, especially in large buildings. Because of lacking supervision, such transport often occurs during the upward rush, though this is against general recommendations.

The deterioration in service quality automatically leads to the result that those passengers who have to wait longer become impatient and therefore do not pay due attention to the passenger information but enter the wrong elevators in the hope of getting to their destination in any case, or they reckon that they will arrive sooner at their destination by first driving to the wrong floor and then changing elevators. This results in an unnecessary reduction of the transportation capacity of the elevator group, and it is very difficult for the group control system to recover from the low service condition before the rush is over.

It is naturally possible to employ operators and charge them with the task of driving the cars to their destinations as efficiently as possible while also taking care that the passengers fill the cars quickly and correctly during the up-rush. One of the drawbacks of this method is that the elevator services can not be properly coordinated because the operators do not see each other during the rush, which often leads to severe bunching and consequently long waiting times even if the transportation demand does not exceed the available capacity. Besides, the zone boundaries can not be quickly changed if the traffic is unevenly distributed. The system also involves considerable extra costs.

Another weakness of the known methods is that the downward and interior traffic, though small in volume, beginning towards the end of the upward rush, causes a cancellation of the temporary zoning with fixed zone boundaries, because the

5. control system is unable to handle this sort of mixed traffic properly. Therefore it is not possible to apply restrictions in a controlled fashion to limit the elevator services for the passengers travelling in the opposite direction during the rush e.g. by letting them wait for their elevators longer than average within certain maximum limits. Thus the
10. rush-time transportation capacity of the whole elevator group begins to deteriorate because of mixed traffic before the rush is over.

The object of the present invention is to achieve a flexible and efficient method for dividing the elevator capacity of a building into appropriate groups during upward peak traffic. The method of the invention is characterized by what is presented in the claims to follow.

The invention is described in the following by the aid of an example with reference to the drawings attached, wherein:

Fig. 1 is a diagram of a big building with a group of six elevators serving eighteen floors, and a machine room housing the control equipment.

Fig. 2 represents the same building with the elevator group divided into two zones.

Fig. 3 shows the elevator lobby on the ground floor, with the six elevators placed in the common manner in two groups of three on opposite sides of the lobby.

Fig. 4 is a block diagram of a known elevator group control system.

Fig. 5 represents the control system of fig. 4 with the addition of a sub-zoning control system as provided by the invention.

5. Fig. 6 is a flow chart visualizing the operation of the control system of the invention.

The diagram in fig. 1 represents a large building 1 where a group of six elevators 2-7 serves eighteen floors. The figure also shows the elevator machine room 8 and the lobby 9. Fig. 2 represents the building of fig. 1 with the elevators divided into two sub-groups 11 and 12 serving the floors 1-10 and 10-18 respectively.

Fig. 3 shows the elevator lobby on the ground floor, with the six elevators placed in the common manner in groups of three on opposite sides of the lobby. The lobby is also provided with a computer 10, which is connected to a display 13 placed on one end wall of the lobby. Connected to the lobby computer 10 is also a traffic indicator 14 for displaying the elevator movements, and a radar 15 for counting the people who stop in the lobby to wait for an elevator (see e.g. Finnish patent application 800954). When the elevators are divided into two or more groups to serve different zones, it is also necessary to consider the layout of the elevator groups in the lobby 9 to ensure that the elevators serving different zones are separated from each other so as to avoid crisscrossing of the paths of people going to different zones. In reference to fig. 3, this means that all the three elevators (2, 3 and 4) on the left serve one zone while those on the right (5, 6 and 7) serve the other.

30. Fig. 4 is a block diagram of the control system of a modern six-elevator group, comprising a main control unit 21, a reserve control unit 22, elevator-specific computers 23-28 for

individual elevator control and adjustment, corresponding computers 29-34 located in the elevator cars, and a special computer 35 communicating with the control room of the building.

