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(71) Applicant: **MITSUBISHI DENKI KABUSHIKI KAISHA**
2-3, Marunouchi 2-chome Chiyoda-ku
Tokyo 100(JP)

(72) Inventor: **Sueyoshi, Takanori Mitsubishi Denki K.K.**
Power and Ind.Systems Center 1-1-2, Wadasakicho
Hyogo-ku Kobe-shi Hyogo(JP)
Inventor: **Sato, Daiki Mitsubishi Denki K.K.**
Power and Ind.Systems Center 1-1-2, Wadasakicho
Hyogo-ku Kobe-shi Hyogo(JP)
Inventor: **Nagashima, Kiyoshi Mitsubishi Denki K.K.**
Power and Ind.Systems Center 1-1-2, Wadasakicho
Hyogo-ku Kobe-shi Hyogo(JP)
Inventor: **Watanabe, Hideo Mitsubishi Denki K.K.**
Power and Ind.Systems Center 1-1-2, Wadasakicho
Hyogo-ku Kobe-shi Hyogo(JP)

(74) Representative: **Eisenführ & Speiser**
Martinistrasse 24
D-2800 Bremen 1(DE)

(54) **Controller for tunnel ventilating system.**

(57) A controller for a tunnel ventilating system comprising an exhaust blower (3), jet fans (4, 5) and/or electric dust collectors (6l, 62), for forcibly ventilating a tunnel having a ventilating shaft (l) formed substantially at the middle of the tunnel. The controller comprises: detecting elements disposed within the tunnel and/or approached to the tunnel for detecting various physical values relating to air pollution within the tunnel, such as ventilation rate, wind speed, type, running speed and volume of vehicles passing through the tunnel, and the degree of air pollution within the tunnel; arithmetic processing element which calculates a correction value for correcting the ventilation rate and a control value for controlling the flow speed of fresh air supplied into the tunnel by the tunnel ventilating system on the basis of physical values detected by the detecting element; and control element which controls the operation of the exhaust blower and/or the electric dust collectors on the basis of the correction value for correcting the ventilation rate, and controls the operation of the jet fans on the basis of the control value for controlling the flow speed of fresh air supplied into the tunnel.

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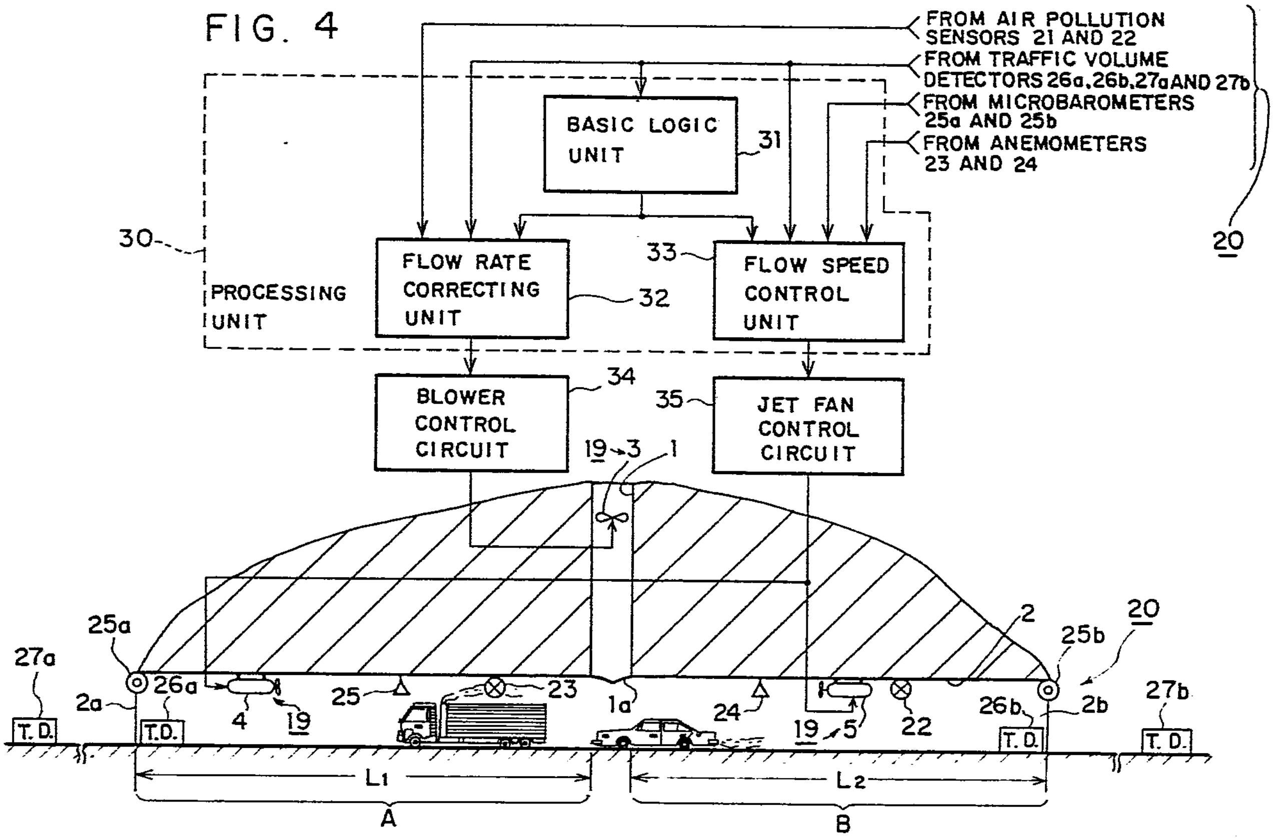
FIG. 4



FROM AIR POLLUTION SENSORS 21 AND 22
FROM TRAFFIC VOLUME DETECTORS 26a,26b,27a AND 27b
FROM MICROBAROMETERS 25a AND 25b
FROM ANEMOMETERS 23 AND 24
20
BASIC LOGIC UNIT
31
30
PROCESSING UNIT
FLOW RATE CORRECTING UNIT
32
33
FLOW SPEED CONTROL UNIT
BLOWER CONTROL CIRCUIT
34
35
JET FAN CONTROL CIRCUIT
19
3
1
2
20
25a
25b
27a
26a
2a
4
19
25
23
1a
24
19
5
22
26b
2b
27b
T.D.
T.D.
T.D.
T.D.
L1
L2
A
B

CONTROLLER FOR TUNNEL VENTILATING SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a controller for tunnel ventilating systems for ventilating a traffic tunnel through which transports such as automobiles that discharge exhaust gas run and, more specifically, to a controller for tunnel ventilating systems, capable of controlling tunnel ventilating systems for stable and economical operation by controlling both the flow speed and flow rate of the air in a traffic tunnel.

Description of the Prior Art

Automobile traffic tunnels and railway tunnels for trains with a diesel locomotive or a steam locomotive need to be ventilated continuously to prevent the danger of the tunnels being filled with the exhaust gas discharged by automobiles or the locomotives. Accordingly, such tunnels are equipped with ventilating holes, exhaust blowers and supply blowers.

Japanese Patent Provisional Publication No. 59-44499 laid open on March l2, l984 discloses a tunnel ventilating system including a controller invented by M. Kusano as illustrated in a block diagram in Fig. l. Figs. 2A, 2B, 3A and 3B are pollution distribution characteristic diagrams showing the condition of air pollution within a tunnel equipped with such a tunnel ventilating system.

