FUEL TANK OR FILLER PIPE FOR THIS TANK

Abstract: Fuel tank or filler pipe for this tank comprising a multilayer wall constituted at least of one layer based on a reinforced thermoplastic composition and of one inner layer, intended to be in contact with the fuel, based on a non-reinforced thermoplastic composition. Use of such a tank/pipe in a hybrid vehicle.

Title: FUEL TANK OR FILLER PIPE FOR THIS TANK

Inventors: MARTIN, Philippe [BE/BE]; Rue de Ransbeek, 310, B-1 120 Bruxelles (BE).

Applicant (for all designated States except US): INERGY AUTOMOTIVE SYSTEMS RESEARCH (Societe Anonyme) [BE/BE]; Rue de Ransbeek, 310, B-1 120 Bruxelles (BE).

Priority Data: 09/02755 8 June 2009 (08.06.2009) FR

Applicant (for US only): MARTIN, Philippe [BE/BE]; Rue Jules Destree, 40, B-4040 Herstal (BE).

CRIEL, Bjorn [BE/BE]; Steenbergstraat HA, B-1750 Sint-Martens-Lennik (BE).

Agents: JACQUES, Philippe et al; Solvay SA, Intellectual Property Department, Rue de Ransbeek, 310, B-1 120 Brussels (BE).
Fuel tank or filler pipe for this tank

The present invention relates to a fuel tank or a filler pipe for this tank, and also to their use as a tank/pipe in a hybrid-engine vehicle.

Hybrid engine generally refers to the combination of a combustion engine and an electric motor.

There is a general operating principle for hybrid engines that consists in operating either the electric motor, or the combustion engine, or both at the same time, depending on the model.

One of the particular principles is as follows:
- during stationary phases (when the vehicle is stationary), both engines are shut down;
- at start-up, it is the electric motor which sets the vehicle in motion, up to higher speeds (25 or 30 km/h);
- when higher speed are reached, the combustion engine takes over;
- in the event of fast acceleration, both engines operate at the same time, which makes it possible to have accelerations equivalent to the engine of the same power, or even greater accelerations;
- in the decelerating and braking phase, kinetic energy is used to recharge the batteries (it should be noted that this functionality is not available in all the hybrid engines that are currently commercially available).

It results from this principle that the combustion engine does not operate constantly and that consequently, the purge phases of the canister (activated carbon filter that prevents fuel vapours being released to the atmosphere) cannot be carried out normally since during these purge phases air, which is optionally preheated, is circulated through the canister in order to regenerate it (i.e. in order to desorb the fuel vapours that are adsorbed therein), this air then being admitted into the engine in order to be burnt therein. Moreover, hybrid vehicles were developed in order to reduce fuel consumption and emissions of exhaust gases, which makes the engine management for burning the fuel vapours coming from the canister more complex, or even impossible, without deteriorating the engine performance.

Therefore, the fuel tanks of these engines are generally pressurized (typically to a pressure of around 300 - 400 mbar) in order to limit loading of the
canister, which is generally carried out by a functional element located after the ventilation valves, known as an FTIV (Fuel Tank Isolation Valve). This element comprises a safety valve (calibrated to the maximum working pressure of the tank) and an electric control in order to be able to bring the tank to atmospheric pressure before filling. As a result, these tanks must have, compared to the fuel tanks of conventional combustion engines, an improved mechanical strength, in particular in the case of plastic tanks.

The solution currently on the market consists of a metal tank of important thickness, which considerably increases the weight of the tank and thus increases the fuel consumption and the exhaust gas emissions.

Other known solutions to the aforementioned pressure problem may consist of an increase in the wall thickness of plastic tanks and/or in the use of internal reinforcements (rods, partitions, etc.) connecting the two walls together, but these solutions generally adversely affect the weight, reduce the working volume of the tank and increase the cost of the tank. Another solution may consist in providing the tank with attachment studs (or kiss points i.e. local welds of the lower wall and of the upper wall), but this solution leads to a reduction of the working volume of the tank.

