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(71) Applicant: HUAWEI TECHNOLOGIES CO., LTD.
[CN/CN]; Huawei Administration Building Bantian Long-
gang District, Shenzhen, Guangdong 518129 (CN).

(72) Inventor; and
(71) Applicant (for US only): MÄKI, Jouni, Tapio [SE/SE];
Huawei Technologies Sweden AB, Skalholtsgatan 9, 16440
Kista (SE).

(72) Inventor: MÄKINEN, Kaisla Alina; Huawei Technolo-
gies Sweden AB, Skalholtsgatan 9, 16440 Kista (SE).

(74) Agent: KREUZ, Georg; Huawei Technologies Duessel-
dorf GmbH, Riesstr. 25, 80992 Munich (DE).

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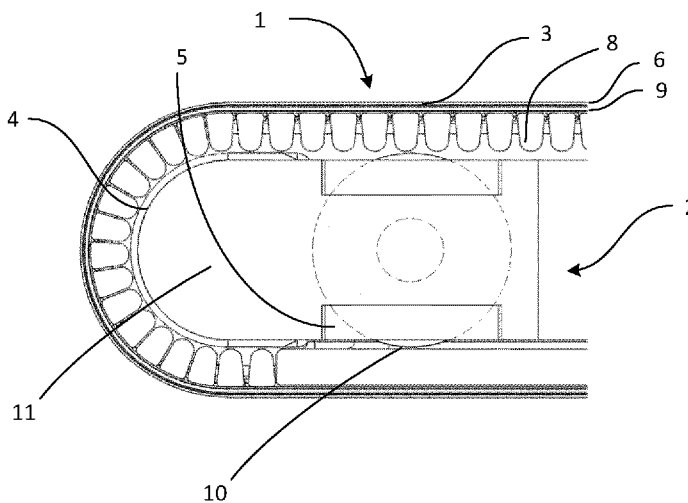


Fig. 2

(57) Abstract: Disclosed herein is an electronic device (1) comprising a chassis module (2) and a rolling display arrangement (3), said rolling display arrangement (3) partially enclosing said chassis module (2) and being configured to slide between a retracted position (P1) and an extended position (P3), wherein the chassis module (2) comprises a body (11) having a rounded edge (4) and a first part (5) of a magnetic pair in at least a mid-section of the body proximal to the rounded edge (4), and the rolling display arrangement (3) comprises a foldable sheet (6) and a support arrangement arranged to support the foldable sheet (6), wherein the rolling display arrangement (3) comprises a second part (9) of a magnetic pair in at least a section opposing the first part (5) of the magnetic pair when the rolling display arrangement (3) is in the retracted position, said first part (5) and second part (9) of the magnetic pair being magnetically attracted to each other. The electronic device (1) reduces or prevents the presence of visual defects due to bending of the rolling display arrangement (3) around the rounded edge (4) of the chassis module (2).



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AN ELECTRONIC DEVICE HAVING A ROLLING DISPLAY COMPRISING MAGNETIC MEANS FOR FLATTENING THE DISPLAY WHEN EXTRACTED

TECHNICAL FIELD

5 The disclosure relates to an electronic device comprising a chassis module and a rolling display arrangement, said rolling display arrangement partially enclosing said chassis module and being configured for sliding between a retracted position and an extended position.

BACKGROUND

10 The size of mobile devices, such as tablets and mobile phones, is an important consideration when designing mobile devices. In order to provide a consumer appealing mobile device, the outer dimensions of the device have to be as small as is technically feasible, while still allowing the display of the device to be as large as possible.

15 This problem may be solved, e.g., by means of a foldable electronic device comprising one or several support bodies, e.g. interconnected by means of hinges, covered by a display. The support body/bodies and the display can be folded together to provide an as small electronic device as possible, i.e. at least partially covering both main faces of the device, and unfolded to provide an as large display as possible, i.e. the display covering only one
20 main face of the device and protruding from said main face.

As the bending radius of the display changes, there will inevitably be more or less deformation of the display. This is due to, as the display is folded around the electronic device, the display stretching on one side of the neutral axis and compressing on the other
25 side of the neutral axis. The neutral axis is the axis along which the display or the housing remains unchanged as the device is folded, i.e. it neither stretches nor compresses.

The situation is even more complex when the display is extendable. In this case, the display is both bent around the device and moved around the edge of the device as it is extended.

The bending of the display below a certain bending radius causes a bulge to appear on a middle area. The bulge results in visual defects.

SUMMARY

5 It is an object to reduce or eliminate the visual defects that results from the formation of a bulge on the display. This and other objects are achieved by the features of the independent claims. Further implementation forms are apparent from the dependent claims, the description, and the figures.

10 According to a first aspect, there is provided an electronic device comprising a chassis module and a rolling display arrangement, the rolling display arrangement partially enclosing the chassis module and being configured to slide between a retracted position and an extended position, wherein the chassis module comprises a body having a rounded edge and a first part of a magnetic pair in at least a mid-section of the body proximal to the
15 rounded edge, and
the rolling display arrangement comprises a foldable sheet and a support arrangement arranged to support the foldable sheet,
wherein the rolling display arrangement comprises a second part of a magnetic pair in at least a section opposing the first part of the magnetic pair when the rolling display
20 arrangement is in the retracted position, the first and second part of the magnetic pair being magnetically attracted to each other.

