United States Patent

Yuminaka et al.

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[45] **Feb. 15, 1972**

[54] GROUP SUPERVISORY CONTROL SYSTEM FOR ELEVATORS

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[73] Assignee: **Hitachi, Ltd.,** Tokyo, Japan

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Dec. 27, 1968 Japan.....43/95477
Jan. 31, 1969 Japan.....44/6677

[52] **U.S. Cl.** .....**187/29 R**
[51] **Int. Cl.**.....**B66b 1/20**
[58] **Field of Search**.....187/29

[56] **References Cited**

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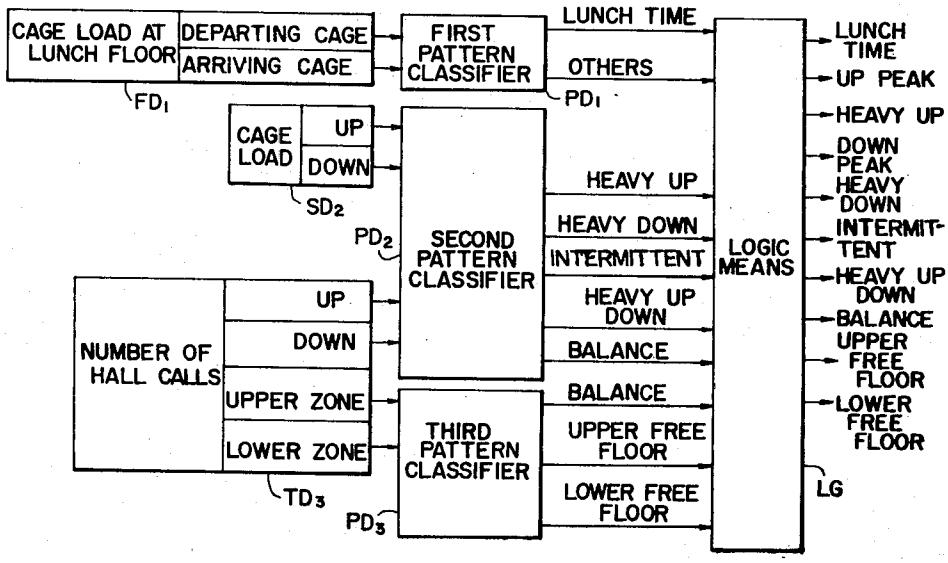
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Primary Examiner—Bernard A. Gilheany
Assistant Examiner—W. E. Duncanson, Jr.
Attorney—Craig, Antonelli & Hill

[57] **ABSTRACT**

A group supervisory system for elevators includes a traffic demand detector for detecting traffic demands to provide a traffic demand signal. Also included is a pattern classifier for producing discriminant functions which are functions of the traffic demand signal and for determining an optimum traffic demand condition by selecting that discriminant function which represents a maximum value.

17 Claims, 22 Drawing Figures



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SHEET 01 OF 16

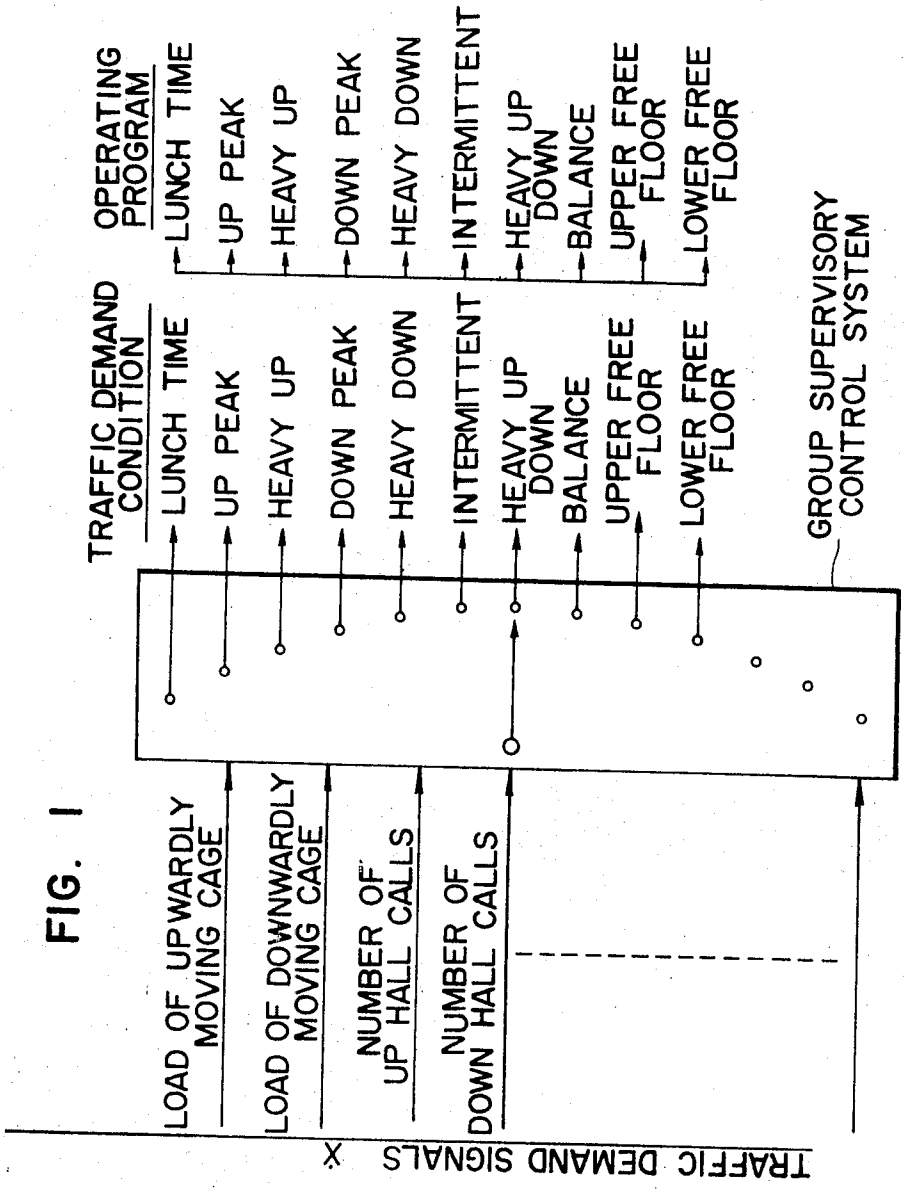


FIG. 1

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FIG. 2

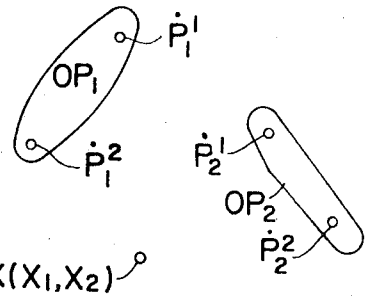


FIG. 5

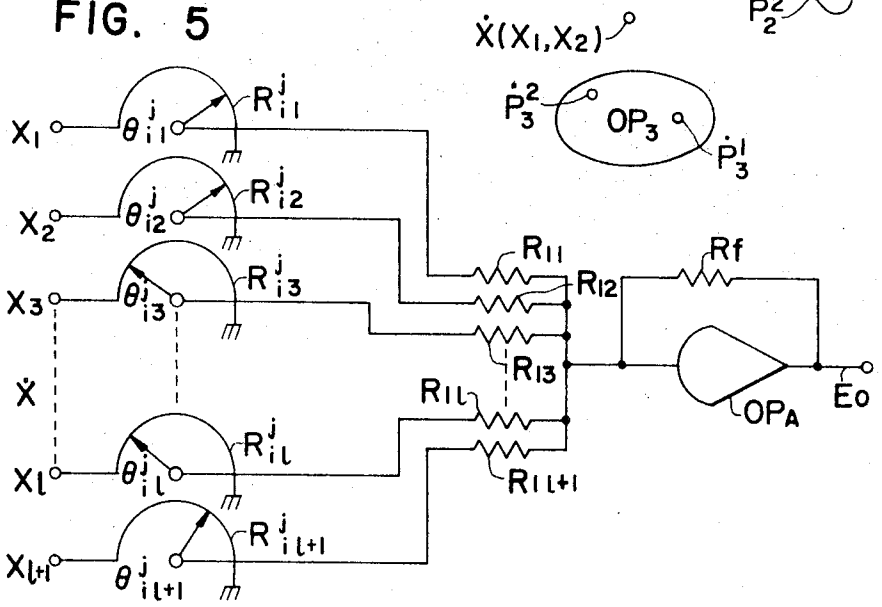
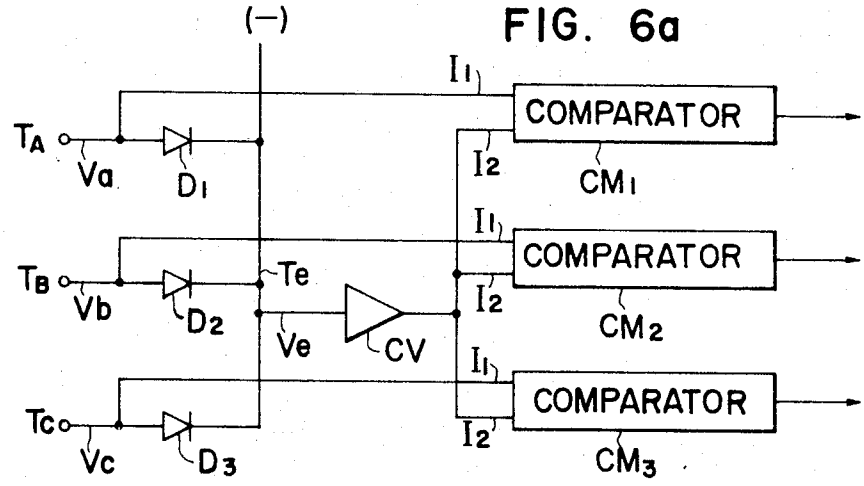


FIG. 6a



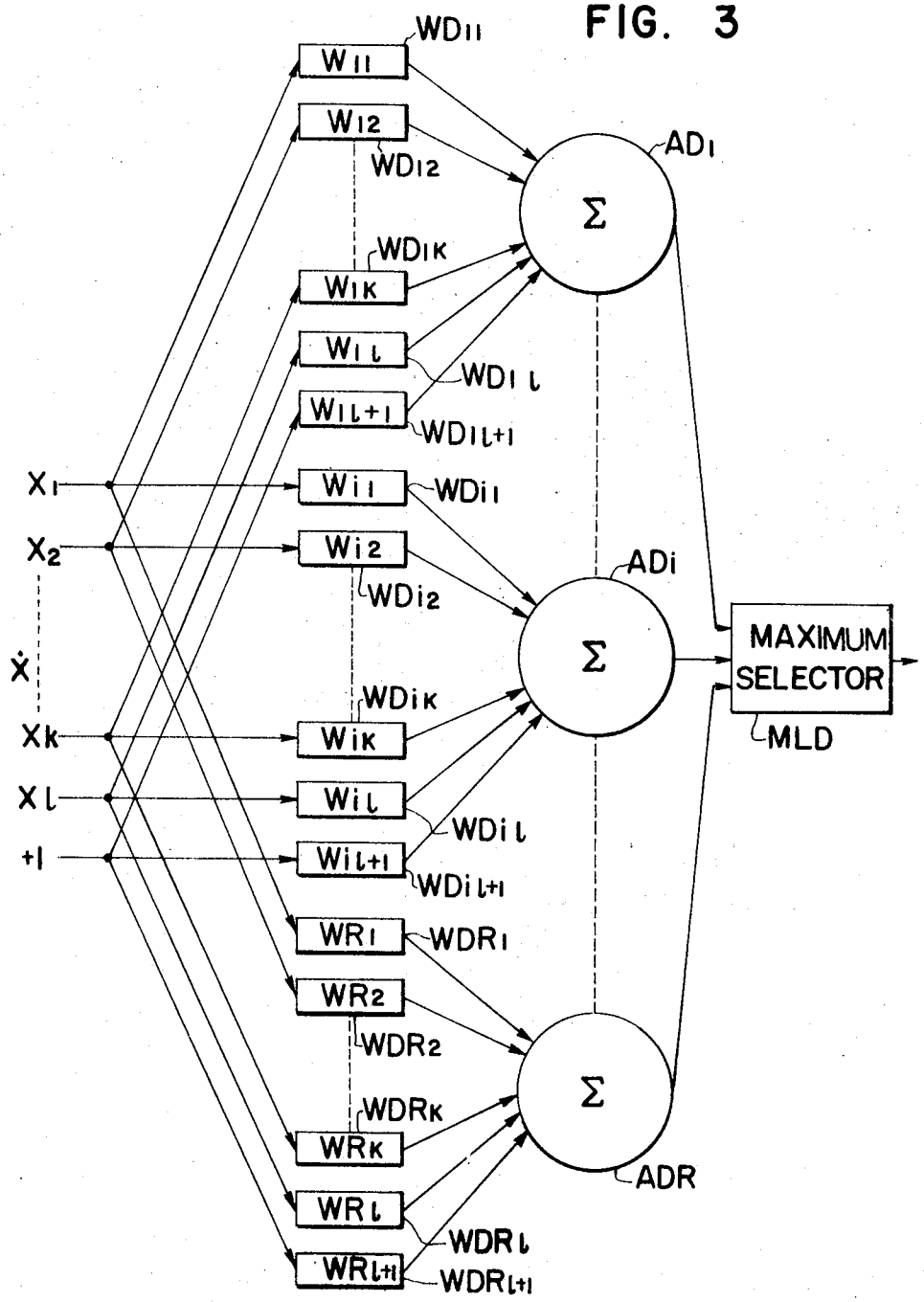
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FIG. 3



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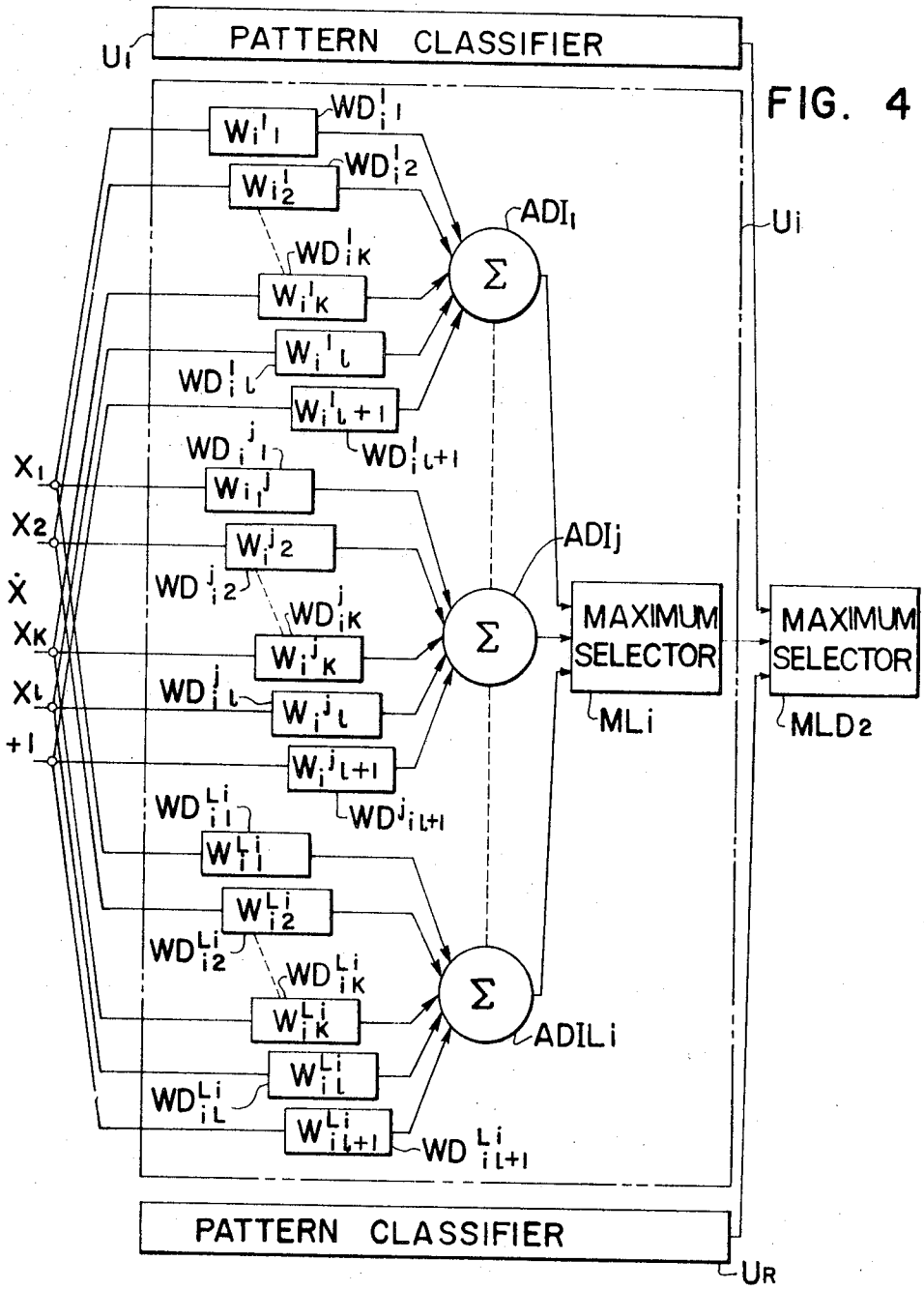


FIG. 4

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FIG. 6b

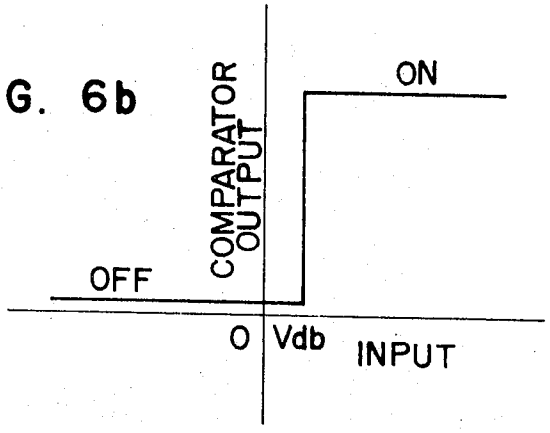


FIG. 7

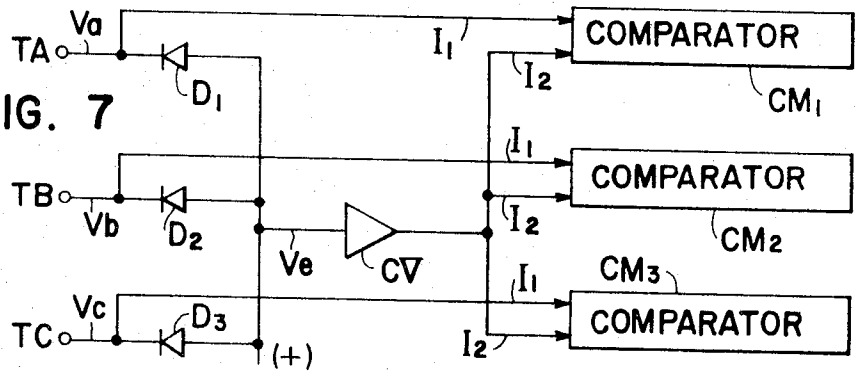
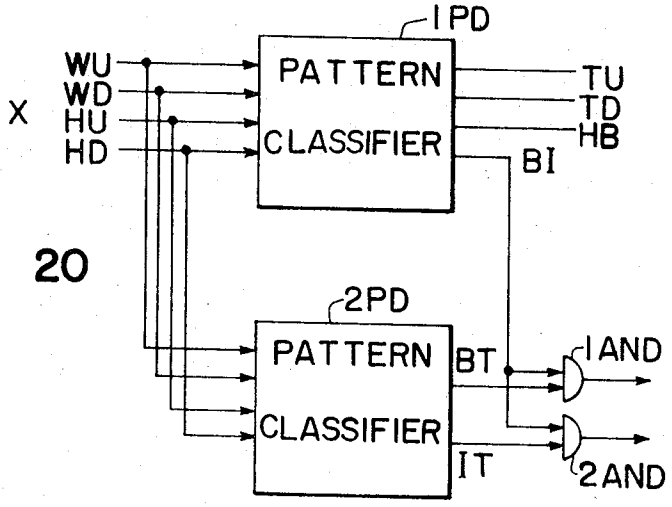


