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(54) **Protective helmet with rearview optical system**

(57) A helmet (1) is described, within the thickness of which an optical duct (7X, 7Y) is formed which conveys an image of the scene behind the person wearing the helmet to a front reflective element (17) and from the

latter to the wearer's eye. This offers the possibility of seeing behind the helmet without the need to attach rearview mirrors to the vehicle and without the wearer having to turn his head.

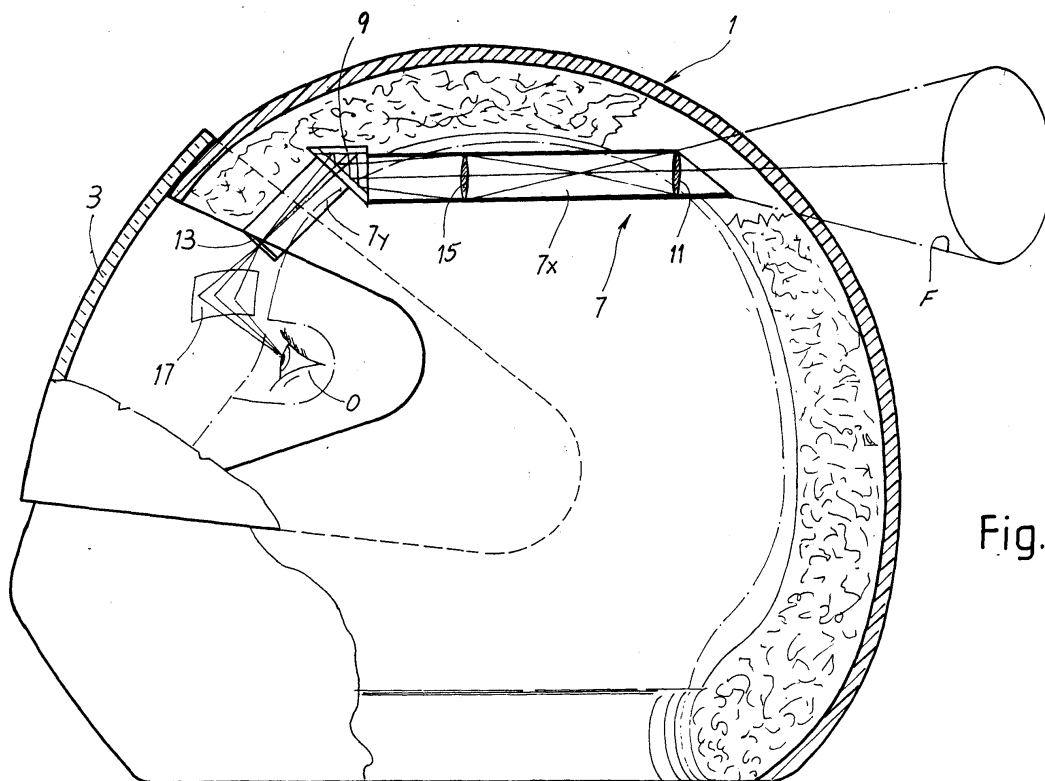


Fig.6

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Description

[0001] The present invention relates to a rearview optical system for protective helmets, in particular for helmets used by cyclists, motorcyclists, drivers and the like, whether in the amateur or sporting and competitive fields, and more particularly for helmets fitted with a visor.

[0002] There are, at the current time, no reliable and practical rearview systems for motorcycle or similar helmets. US-A-3,804,495 discloses a rearview system based on a set of reflective mirrors. This system is bulky since it is attached to the exterior of the helmet, and more specifically on top of a fixed visor projecting from the helmet. A rearview system of this type is not only impractical, but also does not comply with current safety standards which prohibit the presence of projecting objects on protective helmets.

[0003] It is current practice, therefore, to attach small rearview mirrors to the handlebars of vehicles (especially bicycles and motorcycles). These mirrors are expensive, break easily in the event of an accident, are a source of danger in that they project from the handlebars and are completely ineffective since it is still difficult to get a clear rear view, especially for anyone wearing an integral helmet.

[0004] The subject of the present invention is a new rearview system for protective helmets used by motorcyclists, drivers or the like, that does not have the drawbacks of conventional systems.

[0005] More specifically, one object of the present invention is to provide an optical system and a protective helmet which comply with safety standards for protective helmets.

[0006] A further object of the present invention is to provide a helmet with a rearview optical system which allows a comfortable, safe and reliable view of the scene behind and which at the same time does not obstruct the view of the scene in front and does not adversely affect the safety characteristics of the helmet.

[0007] Yet another object of the present invention is to provide a helmet that does away with the need for rearview mirrors on vehicles, these mirrors often being expensive, ineffective and fiddly, if not downright dangerous given that they are attached to the vehicle handlebars.

[0008] These and other objects and advantages, which will be apparent to those skilled in the art on reading the following text, are obtained with a protective helmet comprising at least one optical path within its thickness, along which an image of the scene behind the wearer is conveyed towards the wearer's eye. In this way, given that the entire optical path remains within the thickness of the helmet, there are no projections that can be dangerous or that can actually contravene safety standards.

[0009] According to a particularly advantageous embodiment, the optical path comprises: a duct or channel

with a rear aperture and a front aperture and, located within said rear aperture, a lens. A visor and an optical element which is integral with the visor and which reflects the image coming from the front aperture of the duct toward the wearer's eye, are also provided.

[0010] The reflective optical element can consist of a small mirror, optionally a flat mirror, attached to the visor. Alternatively, the reflective optical element can consist of a diffractive element which follows the curvature of the visor and which correspondingly corrects the phase of light radiation received so as to allow an accurate view. The dimensions of the reflective optical element are such that the amount of light entering from the outside and passing through the visor is kept within current legislative limits.