In a possible implementation form of the first aspect, the first part of the magnetic pair is a static magnet and the second part of the magnetic pair is a magnetic material. It is generally
25 possible to provide the first part of the magnetic pair with a mass higher than the second part of the magnetic pair. Therefore, the magnetic attraction between the parts of the magnetic pairs can be higher in this implementation.

In a further possible implementation form of the first aspect, the foldable sheet is a flexible
30 display having a plastic base layer. While other types of foldable sheets can be used, the display types having a plastic layer are easier to bend around the rounded edge. A display of particular interest is POLED (Plastic Organic Light Emitting Diode). A range of plastics

may be used as the plastic base layer, including polyethylene terephthalate (PET) and polyethylene naphthalate (PEN).

5 In a further possible implementation form of the first aspect, the magnetic material is included in or attached to the plastic base layer. In a specific embodiment, the magnetic material may be a sheet laminated in the plastic base layer or particles of magnetic material is dispersed on the plastic base layer.

10 In a further possible implementation form of the first aspect, the support arrangement comprises a plurality of parallel support rods arranged perpendicular to the sliding direction to support the foldable sheet. Suitably, each support rod is substantially tapered from a base section to an apex section, the base section being attached to the foldable sheet. To obtain a smooth sliding experience usually the apex sections being moved towards each other when the foldable sheet is folded around the rounded edge of the chassis module.

15 In a further possible implementation form of the first aspect, the body of the chassis module is oblong having a pair of opposing short edges and a pair of opposing longer edges, the rounded edge being one of the longer edges.

20 In a further possible implementation form of the first aspect, the first part of the magnetic pair is a static magnet having a planar side facing the rolling display arrangement. A planar static magnet may provide a uniform magnetic attraction over essentially the whole area of the magnet. In another implementation, the first part of the magnetic pair is static magnet formed as a roll configured to turn when the rolling display arrangement is slid between
25 the retracted position and the extended position. A static magnet formed as a roll allows for an arrangement with less friction, which may be translated into better user experience.

30 In a further possible implementation form of the first aspect, a roller is positioned adjacent to the first part of the magnetic pair, said roller having a diameter larger than the thickness of the body to provide for a clearance between the surface of the first part of the magnetic pair and the rolling display arrangement. The presence of a clearance prevents a direct physical contact between the magnet and the rolling display arrangement, obtaining less

friction. The roller may be prepared from a number of materials, such as polymer materials. A suitable polymer material for the roller is POM (polyoxymethylene) due to its low friction properties. In an implementation of the present invention, the first part of the magnetic pair is formed as a roll and the roller are positioned co-axially in the body of the chassis module, the axis being parallel to the rounded edge. Suitably, rollers are co-axially disposed on both sides of the first part of the magnetic pair to obtain the same clearance distance between the surface of the first part of the magnetic pair and the rolling display arrangement.

10 In a further possible implementation form of the first aspect, the magnetic attraction between the first and the second part of the magnetic pair is sufficient to prevent bulging of the rolling display arrangement. When a planar static magnet is used as the first part of the magnetic pair it may be provided on both sides of the body of the chassis module to prevent bulging on both sides of the electronic device.

15

In a further possible implementation form of the first aspect, the second part of the magnetic pair is present in a section of the rolling display arrangement opposing the first part of the magnetic pair when the rolling display arrangement is in the retracted, extended and any intermediary position. According to this implementation attraction remains between the chassis module and the rolling display arrangement through the sliding process. In a further implementation, the second part of the magnetic pair is present in the entire extent of the rolling display arrangement. Suitably, the second part of the magnetic pair is a metal foil provided on or incorporated in the plastic base layer of a flexible display.

25 BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed portion of the present disclosure, the aspects, embodiments and implementations will be explained in more detail with reference to the example embodiments shown in the drawings, in which:

Figs. 1a-1b discloses the prior art according to which a bulging of the display occurs.

30 Fig. 2 shows a cross-sectional view of an electronic device in accordance with an embodiment of the present invention;

Fig. 3 shows a perspective view of a chassis module with a planar static magnet having the rolling display arrangement removed;

Fig. 4 shows a perspective view of a chassis module with a static magnet formed as a roll having the rolling display arrangement removed;

5 Figs. 5a-5c show three sliding positions;

Figs. 6a and 6b show a chassis module with a planar static magnet; and

Figs. 7a and 7b show a chassis module with a static magnet formed as a roll.

DETAILED DESCRIPTION

10 The static magnet generally comprises a material selected among "hard" ferromagnetic materials such as iron, nickel, aluminum, copper, titanium, and cobalt or their alloys, that can be magnetized to produce a permanent magnetic field. Non-limiting examples include alnico and ferrite. The magnetic material generally comprises "soft" ferromagnetic materials that can be temporarily magnetized but do not tend to stay magnetized when a
15 magnetic field is not present. Non-limiting examples of "soft" ferromagnetic materials include annealed iron and carbon steel.

Figs. 1a-1c disclose the prior art and the technical problem. Fig. 1a shows an electronic device comprising a chassis module and a rolling display arrangement partially enclosing
20 said chassis module and being in a retracted position. The arrow indicates the drawing direction of the rolling display arrangement for sliding from the retracted position shown to an extended position. Fig. 1b discloses an end view of an electronic device and Fig. 1c discloses a cross-section of the electronic device in which the display bulges at the middle area proximal to the rounded edge of the body. The arrows indicate the forces attempting
25 to open the folded display.

