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(54) **Title:** OPTICAL MEMBER ASSEMBLY

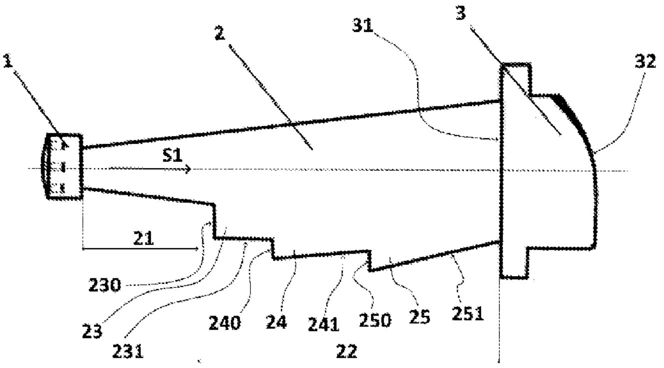

Fig. 1

(57) **Abstract:** The invention relates to an optical member assembly for variable message signs comprising a light source (1) with an RGB LED of SMD type, a light guide (2) arranged behind the light source (1) and an optical lens (3) arranged behind the light guide (2). The light guide (2) comprises a first and a second main quadrilateral prism (21, 22) situated behind each other and following each other in the direction (S1) of light travel from the source (1) which gradually extend both in the vertical and horizontal directions, whereby on the bottom side of the second main quadrilateral prism (22), in the direction (S1) of light travel from the source (1), a trio of stepped extensions (23, 24, 25) is formed, each of which comprises a vertical wall (230, 240, 250) situated transversely to the direction (S1) of light travel from the source (1) and a longitudinal wall (231, 241, 251) situated longitudinally or obliquely to the direction (S1) of light travel from the source (1), whereby the second main quadrilateral prism (22) is followed by an optical lens (3) with its planar input surface (31), the optical lens (3) being arranged on the axis of the optical member and has a quadrilateral prism cross-section, whereby the output surface (32) of the optical lens (3) has a convex-concave shape.

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— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

Optical member assembly

Technical field

The invention relates to an optical member assembly for use especially in the field of traffic control for variable message signs and variable traffic signs in a multi-point matrix arrangement.

Background art

In the field of transport, a range of optical elements with light emitting diodes (LEDs) as light sources in conjunction with optical lenses and other light-directing elements are used for traffic information boards and signs with variable content.

CZ PV 2014 - 410 discloses a solution in which the light guide is created in the shape of a truncated hexagon with the vertex angle of 14°, changing at both ends into a regular hexagon and at the other end of the light guide an optical lens is placed which is made by two curved surfaces, whereby the first curved surface, for example made as a rotary surface, is placed on the side of the optical lens facing the light guide and the other curved surface placed on the side of the optical lens facing away from the light guide, is created as astigmatic according to CZ UV 22619. Between the first curved surface of the optical lens and the output surface of the light guide there is an air gap. The light source – an RGB LED, the light guide and the optical lens are coaxially arranged. The coaxiality of the optical elements is ensured by the cases into which they are inserted. The resulting colour of the light from the light source is except red, green and blue, a mixture of at least two mono-frequency radiation beams of the same or different intensity. So that the resulting colour of light emerging from the optical element would be equally distributed into requested beam angles, the individual mono-frequency radiation beams have to be mixed. The light guide therefore serves to transfer mono-frequency radiation beams from RGB LED chips onto the optical lens.

The main task of the light guide, however, is to evenly distribute the light energy emitted by the RGB LED chips on the output surface of the light guide, and therefore the light guide is made as a truncated hexagon with a vertex angle of 14° which changing at the beginning and at the end into a regular hexagon. The mono-frequency radiation beams emitted by RGB LED chips enter the light guide and part of the rays pass directly through the light guide on its output surface. Rays with the vertex angle of up to 18° pass through the light guide onto its output surface, other rays are reflected inside by the plane surfaces of the truncated as well as regular hexagons. The incidence angle of all rays is always greater than 42°, they are totally reflected and the walls of the hexagons serve as mirrors. Inside the light guide, multiple reflections occur, during which the image of each light-emitting chip always becomes a mirror image around the plane connecting the vertices of the hexagon. This result in the mono-frequency radiation being equally distributed on the output surface the light guide. Depending to the incidence angles, these rays are reflected and hit either directly the output surface of the light guide or the opposite surface where they are reflected again. As a result, the rays of mono-frequency radiation, both direct and mirrored, come from the output surface of the light guide around the three planes connecting the vertices of the hexagon. The input surface of the light guide is placed directly on the casing of the RGB LED chips. Thus, dust particles precipitation on the output surface of the RGB LED and on the input surface of the light guide is prevented.