Referring to Fig. l, a vertical ventilating shaft l is formed substantially at the middle of a tunnel 2 and an exhaust blower 3 for discharging polluted air from the tunnel 2 is provided in the ventilating shaft 2. Jet fans 4a and 4b for driving the polluted air toward the ventilating shaft l is attached to the ceiling of the tunnel 2. A controller l0 for controlling the ventilating system comprising the exhaust blower 3 and the jet fans 4a and 4b controls the ventilating system on the basis of data obtained by sensors 6 and 7 for detecting the degree of air pollution, wind flow direction and wind speed within the tunnel, including visibility index (VI) meters, attached to the ceiling of the tunnel 2 on the opposite sides of the opening la of the ventilating shaft l, respectively. The controller l0 comprises a program notch control unit ll which determines the mode of operation of the exhaust blower 3 and the jet fans 4a and 4b, such as the number and rotating speed of the exhaust blower 3 and the jet fans 4a and 4b, according to a program notch stored in a memory device, not shown; a manual notch control unit l2 which determines the mode of operation of the exhaust blower 3 and the jet fans 4a and 4b, such as the number and rotating speed of the exhaust blower 3 and the jet fans 4a and 4b, according to a notch given to the controller l0; an input data processing unit l3 which receives detection signals periodically from the sensors 6 and 7 and averages the detection signals; a software switching unit l4 which sets the data processing timing of the program notch control unit ll; operation mode correcting unit l5 which receives the output signal of the program notch control unit ll controlled by the switching unit l4, the output signal of the manual notch control unit l2 and the output signal of the input data processing unit l3, and then corrects control patterns specified by the control units ll and l2 on the basis of data processed by the input data processing unit l3; and a control pattern determining unit l6 which determines an actual mode of operation of the exhaust blower 3 and the jet fans 4a and 4b on the basis of the output signal of the operation mode correcting unit l5 and provides control signals. A manual notch given by external means to the manual notch control unit l2 is switched by a switching unit l7. The control pattern determining unit l6 of the controller l0 is connected to the exhaust blower 3 and the jet fans 4a and 4b by a control circuit l8.

The controller l0 thus constituted for controlling the tunnel ventilating system measures the degree of pollution of the air within the tunnel 2 by means of the sensors 6 and 7, and then controls the exhaust blower 3 and the jet fans 4a and 4b on the basis of the measured data. Measured degrees of pollution x and y in sections A and B between the portal 2a of the tunnel 2 and the opening la of the ventilating shaft l and between the portal 2b of the tunnel 2 and the opening la of the ventilating shaft l, respectively, as shown in Fig. 2A vary along characteristic curves shown in Fig. 2B. When fresh air is supplied through the portals 2a and 2b of the tunnel 2 toward the ventilating shaft l as illustrated in Fig. 2A, the degree of pollution is highest in a region in the vicinity of the opening la of the ventilating shaft l as illustrated in Fig. 2B, and hence it is possible to control the ventilation of the tunnel 2 on the basis of the data x and y measured by the sensors 6 and 7. However, the flow of the fresh air within the tunnel 2 is affected by the difference between the portals 2a and 2b of the tunnel 2 in atmospheric pressure, the number, direction and type of vehicles, such as automobiles or trains, which run through the tunnel 2. Therefore, it is difficult to maintain the distribution of degree of pollution in such characteristics as illustrated in Fig. 2B. In some cases, so-called blow-through occurs in the tunnel 2, in which fresh air flows only in one direction from the portal 2a toward the portal 2b or from the portal 2b toward the portal 2a and the air within the tunnel 2 is scarcely ventilated through the ventilating shaft I. When flow-through occurs, the distribution of the degree of pollution assumes a characteristic as illustrated in Fig. 3A or 3B. In Figs. 3A and 3B, blank arrows indicates the direction of flow of fresh air within the tunnel 2. As is obvious from Figs. 3A and 3B, the degree of pollution at the outlet portal 2a or 2b exceeds an allowable level indicated by a dotted line. When the measured degree of pollution x or y at the portal 2a or the portal 2b is excessively high, it is impossible to control the ventilation of the tunnel 2 on the basis of the difference between the degree of pollution measured by the sensor 6 and the degree of pollution measured by the sensor 7. To reduce the degree of pollution below the allowable level after the distribution of the degree of pollution has become a state as illustrated in Fig. 3A or 3B, the inclination of the distribution curves x-y needs to be reduced by increasing the rate of ventilation, which requires a ventilating system having a large supply capacity or a large exhaust capacity. Consequently, such a tunnel ventilating system is expensive and requires increased power cost, and hence such a tunnel ventilating system is economically disadvantageous.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a controller for tunnel ventilating systems, capable of always stably controlling the degree of pollution of the tunnel below an allowable level by controlling the tunnel ventilating system so that fresh air will flow at an appropriate flow rate and at an appropriate wind speed from both the portals of the tunnel toward the opening of a ventilating shaft formed substantially at the middle of the tunnel.

It is another object of the present invention to provide a controller for tunnel ventilating systems, capable of controlling tunnel ventilating operation always at a fixed flow rate and at a fixed wind speed without requiring a tunnel ventilating system having a large ventilating capacity so that the equipment cost and power cost of the tunnel ventilating system are reduced.

The foregoing and additional objects are attained in accordance with the principles of this invention by providing a controller for tunnel ventilating systems, which detects the degree of pollution, the flow rate and flow speed of air within the tunnel and the pressure difference between the interior and exterior of the tunnel by various sensors for data acquisition disposed within the tunnel, controls the tunnel ventilating system by the flow speed control device of an arithmetic data processing unit on the basis of the data acquired by the sensors so that air flows from the opposite portals of the tunnel toward the ventilating shaft of the same always at an appropriate flow speed, determines the rate of ventilation by the flow speed control device of the arithmetic data processing unit so that the degree of pollution of the air within the tunnel will not exceed a predetermined limit of pollution and the tunnel is ventilated at the least necessary rate of ventilation, and controls the operation of the tunnel ventilating system comprising jet fans, an exhaust blower or blowers, and a dust collector or collectors on the basis of the manipulated values determined by the arithmetic data processing unit.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure I is a block diagram of a conventional tunnel ventilating system and a controller for controlling the same shown in combination with a schematic sectional view of a traffic tunnel;

Figures 2A and 2B are a schematic sectional view of a tunnel and a diagram showing a mode of distribution of the degree of pollution within the tunnel, respectively;

Figures 3A and 3B are diagrams showing modes of distribution of the degree of pollution within a tunnel when blow-through occurred under the control of a conventional controller for tunnel ventilating systems;

Figure 4 is a block diagrams of a controller for tunnel ventilating systems, in a first embodiment, according to the present invention;

Figure 5 is a flow chart of assistance in explaining the manner of control operation of the controller of Fig. 4; and

Figure 6 is a block diagram of a controller for tunnel ventilating systems, in a second embodiment, according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the controller for tunnel ventilating systems, according to the present invention will be described hereinafter with reference to the accompanying drawings.