Fig. 2 shows a cross-sectional view of a part of the electronic device 1. The electronic device comprises a chassis module 2 and a rolling display arrangement 3. The rolling display arrangement covers the surface of the chassis module in the shown part of the

electronic device. The chassis module comprises a body 11 having a rounded edge 4 with the rolling display arrangement bend around. The body 11 of the chassis module also comprises a first part of a magnetic pair 5 in a midsection of the body 11 proximal to the rounded edge. The first part of a magnetic pair of the magnetic pair is shown as a static magnet having a planar surface directed towards the rolling display arrangement.

The rolling display arrangement comprise a foldable sheet 6 and a support arrangement comprising a plurality of support rods 8 arranged to support the foldable sheet. The support rods are preferably made of stiff material such that they do not bend in any direction but remain essentially straight regardless of their position. Each support rod may be substantially tapered, such that the support rods 5 do not collide as the foldable support structure folds. The tapering extends from a base section to an apex section, the base section being arranged adjacent the foldable sheet 6. The apex sections are moved towards each other when the foldable sheet is folded around the rounded edge. The base section may comprise a concave surface (not shown), the concave surface being in supportive abutment to the foldable sheet. This allows the foldable sheet to extend as smoothly as possible when the supportive arrangement is folded.

The rolling display arrangement comprises a second part of the magnetic pair 9. In the present embodiment, the second part of the magnetic pair is a magnetic material included in or attached to a plastic base layer of the foldable sheet. The magnetic material is included in at least a section of the foldable sheet opposing the first part of the magnetic pair, i.e. the planar static magnet, when the rolling display arrangement is in the retracted position. Thus, it is ensured that the foldable sheet remains flush with the rest of the display, when the electronic device is used in the retracted position. Usually, the magnetic material is positioned in a section of the foldable sheet opposing the first pair of the magnetic material when the rolling display arrangement is in the retracted position, the extended position, and any intermediary position. In this latter embodiment, the bulging is prevented or reduced in any sliding positions, including any intermediary position.

30

In dashed lines Fig. 2 shows a roller 10. Fig. 3 illustrates that the roller is positioned adjacent to the planar static magnet. Suitably, as illustrated on Fig. 3, rollers are positioned on each side of the planar static magnet to reduce the friction when the foldable sheet is sled over the body 11 of the chassis module. The rollers have a diameter larger than the thickness of the body 11 to provide a clearance between the surface of the magnet and the rolling display arrangement. The clearance prevents a direct physical contact between the surface of the magnet and the rolling display arrangement to obtain less friction when the rolling display arrangement is sled over the chassis module. The rounded edge 4 of the embodiment shown in Fig. 3 are illustrated as a section of rolls, which are turned when the rolling display arrangement is sled from one position to another. The use of a section of rolls results in a low friction.

Fig. 4 discloses an embodiment in which the similar to the embodiment shown in Fig. 3, however, using a magnet formed as roll 11. The roll 5 is positioned co-axially with the rollers 10 and is configured to turn when the rolling display arrangement is sled between the retracted position P1 and the extended position P3. The diameter of the magnet formed as a roll is generally smaller than the diameter of the rollers 5 to allow for the formation of a clearance that prevent a direct physical contact with the rolling display arrangement.

Figs. 5a-5c disclose three sliding positions. In the position shown in Fig. 5a the rolling display arrangement is in a retracted position P1. Fig. 5b shows the rolling display arrangement is in an intermediary position P2 and Fig. 5c shows the rolling display arrangement is in an extended position P3.

Figs. 6a and 6b show an embodiment of the invention using a chassis module 2 with a planar static magnet 5. On each side of the planar static magnet rollers 10 are positioned to reduce the friction during sliding of the not shown rolling display arrangement. The chassis module is provided with rounded edges suitable for abutment with the rolling display arrangement.

Figs. 7a and 7b show an embodiment of the invention using a chassis module 2 with a static magnet formed as a roll 11. On each side of the magnet rollers 10 are positioned to reduce

the friction during sliding of the not shown rolling display arrangement. The chassis module is provided with rounded edges 4 suitable for abutment with the rolling display arrangement.

- 5 The various aspects and implementations have been described in conjunction with various embodiments herein. However, other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed subject-matter, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a”
- 10 or “an” does not exclude a plurality. A single magnet or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.
- 15 The reference signs used in the claims shall not be construed as limiting the scope. Unless otherwise indicated, the drawings are intended to be read e.g., cross-hatching, arrangement of parts, proportion, degree, etc. together with the specification, and are to be considered a portion of the entire written description of this disclosure.

CLAIMS

1. An electronic device (1) comprising a chassis module (2) and a rolling display arrangement (3), said rolling display arrangement (3) partially enclosing said chassis module (2) and being configured to slide between a retracted position (P1) and an extended position (P3), wherein

the chassis module (2) comprises a body (11) having a rounded edge (4) and a first part (5) of a magnetic pair in at least a mid-section of the body (11) proximal to the rounded edge (4), and

the rolling display arrangement (3) comprises a foldable sheet (6) and a support arrangement arranged to support the foldable sheet (6),

wherein the rolling display arrangement (3) further comprises a second part (9) of the magnetic pair in at least a section opposing the first part (5) of the magnetic pair when the rolling display arrangement (3) is in the retracted position (P1), said first part (5) and second part (9) of the magnetic pair being magnetically attracted to each other.