5. Fig. 5 represents the control system of fig. 4 with the addition of a sub-zoning control system as provided by the invention, which is active during the upward rush. The sub-zoning control system comprises a computer 44 for execution of the sub-zoning algorithm and the equipment 10, 14, 36-43 required for providing the necessary information on the zoning and the changes thereof. The sub-zoning computer 44 transmits the zoning data to the lobby computer 10, which, based on these data, controls the zoning display 36, the video monitors 14 and 43 showing the elevator movements, and the elevator-specific displays 37-42. Depending on the form of the lobby and the layout of the elevators, it may be necessary to use additional monitors and/or the information provided by the traffic monitors may vary.

In this embodiment of the invention, the sub-zoning algorithm is placed in a separate computer 44 which commands the group control computers 21 and 22 during the up-rush, but the algorithm may also be placed in one or both (e.g. to provide a back-up function) of the group control computers.

25. In the rush-time operation of the control system, several phases can be distinguished, as shown by the diagram in fig. 6. The zoning algorithm is a continuous checking routine which incessantly collects information from the various parts of the elevator system. The most important data are those concerning the traffic flow, which are collected in the block designated as BED (Basic Elevator Data). These data include long-term traffic flow statistics, radar data, i.e. the number of people waiting in the lobby on the ground floor at each moment, and short-term traffic flow statis-

tics. The statistical data comprise various information collected earlier for a corresponding time interval, e.g. the number of departures, the loads of the cars at each departure, the number and distribution of calls, and the number of passengers leaving the cars at each floor. The division between long-term and short-term information depends on the application, but "short term" can be regarded as referring to time intervals of a few minutes to a few days, whereas long-term statistics may cover information gathered during the entire existence of the system.

In large buildings, the upward rush develops gradually, a peak traffic condition being developed in a matter of a few minutes to a few tens of minutes. The computer 44, which at this stage is mainly occupied with processing momentary load data, compares the load data to certain set limits and decides when the upward rush begins. This is done in the PTC (Peak Traffic Condition) block of fig. 6. If the test result is negative (FALSE), the computer decides that a normal condition still prevails and keeps the elevator group under normal traffic control (NTC). If certain criteria are met during a certain time interval, e.g. two minutes, for example when a given number of elevator cars with a load exceeding a given limit, e.g. 70% of nominal load, have departed in the up-direction, then the PTC test yields a TRUE result. The conclusions to be reached through the PTC test can be controlled by means of long-term or short-term traffic statistics, for instance in such manner that the sub-zoning algorithm is not activated outside the normal peak traffic hours as easily as during the rush time, because if an increased transportation demand appears in the normal traffic hours, it is likely to be caused by a temporary loading peak (e.g. groups of visitors), which can be tolerably handled by normal group control.

Before switching over to the sub-zoning mode, the computer 44 performs a check in the ECD (Elevator Capacity Data) block to see how much elevator capacity is available, to make it possible to consider the reduction in transportation capacity entailed if some of the elevators are used for special purposes, e.g. goods or VIP transport.

By analyzing the traffic distribution in the building, the computer 44 calculates the optimal zone boundary value in the SZC (Sub-Zone Calculation) block of the diagram. In practice the zone boundary means that floor of the building where the average loads of arriving elevators which cannot go any further are about the same as the loads in the elevators for which the floor in question or the next floor is the first stop on their way up. The calculation of the sub-zoning boundary consists of a number of basic operations involving the traffic distribution data and can therefore be performed in many different ways. An example is given below to illustrate the principle.

The calculated theoretical optimum zone boundary as well as the starting values used in previous peak traffic situations are stored in the memory of the computer. When the traffic condition requires activation of the sub-zoning, the computer compares the momentary optimal starting value obtained from fresh calculations to the previous values, the weighted average of which is stored in its memory. If the elevators are in an initial state, e.g. they are only just being started up for first operation or they are otherwise in a special condition, a theoretical optimum value is used. If the difference between the statistical value and the calculated value for the zone boundary does not exceed a certain permitted threshold, e.g. 15 %, the computer will accept the statistical value. If the difference is greater, the zone boundary value is only corrected by a certain increment at a time, e.g. by one floor in the direction indicated by the

new calculated value. The same principle also applies when the zone boundaries are changed during peak traffic, as explained below. Because it is always preferable to take the number of people waiting in the lobby into account in the

5. calculation of the zone boundary, as is also explained below, this information can also be utilized in determining the initial zone boundary, especially if a large increase in the number of people waiting for an elevator occurs in a short time.