In Fig. 4, the constitution and arrangement of a ventilating shaft I, an inner opening Ia of the ventilating shaft I, a tunnel 2, portals 2a and 2b, and an exhaust blower 3 are the same as those of the conventional tunnel ventilating system and the tunnel shown in Fig. I, hence the description thereof will be omitted to avoid duplication. A tunnel ventilating system I9 comprises the exhaust blower 3 and jet fans 4 and 5. The jet fans 4 and 5 are disposed within the tunnel 2 on opposite sides of the opening Ia of the ventilating shaft I, respectively, to supply fresh air from the portals 2a and 2b toward the opening Ia, respectively. A detecting system 20 for detecting various physical values is provided within the tunnel 2. The detecting system 20 comprises air pollution sensors 2I and 22, such as visibility index meters (hereinafter designated as "VI meters") or carbon monoxide concentration detecting meters (hereinafter designated as "CO meters"), anemometers 23 and 24 attached to the ceiling of the tunnel 2 on opposite sides of the opening Ia to detect the respective flow speeds of air flowing from the portal 2a toward the opening Ia and air flowing from the portal 2b toward the opening Ia, respectively, microbarometers 25a and 25b attached to the ceiling of the tunnel 2 near the portals 2a and 2b to measure the atmospheric pressure near the portals 2a and 2b, respectively; traffic volume detectors 26a and 26b disposed near the portals 2a and 2b, respectively, to detect the type, number and running speed of automobiles coming into the tunnel, and traffic volume detectors 27a and 27b disposed outside the tunnel at a fixed distance from the portals 2a and 2b, respectively, to detect the type, number and running speed of automobiles running toward the tunnel 2 on approaches to the tunnel 2.

The data acquired by the detectors of the detecting system 20 are operated and processed by a processing unit 30 comprising a basic logic unit 3I which calculates a long-term traffic volume estimate, a degree of pollution, a required ventilating rate and a flow rate allocation on the basis of data acquired by the traffic volume detectors 26a, 26b, 27a and 27b, a flow rate correcting unit 32 which corrects the flow rate on the basis of data acquired by the air pollution sensors 2I and 22 and the output signal of the basic logic unit 3I, and a flow speed control unit 33 which controls the flow speed of air within the tunnel 2 on the basis of wind speed data detected by the anemometers 23 and 24, atmospheric pressures near the portals 2a and 2b detected by the microbarometers 25a and 25b, a traffic volume detected by the traffic volume detectors 26a, 26b, 27a and 27b and the output signal of the basic logic unit 3I. The exhaust blower 3 of the tunnel ventilating system I9 is controlled by a blower control circuit 34 according to the output signals of the flow rate correcting unit 32 of the processing unit 30. The jet fans 4 and 5 of the tunnel ventilating system I9 are controlled by a jet fan control circuit 35 on the basis of the output signals of the flow speed control unit 33.

The manner of operation of the controller for the tunnel ventilating system will be described hereinafter with reference to Figs. 4 and 5.

The basic logic unit 3I of the processing unit 30 executes a long-term traffic volume estimating task 4I to estimate a traffic volume at a time in the subsequent 30 to I20 min on the basis of various traffic volume data T_D concerning automobiles passing through the tunnel 2, such as the time series data of the number of automobiles classified by type and the running speed of automobiles, detected by the traffic volume detectors 26a, 26b, 27a and 27b, and then the basic logic unit 3I executes a pollution level calculating task 42 to calculate a pollution level within the tunnel 2 under the estimated traffic volume. Then, the basic logic unit 3I executes a ventilation demand calculating task 43 to calculate a ventilation rate necessary to maintain the degree of pollution within the tunnel 2 below an allowable degree of pollution. The exhaust blower 3 and the jet fans 4 and 5 of the ventilating system I9 are operated for a ventilation rate exceeding the ventilation demand calculated in the ventilation demand calculating task 43 to attain a control target. However, the operation of the ventilating system I9 at an excessively high rate increases the power cost wastefully. Accordingly, to select the most economical operation pattern among the operation pattern of the ventilating system I9 meeting the ventilation demand, a flow rate allocation calculating task 44 is executed. After accomplishing the tasks 4I to 44, the basic logic unit 3I provides a reference wind speed S_R, a reference ventilation rate R_R, and a reference jet fan number N_R. The reference wind speed S_R is wind speeds in the sections of the tunnel 2 on the opposite sides of the opening Ia, respectively, when the ventilating system I9 is operated in the operation pattern selected through the flow rate allocation calculating task 44. The reference ventilation rate R_R is an exhaust rate of the exhaust blower 3 when the ventilating system I9 is operated in the selected operation pattern. The reference jet fan number N_R is the number of jet fans to be operated among the jet fans 4 and 5 when the ventilating system I9 is operated in the selected operation pattern. The tunnel ventilating operation is carried out on the basis of those reference values provided by the basic logic unit 3I. The basic logic unit 3I is actuated every 30 to I20 min to update the reference values.

The flow rate correcting unit 32 of the processing unit 30 carries out the following functions. Traffic volume in the tunnel 2 is variable and does not remain constant for 30 to 120 minutes. Since the basic logic unit 31 is actuated every 30 to 120 minutes, the traffic volume data T_D needs correction, and hence the reference values calculated by the basic logic unit 31 also need correction. The flow rate control unit 32 executes a short-term traffic volume estimating task 45 on the basis of the time series data provided by the traffic volume detectors 26a, 26b, 27a and 27b to estimate a short-term traffic volume. Then, a traffic volume feed forward control task 46 is executed to calculate a correction by comparing the estimated short-term traffic volume and the estimated long-term traffic volume obtained through the long-term traffic volume estimating task 41 by the basic logic unit 31. An air pollution feedback control task 47 is executed to calculate an air pollution degree correction by comparing a measured air pollution degree P_M and an air pollution degree target P_T. Generally, the air pollution degree feedback control operation is a VI feedback control operation based on a measured haze transmissivity and its reference value, or a CO feedback control operation based on a measured CO concentration and its reference value.

The flow rate correcting unit 32 adds the reference ventilation rate R_R and corrections obtained through the traffic volume feed forward task 46 and the air pollution feedback control task 47 by means of an adder 48 to provide a final control value 50 of flow rate for the exhaust blower 3. The flow rate control unit 32 is actuated every approximately 10 minutes, because excessively frequent change of the operating condition of the exhaust blower 3 having a large capacity affects adversely to the durability of the exhaust blower 3 and the variation of air pollution degree within the tunnel 2 in a time about one minute is insignificant.

The flow speed control unit 33 of the processing unit 30 carries out the following functions. Generated in the tunnel 2 are various forces affecting the movement of air within the tunnel 2, such as wind force generated by the running of vehicles (ventilating force generated by traffic), natural wind force attributable to the difference between the portals of the tunnel 2 in atmospheric pressure, pressure raising force resulting from the ventilating operation of the tunnel ventilating system 19, frictional resistance of the wall of the tunnel 2 against the flow of air, resistances at the portals causing a loss in wind force and other various forces. To correct the variation of the flow speed of air within the tunnel resulting from the influence of those forces, namely, to maintain the wind speed within the tunnel at the reference wind speed S_R calculated by the basic logic unit 31, a pressure balance calculating task 51 is executed to calculate a pressure balancing value on the basis of the traffic volume data T_D , a natural inflow rate R_N and the reference wind speed S_R. Then, a wind speed feedback control task 52 is executed to calculate a correction by comparing the reference wind speed V_R and a measured wind speed S_M measured by the anemometers 23 and 24. The flow speed control unit 33 adds the reference jet fan number N_R provided by the basic logic unit 31, the pressure balancing value obtained through the tasks 51 and 52, and a feedback wind speed correction, and then provides a jet fan control value 55 for controlling the number of the jet fans to be operated among the jet fans 4 and 5, and the rotating speed of the jet fans.

