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EUROPEAN QUALIFYING EXAMINATION 2011

Paper B(E/M)

Electricity / Mechanics

This paper comprises:

<u>Description of the Application</u>

[**001**] The present application relates to smoke detectors. Smoke results from a fire and consists of smoke particles suspended in air. Smoke detectors generate a smoke alarm signal when a smoke concentration reaches a dangerous level. Smoke concentration means the concentration of smoke particles that are suspended in air.

[**002**] When light shines onto smoke particles suspended in air, the smoke particles reflect the light randomly. This effect is called light scattering. The amount of light scattered increases as the smoke concentration increases. All the smoke detectors mentioned in this application make use of the light scattering effect.

[**003**] Fig. 1 shows a prior art smoke detector 10 according to the preamble of claim 1. The smoke detector 10 has openings 12 which allow smoke to enter an internal detecting chamber (not shown in Fig. 1) in which smoke can be detected. The smoke detector 10 has mounting holes 14 so that it can be attached to a ceiling with screws.

[**004**] Fig. 2 is a view of the smoke detector 10 of Fig. 1 in cross section. The smoke detector 10 has a detecting chamber 30 and a compartment 20. Smoke from outside the smoke detector 10 can enter the detecting chamber 30 through the openings (not shown in Fig. 2).

[**005**] The smoke detector 10 comprises an infrared light source 42, a light sensor 44, and a light shield 40, all of which are located in the detecting chamber 30. The infrared light source 42 can emit infrared light into the detecting chamber 30. The light sensor 44 can receive light from within the detecting chamber 30. The light shield 40 prevents light from the infrared light source 42 being directly received by the light sensor 44. All the surfaces inside the detecting chamber 30 are black so that they absorb infrared light.

[**006**] The smoke detector 10 further comprises a control unit 25, a horn 24 for generating an audible warning and a battery 22 for providing power to the smoke detector 10, all of which are located in the compartment 20.

[**007**] When the smoke detector is in operation, the light source 42 emits infrared light into a portion 31 (partially delimited by the dashed line) of the detecting chamber 30. The light sensor 44 senses the intensity of infrared light that it receives and converts it into an electrical signal. The control unit 25 is electrically connected to the light sensor 44 and monitors the intensity of the infrared light sensed by the light sensor 44.

[**008**] When there is no smoke in the detecting chamber 30, almost no light reaches the light sensor 44. When the intensity of the infrared light sensed by the light sensor 44 is close to zero, the control unit 25 judges that there is no smoke in the detecting chamber 30.

[**009**] Fig. 3 is a cross sectional view of the smoke detector 10 of Fig. 1 with smoke present in the detecting chamber 30. The infrared light source 42 emits infrared light into the detecting chamber 30. Some of the infrared light is scattered by smoke particles 35, as shown schematically by the light scattering paths 37. Some of the scattered infrared light reaches the light sensor 44. The intensity of infrared light sensed by the light sensor 44 is therefore significantly greater than zero.

[**010**] When the intensity of the infrared light sensed by the light sensor 44 exceeds a predetermined light intensity threshold value, the control unit 25 judges that the smoke concentration in the detecting chamber 30 has reached a dangerous level and generates a smoke alarm signal. The smoke alarm signal is received by the horn 24, which produces an audible warning.

[**011**] For a given smoke concentration in the detecting chamber 30, the intensity of scattered infrared light that reaches the light sensor 44 depends on the intensity of the infrared light emitted by the infrared light source 42. For various reasons the latter intensity changes with time. For example, the intensity of light emitted by the infrared light source 42 will decrease as the infrared light source 42 ages, as the infrared light source 42 becomes dirty, or as the battery 22 becomes depleted.

[**012**] Because the light intensity threshold value is predetermined, the smoke concentration in the detecting chamber 30 at which the control unit 25 activates the horn 24 changes with time. For example, if the infrared light source 42 has aged and emits infrared light of a low intensity, the smoke concentration in the detecting chamber 30 may exceed a dangerous level without the control unit 25 generating a smoke alarm signal.

[**013**] An object of the present invention is to address this drawback. This is achieved by the subject matter of the claims.

[**014**] Brief description of the drawings:

Fig. 1 shows a smoke detector according to the prior art.
Fig. 2 is a view of the smoke detector of Fig. 1 in cross section.
Fig. 3 is a view of the smoke detector of Fig. 1 in cross section with smoke.
Fig. 4 shows a smoke detector according to a first embodiment of the invention.
Fig. 5 shows a smoke detector according to a second embodiment of the invention.
Fig. 6 shows a smoke detector according to a third embodiment of the invention.

[**015**] The invention will now be described with reference to the drawings.

[**016**] Fig. 4 shows a smoke detector 100 according to a first embodiment of the invention. The smoke detector 100 comprises an infrared light source 42 for emitting infrared light, a first light sensor 44, and a light shield 40, all of which are located in a detecting chamber 30. The first light sensor 44 can receive light from within the detecting chamber 30 but it cannot receive light directly from the infrared light source 42. The smoke detector 100 of Fig. 4 differs from the prior art smoke detector 10 of Figs. 1 - 3 only in that it has a different control unit 125 and in that it additionally comprises a second light sensor 150 that is arranged to receive infrared light directly from the infrared light source 42 and to sense the intensity of the received infrared light.

[**017**] When smoke particles are suspended in the air in the detecting chamber 30 and the infrared light source 42 emits infrared light into a portion of the detecting chamber, some of the infrared light is scattered by the smoke particles and reaches the first light sensor 44 indirectly. For a given smoke concentration in the detecting chamber 30, the intensity of the scattered infrared light that reaches the first light sensor 44 depends on the intensity of the infrared light emitted by the infrared light source 42.

[**018**] The control unit 125 is electrically connected to the first light sensor 44 and monitors the intensity of infrared light sensed by the first light sensor 44. When the intensity of the infrared light sensed by the first light sensor 44 exceeds a light intensity threshold value, the control unit 125 judges that the smoke concentration in the detecting chamber 30 has reached a dangerous level and generates a smoke alarm signal. The smoke alarm signal is received by the horn 24, which produces an audible warning.

