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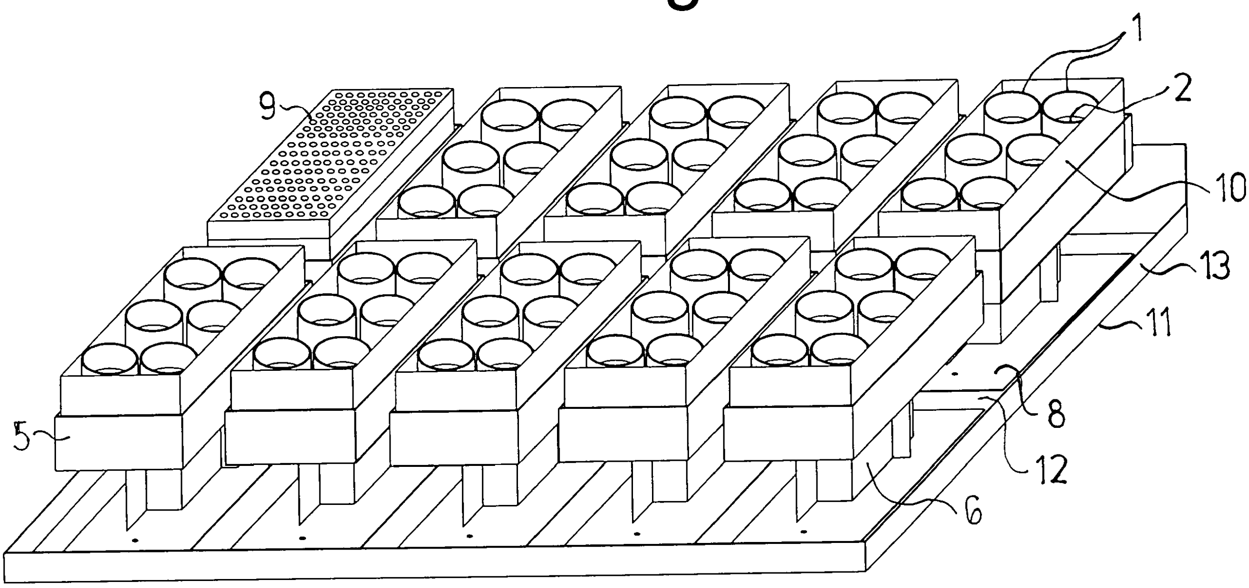
(54) **Method of fire ventilation function test and the testing device**

(57) Generator of non-toxic aerosol of solid and gaseous phase simulating combustion smoke products is placed into the tested space, compositions (2) of which are activated, then propagation of the aerosol cloud is monitored and recorded and the functionality of the fire ventilation is evaluated. The aerosol consists of a mixture based on potassium carbonate, potassium hydrogen carbonate, carbon, carbon dioxide, water vapours, nitrous gases, nitrogen, and ammonia generated at temperature 600 to 1300° C in quantity of 3 to 100 m^3/s while the tested devices for smoke and heat removal are in operation. The device includes generator with vessels (1) containing composition (2) and firing device (3), placed by 4 to 10 in a bed (5) of stands fixed by 1 to 20 in a tub (11) and covered with perforated covers (9). The tub (11) is preferably mounted on a bearing structure (14) of a vehicle.

Fig.1



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Description

Technical Field

[0001] The invention relates to the field of fire safety and fire technology. A new method of fire ventilation function test and a device specifically arranged for carrying out this method of verification test of the fire ventilation functionality are invented.

Background Art

[0002] Fire safety of large complexes such as manufacturing objects, industrial as well as non-industrial halls, tunnels of motorway and road corridors, metro and other constructional objects, is determined most of all theoretically by means of calculation during engineering design of their construction, based on expert science and technology knowledge. Requirements for structural design of objects, used materials, and means of fire ignition and propagation prevention are specified in the project of fire safety of buildings. Means of detection of possible fire, means of fire ventilation of the object, air-handling, escape routes etc. are also specified. Device for heat and smoke removal, that is the fire ventilation, is one of the basic fire safety devices. However, unfortunately the design does not always take into consideration all real dangers, sometimes the design is not exactly followed during the object realization, sometimes the prescribed quality or maintenance of fire ventilation is not observed and in other cases, unexpected situations can occur that are solved as late as during the construction work. For these reasons, it is necessary to perform tests to verify functionality of fire ventilation before commissioning and during operation.

[0003] Currently, tests to verify the functionality of fire ventilation in buildings as well as in linear constructions are carried out by means of so-called performance tests. During these tests, projected parameters of fire ventilation, especially the speed and direction of air flow over the tested area in time, are verified by physical measurement using anemometers. Besides measuring instruments, this method uses no special testing equipment.

[0004] As another method of verifying the functionality of the fire ventilation system, a method is used in which a generator of a real smoke like the true fume during a fire is placed into the tested area, whereupon the movement and concentration of the resulting smoke is monitored in the course of operation of the fire ventilation means. Real smoke is usually obtained by combustion of gasoline and/or diesel fuel, solid combustible materials, or other combustible materials that are known as usual materials burning in fires. The advantage of this method is that it allows visualization, i.e. recording that can be watched with the possibility of monitoring and reviewing the flow of air masses with smoke fumes, and it also gives the possibility of measuring the optical density of smoke and thus monitoring of the smoke stratification. Carrying out of these visualization tests is very important because they allow quite reliable assessment of potential threats to the lives of persons and give accurate values for software and hardware modifications of fire ventilation. This method is mainly used in tunnel constructions, where persons are most endangered by combustion products, whether it is the case of transversal or longitudinal ventilation. A considerable disadvantage of this method is generation of high temperature and creation of toxic combustion products, which limit the possibility of taking measurements and making required records and endanger the persons present. Carbon dioxide (CO_2), carbon monoxide (CO), and hydrogen cyanide (HCN) are generally known as the worst, at higher concentrations lethal combustion products and all these substances are formed also in the case of the mentioned method. Persons performing these tests and any other persons have limited access and movement in these areas during the tests and must be equipped with appropriate personal protective equipments such as fire suits, masks, etc., which are increasing the price of the tests. Huge disadvantage of this method is that the high temperatures accompanying combustion and/or aggressive combustion products can cause destruction of building constructions and/or impair surface finishing and technological equipment of objects, contained markings and signs, air conditioning units, electronic systems, measuring and control elements, etc., which may represent damages even in order of hundreds of thousands of Euros. This method uses simple tanks or tubs filled entirely or partially with combustible matter as a device for generation of smoke fumes.

[0005] A variant of the method described in the previous paragraph is the method prescribed by the Austrian guideline RVS 09.02.31 for verifying the functionality of ventilation in tunnel constructions. Hot smoke is produced by combustion of 5 litres of gasoline or 20 litres of diesel fuel in a steel container on the area of 1 m^2, the passage of the hot smoke through the tested space is recorded on a video and simultaneously the optical density of the smoke is measured at different heights. During operation of contained air-handling equipment, the time of exchange of gases and polluted air in dependence on the volume exchange of air masses and on the smoke optical density is monitored and measured, and then evaluated. According to the results of the test carried out in this way, the parameters of fire ventilation are then set on the contained air-handling equipment and dispatchers are informed on the expected behaviour of a real fire. From the point of view of heat output as well as smoke production, this methodology does not give a true picture of a possible fire, especially because of the failure to keep the required amount of smoke generated in m^3/s. In fact, 20 m^3/s of smoke is created during a fire of a passenger car, 50 m^3/s of smoke is generated during a fire of a medium-sized car, and 80 to 100 m^3/s of smoke is created during a fire of a truck. In addition to the failure to simulate the amount of smoke corresponding to the real fire, this test also generates toxic and aggressive gaseous combustion products that degrade the technological equipment of the tunnel and constitute the need for repairs and replacements, and also imply the need to clean the space of the tunnel, which, in addition to high costs, results in the necessity of long-term shutdown of tunnels and complicates traffic and transportation.