The calculating operation of the flow speed control unit 33 needs to be executed at an interval smaller than those of operation of the basic logic unit 31 and the wind speed correcting unit 32, because, when an automobile runs through the tunnel 2, for example, from the portal 2b toward the portal 2a (Fig. 4), the automobile passes through the section A in L_1/V sec and the section B in L_2/V sec, where L_1 (m) is the distance between the portal 2a and the opening 1a of the ventilating shaft 1, L_2 (m) is the distance between the portal 2b and the opening 1a of the ventilating shaft 1, and V (m/sec) is the running speed of the automobile.

On the other hand, during the stabilized ventilating operation, the wind blows within the tunnel 2 from the portal 2a toward the ventilating shaft 1 in the section A and from the portal 2b toward the ventilating shaft 1 in the section B. However, the ventilating force generated by the automobile running from the portal 2b toward the portal 2a always acts along a direction from the portal 2b to the portal 2a. Accordingly, the ventilating force generated by the automobile acts against the ventilation while the automobile is running in the section B, while the ventilating force generated by the automobile acts for the ventilation while the automobile is running in the section A. Therefore, the wind speed control unit 33 needs to operate at an interval smaller than the smaller one of the times L_1/V sec and L_2/V sec. For example, when $L_1 \approx L_2 \approx$ 3000 m and V = 60 km/hr, appropriate intervals for the operation of the wind speed control unit 33 is in the range of one to three minutes.

Thus, economical, stable ventilation control of the centralized exhaustion system is realized by executing the control soft wares of the basic logic unit 31, flow rate correcting unit 32 and wind speed control unit 33 of the processing unit 30 at appropriate intervals meeting the respective functions and objects of the component units of the processing unit 30, respectively.

As described with reference to Fig. 5, in the first embodiment, the wind speed correcting unit 32 executes the traffic volume feed forward control task 46 and the air pollution degree feedback control task 47 to obtain two corrections. However, a control value 50 for controlling the exhaust blower 3 may be obtained on the basis of one or the other of the two corrections.

Furthermore, when the present invention is applied to a controller for a ventilating system of a small scale, the flow rate correcting unit 32 may be omitted and the processing unit 30 may comprise only the basic logic unit 3l and the wind speed control unit 33.

Still further, although the first embodiment of the present invention has been described as applied to the tunnel ventilating system l9 comprising the exhaust blower 3 and the jet fans 4 and 5, the application of the present invention is not limited thereto, but may be applied, in a second embodiment as illustrated in Fig. 6, to a tunnel ventilating system 59 comprising an exhaust blower 3, jet fans 4 and 5, and electric dust collectors 6l and 62 for collecting dust from the air within the tunnel. In the second embodiment, the controller may include an exhaust and dust collection control circuit 64, and an electric dust collector control unit 60 for controlling the operation of the electric dust collectors on the basis of a flow rate correction value. In such a case, the control value 50 for controlling the exhaust blower 3 is used as a controlled value for controlling the exhaust blower 3 and the dust collectors 6l and 62.

As is apparent from the foregoing description, the controller for tunnel ventilating systems, according to the present invention controls the tunnel ventilating system to regulate the flow speed and flow rate of air within the tunnel on the basis of control values obtained by operating and processing information detected by detectors for detecting various physical values representing the degree of air pollution within the tunnel, and thereby the ventilating system is controlled for stable, economical ventilating operation, in which air flows always from both the portals of the tunnel toward the ventilating shaft.

Claims

l. A controller for a tunnel ventilating system for ventilating a tunnel having a ventilating shaft formed substantially at the middle of the tunnel, which comprises:

detecting means for detecting various physical values representing the degree of air pollution within the tunnel;

processing means which processes the physical values detected by the detecting means to provide a correction value for correcting a ventilation rate, and a control value for air flow speed ventilated by the tunnel ventilating system; and

control means which controls an operation of the tunnel ventilating system on the basis of the correction value and the control value.

2. A controller for a tunnel ventilating system for ventilating a tunnel having a ventilating shaft formed substantially at the middle of the tunnel, an exhaust blower provided within the ventilating shaft, and jet fans provided at a position between one of the portals of the tunnel and an inner opening of the ventilating shaft and at a position between the other portal and the inner opening of the ventilating shaft, which comprises:

detecting means comprising a plurality of sensors disposed within the tunnel and/or approaches to the tunnel, respectively, for measuring the .difference between the portals of the tunnel in atmospheric pressure, wind speed within the tunnel, degree of air pollution within the tunnel, traffic volume within the tunnel and the running speed of vehicles passing through the tunnel;

processing means which processes the physical values detected by the detecting means to provide control values for control the ventilating system so that fresh air always flows at an appropriate flow speed from both the portals of the tunnel toward the ventilating shaft, and a force ventilation rate correction value for maintaining the degree of air pollution within the tunnel below an allowable level; and

control means which controls the jet fans on the basis of the controlled values, and the exhaust blower on the basis of the forced ventilation rate correction value.

3. A controller as recited in Claim 2, wherein said processing means comprises: a basic logic unit which sequentially calculates a long-term traffic volume estimate, an air pollution degree within the tunnel, a ventilation demand and a flow rate allocating value on the basis of the physical values detected by the sensors to determine a reference wind speed, a reference ventilation demand and a reference jet fan number; a flow rate correcting unit which calculates a short-term traffic volume estimate for the feedback control of the tunnel ventilating system on the basis of the physical values detected by the sensors and an air pollution degree for the feedback control of the tunnel ventilating system on the basis of an air pollution degree detected by the air pollution degree sensor, and adds the short-term traffic volume estimate and the air pollution degree to provide a controlled flow rate of the exhaust blower; and a wind speed control unit which calculates the pressure balance within the tunnel on the basis of a wind speed detected

by the wind speed sensors of the detecting means, a traffic volume detected by the traffic volume sensors and the reference wind speed, calculates a wind speed for the feedback control of the tunnel ventilating system on the basis of the wind speed within the tunnel detected by the wind speed sensors and the reference wind speed, one of the output of the basic logic unit, and adds both the calculated values and the reference wind speed to provide a controlled wind speed for controlling the operation of the jet fans.

