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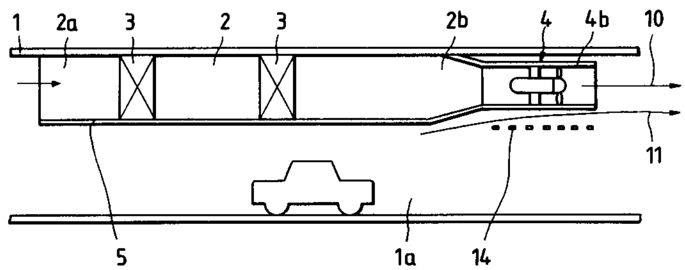
(54) Tunnel dust collecting system.

(57) The invention relates to a tunnel dust collecting system for removing dust and smoke from the contaminated air in a tunnel used for automotive traffic, the system comprising a dust collecting chamber (2) formed in the upper space of a tunnel (1) with a sealing board (5) in such a manner that said dust collecting chamber has one end serving as an air sucking end (2a) and the other end serving as an air supplying end (2b); electric dust collectors (3) arranged in said dust collecting chamber (2); and air blowers (4) in said dust collecting chamber (2) at the air supplying end. According to the prior art, it is a problem to efficiently mix the contaminated with the purified air obtained from such a dust collecting system. This problem is solved in that in said dust collecting system said air blowers (4) have casings exposed in the lower space of said tunnel (1).

FIG. 3(B)



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BACKGROUND OF THE INVENTION

(Field of the Invention)

This invention relates to a tunnel dust collecting system in which an electrical dust collector is used to remove dust and smoke from the contaminated air in a tunnel thereby to use the air again, and more particularly to a tunnel dust collecting system which is installed on the ceiling of a tunnel which is provided mainly for automobiles.

(Prior Art)

There are available a variety of tunnel dust collecting systems. Typical ones of the systems, are a tunnel dust collecting system of bypass tunnel type as shown in Fig. 8(A), and a tunnel dust collecting system of ceiling installation type as shown in Fig. 8(B) and Figs. 9(A) and 9(B). Figs. 9-(A) and 9(B) are a plan view and a sectional view of the tunnel dust collecting system shown in Fig. 8-(B).

In the tunnel dust collecting system of bypass tunnel type as shown in Fig. 8(A), a bypass tunnel is connected, as a dust collecting chamber 2, to the main tunnel 1 provided for automobiles, so that the air contaminated in the tunnel 1 is led into the dust collecting chamber at one end opened in the side wall of the main tunnel 1, where it is decontaminated with an electrical dust collector 3 (hereinafter referred to merely as "a dust collector 3", when applicable). The air thus processed is supplied into the main tunnel 1 with an air blower 4 through the other end of the dust collecting chamber 2.

On the other hand, in the tunnel dust collecting system of ceiling installation type, a ceiling board 5 is installed in such a manner as to form a dust collecting chamber 2 in the upper portion of a tunnel. The dust collecting chamber 2 has one end 2a which is used to suck air from the tunnel (hereinafter referred to as "an air sucking end 2a", when applicable), and the other end 2b which is used to supply decontaminated air into the tunnel (hereinafter referred to as "an air supplying end 2b", when applicable). The contaminated air sucked into the dust collecting chamber 2 through the air sucking end 2a is decontaminated with dust collectors 3, and the air thus decontaminated is supplied into the tunnel with air blowers 4 provided near the air supplying end 2b. When compared with the tunnel dust collecting system of bypass tunnel type, the tunnel dust collecting system of ceiling installation type is advantageous in that its installation cost is lower because it is unnecessary to form the bypass tunnel.

In the tunnel dust collecting system of ceiling installation type, as shown in Fig. 9, two dust collectors 3 are provided in the dust collecting chamber 2 in such a manner that they are separated from each other with a partition board 6. More specifically, the dust collecting chamber is divided by the partition board 6 into two parts,in which the two dust collectors are provided, respectively. Two axial flow type air blowers 4 with cylindrical casings 4b are provided at the air supplying end 2b of the dust collecting chamber 2, and air sucking inlets 7 are provided at the air sucking end of the dust collecting chamber 2. The air in the upper portion of the tunnel is sucked through the air sucking inlets 7 linearly along the central axis of the tunnel into the dust collecting chamber and decontaminated with the dust collectors 3, and the air thus decontaminated is linearly supplied into the tunnel with the air blowers 4 through air supplying outlets 4a.

The ceiling board 5 serves as a base board which supports the dust collectors 3 etc. Generally, the ceiling board 5 is extended to the air supplying outlets 4a of the air blowers 4, being utilized as means for making access to the air blowers for inspection or maintenance.

In the case of Fig. 9, only two dust collectors 3 are provided. However, in the case where more than two dust collectors are employed, they are arranged staggered in the dust collecting chambers from the air sucking end 2a towards the air supplying end 2b.

In the tunnel dust collecting system shown in Fig. 9, the air sucking end 2a of the dust collecting chamber 2 is employed as the air sucking inlets 7. On the other hand, there is available a tunnel dust collecting system of ceiling installation type in which, as shown in Fig. 10, the end of the dust collecting chamber corresponding to the above-described air sucking end is closed, and instead an air sucking inlet is opened in the end portion of the ceiling board 5 (hereinafter referred to as "a tunnel dust collecting system of upward suction type", when applicable).

In the tunnel dust collecting system of upward suction type, as shown in Fig. 10, the air sucking end 2a of the dust collecting chamber 2 defined by the ceiling board 5 is closed with a closing board 8, and instead a rectangular-window-shaped air sucking inlet 9 is formed in the ceiling board 5 near the closing board 8. The contaminated air in the tunnel is led through the air sucking inlet 9 into the dust collecting chamber as indicated by the arrows, and decontaminated with the dust collectors 3. The air thus decontaminated is supplied into the tunnel with the air blowers 4.

The above-described conventional tunnel dust collecting system of ceiling installation type is disadvantageous in the following points lowering its dust collection efficiency. I n the conventional tunnel dust collecting system, as shown in Fig. 9, the air decontaminated by the dust collectors 3 is blown along the central axis of the tunnel 1 into the upper portion of the latter as it is. Therefore, when compared with the tunnel dust collecting system of bypass tunnel type, the decontaminated air is difficult to mix with the contaminated air in the driveway space 1a of the tunnel 1. In general, in order to completely mix the decontaminated air with the contaminated air, there must be a distance of about 100 m. That is, the interval of installation of the dust collecting systems is limited. Therefore, the conventional system cannot decontaminate air sufficiently in the area where the engine load of an automobile is increased to increase the contamination of air as in an up- grade driveway of an undersea tunnel. The interval of installation of dust collecting systems is determined with the distance taken into consideration with which decontaminated air is completely mixed with contaminated air.