[0006] Another method uses so-called cold smoke. Standard smoke cartridge is used as a source for the monitored cloud, or only water vapour is used. The product of smoke cartridge is a mixture of gases. Water vapour is also a gaseous phase only. In both cases, the resulting cloud is based on just harmless gaseous substances and it is visible. The advantage of this method is the absence of toxic fumes and the possibility of recording and observation of movement of the developed cloud. However, it is impossible to achieve the dynamics of behaviour of a real smoke during a fire in terms of stratification, or even approximate to it, mainly because of the absence of thermal dynamics of solid particles, whose presence would make it possible to measure optical density in a way comparable with the smoke in a real fire. Consequence of this fact is the inability to fully evaluate correct functioning of fire ventilation.

Disclosure of Invention:

[0007] The above-mentioned disadvantages are eliminated to a considerable extent by the invention. A new method of fire ventilation function test is invented, according to which a generator of non-toxic aerosol simulating combustion smoke products is placed into the tested space and the generator is equipped with a predetermined number of compositions, these compositions are activated and then propagation of the generated non-toxic aerosol is monitored, while a video is recorded and measurements of values necessary for evaluation of functionality of fire ventilation in the given space are performed, and finally the observed measurements are compared with values of a real smoke, for instance the smoke produced during combustion of gasoline and diesel fuel, measured in a test space. Functionality of fire ventilation of the tested space is evaluated on the basis of observed results and these findings are used for setting detectors of electric fire signalization, control units of tested air-handling devices and devices for heat and smoke removal, for retrofitting as the case may be, construction adjustments, etc.

[0008] Preferably a non-toxic aerosol is generated in the generator and the aerosol formed at the temperature of 600 to 1300° C consists of a mixture of solid and gaseous phases, of which the solid phase consists of particles with a particle size of 1 to 5 μm based on potassium carbonate, potassium hydrogen carbonate and carbon, and the gaseous phase is a medium based on carbon dioxide, water vapours, nitrous gases, nitrogen and ammonia. This aerosol has extinguishing effects. It is non-toxic, considering contents of possible toxic admixtures below the limit values given by standards, and with its stratification, density, mobility and appearance, it is visually as well as regarding measurable values comparable with real properties of smoke formed by combustion of gasoline, diesel fuel, and solid substances of the type of usual materials causing fires such as wood, paper, plastics etc. High temperature of the aerosol formation allows performing temperature measurements at the site of the simulated fire. The high temperature is created only at the site of the generator where it simulates the process of real fire, whereupon in the course of the aerosol movement across the ventilation systems it has no longer the destructive value and it does not devastate technological or structural equipment of the object. Stratification of the aerosol cloud, the way and process of its waft across the tested space as well as the optical density values correspond to the values of the real fire smoke.

[0009] Non-toxic aerosol is preferably generated in quantity fully corresponding to the production of real smoke during fire, i.e. 3 to 100 m^3/s, while the specific generated quantity for individual verification test is determined in advance within the mentioned range. This is done particularly in dependence on projected parameters of the fire ventilation for the tested space, for instance at the level of the highest values permitted by the project or at the level close to these values.

[0010] Preferably all the values mentioned below are monitored in the course of the test. These are the speed of the aerosol cloud movement measured by means of monitoring the flow of air including the contained aerosol, the temperature in the area of the aerosol generator and in the space, and stratification and dispersal of the aerosol cloud by means of measurement of optical density of the aerosol. Preferably at the same time, video is also recorded that indicates the direction and flow of aerosol particles in dependence on functioning of the fire ventilation and also the time of exchange of gases and polluted air in dependence on the volume exchange of air masses and on the aerosol optical density is measured.

[0011] Preferably the aerosol optical density is determined in the tested space during the test by means of video recording and/or by measurements at different distances from activation of compositions and in different heights. These measurements at different distances and at different height levels allow monitoring the movement and dispersal of the generated aerosol cloud.

[0012] If the tested space is equipped with air-handling equipment, it is purposeful to put into operation all or, according to the aim of the test, some of the air-handling equipment of the tested space in the course of the aerosol generation and monitoring of the aerosol propagation. The method is intended especially for verification whether the tested space is equipped with sufficient air-handling devices for smoke and heat removal, and for testing the quality of functionality of these devices in the given spaces. However, alternatively it is not excluded to use it to test even spaces that are lacking air-handling devices for the time being, which is eligible for instance in the case of older constructional objects and in objects with natural ventilation.

[0013] Preferably, the generator of non-toxic aerosol is still before activation of the contained composition placed on at least one carrier mounted on or behind a vehicle, and that in such position and so open to the surrounding space that the generated aerosol can freely propagate to the surrounding space. This propagation has usually a shape of a cloud that is moving in the tested space and diffuses here or is removed with the help of the tested air-handling devices and/or natural ventilation. After the dose of compositions is transported to the site of activation, one-shot or sequential activation is performed by firing the compositions. Activation can take place statically, i.e. with leaving the source of aerosol immovable at the site of the composition activation until diffusion or removal of the aerosol cloud. Preferably, in particular for tests in tunnels and other long corridors, the vehicle can move inside the tested space, for instance by driving across the tested space during and/or after activation of the composition, while a mobile video device such as another vehicle with a video camera is moving in the area of the edge of the generated aerosol cloud and recording a video enabling to visualize the course of the test. This variant of carrying out the method is ideal for testing of railway tunnels or road tunnels.

[0014] The invention solves also design of the device suitable for carrying out the invented method of the fire ventilation function test according to the invention. The device includes a generator containing vessels of non-inflammable solid material, e.g. steel, with inner cavity that are at least partially filled with combustible composition. The essence of the new solution is that the compositions in the vessels are creating the source of non-toxic aerosol imitating with its appearance, optical density, stratification, and the manner of movement authentically the combustion products, i.e. the aerosol consisting of solid particles with the particle size of 1 to 5 μm and non-toxic gaseous substances. No cooler is contained; the vessel contains only a firing device in addition to the composition, and only a free space is in vessels above the composition with the firing device. To produce sufficient amount of the smoke imitation for the purpose of the method, these vessels are in the number of 4 to 10 pieces placed in at least one storage device of non-inflammable solid material such as steel, and here equipped with a common perforated cover.

[0015] The storage device for the vessels is preferably in a shape of a stand with its upper part created as a bed for the vessels and under this bed, a base with at least one inner cavity for necessary electric elements of the firing device is located.

[0016] The bed is preferably equipped with at least one opening and the inner cavity of the base is through, connected to this opening, while the base is equipped with at least one element stabilizing its position relative to the support. For example a support plate with holes and fixing bolts or rivets created at the bottom, or welded strips of material, an extended and bent wall of the base leg, welded profile, etc. can be used as the element stabilizing the position of the stand to the support.

[0017] The stand in the number of one or more is preferably placed in a tub of non-inflammable solid material such as steel, where this tub contains at least a bottom and all-circumferential rim, while the stand is firmly, immovably fixed to the bottom of this tub. The tub creates bearing basis for the stands occupied or only some of them occupied with the vessels, it allows transport of compositions to the site of use and transport during use, as the case may be, and it can serve for possible supplementary flammable charge such as ethanol in case the client requires increasing of the fire effect. Part of the rim on one side can be extended and used for fixing the tub with stands and compositions to the site of use, for instance to the carrier, as shown hereinafter in the example of embodiment.

[0018] The tub preferably contains one to twenty stands, while at least some of the contained stands have full bed filled with the vessels. The perforated cover mentioned above in the first paragraph of the device description can be in a configuration with dimensions for covering all contained stands together or for covering of each one of contained stands separately or as the case may be for covering groups of stands. The stands are preferably covered with the perforated cover separately one by one, which saves material in the case of incomplete occupation of the tub with the stands and facilitates manipulations connected with mounting of individual elements of the device into the whole unit.

[0019] Preferably to allow carrying out the method in tunnels in particular, the tub is placed on a bearing structure of a movable device, for instance of a vehicle, freely open to the surrounding space at least in the area of the cover. Thus the tub with stands and compositions can be preferably fixed for instance on a trailer behind a car or on a special carrier directly on the car. In contrast to existing methods, the device created and arranged in this way can be operated without any danger by a driver present in the tested space.