FIG. 20



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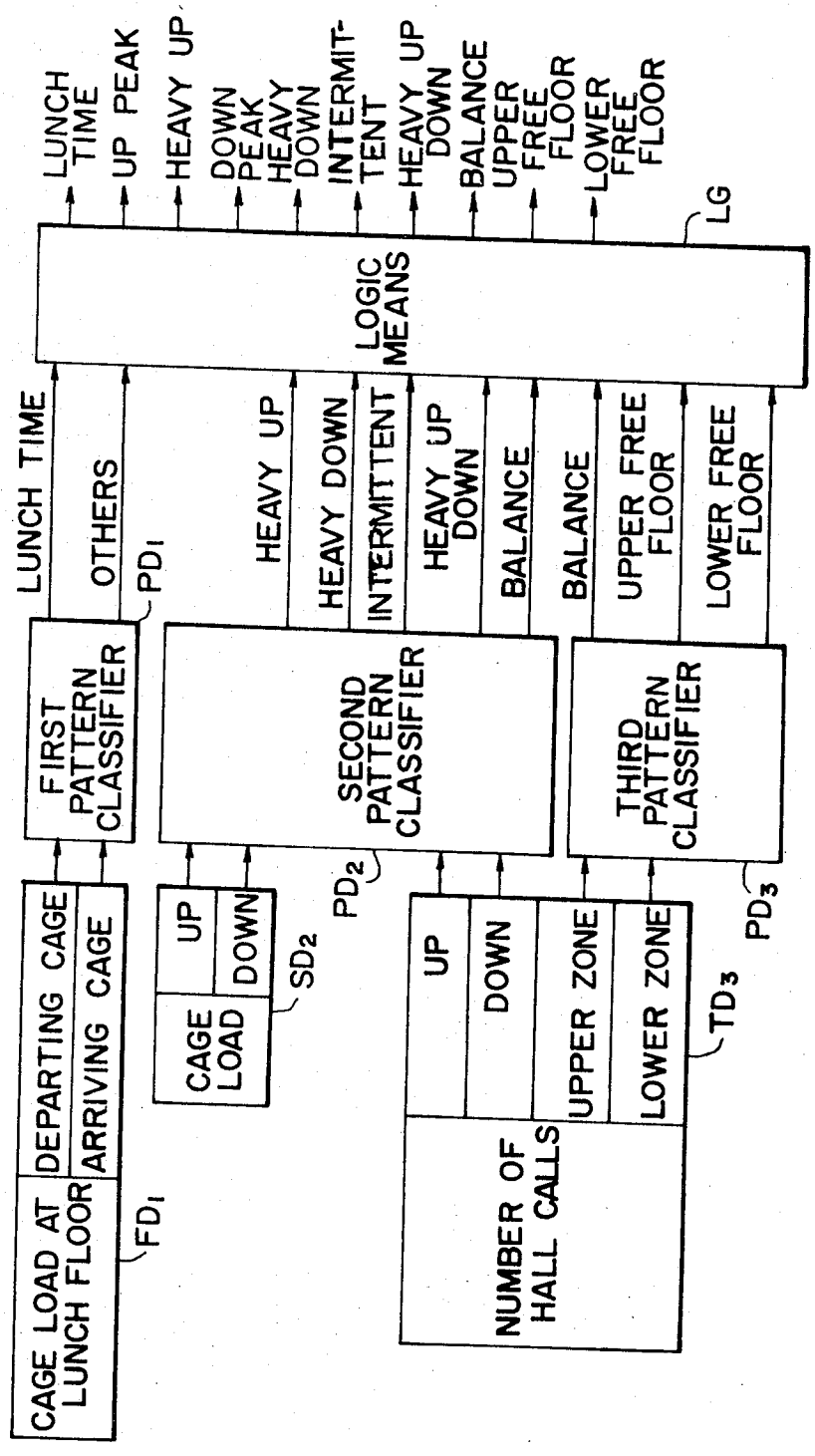


FIG. 8

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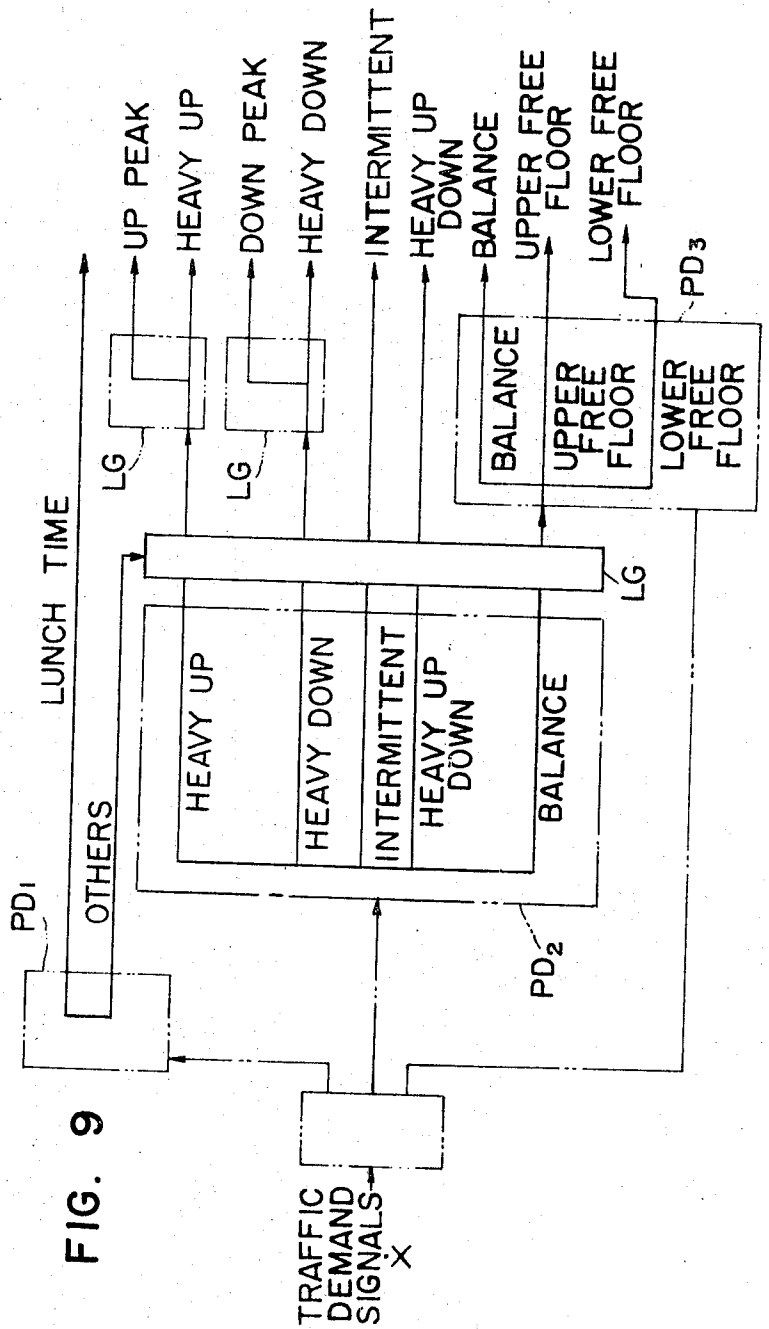


FIG. 9

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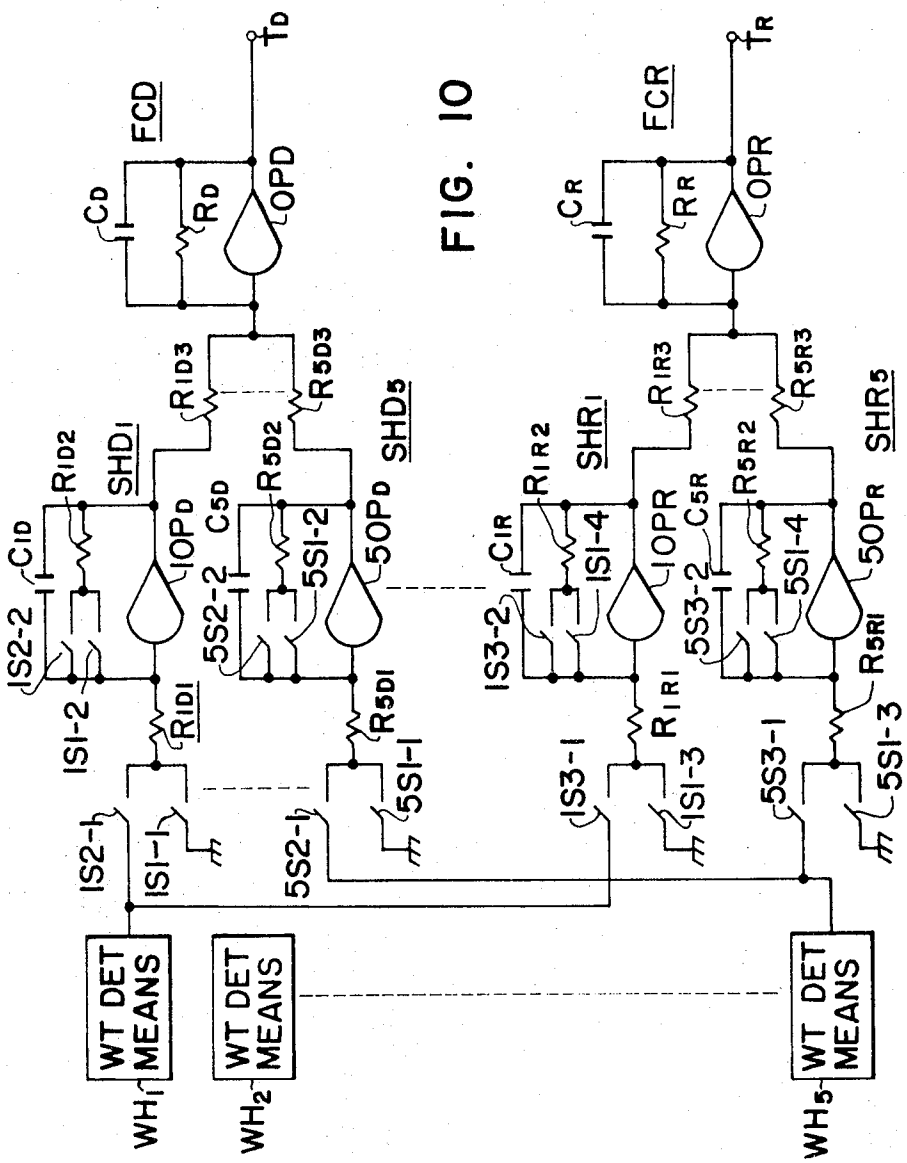


FIG. 10

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FIG. 11

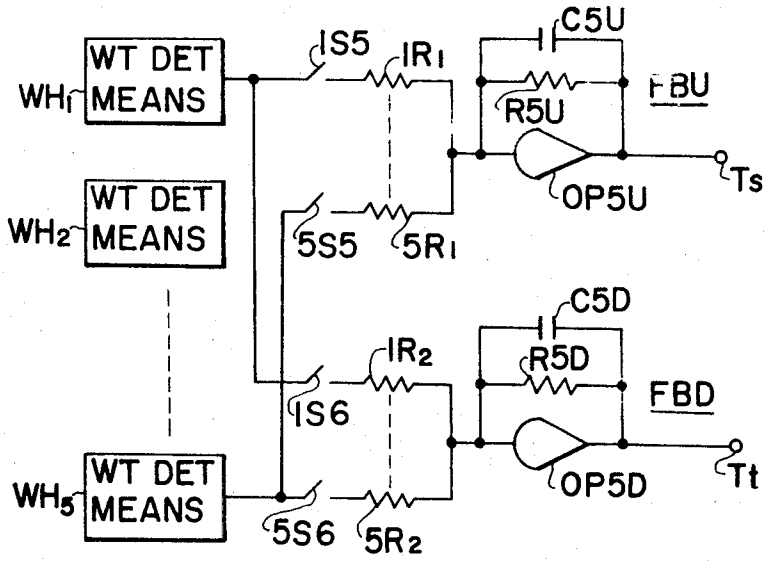
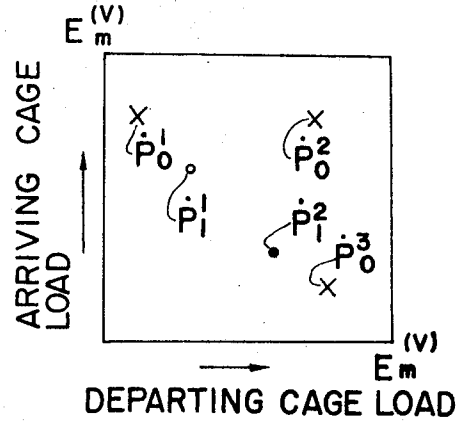


FIG. 14



× LUNCH TIME $\dot{P}_0^1$ • OTHERS $\dot{P}_1^1$

× LUNCH TIME $\dot{P}_0^2$ • OTHERS $\dot{P}_1^2$

× LUNCH TIME $\dot{P}_0^3$

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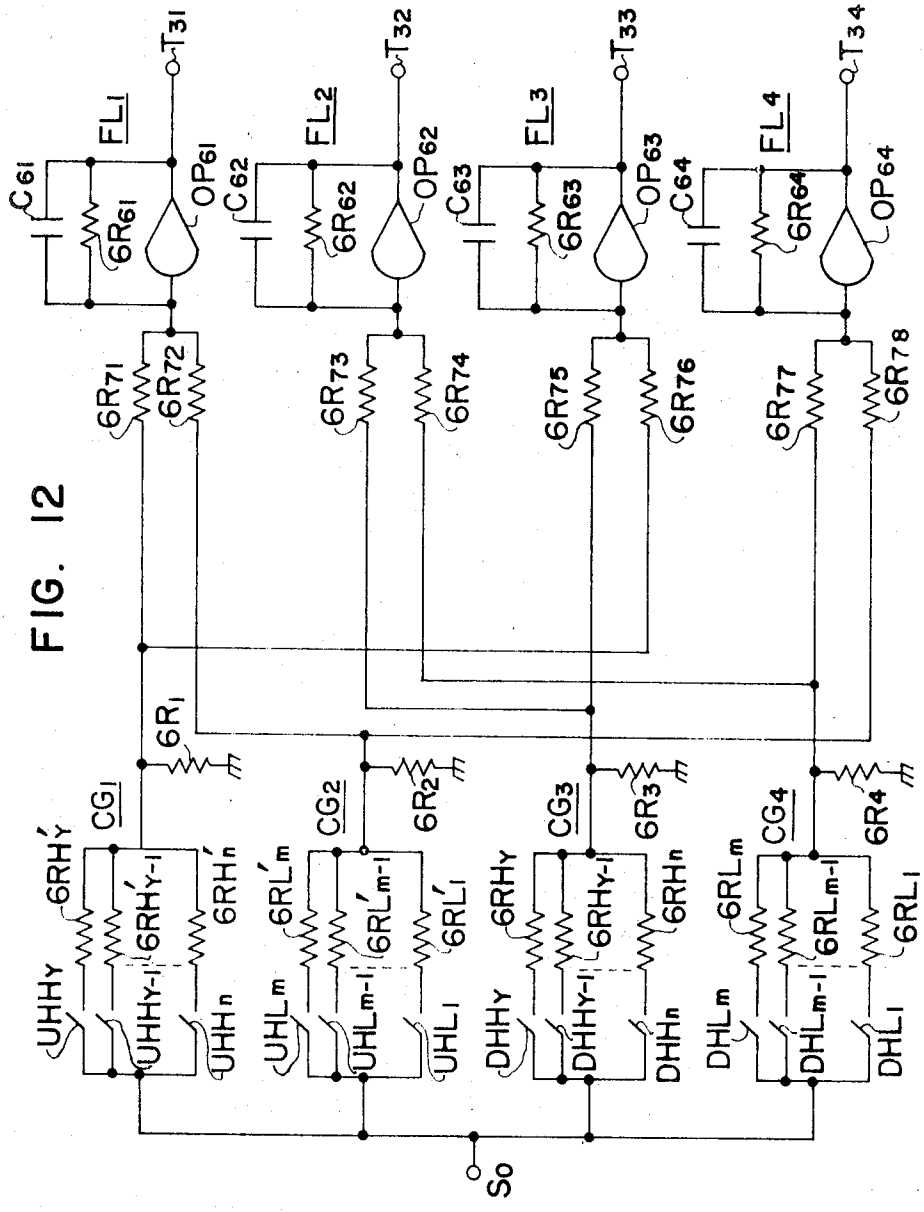