10. The sub-zoning is effected in the SZA block (Sub-Zone Activation). The computer 44 sends the new zone boundary data to the lobby computer 10 and instructs it to activate the passenger information display functions (block PID, Passenger Information Display) to guide the passengers to the right elevators. The passenger information functions are implemented by means of the equipment shown in fig. 5, comprising a zone boundary display 36, video monitors 14 and 43 displaying the elevator movements, and elevator-specific displays 37-42. The zoning data for all elevators of the group are changed simultaneously, but all calls registered before the change are first served normally.

Next, the algorithm performs a new round of checks, i.e. returns to the BED block. During this time the sub-zoning computer 44 is monitoring the operation of the system with the new zone boundary and performing calculations to see if there is a need to change it. If the difference between the calculated value and the current boundary value does not exceed a certain threshold, in this case e.g. 10%, the computer will not change the boundary. If the difference is greater, the zone boundary value is only corrected by a certain increment at a time, e.g. by one floor in the direction indicated by the new calculated value. To avoid repeated changes of the boundary value e.g. between two floors, the algorithm employs a certain hysteresis when the calculations

indicate a need for a change in the opposite direction, by applying a higher threshold value, in the present case 15%. For the calculation of the zone boundary value, it is useful to consider the number of people waiting in the elevator

5. lobby 9, because even during the rush there may appear specific peaks, which can be caused by occurrences like underground trains arriving at a station directly under the building etc. In such cases, if the number of people waiting in the lobby is found to be exceptionally large, this information should be treated as a decisive factor in the calculation of the zone division.

When the traffic condition requires cancellation of the sub-zoning applied during the upward rush, this is done in the PTC block in the diagram in fig. 6, because the computer continuously monitors the traffic, e.g. during each cycle of calculations, to decide whether or not a peak traffic condition exists. The PTC block may also comprise an alternative terminating branch in which the internal traffic in the building is taken into account e.g. in such manner that if the internal traffic volume exceeds a certain appreciable portion of the total traffic, the sub-zoning is cancelled even if a peak traffic condition still prevails on the ground floor. This may sometimes be necessary e.g. towards the end of the peak traffic phase to avoid completely jamming the internal traffic.

The model in fig. 6 represents a greatly simplified embodiment of the method of the invention. The chain of decisions and actions forming the essence of the invention can be implemented in various ways within the scope of the claims.

30. For instance, the calculations required for determining the zone boundary can be performed at a different logical stage, e.g. after the test of the need for change, than the calculation of the initial optimal zone boundary value.

Moreover, the calculation of the zone boundary value during peak traffic can be based on producing alternative values by considering the information provided by long-term statistics, so that the boundary can be changed immediately when

5. the appropriate traffic condition appears.

To allow for cases of exceptional elevator loading, the algorithm can incorporate a provision for changing the elevator grouping described in connection with fig. 3, or detaching one or more elevators from the group and assigning them the role of freely moving "libero" elevators. In certain situations such measures may increase the total transportation capacity of the system at the cost of service quality during peak traffic, e.g. in cases when a moderate amount of important internal traffic has to be handled in peak traffic hours. In relation to the algorithm and the invention, such elevators can be regarded as a group serving a zone that covers all floors of the building, the zone boundary for the group being determined on the basis of the time of starting and the number of detached elevators used.

10. As stated before, the method of the invention need not necessarily be implemented using a separate computer 44, but the logic performing the functions of the method can also be placed in the group control computers 21 and 22, the control room computer 35 or even in the lobby computer 10. Thus it is obvious to a person skilled in the art that the embodiments of the invention are not restricted to the example discussed above but may instead be varied in the scope of the following claims.
- 25.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method for increasing the transportation capacity of elevators in a building by dividing the elevators into two or more groups, each comprising one or more elevators, in such a manner that in certain loading conditions said groups will temporarily serve different zones of said building and wherein an upward peak traffic elevator condition is detected and the boundaries between said zones are determined and maintained by the following steps:

- (a) detecting a peak traffic condition mainly on the basis of elevator loading time and/or the number of people arriving in an elevator lobby of said building.
- (b) calculating an initial optimal zone boundary value, mainly on the basis of traffic statistics and existing transportation capacity.
- (c) effecting transition of elevator operation to sub-zoning during upward peak traffic.
- (d) re-calculating the optimal zone boundary value mainly on the basis of short-term traffic statistics, the number of people in the elevator lobby and the available transportation capacity.
- (e) sensing the need for change in the zone boundary and effecting the change thereof as calculated in section (d) hereof.
- (f) cancelling the sub-zoning upon completion of the upward peak passenger period or when the volume of upward traffic has fallen below a predetermined limit.

2. A method according to claim 1, wherein long-term and short-term traffic statistics for previous traffic flow situations are utilized as an aid in the detection of a peak traffic condition.

3. A method according to claim 1, wherein information regarding the number of people entering the elevator lobby is used as an aid in the calculation of the optimal initial zone boundary value.



4. A method according to claim 1, wherein long-term traffic statistics are used as an aid in the recalculation of the optimal zone boundary value.
5. A method according to claim 1, wherein when the recalculated zoned boundary value indicates a needed for changing the boundary towards its previous value, a threshold beyond the midpoint of the zone boundary change is observed in making the decision to change.
6. A method according to claim 1, wherein when the elevators are divided into two or more groups to serve different zones of the building, the layout of the elevator groups in the lobby is taken into account to ensure that the elevators serving different zones are separated from each other so as to avoid crisscrossing of the paths of people going to different zones.
7. A method according to claim 1, wherein as selectively required a grouping of the elevators is altered or one or some of the elevators are given the status of freely moving all zone elevators.
8. A method of increasing the transportation capacity of elevators substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

DATED this 19th day of October 1990.

KONE ELEVATOR GmbH
By their Patent Attorneys
COLLISON & CO.

[Handwritten signature]