4. A controller for a tunnel ventilating system for ventilating a tunnel having a ventilating shaft formed substantially at the middle of the tunnel, an exhaust blower provided within the ventilating shaft, jet fans provided at a position between one of the portals of the tunnel and the inner opening of the ventilating shaft and at a position between the other portal of the tunnel and the inner opening of the ventilating shaft, respectively, and electric dust collectors provided within the tunnel on the opposite sides of the inner opening of the ventilating shaft to collect and remove dust from the tunnel, which comprises:

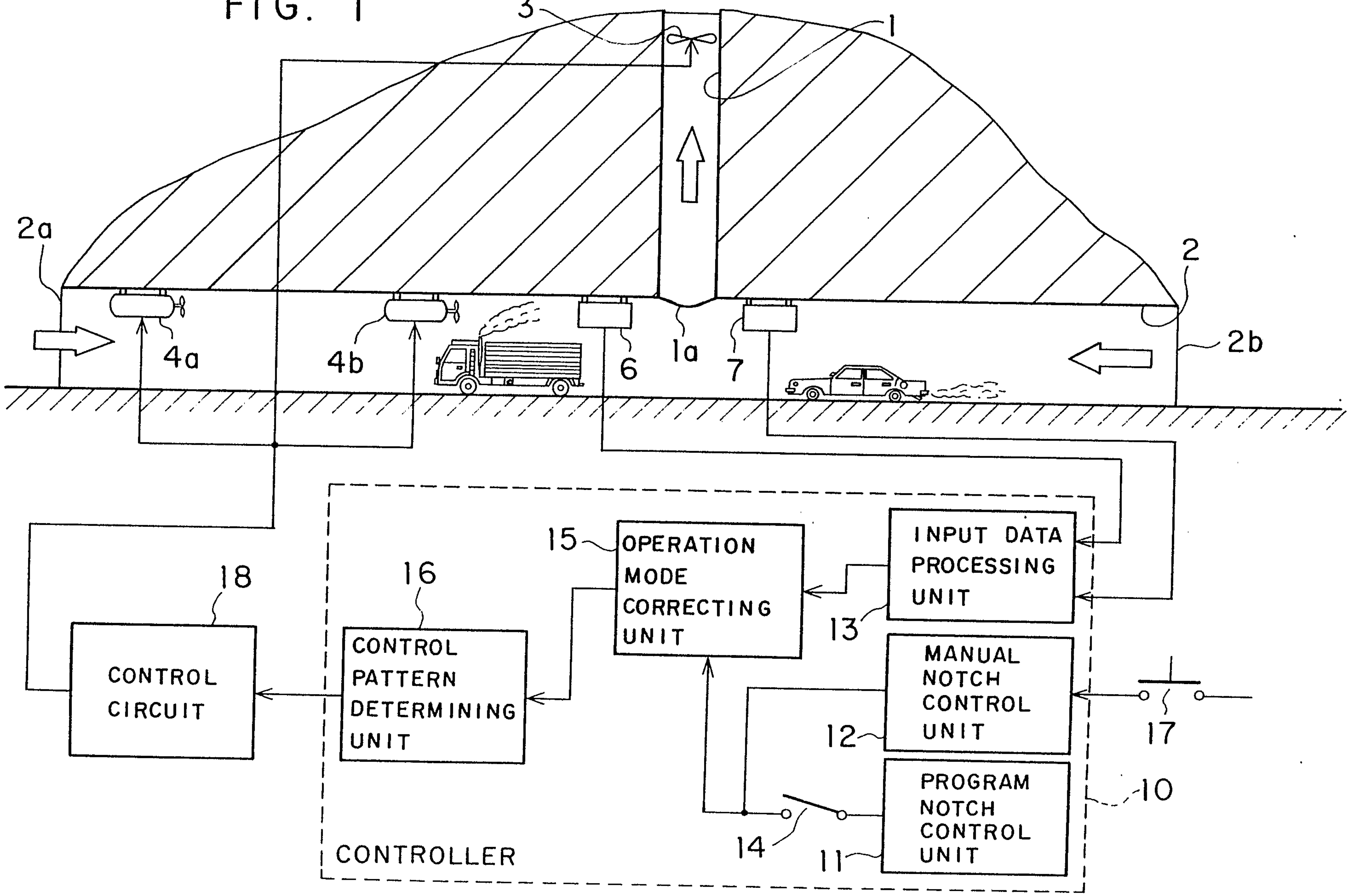
detecting means comprising a plurality of sensors disposed within the tunnel and/or approaches to the tunnel, respectively, to measure the difference between the portals of the tunnel in atmospheric pressure, wind speed within the tunnel, degree of air pollution within the tunnel, traffic volume within the tunnel and the running speed of vehicles passing through the tunnel;

processing means which processes information detected by the detecting means to determine a wind speed so that fresh air always flows at an appropriate flow speed from both the portals of the tunnel toward the ventilating shaft and to determine a forced ventilation rate so that the degree of air pollution within the tunnel is always maintained below an allowable level;

jet fan control means which controls the number of operating jet fans and the rotating speed of the jet fans on the basis of the wind speed determined by the processing means; and

exhaust blower and electric dust collector control means which controls the operation of the exhaust blower provided within the ventilating shaft and the operation of the dust collectors provided within the tunnel on the basis of the forced ventilation rate determined by the processing means.

FIG. 1



3
1
2a
2
2b
4a
4b
6
1a
7
INPUT DATA PROCESSING UNIT
15
OPERATION MODE CORRECTING UNIT
18
16
13
CONTROL PATTERN DETERMINING UNIT
CONTROL CIRCUIT
MANUAL NOTCH CONTROL UNIT
12
17
PROGRAM NOTCH CONTROL UNIT
10
14
11
CONTROLLER