FIG. 12

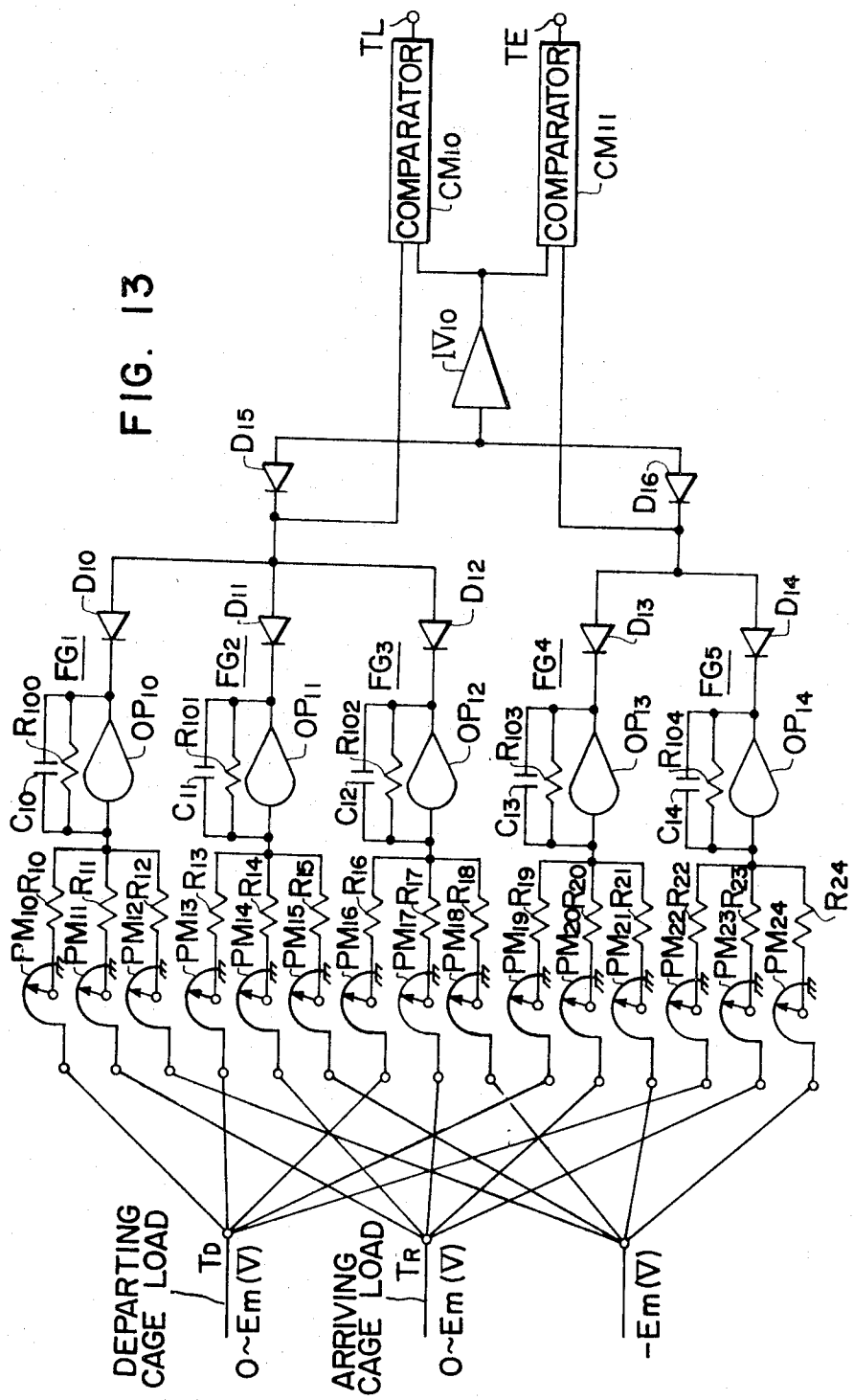
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FIG. 13



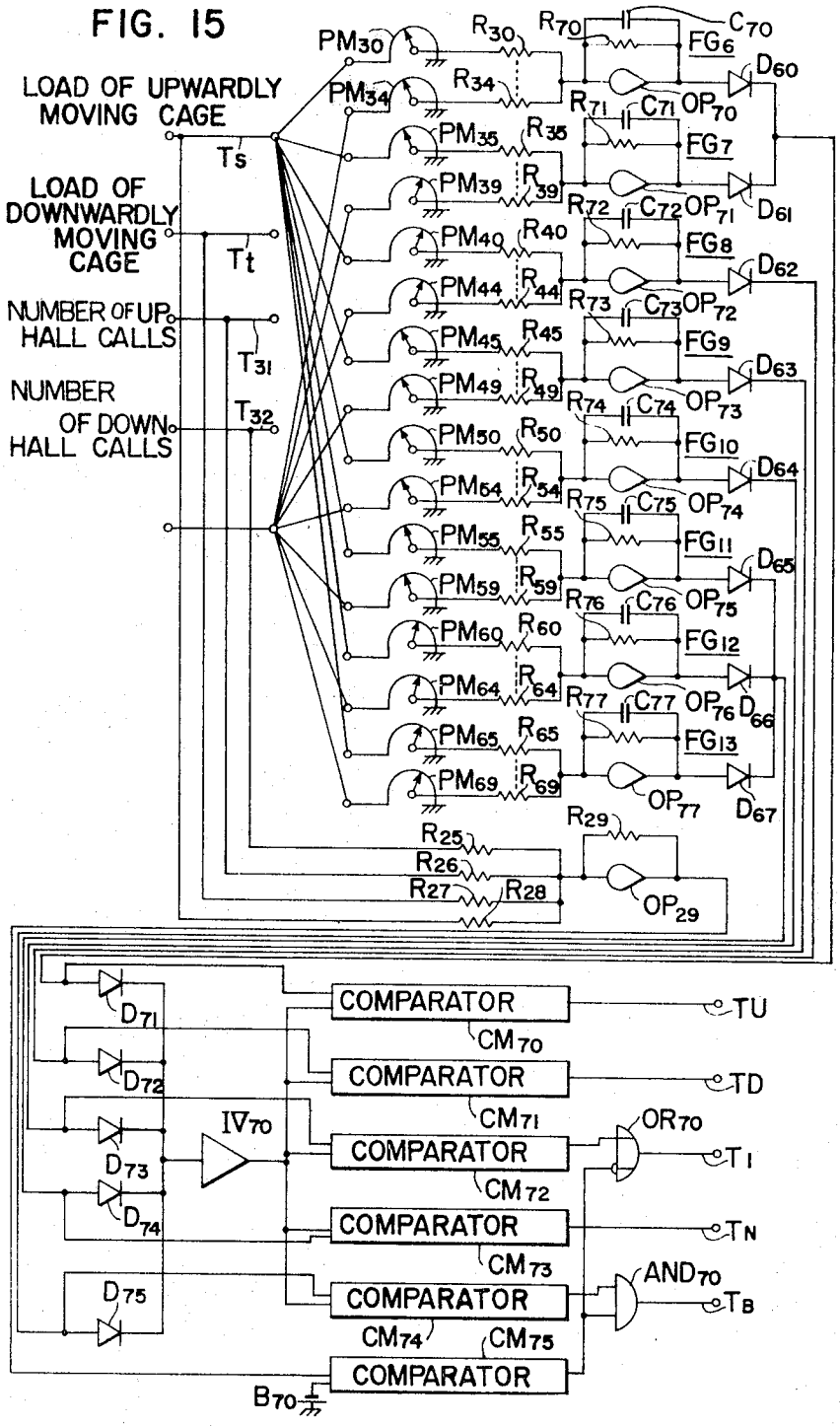
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FIG. 15



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FIG. 16

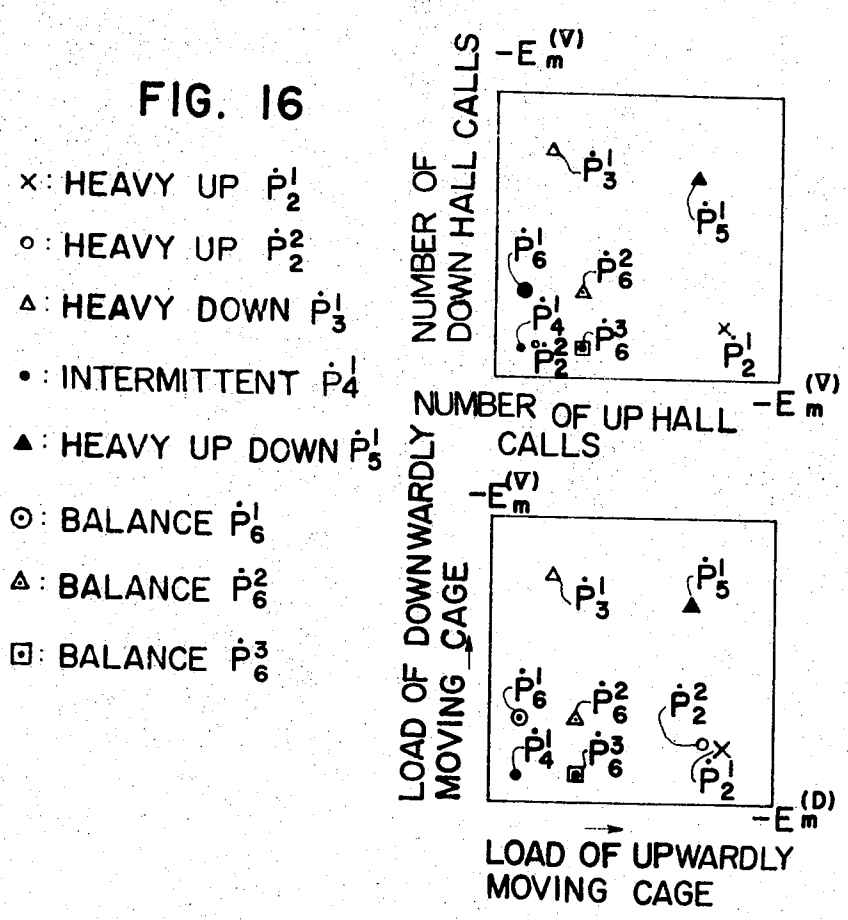
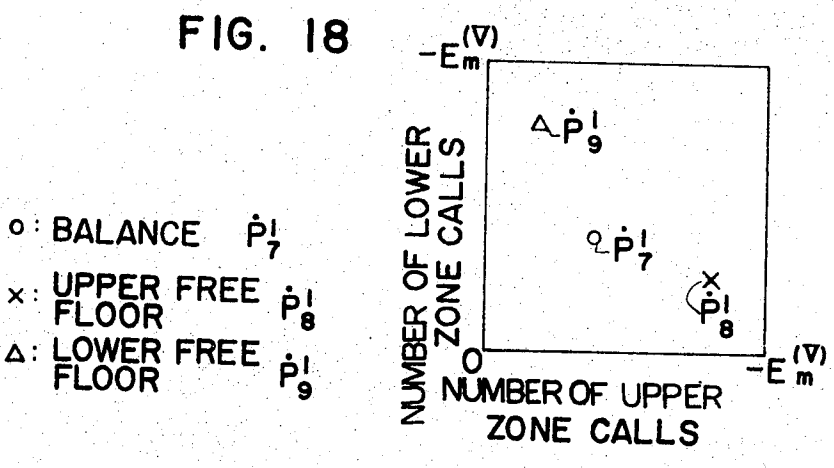


FIG. 18

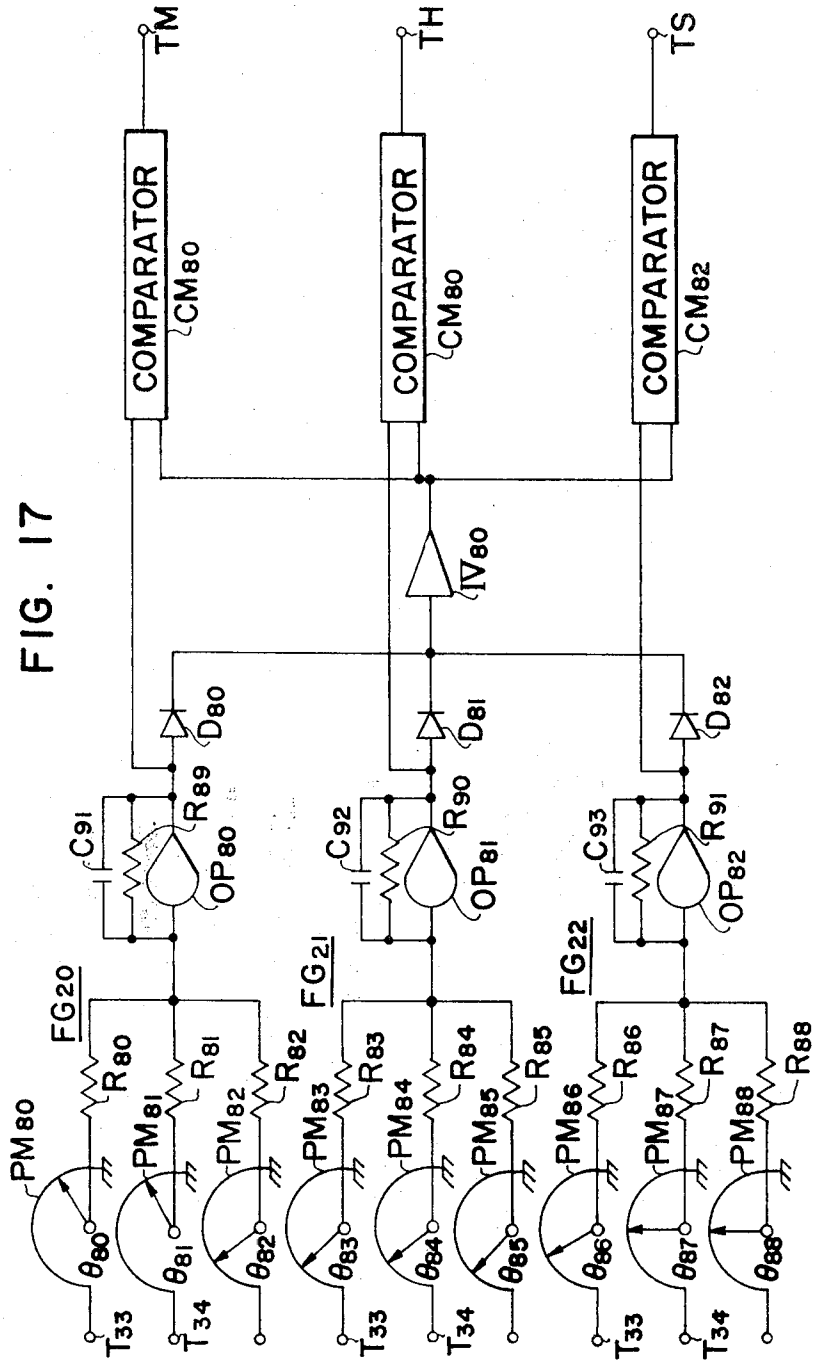


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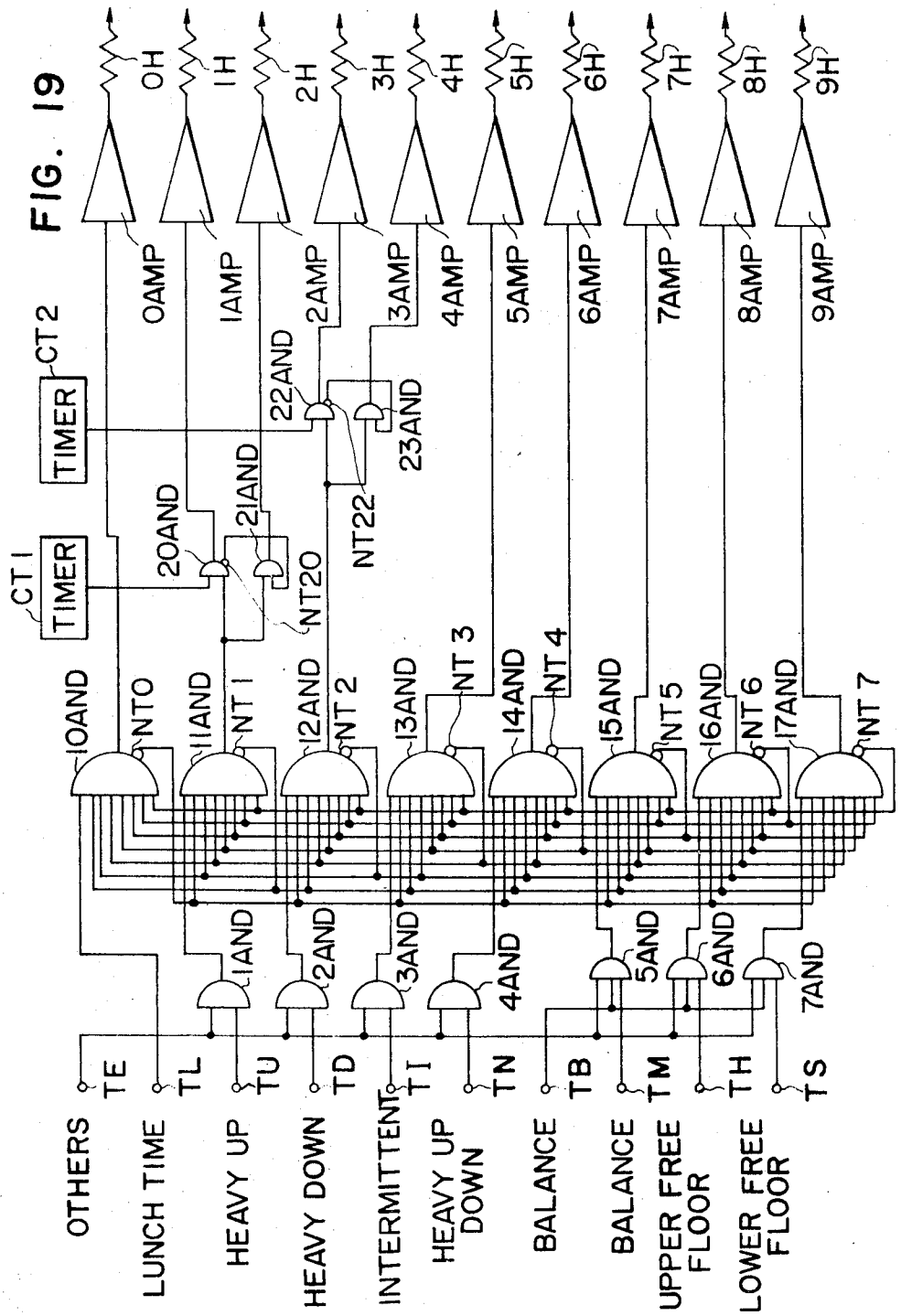
FIG. 17



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FIG. 19



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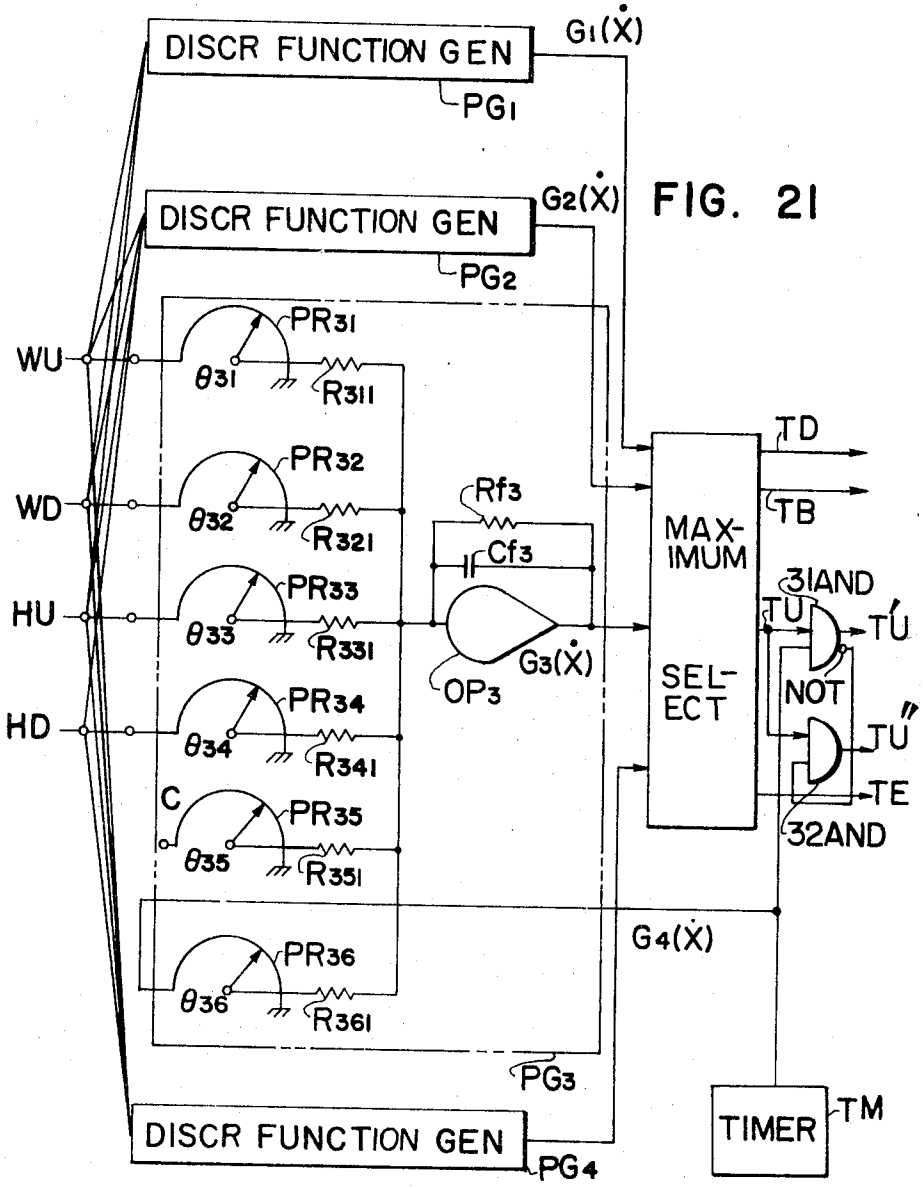


FIG. 21

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GROUP SUPERVISORY CONTROL SYSTEM FOR ELEVATORS

This invention relates to improvements in or relating to elevator group supervisory control system for efficiently operating a plurality of elevators, especially a group of elevators provided in a building in juxtaposition with each other in accordance with the traffic demand for the elevators.

