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(12) # EUROPEAN PATENT APPLICATION

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(71) Applicant: **SECOM CO. LTD.**
Shinjuku Nomura Bldg. 26-2, Nishi-Shinjuku 1-chome
Shinjuku-ku
Tokyo(JP)

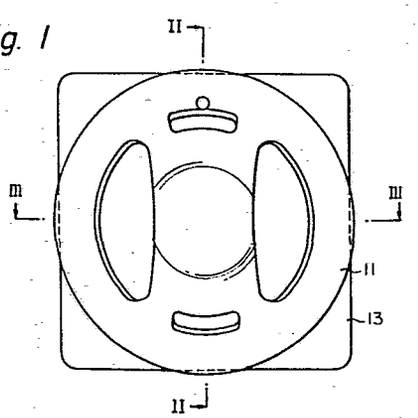
(72) Inventor: **Hanyu, Makoto**
26-106, Iribune Chuo Estate, 44-1 Urayasu-chuo
Higashikatsushika-gun Chiba-ken(JP)

(74) Representative: **George, Roger David et al,**
Raworth, Moss & Cook 36 Sydenham Road
Croydon Surrey CR0 2EF(GB)

(54) **A smoke detector.**

(57) A smoke detector, in which there is provided a light emitting portion (2) for throwing a beam of light onto smoke entering into the detector, and a light detecting portion (3) arranged to receive light having been scattered from particles of the smoke. The light emitting portion comprises a light source (5) and a light pervious sphere element (6a) permitting passage of a beam of light from the light source toward the smoke, while the light detecting portion comprises a light sensitive element (9), generating a smoke detection signal in response to the detection of the scattered light and a light pervious sphere element (6b) permitting passage of the scattered light toward the light sensitive element. In the case where invisible light, such as infrared rays, is employed, the light detecting means comprises a light selecting member.

Fig. 1



EP 0 021 671 A1

A SMOKE DETECTOR

FIELD OF THE INVENTION

The present invention relates to a highly sensitive device for achieving quick detection of smoke which is produced when a fire breaks out, and more particularly relates to an improvement in a smoke detector of the type in which the detection of smoke is carried out through the detection of light scattered by particles of smoke.

BACKGROUND OF THE INVENTION

There is a conventional smoke detector of the above-mentioned type in which a beam of light is thrown on smoke which has entered into the detector so that the beam of light is scattered by particles of the smoke, and in which the scattered light is detected by a photo-electric element which generates an alarm signal indicative of the detection of the smoke. However, in the conventional smoke detector, when a beam of light is thrown on thin smoke which is often produced during an initial stage of a fire, only a small part of the beam of light is scattered by particles of the thin smoke. As a result, the scattered light is so weak that the intensity of the light is at most, for example, several thousandths lux. On the other hand, when the conventional smoke detector is arranged at a place where the smoke detection should be carried out, the surrounding light can be so strong that the intensity of the light is several hundreds luxes. Furhter, when the smoke detector is directly exposed to the sun light, the intensity of the surrounding light is high, up to several ten thousands luxes. Therefore, the conventional smoke detector has, inside thereof, a very complicated dark chamber to permit entrance of air into the chamber, but not to permit entrance of the surrounding light. The Japanese laid-open utility model application No. 54(1979)-29078 or No. 54(1979)-12390 discloses such a complicated dark chamber to be provided for the conventional smoke detector. As a result, the physical structure of the conventional smoke detector is very

complex, and the size of the detector must be large. In addition, the manufacturing cost of the detector is high. Moreover, since the complicated dark chamber of the conventional smoke detector usually makes it difficult to permit the entrance of slowly moving smoke into the chamber, the conventional smoke detector often fails to achieve reliable detection of smoke which is produced during the initial stage of a fire.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an improvement for the conventional smoke detector, so that the above-mentioned drawbacks are entirely eliminated.

Another object of the present invention is to provide a highly sensitive smoke detector capable of achieving quick detection of smoke which is produced during the initial stage of a fire.

A further object of the present invention is to provide a smoke detector having not only a dark chamber of a simple structure, but also a high signal to noise ratio (S/N ratio) which is defined as a ratio of the outputs of the detector in the case where the entrance of smoke to be detected into the detector takes place and in the case where no entrance of smoke into the detector takes place.