[0011] The optical element is preferably built into the visor, i.e. it is molded from the same material that forms the visor itself, not least in order to do away with any additional elements that may constitute a danger to the person wearing the helmet. This means that the helmet contains no elements which, in the event of an accident, could become detached from the visor and endanger the person wearing the helmet. Furthermore, making the optical element an integral part of the visor also helps to reduce production costs.

[0012] By forming the visor and, consequently, the diffractive element in a suitable manner, it is also possible to produce a visor which is capable of correcting slight degrees of ametropia.

[0013] The helmet can have a single optical path or two symmetrical or asymmetrical optical paths corresponding to both of the wearer's eyes.

[0014] Additional advantageous embodiments and features of the helmet and of its associated optical parts are given in the appended dependent claims.

[0015] A better understanding of the invention will be gained by following the description and the appended drawing which shows a practical and non-limiting embodiment of said invention. In the drawing:

Fig. 1 is a front view of a helmet, with the visor removed;

Fig. 2 is a front view similar to Fig. 1, but with the visor mounted in the closed position;

Figs 3, 4 and 5 show two sections on III-III and IV-IV and a view on V-V in Fig. 2, with the visor having been omitted in Fig. 5 for the sake of clarity;

Fig. 6 shows an optical diagram in a cross section similar to the section shown in Fig. IV-IV;

Fig. 7 is a diagrammatic perspective view of a diffractive reflecting element attached to the visor; and Fig. 8 is a diagram illustrating the working principle of a diffractive reflecting element.

[0016] The helmet, given the general reference 1, has a front opening 2 which gives a view of the scene in front and is covered by a visor 3 which is hinged to the helmet at 4 but is omitted in Figs 1 and 5 for the sake of clarity.

The helmet, consisting of an outer shell 5A and padding 5B, contains within its thickness a duct or channel 7 which defines an optical path. The optical path has an entry point formed by a rear aperture 7A in the duct 7 and a front aperture 7B, formed in the top edge of the front opening 2 of the helmet. The optical path 7 is laterally offset with respect to the center line of the helmet 1.

[0017] The channel defining the optical path 7 advantageously has very small dimensions, for example its circular cross section has a radius of 5-7 mm. In this way, as well as not projecting beyond the outer profile of the helmet, the optical path also does not weaken the structure of the helmet and does not, therefore, adversely affect its safety in the event of an accident.

[0018] As can be seen in particular in Fig. 4, the optical path 7 consists of two straight portions, denoted 7X and 7Y, which are inclined with respect to each other and between which there is an optical deflecting element, consisting in the example illustrated of an optical prism 9 but which could also be formed by a mirror. In addition, positioned in the rear aperture 7A and in the front aperture 7B are a lens and an ocular, shown in greater detail in the optical diagram in Fig. 6 and denoted therein by the reference numerals 11 and 13 respectively. An additional lens 15 is inserted along the portion 7X of the optical path 7. The optical path 7 can advantageously be formed by a duct or by duct portions made of sufficiently rigid rubber and inside which the optical components - more specifically the lens 11, the ocular 13 and the lens 15 - are inserted. In this way, in the event of an accident, the rubber duct collapses and retains the lenses within itself, thereby avoiding any risk to the person wearing the helmet. Any material with a suitable degree of deformability can be used instead of rubber to achieve the same function of being squashed and retaining the lenses within itself.

[0019] In order to afford even greater safety, the optical components 11, 13, 15 could also be soft. The optical prism 9 (and possibly also the other optical components along the path 7) can consist, in a manner known per se, of external walls made from a friable and transparent material and containing a transparent liquid. In this way, if there is a collision, the prism shatters but does not form splinters which would be dangerous for the person wearing the helmet.

[0020] Positioned on the visor 3, opposite the front aperture 7B of the optical path 7, is a reflective optical element 17 which can consist of a flat mirror or, preferably, of a diffractive optical element advantageously molded in the same material as the visor 3. Since the surface of the visor 3 is curved, the diffractive optical element 17 is capable of correcting the phase of the optical beam conveyed from the scene at the rear, via the lenses positioned along the path 7 and onto the surface of said diffractive optical element 17. All the optical components 11, 13, 15, 17 are calculated so that the wearer's eye receives a focused image of the scene behind him.

[0021] The way in which the optical system works is schematically illustrated in the diagram shown in Fig. 6; the optical beam F coming from the scene behind the person wearing the helmet is collimated by the lens 11 and is conveyed through the optical path 7 to the ocular 13. From here, the wave front is reflected by the diffractive element 17 located on the visor 3 toward the eye O of the person wearing the helmet 1. Since the surface of the visor 3 is curved, the diffractive element 17 has to correct the phase of incident light so that each point on the incident wave front is in phase with the corresponding point on the wave front reflected by the diffractive element 17 toward the eye O.

[0022] The working principle of the element 17 is schematically illustrated in Fig. 8: a and b denote the incident and reflected waves respectively and P denotes a given pixel (surface element) on the diffractive element 17. The diffractive element 17 introduces a phase difference $\Delta\Phi$. This phase correction is achieved in a manner known per se, by means of a surface which forms the diffractive element 17 and the microscopic profile of which has variations in level linked to the phase difference to be controlled. Fig. 7 schematically shows a surface structure of this type on a greatly enlarged scale.

[0023] The diffractive element 17 is made by cutting a negative image of the profile of the diffractive element into a metal surface and then using said metal surface as part of the mold into which the resin used to form the visor 3 is injected. In this way the diffractive element 17 is made integrally with the visor. Alternatively, the diffractive element 17 can be produced on a thin plate which is then attached to the internal surface of the visor 3.

[0024] Although the example illustrated shows only one optical path 7, it is clearly also possible to have two symmetrical or asymmetrical paths in which the diffractive elements 17 are placed in front of both of the wearer's eyes. In particular, an optical path can be provided on the left-hand side of the helmet (the left-hand side of the person wearing it), which offers a rear/lateral field of view, i.e. with the lens positioned further to the side. This optical path gives the wearer an extensive view of the rear and side where overtaking takes place and is particularly useful in competition motorcycle helmets.