2. The electronic device (1) according to claim 1, wherein the first part (5) of the magnetic pair is a static magnet and the second part (9) of the magnetic pair is a magnetic material.

3. The electronic device (1) according to claim 1 or 2, wherein the foldable sheet (6) is a flexible display having a plastic base layer.

4. The electronic device (1) according to claim 3, wherein the magnetic material is included in or attached to the plastic base layer.

5. The electronic device (1) according to any one of claims 1 to 4, wherein the support arrangement (8) comprises a plurality of parallel support rods arranged perpendicular to the sliding direction to support the foldable sheet (6).

6. The electronic device (1) according to claim 5, wherein each support rod is substantially tapered from a base section to an apex section, said base section being attached to the foldable sheet (6).

5 7. The electronic device (1) according to claim 6, wherein the apex sections of said support rods (8) are moved towards each other when said foldable sheet (6) is folded around said rounded edge (4) of the chassis module (2).

8. The electronic device (1) according any one of the claims 1 to 7, wherein the body (11)
10 of the chassis module (2) is oblong having a pair of opposing short edges (12) and a pair of opposing longer edges (13), the rounded edge (4) being one of the longer edges.

9. The electronic device (1) according any one of the claims 1 to 8, wherein the first part
15 (5) of the magnetic pair is a static magnet having a planar side facing the rolling display arrangement (3).

10. The electronic device (1) according any one of the claims 1 to 8, wherein the first part
(5) of the magnetic pair is static magnet formed as a roll configured to turn when the rolling
display arrangement (3) is slid between the retracted position (P1) and the extended
20 position (P3).

11. The electronic device (1) according to any one of claims 1 to 10, wherein at least one
roller (10) is positioned adjacent to the first part (5) of the magnetic pair, said roller(s) (10)
having a diameter larger than the thickness of the body (11) to provide for a clearance
25 between the surface of the first part (5) of the magnetic pair and the rolling display
arrangement (3).

12. The electronic device (1) according to claim 10 and 11, wherein the first part (5) of the
magnetic pair and the roller(s) (10) are positioned co-axially in the body (11) of the chassis
30 module (2), the axis being parallel to the rounded edge (4).

13. The electronic device (1) according to any one of claim 10 to 12, wherein the rollers (10) are co-axially disposed adjacent opposite ends of the first part (5) of the magnetic pair.

14. The electronic device (1) according to any one of claims 1 to 13, wherein the magnetic attraction between the first part (5) and the second part (9) of the magnetic pair is sufficient to prevent bulging of the rolling display arrangement (3).

15. The electronic device (1) according to any one of claims 1 to 14, wherein the first part (5) of the magnetic pair is provided on both sides of the body (11) of the chassis module (2) to prevent bulging on both sides of the electronic device (1).

16. The electronic device (1) according to any one of the claims 1 to 15, wherein the second part (9) of the magnetic pair is arranged in a section of the rolling display arrangement (3) opposing the first part (5) of the magnetic pair when the rolling display arrangement (3) is in the retracted (P1), extended (P3) and any intermediary position (P2).

17. The electronic device (1) according to any one of claims 1 to 16, wherein the second part (9) of the magnetic pair is present in the entire extent of the rolling display arrangement (3).

18. The electronic device (1) according to any one of claims 2 to 17, wherein the second part (9) of the magnetic pair is a metal foil provided on or incorporated in the plastic base layer of a flexible display.

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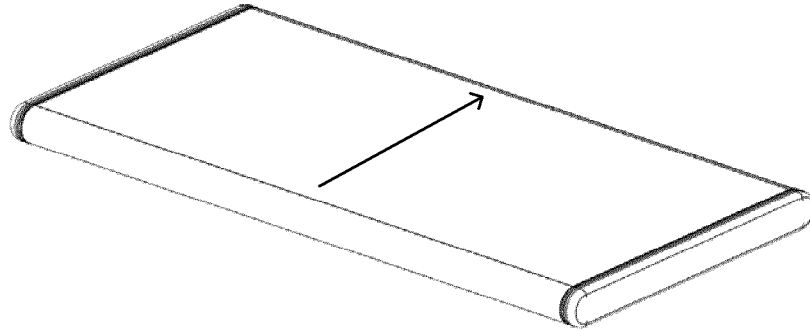


Fig. 1a (Prior art)

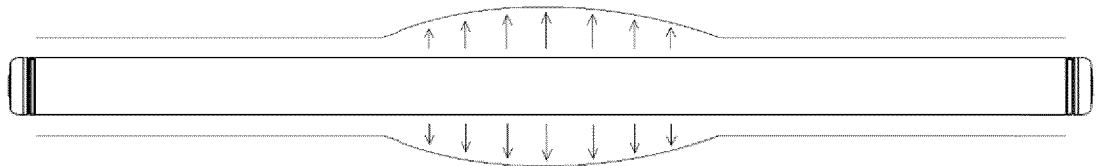


Fig. 1b (Prior art)