Recently, more and more large-sized buildings have been constructed so that the numbers of elevators and floors thereof have correspondingly increased. Thus, it has become essential to control those elevators as a group rather than individually in such an operating program as to be able to efficiently cope with the traffic demand, thereby increasing the carrying power.

The traffic demand for an elevator group differs between buildings but in the case of a typical office building, it may be classified into several patterns. Such patterns are called traffic demand conditions (referred to simply as demand conditions hereinafter), which may include "lunch time," "heavy up," "heavy down," "intermittent," "balance," "heavy up-down" and so forth. "Lunch time condition" occurs due to the fact that at lunch time, the number of passengers arriving at and leaving the lunch floor suddenly increases. "Heavy up condition" occurs due to the fact that the number of passengers going from the lower dispatching landing to upper middle floors increases before the start of the office hours or at the end of the lunch time. This "heavy up condition" is sometimes further classified into "up peak condition" where there are an increased number of passengers required up direction during the rush hours in the morning for example and "heavy up condition" other than such "up peak."

"Heavy down condition" occurs due to the fact that passengers working on upper floors go down to the lower dispatching landing all at once at the end of the office hours or at the start of the lunch time. This "heavy down condition" is often classified into "down peak condition" where there are an increased number of passengers required down direction and other "heavy down condition," other than such "down peak," as in the case of "heavy up."

"Heavy up-down condition" occurs when the number of passengers temporarily increases during the day time, with a balance substantially maintained between the number of passengers required up direction and that of passengers required down direction. As the number of passengers further decreases, "balance condition" occurs which may also be classified into "upper free floor" or "lower free floor" where there is a relatively great demand for the upper floor zone or lower floor zone and other "balance condition," other than such "upper free floor" and "lower free floor." During a "upper free floor" condition, in general, the number of upper zone calls is much greater than the number of lower zone calls. However, during a "lower free floor" condition, the number of lower zone calls is much greater than the upper zone calls.

The foregoing demand conditions may be conceivable, but it is impossible to directly grasp them since the traffic demands for elevators include a variety of factors and always continuously change. However, the aforementioned classification of the demand conditions is possible by effecting analysis and synthesis based upon traffic demand signals $\dot{X}$ (referred to simply as demand signals hereinafter) consisting of several typical factors such as shown in FIG. 1. In an attempt to control the driving of the elevators, the control is effected with respect to each elevator group in accordance with an operating pattern suited to the thus determined demand conditions. This operating pattern is called operating program which is normally made to correspond to the respective demand conditions as shown in FIG. 1. In case the demand condition corresponds to "up peak condition" for example, then a group of elevators are operated in accordance with the program of "peak up operation."

However, if the operating program of "heavy up-down operation" cannot be carried out in the case where the demand condition corresponds to "heavy up-down," then "heavy operation" may be instructed.

The group control system is so designed as to select that demand condition which corresponds to a particular time from the foregoing limited demand signals so as to efficiently operate plural elevators. There have heretofore been proposed a variety of such systems. However, such conventional systems have such a disadvantage that the means for detecting demand signals and means for selecting a particular demand condition become large-sized and complicated as the number of elevators to be group-controlled and elevator floors increase, since all of them are constituted by a mere combination of contact type or contactless type relays.

It is an object of the present invention to provide a group supervisory control system for elevators which can be easily constituted by solid state devices (miniaturized), wherein the adjustment of piecewise boundary line (or piecewise boundary face) can be easily achieved.

Another object of the present invention is to provide a system whereby an l-number of variable parameters defined by l-parameter demand signals $\dot{X}$ consisting of several factors of traffic demand are sectioned in such a manner as to be most suitable to each demand condition, thereby making it possible to select a demand condition closer to the actual traffic demand for the elevators.

Still another object of the present invention is to provide a system wherein use is made of at least two sets of pattern classifiers, demand signals consisting of factors of traffic demand partly and overlapping each other or completely different from each other are supplied to the respective pattern classifiers, the number of parameters of each of the pattern classifiers is reduced to simplify the system, and the volume in which the demand signals are present is reduced so that an accurate faculty of discrimination can be achieved by setting up a small number of prototype points.

Still another object of the present invention is to provide a system wherein use is made of at least two sets of pattern classifiers, demand signals consisting of the same factors of traffic demand are supplied to the respective pattern classifiers, the discriminant functions of the lower rank pattern classifiers are set up to be greater than those of the higher rank pattern classifiers to make the resolutions of the former than those of the latter, thereby making it possible to achieve more accurate discrimination.

A further object of the present invention is to provide a traffic demand detecting means wherein a load in each elevator cage is sampled and held every time a particular floor is reached or left so that the traffic demand for the particular floor is continuously detected, and the demand for the floors between the particular floor and the terminal floor is neglected when the former is close to the latter, thereby accurately detecting traffic demands.

A further object of the present invention is to provide a traffic demand detecting means which is capable of detecting the number of all hall calls for each floor zone and number of "up" hall calls and "down" hall calls at all the floors merely by using one contact (including a contactless type one) corresponding to each hall call.

A still further object of the present invention is to provide a maximum (or minimum) selecting means constituted by a combination of diodes and comparator means utilizing the forward voltages of the diodes.

Other objects, features and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view useful for explaining a group control system for elevators;

FIG. 2 is a view useful for explaining the principle of the present invention for discriminating traffic demand signals into several demand conditions;

FIGS. 3 and 4 are block diagrams showing the functions of an embodiment of the present invention, respectively;

FIG. 5 is a circuit diagram showing an example of distance function generator;

FIG. 6*a* is a block diagram showing an example of maximum selector;

FIG. 6*b* is an input to output characteristic diagram in a comparator;

FIG. 7 is a block diagram showing an example of minimum selector;

FIG. 8 is a functional view illustrating the system according to an embodiment of the present invention;

FIG. 9 is a view useful for explaining the same;

FIG. 10 is a circuit diagram showing an example of the first detector used in the present invention;

FIG. 11 is a circuit diagram showing an example of the second detector;

FIG. 12 is a circuit diagram showing an example of the third detector;

FIG. 13 is a circuit diagram showing an example of the first pattern classifier;

FIG. 14 is a view useful for explaining the prototype point thereof;

FIG. 15 is a circuit diagram showing an example of the second pattern classifier;

FIG. 16 is a view useful for explaining the prototype point thereof;

FIG. 17 is a circuit diagram showing an example of the third pattern classifier;

FIG. 18 is a view useful for explaining the prototype point thereof;

FIG. 19 is a view showing an example of the logic means;

FIG. 20 is a view showing another example of the pattern classifier; and

FIG. 21 is a view showing another example of the discriminant function generator.

The operational principle of the present invention is based on such an idea that a given demand signal is classified by using a discriminant function $gi(\dot{X})$. Now, the traffic demand for juxtaposed elevators is grasped as an l-parameter demand signal $\dot{X}$ consisting of a plurality of factors of traffic demand $X_1, X_2, \ldots, X_l$, and an optimum discriminant function $gi(\dot{X})$ is determined for each demand condition. The term "l-parameter" demand signal $\dot{X}$ refers to a signal representing "l-variable parameters." The term "l-variable parameters" represents the function having any number of parameters. For example, where $l=2$, the "l-variable parameters" represent a pair of variables corresponding to a two-dimensional space or plane. Furthermore, where $l=3$, a cubic or a three-dimensional volume having length, width and height may be used to represent the three parameters. For a set of parameters having l equal to or greater than 4, the function cannot be humanly visualized, but is a physical entity which can exist theoretically. Now assume that the discriminant function $gi_o(\dot{X})$ which belongs to the demand signal i_o represents the largest value in all discriminant functions $gi(\dot{X})$. In the above case, the traffic demand for the elevators at that time is determined as the demand condition i_o.

The discriminant function representing a maximum value described above refers to one which represents a substantially maximum value. Thus, even if superficially an attempt is being made to select a discriminant function which represents a minimum value, substantially a discriminant function which represents a maximum value is being selected. In case $g_3(\dot{X})$ of functions $g_1(\dot{X})$, $g_2(\dot{X})$ and $g_3(\dot{X})$ represents a maximum value, then the function representing a minimum value will be $-g_3(\dot{X})$, on the assumption that the signs of these functions are negative. Conversely, if $g_1(\dot{X})$ of the functions $g_1(\dot{X})$, $g_2(\dot{X})$and $g_3(\dot{X})$ represents a minimum value, then $-g_1(\dot{X})$ will represent a maximum value, on the assumption that the signs of these functions are negative.

Various types of functions may be employed as discriminant functions, but in the following discussion, description will be made of ones of which the prototype points are set up for the respective demand conditions for the sake of simplicity. The term "prototype point" corresponds to a representative point, which is employed to divide an n-parameter function (where n is an arbitrary number) into more than two categories. That is, in the embodiments described herein, traffic demands for the elevators are continuously detected by means of various detectors, detection is made of that one of the prototype points to which the demand signal $\dot{X}$ is closest which consists of a plurality of factors of traffic demand resulting from said continuous detection, and the demand condition to which the prototype point thus detected is dealt with as the demand condition at that time. Thus, it is possible to set up the prototype points so as to cope with the status of each individual building and yet freely adjust them for all the factors of traffic demand.

Assume now that the demand signal is represented by an l-parameter vector $\dot{X}=(X_1, X_2, X_3, \ldots, X_l)$ consisting of l detection elements, and that the demand conditions are given by $OP_1, OP_2, \ldots, OP_R$.

The detection elements described above may include the following. The demand conditions are as already described.

Factors of traffic demand:

A. Weight of the elevator cage during the "up" trip

B. Weight of the elevator cage during the "down" trip

C. Number of up hall calls

D. Number of down hall calls

E. Others

By dividing the l-variable parameter function in which the elevator demand signal $\dot{X}$ represented by the plural factors of traffic demand $X_1, X_2, X_3 \ldots, X_l$ into R regions in accordance with the demand conditions (such division is effected so that the optimum one of the demand conditions may be selected when a certain demand signal $\dot{X}$ is provided for example) and discriminating that region to which belongs the demand signal X represented by the factors of traffic demand $X_1, X_2, X_3, \ldots$ X_l which vary in accordance with the real traffic demand for the elevators, it is possible to make the operating program of the elevator control system corresponding to the selected demand condition optimum. This function is required of the group control system for elevators.

In this case, it may be conceivable to continuously and precisely section the l-variable parameters in which the demand signal $\dot{X}$ is present into R demand conditions, but this is not practical.

Here, description will be made of the case where an attempt is made to operate the elevator group in accordance with an operating program which corresponds to the demand condition to which belongs that one of a suitable number of prototype points set up for each demand condition which is closest to the demand signal $\dot{X}$, with said demand condition as the optimum demand condition at that time.

Assume that the demand signal $\dot{X}$ is two-dimensional or has two variable parameters, that the demand conditions are represented by OP_1 to OP_3 respectively, that the prototype points of the demand condition OP_1 are represented by $\dot{P}_1^1$ and $\dot{P}_1^2$, that the prototype points of the demand condition PO_2 are represented by $\dot{P}_2^1$ and $\dot{P}_2^2$, and that the prototype points of the demand condition OP_3 are represented by $\dot{P}_3^1$ and $\dot{P}_3^2$, as shown in FIG. 2. Then, in the case where the demand signal $\dot{X}$ is as shown in the drawing, it is closest to the prototype point $\dot{P}_3^2$ so that the optimum demand condition is determined to correspond to OP_3, and thus the operation is performed in accordance with the operating program. In the cases where the demand signal represents three-parameters or higher, too, what has been described just above holds true. Generally, this may be explained as follows:

Assume that the following S prototype points are set up in an l-parameter vector set constituting the demand signal $\dot{X}$.

$\dot{P}_1^1, \dot{P}_1^2, \dot{P}_1^3, \ldots, \dot{P}_1^{L_1}$ (Prototype points belonging to the first demand condition)

$\dot{P}_2^1, \dot{P}_2^2, \dot{P}_2^3, \ldots, \dot{P}_2^{L_2}$ (Prototype points belonging to the second demand condition)

$\dot{P}_R^1, \dot{P}_R^2, \dot{P}_R^3, \ldots, \dot{P}_R^{L_R}$ (Prototype points belonging to the Rth demand condition)

$$S=L_1+L_2+L_3+\ldots\ldots\ldots+L_R$$

The prototype point represented by $\dot{P}_i^j$ ($j=1, 2, 3, \ldots L_i$) belongs to the ith demand condition. Thus, the number of prototype points belonging to the first demand condition is L_1, the number of prototype points belonging to the second demand condition is L_2, and the number of prototype points belonging to the Rth demand condition is L_R.

In order to determine the optimum demand condition, therefore, it is necessary to select that one of the S prototype points $\dot{P}_i^j$ which is closest to the distance between the demand signal $\dot{X}$ and each of the S prototype points.

The square of the distance between the demand signal $\dot{X}$ and the prototype point $\dot{P}_i^j$ is represented by

$$|\dot{X}-\dot{P}_i^j|^2=\dot{X}\cdot\dot{X}-2\dot{X}\cdot\dot{P}_i^j+\dot{P}_i^j\cdot\dot{P}_i^j$$
$$=\dot{X}\cdot\dot{X}-2(\dot{P}_i^j\cdot\dot{X}-\tfrac{1}{2}\dot{P}_i^j\cdot\dot{P}_i^j) \quad (1)$$

where "a" indicates inner product. From this, it will be seen that the prototype point closest to the demand signal X is the one where the

$$2(\dot{P}_i^j\cdot\dot{X}-\tfrac{1}{2}\dot{P}_i^j\cdot\dot{P}_i^j)$$

in equation (1) becomes maximum. Assume now that L_i prototype points belonging to the ith demand condition are represented by the following function (this function will be referred to as distance function since the prototype point where this function becomes maximum corresponds to the one having the shortest space distance with respect to the demand signal $\dot{X}$):

$$g_i^j(\dot{X})=\dot{P}_i^j\cdot\dot{X}-\tfrac{1}{2}\dot{P}_i^j\cdot\dot{P}_i^j \quad (2)$$
$$j=1, 2, 3, \ldots\ldots, L_i$$

Then, the term $g_i(\dot{X})$ which represents a maximum value is sought from L_i functions.

$$g_i(\dot{X})=\text{Max}\,[g_i^j(\dot{X})] \quad (3)$$
$$j=1, 2, 3, \ldots\ldots, L_i$$
$$i=1, 2, 3, \ldots\ldots, R$$

By selecting the following term $g_{i0}(\dot{X})$

$$g_{i0}(\dot{X})=\text{Max}\,g_i(\dot{X}) \quad (4)$$

which represents a maximum value from the R distance functions which are selected as one for each demand condition, the i_0th demand condition to which this term belongs becomes the optimum demand condition in this case. Assume that the hth one $\dot{P}_f^h(i=f, L_f=h)$ of the prototype points belonging to the fth demand condition has the short space distance with respect to the demand signal $\dot{X}$. Then, the hth one of the prototype points belonging to the fth demand condition is closest to X, so that the distance function of that prototype point or

$$g_f^h(\dot{X})=\dot{P}_f^h\cdot\dot{X}-\tfrac{1}{2}\dot{P}_f^h\cdot\dot{P}_f^h \quad (5)$$

becomes maximum. Thus, $g_f^h(\dot{X})$ is selected. In the case of other demand conditions, too, the prototype points each of which represents a maximum value are similarly selected.

In this way R prototype points of the respective demand conditions (each prototype point is closest to $\dot{X}$ among the prototype points belonging to each demand condition.) are selected.

It will be apparent that $g_f(\dot{X})$ belonging to the fth demand condition becomes maximum since that one of the functions $g_i(\dot{X})$ which represents the greatest value is closest to $\dot{X}$.

Thus, it is judged that the prototype point which is closest to the demand signal $\dot{X}$ is $\dot{P}_f$, and that the demand condition is the fth one. Consequently, the mode of operation of the elevator group is switched to the fth operating program.

In the foregoing, description has been made of the case where use is made of the following function in order to effect discrimination with respect to the prototype point closest to $\dot{X}$

$$g_i^j(\dot{X})=\dot{P}_i^j\cdot\dot{X}-\tfrac{1}{2}\dot{P}_i^j\cdot\dot{P}_i^j$$

However, it is also possible to use any other function.

As described above, it is essential that at least one prototype point which represents each demand condition be set up in an l-parameter vector set in which the demand signal $\dot{X}$ is present, and that the prototype one which has the minimum function distance with respect to $\dot{X}$ be selected. It has also been described that this can be achieved by effecting operations represented by equations (2), (3) and (4).

Next, description will be made of the case where each demand condition includes one prototype point (this case corresponds to $j=1$), for the sake of simplicity.