The above and other objects and advantages of the present invention will be made apparent from the ensuing description of a preferred embodiment of the present invention with reference to the accompanying drawings wherein:

Fig. 1 is a top plan view of a smoke detector according to an embodiment of the present invention;

Fig. 2 is a cross-sectional view taken along the line II-II of Fig. 1;

Fig. 3 is a cross-sectional view taken along the line III-III of Fig. 1;

Fig. 4 is a plan view, in part cross-section, of a smoke detector shown in Figs. 1 through 3, and;

Fig. 5 is the identical view to Fig. 2 but

illustrating a detailed arrangement of a smoke detection unit incorporated in the detector shown in Figs. 1 through 4.

DESCRIPTION OF AN EMBODIMENT

Referring to the drawings, an optical unit 1 incorporates therein a light emitting portion 2 and a light receiving or detecting portion 3 of a smoke detector according to an embodiment of the present invention. The optical unit 1 is mounted on a base plate 4. The light emitting portion 2 of the optical unit 1 is provided with a beam source 5 for emitting a beam of light, a spacer member 10a for supporting the beam source 5 and for determining an angle of emission of the beam of light, and a light pervious sphere element 6a. The beam source 5 may be, for example, a light emitting diode, usually referred to as an LED element. An outlet opening 7a, having a diameter slightly smaller than the diameter of the sphere element 6a, is formed in an end face of the light emitting portion 2. Therefore, the light emitting portion 2 emits a beam of light through the outlet opening 7a toward the outside of the light emitting portion 2. A flange piece 8 extends from a part of the periphery of the outlet opening 7a toward the outside of the opening 7a. The flange piece 8 is provided for preventing the beam of light emitted by the beam source 5 from directly entering into the light detecting portion 3. The beam source 5 of the light emitting portion 2 is generally comprised of a semi conductor light source, such as the above-mentioned LED. However, many other light sources, such as a visible light radiation element, an infrared rays radiation element, an ultraviolet rays radiation element and a white light emitting lamp may also be employed, as required.

The light detecting portion 3 is arranged adjacent to and at a right angle with the light emitting portion 2, via a space into which the beam of light is emitted from the light emitting portion 2. The light detecting portion 3 is formed with a light inlet opening 7b, and is provided with a

light pervious sphere element 6b having a diameter slightly larger than that of the light inlet opening 7b, a spacer member 10b, and a light sensitive element, such as a photo-electric element 9. The spacer member 10b supports the sphere element 6b and has an opening through which a light, having been scattered from particles of smoke entering into the above-mentioned space, passes at a predetermined converging angle toward the light receiving surface of the photo-electric element 9. Therefore, the beam of light emitted from the beam source 5 passes through the spacer member 10a, the sphere element 6a and the light outlet opening 7a of the light emitting portion 2, and is thrown on smoke which enters into the smoke detector. As a result, the beam of light is scattered from particles of the smoke. The scattered light then enters into the light detecting portion 3 through the inlet opening 7b. Thus, in the light detecting portion 3, the detection of the smoke is carried out through the detection of the scattered light. It should be understood that the light pervous sphere elements 6a and 6b are sphere bodies, respectively, made of a plastic material or glass. The spherical shape of the light pervious sphere element 6a is very advantageous for assembling the light emitting portion 2, since it is very easy to align the central axis of the beam source with the optical axis of the sphere element 6a. Further, since the light pervious sphere elements 6a and 6b can be used, as an optical element having a small optical caliber and a short focal distance, the optical unit 1 incorporating therein the light emitting portion 2 and the light detecting portion 3 can be a very close assembly. Therefore, it is possible not only to acquire strong scattered light from introducing smoke into a space adjacent to the light outlet opening 7a of the light emitting portion 2, but also to direct the strong scattered light into the light detecting portion 3. As a result, even if the smoke is thin, it is ensured that the detection of the smoke is accurate and reliable.