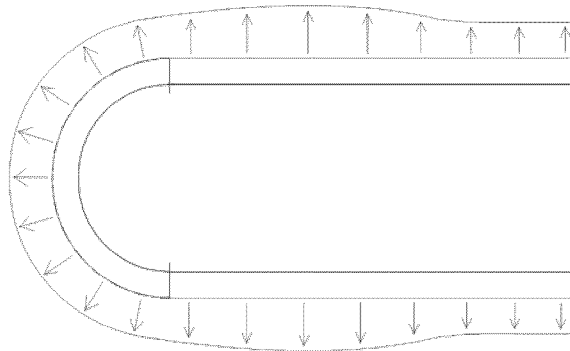


Fig. 1c (Prior art)

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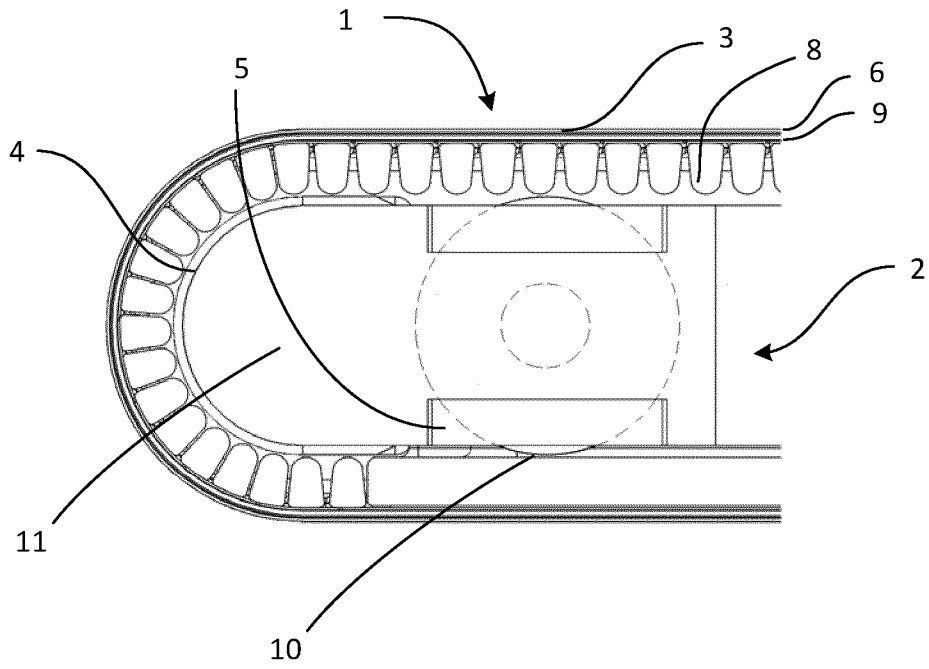