The disadvantage of the solution is loss of light intensity at the input to the light guide and subsequent reduction in light output at the output, and the distribution of white light on the front side of the directional optics is not optimal either.

CZ 2015-524 discloses a solution which comprises a coaxially arranged light guide and the light guide is followed by a coaxially arranged optical lens, where the optical lens is arranged on the side facing away from the diode and is created as astigmatic. The light guide body is formed by a truncated quadrilateral input pyramid and a truncated quadrilateral output pyramid, which are firmly connected to each other by vertex surfaces of identical cross-section, whereby the height of the input pyramid is at least 1.2 mm and, at the same time, it is shorter than the height of the output pyramid, whereby the vertex angle of the input pyramid is acute and the vertex angle of the output pyramid is acute. The length 1.2 mm of the truncated quadrilateral pyramid allows basic uniform colour mixing of three mono-frequency components from the RGB LED of SMD type. The optical lens is further arranged on the axis of the optical member and is created with a quadrilateral prism cross-section, its surface adjacent to the light guide being formed as planar and the surface facing away from the light guide being formed as convex and astigmatic. The optical lens is locked to the light guide in the area of the surface of the base of the output pyramid by means of the identical shape of the contact surfaces of the optical lens and the light guide. At the same time, the shape of the optical lens is designed so that the sun's rays incident on it are deflected out of the light guide after passing through the lens on the first refractive surface.

The disadvantage of this solution is the large dimensions of the entire directional optics. Another problem is the penetration of sunbeams, e.g., at sunset, into the light guide and onto the diode, which causes unwanted lighting of the entire optics and prevents the homologation of the device according to the CSN EN 12966 standard for the highest class R3.

The object of the invention is therefore to eliminate or at least minimize the disadvantages of the background art.

Principle of the invention

The object of the invention is achieved by an optical member 2G25varG for traffic information boards and signs with variable content comprising an RGB LED light source of SMD type, a light guide arranged behind the light source and an optical lens arranged behind the light guide, whose principle consists in that the light guide comprises first and second main quadrilateral prisms situated behind each other in the direction of light travel from the source and following each other, whereby the first and second main quadrilateral prisms gradually extend in the direction of light travel from the source in both the vertical and horizontal directions, whereby on the bottom side of the second main quadrilateral prism in the direction of light travel from the source three stepped extensions are formed, each of which comprises a vertical wall situated transversely to the direction of light travel from the source and a longitudinal wall situated longitudinally or obliquely to the direction of light travel from the source, whereby the second main quadrilateral prism is followed by the optical lens by its planar input surface, the optical lens being arranged on the axis of the optical member and has a quadrilateral prism cross-section, whereby the output surface of the optical lens has a convex-concave shape.

The RGB LED of SMD type is formed by a source of three mono-frequency radiation beams, wherein coaxially arranged behind this diode are the light guide and an optical lens which is arranged behind the light guide on the side facing away from the RGB LED, the output surface of the optical lens being formed by a polynomial of higher order of a convex-concave shape. The body of the light guide has a "free" shape created by permeation of several different bodies (Boolean) - two main perpendicular quadrilateral prisms, two secondary axially following quadrilateral prisms and one axially following pyramid, which are firmly mutually connected by their contact surfaces in the lower part of the two main perpendicular quadrilateral prisms. The length of the edge (the height) of the first main quadrilateral prism is, for example, 3 mm and at the same time it is smaller than the length of the edge (the height) of the second main quadrilateral prism. The vertex angle of the first main quadrilateral prism is acute and the vertex angle of the second main quadrilateral prism is also acute. The height (edge length) of the first main quadrilateral prism is, for example, 3 mm and is determined by simulating the tracing of the rays by the given optical system. The total axial length of both main quadrilateral prisms allows basic uniform colour mixing of the three mono-frequency components from RGB LEDs of SMD type and at the same time allows to lead out the light directed from the entrance into the light guide by means of two secondary quadrilateral prisms (first two extensions on the bottom side of the second main quadrilateral prism) and the following secondary pyramid (last extension on the bottom side of the second main quadrilateral prism). The optical lens is placed on the axis of the optical member and is created, for example, with a quadrilateral prism cross-section, whereby its surface facing the light guide is formed as planar, and the surface facing away from the light guide, i. e., the output surface, is formed as a convex-concave free shape described by a higher order polynomial. The optical lens is locked to the light guide in the area of the output surface of the second main quadrilateral prism by means of the identical shape of the contact surfaces of the optical lens and the light guide. The shape of the free-form light guide and of the lens is given by the RGB LED. It is exactly this shape that enables the correct leading of the light into the light guide and its primary mixing. Leading light into the light guide minimizes intensity losses at the light entry into the light guide.