17783/82

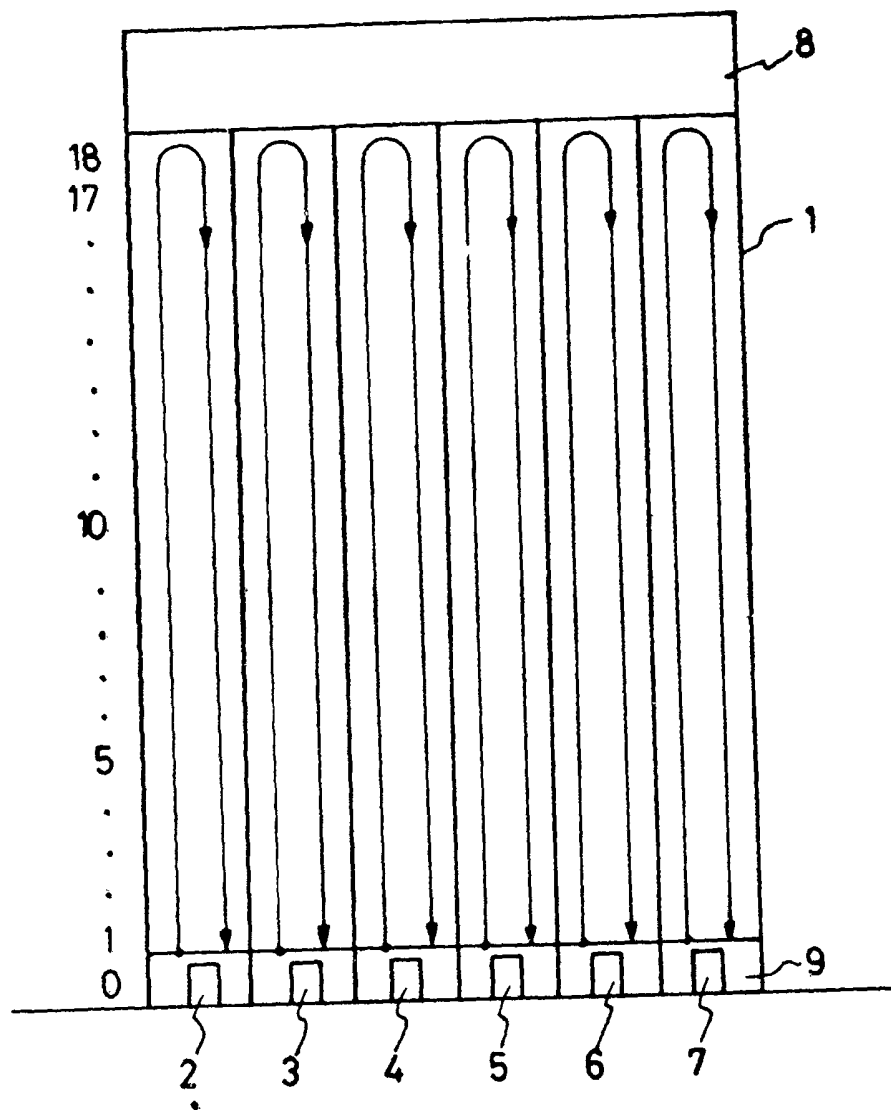


FIG. 1

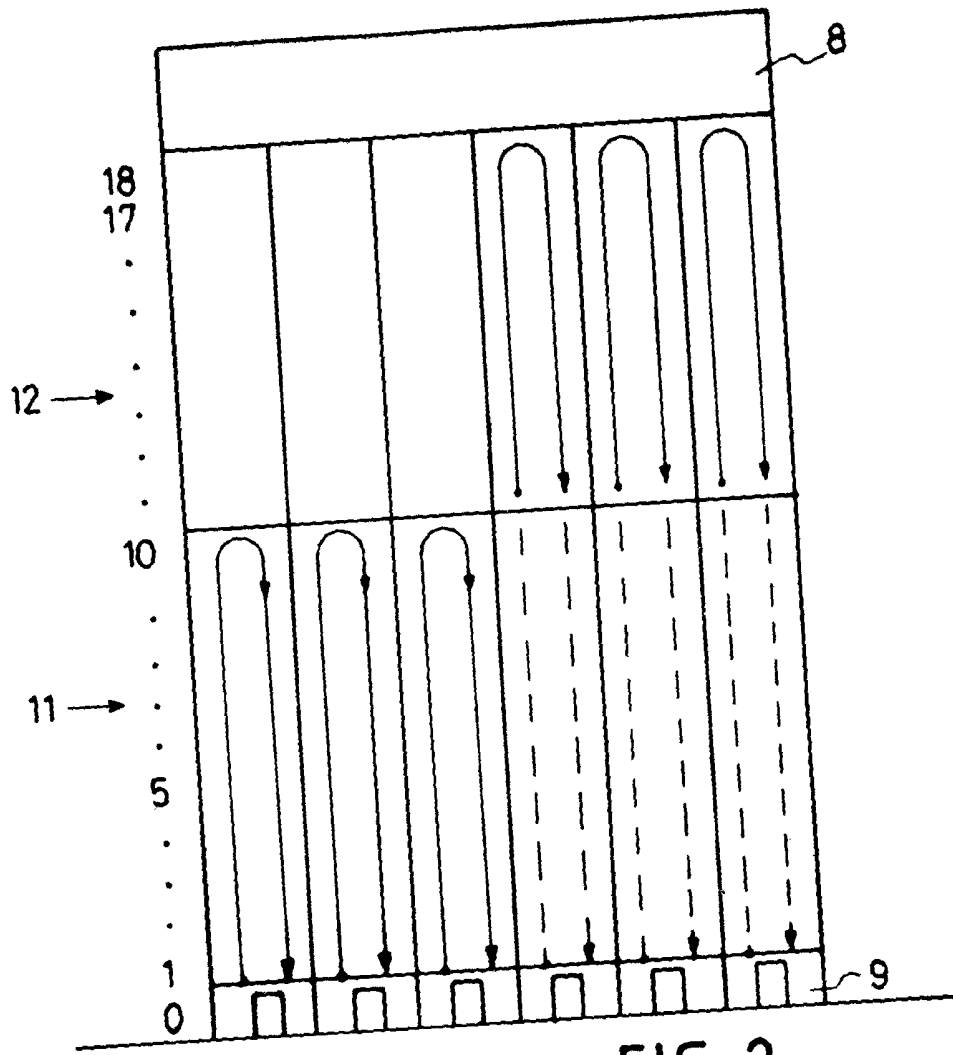