Fig. 2

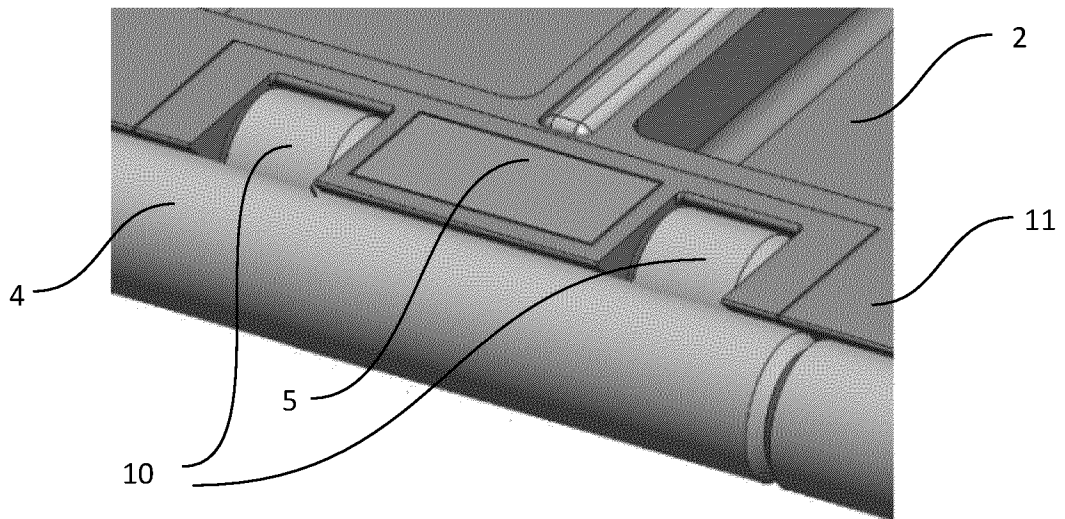


Fig. 3

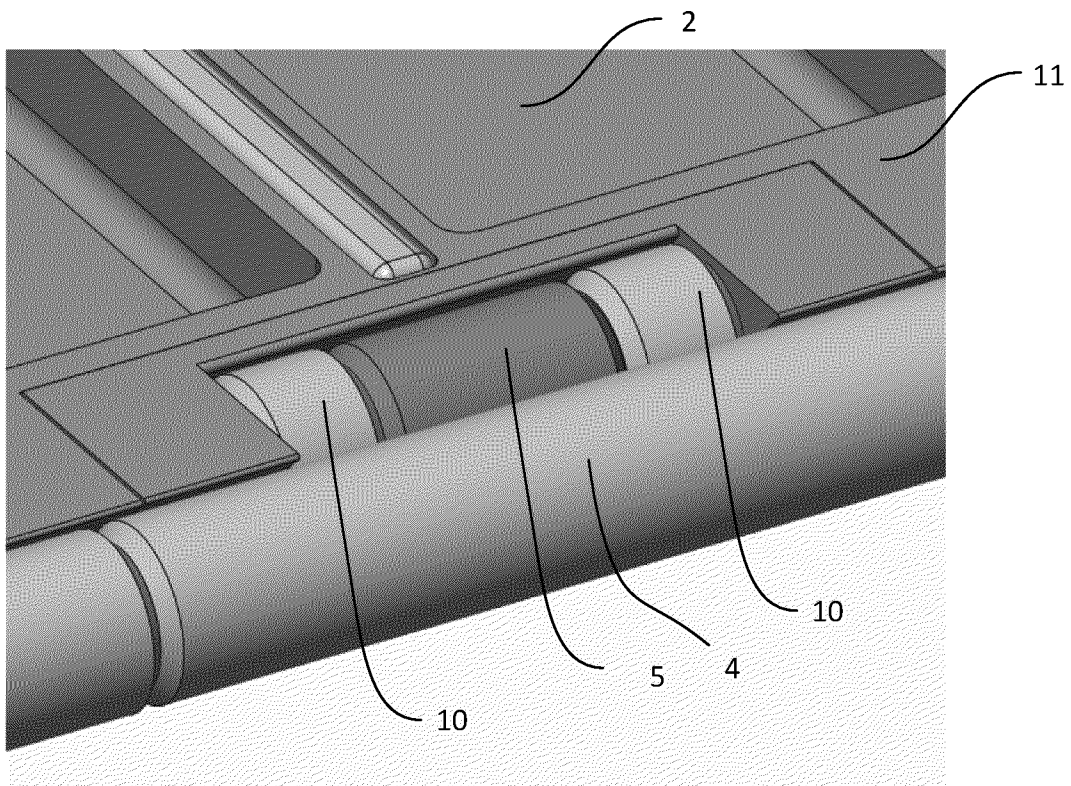


Fig. 4

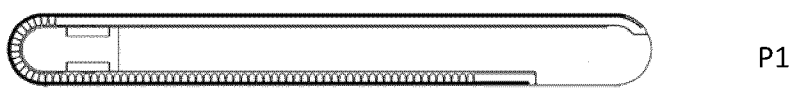