The above-mentioned optical unit 1 mounted on the base

plate 4 is housed in a housing 13 and a top covering 11 attached to the top of the housing 13. The top covering 11 prevents the surrounding light from entering into a dark chamber which is formed inside the top covering 11. At this stage, it should be appreciated that, as stated above, since the optical unit 1 is a very close assembly in which the detection of smoke is achieved with certainly through the detection of strong scattered light, complete prevention of the entrance of the surrounding light into the smoke dtector is not necessary. This fact contributes to simplifying the structure of the dark chamber formed inside the top covering 11. Therefore, in the smoke detector of the embodiment shown in Figs. 1 through 5, simple light block plates 12a and 12b are arranged inside the top covering 11, so that sun beams are not permitted to directly enter into the dark chamber. The simple structure of the dark chamber is very advantageous for enabling smoke to easily enter into the dark chamber. Therefore, the smoke detector can be a highly sensitive smoke detecting device. As shown in Figs. 3 through 5, the pair of light blocking plates 12a arranged on opposite sides of the optical unit 1, are effective for preventing the surrounding light or sun beams from directly entering into the dark chamber through the large smoke entrance bores 11a formed in the top covering 11. The light blocking plate 12b is effective for preventing the surrounding light from directly entering into the dark chamber through a small smoke entrance bore 11b formed in the top covering 11. However, as shown best in Fig. 5, the light blocking plate 12b is also effective for preventing the beam of light emitted from the light emitting portion 2 from entering into the light detecting portion 3 after the beam of light have been reflected from an inner surface of the top covering 11. That is, the plate 12b absorbs the beam of light reflected from the inner surface of the top covering 11.

Referring now to Figs. 2 and 3, the smoke detector is provided with a conventional electric amplifier 14

electrically connected to the photo-electric element 9. The amplifier 14 amplifies electrical smoke detection signals coming from the photo-electric element 9 of the light detecting portion 2. The amplified signal is then used for actuating alarm devices (not shown) or fire extinguishing devices (not shwon).

The description will now be provided hereinafter with respect to an embodiment of the smoke detector in which the beam source 5 of the light emitting portion 2 emits a beam of light having wave lengths except for wave lengths of visible lights. That is, the beam source 5 emits infrared rays or ultraviolet rays. One typical example of the beam source 5 may be comprised of an infrared light emitting diode (LED) which emits infrared rays having a peak wave length of 9400 Å. Therefore, the light detecting portion 3 employs a light selecting element which permits passage therethrough of only the above-mentioned infrared rays. As one typical example of the light selecting element, a filter member 15 (Fig. 5) is used for blocking light having wave lengths less than 9200 Å, and is arranged adjacent to the light inlet opening 7b. In another example of the light selecting element, the photo-electric element 9 per se used as a light sensitive element may be comprised of a certain selected photo-electric element responsive to light having a preselected wave length. In a further example of the light selecting element, the light pervious sphere element 6b may be made of material which has the same filtering effect as the above-mentioned filter member 15. Moreover, the filter member 15 may be arranged between the photo-electric element 9 and the light pervious sphere element 6b.

When the infrared rays are emitted from the beam source 5 of the light emitting portion 2, the infrared rays are scattered by smoke entering into the dark chamber of the smoke detector. Then, with the scattered infrared rays, the ray components having wave lengths of 9200 Å or more are permitted to enter into the light detecting portion 3 through the filter member 15. Therefore, the light

detecting portion 3 is not affected by visible light, including the surrounding light of the detector. As a result, S/N ratio of the smoke detector can be very high. Consequently, the smoke detector can have a high smoke detection performance without erroneous operation. Further, since the structure of the dark chamber formed inside the top covering 11 is very simple, smoke is able to easily enter into the dark chamber. Therefore, quick detection of smoke is ensured by the smoke detector of the present invention. At this stage, it should be noted that in the case where invisible light, such as infrared rays or ultraviolet rays are employed, the top covering 11 may be eliminated.

While the described embodiment represents a preferred form of the present invention, it is to be understood that some modifications will occur to those skilled in the art without departing from the spirit of the invention.

CLAMS

1. A smoke detector, comprising:

a light emitting means for throwing a beam of light onto smoke entering into the detector, said light emitting means comprising a light source and a light pervious sphere element permitting passage of a beam of light from the light source toward the smoke, and;

a light detecting means arranged to receive light having been scattered from particles of said smoke, said light detecting means comprising a photo-electric element generating a smoke detection signal in response to detection of said scattered light, and a light pervious sphere element permitting passage of said scattered light toward said photo-electric element.

2. A smoke detector according to Claim 1, further comprising means for preventing direct passage of a beam of light from said light emitting means to said light detecting means.

3. A smoke detector according to Claim 2, wherein said preventing means comprises a flange piece extending from an outer opening of said light emitting means toward a position adjacent to an entrance opening of said light detecting means.