Generally, a vector inner product $\dot{P}\cdot\dot{X}$ is represented by

$$P_1X_1+P_2X_2+P_3X_3+\ldots\ldots+P_lX_l \quad (6)$$

on the assumption that the components of the vector $\dot{P}$ are P_1, P_2, P_3, ..., P_l and those of the vector $\dot{X}$ are X_1, X_2, X_3, ..., X_l. Thus, if it is assumed that the components of the demand signal $\dot{X}$ are X_1, X_2, X_3, ..., X_l and that the components of the prototype point P_i of the ith demand condition are P_{i1}, P_{i2}, P_{i3}, ..., P_{il}, then the following equation holds true

$$\dot{P}_i\cdot\dot{X}=P_{i1}X_1+P_{i2}X_2+\ldots\ldots+P_{il}X_l\ldots\ldots \quad (7)$$

Similarly, the following equation holds true

$$-\tfrac{1}{2}\dot{P}_i\cdot\dot{P}_i=-\tfrac{1}{2}\sum_{k=1}^{l}(P_{ik})^2 \quad (8)$$

Therefore, equation (2) is reduced to

$$P_{i1}X_1+P_{i2}X_2+\ldots\ldots+P_{il}X_l-\tfrac{1}{2}\sum_{k=1}^{l}(P_{ik})^2 \quad (9)$$

Since

$$P_{i1}, P_{i2}, \ldots\ldots, P_{il} \text{ and } -\tfrac{1}{2}\sum_{k=1}^{l}(P_{ik})^2$$

are all correspond to the components of the prototype point $\dot{P}_i$, each of them assumes a predetermined constant value. By representing these terms by $\dot{W}$ which is called weight, the distance function of the prototype point $\dot{P}_i$ and $\dot{X}$ is sought from the following equation:

$$g_i(\dot{X})=W_{i1}W_{X1}+W_{i2}X_2+\ldots..+W_{il}X_l+W_{il}+1 \quad \text{(10) where}$$

$$W_{ik}=P_{ik},\ W_{il+1}=-\tfrac{1}{2}\sum_{k=1}^{l}(P_{ik})^2$$

and $k=1, 2, 3, \ldots, l$. Generally, if it is assumed that there are R demand conditions, then the distance functions of R prototype points and vector $\dot{X}$ are respectively given by

$$g_1(\dot{X})=W_{11}X_1+W_{12}X_2+W_{13}X_3+\ldots\ldots W_{1l}X_l+W_{1l+1}$$
$$g_2(\dot{X})=W_{21}X_1+W_{22}X_2+W_{23}X_3+\ldots\ldots+W_{2l}X_l+W_{2l+1}$$
$$\vdots \qquad\qquad \vdots$$
$$g_R(\dot{X})=W_{R1}X_1+W_{R2}X_2+W_{R3}X_3+\ldots\ldots+W_{Rl}X_l+W_{Rl+1} \quad (11)$$

Thus, by seeking that one of the R distance functions which represents the maximum value, it is possible to determine the demand condition to be sought to which the thus sought distance function belongs.

For example, on the assumption that the demand signal is represented by $\dot{X}$, if the following equation

$$g_5(\dot{X})=W_{51}X_1+W_{52}X_2+W_{53}X_3+\ldots..+W_{5l}X_l+W_{5l}+1$$

becomes maximum, then the 5th demand condition ($i=5$) is selected so that the mode of operation of the elevators is switched to the fifth operating program corresponding to the selected demand condition.

Consider the case where the number of prototype points belonging to each demand condition is j which is 2 or more. For example, if it is assumed that the jth prototype point in the ith demand condition is represented by $\dot{P}_i$, and that the components of this prototype point are respectively represented by P_{i1}^j, P_{i2}^j, ..., P_{il}^j, then the distance function $g_i^j(\dot{X})$ of the prototype point and vector $\dot{X}$ is given by the following equation as in the foregoing case:

$$g_i^j(\dot{X})=W_{i1}^jX_1+W_{i2}^jX_2+\ldots+W_{il}^jX_l+W_{il+1}^j$$

where

$$W_{ik}^j=P_{ik}^j,\ k=1, 2, 3, \ldots l$$

$$W_{il+1}^j=-\tfrac{1}{2}\sum_{k=1}^{l}(P_{ik}^j)^2 \quad (12)$$

If there are L_i prototype points belonging to the ith demand condition, then this distance function becomes as follows:

$$g_i^1(\dot{X}) = W_{i1}^1 X_1 + W_{i2}^1 X_2 + W_{i3}^1 X_3 + \ldots + W_{il}^1 X_l + W_{il+1}^1$$
$$g_i^2(\dot{X}) = W_{i1}^2 X_1 + W_{i2}^2 X_2 + W_{i3}^2 X_3 + \ldots + W_{il}^2 X_l + W_{il+1}^2$$
$$\vdots \qquad \vdots \qquad \vdots$$
$$g_i^{Li}(\dot{X}) = W_{i1}^{Li} X_1 + W_{i2}^{Li} X_2 + W_{i3}^{Li} X_3 + \ldots + W_{il}^{Li} X_l + W_{il+1}^{Li} \quad (13)$$

The maximum value or

$$\text{Max } g_i^j(\dot{X}) \quad j = 1, 2, 3, \ldots, L_i$$

is selected from the above expressions, this maximum value is made to correspond to the maximum distance function of the ith demand condition, and the demand condition i_o to which belongs the maximum term $g_{io}(\dot{X})$ of the R distance functions selected for the respective demand conditions becomes the demand condition to be sought.

FIG. 3 is a block diagram illustrating an embodiment of the present invention, wherein detection elements X_1, X_2, ..., X_l constituting the demand signal $\dot{X}$ are provided as output signals of various detector means which will be described later. This embodiment is of such a type that a single prototype point is provided for each demand condition, wherein there are $(l+1)$ weighting devices WD_{11} to WD_{1l+1} for the first demand condition. The respective weighting devices correspond to the respective factors of traffic demand and provide signals which correspond to the factors of traffic demand multiplied by the weights W_{11} to W_{1l+1} respectively. Similarly, there are provided weighting devices for each demand condition. (In the drawing, there are shown part of the weighting devices for the 1st, ith and rthe demand conditions.)

Adder AD_1 adds the outputs of the aforementioned weighting devices WD_{11} to WD_{1l+1} and provides the following distance function represented by equation (10):

$$g_i(\dot{X}) = W_{11}X_1 + W_{12}X_2 + W_{13}X_3 + \ldots\ldots + W_{1l}X_L + W_{1l+1}$$

Similarly, adders AD_2 to AD_R add the outputs of the weighting devices for the respective demand conditions and provide distance function signals corresponding to equation (10) respectively. That is, the output signals of the adders AD_1 to AD_R correspond to the R distance functions shown by equation (11). MLD represents a maximum selector which is adapted to determine the demand condition by selecting the maximum term from the distance functions produced by the adders AD_1 to AD_R. (This selector achieves the function represented by equation (4).

These devices will be referred to as pattern classifiers hereinafter since the demand signal X is supplied as an input thereto thereby to select the demand condition.

FIG. 4 is a block diagram showing a pattern classifier wherein more than two prototype points are set up for each demand condition, and where X_1, X_2, X_3, ..., X_l, +1 represent the multiplied of traffic demand of the demand signal $\dot{X}$ as in FIG. 3 respectively. In the drawing, there are shown the weighting devices, adders and maximum selector which are associated with the ith demand condition, and those associated with the other demand conditions are omitted.

The weighting devices

$$WD_{i1}^1 \sim WD_{il+1}^1$$

are adapted to multiply the factors of traffic demand X_1 to X_l and +1 of the demand signal $\dot{X}$ by the weights W_{il}^1 to W_{il+l}^1 respectively and provide the thus multipled signal to adder ADI_i. Thus, the output $g_i^1(\dot{X})$ of the adder ADI_i becomes as follows:

$$g_i^1(\dot{X}) = W_{i1}^1 X_1 + W_{i2}^1 X_2 + \ldots\ldots + W_{il}^1 X_l + W_{il+1}^1$$

This is nothing but the distance function of the prototype point P_i^1 belonging to the ith demand condition and the demand signal $\dot{X}$.

Similarly, if there are L_i prototype points, then an output signal is imparted to each of the adders ADI_2 to ADI_{li} in correspondence with equation (13).

Maximum selector ML_i is adapted to select the maximum value from these distance functions. Thus, $g_i(\dot{X})$ is selected. (See equation (3)).

The distance function is the one corresponding to that one of the prototype points in the ith demand condition which is closest to the demand signal $\dot{X}$.

In the similar manner, the distance functions corresponding to the respective demand conditions are selected by the discriminating devices U_1 to U_R respectively, so that there are obtained R distance functions.

Maximum selector MLD_2 is adapted to select the maximum value from these distance functions and finally determine the prototype point which is closest to the demand signal $\dot{X}$.

Thus, the demand condition to which this prototype point belongs becomes the optimum demand condition.

As will be apparent from the foregoing, the pattern classifiers employed in the aforementioned embodiment of the present invention require means for providing a distance function of products and sums of the factors of traffic demand X_1 to X_{l+1} of the demand signal $\dot{X}$ and weight $\dot{W}$.

FIG. 5 is a circuit diagram showing an example of distance function generator which can be utilized for the above purpose, which comprises an operational amplifier OPA, feedback resistor Rf, input resistors R_{11}, R_{12}, ..., R_{1l} and R_{1l+1} and weight setting potentiometers R_{i1}^j, R_{i2}^j, ..., R_{il}^j and R_{il+1}^j. The operation of this distance function generator is similar to that of the conventional analog adder.

For input signals of X_1, X_2, ... X_{l+l}, this device provides the following output signal:

$$-E_0 = \frac{\theta_{i1}{}^j R_f}{R_{11}} X_1 + \frac{\theta_{i2}{}^j R_f}{R_{12}} X_2 + \ldots\ldots + \frac{\theta_{il}{}^j R_f}{R_{1l}} X_l \quad \frac{\theta_{il+1}{}^j R_f}{R_{1l+1}} X_{l+1}$$

In this case, the weights becomes as follows:

$$\frac{\theta_{i1}{}^j R_f}{R_{11}}, \frac{\theta_{i2}{}^j R_f}{R_{12}}, \ldots\ldots, \frac{\theta_{il}{}^j R_f}{R_{1l}}, \frac{\theta_{il}{}^j R_f}{R_{1l+1}}$$

Thus, the weights can be adjusted by changing the values or settings θ_{i1}^j, θ_{i2}^j, ..., θ_{il}^j and θ_{il+1}^j of the weight setting potentiometers R_{i1}^j, R_{i2}^j, ..., R_{il}^j and R_{il+1}^j respectively.

The use of this device results in phase reversal (due to the fact that the amplification degree of the operational amplifier OPA is negative), so that the output signals are of an opposite polarity to the distance functions. Therefore, in order to select the maximum distance function, it is required that a minimum value or minimum term selector be used in the case where the output signals are negative, and that a maximum value or maximum term selector be employed in the case where the output signals are positive.

FIG. 6*a* shows an example of the maximum selector which is applicable to the present invention, wherein input signal voltages each having an optional amplitude (these voltages are shown as three signal voltages Va, Vb and Vc in the drawings) are imparted to input terminals T_A, T_B and T_C, respectively. Diodes D_1, D_2 and D_3 have the cathodes thereof connected with each other at a common connection point Te and the anodes thereof connected with the input terminals T_a, T_B and T_C respectively. The common connection point Te is connected with the negative potential side of a power source.

The voltage at the common connection point Te is applied as an input to a sign changing means, and an output voltage of a reverse sign (polarity) is obtained therefrom. Comparator means CM_1, CM_2 and CM_3 are adapted to compare the signal voltages Va to Vc at the respective input terminals and the voltage (Ve) at the common connection point Te and provide an output signal when the voltages obtained by subtracting the voltage Ve from the voltages Va to Vc exceed the forward voltage drops Vdb of the diodes D_1, D_2 and D_3.

For example, assume that the signal voltages Va to Vc at the input terminals T_A to T_C are 1 v., 3 v., and 5 v., respectively. In such a case, it will be apparent that only the diode D_3 is rendered conductive, and that the remaining diodes are

rendered nonconductive. Thus, assuming that the forward voltages drop Vdb of these diodes are 0.5 v., the voltage Ve at the common connection point Te will become 4.5 v., (5v.-0.5 v.). Consequently, the output voltage of the sign changing means CV becomes −4.5 v.

Thus, a first input I_1 to the comparator means CM_1 is 1 v., a second input I_2 thereto is −4.5 v., a first input I_1 to comparator means CM_2 is 3 v.; a second input I_2 thereto is −4.5 v.; a first input I_1 to comparator means CM_3 is 5 v.; and a second input I_2 thereto is −4.5 v. These comparator means CM_1 to CM_3 are so set up as to provide outputs when the voltages obtained by subtracting the voltage at the common connection point from the input signal voltages Va to Vc exceed the forward voltage drops Vdb of the diodes D_1 to D_2. In the foregoing case, therefore, only the comparator means CM_3 wherein the difference is 0.5 v., is enabled to provide an output. (In CM_2, the difference is −1.5 v., and in CM_1, it is −3.5 v.)

The fact that the output is provided by the comparator CM_3 indicates that the input signal voltage Vc at the input terminal Tc is maximum. Similarly, when any of the input voltages other than Vc is maximum, too, the corresponding comparator means is caused to provide an output. Although the input signal voltages are shown as three in FIG. 6*a*, similar operation is also performed if there are any number greater than 2of the input signal voltages. Each of the comparator means CM_1 CM_3 shown in FIG. 6*a* is so designed as to provide an output signal when the sum of the two input voltages I_1 and I_2 imparted thereto exceeds a preset voltage (the forward voltage drop of the diodes, for example).

For this reason, the sign changing means was required. However, the use of means capable of achieving the sign changing function as comparator means eliminates the sign changing means CV.

FIG. 7 shows an example of the minimum selector which is adapted to select the lowest one from the input signals on the contrary to the above. In FIG. 6, the anodes of the diodes D_1, D_2 and D_3 were connected with the input terminals T_A to T_C respectively, and the cathodes thereof were connected with each other at the connection point Te In FIG. 7, the diodes have their cathodes connected with the input terminals T_A to T_C respectively and their anodes connected with each other at the common connection point Te. Furthermore, each of the comparator means CM_1 to CM_3 are so set up as to provide an output when the voltages obtained by subtracting the input signal voltages Va to Vc from the voltage Ve at the common connection point exceeds the forward voltage drop Vdb of the diodes.

In FIG. 7, if it is assumed that Va=5 v., Vb=3 v., and Vc=1, then the diode D_3 is rendered conductive while the diodes D_1 and D_2 are rendered nonconductive. Thus, assuming that the forward voltage drop Vdb of the diodes is 0.5 v., the voltage Ve at the common point Te becomes 1.5 v.(1+0.5). This voltage is imparted to the sign changing means CV of which the output −1.5 v. is in turn applied as second input I_2 to all the comparator means CM_1 to CM_3. For this reason, a voltage of 3.5 v. is imparted to the comparator means CM_1, a voltage of 1.5 v. to CM_2, and a voltage of −0.5 v. to CM_3 , and only the comparator means CM_3 wherein the voltage obtained by subtracting the first input I_1 from the second input I_2 is in excess of the forward voltage drop (0.5 v.) of the diodes is caused to provide an output. If the comparator means CM_3 provides the output, then it is judged that Vc is the lowest of all the three input signals.

All of these maximum and minimum selectors are used to select the maximum term of the distance function. In the case where use is made of the distance function generator shown in FIG. 5, the maximum selector is used when the input signal is negative (when the output signal is positive), whereas when the input signal is positive (when the output signal is negative), the minimum selector is employed.

WIth the foregoing arrangement, it it possible to select the maximum or minimum signal from a plurality of signals by using diodes and comparators.

FIG. 8 is a block diagram showing one embodiment of the present invention, wherein a first detector FD_1 is adapted to detect the load of elevator cages leaving the lunch floor and that of elevator cages arriving at the lunch floor.

A first pattern classifier PD_1 is adapted to receive two demand signals from the detector FD_1 to thereby select either one of "lunch time" and "others." (This corresponds to the case where l=2 and R=2.)

A second detector SD_2 is adapted to detect the load of the upwardly moving cages and that of the downwardly moving cages.

A third detector TD_3 is adapted to detect the number of up hall calls, number of upper floor zone hall calls and number of lower floor zone hall calls. A second pattern classifier PD_2 is adapted to receive two demand signals from a second detector SD_2 and two demand signals from a third detector TD_3 (the number of the up hall calls and that of the down hall calls) to thereby select one of the five demand conditions "heavy up," "heavy down," "intermittent," "heavy up-down" and "balance." (This corresponds to the case where l=4 and R=5.) A third pattern classifier PD_3 is adapted to receive the two demand signals (the number of upper zone calls and that of lower zone calls) from the third detector TD_3 as inputs thereby to select one of the three demand conditions "balance," "upper free floor" and "lower free floor." (This corresponds to the case where L=2 and R=3.)

Logic means LG is adapted to finally determine which one of "lunch time," "up peak," "heavy up," "down peak," "heavy down," "intermittent," "heavy up-down," "balance," "upper free floor" and "lower free floor" is the demand condition for the elevators, in accordance with the outputs of the three pattern classifiers. Thus, the mode of operation of the elevator group is switched to the operating program corresponding to that demand condition.

The operations described referring to FIG. 8 are functionally shown in FIG. 9. That is, the first pattern classifier PD_1 broadly divides the condition into two, namely, "lunch time" and "others", and the second pattern classifier PD_2 further divides the condition into five, namely, "heavy up", "heavy down", "intermittent", "heavy up-down" and "balance" in the case of "others", and the third pattern classifier PD_3 further divides the condition into three, namely, "balance", "upper free floor" and "lower free floor" in the case of "balance".

That is, in the embodiment shown in FIG. 9, there are provided at least two sets of pattern classifiers each of which is adapted to select one demand condition out of its own demand conditions in accordance with the demand signal imparted thereto. Further, the front stage or upper rank pattern classifier is so designed as to select one demand condition out of its own demand conditions in accordance with the demand signal imparted thereto, and the rear stage or lower rank pattern classifier is so designed as to select one demand condition out of a plurality of lower rank demand conditions of its own which belong to the demand condition selected by the front stage pattern classifier. When the demand condition selected by the lower rank pattern classifier is included in that selected by the upper rank pattern classifier, the demand condition selected by the lower rank pattern classifier is provided as output. By such a design, it is possible to simplify the construction of each of the pattern classifiers.

In case use is made of a single pattern classifier and a demand signal consisting of all the factors of traffic demand concerning the elevators is supplied to this pattern classifier, then the construction becomes complicated due to the fact that the number of dimensions of the demand signal is so high that the number of dimensions of the distance function generator becomes great.

For a greater number of dimensions, a greater number of prototype points must be set up. Otherwise, a sufficiently high accuracy cannot be attained. These drawbacks are compensated for by the arrangement shown in FIG. 9. Thus, the construction can be simplified.

FIG. 10 is a circuit diagram showing an example of the first detector FD_1, wherein there are five elevators. Each of the elevator cages is provided with load detectors WH_1, WH_2, ..., WH_5 each adapted to detect the load thereof. (The suffix indicates the cage number.) These load detectors WH_1 to WH_5 are adapted to continuously detect 0 to 100 percent of the rated load to provide an output voltage of 0 to 10 v. for example.