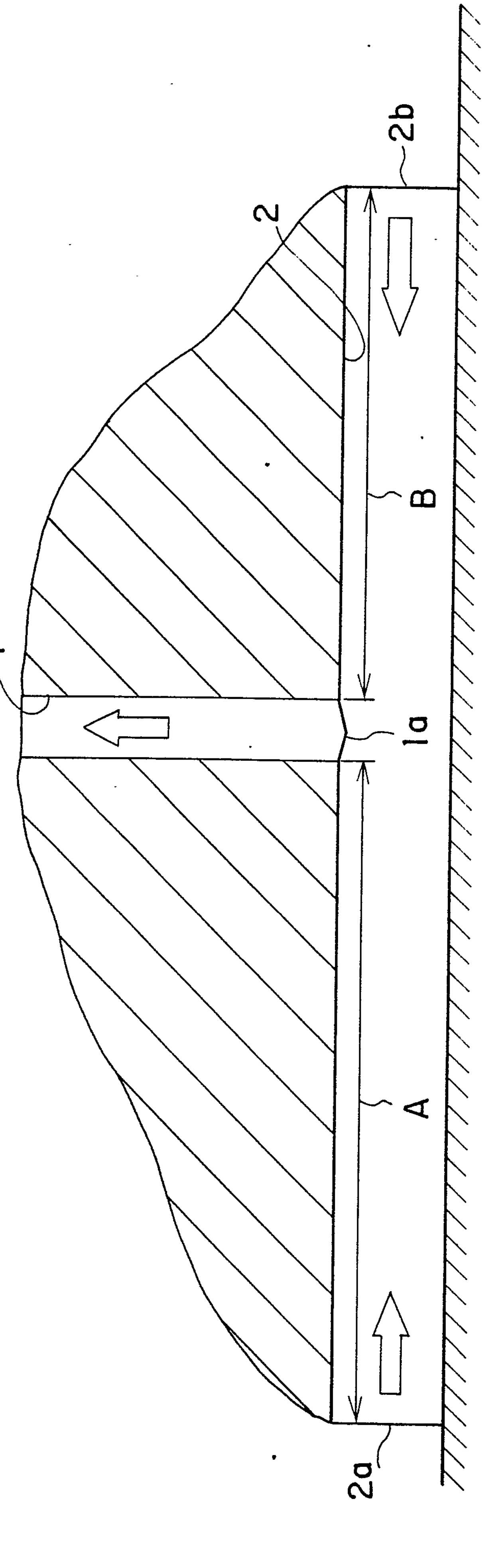

2b
2
B
1
1a
A
2a

FIG. 2A

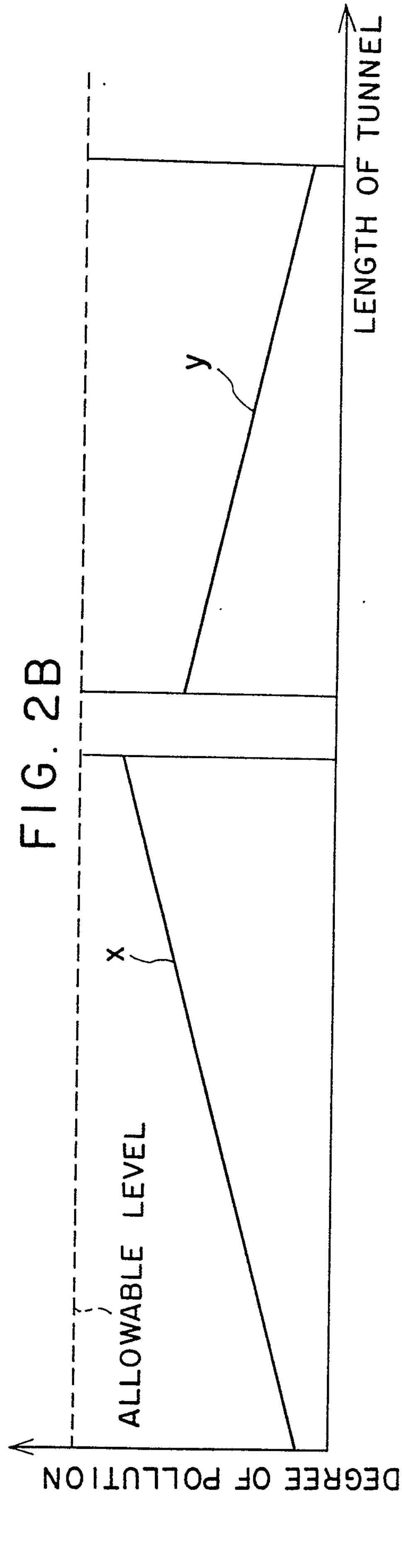

LENGTH OF TUNNEL
y
x
ALLOWABLE LEVEL
DEGREE OF POLLUTION

FIG. 2B

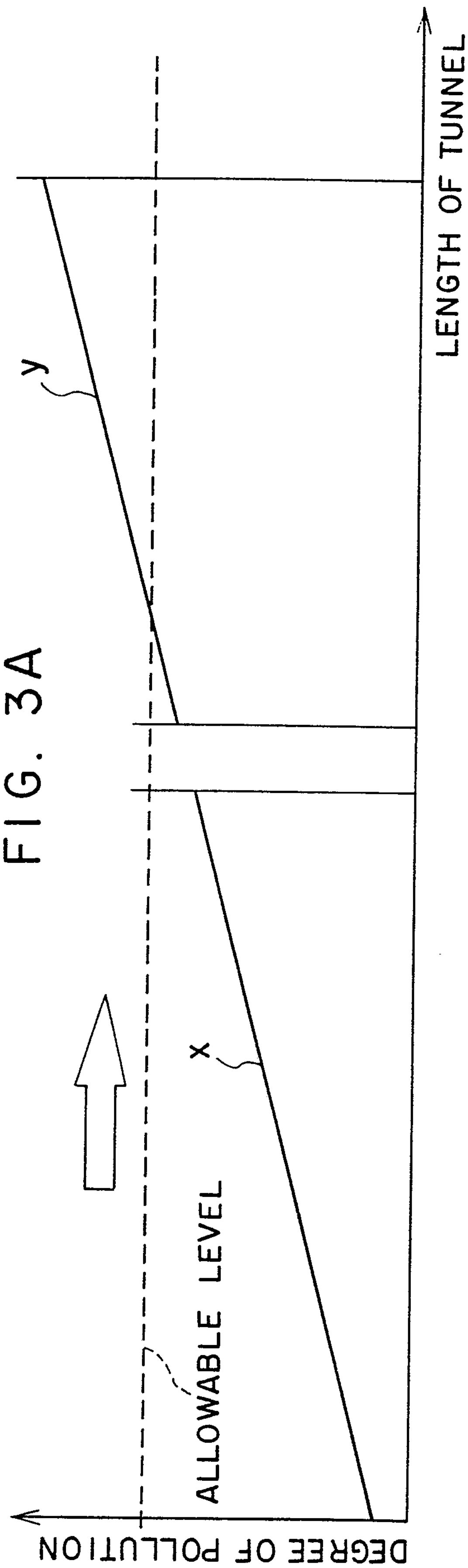

LENGTH OF TUNNEL
DEGREE OF POLLUTION
ALLOWABLE LEVEL
y
x

FIG. 3A

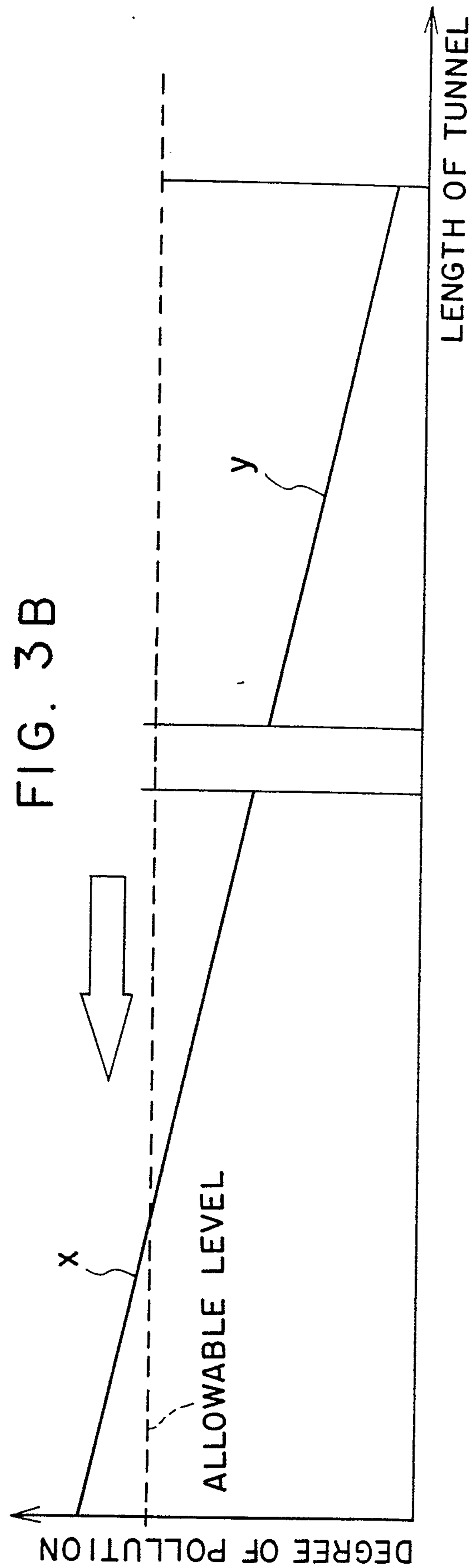
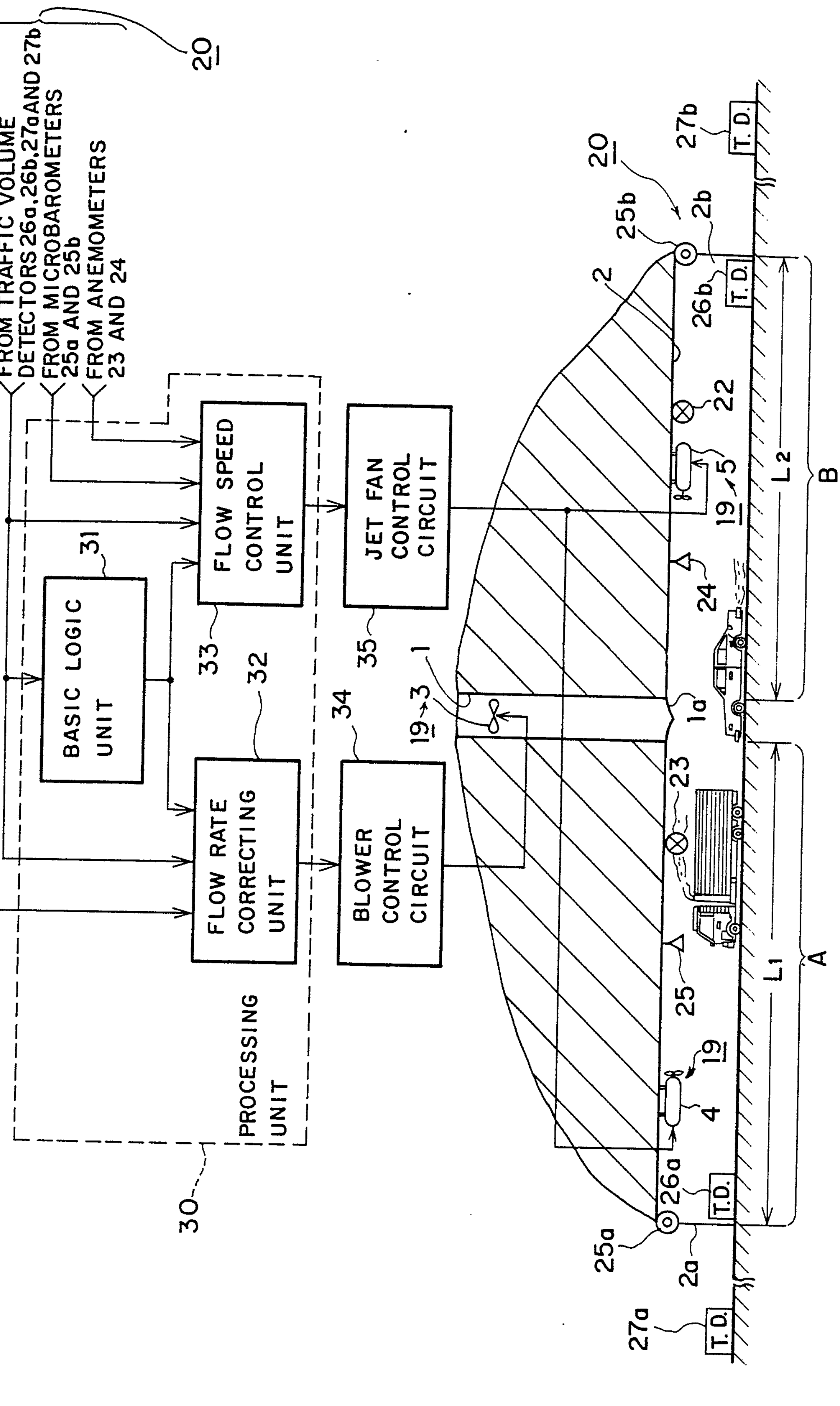

LENGTH OF TUNNEL
DEGREE OF POLLUTION
ALLOWABLE LEVEL
y
x

FIG. 3B



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FLOW RATE CORRECTING UNIT
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PROCESSING UNIT
30
JET FAN CONTROL CIRCUIT
35
BLOWER CONTROL CIRCUIT
34
19
3
1
1a
2
2a
2b
4
5
19
22
23
24
25
25a
25b
26a
26b
27a
27b
T.D.
L1
L2
A
B

FIG. 4

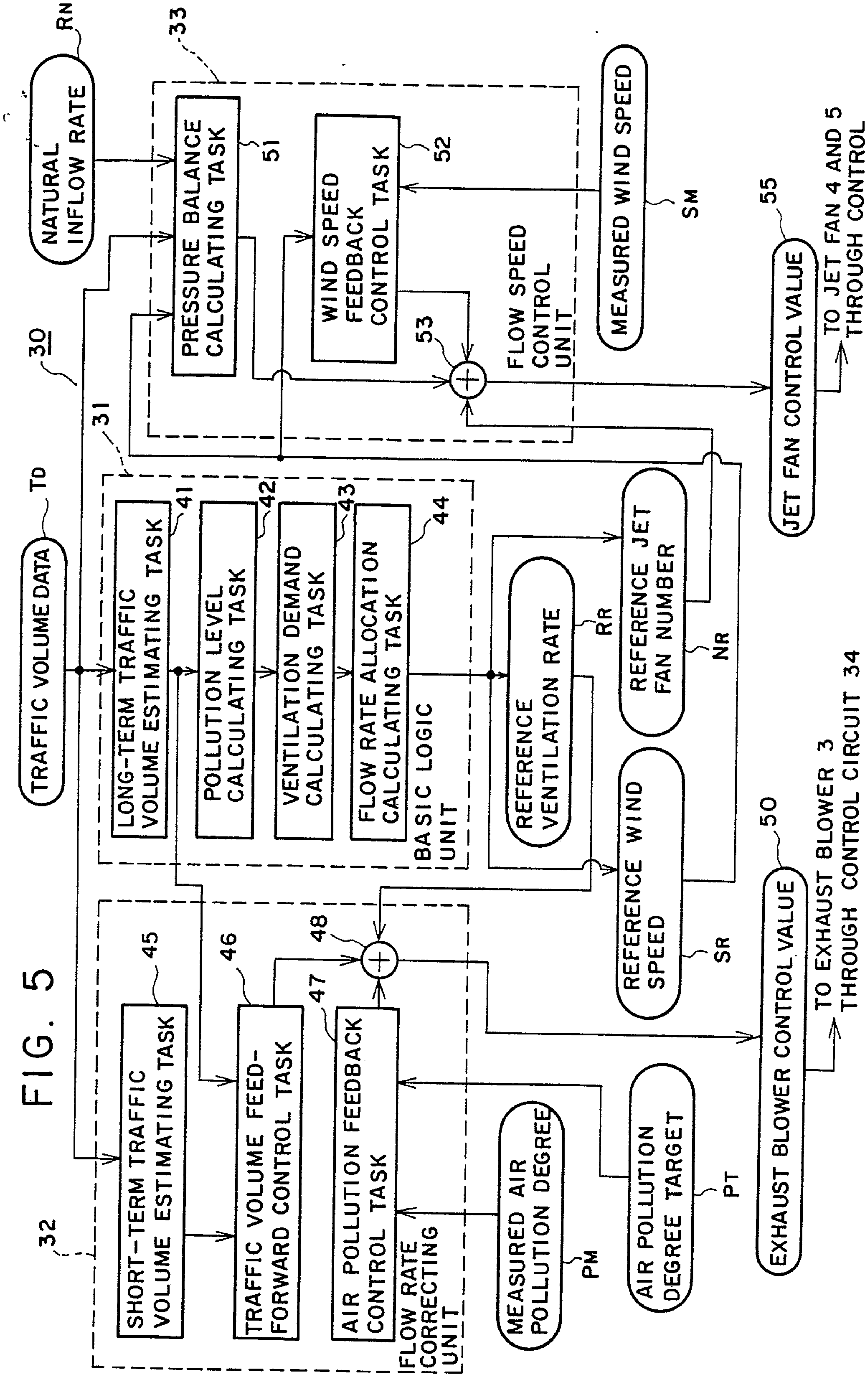
NATURAL INFLOW RATE