[0020] The composition preferably consists of a material from which in case of firing the composition the non-toxic aerosol is generated, solid particles of which contain a mixture of potassium carbonate, potassium hydrogen carbonate and carbon, and the gaseous phase of which contains a mixture of carbon dioxide, water vapours, nitrous gases, nitrogen, and ammonia. This material is known already and available on the market, but it is manufactured and used up to now for completely different purpose, i.e. as an extinguishing mixture.

[0021] The designed technical solution according to the invention has the advantages in that it simulates the real smoke that is produced during a fire, but it is non-toxic and does not cause destruction or damage to the instrumentation and other equipment in the object due to high heat. Simulation of the real smoke from combustion of substances that are frequently the usual cause of the fire, i.e. gasoline, diesel fuel, paper, wood, solid fuels, plastics, etc. is perfect especially regarding the optical features. The aerosol cloud is generated that has the appearance for human eye and even for detecting device identical to the smoke during a fire, and that has also identical stratification with respect to the particle density, cloud shape, the way of movement of the cloud as well as the way and speed of diffusion. The said values can be visualised by means of video recording, with the possibility of subsequent and repeated reviewing and with the possibility to measure the values such as optical density in various places and heights etc. The figures of toxic admixtures present are below the toxicity levels stated by the standards, and thus this aerosol can be considered to be non-toxic. Because of the fact that the aerosol cloud is non-toxic and it is even dispersed in the tested space and removed from the tested space by air-handling system during the test, it is possible to perform firing of the composition on a static or moving vehicle with a driver without the risk of persons' health hazard and it is possible to perform in an ideal way a video recording during the test, for instance from a vehicle moving behind the vehicle with the composition. With the help of the invented method and device, it is possible to perform high quality and safe testing of functionality of fire ventilation without the need of subsequent replacing of these devices or other equipment of the tested area, and also without the need for demanding cleaning of these devices and tested space, i.e. without the necessity of high costs and of long-term shutdown of the tested space. The method and device according to the invention allow finding in an optimal way the values to which the particular fire ventilation has to be set. It further allows making dispatchers familiar with a real fire, i.e. with probable direction of the fire propagation according to the place of origin and with its course. From the point of view of toxicity of substances, the concentration of toxic admixtures ranges in values in order of 100 to 600 times lower than the prescribed permissible exposure limits. It is possible to generate imitation of smoke according to the required output, in exactly preset value within the interval of 3 to 100 m^3/s. Activation of the aerosol formation can be performed manually or remotely using electric pulse. The method and the device are suitable for utilisation for any tested spaces, in particular road and railroad tunnels, large structural complexes, industrial and other halls, technological workshops, etc.

Review of Figures on Drawings

[0022] The invention is illustrated using drawings, where Fig. 1 shows perspective view of an example of the device for the fire ventilation function test according to the invention, Fig. 2 shows top plan view into the individual vessel with the composition, Fig. 3 shows front view of the vessel when section is drawn along the line A-A indicated on the previous figure, Fig. 4 shows perspective view of individual stand, Fig. 5 shows front view of vertical longitudinal section drawn across the stand filled with the vessels, through the centre of the vessels, Fig. 6 shows perspective view of the tub filled with empty stands, Fig. 7 shows perspective view of the individual tub, Fig. 8 shows illustration of function of the invented device and of carrying out the method during the fire ventilation function test in a room equipped with air-handling device with a fan, Fig. 9 shows illustration of function of the invented device and of carrying out the method during the fire ventilation function test in a room with natural ventilation by means of an air shaft, Fig. 10A, B, C shows illustration of function of the invented device and three demonstrative variants of carrying out the method during the fire ventilation function test in a tunnel using static compositions, and Fig. 11A, B, C shows illustration of function of the invented device and three demonstrative variants of carrying out the method during the fire ventilation function test in a tunnel using mobile compositions.

Example of Embodiment of Invention

[0023] Example of the best embodiment of the invention is the device for carrying out the method of the fire ventilation function test with illustrations of its use and process during carrying out the method according to Figs. 1 to 11.

[0024] The core of the device for carrying out the method of the fire ventilation function test is the generator shown on Fig. 1. The generator contains the source of non-toxic aerosol simulating smoke fumes created during a fire, which creates the charge in vessels 1 of non-inflammable solid material. In this example of embodiment, vessels 1 of practical cylindrical shape has been chosen, which are made of steel and thus are having sufficient strength and mechanical durability. The inner cavity of the vessels 1 is only partially filed with the charge, this charge is as the aerosol source the flammable composition 2. Besides the composition 2, each vessel 1 placed in the generator contains only the firing device 3 with necessary electric accessories allowing firing, including electric conductors 4 in the case of wire firing. Only a free space is inside the vessels 1 above the composition 2 with the firing device 3, no cooler is contained, presence of which is considered to be essential in case of existing devices. Arrangement of 1 is clearly visible on Figs. 2 and 3. As shown on Fig.1, the vessels 1 are in the number of 4 to 10 pieces placed in storage devices in the shape of stands made of non-inflammable solid material. In this example of embodiment, preferred chosen number of vessels 1 is six pieces per each stand, which is within the abovementioned range. The stands for this example of embodiment has been made of steel, however, also other suitable material can be used that ensures sufficient strength and mechanical durability for the stands.

[0025] Arrangement of stands and their occupation is clearly visible on Figs. 4 and 5. The upper part is created by the bed 5 for placing the vessels 1, and it has a shape of a box with a cut-out in the centre. Under this bed 5, the base 6 is located and in this case it is arranged as a leg, but it can have also different suitable shape in other case. The base 6 is hollow; its inner cavity has dimensions and shape allowing placing of necessary accompanying electric elements and the firing device, electric conductors 4 in particular. The cut-out in the centre of the bed 5 is arranged as an admission opening 7 into the cavity of the base 6, which is through and connected to the opening 7. The base 6 is equipped with at least one element stabilizing its position to the support, in this case it is a support plate 8 created at the bottom. Each stand is equipped with a bolt-on perforated cover 9 covering the vessels 1 and preventing their unwanted loosening during transport to the site of use and during the aerosol generation and preventing also unwanted premature damage to the firing device 3 and possibly contained conductors 4. Perforation of the cover 9 creates openings for escape of generated aerosol from vessels 1 into space and for creation of the aerosol cloud. The vessels 1 can be placed in the bed 5 of the stand together with the boxes 10, in which they are supplied, or possibly such boxes 10 filled with vessels 1 containing the composition 2 can be prepared in advance separately and their presence facilitates manipulation during counting charges, filling of stands, and also clean-up of used vessels 1 and a trash left over later after completion of tests.

[0026] The stands in the number of one to twenty are placed in a tub 11 of non-inflammable sufficiently strong material. In this example of embodiment, the tub 11 is made of steel. The tub 11 has a bottom 12, to which all contained stands are firmly and immovably fixed using common means of connection such as screws, bolts, rivets, or welding joints. A peripheral rim 13 projecting upwards is created around the bottom 12 of the tub 11 to prevent falling out of possibly broken off pieces of material and allowing placing of supplementary charge such as ethanol etc. on the client's request to increase the fire effect for instance. If the wire firing device 3 is used, the tub 11 can have created openings 7 for electric conductors 4, where these openings 7 are arranged so that they are linked adequately to the cavities of bases 6 and openings 7 of beds 5 of the stands. Even several tubs 11 with stands can be used for one test, according to calculated necessary dose of compositions 2. As far as the number of vessels 1 in individual stands is concerned, it is of course significantly more economic to fill preferentially full beds 5 with the vessels 1, with possible gathering of calculated remaining number of vessels 1 gathered into one stand, with a higher number of unused stands, rather than evenly but incompletely occupy unnecessarily high number of stands and to provide them with perforated covers 9.

[0027] The tub 11 can be in the number of one or more fixed on a bearing structure 14 of a movable device, for instance on a vehicle, and that in such position and place on the vehicle selected so that at least the area of each contained cover 9 shall remain freely open to the surrounding space for all the time of the test, which is necessary to prevent occurrence of any barrier to creation of cloud from the generated aerosol. The optimal placement is using a special bearing structure 14 custom made for this purpose and mounted at the rear side of a car, however any other suitable carrying means can be possibly chosen such as roof baggage rack on the vehicle, trailer, bowl etc. Angular circumferential shape of the tub 11 and other elements mentioned above is not a requirement.