Furthermore, the shape of the optical lens is designed so that the sun's rays incident on the lens at a small angle (approximately 10 degrees) will be, after passing through the lens, focused on the edges of the two secondary quadrilateral prisms and of the secondary pyramid. According to the law of refraction and reflection, the edges then lead the rays out of the light guide so that less than 1 % of parasitic light falls on the input of the waveguide (onto the SMD diode).

The advantage of this solution is minimizing light intensity losses at the output of the optical lens in the reference direction and thus achieving a high light output in the desired area. Other advantages include small installation parameters of the whole optics and a dramatic reduction in the Phantom effect – i.e., reduction of parasitic rays in the whole optical system and the efficiency of the leading of parasitic rays out of the optical system. The dramatic reduction of the Phantom effect enables certification according to the CSN EN 12966 standard for the highest class R3, even with the small dimensions of the entire optical system.

The solution according to the invention meets the conditions given by the standard CSN EN 12966 both in the range of radiation angles and in the value of brightness measured in the reference axis, or within the limits of the respective class of radiation angles. The solution also minimizes the loss of light intensity at the output of the optical lens through the optical surface into the reference direction and thus achieves high light output in the required area of class B6 according to the CSN EN 12966 standard for the highest radiation class R3.

Description of drawings

The invention is schematically represented in the enclosed drawings wherein Fig. 1 shows a basic diagram of the whole optics according to the invention, Fig. 2 shows a diagram of a separate light guide, where the forming bodies are highlighted, Fig. 3 shows a free-form output optical lens, Figs. 4 to 4b show an exemplary embodiment the light guide according to the invention (a longitudinal section - Fig. 4, a plan view - Fig. 4a, a front view - Fig. 4b) and Figs. 5 to 5c represent an exemplary embodiment of the optical lens (an overall perspective view is shown in Fig. 5, a longitudinal section in Fig. 5a, a front view in Fig. 5b and a plan view in Fig. 5c).

Example of embodiment

The optical member assembly, which is shown in Figs. 1 - 5c and is intended for variable message signs, comprises a light system consisting of a light source **1** with an RGB LED of SMD type. The output of the light source **1** is followed by an input of a light guide **2**, the output of which is followed by an input **31** of an optical lens **3** which is provided on its output side with a shaped output surface **32**. The light guide **2** and the optical lens **3** are either made of one piece of material, which means that they form a one-piece element, or they are made of separate and interconnected bodies.

The light guide **2** consists of a compound body, which is formed by connecting and partial permeation of several bodies. The light guide **2** comprises two main quadrilateral prisms **21** and **22** situated behind each other and following each other in the direction **S1** of light travel from the source **1**. The main quadrilateral prisms **21** and **22** gradually extend both in the vertical and horizontal directions, in the direction **S1** of light travel from the source **1** of light, where angle α_1 indicates extension of the first main quadrilateral prism **21** in the vertical direction, angle β_1 indicates extension of the first main quadrilateral prism **21** in the horizontal direction, angle α_2 indicates extension of the second main quadrilateral prism **22** in the vertical direction and angle β_2 indicates extension of the second main quadrilateral prism **22** in a horizontal direction.

On the bottom side of the second main quadrilateral prism **22,** in the direction **S1** of light travel from the light source **1,** a trio of stepped extensions **23 24**, **25**, is formed, each of which comprises a vertical wall **230**, **240**, **250,** situated transversely to the direction **S1** of light travel from the light source **1,** and a longitudinal wall **231**, **241**, **251,** situated longitudinally or obliquely to the direction **S1** of light travel from the light source **1**.