Contacts **1S1–1**, **1S1–2**, **1S1–3** and **1S1–4** are closed for time setting when the elevator No. 1 is moved past the lunch floor, contacts **1S2–1** and **1S2–2** closed when the elevator No. 1 departs from the lunch floor, and contacts **1S3–1** and **1S3–2** closed when the elevator No. 1 arrives at the lunch floor. Similar contacts are provided in the elevators Nos. 2 to 5. (The elevator No. 5 is shown in detail, and the numerals represent the numbers of the elevators.)

A sample hold device for departure SHD_1 includes an operational amplifier $1OP_D$, feedback capacitor C_{1D} and resistors R_{1D1} and R_{1D2}, and it is adapted to respond to the value of time lag of the first order during the period of time that the contact **1S2–1** is closed as a result of departure of the elevator No. 1 from the lunch floor (this period of time is referred to as sampling time) and hold the value after the contacts **1S2–1** and **1S2–2** have been opened. The term time lag of the first order is usually used in the field of automatic control systems and "time lag of a higher order" is another term of this kind. The term "time lag of the first order" can be expressed in the form of a transfer function such as $1/(1+ST)$, where T is a constant and S is a Lapalce operator. A typical electric circuit to express such a transfer function may consist of a resistor-capacitor integrator circuit. When an input current I is applied to the resistor portion of the network, the output across the capacitor does not instantaneously follow the variation of the input but gradually increases with a time lag. In such a case, where the output varies exponentionally, such a time lag is called a "time lag of the first order". A sample hold device for arrival SHR_1 includes an operational amplifier $1OP_R$, feedback capacitor C_{1R} and resistors R_{1R1} and R_{1R2}, and it is adapted to hold the output of the load detector WH_1 during the period of time that the contacts **1S3–1** and **1S3–2** are closed as a result of the arrival of the elevator No. 1 at the lunch floor. The number of these devices corresponds to that of the elevators. Description of the elevators Nos. 2 to 4 will be omitted.

A filtering device for departure FCD includes input resistors R_{1D3} to R_{5D3}, feedback resistor R_D, feedback capacitor C_D and operational amplifier OPD, and it is adapted to provide an output which is obtained by smoothing out the sum of the outputs of all the sample hold devices for departure. Thus, a signal corresponding to the loads of all the elevator cages leaving the lunch floor is available from the output terminal T_D.

A filtering device for arrival FCR comprises input resistors R_{1R3} to R_{5R3} feedback resistor R_R, feedback capacitor C_R and operational amplifier OPR, it is adapted to provide an output which is obtained by smoothing out the sum of the outputs of all the sample hold devices for arrival.

Thus, a signal corresponding to the loads of the elevator cages arriving at the lunch floor is available from the output terminal T_R. In the foregoing system, however, the motion of the elevators at higher or lower floors than the lunch floor has an adverse effect on the judgement of the operating program in the case where the lunch floor is close to the roof floor or basement floor. This is because the number of passengers going up and down between the lunch floor and the upper floors is naturally less in the case where the lunch floor is closed to the roof floor and the number of passengers going up and down between the lunch floor and the lower floors is also naturally less in the case where the lunch floor is close to the basement floor.

In the case where the lunch floor is close to the roof floor, it is desirable that the design be made such that the switches for arrival **1S3–1** and **1S3–2** (likewise also in the case of the other elevators than the elevator No. 1) are closed when the elevator arrives at the lunch floor while moving upwardly and the switches for departure **1S2–1** and **1S2–2** (likewise also in the case of other elevators than the elevator No. 1) are closed when the elevator cage is departed downwardly, in order that the motions of elevators at the upper floors may be neglected. On the other hand, in the case where the lunch floor is close to the basement floor, it is desirable that the design be made so that the motions of the elevators at the lower floors than the lunch floor may be neglected by setting each of these switches in the opposite manner to the above.

Furthermore, it is essential that the motion of a nonstop elevator be also neglected. For this purpose, in the case where the lunch floor is close to the uppermost floor, the design may be made such that the contacts **1S1–1** and **1S1–2** (likewise also in the case of the other elevators than the elevator No. 1) are made in the case of nonstop of elevators directed upwardly and the contacts **1S1–3** and **1S1–4** (likewise also in the case of the other elevators than the elevator No. 1) are made in the case of nonstop of elevators directed downwardly.

FIG. **11** is a circuit diagram showing an example of the second detector including load detecting means WH_1 to WH_5 similar to those of the first detector, wherein a voltage say 0 to 10 v. is generated in accordance with the load of each elevator cage. Switch **1S5** is closed when the elevator No. 1 is moving upwardly, and switch **1S6** is closed when the elevator No. 1 is moving downwardly. Similar devices are provided for each elevator, and outputs thereof are passed to the filtering devices FBU and FBD. In the drawing, **5S5** and **5S6** indicates such switches associated with the elevator No. 5.

The filtering device FBU is constituted by input resistors **1R1** to **5R1**, operational amplifier **OP5U**, capacitor **C5U** and resistor **R5U**, and it is adapted to continuously provide an output voltage corresponding to the sum of the loads of the upwardly moving elevator cages. The filtering device FBD is constituted by input resistors **1R2** to **5R2**, operational amplifier **OP5D**, capacitor **C5D** and resistor **R5D**, and it is adapted to continuously provide an output voltage corresponding to the sum of the loads of the downwardly moving elevator cages.

Thus, an output signal corresponding to the total weight of all upwardly moving cages is available from the output terminal T_S of the second detector SD_2, and an output signal corresponding to the total weight of all downwardly moving cages is available from the output terminal T_t.

FIG. **12** shows an example of the third detector for detecting the number of hall calls, wherein Y indicates the entire floors in common, and these floors are divided into two sections, namely, lower zone floors which are lower than the mth floor and upper zone floors which are higher than *n*th floor. Contacts DHL_1 to DHL_m are made upon registration of the number of down hall calls at the lower zone floors (the suffixes indicate the corresponding floors), and contacts DHH_n to DHH_y are made upon registration of the number of down hall calls at the upper zone floors. Contacts UHL_1 to UHL_m and UHH_n to UHH_y are made upon registration of up hall calls at the lower zone floors and up hall calls at the upper zone floors, respectively. Output resistors $6R_1$ to $6R_4$ are connected with contact groups CG_1 to CG_4, respectively.

An output signal of the contact group CG_1 corresponding to the up hall calls at the upper zone floors and that of the contact group CG_2 are passed to a filtering device FL_1 through resistors $6R_{71}$ and $6R_{72}$, respectively. The filtering device FL_1 comprises an operational amplifier OP_{61}, resistor $6R_{61}$ and capacitor C_{61}, and it is adapted to provide an output signal corresponding to the time lag of the first order of the sum of said two input signals. That is, this filtering device is adapted to provide a signal corresponding to the number of up hall calls with respect to the entire floors.

Passed to a filtering device FL_2 are an output signal of the contact group CG_3 corresponding to down hall calls at the upper zone floors and an output signal of the contact group CG_4 corresponding to down hall calls at the lower zone floors through resistors $6R_{27}$ and $6R_{74}$ respectively. Thus, a signal corresponding to the number of down hall calls from the en-

tire floors is available from the filtering device FL_2. Passed to a filtering device FL_3 are an output signal of the contact group CG_1 corresponding to the up hall calls at the upper zone floors and that of the contact group CG_3 corresponding to down hall calls at the upper zone floors through resistors R_{75} and R_{76}, respectively. Thus, a signal corresponding to the entire hall calls at the upper zone floors is available from the filtering device FL_3.

Passed to a filtering device FL_4 are an output signal of the contact group CG_4 corresponding to down hall calls at the lower zone floors and that of the contact group CG_2 corresponding to up hall calls at the lower zone floors through resistors R_{77} and R_{78} respectively. Thus, a signal corresponding to the entire hall calls at the lower zone floors is available from the filtering device FL_4.

Assume now that the number of up hall calls at the upper and lower zone floors are n_1 and n_2 respectively, and that the numbers of down hall calls at the upper and lower zone floors are n_3 and n_4 respectively (the maximum is n_0). Then, voltages V_1, V_2, V_3 and V_4 corresponding to the number of up hall calls, that of down hall calls and those of hall calls at the upper and lower zone floors expressed in terms of the output voltages of the filtering devices FL_1 to FL_4 respectively become as follows:

$$V_1=-\frac{R_6}{R_7}V_0\left(\frac{R_0}{R_0+\frac{R}{n_1}}+\frac{R_0}{R_0+\frac{R}{n_2}}\right)$$

$$V_2=-\frac{R_6}{R_7}V_0\left(\frac{R_0}{R_0+\frac{R}{n_3}}+\frac{R_0}{R_0+\frac{R}{n_4}}\right)$$

$$V_3=-\frac{R_6}{R_7}V_0\left(\frac{R_0}{R_0+\frac{R}{n_1}}+\frac{R_0}{R_0+\frac{R}{n_3}}\right)$$

$$V_4=-\frac{R_6}{R_7}V_0\left(\frac{R_0}{R_0+\frac{R}{n_2}}+\frac{R_0}{R_0+\frac{R}{n_4}}\right)$$

where V_0 : input voltage

R_7 : resistance values for resistors $6R_{71}$ to $6R_{78}$

R_6 : resistance values for resistors $6R_{61}$ to $6R_{64}$

R_0 : resistance values for resistors $6R_1$ to $6R_4$

R : values for resistors $6RH_r$ to $6RL_4$

By making $R_0<<R/n_0$, the following expressions can be obtained:

$$V_1=-\frac{R_6}{R_7}V_0\frac{R_0}{R}(n_1+n_2)$$

$$V_2=-\frac{R_6}{R_7}V_0\frac{R_0}{R}(n_3+n_4)$$

$$V_3=-\frac{R_6}{R_7}V_0\frac{R_0}{R}(n_1+n_3)$$

$$V_4=-\frac{R_6}{R_7}V_0\frac{R_0}{R}(n_2+n_4)$$

Thus, obtained from the filtering device FL_1 are output signals corresponding to the number (n_1+n_2) of the entire up hall calls, that (n_3+n_4) of the entire down hall calls, that (n_1+n_3) of the entire hall calls at the upper zone floors and that (n_2+n_4) of the entire hall calls at the lower zone floors, respectively.

With the foregoing arrangement, the number of hall calls can be detected by being divided into four types, namely, numbers of up and down hall calls at the upper and lower zone floors, that of the entire up hall calls and that of the entire down hall calls.

This is because in this arrangement, the required signal is obtained by summing up signals corresponding to the numbers of up and down hall calls at each of the floor zones.

FIG. **13** is a circuit diagram showing an example of the first pattern classifier PD_1 which receives two demand signals such as "signal corresponding to the total loads of all cages leaving the lunch floor" and "signal corresponding to the total loads of all cages arriving at the lunch floor" (both are voltage signals of **0** to Em V) available at the output terminals T_D and T_R of the aforementioned first detector FD_1 thereby to discriminate between two demand conditions, namely, "lunch time" and "others". There are set up three prototype points belonging to the "lunch time" condition and two prototype points belonging to the "others" condition. Thus, this corresponds to the case where $i=1, 2$; $j=1, 2, 3$ (lunch time); $j=1, 2$ (others); and $l=2$.

In this case, the demand signals have two-parameter variables, and are represented on a plane having two dimensions corresponding to the weight of a departing cage and that of an arriving cage, as shown in FIG. **14**.

For example, the prototype points representing the "lunch time" condition are $\dot{P}_0^1$, $\dot{P}_0^2$ and $\dot{P}_0^3$; and those representing the "others" condition are $\dot{P}_1^1$ and $\dot{P}_1^2$; and the pattern classifier PD_1 is adapted to select the demand condition to which the closest prototype point belongs.

Potentiometers PM_{10} to PM_{12}, resistors R_{10} to R_{12}, operational amplifier OP_{10}, capacitor C_{10} and resistor R_{100} constitute together a distance function generator FG_1 which is adapted to produce a distance function $\dot{P}_0^1$.

Similarly, potentiometers PM_{13} to PM_{24}, resistors R_{13} to R_{24}, operational amplifiers OP_{11} to OP_{14} and resistors R_{101} to R_{104} constitute together distance function generators FG_2 to FG_5 for generating distance functions corresponding to the prototype points $\dot{P}_0^2$, $\dot{P}_0^3$, $\dot{P}_1^1$ and $\dot{P}_1^2$, respectively. The signal corresponding to the weight of a departing cage is provided as a positive voltage of 0 to Em V. Thus, for the maximum distance function, the output of the distance function generators becomes minimum. Diodes D_{10} to D_{12} constitute this minimum selector. The diode connected with the distance function generator which provides the lowest output voltage is rendered conductive, while the remaining diodes are rendered nonconductive.

The maximum one of the distance functions corresponding to the prototype points $\dot{P}_1^1$ and $\dot{P}_1^2$ is selected by the minimum selector constituted by diodes D_{13} and D_{14}.

Further, use is made of a minimum selector for the purpose of selecting that one of the selected two distance functions which becomes maximum. This minimum selector is constituted by diodes D_{15} and D_{16}, sign changing means IV_{10} and comparator means CM_{10} and CM_{11}, and the operation thereof is as described above in connection with FIG. 7.

An output is available at the terminal TL under the "lunch time" condition and at the terminal Te under the "others" condition.

FIG. **15** is a circuit diagram showing an example of the second pattern classifier PD_2 which receives four demand signals (voltage signals of 0 to −Em V) corresponding to "-total loads of all upwardly moving cages", "total loads of all downwardly moving cages", "number of up hall calls" and "-number of down hall calls" occurring at the output terminals T_s, T_t, T_{31} *and* $_{732}$ of the aforementioned second and third detectors, respectively, thereby discriminating five demand conditions, namely, "heavy up", "heavy down", "intermittent" and "heavy up-down".

The following eight prototype points are set up. These prototype points are to be represented in a four-variable parameter system. However, FIG. **16** shows the case where such prototype points are indicated on a plane having two dimensions corresponding to the loads of all upper moving cages and the loads of all downwardly moving cages respectively and a plane having two dimensions corresponding to the number of up hall calls and that of down hall calls respectively. In the drawings, $\dot{P}_2^1$ and $\dot{P}_2^2$ represents the prototype points for "heavy up", $\dot{P}_3^3$ the prototype point for "heavy down", $\dot{P}_4^1$ the prototype point for "intermittent", $\dot{P}_2{}^1$the prototype point for "heavy up-down", and $\dot{P}_6{}^1$, $\dot{P}_6{}^2$ and $\dot{P}_6{}^3$the prototype points for "balance", respectively.

By potentiometers PM_{30} to PM_{34} (only PM_{30} and PM_{34} are shown in the drawing), resistors R_{30} to R_{34} (only R_{30} and R_{34} are shown in the drawing), capacitor C_{70}, resistor R_{70} and operational amplifier CP_{70}, there is constituted a distance function generator FG_6 which has the same construction and function as described above in connection with FIG. **5** and is adapted to produce a distance function corresponding to the prototype point $\dot{P}_2{}^1$. By potentiometers PM_{35} to PM_{69}, resistors R_{35} to R_{69}, capacitors C_{71} to C_{77}, resistors R_{71} to R_{77} and operational amplifiers, devices FG_7 to FG_{13} are constituted respectively which are adapted to produce distance functions corresponding to the respective prototype points.

Diodes D_{60} and D_{61} constitute a maximum selector which is adapted to select the greater one of the distance functions corresponding to the prototype points $\dot{P}_2{}^1$ and $\dot{P}_2{}^2$ (heavy up).

AVailable from the diodes D_{62}, D_{63} and D_{64} are signals corresponding to the distance functions of the respective prototype points $\dot{P}_3{}^1$ (heavy down), $\dot{P}_4{}^1$ (intermittent) and $\dot{P}_5{}^1$ (heavy up-down). Diodes D_{65} to D_{67} constitute a maximum value selector which is adapted to select the maximum value from the distance functions of the three prototype points $\dot{P}_6^1$, $\dot{P}_6^2$ and $\dot{P}_6^3$ belonging to the "balance" condition.

The signals corresponding to the distance functions for the respective demand conditions are positive, and therefore they are supplied to a maximum selector which is constituted by diodes D_{71} to D_{75}, sign changing means IV_{70} and comparator means CM_{70} to CM_{75}, whereby the demand condition to which belongs the prototype point of which the distance function becomes maximum is selected so that output signals are available at the terminals TU and TB.

Due to the fact that the comparator means have a hysteresis, there is a possibility that the "balance" condition occurs (the distance function of the prototype $\dot{P}_4{}^1$ becomes maximum) even if the demand signal $\dot{X}$ is closest to the prototype point belonging to the "intermittent" condition. Therefore, it is desirable to restrain "balance" and force it into "intermittent" when the sum of signals representing the load of an upwardly moving cage, that of a downwardly moving cage, number of up hall calls and that of down hall calls becomes lower than a preset value. For this reason, there is provided an adder comprising resistors R_{25} to R_{28} and R_{29} and operational amplifier OP_{29} to provide a signal corresponding to the sum of the total loads of all upwardly moving cages, and the total loads of all downwardly moving cages, number of up hall calls and number of down hall calls.

This signal is supplied to comparator CM_{75} as first input I_1 so as to be compared with a reference power source B_{70}. Normally, the first input I_1 is so high that the comparator CM_{75} provides an output signal which is in turn passed to an AND means AND_{70} and OR means OR_{70}. Therefore, the design is made such that "balance" occurs as soon as the comparator CM_{74} provides an output. However, when the traffic demand decreases so that no output is available from the comparator CM_{75}, the "balance" condition is eliminated, whether the comparator CM_{74} is on or off, and at the same time the OR means OR_{70} is rendered conductive to establish the "intermittent" condition.

Thereafter, either one of the "heavy up", "heavy down", "intermittent" "heavy up-down" and "balance" is selected by the third pattern classifier PD_3, so that an output corresponding to the condition thus selected appears at the terminal TU and TB.

FIG. **17** is a diagram showing an example of the third pattern classifier PD_3 which is adapted to classify the demand conditions into three, namely, "balance", "upper free floor" and "lower free floor" by using as demand signals the two factors of traffic demand such as the number of hall calls at the upper zone floors and the number of hall calls at the lower zone floors. There are set up three prototype points, each one for each demand condition. This pattern classifier is capable of achieving the functions described above in connection with equations (6), (7), (8), (9), (10) and (11).

Due to the fact that the demand signal is two-variable, the prototype points can be shown as in FIG. **18**, with the numbers of upper and lower zone hall calls as the two dimensions, wherein $\dot{P}_7{}^1$, $\dot{P}_8{}^1$ and $\dot{P}_9{}^1$ represent the prototype points for "balance", "upper free floor" and "lower free floor".

By potentiometers PM_{80} to PM_{82}, resistors R_{80} to R_{82}, operational amplifier OP_{80}, resistor R_{89} and capacitor C_{91}, there is constituted a distance function generator FG_{20} which is adapted to produce a distance function signal for the prototype point $\dot{P}_7{}^1$. Similarly, by potentiometers PM_{83} to PM_{88}, resistors R_{83} to R_{88} and R_{89} to R_{91}, operational amplifiers OP_{80} to OP_{82} and capacitors C_{91} to C_{93}, there are constituted distance function generators FG_{21} and FG_{22} which are adapted to provide signals corresponding to the distance functions thereof.

The maximum distance function can be obtained by seeking the maximum term from the signals corresponding to these distance functions since the demand signal from the third pattern classifier is provided as a negative signal.