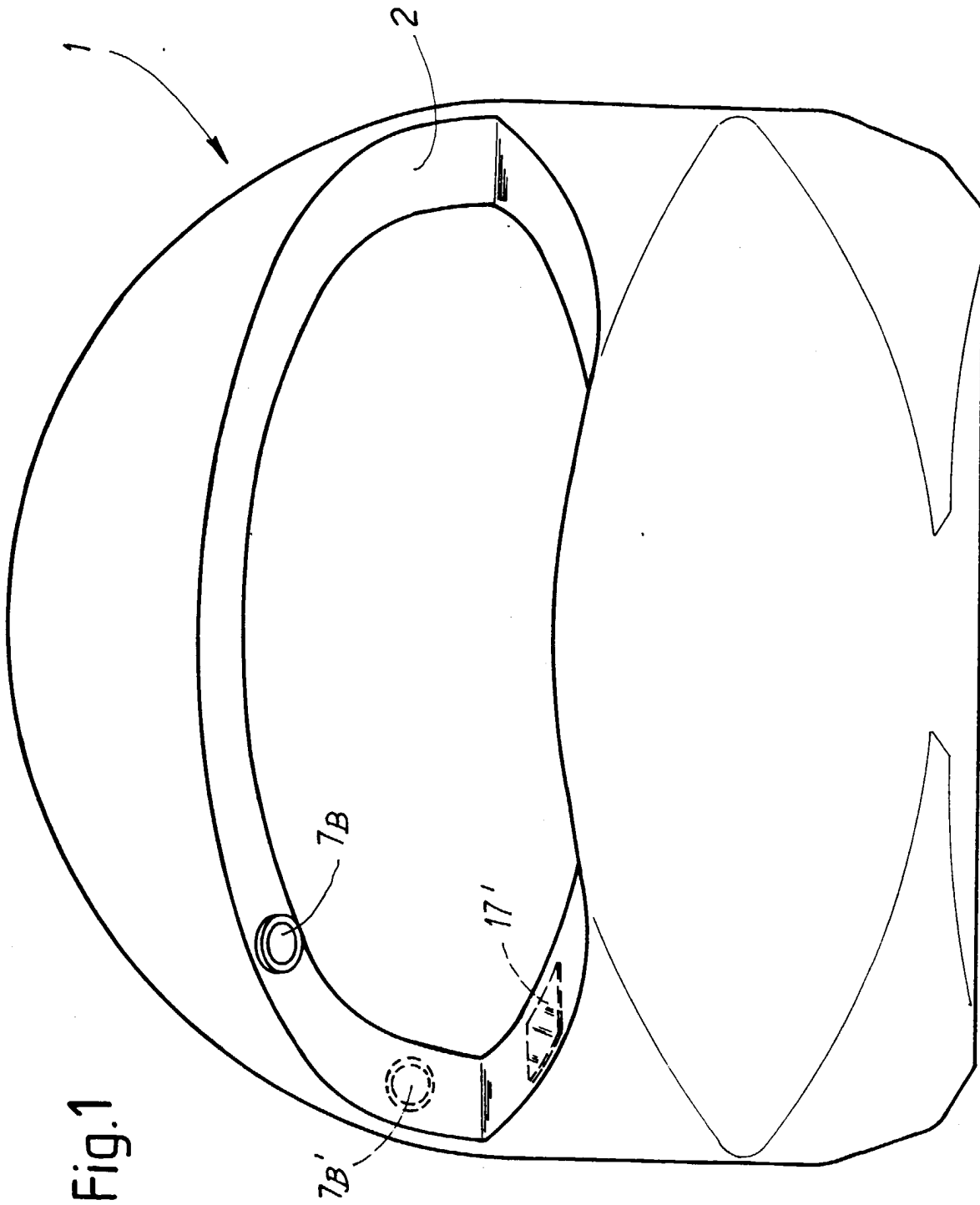
[0025] In the example described above, the optical path 7 is located in the top of the helmet. However, in an especially advantageous variant embodiment, this path can also be located at a lower level, for example at the same height as the visor hinge axle. In this case the already negligible effect that the presence of this path can have on the mechanical strength of the helmet is even further reduced. What is more, by placing the path lower down, the ocular 7B can be positioned closer to the bottom of the front part of the helmet, i.e. closer to the so-called chinguard - in other words that part of the helmet designed to protect the wearer's chin. In this way, the reflective optical element can be placed on the chin-

guard instead of on the visor. A solution of this type is schematically illustrated in dash lines in Fig. 1, in which the alternative position of the ocular is denoted 7B' and the alternative position of the reflective optical element is denoted 17'. This arrangement offers the following advantages: the reflective optical element does not reduce the amount of light passing through the visor; the reflective optical element can be made as a removable accessory which is housed in a suitable seat in the chin-guard of the helmet; the rearview system works even when the helmet is used with the visor open.

[0026] Needless to say, the drawing shows only one practical embodiment of the invention which may vary in its forms and arrangements without thereby departing from the scope of the concept on which said invention is based. The purpose of any reference numerals in the appended claims is to facilitate reading thereof in the light of the preceding description and of the appended drawings but does not limit the scope of protection.