Another solution is that described in patent US 5,020,687 which consists in attaching a reinforcing fabric to the outer wall of the tank, this attachment taking place by overmoulding said fabric during the manufacture of the tank by extrusion-blow moulding, the fabric being introduced into the mould prior to the introduction of the parison which, after blow moulding, will give the tank.

However, this solution has several drawbacks:

- the fabric in fact exerts only a local reinforcement, at the location where it is attached;
- in the long term, the diffusion of fuel vapours through the tank wall may lead to problems of swelling, or even of loss of adhesion of the fabric to the tank wall, hence reducing the reinforcing effect;
- by virtue of the technique used, there are limitations in terms of fabric thickness and/or mould geometry;
- and lastly: such a type of reinforcement is relatively expensive.

One subject of the present invention is therefore a fuel tank or a filler pipe for this tank which has good long-term mechanical strength without suffering from the aforementioned drawbacks.
It is based on the idea of using a reinforced plastic composition, i.e. a plastic in which a reinforcement (in particular, a fibrous reinforcement) has been dispersed/mixed (for example: in the molten state of the plastic, using an extruder), which is known *per se*, but not using such a composition in the inner layer of a multilayer tank (i.e. the one which is in contact with the fuel), but only in the outer layer and/or in an intermediate layer, where appropriate. The applicant has in fact observed that when the inner layer of the tank comprises a reinforcement (in particular: when it comprises fibres), the impact strength of the tanks was greatly reduced, to the extent that they no longer pass the standards imposed by motor vehicle manufacturers. On the other hand, on condition that a non-reinforced inner layer is provided that has a sufficient thickness (the value of which depends on the composition of said layer, but which is generally at least 20%, or 30% or even 40% of relative thickness), such a reduction is no longer observed, and even better: a substantial improvement is even observed in certain cases.

The present invention therefore relates to a fuel tank or filler pipe for this tank comprising a multilayer wall constituted at least of one layer based on a reinforced thermoplastic composition and of one inner layer, intended to be in contact with the fuel, based on a non-reinforced thermoplastic composition.

The fuel for which the tank/pipe according to the invention is intended may be petrol, diesel, a biofuel, etc. and may have an alcohol content of 0 to 100%.

The expression "tank or pipe" is understood to mean any tank or pipe obtained by moulding or by coextrusion of at least the two aforementioned layers.

A moulding operation that can be used for the manufacture of a tank or pipe of finite length in accordance with the invention may be of any nature, as long as it includes the use of a mould that determines the shape of the tank or of the pipe. This moulding operation may be carried out, for example, starting from a preform or directly by introducing the gelled thermoplastic into the mould.

The moulding operation may also be coupled, in particular, to a blow-moulding operation. It may also be followed by a subsequent assembly step, especially by welding. If the moulding operation is carried out starting from a preform, this preform may be obtained, in particular, by coextrusion or coinjection.

Very good results have been obtained using moulding by coextrusion-blow moulding, moulding by coinjection-welding or else moulding by thermoforming.
Preferably, the multilayer tank or pipe is produced by coextrusion-blow moulding. In the latter case, it is possible to use a continuous extrusion technique or else an accumulating extrusion technique or a sequential extrusion technique, all techniques that are well known to those skilled in the art.

The term "thermoplastic" is understood to mean any thermoplastic polymer, including thermoplastic elastomers, and also blends thereof. The term "polymer" is understood to mean both homopolymers and copolymers (especially binary or ternary copolymers), for example random copolymers, linear block copolymers, other block copolymers and graft copolymers, etc.

The plastic of the inner layer and that of the reinforced layer may be (and preferably are) of the same nature. In the case of fuel tanks, this is generally a polyolefin. The term "polyolefin" is understood to mean any olefin homopolymer, any copolymer containing at least two different olefins and any copolymer comprising at least 50% by weight of units derived from olefins.