Diodes D_{80} to D_{82}, sign changing means IV_{80} and comparators CM_{80} to CM_{82} constitute a maximum selector, which operates in the same manner as described above.

Therefore, if the distance function of the prototype point $\dot{P}_7{}^1$ is maximum, then the comparator CM_{80} is caused to provide an output so that an output signal indicating that the demand condition is "balance" is available at the terminal TM.

Similarly, if the distance function of the prototype point $\dot{P}_8{}^1$ or $\dot{P}_9{}^1$ becomes maximum, then an output indicating "upper free floor" or "lower free floor" is available at the terminal TH or TS.

FIG. **19** shows an example of the logic means LG, wherein the output signals of the first, second and third pattern classifiers PD_1 to PD_3 are applied to the input terminals TE to TS. In the case where the demand condition is "others", then an output signal is imparted to the input terminal TE so as to be passed to AND elements **1**AND to **7**AND. In the case where the demand condition is "heavy up", "heavy down", "intermittent" or "heavy up-donw", then an output will appear at the corresponding one of the input terminals TU to TN so as to be passed to the AND elements **1**AND to **4**AND.

If the demand condition is "balance", then an output signal will appear at the input terminal TB so as to be passed to the AND elements **5**AND to **7**AND. If the demand condition is "upper free floor" or "lower free floor", then an output will occur at the input terminal TH or TS so as to be passed to the AND elements **6**AND and **7**AND.

If the outputs of the respective AND elements and demand condition correspond to "lunch time", then the output appearing at the input terminal TL is further passed to AND elements **10**AND to **17**AND which are provided with NOT output terminals NT**0** to NT**7** in addition to the normal output terminals respectively so that they are adapted to interlock with each other. That is, if any one of these AND elements **10**AND to **17**AND provides an output signal, then the output at its NOT terminal becomes extinct, so that the outputs of all the remaining AND elements also become extinct.

This eliminates the possibility that two or more demand conditions are simultaneously selected by error.

The outputs of the AND elements **10**AND and **13**AND to **17**AND are directly amplified in the amplifiers **0**AMP and **5**AMP so as to be imparted to a relay for lunch time program OH, relay for intermittent program **5**H, relay for heavy up down program **6**H, relay for balance program **7**H, relay for upper free floor program **8**H and relay for lower free floor program **9**H, respectively. The outputs of the AND elements **11**AND and **12**AND are further supplied to AND elements **20**AND, **21**AND, **22**AND and **23**AND and then each of them is classified into two demand conditions by the outputs of timers CT**1** and CT**2**.

The timer CT**1** which is provided for "up peak" is adapted to supply an output signal to the AND element **20**AND from 8 a.m. to 9 a.m., for example, and the timer CT**2** which is provided for "down peak" is adapted to supply an output signal to the AND element **22**AND from 4 p.m. to 5 p.m., for example.

When the demand condition is "heavy up" and the AND element 11AND is providing an output signal, if it is within the set time of the timer CT1, then AND element 20AND is caused to provide an output, which is in turn amplified by amplifier 1AMP so as to energize the relay for up peak 1H.

When the AND element 20AND provides the output, the output at the NOT output terminal NT20 thereof becomes extinct so that no output is available from the AND element 21AND. If it is outside the set time of the timer CT1, then the AND element 21AND provides an output, which is in turn amplified in amplifier 2AMP so as to energize the relay for heavy up program 2H.

It it is within the set time of the timer CT2 when the demand condition is "heavy down" and the AND element 12AND is providing an output signal, then the AND element 22AND is caused to provide an output signal, which is in turn amplified in amplifier 3AMP so as to energize the relay for down peak 3H. When the AND element 22AND provides the output, the output at the NOT output terminal NT22 thereof becomes extinct, so that the output of the AND element 23AND is interlocked. If it is outside the set time of the timer CT2, then the AND element 23AND provides an output, which in turn energizes the relay for heavy down program 4AMP through amplifier 4AMP.

Description will now be made of the entire operation of the aforementioned embodiment.

1. Lunch Time Condition

When the floor where there is a lunch hall is crowded or at lunch time, the loads of cages arriving at and leaving the lunch floor increase.

This is instantaneously detected by the first detector FD_1 (FIG. 10), so that a high output voltage appears at one or both of the output terminals T_D and T_R.

This output voltage is imparted to the first pattern classifier PD_1, but since its prototype points are set up as shown in FIG. 14, either one of the distance function generators FG_1 to FG_3 provides a minimum output voltage.

For example, if the load of the cage leaving the lunch floor is high, then the distance function of the prototype point $\dot{P}_0^3$ becomes maximum; if the load of the cage arriving at the lunch floor is high, then the distance function of the prototype point $\dot{P}_0^1$becomes maximum; and if the loads of the both cages are high, then the distance function of the prototype point $\dot{P}_0^2$. Thus, the comparator CM_{10} indicating the "lunch time" condition is turned on so that an output signal appears at the terminal TL.

When the output appears at the terminal TL, the AND element 10AND is caused to provide an output by which the relay for lunch time program OH is energized, as shown in FIG. 19. At this point, two demand conditions, to which belong the prototype points of which the destined functions are a maximum are selected from the output terminals of the second and third pattern classifiers PD_2 and PD_3. However, there is not output at the terminal TE, the AND elements 1AND to 7AND are closed, so that no other demand condition is selected.

If the "lunch time" program is instructed, the dispatching floor landing of all the elevators is changed to the lunch floor from where control instructions are provided to these elevators to increase the carrying power.

2. Up peak operation

During the rush hours in the morning, it is often the case that the elevators move up while being full due to an increased number of passengers who wish to go up from the dispatching floor. In such case, number of cages leaving and arriving at the lunch floor naturally becomes less. Thus, the output of the first detector FD_1 decreases so that the distance function of the prototype point belonging to "others" of the conditions available from the first pattern classifier shown in FIG. 13 becomes great, with a result that either one of the outputs of the distance function generators FG_4 and FG_5 becomes minimum. Consequently, the comparator CM_{11} is turned on so that an output signal appears at the output terminal TE.

The increase of the load of upwardly moving cages is detected as an increase in the output voltage at the output terminal T_s of the second detector (FIG. 11) and decrease in the output voltage at the output terminal T_t. On the other hand, a decrease in the number of hall calls is detected as decrease in the output voltages at the output terminals T_{31} and T_{32} of the third detector TD_3. These four outputs are imparted to the second pattern classifier PD_2 (FIG. 15). In this case, as will be apparent from the prototype points shown in FIG. 16, the prototype point $\dot{P}_2^2$ belonging to the "heavy up" condition is closest to the demand signal $\dot{X}$. Therefore, the output voltage of the distance function generator FG_7 of those available from the distance function generators FG_6 to FG_{13} for the respective prototype points shown in FIG. 15 becomes maximum. Thus, the comparator CM_{70} is turned on so that an output signal is available at the output terminal TU.

In FIG. 19, outputs are obtained at the terminals TU and TE, whereby the 1AND element is caused to provide an output to cause the AND element 11AND to provide an output.

During the time to attend office, then the timer CT_1 is also providing an output signal to cause the AND element 20AND to provide an output by which the relay for up peak program 1H is energized. If the "up peak" program is instructed, the elevator service floors are grouped into a plurality of zones (upper zone and lower zone, for example), and the elevator group is also divided into two subgroups for the upper and lower zone services thereby to effect divided express services. In this way, the jam in the lobby can be rapidly eliminated.

3. Heavy up operation

If it is outside the set time of the timer CT1 during the up peak operation in the above item (2), the "heavy up" program will be instructed. In case due to a further increase in the number of passengers wishing to go up, either the load of the upwardly moving cages increases or the number of up hall calls increases, then an output will appear at the output terminal TE of the first pattern classifier PD_1 as in the case of the up peak operation. The increase in the upwardly moving cage load is also detected as an increase in the output voltage at the output terminal T_s of the second detector SD_2 and decrease in the output voltage at the output terminal T_t. An increase in the number of up hall calls and decrease in the number of down hall calls are detected as an increase in the voltage at the output terminal T_{31} of the third detector TD_3 and decrease in the voltage at the output terminal T_{32}, respectively.

These four demand signals are supplied to the second pattern classifier PD_2 (FIG. 15). As will be seen from FIG. 16, the prototype point $\dot{P}_2^1$ is closest to the demand signal $\dot{X}$. Therefore, the output of the distance function generator FG_6 (which produces the distance function for $\dot{P}_2^1$)becomes maximum so that an output appears at the output terminal TU. As in the case of the time to attend office (up peak condition), therefore, the AND element 11AND is caused to provide an output. However, since the timer CT_1 provides no output during the time other than the set time, the AND element 21AND is caused to provide an output by which the relay for heavy up program 2H is energized.

The departure time is so controlled that the number of upwardly moving elevators is increased when the "heavy up" program is instructed, and maximum call automatic reversal is effected so that the problem of imbalance of calls can be rapidly solved.

4. Down peak operation

At closing time (it may differ from building to building), it is more likely that most of the elevators go down to the lower reference floor while being full with passengers. At this point, these are detected by the second and third detectors.

In this case, too, an output appears at the output terminal TE of the first pattern classifier PD_1, as described above in connection with the up peak operation.

On one hand, the increase in the downwardly moving cage load results in an increase of the voltage at the output terminal T_t and decrease of the voltage at the output terminal T_s. On the other hand, the increase in the number of down hall calls

and decrease in the number of up hall calls are detected as an increase in the voltage at the terminal T_{32} of the third detector and an increase in the voltage at the terminal T_{31} respectively. These four demand signals are supplied to the second pattern classifier PD_2. As will be seen from FIG. **16**, the prototype point $\dot{P}_3^1$ for "heavy down" is closest to the demand signals $\dot{X}$. Thus, the FG_3 output of those of the distance function generators for the respective prototype points shown in FIG. **15** becomes maximum. At this point, the comparator CM_{71} is turned on so that an output signal indicating "heavy down" is obtained at the output terminal TD.

In the logic unit shown in FIG. **19**, the AND element **12**AND is caused to provide an output. If it is now the office closing time, then the timer CT_2 is providing an output to cause the AND element **22**AND to provide an output by which the relay for down peak program **3**H is energized.

When the down peak program is instructed, the elevator group is divided into two subgroups for the upper and lower zones. In this case, the dispatching floor landing corresponds to the uppermost floor of the respective service zones so as to provide satisfactory services to passengers which wish to go down. In case there occurs an imbalance in the number of the passengers between the two zones, then cooperation will be made to complete the services substantially at the same time.

5. Heavy down operation

If it is after the set time of the timer TC_2 during the down peak operation (4), AND element **23**AND is caused to provide an output by which the relay for heavy down program **4**H is energized.

When the "heavy down" program is instructed, the reference floor is changed to the upper dispatching floor landing. In this case, the lowest call automatic reversal is always effected, and the dispatching time is so selected that the number of downwardly moving elevators becomes greater, thereby quickly eliminating the imbalance of calls.

6. Intermittent operation

In the case where there is a less traffic demand for the elevators as at nights or on holidays, the load of upwardly moving cages, load of downwardly moving cages and numbers of up and down hall calls become less.

That is, all the demand signals available from the first pattern classifier PD_2 are decreased. The prototype point $\dot{P}_4^1$ belonging to the "intermittent" condition is set up as shown in FIG. **16**. Therefore, the distance function for the prototype point $\dot{P}_4^1$ becomes maximum, and the output of the distance function generator FG_9 becomes maximum. Thus, the comparator CM_{27} is turned on so that an output signal appears at the terminal TI. At this point, in FIG. **19**, the AND element **3**AND provides an output (an output is available at the terminal TE as in the case of the up peak operation), and the AND element **13**AND is turned on so that the relay for intermittent program **5**H is energized.

If the intermittent program is instructed, then only one elevator optionally selected is operated to cope with hall calls at the entire floors, and the remaining elevators are returned to the lower reference floor and rest thereat. Thereafter, the number of elevators to be operated may be increased or decreased in accordance with the traffic demands which arise at the entire floors. If the number of passengers further decreases, the last one elevator is also returned to the lower reference floor, lamps are turned off, and the motor-generator is automatically deenergized.

7. Heavy up down operation

In case the traffic demands for upwardly and downwardly moving elevators are substantially equal to each other and the quantities of the demands are great, both the loads of upwardly and downwardly moving cages and numbers of up and down hall calls increase.

In such case, both the output voltages at the terminals T_s and T_t of the second detector SD_2 and output voltages at the terminals T_{31} and T_{32} of the third detector TD_3 build up.

At this point, the distance function for the prototype point $\dot{P}_5^1$ will become maximum since this prototype point $\dot{P}_5^1$ is set up as shown in FIG. **16**, and the output of the distance function generator FG_{10} assumes the maximum value so that an output appears at the terminal TN. Due to the fact that an output signal is available at the terminal TE as in the up peak operation, each of the AND elements **4**AND and **14**AND is caused to provide an output so that the relay for heavy up down program **6**H is energized.

If the heavy up down program is instructed, the entire elevators are divided into two groups. One of the two elevator groups are dispatched at reduced intervals with the lower dispatching landing as the reference, thereby shortening the cyclic period to provide satisfactory services to passengers who wish to go up, and the other group of elevators are also dispatched at reduced intervals with the upper dispatching landing as the reference, thereby shortening the cyclic period to improve the efficiency of transportation and shorten the waiting time for waiting passengers.

8. Balance Operation

This corresponds to the case where there is a traffic demand approximately intermediate between the "intermittent" condition and "heavy up down" condition. When the upwardly and downwardly moving loads and numbers of the up and down hall calls are medium, when the upwardly and downwardly moving cage loads are medium and the numbers of the up and down hall calls are small, or when the upwardly moving cage load and number of the up hall calls are small and the downwardly moving cage load and number of the down hall calls are medium, the distance function of either one of the prototype points $\dot{P}_6^1$, $\dot{P}_6^2$ and $\dot{P}_6^3$ belonging to the "balance" condition as shown in FIG. **16** becomes maximum. Therefore, the output available from either one of the second pattern classifiers FG_{11} to FG_{13} is maximum, and it is selected by the maximum selector so that an output is available at the terminal TB.

An output signal is available at the terminal TE as described above in connection with the up peak operation. If an output signal appears at the terminal TB, then two inputs are imparted to the AND elements **5**AND to **7**AND, and the third pattern classifier PD_3 determines which one of the AND elements is to be turned on.

Assume now that the "balance" condition is selected and that hall calls at the upper and lower zone floors are substantially balanced. In such case, the output voltages at the output terminals T_{33} and T_{34} of the third detector TD_3 are medium. The demand signal is supplied to the third pattern classifier PD_3. At this point, since the prototype points $\dot{P}_7^1$, $\dot{P}_8^1$ and $\dot{P}_9^1$ are set up as shown in FIG. **18**, the output of the distance function generator FG_{20} should be maximum in the above case. Thus, the comparator CM_{30} is turned on so that an output is available at the terminal TM.

As a result, in FIG. **19**, the AND elements **5**AND and **15**AND are caused to provide an output by which the relay for balance program **7**H is energized.

If the "balance" program is instructed, then all the elevators are made to provide services to all the floors, and an optionally selected elevator is operated to cope with calls at the basement floor and/or roof floor depending upon the operational condition. Further, the elevators which have left the lower dispatching floor landing are made to run up to the upper dispatching landing as a rule, and the intervals between the preceding elevators and the succeeding elevators are always controlled so that the elevators may be scattered evenly throughout the entire floors, thereby shortening the waiting time for waiting passengers.

9. Upper free floor Operation

In case the number of hall calls at the upper zone floors is great and that at the lower zone floors is small under the "balance" condition, then the output voltage at the terminal T_{33} of the third detector TD_3 is high, whereas the output voltage at the terminal T_{34} is low. Therefore, as will be seen from FIG. **18**, the distance function for the prototype point $\dot{P}_8^1$ becomes maximum, and the output voltage available from the distance function generator FG_{21} is maximum so that an output is obtained at the terminal TH.

In FIG. 19, and AND elements 6AND and 16AND are caused to provide an output so that the relay for upper free floor program 8H is energized.

When the upper free floor program is instructed, the elevators are dispatched from the upper dispatching landing at predetermined intervals (say 15 seconds) in accordance with substantially the same operational instruction as that for the case of "heavy down" with "balance" operation as the reference, and lowest call automatic reversal is effected to further improve the services.

10. Lower Free Floor Operation

In case the number of hall calls at the lower zone floors is great and that at the upper zone floors is small, then the output voltage at the terminal T_{34} of the third detector is high, and that at the terminal T_{33} is low. Since the distance function for the prototype point P_9^1 is maximum as will be seen from FIG. 18, the output voltage of the distance function generator FG_{22} is maximum so that an output is obtained at the terminal TS. Thus, in FIG. 19, the AND elements 7AND and 17AND are turned on so that the relay for lower free floor program 9H is energized.

When the lower free floor program is instructed, the elevators are operated in substantially the same manner as in the case of "heavy up" , with the "balance operation" as the reference.

FIG. 20 is a block diagram showing another example of pattern classifier well suited to the system of the present invention, wherein the discriminant resolution of the aforementioned pattern classifier (especially shown in FIG. 15) is improved.

Pattern classifier 1PD receives four demand signals WU, WD, HU and HD to discriminate four demand conditions TU, TD, HB and BI. Pattern classifier 2PD similarly receives four demand signals WU, WD, HU and HD to discriminate two demand conditions BT and IT. The demand signals $\dot{X}$ and demand conditions used in this example are as follows:

Demand signals
WU: load of upwardly moving cages (sum of all the upwardly moving cage loads)
WD: load of downwardly moving cages (sum of all the downwardly moving cage loads)
HU: number of up hall calls
HD: number of down hall calls
Demand condition
TU: heavy up
TD: heavy down
HB: heavy up down
BI: balance intermittent (either balance or intermittent)
BT: balance
IT: intermittent

The output of the pattern classifier 2PD is supplied to the AND elements 1AND and 2AND. These AND elements are employed to make the pattern classifier 1PD at the preceding stage or at the higher rank to the pattern classifier 2PD at the succeeding stage or at the lower rank.

The final purpose of this embodiment is to discriminate the five demand conditions TU to IT (except BI) by using the four demand signals WU to HD as inputs. Therefore, it is apparent that it is also possible to use a single pattern classifier. In the case of "heavy up," "heavy down" and "heavy up down," the forms of pattern are so remarkably different from each other that the difference between the discriminant functions is great. In the case of "balance" and "intermittent," however, there is a great similarity. For this reason, difficulty is encountered in an attempt to discriminate these five demand conditions by means of only one pattern classifier. In accordance with the present invention, the demand condition is classified into four demand conditions TU to BI by the higher rank pattern classifier, and it is further classified into two demand conditions BT and IT by the lower rank pattern classifier, thereby improving the resolution.