RN
33
PRESSURE BALANCE CALCULATING TASK
51
WIND SPEED FEEDBACK CONTROL TASK
52
MEASURED WIND SPEED
SM
53
FLOW SPEED CONTROL UNIT
55
JET FAN CONTROL VALUE
TO JET FAN 4 AND 5 THROUGH CONTROL CIRCUIT 35
30
31
TRAFFIC VOLUME DATA
TD
LONG-TERM TRAFFIC VOLUME ESTIMATING TASK
41
POLLUTION LEVEL CALCULATING TASK
42
VENTILATION DEMAND CALCULATING TASK
43
FLOW RATE ALLOCATION CALCULATING TASK
44
BASIC LOGIC UNIT
REFERENCE VENTILATION RATE
RR
REFERENCE JET FAN NUMBER
NR
REFERENCE WIND SPEED
SR
50
EXHAUST BLOWER CONTROL VALUE
TO EXHAUST BLOWER 3 THROUGH CONTROL CIRCUIT 34
32
SHORT-TERM TRAFFIC VOLUME ESTIMATING TASK
45
TRAFFIC VOLUME FEED-FORWARD CONTROL TASK
46
AIR POLLUTION FEEDBACK CONTROL TASK
47
48
FLOW RATE CORRECTING UNIT
MEASURED AIR POLLUTION DEGREE
PM
AIR POLLUTION DEGREE TARGET
PT

