INFLATABLE DEVICE WITH PRESSURE LIMITING VALVE

An inflatable device having a bladder (2) bounding a chamber (3) and a passage (4) for filling that chamber (3) is provided with a cover (6) covering a portion of the bladder (2) and with a shut-off structure (8) between the cover (6) and the bladder (2). The shut-off structure (8) has an operating member (9) extending along a first surface area (10) of the bladder (2) and a shut-off portion (11) having a second surface area (12) displaceable between a forward position at least partially shutting off the passage (4) and a retracted position clearing the passage (4). When, during inflation, a predetermined pressure has been achieved, the shut-off structure is compressed between the tensioned cover and the inflated bladder, which causes the shut-off portion to move into its forward position at least partially shutting off the passage (4).
FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>Albania</td>
<td>RS</td>
<td>Spain</td>
<td>LS</td>
<td>Lesotho</td>
<td>SI</td>
<td>Slovenia</td>
</tr>
<tr>
<td>AM</td>
<td>Armenia</td>
<td>FI</td>
<td>Finland</td>
<td>LT</td>
<td>Lithuania</td>
<td>SK</td>
<td>Slovakia</td>
</tr>
<tr>
<td>AT</td>
<td>Austria</td>
<td>FR</td>
<td>France</td>
<td>LU</td>
<td>Luxembourg</td>
<td>SN</td>
<td>Senegal</td>
</tr>
<tr>
<td>AU</td>
<td>Australia</td>
<td>GA</td>
<td>Gabon</td>
<td>LV</td>
<td>Latvia</td>
<td>SZ</td>
<td>Swaziland</td>
</tr>
<tr>
<td>AZ</td>
<td>Azerbaijan</td>
<td>GB</td>
<td>United Kingdom</td>
<td>MC</td>
<td>Monaco</td>
<td>TD</td>
<td>Chad</td>
</tr>
<tr>
<td>BA</td>
<td>Bosnia and Herzegovina</td>
<td>GE</td>
<td>Georgia</td>
<td>MD</td>
<td>Republic of Moldova</td>
<td>TG</td>
<td>Togo</td>
</tr>
<tr>
<td>BB</td>
<td>Barbados</td>
<td>GH</td>
<td>Ghana</td>
<td>MG</td>
<td>Madagascar</td>
<td>TJ</td>
<td>Tajikistan</td>
</tr>
<tr>
<td>BE</td>
<td>Belgium</td>
<td>GN</td>
<td>Guinea</td>
<td>MK</td>
<td>The former Yugoslav Republic of Macedonia</td>
<td>TM</td>
<td>Turkmenistan</td>
</tr>
<tr>
<td>BF</td>
<td>Burkina Faso</td>
<td>GR</td>
<td>Greece</td>
<td>ML</td>
<td>Mali</td>
<td>TR</td>
<td>Turkey</td>
</tr>
<tr>
<td>BG</td>
<td>Bulgaria</td>
<td>HU</td>
<td>Hungary</td>
<td>MN</td>
<td>Mongolia</td>
<td>TT</td>
<td>Trinidad and Tobago</td>
</tr>
<tr>
<td>BJ</td>
<td>Benin</td>
<td>IE</td>
<td>Ireland</td>
<td>MN</td>
<td>Mongolia</td>
<td>UA</td>
<td>Ukraine</td>
</tr>
<tr>
<td>BR</td>
<td>Brazil</td>
<td>IL</td>
<td>Israel</td>
<td>MR</td>
<td>Mauritania</td>
<td>UG</td>
<td>Uganda</td>
</tr>
<tr>
<td>BY</td>
<td>Belarus</td>
<td>IS</td>
<td>Iceland</td>
<td>MW</td>
<td>Malawi</td>
<td>US</td>
<td>United States of America</td>
</tr>
<tr>
<td>CA</td>
<td>Canada</td>
<td>IT</td>
<td>Italy</td>
<td>MX</td>
<td>Mexico</td>
<td>UZ</td>
<td>Uzbekistan</td>
</tr>
<tr>
<td>CF</td>
<td>Central African Republic</td>
<td>JP</td>
<td>Japan</td>
<td>NE</td>
<td>Niger</td>
<td>VN</td>
<td>Viet Nam</td>
</tr>
<tr>
<td>CG</td>
<td>Congo</td>
<td>KE</td>
<td>Kenya</td>
<td>NL</td>
<td>Netherlands</td>
<td>YU</td>
<td>Yugoslavia</td>
</tr>
<tr>
<td>CH</td>
<td>Switzerland</td>
<td>KG</td>
<td>Kyrgyzstan</td>
<td>NO</td>
<td>Norway</td>
<td>ZW</td>
<td>Zimbabwe</td>
</tr>
<tr>
<td>CI</td>
<td>Côte d'Ivoire</td>
<td>KP</td>
<td>Democratic People’s Republic of Korea</td>
<td>NZ</td>
<td>New Zealand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CM</td>
<td>Cameroon</td>
<td>KR</td>
<td>Republic of Korea</td>
<td>PL</td>
<td>Poland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CN</td>
<td>China</td>
<td>KZ</td>
<td>Kazakhstan</td>
<td>PT</td>
<td>Portugal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CU</td>
<td>Cuba</td>
<td>LC</td>
<td>Saint Lucia</td>
<td>RO</td>
<td>Romania</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CZ</td>
<td>Czech Republic</td>
<td>LI</td>
<td>Liechtenstein</td>
<td>RU</td>
<td>Russian Federation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DE</td>
<td>Germany</td>
<td>LK</td>
<td>Sri Lanka</td>
<td>SD</td>
<td>Sudan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DK</td>
<td>Denmark</td>
<td>LR</td>
<td>Liberia</td>
<td>SE</td>
<td>Sweden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE</td>
<td>Estonia</td>
<td></td>
<td></td>
<td>SG</td>
<td>Singapore</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TITLE: Inflatable device with pressure limiting valve