In the conventional tunnel dust collecting system, the ceiling board 5 is provided below the air blowers 4. Therefore, as shown in Fig. 9(B), the stream of air blown by the air blowers 4 is not smoothly met with the stream of air around it, thus forming eddies 12. As a result, energy loss is caused, and accordingly it is necessary to use high electric power to supply decontaminated air at a predetermined flow rate.

On the other hand, the space for installation of a dust collecting system is limited because of limitations in public engineering works. It is desirable to increase the flow rate of decontaminated air as much as possible with the installation space per station decreased as much as possible.

In the dust collecting system of upward suction type described above, the air sucking inlet 9 is formed in the ceiling board 5 in such a manner that its edges are perpendicular to the ceiling board. Therefore, as shown in Fig. 11, the air sucked into the dust collecting chamber 2 forms a contraction flow; that is, the air sucked into the dust collecting chamber tends to concentrate at the center of the dust collector 3 leaving the front and rear edges 9a an 9b of the air sucking inlet 9. As a result, only 85 to 90% of the capacity of the dust collector is used, and the pressure loss at the air sucking inlet 9 is as high as 5 to 10%.

SUMMARY OF THE INVENTION

Accordingly, a general object of this invention is to provide a tunnel dust collecting system in which these difficulties are eliminated, thereby to improve the cleanliness of the air in a tunnel. This will be described in more detail.

A first object of this invention is to provide a tunnel dust collecting system with which the distance required for mixing decontaminated air with contaminated air is decreased, so that the number of dust collecting systems per unitary length of a tunnel is increased, whereby the air decontamination degree in the tunnel is improved.

A second object of the invention is to provide a tunnel dust collecting system in which the above-described streams of air smoothly meet one another at the outlets of the air blowers whereby electric power is economically used.

A third object of the invention is to provide a tunnel dust collecting system in which dust collectors are suitably arranged to increase the flow rate of decontaminated air per station.

The foregoing objects and other objects of the invention have been achieved in tunnel dust collecting systems according to claim 1.

In the system, according to the invention, the ceiling board is extended to the air blowers, so that the casings of the air blowers are exposed in the lower space of the tunnel, thus achieving the second object of the invention. In this case, a ventilated scaffold may be installed below the air blowers to make access to the latter for maintenance.

In the conventional tunnel dust collecting system, the dust collectors are, in general, arranged in parallel with the longitudinal direction of the tunnel so as to lead the air stream straightly to the air sucking surfaces of the dust collectors.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

Figs. 1(A) and 1(B) are a plan view and a longitudinal sectional view, respectively, showing a tunnel dust collecting system;

Fig. 1(C) is a cross sectional view taken along line C-C in Fig. 1(B);

Fig. 2 is a longitudinal diagram showing one application of the tunnel dust collecting system shown in Figs. 1(A) and 1(B);

Figs. 3(A) and 3(B) are a plan view and a longitudinal sectional diagram, respectively, showing a dust collecting chamber in an example of a tunnel dust collecting system provided according to the invention;

Fig. 4(A) is a plan view showing a dust collecting chamber in a tunnel dust collecting system according to a third aspect;

Fig. 4(B) is a cross sectional view taken along line B-B in Fig. 4(A);

Fig. 5 is a horizontal sectional view showing the arrangement of a dust collector in the system;

Fig. 6 is a plan view showing essential components of the dust collecting chamber shown in Fig. 4, for a description of air streams therein;

Fig. 7 is a longitudinal sectional view showing essential components in a tunnel dust collecting system according to a fourth aspect;

Fig. 8(A) is a perspective view showing a typical example of a conventional tunnel dust collecting system of bypass tunnel type;

Fig. 8(B) is a perspective view showing an example of a conventional tunnel dust collecting system of ceiling installation type;

Figs. 9(A) and 9(B) is a plan view and a longitudinal sectional view of the tunnel dust collecting system of ceiling installation type shown in Fig. 8(B), respectively;

Fig. 10 is a longitudinal sectional view showing a typical example of a tunnel dust collecting system of upward suction type; and

Fig. 11 is a longitudinal sectional view showing essential components of the tunnel dust collecting system illustrated in Fig. 10.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the tunnel dust collecting system according to Fig. 1, the decontaminated air blowing direction of the air blowers are set slightly downwardly outwardly with respect to the central axis of the tunnel so as to form spiral air streams in the tunnel thereby to quickly mix the decontaminated air with the contaminated air in the tunnel.

In the tunnel dust collecting system according to the invention, the ceiling board is extended only to the air blowers; that is, no ceiling board is provided below the air blowers, so that the air streams outputted by the air blowers are made in parallel with external air streams around them; that is, the former meet the latter smoothly, thereby preventing formation of eddies. If it is necessary to make access to the air blowers for maintenance, a ventilated scaffold made of metal net, perforated steel plate or metal grid can be installed below them.

When a plurality of dust collectors are arranged in the dust collecting chamber in such a manner that they are shifted from one another both longitudinally and laterally of the dust collecting chamber, the effective air flow area for the dust collectors is increased when compared with the air flow area provided for the dust collecting chamber. However, if, in this case, the dust collectors are positioned as if they were partially overlapped with one another when viewed from the air sucking end of the dust collecting chamber, then the air stream to a dust collector is disturbed by the preceding dust collector.

It has been found through experiments that, when all of the dust collectors except the first one as viewed from the air sucking end of the dust collecting chamber are arranged obliquely with respect to the longitudinal direction of the dust collecting chamber, then the air stream of a dust collector will not be disturbed by the preceding dust collector even if they are overlapped more.

If, in this case, the dust collectors form an excessively large angle with the longitudinal direction of the dust collecting, then the contaminated air is not uniformly distributed to the dust collectors. In this connection, it has been found through experiments that, when the angle is not more than 12°, and the distance between adjacent dust collectors is at least twice the width of the dust collector, then the contaminated air is uniformly distributed to the dust collectors.

Even in this case, the air flow area occupied by the first dust collector as viewed from the air sucking end of the dust collecting chamber is large when compared with the whole air flow area of the dust collecting chamber, so that the first dust collector adversely affects the flow rate of air in the second dust collector, at worst that in the third dust collector or in the fourth dust collector. This is due to the fact that the air flow area of the dust collecting chamber is greatly contracted by the top dust collector, thus forming contraction flows, as a result of which the air stream leaving the ceiling board in front of the second dust collector is allowed to flow over the second dust collector to the third or fourth dust collector.

In order to overcome this difficulty, according to Fig. 4, the first dust collector is made smaller in air stream projection area than the others, and the distance between the first and second dust collectors is made longer than the distance between the second and third dust collector, the distance between the third and fourth dust collectors, and so forth. Preferably the distance between the first and second dust collectors is least 1.5 times the diameter of the air stream in the dust collecting chamber at the air sucking end.