Fig. 5a



Fig. 5b

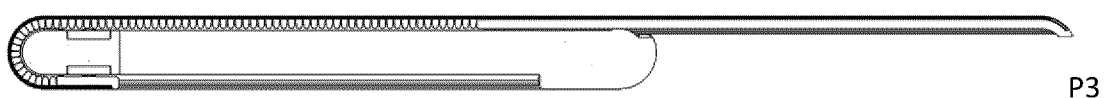
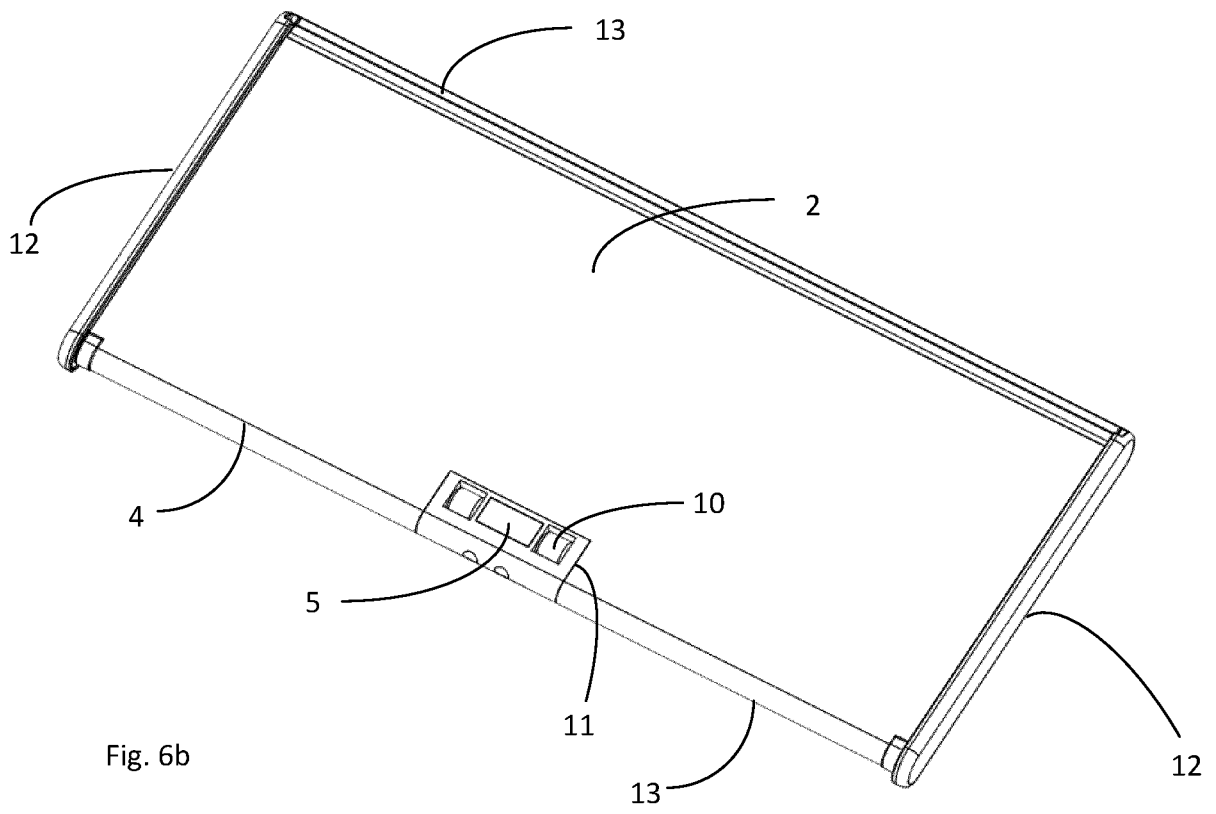
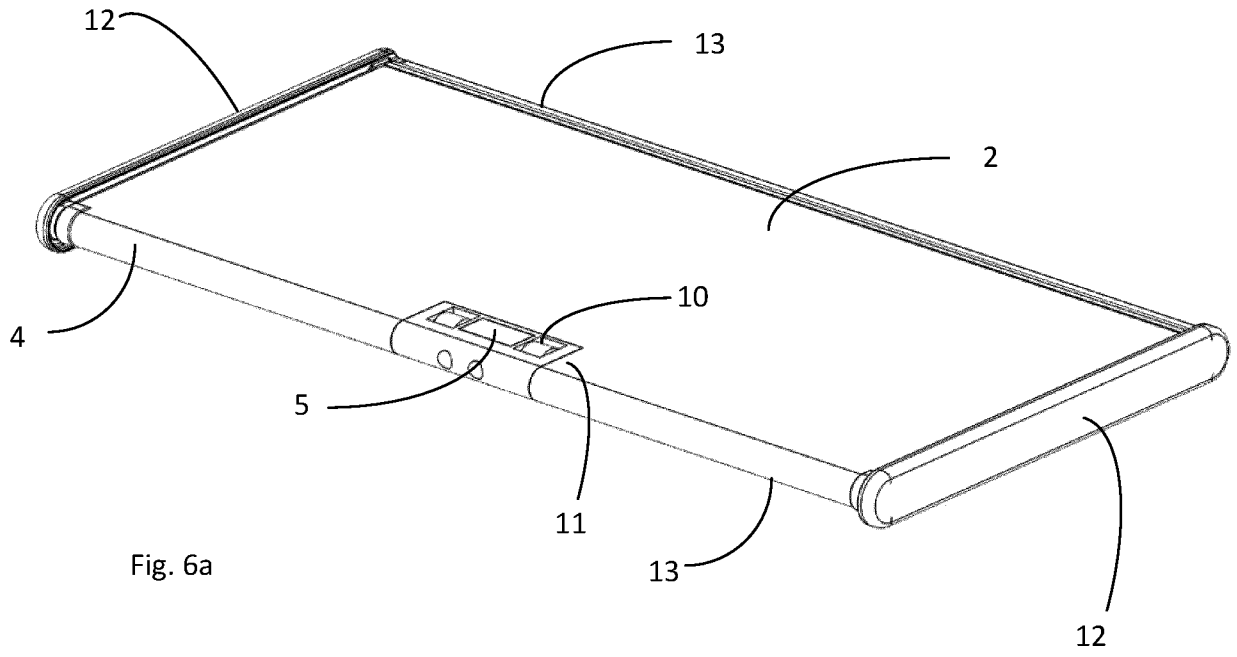