As shown in Fig. 2, the above-mentioned extensions **23**, **24**, **25** can be also described as an assembly of bodies partially nested within the lower part of the second main quadrilateral prism **22**, where these bodies are, for example, formed by a pair of quadrilateral prisms, still partially nested into each other, and one pyramid.

In the exemplary embodiment shown, the propagation angle α_1 of the first main quadrilateral prism **21** in the vertical plane is 14.35° and the propagation angle β_1 of the first main quadrilateral prism **21** in the horizontal plane is 13°. The propagation angle α_2 of the second main quadrilateral prism **22** in the vertical plane is 14.35°, i.e., it is identical to the propagation angle α_1 of the first main quadrilateral prism **21** in the vertical plane, whereby the propagation angle β_2 of the second main quadrilateral prism **22** in the horizontal plane is 10.12°. These angles α_1, α_2, β_1, β_2 are size dependent on the required total length of the optical assembly and the above-mentioned specified values apply to the required total length of the optical member assembly, including the directional optics, of less than 25 mm. Under these conditions, the length of the entire light guide **2** is 21.45 mm and allows basic uniform colour mixing of three mono-frequency components from RGB LEDs of SMD type. The shape of the light guide **2** is influenced by the shape of the RGB LED. The selected shape of the light guide **2** allows the correct leading of light to the light guide **2** and its primary mixing, whereby the loss of light intensity otherwise caused at the entry of light into the light guide **2** is minimized here by leading the light into the light guide **2.** The second main quadrilateral prism **22** has a size influenced by the desired optical diameter, here in particular the optical diameter of the front directional optics <= 10 mm.

The optical lens **3** is formed by a body with a quadrilateral prism cross-section, whereby its entrance surface **31** is planar and its output surface **32** has a convex-concave shape. The optical lens **3** is locked to the light guide **2** by the identical shape of the contact surfaces of the optical lens **3** and the light guide **2**.

Industrial applicability

The optical member according to the present invention is applicable especially in the field of transport infrastructure for traffic information boards and signs with variable content with a matrix arrangement of full-chromatic light points.

PATENT CLAIMS

1. An optical member assembly for variable message signs comprising a light source (1) with an RGB LED of SMD type, a light guide (2) arranged behind the light source (1) and an optical lens (3) arranged behind the light guide (2), **characterized in that** the light guide (2) comprises a first and a second main quadrilateral prism (21, 22) situated behind each other and following each other in the direction (S1) of light travel from the source (1) which gradually extend both in the vertical and horizontal directions, whereby on the bottom side of the second main quadrilateral prism (22), in the direction (S1) of light travel from the source (1), a trio of stepped extensions (23, 24, 25) is formed, each of which comprises a vertical wall (230, 240, 250) situated transversely to the direction (S1) of light travel from the source (1) and a longitudinal wall (231, 241, 251) situated longitudinally or obliquely to the direction (S1) of light travel from the source (1), whereby the second main quadrilateral prism (22) is followed by an optical lens (3) with its planar input surface (31), the optical lens (3) being arranged **on the axis** of the optical member and has a quadrilateral prism cross-section, whereby the output surface (32) of the optical lens (3) has a convex-concave shape.

2. The optical member assembly according to claim 1, **characterized in that** the first main quadrilateral prism (21) has a propagation angle (α_1) of 14.35° in the vertical plane and a propagation angle (β_1) of 13° in the horizontal plane, whereby the second main quadrilateral prism (22) has a propagation angle (α_2) of 14.35° in the vertical plane and a propagation angle (β_2) of 10.12° in the horizontal plane, whereby the total length of the optical member assembly is less than 25 mm, the length of the entire light guide (2) is 21.45 mm.

3. The optical member assembly according to any of claims 1 or 2, **characterized in that** the light guide (2) and the optical lens (3) are made of one piece of material.

4. The optical member according to any of claims 1 or 2, **characterized in that** the light guide (2) and the optical lens (3) are each made of a separate piece of material.