The flow rate of air in each dust collector is controlled by adjusting the degrees of opening of dampers provided at the air outlet. When the degrees of opening of the dampers of a dust collector are decreased, the flow rate of air in the dust collector is decreased, and the air stream is distributed to the other dust collectors as much. The same dampers are provided at the air inlet of each dust collector. However, if the dampers at the air inlet are adjusted, then the air stream flowing through the electrode boards is deflected, so that the dust collection efficiency is lowered. Thus, preferably only the degrees of opening of the outlet dampers are controlled.

Furthermore, in the tunnel dust collecting system of upward suction type, according to Fig.7, the air sucking inlet formed in the ceiling board has a first wall upstream thereof and a second wall downstream thereof whose upper and lower edges are continuously rounded with two different radii in such a manner that the first and second walls are inclined in the direction of air stream. As a result, the difficulties are eliminated that the air stream leaving the ceiling board at the edges of the air sucking inlet flows flow irregularly, thus causing pressure loss.

A first tunnel dust collecting system, will be described with reference to Figs. 1(A) through 1(C).

As shown in Fig. 1, a ceiling board 5 having a predetermined length is installed in a tunnel 1 to form a dust collecting chamber 2 in the upper portion of the tunnel. In the figure, the left end of the dust collecting chamber 2 is an air sucking end 2a, and the right end is an air supplying end 2b. Two dust collectors 3 are arranged along the right and left side walls of the dust collecting chamber 2, respectively, in such a manner that they are positioned staggered in the dust collecting chamber 2, or they are arranged as if overlapped as viewed from the air sucking end of the dust collecting chamber. The dust collecting chamber 2 is separated into two right and left air flow chambers with a partition wall 6 extended along the central axis of the dust collecting chamber 2 in such a manner that the right and left air flow chambers have the two dust collectors 3, respectively. Two axial-flow type air blowers 4 are connected to the right and left air flow chambers at the air supplying end. Each of the air blowers 4 comprises a cylindrical casing, and an impeller and a drive motor which are built in the casing. Each of the air blowers 4 has an air supplying outlet 4a with a nozzle 13 for determining its air blowing direction. The nozzles 13 are directed slightly downwardly outwardly with respect to the central axis of the tunnel 1.

When the tunnel dust collecting system thus constructed is operated, the contaminated air in the driveway space 1a in the tunnel 1 is led into the dust collecting chamber 2 through the air sucking inlets 7 at the air sucking end 2a. The contaminated air thus led is decontaminated with the dust collectors 3. The air thus decontaminated is supplied into the driveway space 1a through the nozzles 13 of the air blowers 4. In this operation, since the nozzles are directed downwardly outwardly with respect to the central line of the tunnel 1 as was described before, the decontaminated air blown through the nozzles 13 forms a pair of spiral air streams in the driveway space 1a as indicated by the broken lines in Fig. 1. As a result, the decontaminated air supplied through the nozzles mixes with the contaminated air in the driveway space 1a in a short time while winding the latter. It has been confirmed through experiments that the distance required for the decontaminated air to mixed with the contaminated air in the driveway space is shorter about 10% than in the conventional tunnel dust collecting system.

As shown in Fig. 2, the technical concept of the system can be applied to an air blower (jet fan) 4 arranged in a dust collecting system in order to accelerate the mixing of decontaminated air with contaminated air. That is, the air blow 4 is provided with a nozzle 12 so that the air is blown downwardly outwardly. As a result, the air thus blown forms a spiral air stream as indicated by the broken line, with the result that the air mixing efficiency is improved as much, and accordingly a jet fan 4 may be employed which is smaller in capacity.

In the above-described first system, the decontaminated air supplied by the air blowers 4 forms spiral air streams in the driveway space 1a of the tunnel 1. Hence, when compared with the conventional system, in the system of the invention, the mixing of decontaminated air with contaminated air is accelerated, and the interval of installation of dust collecting systems can be reduced to about 100 m to 90 m.

An embodiment of the invention, a tunnel dust collecting system, will be described with reference to Fig. 3. Figs. 3(A) and 3(B) are a plan view and a side view showing a dust collecting chamber in the dust collecting system.

As shown in Fig. 3, a ceiling board 5 defining the dust collecting chamber 2 is terminated at two air blowers 4, and the cylindrical casings 4b of the air blowers are exposed downwardly. Hence, as decontaminated air streams 11 are formed by the air blowers 4, air streams 11 around the air streams 11 come close to the latter in such a manner that the former is substantially in parallel with the latter, so that the former and the latter smoothly meet each other without forming eddies. The energy loss attributing to the mixing of the two air streams 10 and 11 is much less than in the conventional tunnel dust collecting system. If necessary for maintenance of the air blowers 4, a ventilated scaffold 14 made of metal net for instance may be installed below the air blowers 4. With the scaffold, the air stream 11 from below is not obstructed.

Figs. 4 and 5 shows a third system. In the tunnel dust collecting system, as shown in Fig. 4-(A), six dust collectors 3A through 3F are provided in the dust collecting chamber 2 in such a manner that they are arranged longitudinally of the dust collecting chamber 2 and shifted from one another laterally of the dust collecting chamber (from one side wall (left side wall) of the dust collecting chamber towards the other side wall (right side wall)) in the stated order. Partition boards 15 are extended between the dust collectors 3A through 3F. The top dust collector 3A is connected through a partition board 16 to the one side wall of the dust collecting chamber 2, and similarly the last dust collector 3F is connected through another partition board 16 to the other side wall of the dust collecting chamber 2. That is, these partition boards 15 and 16 are to separate the contaminated air to be processed by the dust collectors 3A through 3F from the air decontaminated by the latter. A guide board 17 is connected between the last dust collector 3F and to the other side wall of the dust collecting chamber 2, so as to lead the contaminated air to the dust collector 3F.

Of the six dust collectors 3, the first dust collector 3F closest to the air sucking end 2a of the dust collecting chamber 2 is smaller in the area of projection to air stream than the others and is set in parallel with the longitudinal direction (right-to-left direction in Fig. 4(A) of the dust collecting chamber. The remaining dust collectors 3B through 3F are arranged in such a manner that they form angles (described later) with the longitudinal direction of the dust collecting chamber 2, and they are partly overlapped one another as viewed from the end of the dust collecting chamber 2. The dust collectors 3B through 3E form an inclination angle (α) of 10°, and only last dust collector 3F 5°. The partition board 15 between the first and second dust collectors 3A and 3B includes a part S which is in parallel with the central axis of the dust collecting chamber 2, so that the distance D between the first and second dust collectors 3A and 3B is longer than the distance d between the second and third dust collectors 3B and 3C, the third and fourth dust collectors 3C and 3D, and so forth.