Several polyolefins may also be used in the blend. More particularly, the blend may contain a certain proportion of recycled polyolefin in addition to the virgin polyolefin, or else a certain proportion of a blend of recycled resins originating (i) from the grinding of scrap obtained at various stages of the manufacture of the multilayer tank or pipe and/or (ii) from the recycling and treatment of end-of-life fuel tanks. The blend may also comprise a polyolefin of plant origin or from another renewable source (biomaterials).

Preferably, the polyolefin is a polyethylene. Very good results have been obtained with a high-density polyethylene (HDPE).

The plastic compositions may comprise customary additives such as one (or more) stabilizer(s), lubricant(s), pigment(s) and other "fillers" provided however that the additive(s) of the inner layer do not have a reinforcing effect and/or are present in an amount such that they do not have a significant effect on its mechanical properties.

The term "reinforced" is understood, within the context of the present invention, to mean comprising a (mixture of) reinforcement(s) in the dispersed state (i.e. in the form of "free" particles, mixed with the plastic, as opposed to woven or entangled particles (fibres) as in a woven fabric or a mat), in an amount such that it has a significant influence on the mechanical properties of the composition. At this stage a distinction should be made between (i) microscopic fillers/reinforcements for which a significant influence on the properties is obtained with high filling levels (typically greater than 10%) and (ii) nanofillers
for which large variations in properties are obtained with only a few % of reinforcements.

Generally, these are fibrous reinforcements (carbon fibres, natural fibres, glass fibres, etc.), beads (for example glass beads, generally hollow beads) or platelets (talc, clays, montmorillonite, vermiculite, expanded graphite, graphene for example). They are preferably fibres. Powders (carbon black, chalk, talc, barium sulphate, etc.) are not generally considered to be reinforcements within the context of the invention except, of course, for those which could have a significant impact on the mechanical properties of the composition. Glass fibres give good results within the context of the invention, and, in particular, short and long glass fibres. For the short fibres, good results have been obtained by dispersing, in HDPE, fibres based on E-type glass (in particular provided with a sizing agent and/or a compatibilizer such as PE-g-MAH), having a diameter between 10 and 20 µm and an initial length between 2 and 8 mm.

According to one preferred variant, glass fibres are chosen as the reinforcement that are incorporated (preferably homogeneously, generally by mixing in an extruder in order to make masterbatch granules) in an amount of 10-50% (by weight versus the complete weight of the mixture), or even 20-40%, a content of around 30% generally giving good results, in particular in an intermediate layer and very particularly in a layer made from grindings as described above.

Indeed, the applicant has blow moulded bottles respectively based on virgin HDPE (Lupolen ® 4261 AG, density of 0.945 g/cm³ and HLMI of 6 g/10 min (190°C/21.6 kg)) in a single-layer structure, and bottles based on this same HDPE but that comprise a layer of industrial regrinds of 6-layer tanks as defined above, between 2 layers of virgin PE of around 45% relative thickness (with respect to the total thickness of the wall) for the inner layer and 20% relative thickness for the outer layer. The applicant varied, over several tests, the content of glass fibres and observed respectively the properties that appear in the table that appears at the end of the present description.

In particular when it comprises at least one polyethylene-based layer, the tank according to the invention preferably also comprises a barrier layer and/or has preferably been subjected to a surface treatment (for example: to a fluorination or a sulphonation of its inner layer). It preferably comprises a barrier layer also made of a thermoplastic, which is generally either the inner, non-
reinforced layer of the tank, or an intermediate layer between the inner layer and the reinforced layer.

The barrier resin that can be used within the context of this variant of the invention may be of any nature known to those skilled in the art as long as it is a polymer or copolymer that is compatible with the moulding technique in question. It may also be a mixture of various barrier resins. Among the resins that can be used, mention is especially made of polyamides or copolyamides, or random ethylene/vinyl alcohol (EVOH) copolymers.

The term "polyamide" is understood to mean any homopolymer based on an amide unit, any copolymer comprising at least two different amide units and any copolymer comprising at least 50% by weight of units derived from an amide. It does not matter whether the amide units of this definition are obtained by the opening of the ring of a cyclic polyamide or by the polycondensation of a dicarboxylic acid with a diamine. Several polyamides may also be used as a blend. As examples of polyamides that can be used, mention may be made, non-limitingly, of: PA-6, PA-11, PA-12 and n-mXD6 (polyarylamide). PA-6 is generally preferred.