[**019**] The second light sensor 150 is physically in contact with the infrared light source 42. The control unit 125 is electrically connected to the second light sensor 150 and monitors the intensity of infrared light sensed by the second light sensor 150. The control unit 125 is arranged to set the light intensity threshold value. The control unit sets the light intensity threshold value as a function of the intensity of infrared light sensed by the second light sensor 150. The control unit 125 decreases or increases the light intensity threshold value it sets as the intensity of infrared light sensed by the second light sensor 150 decreases or increases respectively. Two situations will now be described to explain this.

[**020**] In a first situation, the battery 22 is new. Because the battery 22 is new, the infrared light source 42 is bright and the infrared light sensed by the second light sensor 150 is of a high intensity. The control unit 125 then sets the light intensity threshold to a relatively high value.

[**021**] In a second situation the battery 22 is old. Because the battery 22 is old, the infrared light source 42 is dim and the infrared light sensed by the second light sensor 150 is of a low intensity. The control unit 125 then sets the light intensity threshold to a relatively low value.

[**022**] The smoke detector 100 of the first embodiment of the invention consistently generates a smoke alarm signal as soon as the smoke concentration in the detecting chamber 30 reaches a dangerous level, irrespective of the condition of the battery 22.

[**023**] Smoke detectors of the second embodiment of the invention differ from smoke detectors of the first embodiment only in that the infrared light source and the second light sensor are spaced apart by a gap that is less than 5mm.

[024] Fig. 5 shows a smoke detector 200 according to the second embodiment of invention. It differs from the smoke detector 100 of Fig. 4 only in that the infrared light source 42 and the second light sensor 250 of this embodiment are spaced apart by a gap X of 4mm. Because the infrared light source 42 is so close to the second light sensor 250, the intensity of infrared light directly reaching the second light sensor 250 from the infrared light source 42 is not significantly reduced when smoke is present in the gap X.

[**025**] The control unit 225 is arranged to set the light intensity threshold value as described above in conjunction with the first embodiment. Smoke detectors according to the second embodiment have the further advantage that when the intensity of infrared light emitted by the infrared light source 42 is reduced due to the infrared light source 42 getting dirty, the control unit 225 sets a decreased light intensity threshold value.

[**026**] Smoke detectors of the third embodiment of the invention differ from smoke detectors of the second embodiment in that the infrared light source and the second light sensor are spaced apart by a gap that is greater or equal to 5mm and in that they comprise a signal-averaging filter that is arranged to average a light intensity signal it receives from the second light sensor over a period of time. The signal-averaging filter is necessary to ensure that the sudden appearance of smoke in the detecting chamber does not cause the control unit to immediately set a new light intensity threshold value. However the signal-averaging filter does not prevent the control unit from setting a new light intensity threshold value in response to long-term changes in the intensity of infrared light emitted by the infrared light source.

[027] Fig. 6 shows a smoke detector 300 according to the third embodiment of the invention. It differs from the smoke detector 200 of Fig. 5 in that the infrared light source 42 and the second light sensor 350 are spaced apart by a gap Y which is equal to 50mm and in that the smoke detector 300 comprises a signal-averaging filter 326. The second light sensor 350 is electrically connected to the control unit 325 via the signal-averaging filter 326. The signal-averaging filter 326 receives an electrical signal representing the intensity of the infrared light that the second light sensor 350 senses, averages the signal over a period of time and sends an averaged light intensity signal to the control unit 325. The control unit 325 is arranged to set the light intensity threshold value. The control unit 325 decreases or increases the light intensity threshold value as the averaged light intensity signal decreases or increases respectively. In this way the light intensity threshold value is set as a function of the infrared light intensity sensed by the second light sensor 350.

[**028**] For smoke detectors according to the third embodiment of the invention, a signal-averaging filter that averages the light intensity signal it receives from the second light sensor over a period of 24 hours has been found to be suitable.

[**029**] Preferably in all the embodiments of the invention, the infrared light source is arranged to emit infrared light having a wavelength in the range of 850-900 nm and the first and second light sensors are arranged to sense the intensity of infrared light having a wavelength in the range of 850-900 nm. The smoke detectors of the invention can be powered by a battery or by mains electricity when available.

Claims

Claims currently on file: claim 1 as originally filed; claims 2-7 filed after receipt of the search report.

1. A smoke detector (100, 200, 300) comprising:
   an infrared light source (42),
   a light sensor (44) arranged to receive infrared light from the infrared light source (42) which has been scattered by smoke and to sense the intensity of the received infrared light,
   a light shield (40) arranged to prevent infrared light from the infrared light source (42) from being directly received by the light sensor (44),
   a control unit (125, 225, 325) electrically connected to the light sensor (44),
   the control unit (125, 225, 325) being arranged to generate a smoke alarm signal when the intensity of infrared light sensed by the light sensor (44) exceeds a light intensity threshold value,
   characterised by the method step of the control unit (125, 225, 325) setting the light intensity threshold value.

2. A smoke detector (100, 200, 300) according to claim 1 comprising a further light sensor (150, 250, 350) arranged to sense the intensity of light having a wavelength in the range of 850-900 nm and wherein the control unit (125, 225, 325) is electrically connected to the further light sensor (150, 250, 350).

3. A smoke detector (100) according to claim 2 wherein the further light sensor (150) is physically in contact with the infrared light source (42).

4. A smoke detector (200, 300) according to claim 2 wherein the further light sensor (250, 350) and the infrared light source (42) are spaced apart by a gap (X, Y).