TECHNICAL FIELD

The invention relates to an inflatable device which is to be inflated to a predetermined pressure. A particular example of such a device is a dunnage bag for filling or bridging free interspaces during transport of pieces of cargo to prevent shifting and abrasion of the cargo. Other examples of such inflatable devices are balloons, inflatable water crafts, and devices for positioning injured limbs.

BACKGROUND ART

An inflatable device according to the preamble of claim 1 is known from U.S. Patent 3 462 027 in which a dunnage bag is described. Generally, the prescribed practice for inflating dunnage bags and many other inflatable devices is to use a pressure gauge to check whether the required pressure has been achieved. This, however, is cumbersome procedure. Therefore a usual practice for checking the pressure in many inflatable devices is to simply press on the device and to feel how resilient it is. Obviously, this is a very unreliable method of checking the pressure of an inflated device. This is particularly true if the pressure difference with the surrounding atmosphere is in excess of 0.5 to 1.0 bar.

Dunnage bags for example typically have to be inflated to about 0.3 bar. To fill the dunnage bags, usually a compressor is used which provides a maximum pressure of about 8 bar. In practice it has been found that dunnage bags are typically inflated to pressures of up to 4.0 bar. At this pressure, a dunnage bag having a contact surface with cargo or walls of the load space of about 1 m², which is a usual size of the contact surface, exerts a force of about 4,000 kg to the cargo. Such forces often result in damaging deformation of the cargo or of the container or transport means into which it has been loaded. Another disadvantage of overinflating dunnage bags is that it leads to a substantially increased risk of punctures and explosion. This in turns entails increased costs. Not
only exploding dunnage bags, but also leaking or even empty dunnage bags form a safety hazard in that cargo is no longer prevented from shifting, which may be detrimental to the stability of the transport means and cause damage to the transport carrier and the cargo.