FIG. 5

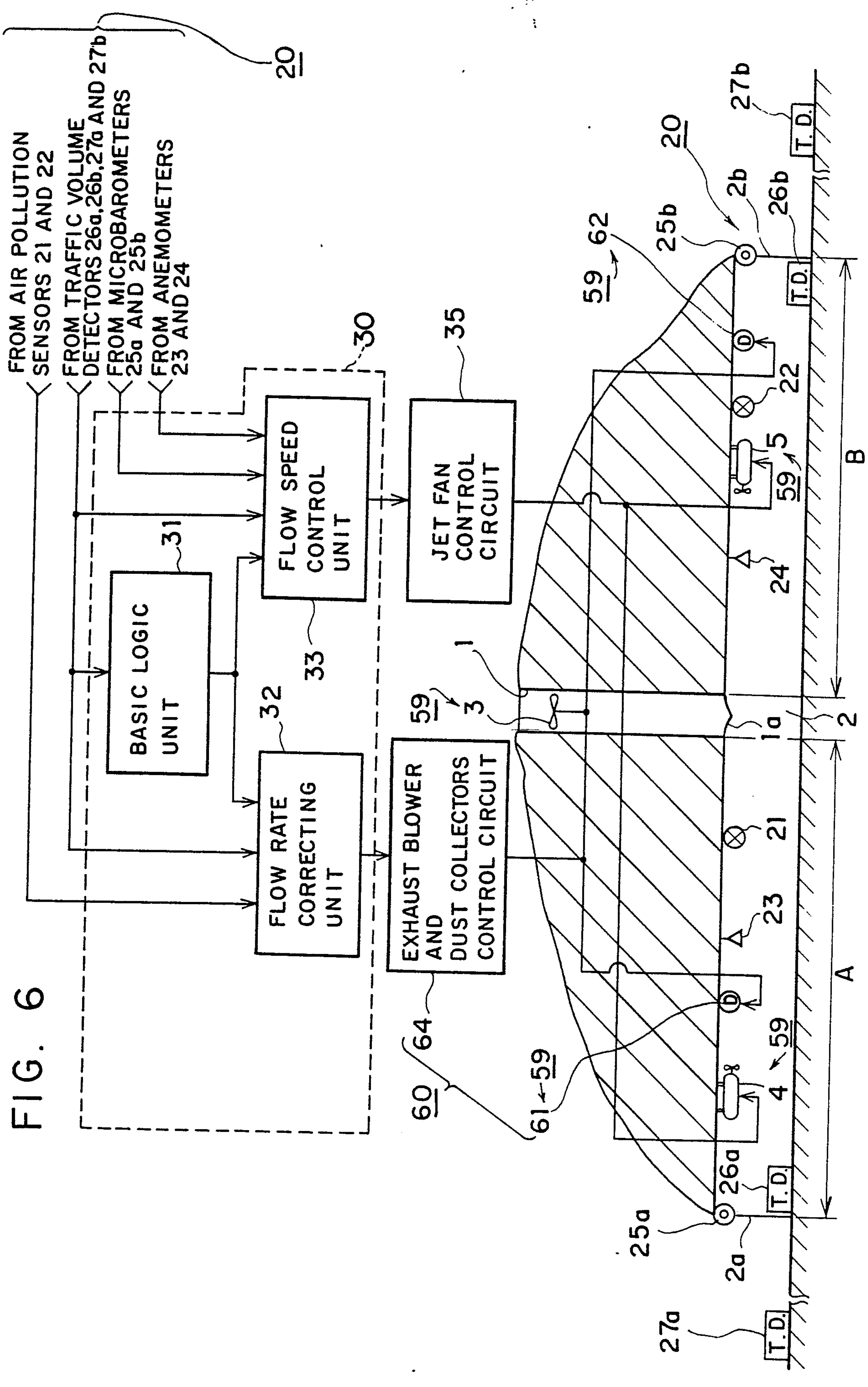
FROM AIR POLLUTION SENSORS 21 AND 22
FROM TRAFFIC VOLUME DETECTORS 26a,26b,27a AND 27b
FROM MICROBAROMETERS 25a AND 25b
FROM ANEMOMETERS 23 AND 24
20
30
BASIC LOGIC UNIT
31
FLOW SPEED CONTROL UNIT
33
FLOW RATE CORRECTING UNIT
32
JET FAN CONTROL CIRCUIT
35
EXHAUST BLOWER AND DUST COLLECTORS CONTROL CIRCUIT
64
60
61
59
62
1
1a
2
2a
2b
3
4
5
21
22
23
24
25a
25b
26a
26b
27a
27b
T.D.
A
B

FIG. 6

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 87 10 3005

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	DE-A-2 005 424 (FÖLDIAK) * Pages 4-7; figure *	1	E 21 F 1/00
A		2-4	
A	DE-A-3 117 147 (DAIMLER-BENZ) * Abstract; figure 1 *	1-4	
A	DE-A-3 336 031 (NUKEM)		
A	FR-A-2 358 542 (SOFRAIR)		
A	PATENT ABSTRACTS OF JAPAN, vol. 3, no. 35 (M-53), 24th March 1979, page 133 M 53; & JP-A-54 12 137 (TOKYO SHIBAURA DENKI K.K.) 29-01-1979		TECHNICAL FIELDS SEARCHED (Int. Cl.4) E 21 F F 24 F
P,X	EP-A-0 205 979 (MITSUBISHI) * Whole document *	1-3	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24-06-1987	RAMPELMANN J.

CATEGORY OF CITED DOCUMENTS

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