[0028] The composition 2 consists of a material generating in case of firing a non-toxic aerosol, solid particles of which contain a mixture of potassium carbonate (K_2CO_3), potassium hydrogen carbonate ($KHCO_3$) and carbon (C), and the gaseous phase of which contains a mixture of carbon dioxide (CO_2) water vapours (H_2O), nitrous gases (NO_x), nitrogen (N_2), and ammonia (NH_4). For instance mixture of the following composition suits well as this material:

Substance	% by weight in the mixture
Potassium perchlorate ($KClO_4$)	20 to 26
Potassium nitrate (KNO_3)	50 to 60
Binding component, epoxy resin	19 to 23
Binding component, hardener	0.8 to 1.2

[0029] The abovementioned quantities and types of substances imply materials available on the market, i.e. of technical purity of approximately 99%, so that besides the listed substances, also a small amount of admixtures can be contained. Aerosol generated by firing this mixture can be characterised as unhealthy up to harmful, however this harmfulness does not reach such a degree that it could be considered as toxic.

[0030] The device is designed for the new method of the fire ventilation function test according to the invention. Example performance of tests according to this method is described hereinafter. Function of the device and carrying out of the method are shown on Figs. 8 to 11.

[0031] Preparation for performance of the method includes at least examination of the project documentation of the tested space, ascertainment of the type, number, and location of air-handling devices and devices for smoke and heat removal, and of other devices in the tested space, finding of elements of natural ventilation, determination of shape, dimensions, and materials in the tested premises and identification of projected parameters of the fire ventilation. Further on, this preparation includes distribution of corresponding sensors and gauges in the tested space, including possible video cameras 15 unless they were already installed sooner. The device according to the invention equipped with calculated necessary number of vessels 1 with composition 2 is prepared in advance. The generator of non-toxic aerosol simulating combustion smoke products is placed into the tested space, its compositions 2 are activated and then propagation of the generated aerosol is monitored, while a video is recorded and measurements of values necessary for evaluation of functionality of fire ventilation in the given space are performed, and finally the observed measurements are compared with values of a real smoke, for instance the smoke formed during combustion of gasoline and diesel fuel, measured in a test space. On the basis of the found results, evaluation of functionality of the fire ventilation of the tested space is performed. Modern scientific and technical equipment including data control and evaluation systems are used as far as possible for measurements and evaluation.

[0032] When fired, the non-toxic aerosol is generated in the generator at the temperature of 600 to 1300° C, while the specific temperature values from the given range depend in particular on the quantity of material in the compositions 2, on the specific composition of the compositions 2, on the presence and quantity of oxidizers and, as the case may be, on the presence of supplementary ignited media increasing temperature such as ethanol poured in the tub 5. The aerosol generated from the compositions 2 forms an aerosol cloud consisting of a mixture of solid and gaseous phases, of which the solid phase consists of particles with a particle size of 1 to 5 μm based on potassium carbonate, potassium hydrogen carbonate and carbon, and the gaseous phase is created by a mixture of substances in a gaseous state containing carbon dioxide, water vapours, nitrous gases, nitrogen, and ammonia and/or compounds of these substances. Dose of compositions 2 is calculated so that the non-toxic aerosol is generated in quantity of 3 to 100 m^3/s, while the specific generated quantity of aerosol for individual verification test is determined within the given range in advance depending on the client's request, as far as possible in dependence on projected parameters of the fire ventilation for the tested space, for instance at the level identical or close to the upper threshold of the highest values permitted by the project. In the course of the test, the flow speed of the air containing aerosol, the temperature in the area of the aerosol generator and in the space, optical density of the aerosol, and possibly other measurable values in the tested space and, as the case may be, also at inputs and outputs of air-handling devices are monitored. Significant contribution of the invention is among others the possibility to record video indicating the direction and flow of the aerosol particles in dependence on functioning of the fire ventilation right in the area of the edge of the aerosol cloud. Also the time of exchange of gases and polluted air in dependence on the volume exchange of air masses and on the aerosol optical density is measured. Because the aerosol cloud has properties with respect to optical density, movement, and diffusion comparable with the real smoke from a fire, also the aerosol optical density at different height levels is determined in the tested space during the test by means of video recording and/or by measurements at different heights. The video recorded then allows for visualisation of the course of the test utilisable for evaluation of the test results as well as for demonstrative purposes such as exhibition at training courses, for practical instruction exercise of fire-fighters etc.

[0033] If air-handling devices are contained in the tested space, they are preferably operating in the course of the aerosol generation and monitoring of the aerosol propagation. The method is solved completely for purposes of tests of ventilation of tunnels and other corridors in the following way for tunnels, halls, and similar tested spaces of large dimensions, the generator of non-toxic aerosol is still before activation of the contained compositions 2 placed on at least one carrier mounted on or behind a vehicle, and that in such position and so open to the surrounding space that the generated aerosol can freely propagate to the surrounding space. The vehicle with the composition 2 is transported to the site of activation of compositions 2 and then, during activation and/or after activation of compositions 2 by their firing, the vehicle moves in the tested space. Visible aerosol cloud is generated from activated compositions 2, which propagates in the tested space in a way similar to a smoke from a real fire during combustion of gasoline, diesel fuel, etc. The area of the edge of the aerosol cloud is monitored for all the time of the test, i.e. at least for the time of movement of the cloud in the tested space. This monitoring can be ensured by a mobile video device such as a video camera 15 located on a separate vehicle, by means of which a video recording enabling to visualize the course of the test is continuously recorded.

[0034] The abovementioned method according to the invention and functioning of the device according to the invention designed for this method is clearly illustrated on Figures 8 and 9 in the case of statically placed generator, from which Fig. 8 demonstrates generation and propagation of the aerosol cloud in a room ventilated with the air-handling device with a pipe system and Fig. 9 in a room only with natural ventilation by means of an air shaft. The line on these figures marks so called safe line h, which is the height limit showing the height in a direction from the room floor, up to which breathing is still safe for persons in the area during fire in the case of utilisation or operation of the present means of fire ventilation. Here, arrows indicate natural inflow of air through structural holes.

[0035] Fig. 10 shows carrying out of the fire ventilation function test in a tunnel using the generator placed on the bearing structure 14 mounted on a vehicle that is standing during performance of the test. In the case A, the vehicle with the generator is standing in the central part of the tested tunnel; in the case B, it is standing in the area at the beginning of the tunnel; in the case C, it is standing in the area at the end of the tunnel. In all cases A, B, C, two additional vehicles are used for monitoring, each with the video camera 15, which are standing near the edge of the aerosol cloud and are driving further back and forth depending on how the aerosol cloud propagates at the beginning and finally wanes through ventilation. The invention enables persons to operate these vehicles as well as the video camera 15 without the risk to the persons' life and health hazard. At that, none of the vehicles in the tunnel area are exposed to danger of fire too.

[0036] Fig. 11 shows carrying out of the fire ventilation function test in a tunnel using the generators placed on the bearing structures 14 mounted on vehicles that are moving during performance of the test. In the case A, the compositions 2 of the generators are activated in the area of the central part of the tested tunnel, after which the vehicles drive away spreading the aerosol cloud towards the end of the tunnel. In the case B, the compositions 2 of the generators are activated already in the area of the beginning of the tested tunnel, after which the vehicles drive away spreading the aerosol cloud towards the end of the tunnel. In the case C, the compositions 2 of the generators are activated in the area of the end of the tested tunnel, after which the vehicles drive away spreading the aerosol cloud towards the beginning of the tunnel. In all cases A, B, C, one or two additional vehicles with the video camera 15 can be used for monitoring and shooting of video-recording, in a way similar to the case described with Fig. 10.

[0037] The abovementioned variants of the solution according to the invention are demonstrating, and not limiting. Therefore still various other combinations of the embodiment of the device as well as of the method within the frame of conditions according to the invention are possible.