4. A smoke detector according to Claim 1, wherein said light detecting means further comprising a light selecting element for passing, through said light detecting means, light components of said scattered light having wave lengths other than those of visible light.

5. A smoke detector according to Claim 4, further comprising means for preventing direct passage of a beam of light from said light emitting means to said light detecting means.

6. A smoke detector according to Claim 5, wherein said preventing means comprises a flange piece extending from an outer opening of said light emitting means toward a position adjacent to an entrance opening of said light detecting means.

7. A smoke detector according to Claim 1, further comprising means for covering said light emitting means and said light detecting means, and a light blocking means for preventing said beam of light coming from said light emitting means from entering into said light detecting means after being reflected from an inner surface of said covering means.

8. A smoke detector according to Claim 7, wherein said covering means comprises a housing for said light emitting means and said light detecting means, and a top covering mounted on said housing, said housing and said covering defining therein a dark chamber.

9. A smoke detector according to Claim 8, wherein said light blocking means comprises light block plates formed as one part of said top covering.

10. A smoke detector according to any one of Claims 7 through 9, further comprising means for preventing direct passage of a beam of light from said light emitting means to said light detecting means.

11. A smoke detector according to Claim 10, wherein said preventing means comprises a flange piece extending from an outer opening of said light emitting means toward a position adjacent to an entrance opening of said light detecting means.

12. A smoke detector, comprising:

a light emitting means for illuminating smoke entering into the detector;

a light detecting means arranged to receive light having been scattered from said smoke, said light detecting means comprising a light sensitive element capable of generating a smoke detection signal upon receipt of said scattered light, and a light selecting means for passing, through said light detecting means, invisible components of said scattered light which have wave lengths other than those of visible light.

13. A smoke detector according to Claim 12, wherein said light emitting means comprises a light source capable

of emitting a beam of light having wave lengths that include no wave lengths of visible light.

14. A smoke detector according to Claim 13, wherein said light source comprises an infrared light emitting diode.

15. A smoke detector according to Claim 12, wherein said light selecting means of said light detecting means comprises a filtering element arranged at an entrance opening of said light detecting means.

16. A smoke detector according to Claim 12, wherein said light sensitive element comprises a photo-electric element capable of generating an electric signal upon receipt of only light having wave lengths that include no wave lengths of visible light, said photo-electric element operating as said light selecting means.

17. A smoke detector according to Claim 12, wherein said light selecting means comprises a filter member positioned ahead of and arranged so as to be integral with said light sensitive element.

18. A smoke detector according to Claim 12, wherein said light selecting means comprises a sphere lens element having a filtering effect to pass therethrough said invisible components of said scattered light.

19. A smoke detector according to Claim 12, wherein said light emitting means and said light detecting means are arranged so as to be exposed to the atmosphere without being covered by any covering means.