In the tunnel dust collecting system thus constructed, the contaminated air in the tunnel is led into the dust collecting chamber through an air sucking inlet 7 at the air sucking end 2a. The contaminated air thus led is distributed uniformly to the dust collectors 3 as indicated by the solid line arrows, where it is decontaminated. The decontaminated air outputted by the dust collectors 3 is supplied into the driveway space 1a by the air blowers 4 as indicated by the broken line arrows.

In the tunnel dust collecting system shown in Fig. 4, the effective air flow area is the sum of the areas of the air inlets of the dust collectors 3, and it is larger about 20% than that in the conventional dust collecting system, because the dust collectors 3 are arranged as if overlapped as was described before; that is, the flow rate of air processed per station is increased as much. Furthermore, since the second to last dust collectors 3B through 3F are so arranged as to form angles with the central axis of the dust collecting chamber as was described before, the contaminated air is distributed along the partition boards 15 substantially uniformly to the dust collectors 3B through 3F although the latter are arranged as if overlapped as viewed from the end of the dust collecting chamber.

The area occupied by the first dust collector 3A in the air flow path in the dust collecting chamber 2 is larger than those occupied by the other dust collectors. Therefore, if the first dust collector 3A is equal in the area of projection to air stream to the remaining dust collectors 3B through 3F, then as shown in Fig. 6 contraction flows occur, as a result of which the air stream leaves the partition board 15 to flow over the second dust collector 3B to the third dust collector 3C. This difficulty is eliminated as follows: A relatively small dust collector is employed as the first dust collector 3A to suppress the possibility of occurrence of contraction flows. In addition, the distance D is increased so that the air stream flows to the second dust collector 3B. It has been confirmed through experiments that the distance D should be at least 1.5 times the diameter of the air stream at the air sucking end 2a of the dust collecting.

In the dust collecting chamber thus constructed, the distribution of air stream to the dust collectors 3 may be precisely controlled by adjusting the degrees of opening of the outlet dampers of the dust collectors 3 as described below.

Fig. 5 is a sectional plan view showing the arrangement of each of the dust collectors 3. The dust collector 3 comprises: inlet dampers 18; a charging section 19; a dust collecting section 20; and outlet dampers 21. The particles such as dust and smoke particles in the contaminated air led into the dust collector 3 through the inlet dampers 18 are charged by the charging section 19, so that they are caught by the dust collecting section 20 to which high voltage is applied by a high voltage generator 22; that is, the air is decontaminated. The air thus decontaminated is allowed to flow out of the dust collector through the outlet dampers 19. When the particles are deposited in the charging section 19 and the dust collecting section 20, compressed air is jetted to remove them therefrom.

The inlet dampers 18 and the outlet dampers 21 are mounted on vertical shafts 18a and 21a, respectively, and are turned to open and close the air inlet and the air outlet of the dust collector. When the degrees of opening of the dampers 18 and 21 are decreased, the resistance of the dust collector to the air stream is increased, so that the flow rate of air stream is decreased, and accordingly the air stream is distributed to the other dust collectors as much as the flow rate of air stream has been decreased in the above-described manner. In this case, with the inlet dampers 18 fully opened, the degrees of opening of the outlet dampers 21 are so adjusted that all the dust collectors are uniform in the flow rate of air. If the degrees of opening of the inlet dampers 18 are decreased, then when flowing through the electrode boards in the dust collecting section 20, the decontaminated air stream may be deflected, with the result that the dust collection efficiency is lowered. Thus, it is preferable that only the outlet dampers is adjusted.

In the dust collecting chamber, the air stream may be distributed uniformly to the dust collectors by providing guide vanes 26 as shown in Fig. 6. However, it is rather difficult to design the guide vanes most suitably because the guide vanes delicately affect one another depending on the positional relationships between the dust collectors 3. In addition, the provision of the guide vanes may excessively increases the loads of the air blowers 4 (Fig. 4). On the other hand, adjustment of the flow rate of air with the outlet dampers 21 in each dust collector 3 is advantageous in that it will not affect the flow rate of air in the other dust collectors 3.

A fourth tunnel dust collecting system of upward suction type, is a shown in Fig. 7. In the system, contaminated air is led into a dust collecting chamber 2 through an air sucking inlet 9 as indicated by the arrows. The air sucking inlet 9 has an upstream wall 9a and a downstream wall 9b which are curved in section inwardly. More specifically, the upper and lower edges of the upstream wall 9a are continuously rounded with radii R_1 and R_2 ($R_1 > R_2$), respectively; and similarly, the upper and lower edges of the downstream wall 9b are continuously rounded with radii R_2 and R_1, respectively. Hence, the contaminated air is sucked through the air sucking inlet 9 into the dust collecting chamber 2 obliquely upwardly along the gradients of the upstream and downstream walls 9a and 9b. Therefore, the air thus sucked is allowed to go along the ceiling board, thus forming no contraction flow. The air flows to substantially the whole of the air sucking surface of the dust collector 3, so that it is decontaminated with high efficiency contacting the electrode boards not shown. In addition, the pressure loss at the air sucking inlet 9 is minimized.

As is apparent from the above description, the tunnel dust collecting systems have the following effects or merits:

According to the first system, the nozzle is connected to the air outlet of each of the air blowers in such a manner that the decontaminated air is blown downwardly outwardly with respect to the central axis of the tunnel. As a result, the distance is reduced which is required for the decontaminated air supplied from the dust collector to mix the contaminated air in the tunnel, and accordingly the number of dust collecting systems per unitary length of a tunnel can be increased as much. Thus, with the tunnel dust collecting system of the invention, even a tunnel high in air contamination can be sufficiently ventilated.

As the casings of the air blowers provided are exposed in the lower spaced of the tunnel, the energy loss at the air outlets of the air blowers is minimized, and accordingly, the power consumption of the air blowers in the system of the invention is smaller by 1 to 5 % than in the conventional system. In addition, for the same reason, a ventilated scaffold can be installed below the casings for maintenance of the air blowers.

In the tunnel dust collecting system shown in Fig. 4, a plurality of dust collectors are provided in the dust collecting chamber in such a manner that they are arranged longitudinally of the dust collecting chamber and shifted from one another laterally of the dust collecting chamber (from one side wall of the dust collecting chamber towards the other side wall) as if they were overlapped when viewed from one end of the dust collecting chamber. In the system, the effective air flow area is increased, so that the flow rate of air to be processed per dust collecting system can be increased without increasing its dust collector installation space. Furthermore in the system, the top dust collector is selected to be smaller than the remaining dust collectors, and the distance between the top and second dust collectors is made longer than those between the second and third dust collectors, between the third and fourth dust collector, and so forth, whereby the contaminated air led into the dust collecting chamber can be distributed uniformly to the dust collectors. In addition, the degrees of opening of the outlet dampers at each of the dust collectors are adjusted to finely control the flow rate of air therein.