A variety of discriminant functions to be used by the pattern classifiers 1DP and 2DP may be conceivable, and in the present example, the following function is considered as discriminant function $g(\dot{X})$:

$$g(\dot{X}) = W_1X_1 + W_2X_2 + \ldots W_lX_l - \frac{1}{2}\sum_{k=1}^{l}(W_k)^2 \qquad (1)$$

Thus, by letting
$X_1=WU$
$X_2=WD$
$X_3=HU$
$X_4=HD$
the discriminant functions for the respective demand conditions TU, TD, HB and BI of the pattern classifier 1DP can be given by the following equations:

$$g_{TU}=W_{11}\times WU+W_{12}\times WD+W_{13}\times HU+W_{14}\times HD -\tfrac{1}{2}(W_{11}^2+W_{12}^2+W_{13}^2+W_{14}^2) \qquad (2)$$

$$g_{TD}=W_{21}\times WU+W_{22}\times WD+W_{23}\times HU+W_{24}\times HD -\tfrac{1}{2}(W_{21}^2+W_{22}^2+W_{23}^2+W_{24}^2) \qquad (3)$$

$$g_{HB}=W_{31}\times WU+W_{32}\times WD+W_{33}\times HU+W_{34}\times HD -\tfrac{1}{2}(W_{31}^2+W_{32}^2+W_{33}^2+W_{34}^2) \qquad (4)$$

$$g_{BI}=W_{41}\times WU+W_{42}\times WD+W_{43}\times HU+W_{44}\times HD -\tfrac{1}{2}(W_{41}^2+W_{42}^2+W_{43}^2+W_{44}^2) \qquad (5)$$

g_{TU} to g_{BI} are discriminant functions each of which is associated with each demand condition. However, it is also possible that two such discriminant functions may be associated with each demand condition. In the similar manner the discriminant functions q_{BT} and g_{IT} for the demand conditions BT and IT of the pattern classifier 2PD are given by

$$g_{BT}=W_{51}\times WU+W_{52}\times WD+W_{53}\times HU+W_{54}\times HD -\tfrac{1}{2}(W_{51}^2+W_{52}^2+W_{53}^2+W_{54}^2) \qquad (6)$$

$$g_{IT}=W_{61}\times WU+W_{62}\times WD+W_{63}\times HU+W_{64}\times HD -\tfrac{1}{2}(W_{61}^2+W_{62}^2+W_{63}^2+W_{64}^2) \qquad (7)$$

In order to discriminate the four demand conditions, namely, "heavy up," "heavy down,", "heavy up down" and "balance intermittent" (the function for "balance intermittent" is determined so that it may be discriminated under any of the "balance" and "intermittent" conditions), there is no need to separate "balance" and "intermittent," and therefore it is possible to effect discrimination with a sufficient accuracy as described hereinbefore.

However, if it is attempted to separate "balance" and "intermittent" by the same pattern classifier, then the difference between the functions is so small that it is impossible to achieve discrimination with a high accuracy.

Assume now that the demand signals WU to HD vary in the range of 0 to 10 and that W_{11} to W_{1l} changes in the range of 0 to 10. Then the maximum value and minimum value of the discriminant function becomes ±200 respectively. In this case, it is generally required that the weights W_{51} to W_{54} be made to be about 3 and that W_{61} to W_{64} be made to be about 1, and therefore

$$g_{BT}=3\times1.7-\tfrac{1}{2}\times36=12.9$$
$$g_{IT}=1\times1.7-\tfrac{1}{2}\times4=-0.3$$

in the case where the following is provided as a demand signal

$$(WU, WD, HU, HD)=(1.7, 0, 0, 0)$$

Thus, since $g_{IT}<g_{BT}$, the demand condition should be made to be IT or "intermittent," but difficulty is encountered in detecting it since the difference between them is only about 3% (12.6/400) of the whole.

In order to improve the resolution, it may be conceivable to increase the discriminant functions. That is, for example, in order to enhance the resolution by four times, the aforementioned discriminant functions may be $4g_{BT}$ and $4g_{IT}$ respectively. In this case, however, these discriminant functions turn out to be ±800 respectively since the demand signals and weights W_1 to W_l change in the range of 0 to 10. The fact that the discriminant functions are increased by four times means that the output of the discriminant function generator (amplifier, etc.) is increased by four times. Thus, difficulty is involved. In accordance with the present invention, however, the discriminant functions g_{BT}' and g_{IT}' of the pattern classifier 2PD are made four times as great as g_{BT} and g_{IT} as follows:

$$g_{BT}'=4g_{BT}$$
$$g_{IT}'=4g_{IT}$$

When the demand signals (1.7, 0, 0, 0) are provided, the discriminant functions become as follows:

$B_{BT}'=-51.6$

$B_{IT}'=-1.2$

which correspond to 12 percent of the maximum output width of the pattern classifiers, thus resulting in a resolution four times as high as the above.

In the case of "intermittent" and "balance," the magnitudes of the demand signals *WU* to *HD* which are inputs to the pattern classifier **2PD** are ½ or less of the maximum value of the demand signals. Therefore, there is no possibility that the discriminant functions of the pattern classifier exceed ±200. In this pattern classifier **2PD**, the weight *W* is 5 at maximum, demand signal is 5 at maximum, and the discriminant functions are ±2,000, but in the case of "balance" and "intermittent," both the weight and demand signal may be 5 or less.

As described above, it is possible to improve the resolution of the pattern classifier, and therefore satisfactory discrimination can be achieved irrespective of similarity of patterns, without using any precision comparator.

Furthermore, there is no need to increase the outputs of the various instruments and devices in use since it is possible to prevent the magnitudes of the discriminant functions from changing.

In the foregoing, description has been made of the case where the "balance" and "intermittent" conditions are separated, but it will be apparent that the present invention can equally be applied in an attempt to recognize demand conditions which are difficult to discriminate.

FIG. **21** is a circuit diagram showing the system according to another embodiment of the present invention which is designed so that the discriminant functions can easily be changed by externally imparting input signals to the discriminant functions generators incorporated in the pattern classifiers (especially those shown in FIG. **15**). In the drawing, discriminant function generators PG_1 to PG_4 are adapted to receive demand signals $\dot{X}$=(*WU*, *WD*, *HU*, *HD*) so as to produce discriminant functions $g_1(\dot{X})$, $g_2(\dot{X})$, $g_3(\dot{X})$ and $g_4(\dot{X})$ respectively.

In the following discussion, it is assumed that the discriminant function $g_1(\dot{X})$ corresponds to "heavy down," $g_2(\dot{X})$ to "-balance," $g_3(\dot{X})$ to "heavy up" (including "up peak" and common "heavy up") and $g_4(\dot{X})$ to "intermittent."

The discriminant function generator PG_3 comprises an operational amplifier OP_3, feedback resistor Rf_3, feedback capacitor Cf_3, input resistors R_{311} to R_{361} and weight setting potentiometers PR_{31} to PR_{36}, and the operation thereof is similar to that of the conventional analog adder.

The output signal or discriminant function $g_3(\dot{X})$ of the discriminant function generator PG_3 when the demand signals *WU*, *WD*, *HU* and *HD* are supplied thereto is given by

$$g_3(\dot{X})=\frac{\theta_{31}\cdot Rf_3}{R_{311}}WU+\frac{\theta_{32}\cdot Rf_3}{R_{321}}WD$$

$$+\frac{\theta_{33}\cdot Rf_3}{R_{331}}HU+\frac{\theta_{34}\cdot Rf_3}{R_{341}}HD$$

$$+\frac{\theta_{35}\cdot Rf_3}{R_{351}}C$$

where C is a constant input. In this case, the weights are

$$\frac{\theta_{31}\cdot Rf_3}{R_{311}},\ \frac{\theta_{32}\cdot Rf_3}{R_{321}},\ \frac{\theta_{33}\cdot Rf_3}{R_{331}},\ \frac{\theta_{34}\cdot Rf_3}{R_{341}}\text{ and }\frac{\theta_{35}\cdot Rf_3}{R_{351}}$$

respectively. Thus, it is possible to change the characteristics of the discriminant functions by changing the settings θ_{31}, θ_{32}, θ_{33}, θ_{35}. These discriminant functions are linear functions, and therefore they are referred to as linear discriminant functions.

Maximum selector MLD is adapted to select that one of the discriminant functions $g_1(\dot{X})$ to $g_4(\dot{X})$ which represents a maximum value and provide an output at one of the output terminals T_D, T_B, T_U and T_I depending upon which discriminant function represents a maximum value.

AND elements **31**AND and **32**AND are connected with the output terminal T_u. The AND element **31**AND is adapted to provide an output when the discriminant function $g_3(\dot{X})$ is maximum and timer TM provides an output, thereby discriminating the "up peak" condition, so that an output is available at an output terminal TU'.

The other AND element **32**AND is adapted to provide an output when the discriminant function $g_3(\dot{X})$ is maximum and the AND element **31**AND is in the OFF state, so that an output is obtained at a terminal TU'' to thereby discriminate the common "heavy up" condition.

When the AND element **31**AND is in the ON state, there is no output at the NOT terminal NOT thereof, and therefore the AND element **32**AND provides no output.

In the case where the demand signal $\dot{X}$ corresponds to "-heavy down," the discriminant function $g_1(\dot{X})$ becomes maximum; in the case where the demand signal $\dot{X}$ corresponds to "balance," $g_2(\dot{X})$ becomes maximum; and in the case where the demand signal $\dot{X}$ corresponds to "intermittent," $g_4(\dot{X})$ becomes maximum. Thus, the corresponding demand condition is selected.

It is to be noted however that the discriminant function generator RG_3 is different from the remaining ones. That is, this discriminant function generator is so set up that it operates similarly to the other distance function generators during the time other than a set time such for example as the time to attend office in the morning but under a "heavy up" condition where *WD*=20%, *WU*=70%, *HU*=70% and *HD*=20 % for example (that is, in case the number of passengers who wish to go up is great and the number of passengers who wish to go down is small) the discriminant function thereof becomes maximum.

Generally, as the rush hours in the morning approaches, the number of persons coming in the building begins increasing. That is, the number of passengers who wish to go up increases.

However, since most of these passengers go from the lower dispatching landing toward the upper intermediate floors, up hall calls *HU* are less although the upwardly moving cage loads *WU* increase, so that the discriminant function $g_3(\dot{X})$ is small. Thus, this condition cannot be discriminated from the "heavy up" condition.

When the timer TM operates at the time to attend office, however, an input is imparted to the potentiometer PR_{36} and also to the AND element **31**AND.

When the input signal is imparted to the potentiometer PR_{36}, the discriminant function $g_3(\dot{X})$ becomes greater than the other ones so that an output is available at the terminal TU, if the upwardly moving cage loads are high even though up hall calls are less.

Thus, the AND element **31**AND is caused to provide an output whereby this condition is discriminated from the "up peak" condition. If *WU* decreases, the discriminant function $g_3(\dot{X})$ becomes small even so that the condition is shifted to "intermittent"or other condition, even if the timer TM is providing an output.

During the time other than the time to attend office, since the timer TM is in the OFF state, the discriminant function $g_3(\dot{X})$ does not become maximum unless both of the upwardly moving cage loads WU and the number of up hall calls become great, so that the other demand condition than "up peak" and "heavy up" is selected, as already described above.

In this example, during the time other than the time to attend office, the discriminant function is the one to discriminate the common "heavy up" condition (under this condition, the number of passengers who go up toward the upper floors is remarkably greater than that of downwardly moving passengers), but at the time to attend office, an external signal is imparted to forcibly change the discriminant function to the one which is suited to the discrimination of the "up peak" condition (where there is a greater number of passengers who wish to move from the dispatching landing toward the upper intermediate floors).

This forcing input may be provided by an adder provided at the output side of the amplifier OP_3.

Although in the foregoing, description has been made of the case where system of the present invention is applied to "-heavy up" only. It will be readily apparent to those skilled in the art that the system of the present invention can equally be applied to any other demand condition.

What is claimed is:

1. A group supervisory control system for determining that a traffic demand condition, to which belongs a discriminant function representing a maximum value, is an optimum traffic demand condition at a point in time for elevators, comprising a plurality of elevators arranged in juxtaposing relationship to each other, traffic demand detecting means for detecting the traffic demands for said elevators to provide an 1-variable parameter traffic demand signal consisting of a plurality of factors of traffic demands and pattern classifier means for producing said discriminant function which is a function of said traffic demand signal for each of said traffic demands whereby the traffic condition corresponding to said optimum traffic demand condition is determined.

2. A group supervisory control system for elevators according to claim 1, including traffic demand detecting means for providing an l-variable parameter traffic demand signal consisting of a plurality of factors of traffic demand and pattern classifier means for setting up at least one l-parameter prototype type for each of the traffic demand conditions of said elevators and selecting that one of the traffic demands to which the prototype point closest to the traffic demand signal belongs.

3. A group supervisory control system for elevators according to claim 1, including at least two sets of pattern classifier means adapted to select one of the demand conditions of their own in accordance with demand signals imparted thereto, said demand signals partly overlapping or being completely different from each other, one of said pattern classifier means provided at the front stage or higher rank being adapted to select one of the demand conditions thereof in accordance with the demand signal imparted thereto, other of said pattern classifier means provided at the rear stage or lower rank being adapted to select one of a plurality of lower rank demand condition selected by the front stage pattern classifier means, and means for providing an output corresponding to the demand condition selected by the lower rank classifier classifier means when the demand condition selected by the lower rank pattern classifier is included in the demand condition selected by the higher rank pattern classifier means.

4. A group supervisory control system for elevators according to claim 1, comprising at least two sets of pattern classifier means adapted to select one of the demand conditions thereof in accordance with demand signals, the demand signals imparted thereto being identical with each other, the discriminant function of the pattern classifier means provided at the front stage or higher rank being made smaller than that of the pattern classifier means provided at the rear stage or lower rank, said front stage or higher rank pattern classifier means being adapted to select one of the demand conditions thereof in accordance with the demand signal imparted thereto, said rear stage of lower rank pattern classifier means being adapted to select one of a plurality of lower rank demand conditions thereof which belong to the demand condition selected by the front stage pattern classifier means, and means for providing an output corresponding to the demand condition selected by the lower rank pattern classifier means when the demand condition selected by the lower rank pattern classifier means is included in the demand condition selected by the higher rank pattern classifier means.

5. A group supervisory control system for elevators according to claim 1, comprising timer means adapted to provide an output at a predetermined time such as the time to attend or leave office, and means adapted to select one of two lower rank demand conditions belonging to the demand condition selected by the pattern classifier means depending upon whether the time is inside or outside the set time of said timer means.

6. A group supervisory control system for elevators according to claim 1, including means for externally imparting an input signal to the discriminant function generator means for producing a discriminant function belonging to a particular traffic demand condition set up in the pattern classifier means, thereby forcibly changing the discriminant function.

7. A group supervisory control system for elevators according to claim 1, comprising means for externally imparting an input signal during a predetermined period of time to the discriminant function generator means for producing a discriminant function belonging to said particular traffic demand condition, thereby forcibly changing the discriminant function.

8. A group supervisory control system for elevators according to claim 1, comprising traffic demand detecting means to producing a weight signal corresponding to the load of each elevator cage, wherein said weight signal is supplied to sample hold means so as to be held therein when an elevator cage arrives at or leaves a particular floor; when the elevator cage passes said particular floor, said weight signal is made to be zero and supplied to said sample hold means so as to be held therein; and the outputs of said sample hold means are added to be used as an output signal which constitutes part of the factors of traffic demand.

9. A group supervisory control system for elevators according to claim 1, comprising traffic demand detecting means for producing a weight signal corresponding to the load of each elevator cage, wherein the case where a particular floor is close to the upper terminal floor, said weight signal is supplied to sample hold means to be held therein when the elevator arrives at the particular floor while moving upwardly; when the elevator passes said particular floor while moving upwardly or downwardly, the weight signal is made to be zero and supplied to the sample hold means so as to be held therein; in the case where the particular floor is close to the lower terminal floor, said weight signal is supplied to sample hold means to be held therein when the elevator arrives at the particular floor while moving upwardly or leaves the particular floor while moving downwardly, said weight signal is made to be zero and supplied to the sample hold means so as to be held therein; and the outputs of the sample hold means are added to provide a particular floor arrival or departure weight signal which constitutes part of factors of traffic demand.

10. A group supervisory control system for elevators according to claim 1, wherein the elevator service floors are divided into two, upper and lower, floor zones, up and down hall call means are provided on the respective floors, said means being adapted to generate signals corresponding to the number of up hall calls and that of down hall calls for each floor zone, there is provided means for producing a signal corresponding to the sum of the signals corresponding to the total number of up hall calls at the respective floor zone, and there is also provided means for producing a signal corresponding the sum of the signals corresponding to the number of up hall calls and that of down hall calls at each floor zone.

11. A group supervisory control system for elevators according to claim 1, including maximum or minimum selector means comprising a plurality of input terminals to which input signal voltages are applied, a plurality of diodes having the cathode sides or anode sides thereof connected with each other, the other electrode of each of said plurality of diodes being connected with each one of said input terminals and a plurality of comparator means each adapted to provide an output when a voltage obtained by subtracting the voltage at the common connection point from the input signal voltage exceeds the forward voltage drop of said diodes or when a voltage obtained by subtracting the input signal voltage from the voltage at the common connection point exceeds the forward voltage drop of the diodes, thereby selecting a discriminant function which represents a maximum value.

12. A group supervisory control system for elevators comprising:

traffic demand detecting means for detecting the traffic demands for elevators to provide a traffic demand signal consisting of a plurality of factors of traffic demands; and

pattern classifier means for producing discriminant functions which are functions of said traffic demand signal for each of said traffic patterns, thereby determining that a traffic demand condition, to which belongs the discriminant function which presents a maximum value, is the optimum traffic demand condition at that point of time.

13. A group supervisory control system for elevators according to claim 12, wherein said pattern classifier means includes means for setting up at least one prototype point which represents each traffic demand condition for each of them and means for selecting that one of the traffic demands to which the prototype point closest to the traffic demand signal belongs.

14. A group supervisory control system for elevators according to claim 12, including at least two sets of pattern classifier means for selecting one of the demand conditions of their own in accordance with demands signals imparted thereto, said demand signals partly overlapping or being completely different from each other, one of said pattern classifier means being adapted to select one of the demand conditions in accordance with the demand signal imparted thereto another of said pattern classifier means adapted to select one of a plurality of lower rank demand conditions selected by another pattern classifier means, and means for providing an output corresponding to the demand condition selected by said other pattern classifier means when the demand conditions selected by said other pattern classifier means is included in the demand condition selected by the one pattern classifier means.

15. An elevator system in accordance with claim 14, further including timing means for providing an output at a preselected time and means for selecting one of two lower rank demand conditions belonging to the demand conditions selected by the pattern classifier means in response to the occurrence of the time either inside or outside the time set by said timing means.

16. An elevator system in accordance with claim 15, including means for externally imparting an input signal to the discriminant function generator means for producing a discriminant function belonging to a particular traffic demand condition established in the pattern classifier means, thereby forcibly changing the discriminant function.

17. An elevator system in accordance with claim 16, including traffic demand detecting means for producing a weight signal corresponding to the load of each elevator cage, wherein said weight signal is supplied to sample and hold means so as to be held therein when an elevator cage arrives at or leaves a particular floor when the elevator cage passes said particular floor, said weight signal being made to be equal to 0 and supplied to said sample and hold means so as to be held thereat and the outputs of said sample and hold means being added as an output signal as part of the traffic demand indication signal.

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