FIG. 2

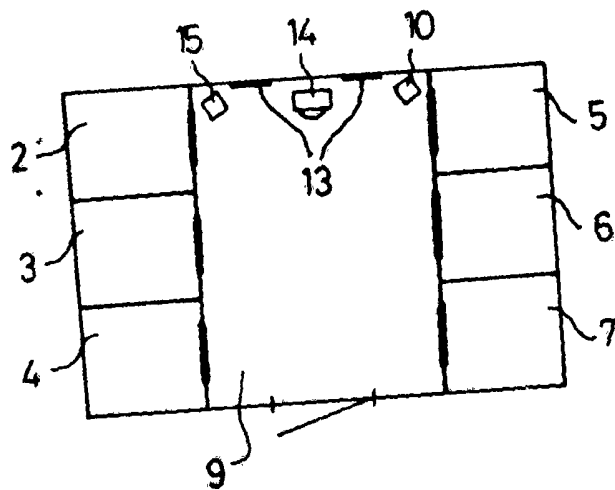


FIG. 3

17 6 88 1783

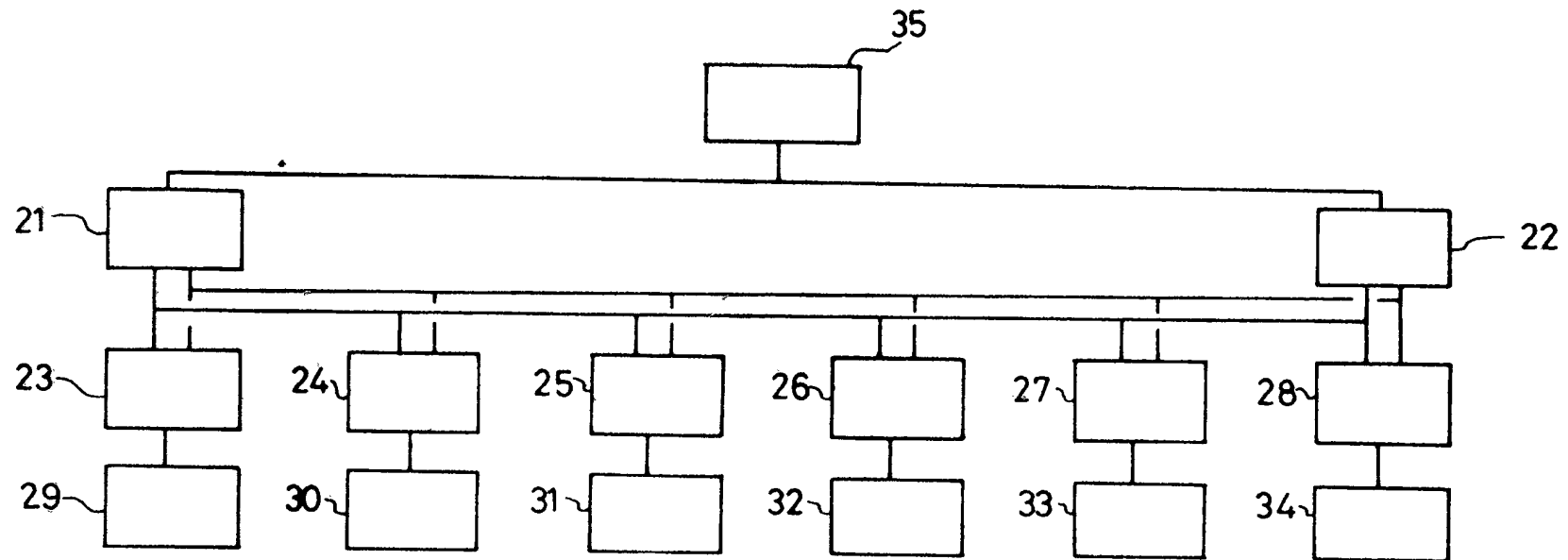


FIG. 4

17 8 88 1783