Claims

1. Method of the fire ventilation function test, **characterized by that** a generator of non-toxic aerosol simulating combustion smoke products is placed into the tested space while the generator is equipped with a predetermined number of compositions (2), these compositions (2) are activated and then propagation of the generated aerosol is monitored, while a video is recorded and measurements of values necessary for evaluation of functionality of the fire ventilation in the given space are performed, and finally the taken measurements are compared with values of a real smoke, for instance the smoke produced during combustion of gasoline and diesel fuel, measured in a test space and the functionality of the fire ventilation of the tested space is evaluated on the basis of the observed results.

2. Method of the fire ventilation function test according to claim 1 **characterized by that** the non-toxic aerosol is generated in the generator at the temperature of 600 to 1300° C consisting of a mixture of solid and gaseous phases, of which the solid phase consists of particles with a particle size of 1 to 5 μm based on potassium carbonate, potassium hydrogen carbonate, and carbon, and the gaseous phase is a medium based on carbon dioxide, water vapours, nitrous gases, nitrogen and ammonia.

3. Method of the fire ventilation function test according to claims 1 and 2 **characterized by that** the non-toxic aerosol is generated in quantity of 3 to 100 m^3/s, while the particular generated quantity for individual verification test is determined within the given range in advance depending on the projected parameters of the fire ventilation for the tested space, for instance at the level of the highest values permitted by the project.

4. Method of the fire ventilation function test according to claims 1 to 3 **characterized by that** in the course of the test, the flow speed of the air including the contained aerosol, the temperature in the area of the aerosol generator and in the space, and optical density of the aerosol are monitored, video is recorded of the direction and flow of aerosol particles in dependence on functioning of the fire ventilation, and the time of exchange of gases and polluted air in dependence on the volume exchange of air masses and on the aerosol optical density is measured.

5. Method of the fire ventilation function test according to claims 1 to 4 **characterized by that** the aerosol optical density at different height levels is determined in the tested space during the test by means of video recording and/or by measurements in different heights.

6. Method of the fire ventilation function test according to claims 1 to 5 **characterized by that** the air-handling devices of the tested space are in operation in the course of the aerosol generation and monitoring of the aerosol propagation in the tested space.

7. Method of the fire ventilation function test according to claims 1 to 6 **characterized by that** at least one generator of non-toxic aerosol is still before activation of the contained composition (2) placed on a carrier mounted on or behind a vehicle, and this in such position and so open to the surrounding space that the generated aerosol can freely propagate to the surrounding space, after which the vehicle together with the composition (2) is transported to the site of activation of the composition (2) and then, during activation and/or after activation of the composition (2), the vehicle moves within the tested space, for instance by driving across the tested space, and during this time, the generated aerosol cloud simulating smoke propagates in the tested space, while a mobile video device such as a video camera (15) located on another vehicle is moving in the area of the edge of this cloud for all the time of the

test and is continuously recording a video record enabling to visualize the course of the test.

8. Device for carrying out the method of the fire ventilation function test according to any of the claims 1 to 7 including the generator containing vessels (1) of non-inflammable solid material, for instance steel, with inner cavity, that are at least partially filled with combustible composition (2), **characterized by that** the compositions (2) in the vessels (1) constitute the source of non-toxic aerosol imitating the combustion products, i.e. the aerosol consisting of solid particles with the particle size of 1 to 5 μm and non-toxic gaseous substances, while the vessel (1) contains only a firing device (3) in addition to the composition (2), and only a free space is in vessels (1) above the composition with the firing device (3), and while these vessels (1) are in the number of 4 to 10 pieces placed in at least one storage device made of non-inflammable solid material such as steel, and are equipped here with a common perforated cover (9).

9. Device for carrying out the method of the fire ventilation function test according to claim 8 **characterized by that** the storage device for the vessels (1) is in a shape of a stand, the upper part of which is created by a bed (5) for the vessels (1), and under this bed (5) a base (6) with at least one inner cavity for necessary electric elements of the firing device (3), for instance for conductors (4), is located.

10. Device for carrying out the method of the fire ventilation function test according to claim 9 **characterized by that** the bed (5) is equipped with at least one opening (7) and the inner cavity of the base (6) is through, connected to this opening (7), while the base (6) is equipped with at least one element stabilizing its position relative to the support, for example a support plate (8) created at the bottom.

11. Device for carrying out the method of the fire ventilation function test according to claims 9 and 10 **characterized by that** the stand in the number of at least one is placed in a tub (11) made of non-inflammable solid material such as steel, where this tub (11) contains at least a bottom (12) and all-circumferential rim (13), while the stand is firmly, immovably fixed to the bottom (12) of this tub (11).

12. Device for carrying out the method of the fire ventilation function test according to claim 11 **characterized by that** the tub (11) contains one to twenty stands, while at least some of the contained stands have the bed (5) fully filled with the vessels (1) covered with the perforated cover (9).

13. Device for carrying out the method of the fire ventilation function test according to claim 12 **characterized by that** the tub (11) is placed on a bearing structure (14) of a movable device, for instance of a vehicle, freely open to the surrounding space at least in the area of the cover (9).

14. Device for carrying out the method of the fire ventilation function test according to any of the claims 8 to 13 **characterized by that** the composition (2) consists of a material generating in case of firing the composition (2) the non-toxic aerosol, solid particles of which contain a mixture of potassium carbonate, potassium hydrogen carbonate and carbon, and the gaseous phase of which contains a mixture of carbon dioxide, water vapours, nitrous gases, nitrogen, and ammonia.