In the tunnel dust collecting system of upward suction type, the air sucking inlet formed in the ceiling board has the first wall upstream thereof the upper and lower edges of which are rounded continuously with the first radius and the second radius smaller than the first radius, respectively, and the second wall downstream thereof the upper and lower edges of which are rounded continuously with the second and first radii, respectively. As a result, the difficulty is substantially eliminated that the air stream leaves from the ceiling board at the air sucking inlet. Accordingly, concentration of the air steam at the central portion of the air sucking surface of the dust collector is substantially suppressed, and the pressure loss is minimized, with the dust collection efficiency increased 10% to 15%.

While there has been described in connection with the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is aimed, therefore, to cover in the appended claims all such changes and modifications as fall within the true spirit and scope of the invention.

Claims

1. A tunnel dust collecting system comprising: a dust collecting chamber (2) formed in the upper space of a tunnel (1) with a ceiling board (5) in such a manner that said dust collecting chamber has one end serving as an air sucking end (2a) and the other end serving as an air supplying end (2b); electric dust collectors (3) arranged in said dust collecting chamber (2); and air blowers (4) in said dust collecting chamber (2) at the air supplying end; **characterised in that** said air blowers (4) have casings exposed in the lower space of said tunnel (1).

2. A tunnel dust collecting system as claimed in claim 1, in which a ventilated scaffold (14) is installed below said air blowers (4).

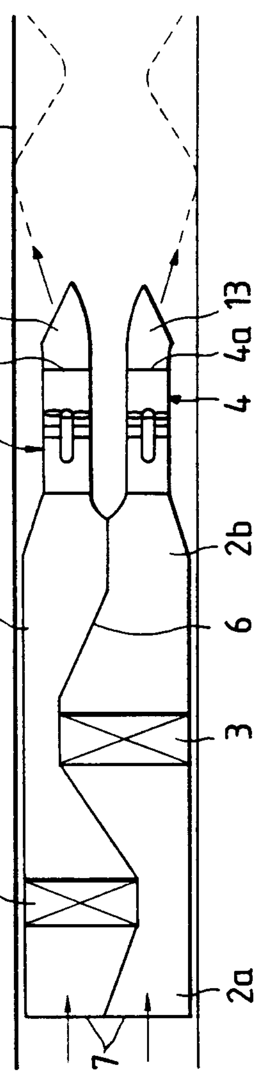


FIG. 1(A)

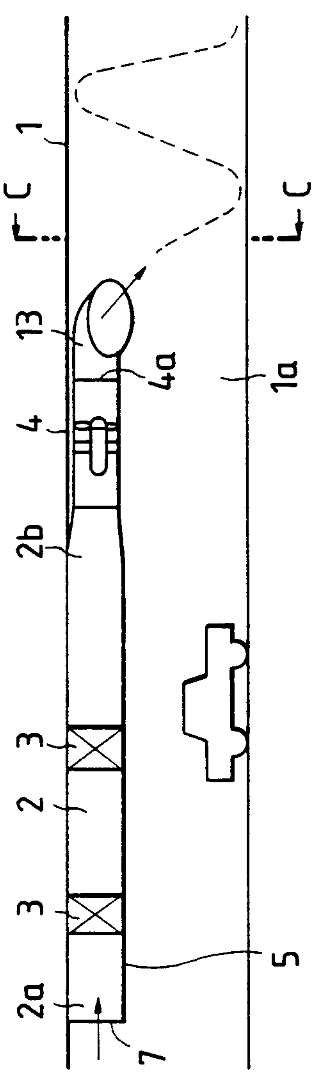


FIG. 1(B)

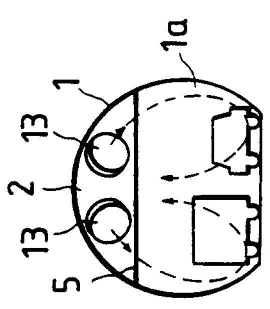


FIG. 1(C)

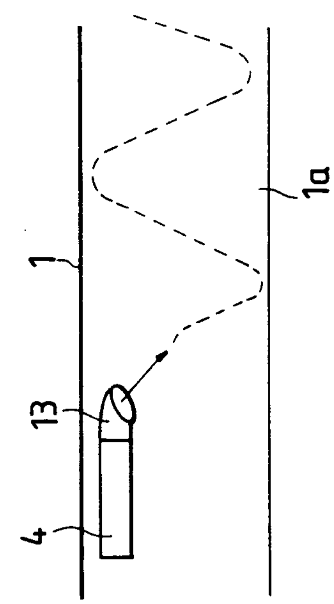


FIG. 2

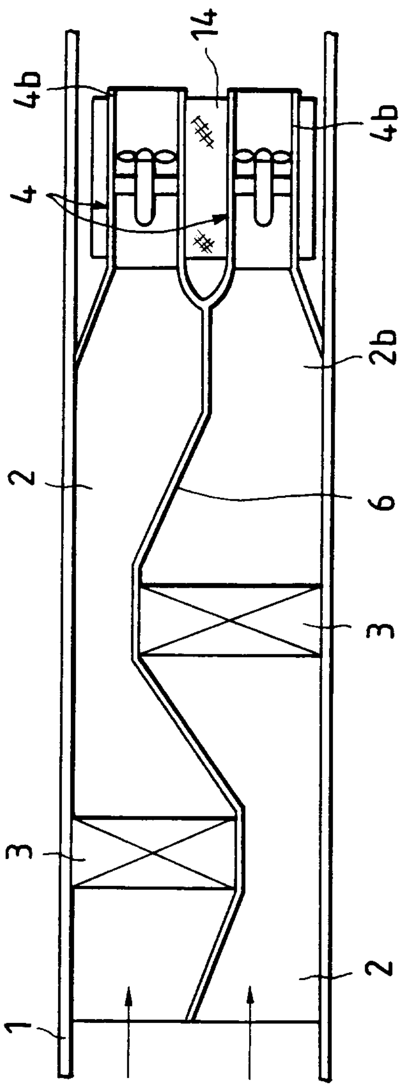


FIG. 3(A)