Advantageous results have been obtained in the case where the barrier resin is EVOH and in particular with an intermediate EVOH-based barrier layer between 2 layers of HDPE (generally by means of interposing two layers of PE-based adhesive at the 2 EVOH/HDPE interfaces). Advantageous results have also been obtained in the case where the barrier resin is a polyarylamide of n-mXD6 type constituting the inner layer of the structure.

The layer comprising the barrier resin may also comprise certain additives well known to those skilled in the art, which additives may or may not be polymeric, such as stabilizers, lubricants, etc.

Preferably, the layer comprising the barrier resin is essentially constituted of the barrier resin.

Generally (and this is incidentally the case with HDPE and EVOH or HDPE and the polyamide), the barrier resin and the thermoplastic resin of the other layers of the tank/pipe are not compatible. Therefore, generally at least one, or even two, layer(s) of adhesive is (are) provided between the barrier layer and the layer or the 2 other layers in contact with it. Alternatively or in addition, an adhesive that is compatible with the thermoplastic resin may be blended with this resin.
Preferably, the adhesive in question above comprises at least one functionalized polyolefin.

The expression "functionalized polyolefin" is understood to mean any polyolefin comprising, in addition to the units derived from olefins, functional monomer units. These functional monomer units may be incorporated into the polyolefin, either into the main chain, or into the side chains. They may also be incorporated directly into the backbone of said main and side chains, for example by copolymerization of one or more functional monomers with the olefin monomer(s) or else may result from the grafting of one or more functional monomers to said chains, after the manufacture of the polyolefin. In this case, the polyolefin/functionalized polyolefin blend may especially be produced in a single step, by reactive processing during the gelling step included in the process for manufacturing the tank or pipe.

In this variant of the invention, the functional monomer units are chosen from carboxylic acids, dicarboxylic acids and anhydrides corresponding to said dicarboxylic acids. Therefore, these units generally result from the copolymerization or grafting of at least one unsaturated monomer having these same functional groups. As examples of monomers that can be used, mention is especially made of acrylic acid, methacrylic acid, maleic acid, fumaric acid, itaconic acid, maleic anhydride, fumaric anhydride and itaconic anhydride.

Preferably, the functional monomer units result from the copolymerization or grafting of maleic anhydride.

The functionalized polyolefins thus described are well known to those skilled in the art and are commercially available.

In the case where the polyolefin is a polyethylene, it is particularly advantageous for the functionalized polyolefin to be a polyethylene grafted by means of maleic anhydride (PE-g-MAH), that is to say that the functional monomer units result from the grafting of maleic anhydride onto a polyethylene.

The multilayer tank or pipe according to the invention may advantageously comprise one or more additional layers comprising a recycled plastic, preferably as an intermediate layer (i.e. a layer located between 2 other layers).

The expression "recycled plastic" is understood to mean a plastic obtained by grinding the scraps obtained at various stages of the manufacture of a hollow body, in particular the tank/pipe according to the invention, or by grinding such objects at the end of their life time.

In this variant, the reinforcement may be incorporated into the recycled
plastic layer(s). For doing this, it is enough to collect the particles from the
described process and mix them with granules of a masterbatch
comprising the filler and then feed this mixture into an extruder of the
aforementioned coextrusion-blow moulding installation. Alternatively, the
regrinds may be used for the manufacture of a masterbatch having the desired
reinforcement content. This variant is preferred as it enables the grindings to be
reused as much as possible.

In one particularly advantageous embodiment of multilayer tank or pipe
according to the invention, the latter comprises 6 layers: an inner layer (I) based
on non-reinforced HDPE, a first layer of adhesive (A1) preferably based on PE-
g-MAH, a layer comprising a barrier resin (B) (preferably, EVOH), a second
layer of adhesive (A2) preferably based on PE-g-MAH, a layer based on recycled
resin (R) comprising a reinforcement (preferably, glass fibres) and an outer layer
(E) based on HDPE.