Fig.1

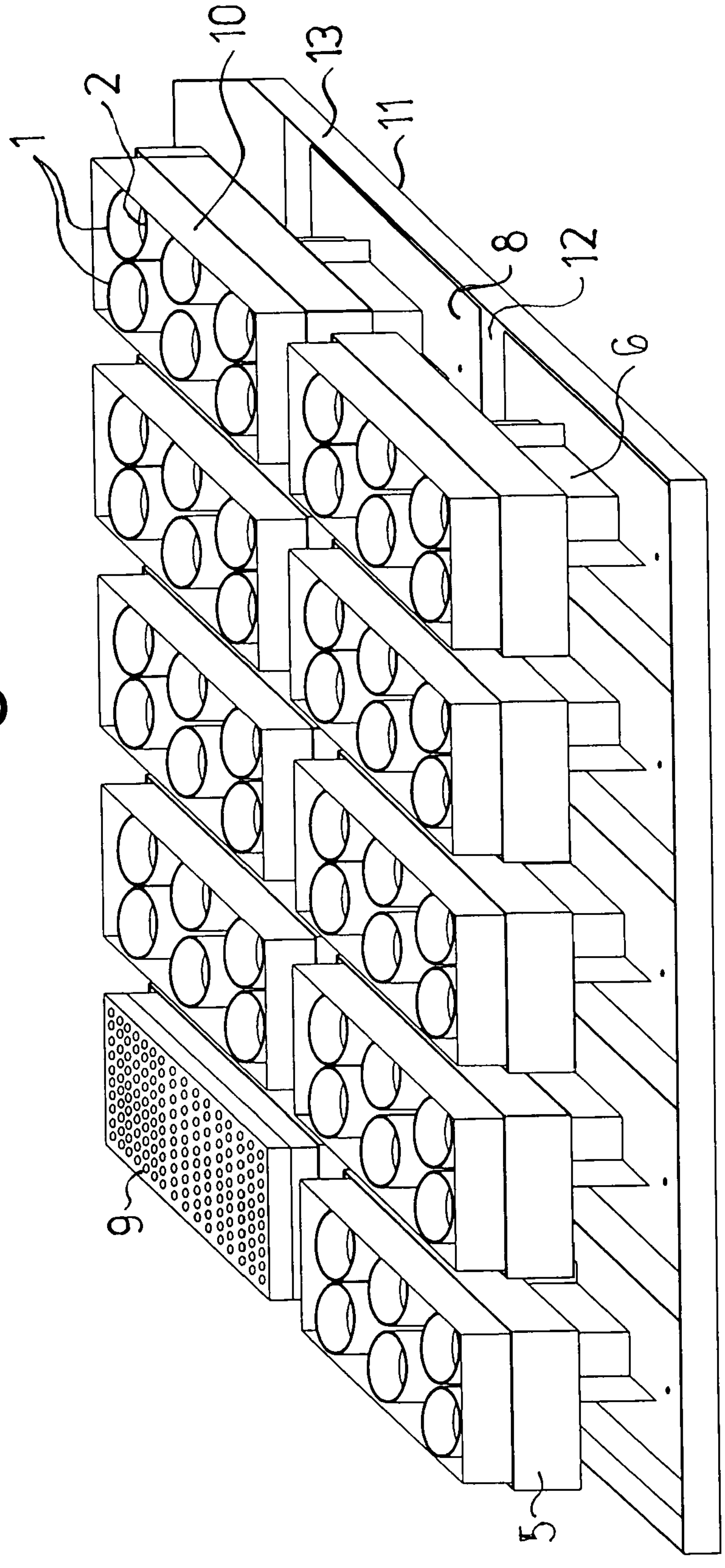

Fig.2

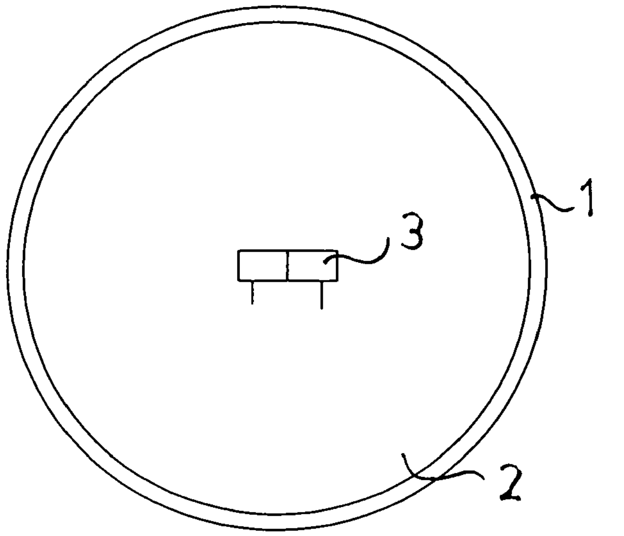

Fig.3

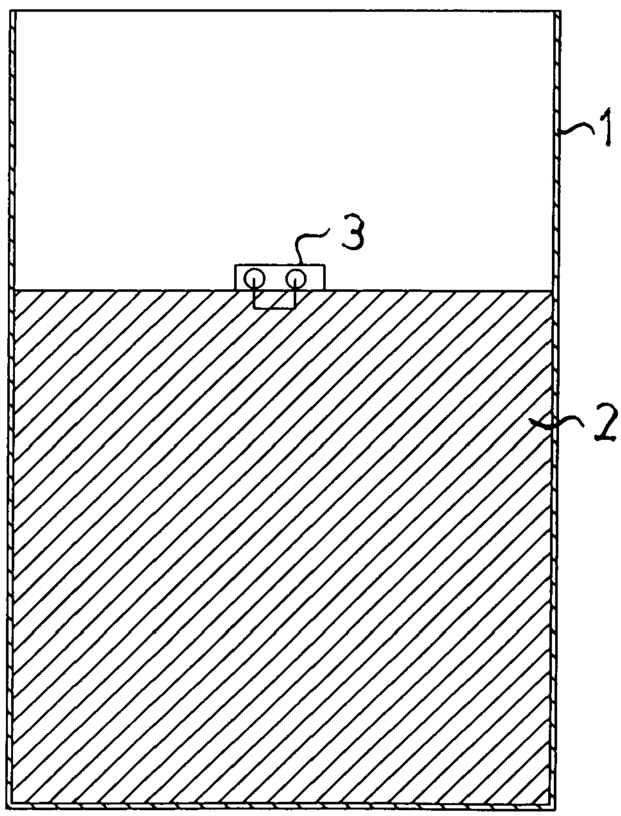

Fig.4