Fig. 5c



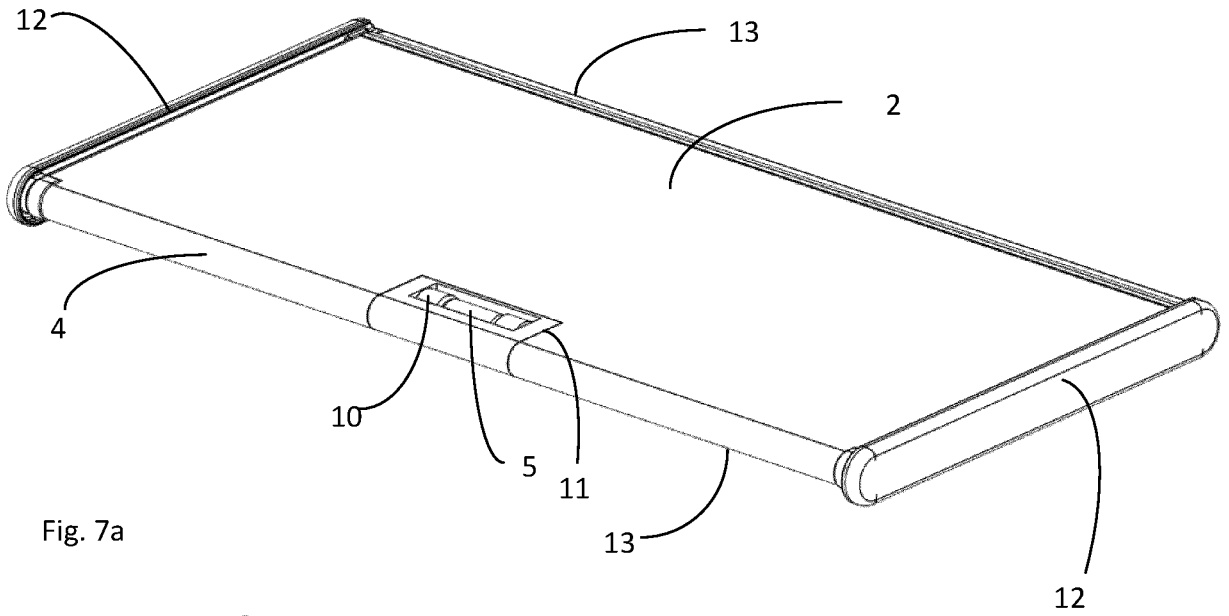


Fig. 7a

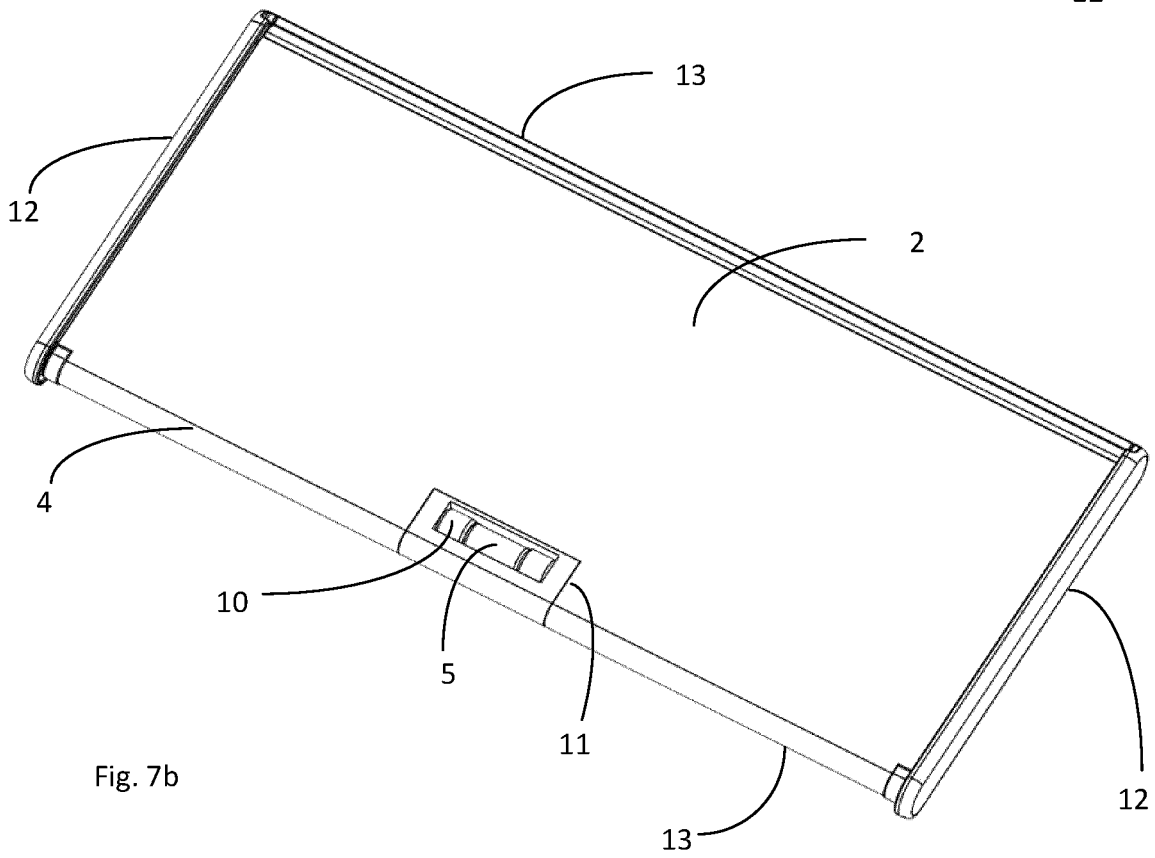


Fig. 7b

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/052453

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04M1/02 G06F1/16
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)
H04M G06F

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2019/153257 A1 (SHENZHEN ROYOLE TECHNOLOGIES CO LTD [CN]) 15 August 2019 (2019-08-15) abstract figures 6,1, paragraph [0026] paragraph [0030] - paragraph [0038] paragraph [0041] paragraph [0062]	1-10, 14-18
X	US 2018/375054 A1 (WANG WEI [CN] ET AL) 27 December 2018 (2018-12-27) abstract figures 2,5 paragraph [0004] - paragraph [0017] paragraph [0029] paragraph [0031] - paragraph [0034] ----- -/--	1-10, 14-18

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 2 October 2020	Date of mailing of the international search report 15/10/2020
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Kim-Mayser, Michael
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/052453

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/278436 A1 (CHU SHANGCHIEH [CN]) 28 September 2017 (2017-09-28) abstract figure 2 paragraph [0006] - paragraph [0014] paragraph [0026] - paragraph [0028] paragraph [0034] - paragraph [0036] -----	1-10, 14-18
A	US 2018/107250 A1 (CHO SUNHAENG [KR]) 19 April 2018 (2018-04-19) the whole document -----	1-18
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/EP2020/052453

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