Also for many other inflatable devices the correct inflating pressure is critical for making full use of the properties of the device. Underinflation of an inflatable craft for example leads to a reduced stiffness of the hull while overinflation entails the risk of damage to the wall material and the seams. Underinflation of inflatable systems for fixating injured persons leads to a poor fixation while overinflation can hinder blood circulation.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a simple, low-cost solution for reliably and automatically obtaining an pressure difference with the surrounding atmosphere in a predetermined range when inflating an inflatable device.

According to the invention, this object is achieved by providing an inflatable device of the above-identified type with the characterizing features of claim 1.

When, during inflation of an inflatable device according to the invention, a pressure in a predetermined range has been achieved, the shut-off structure is compressed in the interspace between the tensioned cover and the inflated bladder. Thus, a force proportional with the pressure difference between the chamber of the bladder and of the surrounding atmosphere is exerted onto the operating member extending by the surface area of the bladder along which the operating member extends while the bladder is in inflated condition. This force is transferred to the shut-off portion and causes the surface area of the shut-off portion to move, against the pressure difference with the surrounding atmosphere in the filling passage, from its retracted position into its forward position at least partially shutting off the filling passage.
For inflating an inflatable device according to the invention, it is sufficient to connect a pressure source to the filling passage and to inflate the device until the flow of air into the device is stopped or substantially restricted by the shut-off structure. The invention does not only prevent overinflation, but can also be used to assure that a predetermined minimum pressure is achieved by inflating a device until the shut-off structure is activated in response to a predetermined pressure in the chamber. The pressure limiting features according to the present invention do not interfere with any measures taken to assure airtightness of the filling system.

To obstruct the filling passage against a relatively large pressure difference with the surrounding atmosphere in response to a relatively small pressure difference with the surrounding atmosphere in the bladder, various structures for transmitting a first force into a second, larger force can be used, such as a lever structure. However, a particularly simple, wear resistant shut-off structure generating sufficient force to close off the filling passage against the relative large pressure generated by a pressure source is obtained if the surface area of the operating member extending along the bladder is substantially larger than the surface area of the shut-off member which is displaceable between a forward and a retracted position.

Other objects, advantages and particular embodiments of the present invention appear from the below description in conjunction with the accompanying drawings and from the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective, cut-away view of a dunnage bag according to the present invention;

Figs. 2 and 3 are cross-sectional views of a portion of the bag according to claim 1 including the shut-off structure in different operating conditions;

Figs. 4 and 5 are more schematic cross-sectional views according to Figs. 2 and 3 of a bag according to the invention having a different shut-off structure;
Fig. 6 is a top plan view of a shut-off structure according to Figs. 4 and 5;

Fig. 7 is a schematic side view of a buoyancy bag according to the present invention; and

Fig. 8 is a cross-sectional view along the line VIII-VIII in Fig. 7.

MODES FOR CARRYING OUT THE INVENTION

In the drawings, corresponding parts of different embodiments of the device according to the invention are designated by mutually identical reference numerals.

Figs. 1, 2 and 3 show an example of an inflatable device according to the invention in the form of a dunnage bag 1 for filling up remaining space in a compartment to prevent shifting of cargo in that compartment.

The dunnage bag has a collapsible, essentially airtight bladder 2 bounding a chamber 3 and a passage 4 communicating with the chamber 3 for filling that chamber 3. The passage extends through a tube 5 of fibre-reinforced resilient PVC material or other suitable material.

A portion of the bladder 2 is covered by a cover 6. The cover 6 is dimensioned and arranged such that it is tensioned if the bladder 2 is inflated. Between the cover 6 and the bladder 2 an interspace 7 is formed, in which a shut-off structure 8 is arranged.

The shut-off structure 8 has an operating member 9 extending along a first surface area 10 of the bladder 2 and a shut-off portion 11 having a second surface area 12 displaceable between a retracted position clearing the passage 4 (Fig. 2) and a forward position at least partially shutting off the passage 4 (Fig. 3).