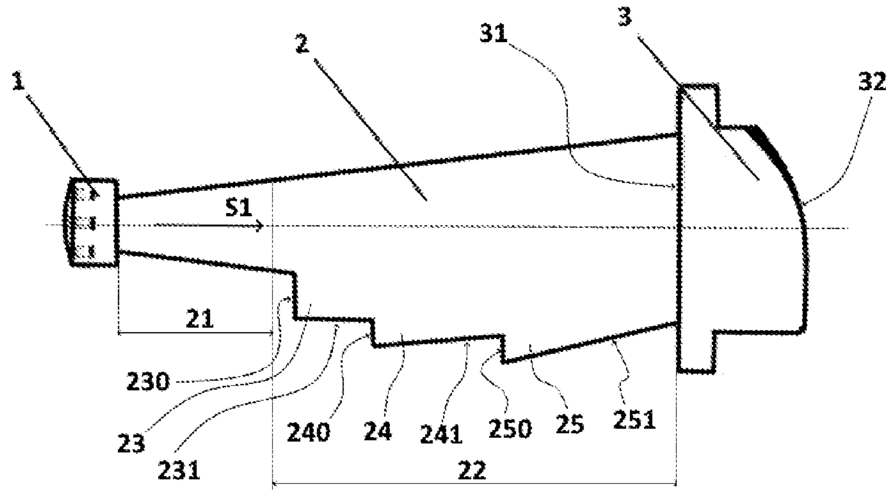

Fig. 1

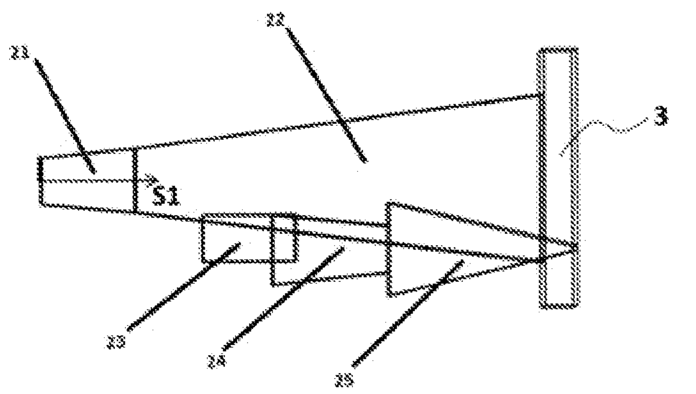

Fig. 2

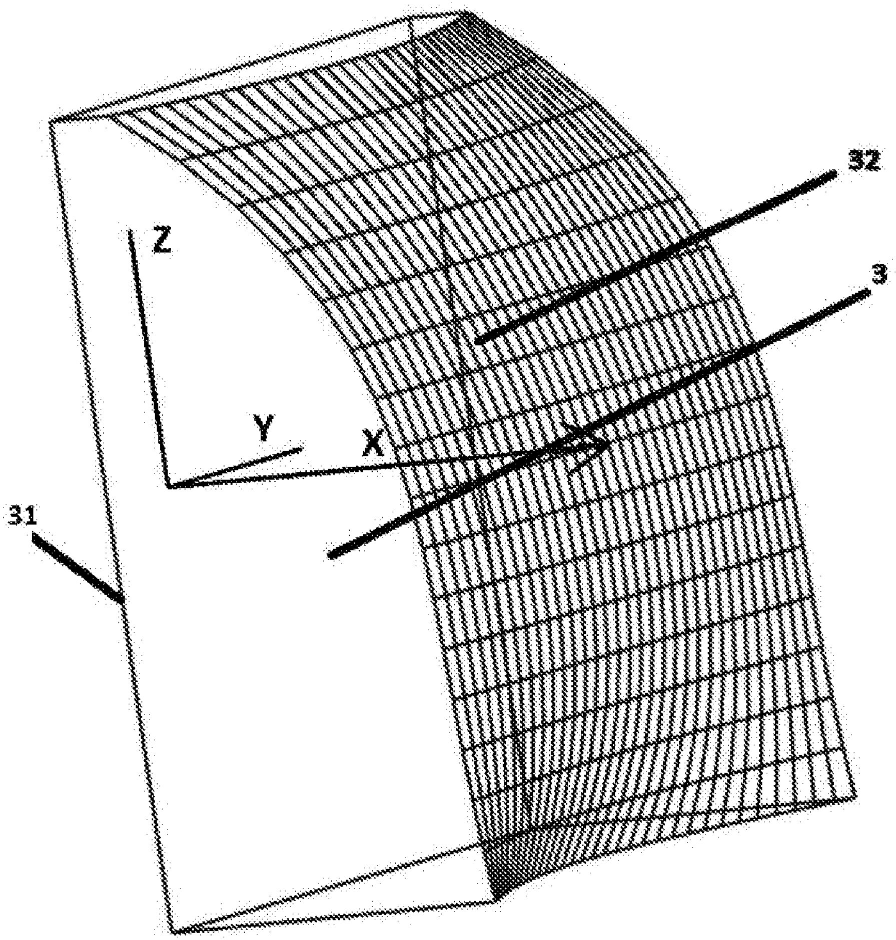

Fig. 3

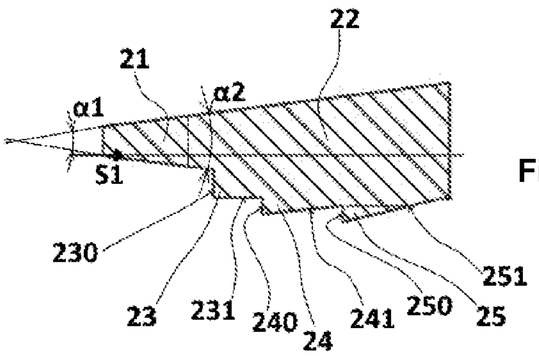

Fig. 4

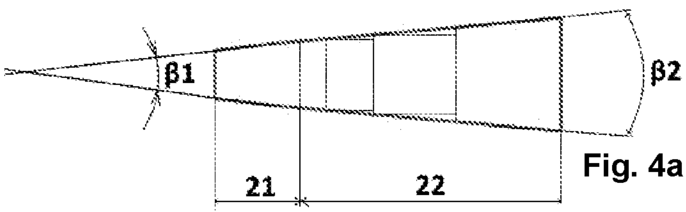

Fig. 4a

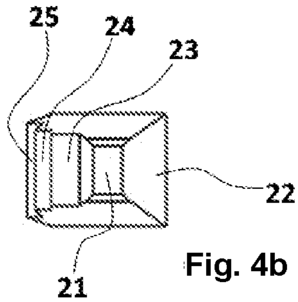

Fig. 4b

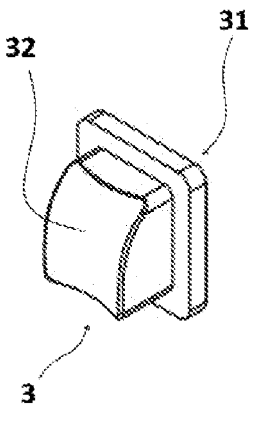

Fig. 5

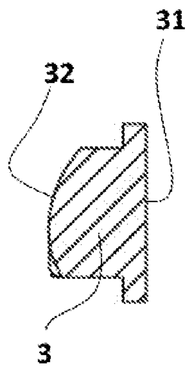

Fig. 5a

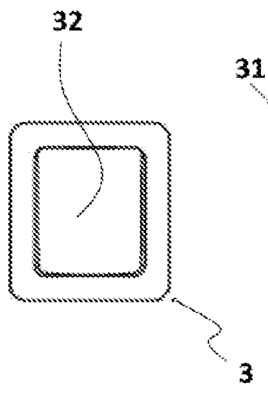

Fig. 5b

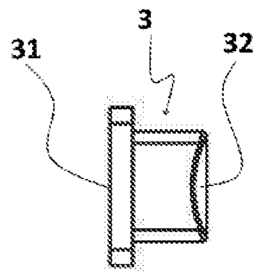

Fig. 5c

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2021/050026

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V8/00 G09F9/33 G09F13/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02B G09F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 110 858 031 A (SHANGHAI SANSI TECHNOLOGY CO ET AL.) 3 March 2020 (2020-03-03) page 5, paragraphs 7,8 page 7, paragraph 7 figures 4A,4C,5,7 -----	1-4
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Y	US 5 636 057 A (DICK GEORGES P [CA] ET AL) 3 June 1997 (1997-06-03) column 7, line 65 - column 8, line 3 -----	1-4

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Date of the actual completion of the international search	Date of mailing of the international search report
15 June 2021	21/06/2021

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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