Claims

1. A protective helmet comprising at least one optical path within its thickness, along which an image of the scene behind the wearer is conveyed towards of the wearer's eye.
2. Helmet according to claim 1, in which said optical path comprises: a duct with a rear aperture and a front aperture; a lens located within said rear aperture; an ocular located within said front aperture; and a reflective optical element in front of said ocular, positioned so as to reflect the image coming from said ocular toward the eye of the person wearing the helmet.
3. Helmet according to claim 2, comprising a visor and in which said reflective optical element is integral with said visor.
4. Helmet according to claim 3, in which said optical element integral with the visor is a diffractive element.
5. Helmet according to claim 4, in which said diffractive element is made integrally with and in the same material as the visor.
6. Helmet according to one or more of the preceding claims, in which said duct contains an optical deflecting element which deflects the beam coming from said lens toward said ocular, the duct having at least two portions which are inclined with respect to each other and between which the optical deflecting element is located.
7. Helmet according to one or more of the preceding claims, in which said optical path is defined by at least one duct made from a deformable material which becomes squashed in the event of a collision and retains the optical components located along the optical path within itself.
8. Helmet according to at least claim 2, in which said lens and said ocular are made of soft lenses.
9. Helmet according to at least claim 4, in which said optical deflecting element is a prism made from a liquid material contained within friable transparent walls.
10. Helmet according to one or more of the preceding claims, in which two optical paths are provided for both of the wearer's eyes.
11. Helmet according to claim 10, in which said optical paths are asymmetrical, one of them giving an at least partial side view.
12. Helmet according to at least claim 2, in which the front aperture of said duct is located within the thickness of the material constituting the helmet, along an opening in the front of the helmet which is closed by the visor.
13. Helmet according to at least claim 2, in which said reflective optical element is secured to the helmet.
14. Helmet according to claim 12 and 13, in which said reflective optical element is attached to the chin-guard of the helmet, in the vicinity of the opening closed by the helmet visor.