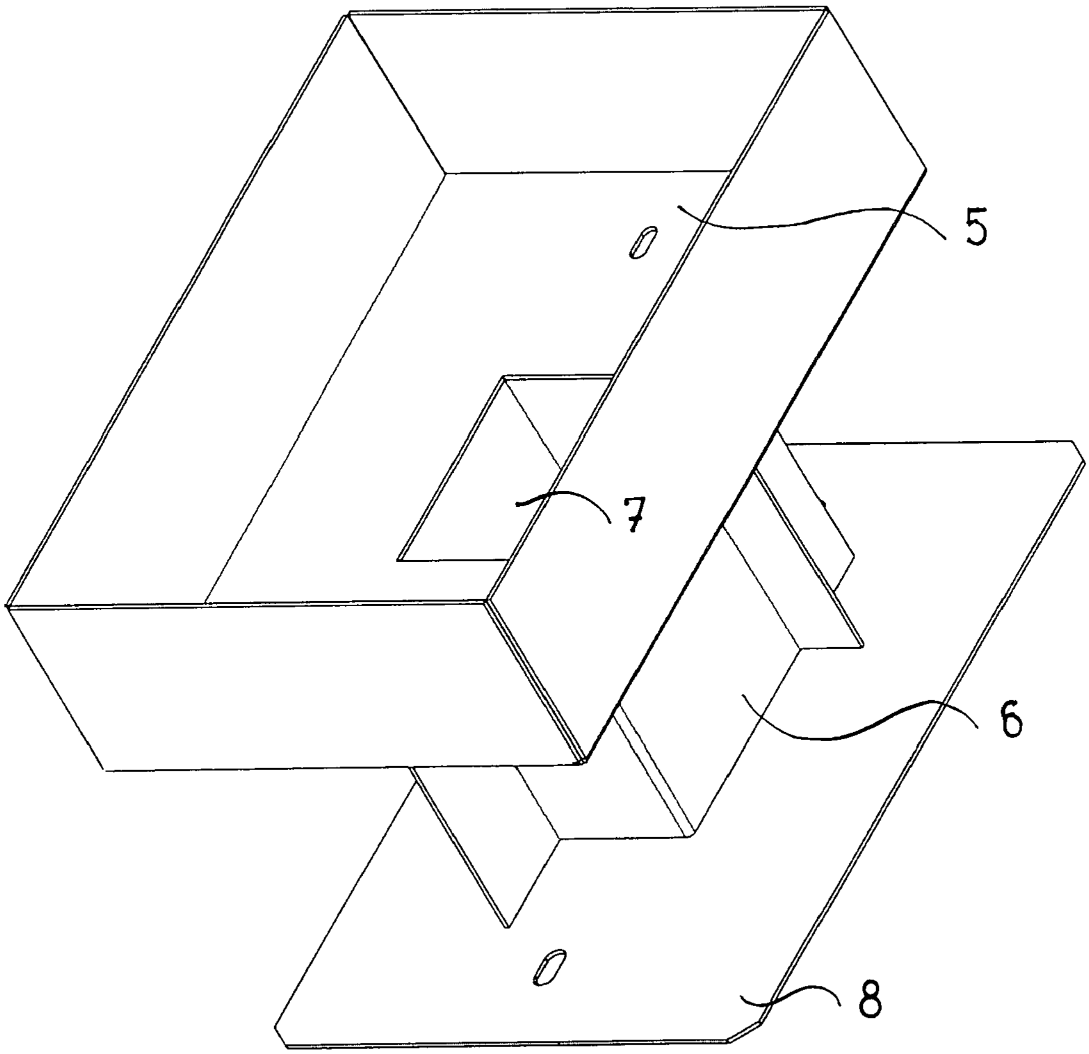

Fig.5

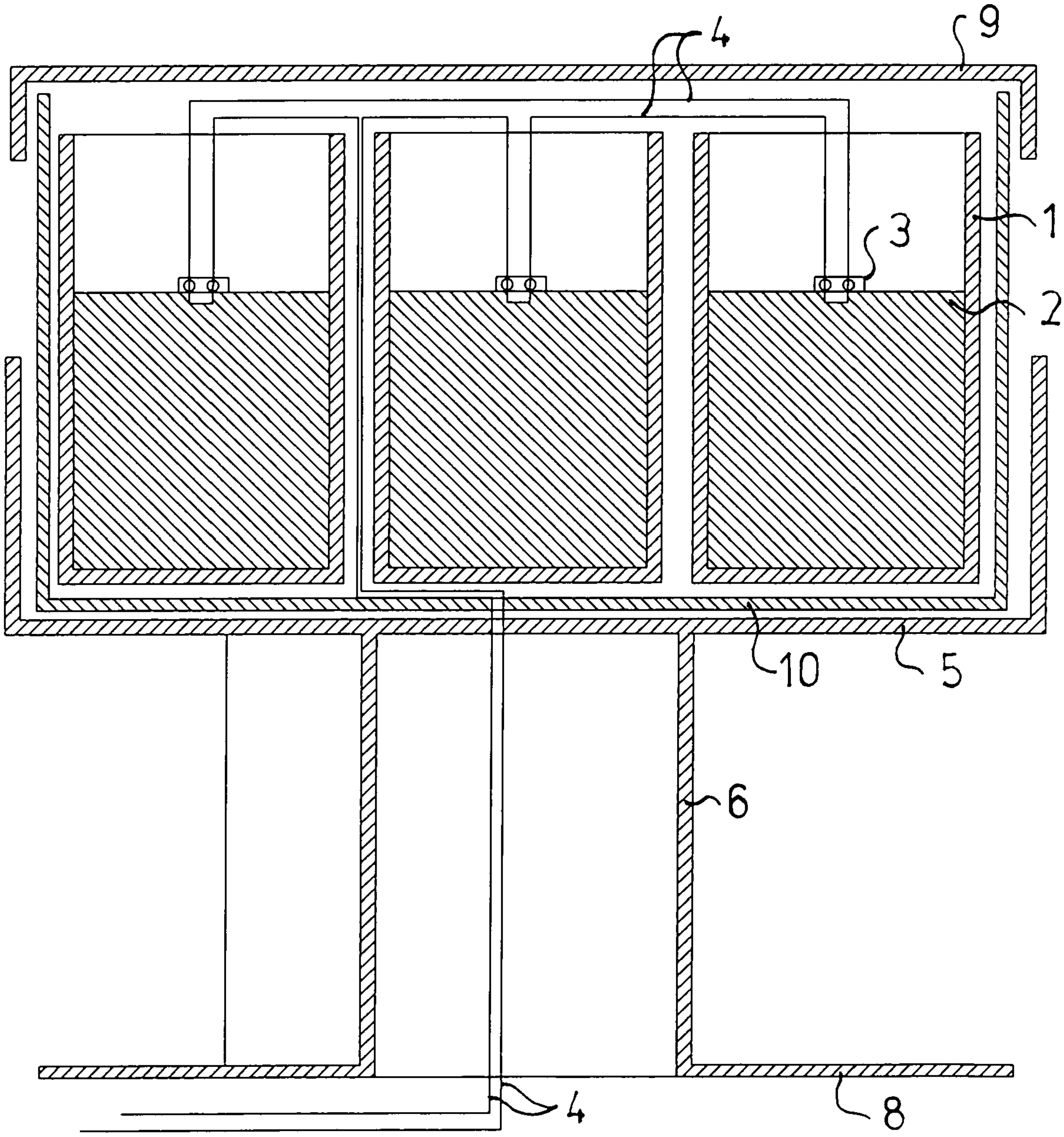

Fig.6

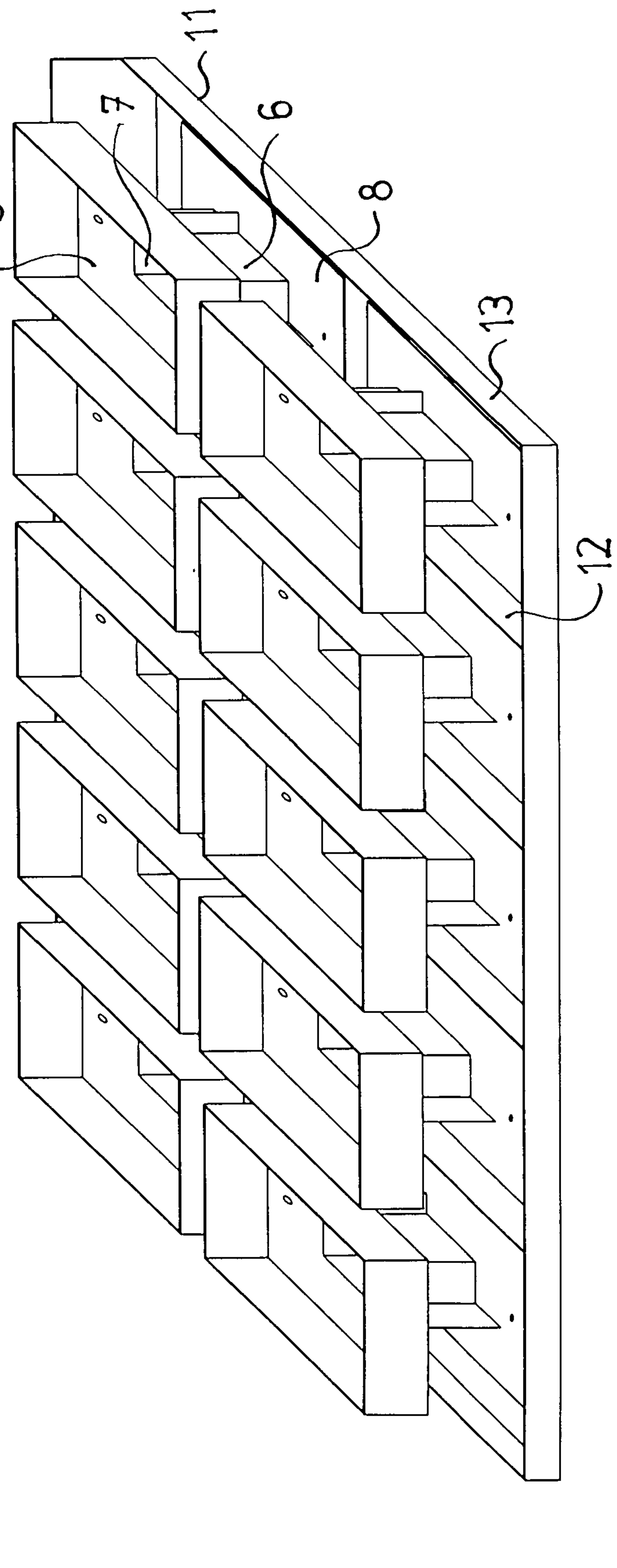

Fig.7

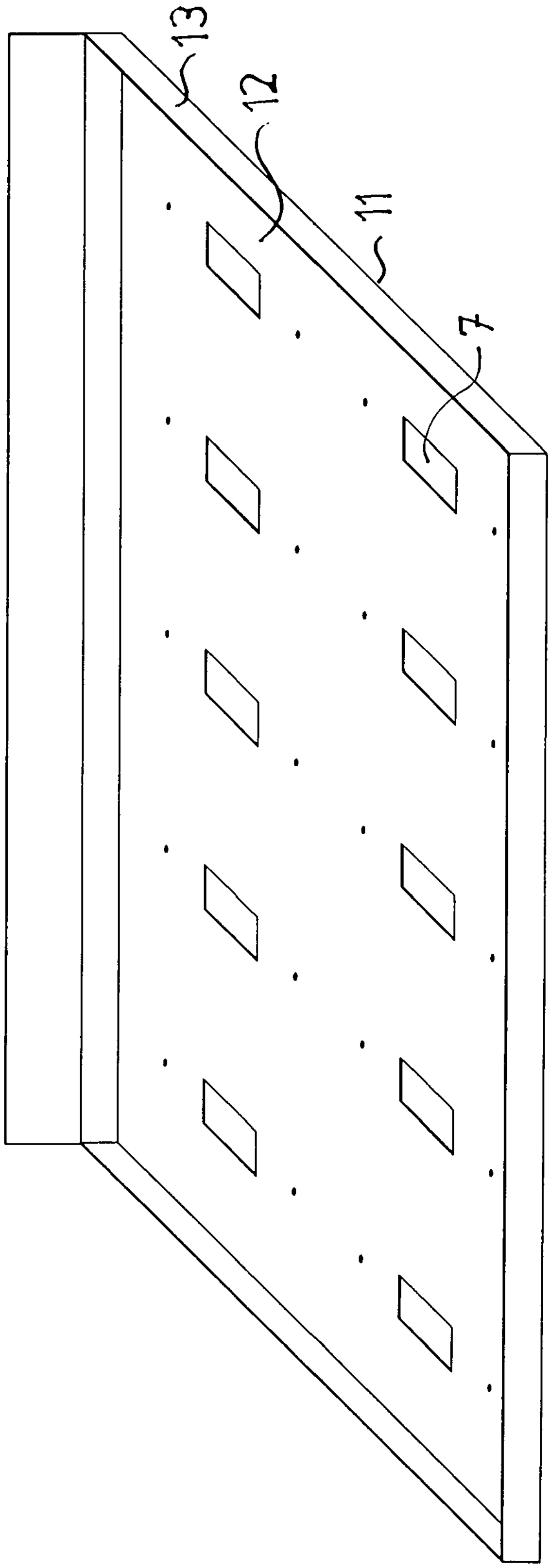