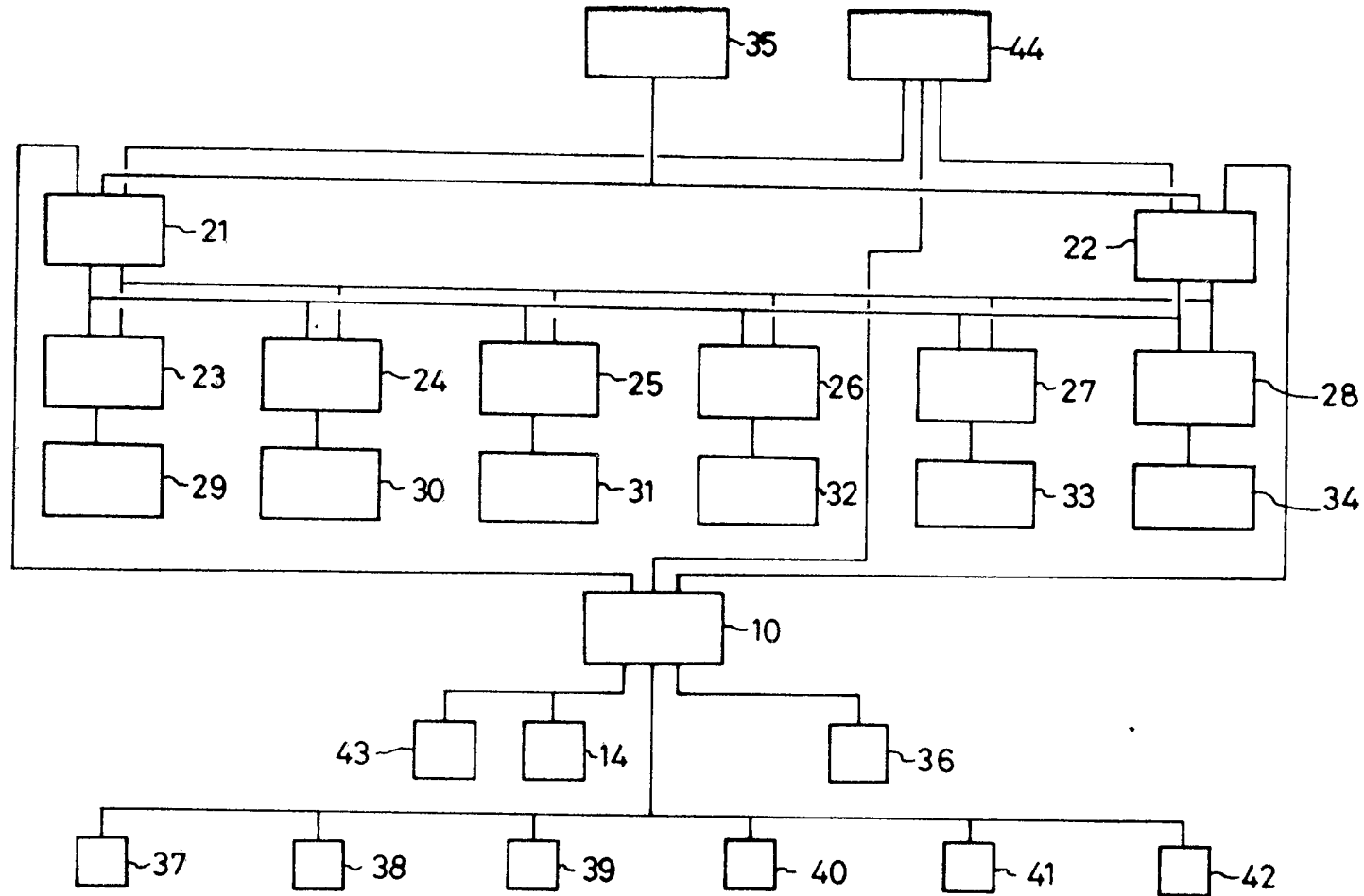


FIG. 5

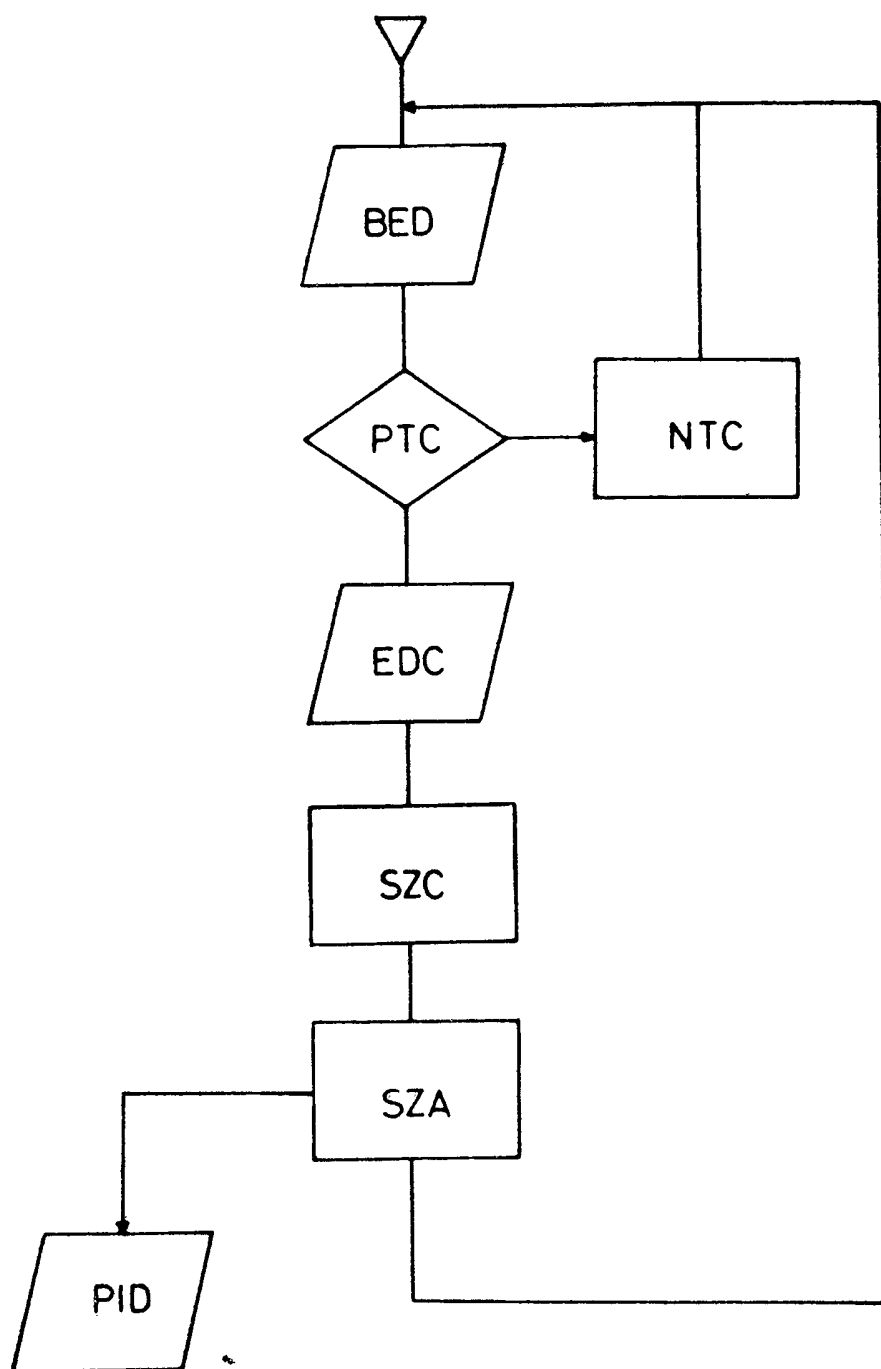


FIG. 6