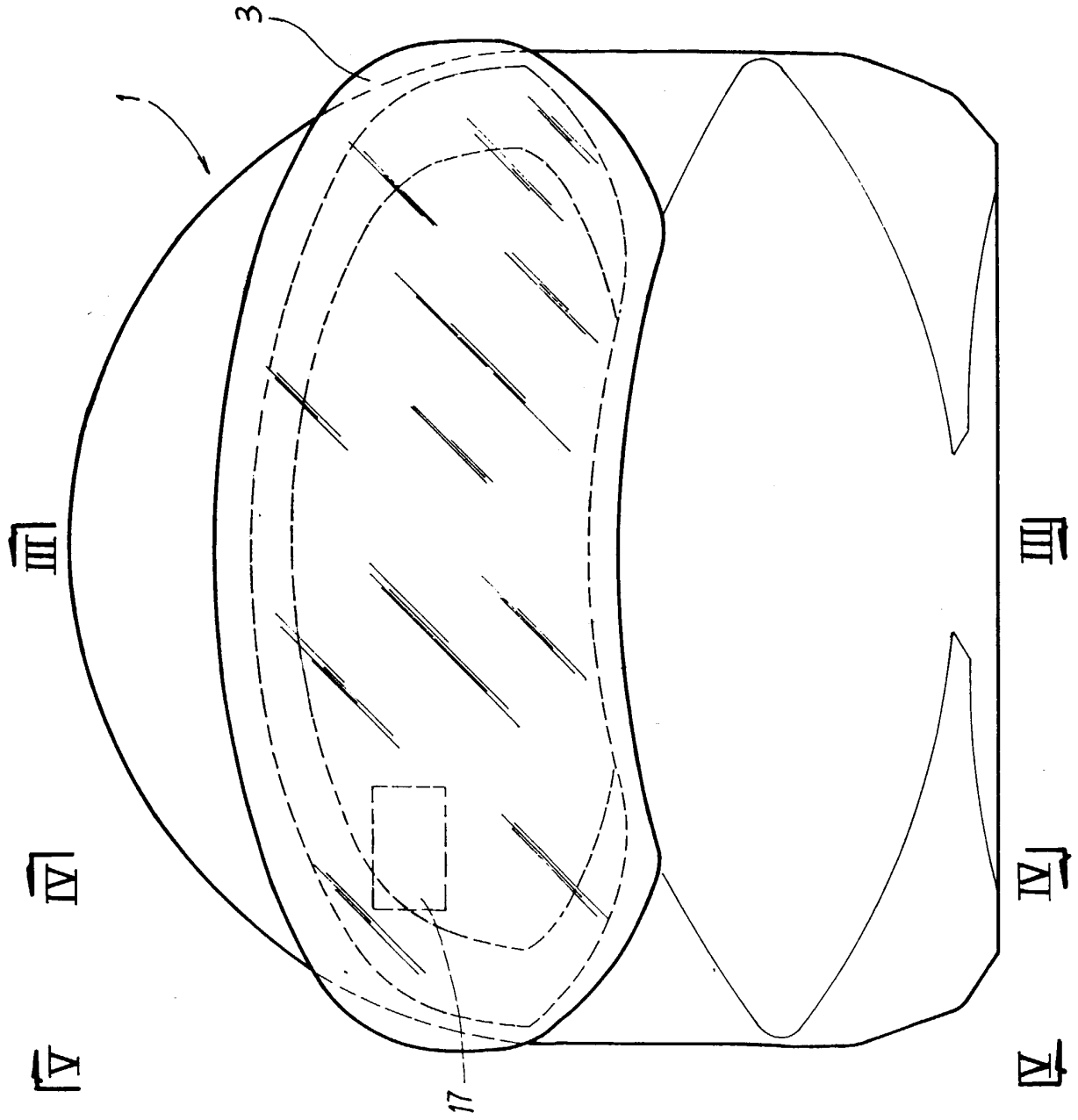


Fig. 2

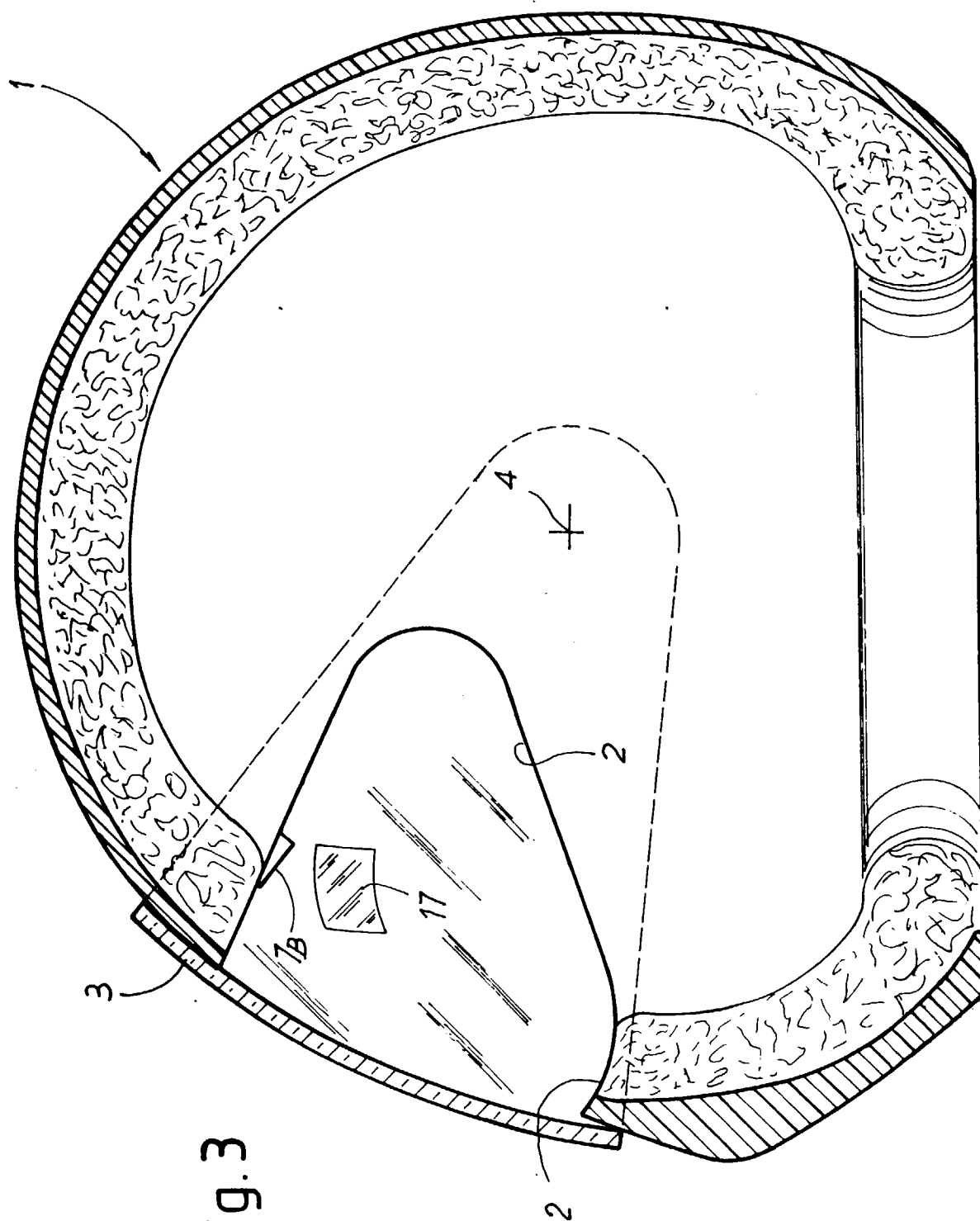