5. A smoke detector (200) according to claim 4 wherein the gap (X) is very small.

6. A smoke detector (300) according to claim 4 wherein the gap (Y) is larger than the gap (X) defined in claim 5.

7. A smoke detector (300) according to any previous claim comprising a signal-averaging filter (326).

Drawings of the Application

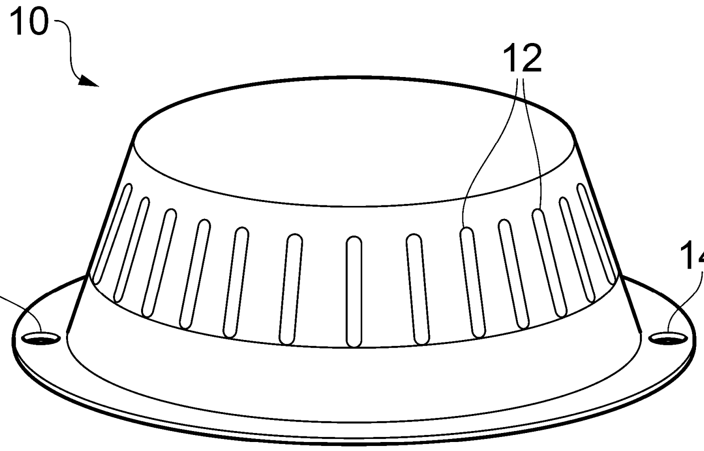

FIG.1 (Prior Art)

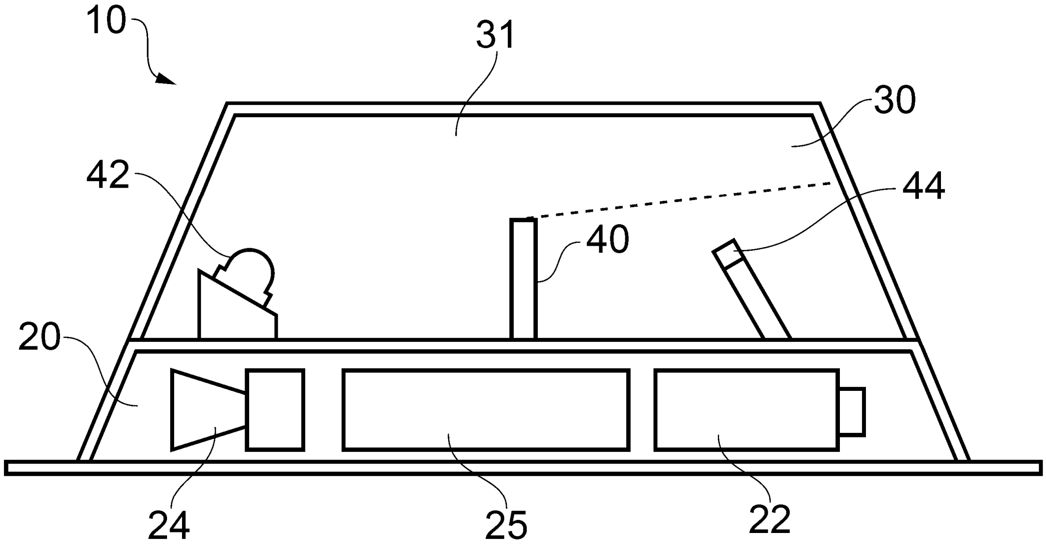

FIG. 2 (Prior Art)

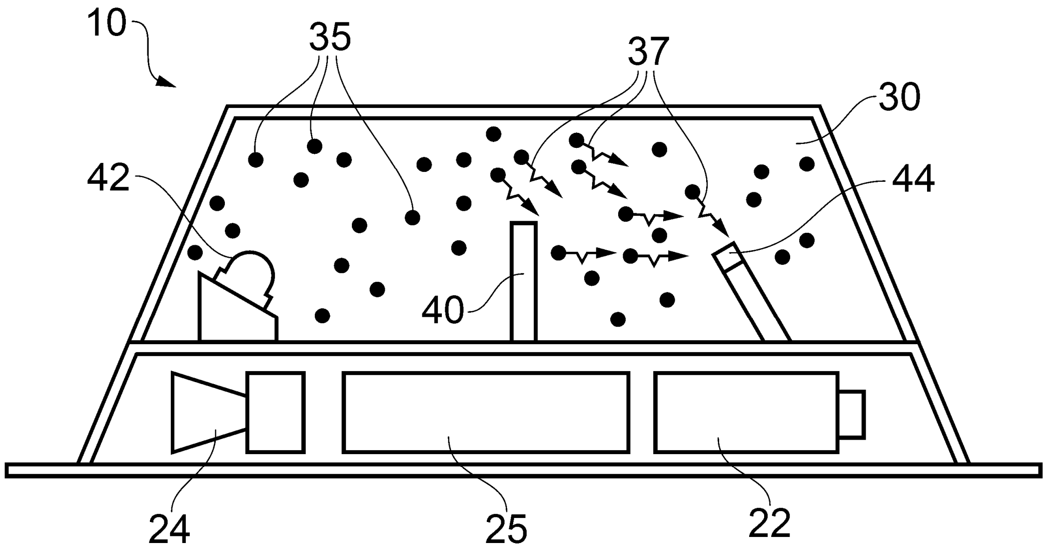

FIG. 3 (Prior Art)