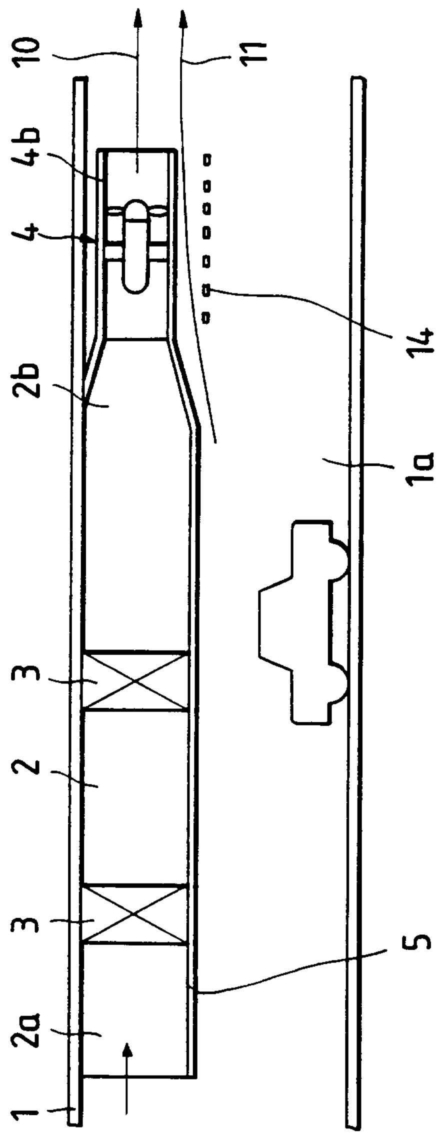


FIG. 3(B)

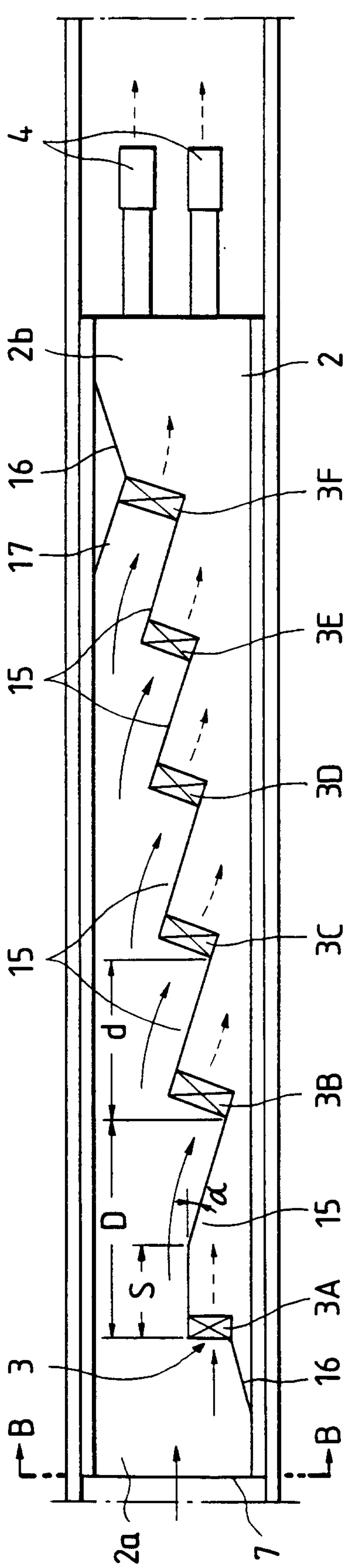


FIG. 4(A)

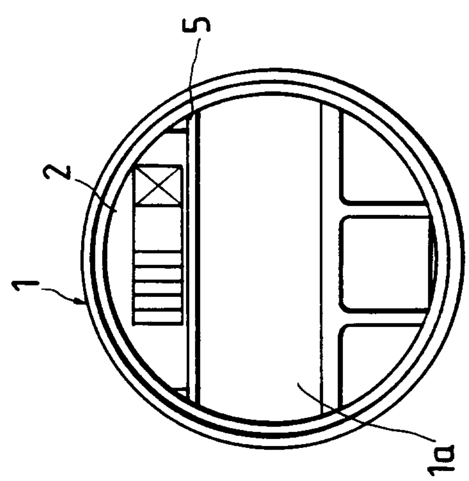


FIG. 4(B)