The surface area 10 of bladder 2 along which the operating member 9 extends is substantially larger than the surface area 12 of the shut-off portion 11 which is displaceable between positions closing off and clearing the passage 4.

To assure that the dunnage bag remains filled during transport, the filling passage is also provided with a one-way valve 13, which may be provided in the form of a conventional valve of the
type used for automobile tyres. To allow quick emptying of the
dunnage bag 1, it is further provided with a release tube 14 and a
release valve 15.

During inflation of a dunnage as shown in Figs. 1, 2 and 3,
the shut-off structure 8 is initially in a condition as shown in
Fig. 2 in which the passage 4 is open and air supplied from a
suitable pressure source connected to the valve 13 flows into the
chamber 3 via the filling passage 4. As pressure is built up in the
chamber 3, the bladder 2 commences to exert a pressure on the
operating member 9 along its surface portion 10. As the pressure in
the chamber 3 increases, the shut-off portion 11 is urged towards
its forward position by a projection 16 of the operating member 9
until the forward position of the shut-off portion 11 is achieved
and the passage 4 is substantially obstructed. Thus, overfilling of
the dunnage bag is automatically prevented. During inflation, the
activation of the shut-off structure is easily noticeable by changes
in the sound generated by the air flowing into the chamber 3 and by
the pressure source encountering a quickly increasing resistance. If
the bladder is pumped up using a hand pump or a foot pump, the
increased resistance is immediately sensed. It is noted that it is
not necessary that the obstruction of the passage 4 is complete when
the desired maximum pressure has been achieved. In practice it is
sufficient that the passage is obstructed to an extent which is
sufficient to signal that the maximum pressure has been achieved and
to slow down further filling to such an extent that users are
discouraged from trying to inflate the bladder any further.

The pressure at which the shut-off structure can simply be
determined by choosing suitable dimensions of the surfaces 10 and
12. For dunnage bags, the shut-off structure can for example be
designed to be activated in response to a pressure difference with
the surrounding atmosphere of 0.3 bar in the chamber at a maximum
filling pressure in the passage of up to 8 bar.

The pressure at which the shut-off structure 8 is activated
for obstructing the passage 4 can be dependent on the balance
between the pressure in the chamber and a counterforce generated by
the filling pressure. To reduce the pressure drop over the shut-off
structure during inflation and the dependence of the maximum
pressure in the chamber on the maximum filling pressure generated by
the available pressure source, the shut-off structure 8 is provided
with elastic members in the form of the tube 5 and a flexible
connection 17 between the operating member 9 and a support plate 18
opposite the operating member 9 for urging the shut-off portion 11
towards its retracted position. Thus, the counterforce against which
the shut-off portion 11 has to urged into its forward position by
the pressure exerted by the inflated bladder 2 onto the operating
member 9 is mainly dependent on the stiffness of the elastic members
5, 17 and only slightly dependent on the counterforces exerted by
the maximum filling pressure.

The operating member is formed by an operating plate 9 and
the passage 4 passes between this operating plate 9 and the opposite
support plate 18 opposite said operating plate 9. This provides the
advantage that a robust construction is obtained in which the
passage 4 into the chamber 3 is protected between the plates 9, 18.
Furthermore a simple construction is obtained since the two plates
9, 18 can simply be formed by folding a single plate.

The plates 9, 18 are preferably made of resilient plastic
material, such as PE, PP or Nylon. It has for example been found
that a construction a shown in Figs. 1-3 is not damaged if wheels of
a medium size fork-lift truck are driven over it.

Simplicity of construction is further enhanced since the
shut-off portion 11 is formed by a portion of flexible tubing 5
bounding the passage 4, a local projection 16 is provided closely
adjacent that tubing 5 and a support 18 is provided opposite that
projection 16 such that the wall portion 11 of the tubing 5 is urged
in a flattened condition between the projection 16 and the support
18 if the bladder 2 is in inflated condition.