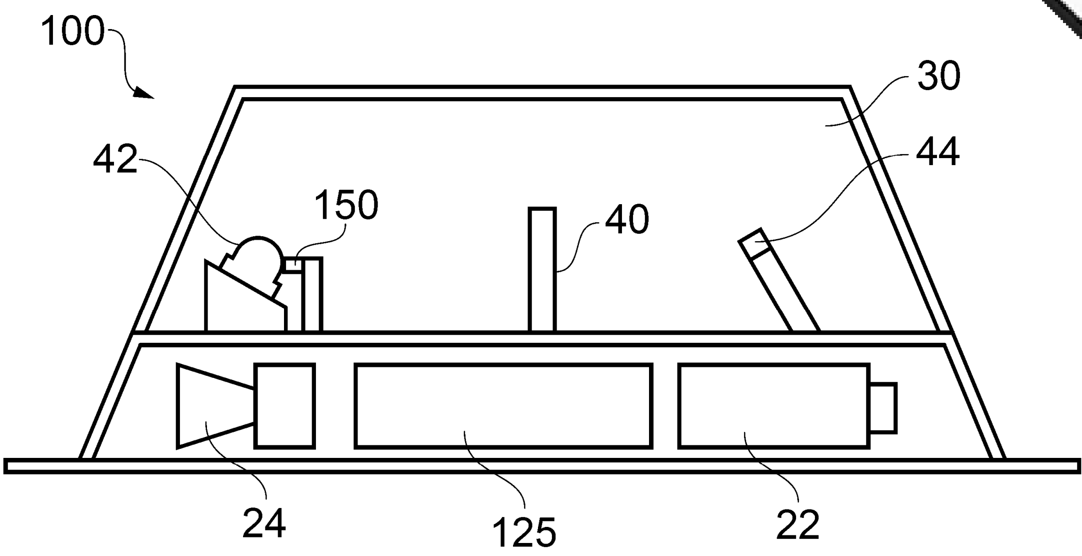

FIG. 4

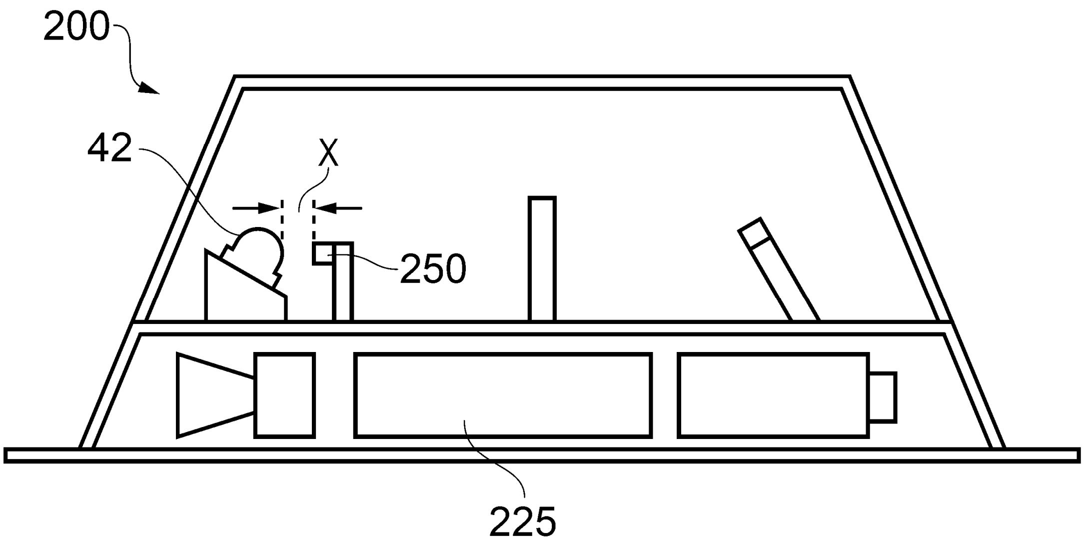

FIG. 5

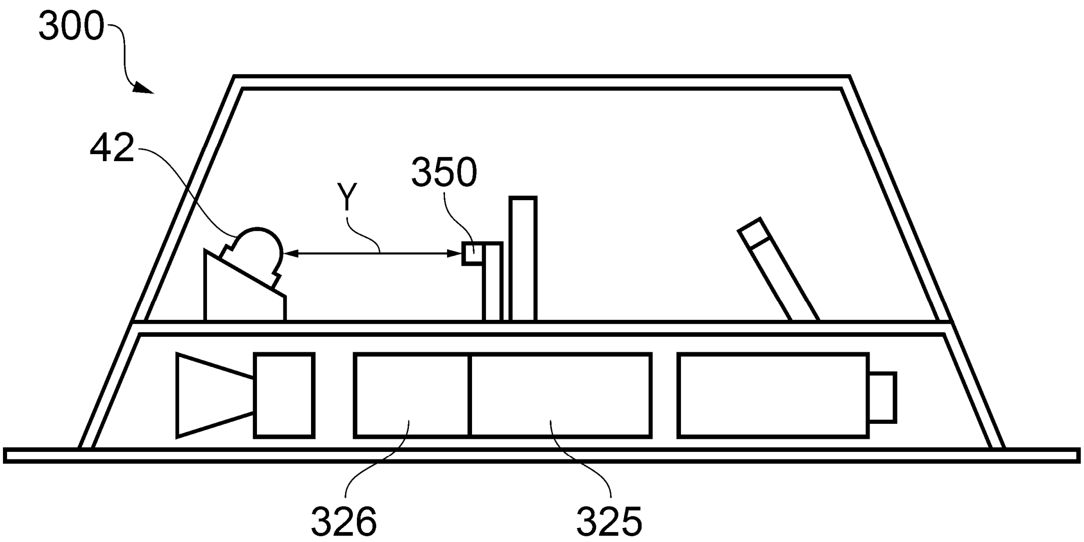

FIG. 6

Communication

1. The examination is based on the following application documents:

   Description: as originally filed
   Claim 1: as originally filed
   Claims 2 to 7: as filed after the search report under Rule 137(2) EPC
   Figures 1 to 6: as originally filed

2. Documents D1, D2 and D3 were published before the priority date of the present application.

3. Claim 1 does not meet the requirements of Art. 84 EPC, because it lacks clarity. The preamble of claim 1 defines an apparatus whereas the characterising feature of the claim defines a method step, see Guidelines C-III, 4.1, first paragraph.

4. Notwithstanding the above mentioned lack of clarity, the subject matter of claim 1 is not new within the meaning of Art. 54(1) and (2) EPC, and therefore the requirements of Art. 52(1) EPC are not met. In particular the subject matter of claim 1 is known from either D1 (par. [**003**] to [**007**] and Fig. 1) or from D2 (par. [**003**] [**004**] [**006**] and [**012**]).

4.1 Using as far as possible the wording of claim 1, but referring to D1, D1 disc

A smoke detector (400) comprising:
an infrared light source (442, par. [**004**]),
a light sensor (444) arranged to receive infrared light from the infrared light source (442) which has been scattered by smoke and to sense the intensity of the received infrared light,
a light shield (440) arranged to prevent infrared light from the infrared light source (442) from being directly received by the light sensor (444),
a control unit (425) electrically connected to the light sensor (444),
the control unit (425) being arranged to generate a smoke alarm signal when the intensity of infrared light sensed by the light sensor (444) exceeds a light intensity threshold value.