FIG. 5

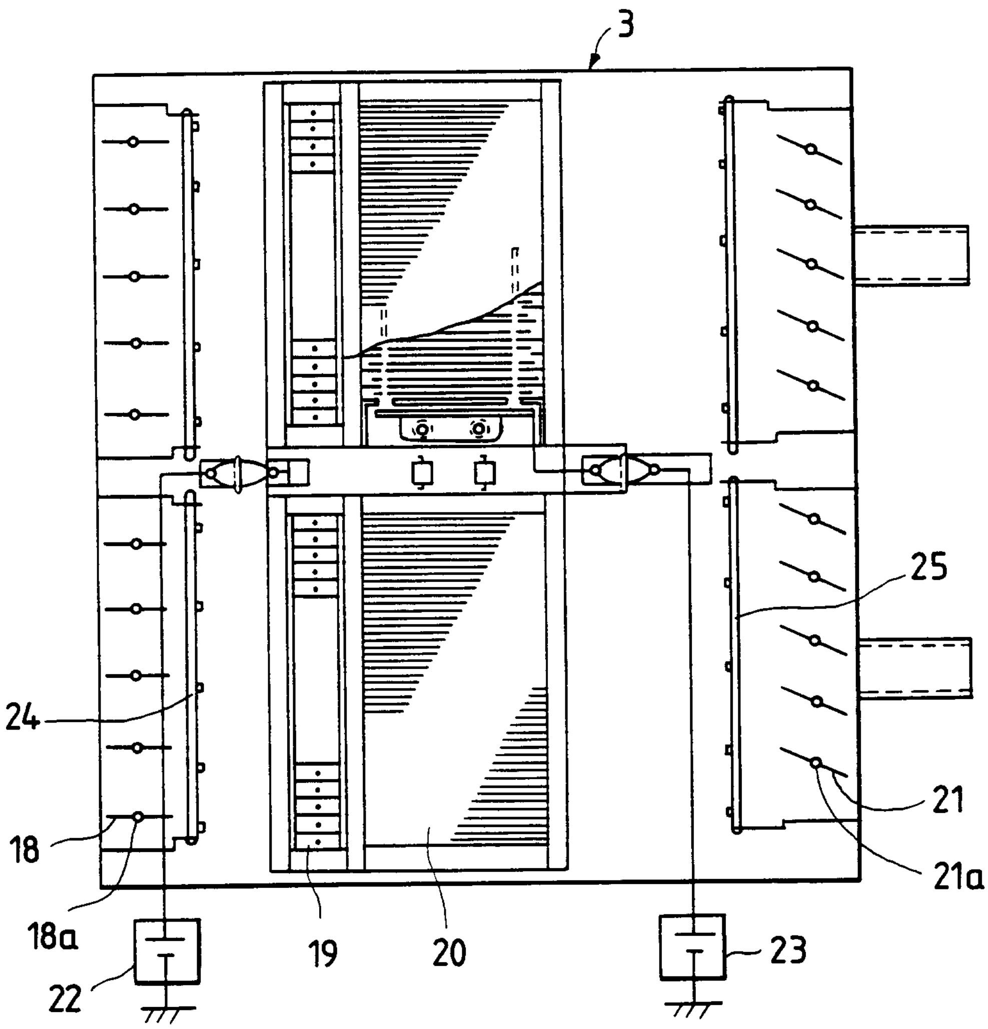


FIG. 6

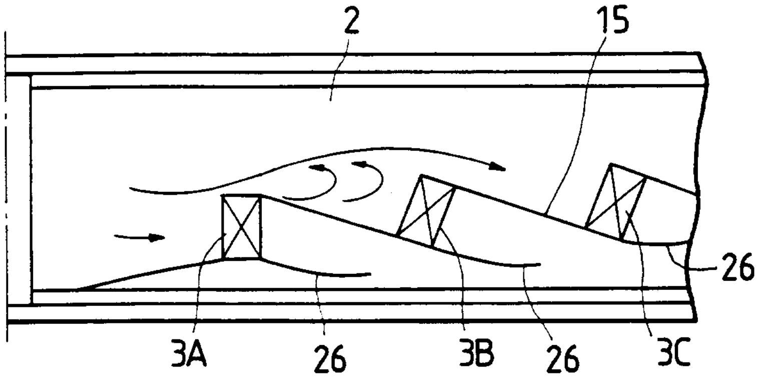
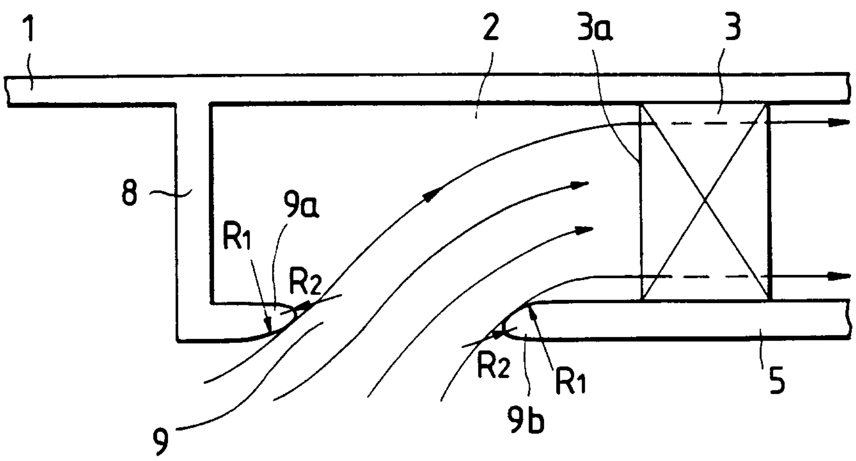


FIG. 7



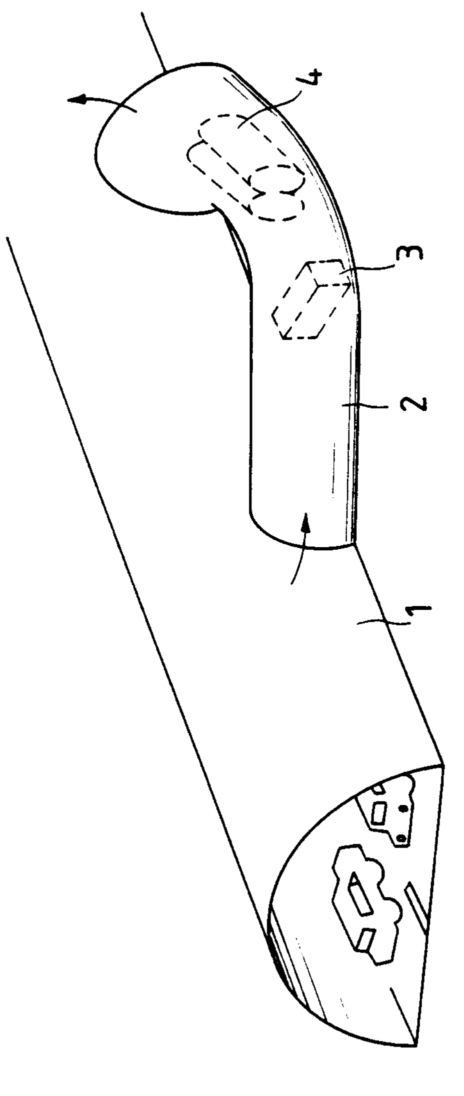


FIG. 8(A)

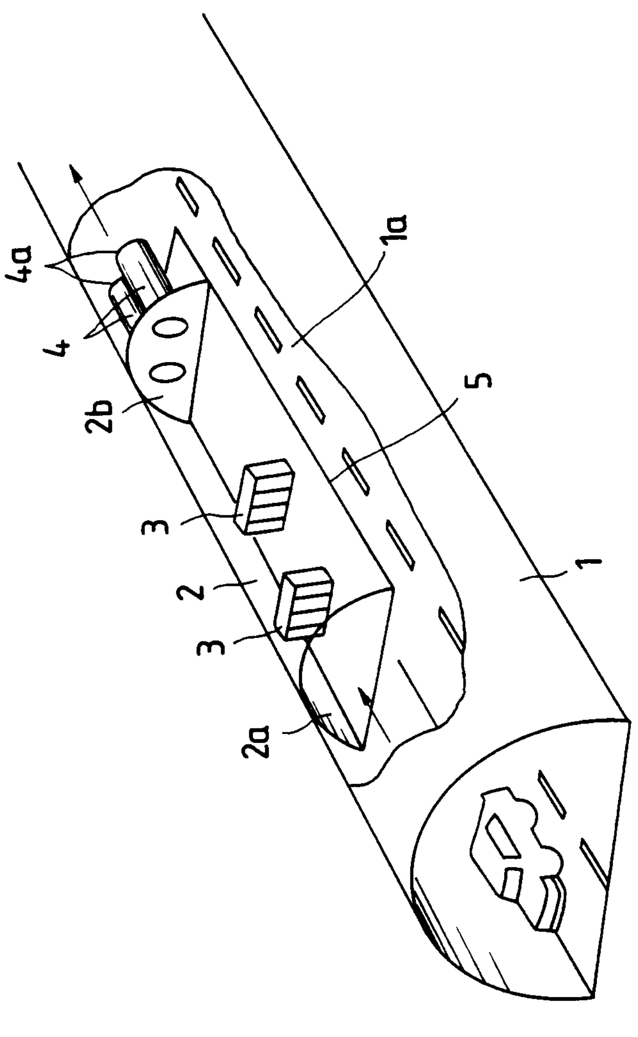


FIG. 8(B)