Fig.8

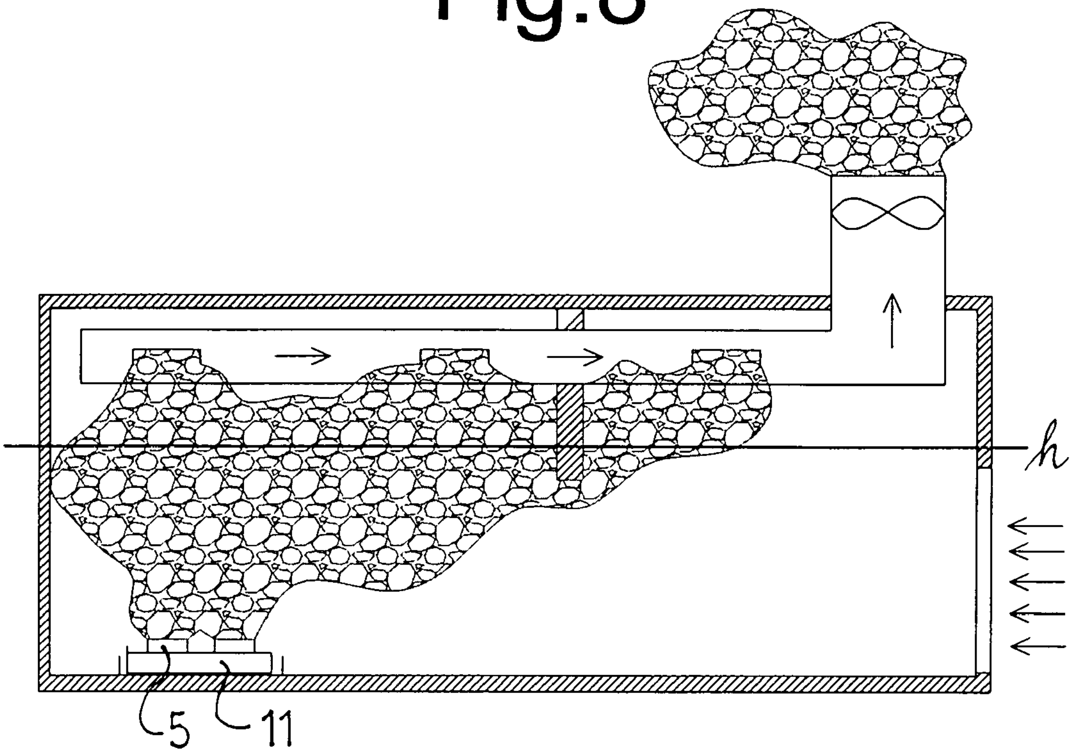

Fig.9

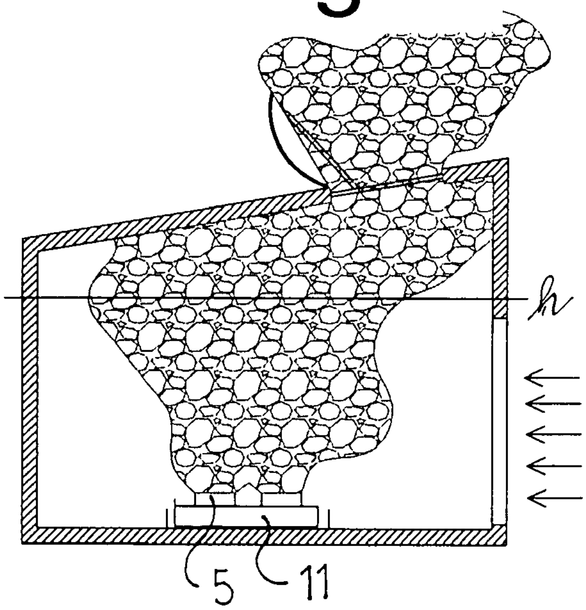

Fig.10

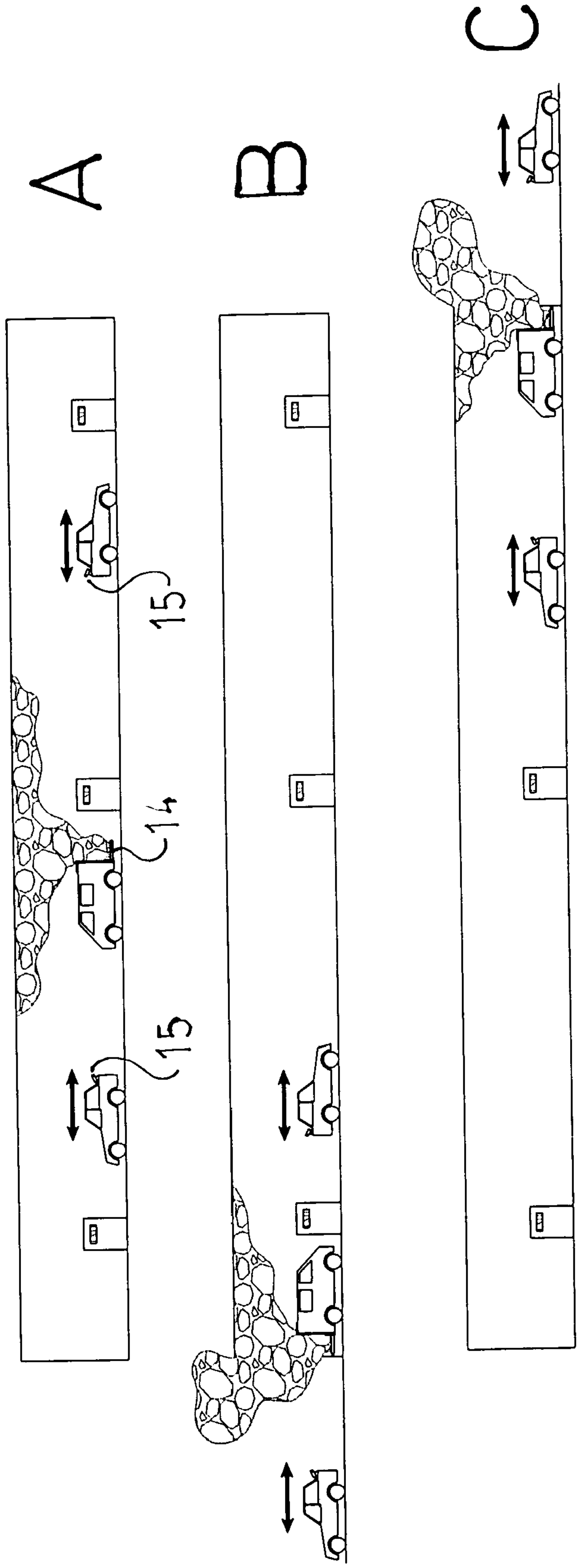

Fig.11