D1 further discloses how the control unit is used to optimise the light intensity threshold value including the method step of the control unit (425) setting the light intensity threshold value (par. [**009**], first and third steps).

4.2 Using as far as possible the wording of claim 1, but referring to D2, D2 disc

A smoke detector (500) comprising:
an infrared light source (542, par. [**012**]),
a light sensor (544) arranged to receive infrared light from the infrared light source (542) which has been scattered by smoke and to sense the intensity of the received infrared light,
a light shield (540) arranged to prevent infrared light from the infrared light source (542) from being directly received by the light sensor (544),
a control unit (525) electrically connected to the light sensor (544),
the control unit (525) being arranged to generate a smoke alarm signal when the intensity of infrared light sensed by the light sensor (544) exceeds a light intensity threshold value.

D2 further discloses how the control unit is used to optimise the light intensity threshold value including the method step of the control unit (525) setting the light intensity threshold value (par. [**006**], the control unit (525) sets the light intensity threshold value depending on whether a battery is fitted or not).

5. Claim 2 does not fulfil the requirements of Art. 123(2) EPC since it adds subject matter that extends beyond the application as originally filed.

5.1 There is no basis in the original application for a further light sensor unless it is "arranged to receive light directly from the infrared light source, and to sense the intensity of the received infrared light", see for example original claim 2 of the application.

5.2 Furthermore there is no basis in the originally filed application for a further light sensor (150, 250, 350) arranged to sense the intensity of light having a wavelength in the range of 850-900 nm unless it is specified that the light source is arranged to emit infrared light having a wavelength in the range of 850-900 nm, see description par. [**029**].

6. Claims 3 to 7 depend on claim 2 and therefore they incorporate all the features of claim 2. For this reason claims 3 to 7 are likewise not allowable under Art. 123(2) EPC.

7. In view of points 5 and 6 above, no opinion with respect to the patentability of claims 3 to 7 will be given in this communication. However the following points are noted:

7.1 Both D2 and D3 disclose smoke detectors which comprise two light sensors and which make use of the light scattering effect. D2 discloses a smoke detector (500) comprising two light sensors (544, 550) both of which are spaced apart from the light source (542) by gaps. D2 further discloses a smoke detector with a signal-averaging filter (par. [**004**]). D3 discloses a smoke detector (600) comprising a light sensor (650) that physically contacts the infrared light source (642).

7.2 With respect to claims 5 and 6, the term “very small” used in claim 5 has no well-recognised meaning for defining a gap in the field of smoke detectors, and is therefore unclear (see Guidelines C-III, 4.6).

8. Please identify any amendments made to the claims in accordance with Art.123(1) EPC. Please indicate, and where necessary explain, the basis for such amendments with respect to the application as originally filed (Rule 137(4) EPC).

Annex 1

<u>Claims 1 to 4 as originally filed</u>:

1. A smoke detector (100, 200, 300) comprising:
an infrared light source (42),
a light sensor (44) arranged to receive infrared light from the infrared light source (42) which has been scattered by smoke and to sense the intensity of the received infrared light,
a light shield (40) arranged to prevent infrared light from the infrared light source (42) from being directly received by the light sensor (44),
a control unit (125, 225, 325) electrically connected to the light sensor (44),
the control unit (125, 225, 325) being arranged to generate a smoke alarm signal when the intensity of infrared light sensed by the light sensor (44) exceeds a light intensity threshold value,
characterised by the method step of the control unit (125, 225, 325) setting the light intensity threshold value.

2. A smoke detector (100, 200, 300) according to claim 1 comprising a further light sensor (150, 250, 350) arranged to receive light directly from the infrared light source, and to sense the intensity of the received infrared light, wherein the control unit (125, 225, 325) is electrically connected to the further light sensor (150, 250, 350).

3. A smoke detector (100) according to claim 2 wherein the further light sensor (150) is physically in contact with the infrared light source (42).

4. A smoke detector (200, 300) according to claim 2 wherein the further light sensor (250, 350) and the infrared light source (42) are spaced apart by a gap (X, Y).

<u>Document D1</u>

[**001**] This article describes a smoke detector that makes use of the light scattering effect. The smoke detector has a light source, a light sensor arranged to indirectly receive light from the light source that has been scattered by smoke and a control unit arranged to generate a smoke alarm signal when the intensity of light sensed by the light sensor exceeds a light intensity threshold value. An integral battery powers the smoke detector.

[**002**] When the smoke detector leaves our factory, the battery is new and the light intensity threshold value is preset at an optimal value. An optimal light intensity threshold value is one which is low enough to ensure that the smoke detector generates an alarm signal in the presence of a dangerous concentration of smoke, whilst being high enough to ensure that the smoke detector does not generate an unwanted alarm signal in the presence of a very low concentration of smoke, for example from a cigarette. As the battery ages, the light source emits light of a lower intensity. The preset light intensity threshold value will then no longer be optimal, and the smoke detector may fail to generate an alarm signal in the event of a fire.

[**003**] Fig. 1 shows the smoke detector 400 in cross section. The smoke detector 400 has a detecting chamber 430 into which smoke can enter and a compartment 420.

[**004**] The detecting chamber 430 accommodates: a light source 442; a light sensor 444, arranged to receive light from the light source 442 which has been scattered by smoke; and a light shield 440 arranged to prevent light from the light source 442 from being directly received by the light sensor 444. The light source 442 emits infrared light having a wavelength of 820 nanometres (820 nm). The light sensor 444 can sense light of this wavelength.

[**005**] The compartment 420 accommodates: a control unit 425 which is electrically connected to the light sensor 444 and arranged to generate a smoke alarm signal when the intensity of light sensed by the light sensor 444 exceeds a light intensity threshold value; a horn 424 for generating an audible warning in response to the smoke alarm signal; and a battery 422 for powering the smoke detector 400.

[**006**] The smoke detector further comprises: a control knob 410, mounted on the exterior of the compartment 420; a testing block 460 for scattering light; a guide 461 for guiding the testing block 460; a spring 462 for holding the testing block 460 in the guide 461; and a button 463 for pushing the testing block 460 into the detecting chamber 430.