The bladder 2 of the dunnage bag shown in Figs. 1-3 is made
of plastic, preferably reinforced PVC material. The cover 6 is also
made of plastic material, preferably the same material. The cover 6
is welded to the bladder 2 and provided with at least one aeration
passage 19. Thus, the bladder 2 and the cover 6 are can be
manufactured efficiently from the same material and the aeration
hole 19 allows air between the cover 6 and the bladder 2 to escape
when the bladder 2 is inflated and the cover 6 is tensioned tight by
the bladder 2 pressing against that cover 6. It is noted that the bladder and the cover can also be of different materials. The cover can for example advantageously be formed by a craft paper reinforcement of a thin PE bladder or by a netting or a belt arranged against or around the bladder.

To facilitate simultaneous positioning and filling by one person, the dunnage bag according to Figs. 1-3 comprising a hand grip 20 and the tube 5 bounding a portion of the passage 4 and extends from the hand grip 20. This facilitates holding the bag and the tube 5 in position with one hand and holding the orifice of a inflating device against the valve free end of the tube 5 with the other hand. It is noted that this feature can also be employed advantageously in a dunnage bag which is not provided with a structure for preventing overinflation.

In Figs. 4-7 relevant portions of a dunnage bag with a shut-off structure 8 according to a presently most preferred embodiment of the present invention are shown.

This shut-off structure 8 differs from the shut-off structure 8 shown in Figs. 1-3 in that the operating plate 9 is articulated to the support plate 18 by a hinge 21. Thus, the elastic force urging the shut-off portion 11 to its retracted position is not influenced by the stiffness and the curvature of the transition between the operating plate 9 and the support plate 18. This is particularly advantageous if the plates 9, 19 are made of plastic material and the bags are to be inflated at widely differing ambient temperatures.

The elastic force urging the shut-off portion 11 to its retracted position is particularly accurately controllable and independent of ambient temperatures, because the elastic members includes a metal spring 22.

The metal spring 22 is a cupped spring washer of a type which has a negative spring constant over a portion of its operating trajectory. This provides the advantage that the shut-off portion 11 is essentially maintained in its retracted position until the force exerted onto the operating plate 9 exceeds a predetermined level. Then the spring 22 quickly switches from its extended condition shown in Fig. 4 to its compressed condition shown in Fig. 5. Thus a
quick easily distinguishable action of the shut-off structure is achieved and resistance by the shut-off portion 11 during inflation up to the predetermined level is minimised.

The shut-off portion 11 is located closely to the hinge 21 between the plates 9, 10. Thus, the plates 9, 10 also function as levers increasing the force exerted by the bladder 2 to a larger force exerted onto the shut-off portion 11. Furthermore, this position of the shut-off portion 11 provides the advantage that the pressure in the chamber 3 at which the shut-off structure 8 obstructs the passage 4 is less influenced by variations in the counterforces exerted by the filling pressure and the stiffness of the tube 5. The latter is typically relatively low if ambient temperature is relatively high.

In Figs. 7 and 8 a different application of the invention to a buoyancy bag is shown. The cover is provided in the form of a belt 6 arranged around the bladder 2 which forms a buoyancy body. The operating member 9 is integrated in a housing 23 through which the passage extends and which also includes a passage through which the belt 6 extends. The shut-off portion 11 is provided in the form of a piston which is displaceable in a bore 23 traversed by the passage 4. A spring 25 is provided for urging the piston 11 into its retracted position.