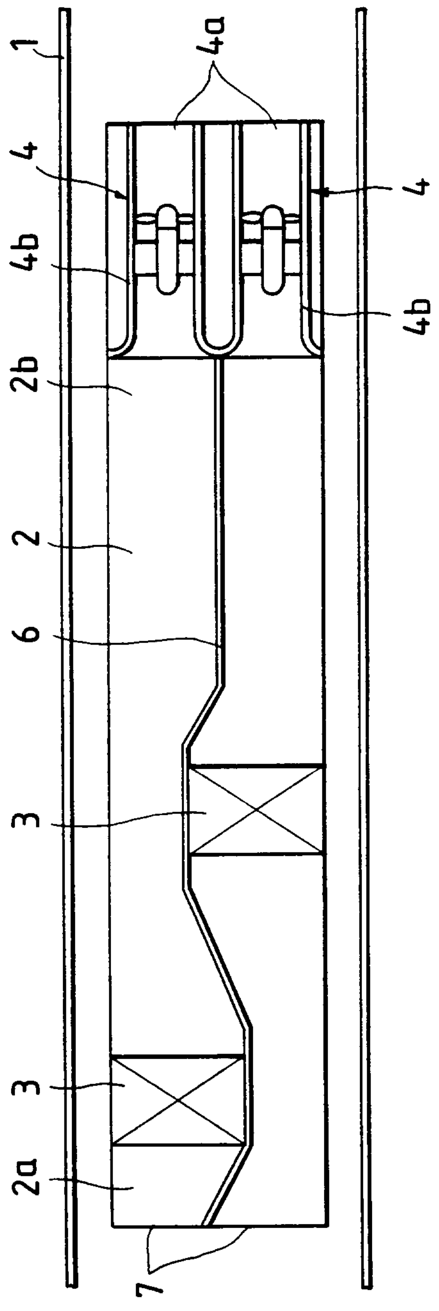


FIG. 9(A)

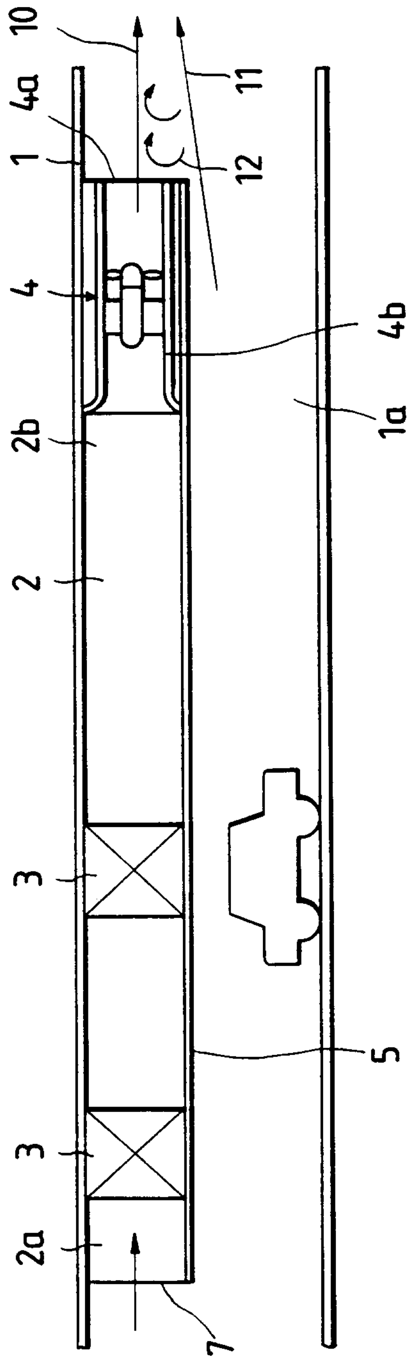


FIG. 9(B)

FIG. 10

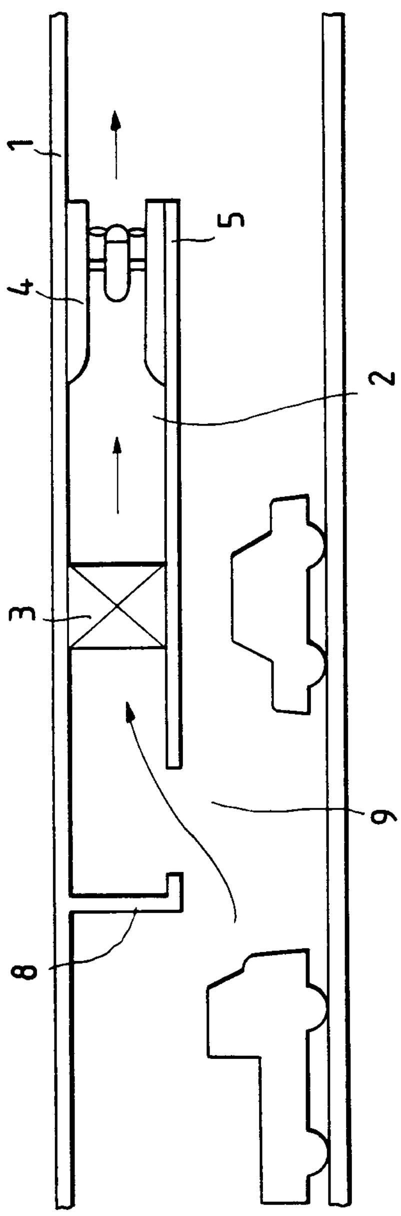
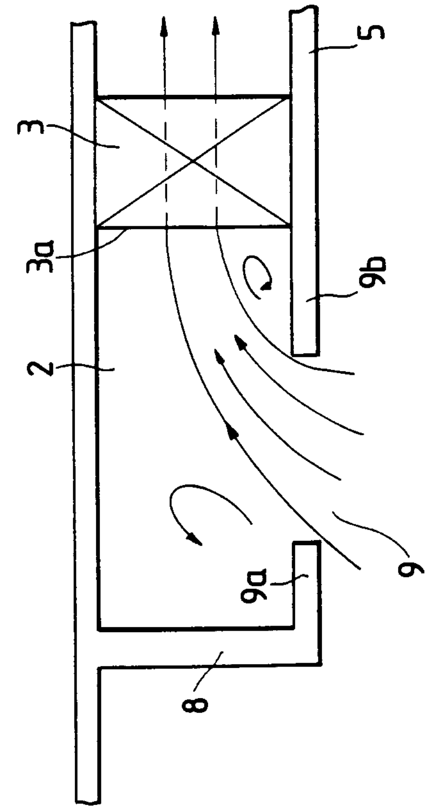


FIG. 11



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 10 6613

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.5)
Y	PATENT ABSTRACTS OF JAPAN vol. 13, no. 169 (C-587) (3517) 21 April 1989 & JP-A-63 319 072 (FUJI ELECTRIC) 27 December 1988 * abstract * * the whole document *	1,2	E21F1/00 E21F5/20
Y	FR-A-1 601 611 (S.I.N.A.) * the whole document *	1,2	
A	DE-A-14 59 883 (J.M.VOITH) * figure 1 *	1,2	
A	DE-C-36 08 308 (HILL,D) * figures *	1,2	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			E21F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 July 1994	Fonseca Fernandez, H

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