[**007**] The control knob 410 is electrically connected to the control unit 425. The control unit 425 is arranged to sense the rotational position of the knob 410 and to set the light intensity threshold value as a function of the rotational position of the knob 410.

[**008**] The testing block 460 is a glass block in which reflective beads 465 are randomly distributed. The beads 465 scatter light in the same way as smoke particles. The testing block 460 scatters the same amount of light as smoke of the lowest concentration considered to be dangerous.

[**009**] Once a month, the light intensity threshold value can be optimised to compe for the effect of the battery aging by performing the following method steps. Firstly the control knob 410 is manually turned as far as possible in a clockwise direction so that the control unit 425 sets a maximum light intensity threshold value. Secondly the button 463 is pushed in the direction of the arrow A until the testing block 460 reaches the position shown with dashed lines in the detecting chamber 430. The intensity of light sensed by the light sensor 444 is less than the maximum light intensity threshold value, so no alarm signal is generated. Thirdly the control knob 410 is manually turned in an anticlockwise direction to reduce the light intensity threshold value, until it reaches a position at which an alarm signal is generated. When the control knob 410 reaches this position, the control unit 425 sets an optimal light intensity threshold value. Fourthly the button 463 is released and the spring 462 pushes the testing block 460 out of the detecting chamber 430 and the alarm signal is no longer generated.

[**010**] We are currently developing a smoke detector that will automatically carry out this optimisation process.

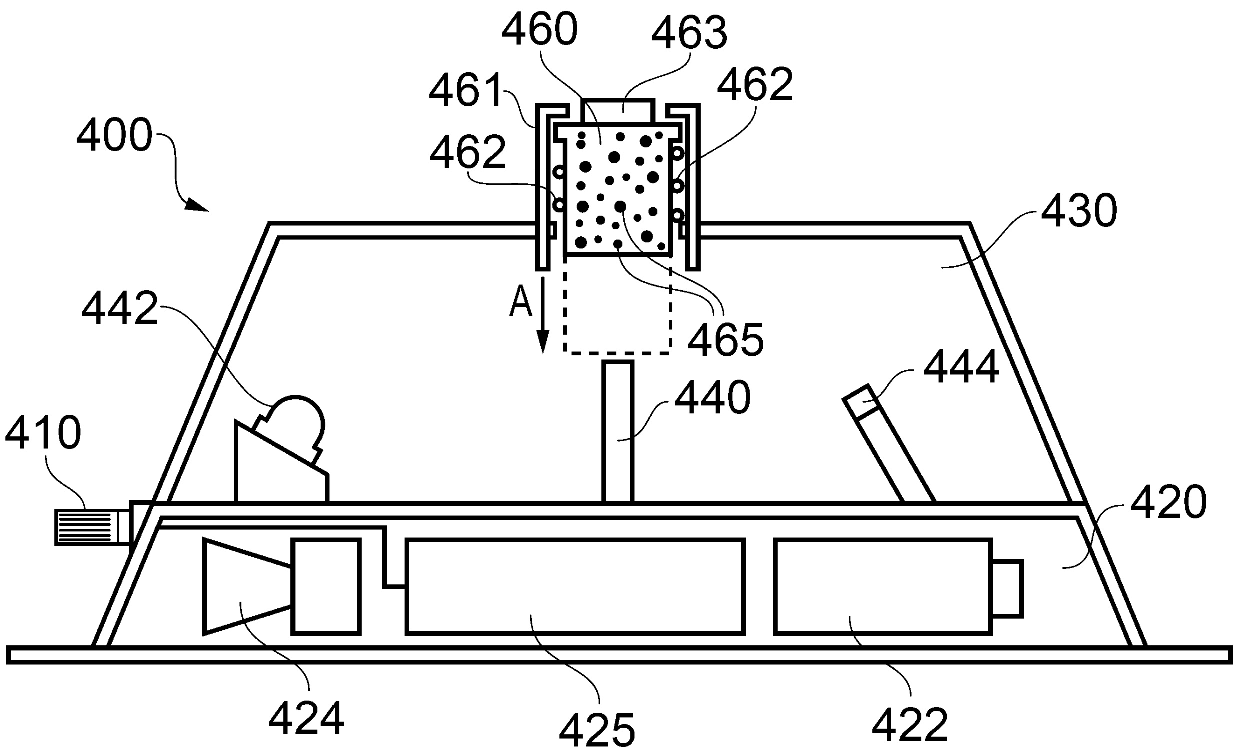

FIG. 1

Document D2

[**001**] This article describes a smoke detector that makes use of the light scattering effect. The smoke detector has a light source, a first light sensor arranged to indirectly receive light from the light source that has been scattered by smoke and a control unit arranged to generate a smoke alarm signal when the intensity of light sensed by the first light sensor exceeds a light intensity threshold value. The smoke detector can be fitted with a battery for powering the smoke detector. When a battery is not fitted, the smoke detector can be powered by mains electricity.

[**002**] Fig. 1 shows the smoke detector 500 in cross section when fitted with a battery 522. The smoke detector 500 has a detecting chamber 530 into which smoke can enter and a compartment 520.

[**003**] The detecting chamber 530 accommodates: a light source 542; a first light sensor 544, arranged to receive light from the light source 542 which has been scattered by smoke; and a light shield 540 arranged to prevent light from the light source 542 from being directly received by the first light sensor 544.

[**004**] The compartment 520 accommodates: a control unit 525 which is electrically connected to the light sensor 544 and arranged to generate a smoke alarm signal when the intensity of light sensed by the first light sensor 544 exceeds a light intensity threshold value; a horn 524 for generating an audible warning in response to the smoke alarm signal; the battery 522; a battery power monitoring circuit 528 for continuously monitoring the power capability of the battery; a signal-averaging filter 526; and a switch 527 that is automatically closed by fitting the battery 522 and opened by removing the battery.

[**005**] The smoke detector 500 further comprises a second light sensor 550 mounted on the exterior of the compartment 520, for receiving ambient light.