In this embodiment, it is advantageous for the relative distribution of the
thicknesses to be as follows (for a total thickness of 1 to 10 mm, or even of 3 to 7
mm; generally in the vicinity of 6 mm): I: 30-50%, A1: 1-3%, B: 1-3%, A2: 1-
3%, R: 30-60%, E: 5-20%. The following structure is advantageously used (to
within a few %): 39/2/2/2/45/10 as % of the total thickness for each of the layers

According to one particular embodiment, the layer E (in contact with the
atmosphere) comprises a compound based on carbon black for the purpose of
protecting against UV radiation.

Multilayer structures having 2 or 3 layers including one (inner) layer based
on n-MXD6, one layer based on reinforced HDPE (optionally containing
adhesive) and optionally one layer of adhesive (if the HDPE layer does not
contain any) are also advantageous.

The present invention also relates to the use of a tank/pipe as described
above as a fuel tank for a hybrid vehicle. This tank/pipe may also be used in a
conventional vehicle, where the reinforcing effect obtained may be taken
advantage of to avoid the use of the metal straps that are generally used to
prevent the creep of the lower wall of the tank when the tank is fastened to the
bottom of the vehicle body.

It should also be noted that the reinforcing effect obtained by the subject of
the invention may be combined with the use of other known reinforcements such
as straps, attachment studs, internal reinforcements (rods, partitions),
overmoulded fabrics, etc. mentioned above and any other type of both internal and external reinforcement.

The combination of the invention with these known techniques makes it possible to reduce the size and/or the amount of attachment studs, internal reinforcements (rods, partitions), overmoulded fabrics, etc. Thus the weight of the final solution is minimized and the working volume of the tank is maximized.
Examples 1 to 4: 1-litre flasks; examples 5 to 10: 3-litre flasks; examples IR and 5R: single-layer flasks and the other examples: multilayer flasks having inner (I)/intermediate (R)/outer (E) layers of relative thicknesses 45/40/15 approximately, the inner layer (I) being based on regrinds; the letter R indicates that it is a comparative example (not in accordance with the invention); 

(1) Examples 1 to 4: 1-litre flasks; examples 5 to 10: 3-litre flasks; examples IR and 5R: single-layer flasks and the other examples: multilayer flasks having inner (I)/intermediate (R)/outer (E) layers of relative thicknesses 45/40/15 approximately, the inner layer (I) being based on regrinds; the letter R indicates that it is a comparative example (not in accordance with the invention); 
(2) layer containing glass fibres; 
(3) flasks filled to 90% with a water/ethylene glycol (60/40) mixture, conditioned for 16 h at -40°C and that were dropped from a height of 6 m; 
(4) and (5): according to the ISO 527/1 standard; 
(6) compared to a single-layer flask (tests IR and 5R). Deformation of the flask at mid-height under a pressure of 500 mbar at ambient temperature measured by a GOM image acquisition system.
CL A I M S

1 - Fuel tank or filler pipe for this tank comprising a multilayer wall constituted at least of one layer based on a reinforced thermoplastic composition and of one inner layer, intended to be in contact with the fuel, based on a non-reinforced thermoplastic composition.

2 - Multilayer tank or pipe according to Claim 1, produced by coextrusion-blow moulding.

3 - Multilayer tank or pipe according to either one of the preceding claims, in which the reinforced thermoplastic composition contains a fibrous reinforcement.

4 - Multilayer tank or pipe according to the preceding claim, in which the reinforcement comprises glass fibres.

5 - Multilayer tank or pipe according to the preceding claim, in which the glass fibre content of the reinforced layer is between 10 and 50%.

6 - Multilayer tank or pipe according to any one of the preceding claims, the wall of said tank/pipe comprising a barrier layer between 2 HDPE layers or in direct contact with the inside of the tank or of the pipe.