During inflation of the bladder 2, the belt 6 is tensioned and urges the piston 11 towards its forward position in the bore 23 closing off the passage. The piston is moved into its forward position if the force exerted pressing the bladder 2 and the belt 6 together in the area of the shut-off structure 3 exceeds is sufficient to compress the spring 25.
CLAIMS

1. An inflatable device comprising:
   a collapsible, essentially airtight bladder (2) bounding a
   chamber (3); and
   a filling passage (4) communicating with said chamber (3) for
   filling said chamber (3);
   characterized by:
   a cover (6) covering at least a portion of said bladder (2),
   such that said cover (6) is tensioned if said bladder (2) is in
   inflated condition;
   an interspace (7) between said cover (6) and said bladder
   (2); and
   a shut-off structure (8) in said interspace (7) for at least
   partially shutting off said passage (4); wherein:
   said shut-off structure (8) has an operating member (9)
   extending along a first surface area (10) of said bladder (2), at
   least if said bladder (2) is in inflated condition, and a shut-off
   portion (11) having a second surface area (12) displaceable between
   a forward position at least partially shutting off said passage (4)
   and a retracted position clearing said passage (4).

2. A device according to claim 1, wherein said first surface
   area (10) is substantially larger than said second surface area
   (12).

3. A device according to claim 1 or 2, further including at
   least one elastic member (5, 17, 22, 25) arranged for urging said
   second surface area (12) towards said retracted position.

4. A device according to claim 3, wherein said at least one
   elastic member includes a metal spring (22, 25).

5. A device according to claim 3 or 4, wherein said elastic
   member (22) has a negative spring constant over a portion of its
   operating trajectory.

6. A device according to any one of the preceding claims,
   wherein said operating member (9) is formed by an operating plate
   and said passage (4) passes between said operating plate (9) and a
   support plate (18) opposite said operating plate (9).
7. A device according to claims 3 and 6, wherein said at least one elastic member includes a flexible connection (17) between said plates.

8. A device according to claim 6 or 7, wherein said operating plate (9) is articulated to said support plate (18).

9. A device according to claim 6 or 7, wherein said plates (9, 18) are formed of resilient plastic material.

10. A device according to any one of the preceding claims, wherein said shut-off structure (8) further includes a flexible tubing (5) bounding at least a portion of said passage (4), a local projection (16) closely adjacent said tubing and a support (18) opposite said projection (16), said second surface (12) being formed by an inner surface of a wall portion of said tubing (5) urged in a flattened condition between said projection (16) and said support (18) if said bladder (2) is in inflated condition.

11. A device according to any one of the preceding claims, further comprising a hand grip (20) and a tube section (5) bounding a portion of said passage (4) and extending from said hand grip (20).

12. A device according to any one of the preceding claims, wherein said bladder (2) is made of plastic material, said cover (6) is also made of plastic material, welded to said bladder (2) and provided with at least one aeration passage (19).
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 6 F16K15/20 F16K7/07

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)

IPC 6 F16K

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 practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 2 024 780 A (RUCKMAN) 17 December 1935 see page 1, column 2, line 23 - line 34; figure 1</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>US 1 618 676 A (REACH) 22 February 1927 see the whole document</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>EP 0 324 519 A (SCHRAM HENK) 19 July 1989 see column 3, line 38 - column 4, line 5; figures 1,2</td>
<td>1</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of box C.

**Date of the actual completion of the international search**

28 April 1997

**Date of mailing of the international search report**

22.05.97

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HJ Rivierenhoek
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+ 31-70) 340-3016

Authorized officer

Christensen, J

* Special categories of cited documents:

- **A** document defining the general state of the art which is not considered to be of particular relevance
- **E** earlier document but published on or after the international filing date
- **L** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- **O** document referring to an oral disclosure, use, exhibition or other means
- **P** document published prior to the international filing date but later than the priority date claimed

- **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
- **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
- **Y** document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- **&** document member of the same patent family
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 2024780 A</td>
<td>17-12-35</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 1618676 A</td>
<td></td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>EP 0324519 A</td>
<td>19-07-89</td>
<td>NL 8800020 A</td>
<td>01-08-89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 1238780 A</td>
<td>22-09-89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 4966185 A</td>
<td>30-10-90</td>
</tr>
</tbody>
</table>