[**006**] The control unit 525 determines whether or not a battery is fitted by monitoring whether the switch 527 is open or closed. When the control unit determines that the smoke detector 500 is not fitted with a battery and the smoke detector is powered by mains electricity, the smoke detector is arranged so that the light source emits light of a higher intensity and the control unit sets a predetermined higher light intensity threshold value. When the control unit determines that the smoke detector is fitted with a battery, the smoke detector is arranged so that the light source emits light of a lower intensity and the control unit sets a predetermined lower light intensity threshold value. This makes the battery last longer than one year.

[**007**] However, when the battery is more than a year old, it becomes less capable of providing power and the intensity of the light emitted by the light source consequently reduces. When the battery is exhausted, the intensity of scattered light sensed by the first light sensor 544 will no longer exceed the predetermined lower light intensity threshold value in the event of a fire. Our smoke detector gives an audible warning to change the battery a few days before the battery is exhausted. So that no one sleeping near to the smoke detector is disturbed this audible warning should not be generated at night.

[**008**] The battery power monitoring circuit 528 generates a power signal representing the power capability of the battery 522. The control unit is electrically connected to the power monitoring circuit 528 and monitors the power signal. When the power signal is less than a power-threshold value, the control unit judges that the battery is nearly exhausted. The control unit then generates a low-battery alarm signal. The low-battery alarm signal activates the horn to generate an audible warning to change the battery.

[**009**] The second light sensor 550 senses ambient visible light and generates a si[illegible] representing the intensity of the ambient light sensed. The second light sensor 550 is electrically connected to the control unit 525 via the signal-averaging filter 526. The signal-averaging filter receives the ambient light intensity signal from the second light sensor 550, averages the signal over a period of one hour, and sends an averaged ambient light intensity signal to the control unit 525. During the night, the intensity of the ambient light is low and the control unit 525 receives a low level averaged ambient light signal. During the day, the intensity of the ambient light is high and the control unit 525 receives a high level average ambient light signal.

[**010**] The control unit 525 sets the power-threshold value lower or higher in proportion to a decrease or an increase in the averaged ambient light intensity signal, thereby automatically setting the power-threshold value as a function of the light intensity sensed by the second light sensor 550. Because the power-threshold value is set to be lower during the night, the smoke detector 500 rarely generates a low battery alarm signal at night.

[**011**] The signal-averaging filter 526 prevents the control unit 525 from immediately setting a higher power-threshold value when room lighting near to the smoke detector is turned on for a short period during the night.

[**012**] The light source 542 is chosen to emit infrared light at a wavelength that is between 800 and 1000 nm. The first light sensor 544 is chosen to sense light of the same wavelength.

[**013**] In humid environments, such as a kitchen, water droplets may condense on light source. The detecting chamber 530 is partly formed by a removable cover 532. Removing the cover 532 allows condensation droplets on the surface of the light source 542 to be wiped off. If these are not wiped off, the amount of light emitted from the light source 542 will be reduced, which could result in the smoke detector 500 failing to generate an alarm signal in the event of a fire. Because the smoke detector operates with infrared light it is not influenced by visible light and will still work with the cover permanently removed.

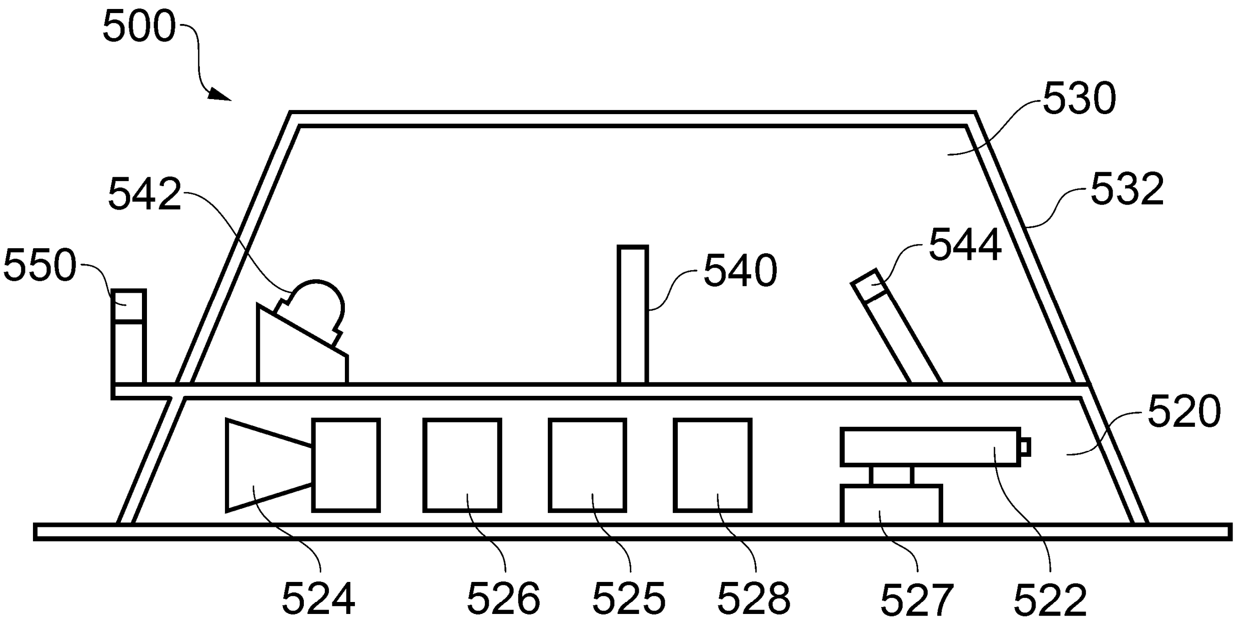

FIG. 1

<u>Document D3</u>

[**001**] This article describes a smoke detector that makes use of the light scattering effect. The smoke detector has a light source, a first light sensor arranged to indirectly receive light from the light source that has been scattered by smoke and a control unit arranged to generate a smoke alarm signal when the intensity of light sensed by the first light sensor exceeds a light intensity threshold value.