7 - Multilayer tank or pipe according to any one of the preceding claims, the wall of said tank comprising a layer based on recycled plastic.

8 - Multilayer tank or pipe according to the preceding claim, in which the reinforcement is included in the intermediate layer based on recycled plastic.

9 - Multilayer tank or pipe according to the preceding claim, said tank/pipe comprising 6 layers: an inner layer (I) based on non-reinforced HDPE, a first layer of adhesive (A1) preferably based on PE-g-MAH, a layer comprising a barrier resin (B) (preferably, EVOH), a second layer of adhesive (A2) preferably based on PE-g-MAH, a layer based on recycled resin (R) comprising a reinforcement (preferably, glass fibres) and an outer layer (E) based on HDPE.

10 - Use of a tank/pipe according to any one of the preceding claims, as a fuel tank/pipe for a hybrid vehicle.
INTERNATIONAL SEARCH REPORT

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C49/04 B29C49/20 B60K15/03 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)
B29C B60K

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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document with indication of the relevant passages</th>
<th>Relevant to claim No</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>WO 2005/113278 A1 (ENERGY AUTOMOTIVE SYSTEMS RES [BE]; POTIER VINCENT [BE]; LACOMBE PIERRE) 1 December 2005 (2005-12-01) page 3, line 29 - page 4, line 7 page 7, line 22</td>
<td>1-6,10</td>
</tr>
<tr>
<td>A</td>
<td>WO 2007/093006 A1 (RODGERS WILLIAM [AU]) 23 August 2007 (2007-08-23) figures 1,2</td>
<td>1,3-5,10</td>
</tr>
<tr>
<td>A</td>
<td>-/-</td>
<td>2,6-9</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C

See patient 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
E: earlier document but published on or after the international filing date
L: document which may throw doubts on the novelty of the invention (as specified)
D: 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

Date of the actual completion of the international search
21 July 2010

Date of mailing of the international search report
29/07/2010

Name and mailing address of the ISA/Authorized officer
European Patent Office, P B 5616 Patentliaan 2 NL - 2280 HV Rijswijk Tel (+31-70) 340-2040, Fax (+31-70) 340-3016
Lindner, VoIker
<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>the whole document</td>
<td>2</td>
</tr>
<tr>
<td>X</td>
<td>US 5 799 817 A (SHARP BRUCE R [US])</td>
<td>1,3-5,10</td>
</tr>
<tr>
<td>A</td>
<td>1 September 1998 (1998-09-01) figure 4</td>
<td>6-9</td>
</tr>
<tr>
<td>X</td>
<td>US 6 033 749 A (HATA NOBUHIRO [JP] ET AL)</td>
<td>1,3-8,10</td>
</tr>
<tr>
<td>A</td>
<td>7 March 2000 (2000-03-07) the whole document</td>
<td>2,9</td>
</tr>
<tr>
<td>A</td>
<td>the whole document</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>JP 2004 176898 A (TORAY INDUSTRIES)</td>
<td>1,10</td>
</tr>
<tr>
<td>A</td>
<td>24 June 2004 (2004-06-24) the whole document</td>
<td></td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>DE 102004009365 A1</td>
<td>09-09-2004</td>
<td>JP 2004256096 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1950234 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2870171 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2007537393 T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2007289580 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2640568 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 101460299 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EA 200801857 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1991413 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2009533238 T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 20080108243 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2009304962 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZA 200807931 A</td>
</tr>
<tr>
<td>US 5344038 A</td>
<td>06-09-1994</td>
<td>NONE</td>
</tr>
<tr>
<td>us 5799817 A</td>
<td>01-09-1998</td>
<td>NONE</td>
</tr>
<tr>
<td>us 6033749 A</td>
<td>07-03-2000</td>
<td>NONE</td>
</tr>
<tr>
<td>us 2002110658 A1</td>
<td>15-08-2002</td>
<td>WO 20064436 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 200496611 A1</td>
</tr>
<tr>
<td>JP 2004176898 A</td>
<td>24-06-2004</td>
<td>NONE</td>
</tr>
</tbody>
</table>