Fig. 3

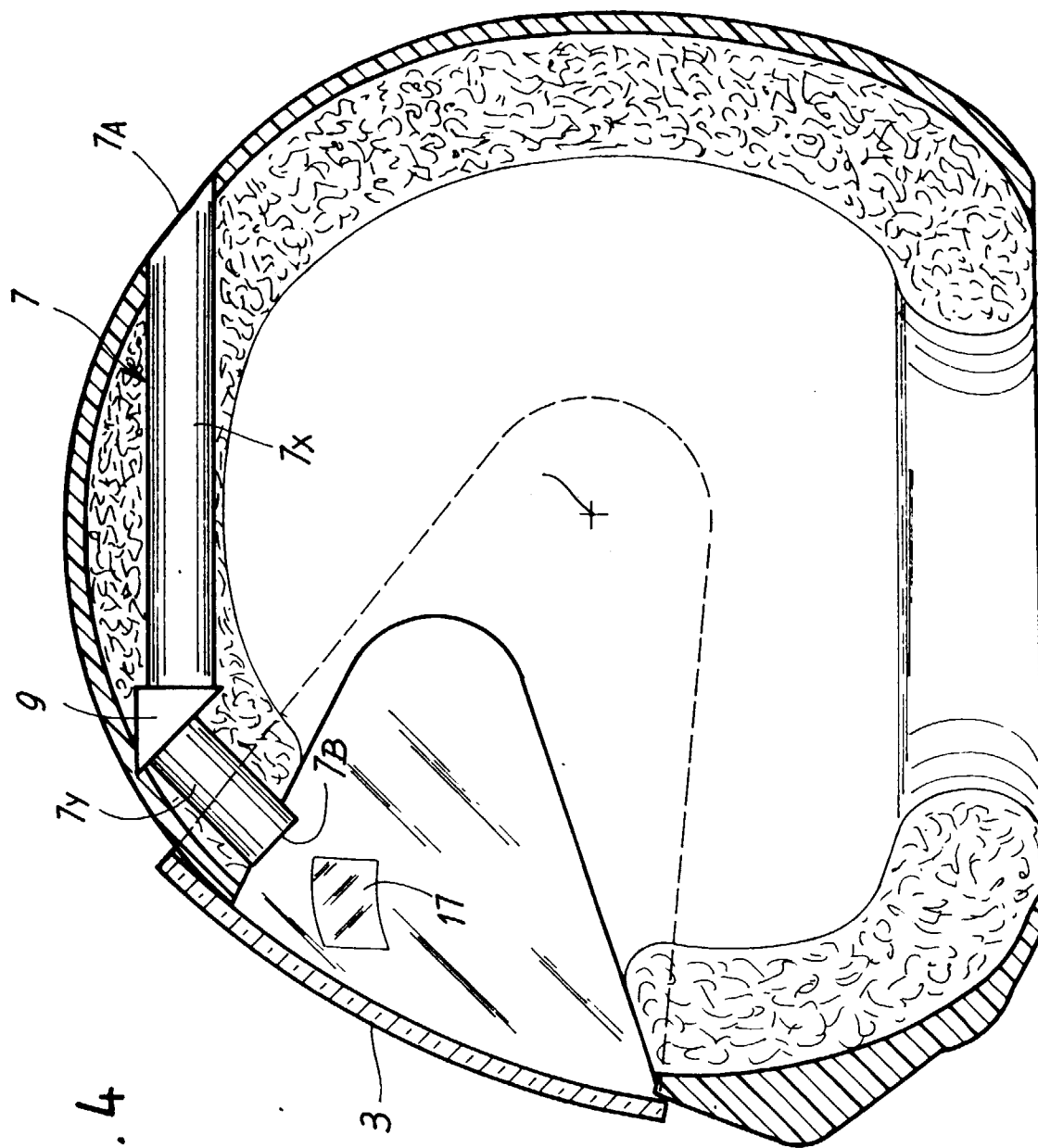


Fig. 4

Fig. 5