[**002**] If the light source fails, the smoke detector cannot generate a smoke alarm signal in the event of a fire. Our smoke detector generates an audible warning if the light source fails.

[**003**] Fig. 1 shows the smoke detector 600 in cross section. The smoke detector 600 has a detecting chamber 630 into which smoke can enter, and a compartment 620.

[**004**] The detecting chamber 630 accommodates: a light source 642; a first light sensor 644, arranged to receive light from the light source 642 which has been scattered by smoke; a light shield 640 arranged to prevent light from the light source 642 from being directly received by the first light sensor 644; and a second light sensor 650.

[**005**] The compartment 620 accommodates: a control unit 625 that is electrically connected to the first light sensor 644 and arranged to generate a smoke alarm signal when the intensity of light sensed by the first light sensor 644 exceeds a light intensity threshold value; a horn 624 for generating an audible warning in response to the smoke alarm signal; and a battery 622 for powering the smoke detector 600.

[**006**] The second light sensor 650 is arranged to receive light directly from the light source 642 and to sense the intensity of the received light. The second light sensor 650 physically contacts the light source 642 so that dirt cannot reduce the amount of light passing between the light source 642 and the second light sensor 650, as would be the case if they were separated by a gap.

[**007**] The control unit 625 is electrically connected to the second light sensor 650 and continuously monitors the intensity of light sensed by the second light sensor 650. When the intensity of light sensed by the second light sensor 650 falls below a light intensity threshold value, the control unit 625 judges that the light source 642 has failed. The control unit 625 then activates the horn 624 to generate an audible warning indicating that the light source 642 has failed. The faulty smoke detector 600 can then be repaired or replaced.

[**008**] The light source and the first and second light sensors all operate with infrared light having a wavelength of 850 nm.

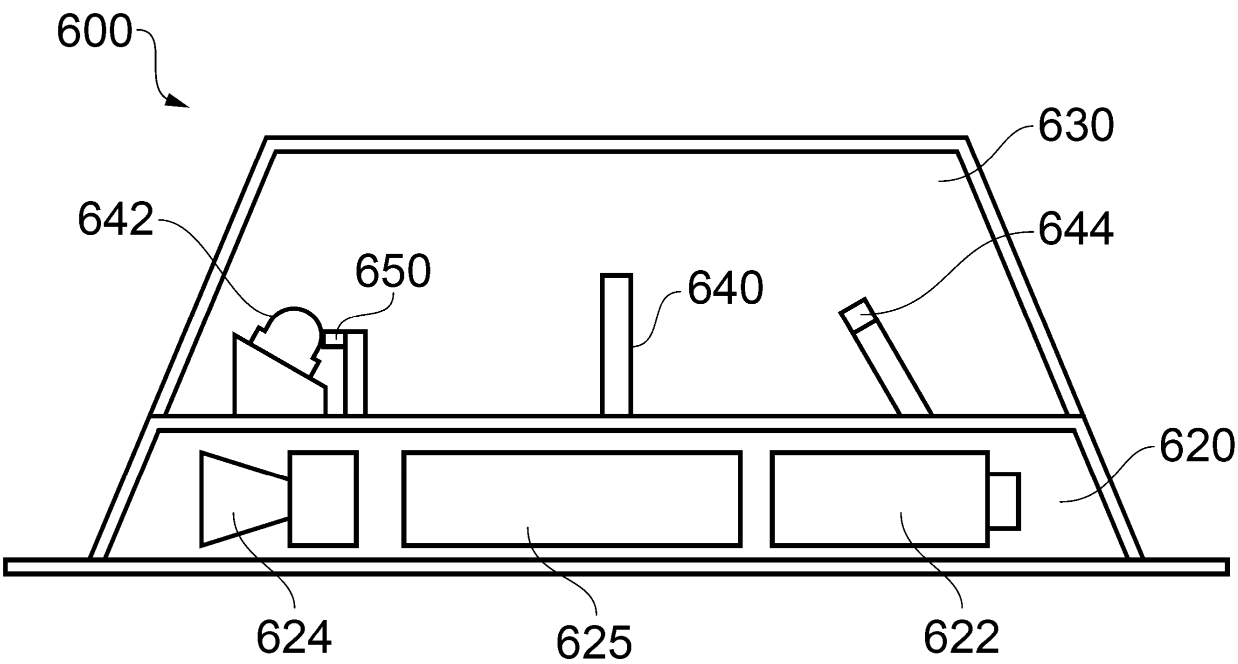

FIG. 1

Client's Letter

Dear Mr Soot,

We sell smoke detectors according to all the embodiments described in our application. Please reply to the official communication and file a new claim set which best protects our invention.

The examiner has raised a novelty objection against claim 1 of our application on the basis of D1. However we think that smoke detectors according to our invention are much better than the one described in D1 because ours do not need to be manually adjusted every month.

After we received the search report, our ex-employee, Mr Butch, filed claims 2 to 7 now on file. The only information Mr Butch gave us was that claim 2 had been amended, the wording of claims 3 and 4 had not changed and that claims 5 to 7 had been added as fall-back claims covering specific embodiments of our invention. Please make sure that you likewise file appropriate fall-back claims.

When we were developing smoke detectors according to the second embodiment, we found that, when the gap was less than 5mm, the concentration of smoke at which the smoke detector generated an alarm was always the same. When we tried to make the gap 5mm or greater, swirling smoke unpredictably and significantly influenced the intensity of light directly reaching the second light sensor from the light source. This made the smoke detector behave erratically. We solved this by using a signal averaging filter.

Smoke detectors according to the second embodiment of our invention operate consistently in environments where the humidity can change rapidly, such as a kitchen. These smoke detectors are more convenient to use than those that require condensation to be wiped off the light source, as suggested in D2.

Detectors according to the third embodiment do not work very well in environments where the humidity can change rapidly. However, as long as the gap between the light source and the second detector is at least 5mm, the gap does not have to be precisely predefined. We usually make the gap about 50mm; consequently these smoke detectors have the advantage that they are easy to assemble.

Regards,
D. Tector