Fig. 1

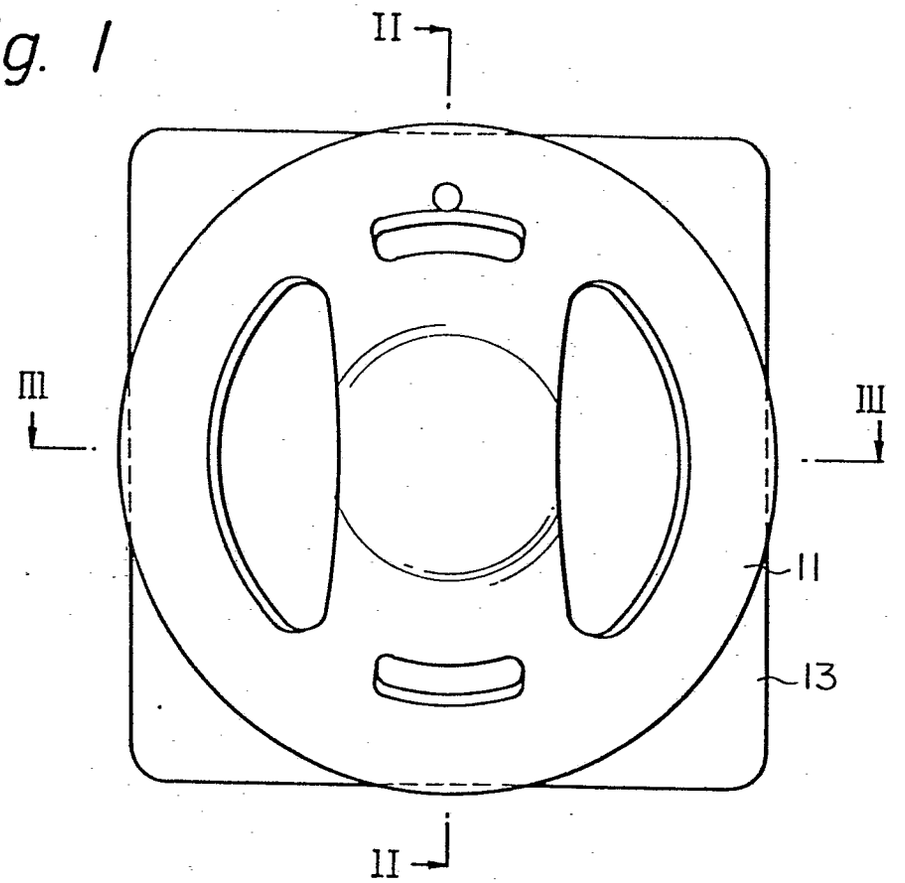


Fig. 2

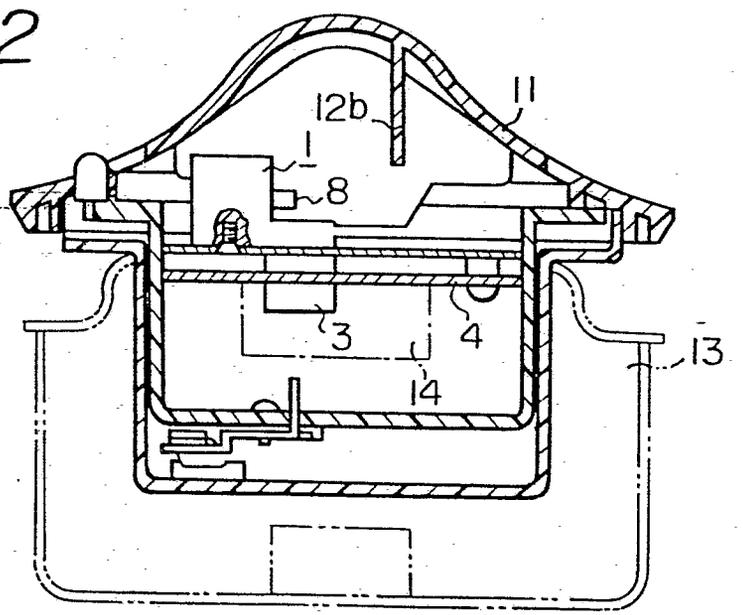


Fig. 3

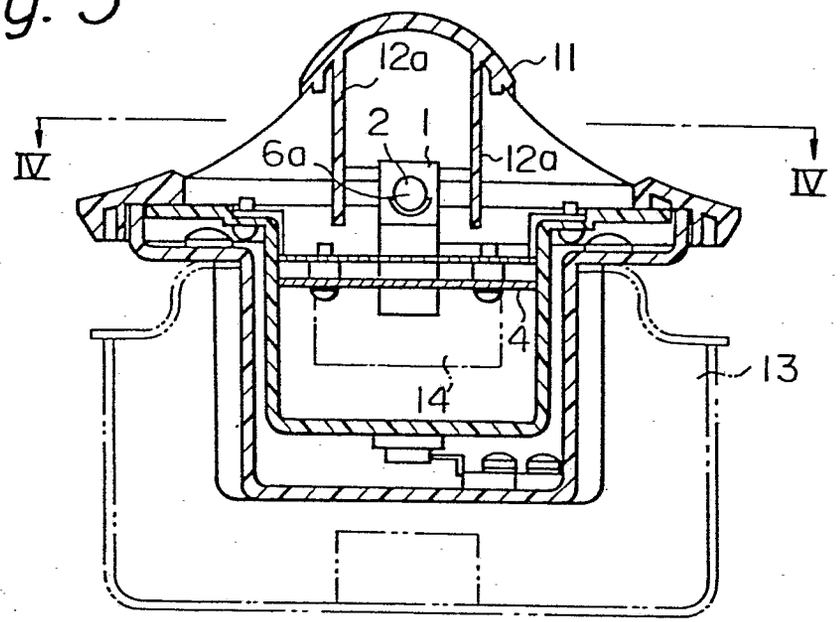


Fig. 4

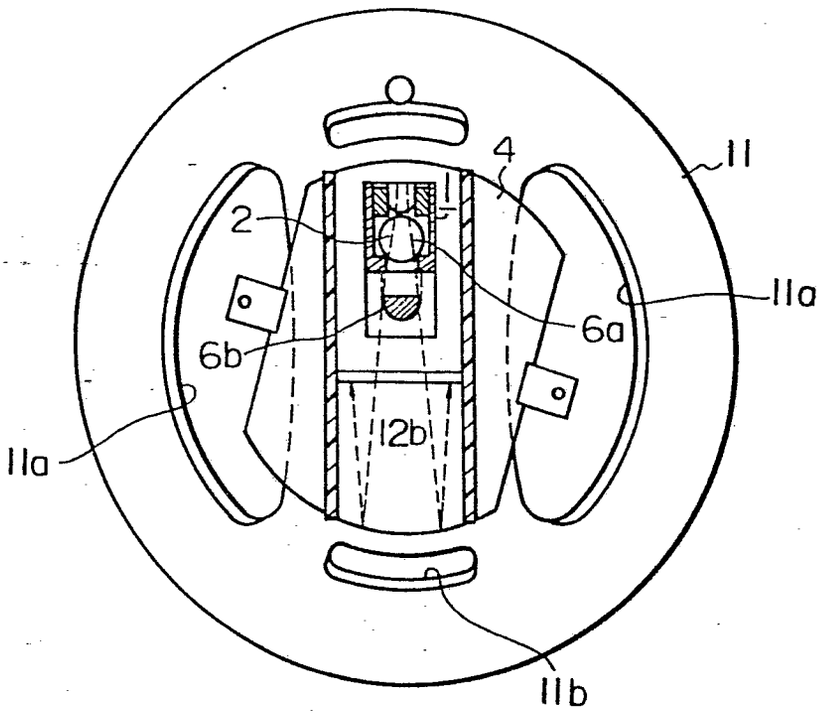
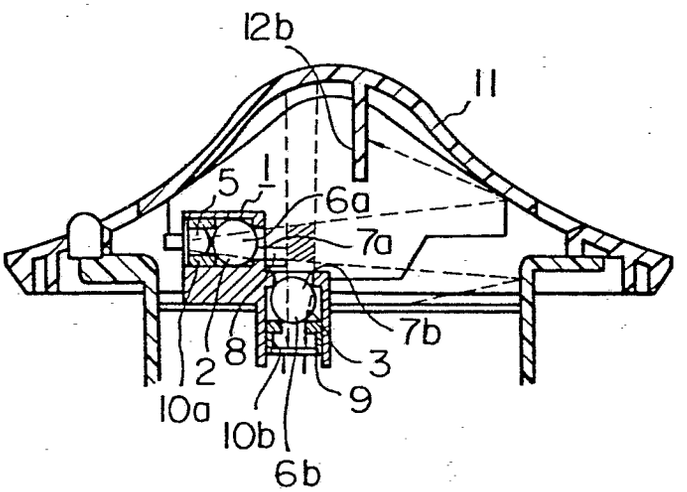


Fig. 5



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EUROPEAN SEARCH REPORT

Application number
EP 80 30 1890

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	FR - A - 2 141 655 (ELECTRO SIGNAL LAB.) * Page 1, lines 1-10; page 3, line 27 - page 5, line 4 *	1-3,12
	US - A - 4 129 383 (MALINOWSKI) * Column 1, lines 6-17; column 2, lines 19-65; column 3, lines 30-68; column 5, lines 3-16; figure 2 *	1-3,7, 8,10-12,19
	US - A - 3 882 477 (MUELLER) * Column 2, lines 12-20; column 3, lines 10-22; column 7, lines 31-61 *	1-7, 10-14, 16
	US - A - 3 916 209 (STEELE) * Column 1, lines 39-55; column 3, line 12 - column 4, line 13 *	1-3,7-10

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
G 08 B 17/10

TECHNICAL FIELDS SEARCHED (Int. Cl.³)
G 08 B 17/10

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	08-10-1980	ORNELIS