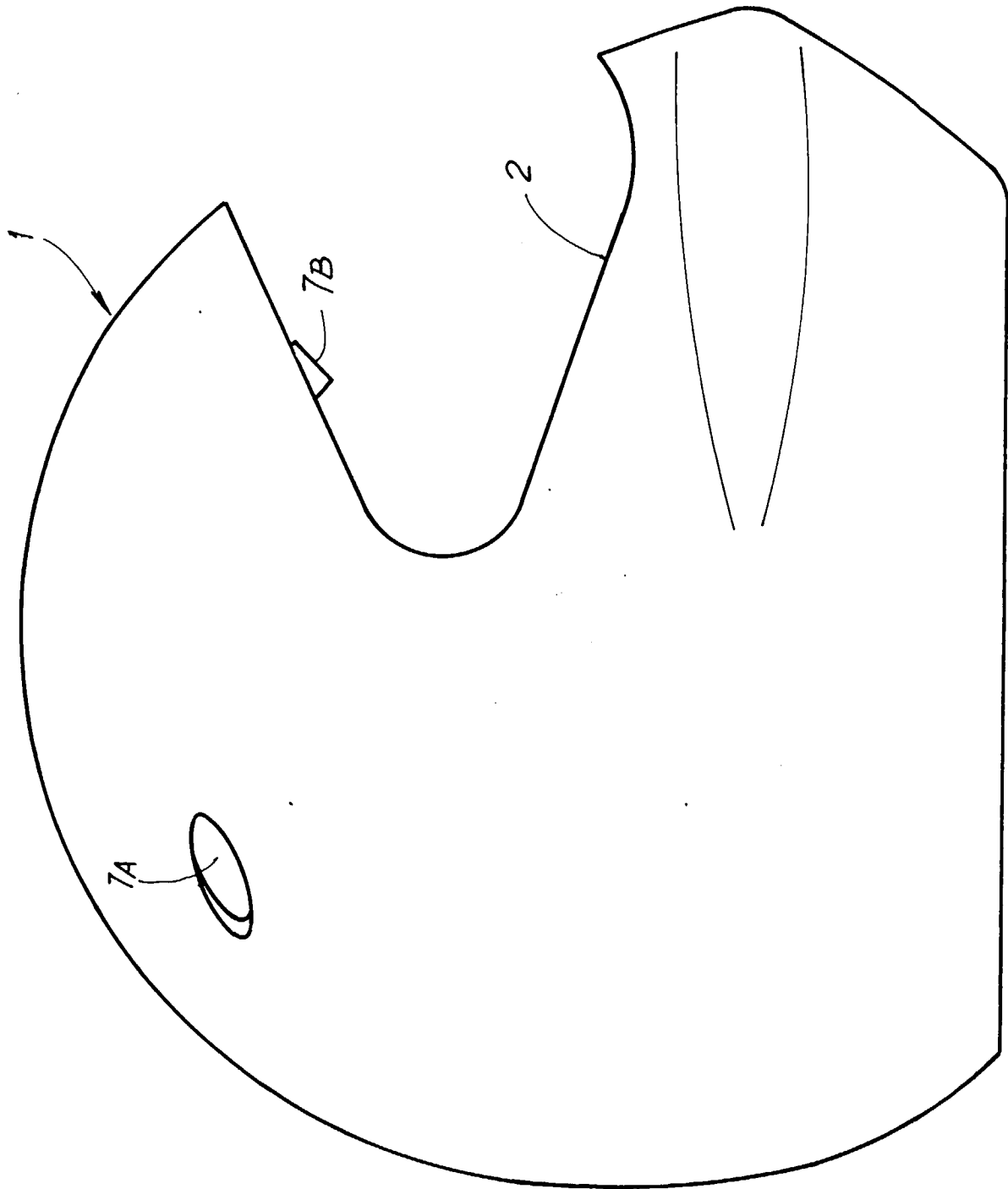
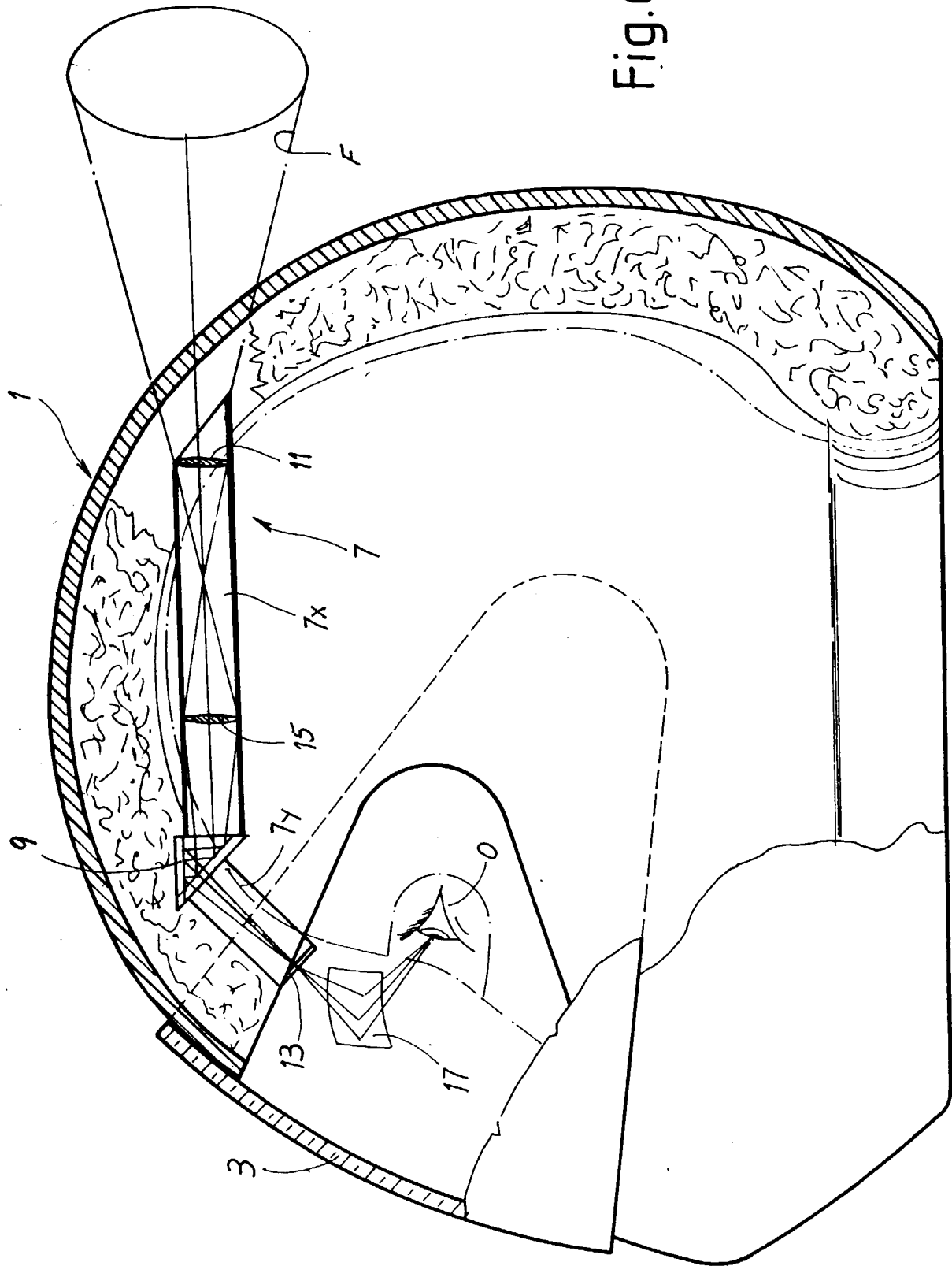


Fig.6



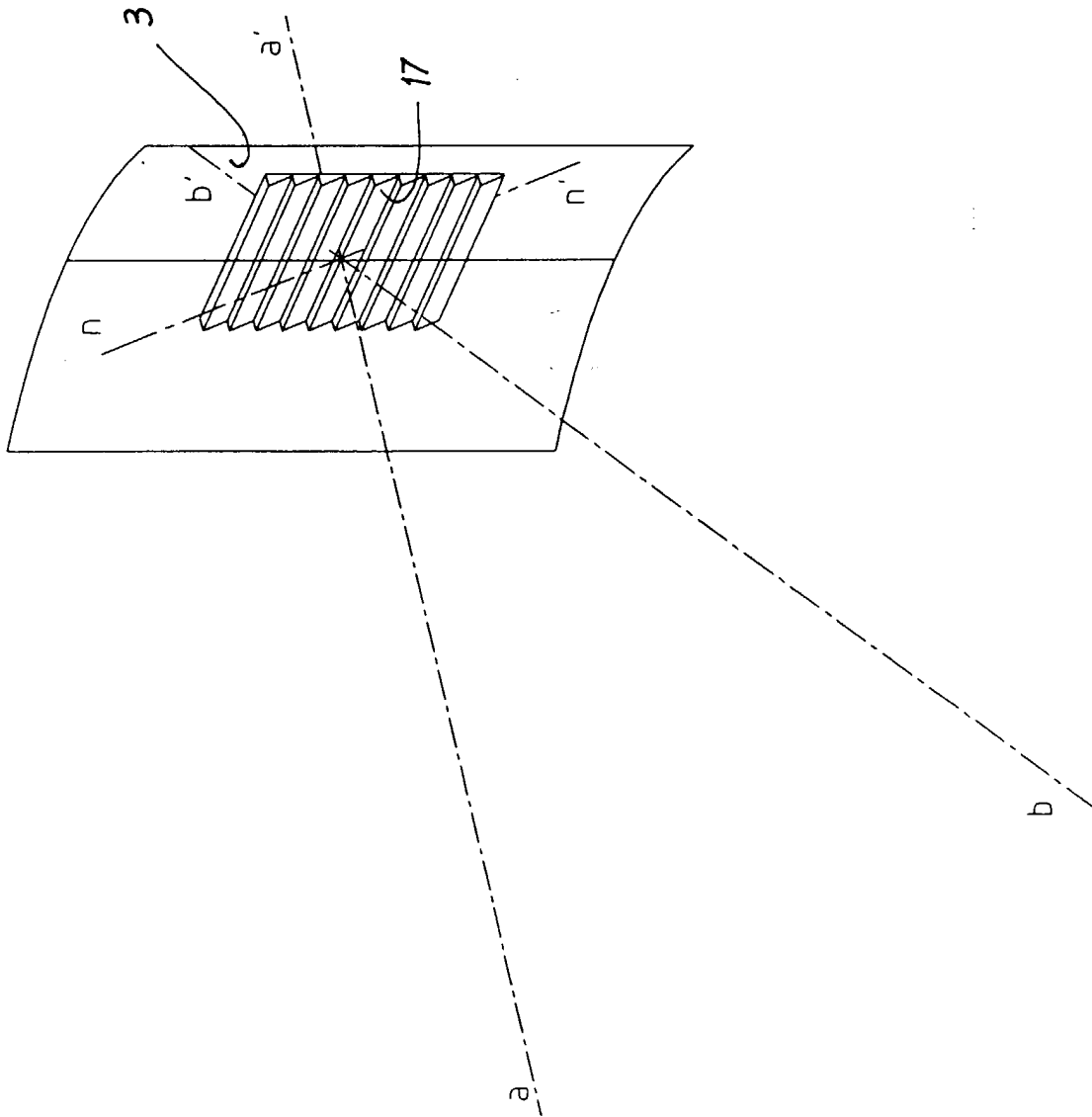


Fig. 7

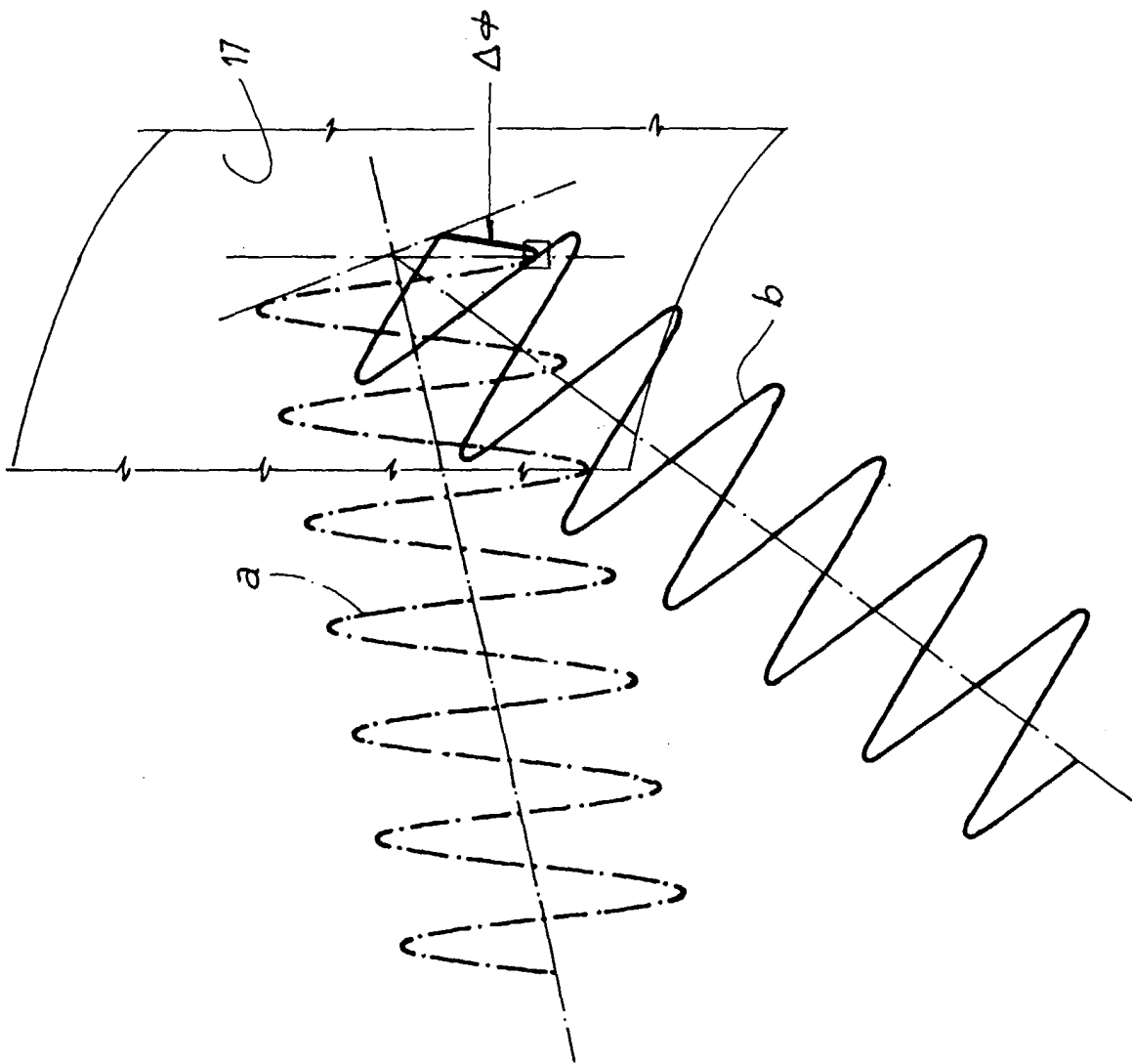


Fig. 8



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EUROPEAN SEARCH REPORT

Application Number
EP 99 83 0422

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 16 December 1999	Examiner Bourseau, A-M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 99 83 0422

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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