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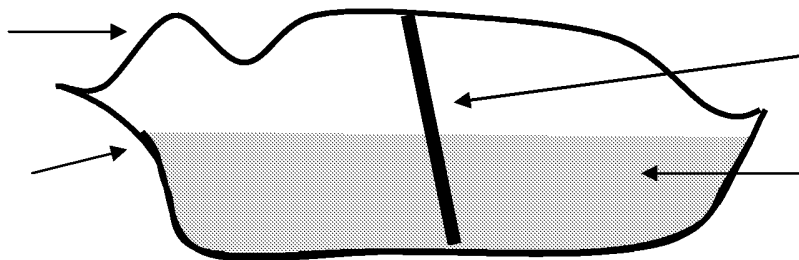
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(54) Title: METHOD FOR MANUFACTURING A PLASTIC FUEL TANK WITH IMPROVED CREEP STRENGTH



(57) Abstract: Method for manufacturing a plastic fuel tank with improved creep strength, whereby: a) a plastic parison comprising two distinct parts is inserted into an open two-cavity mould; b) a core is inserted inside the parison, the said core bearing at least part of a reinforcing element capable of securing (creating a link between) the two parts of the parison; c) the parison is pressed firmly against the mould cavities (by blowing through the core and/or creating suction behind the cavities); d) (the part of) the reinforcing element is fixed to at least one of the parts of the parison using the core; e) the core is withdrawn; f) the mould is closed again, bringing its two cavities together in such a way as to grip the two parts of the parison around their periphery in order to weld them together; g) a pressurized fluid is injected into the mould and/or a vacuum is created behind the mould cavities in order to press the parison firmly against the mould cavities; h) the mould is opened and the tank is extracted.

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Method for manufacturing a plastic fuel tank with improved creep strength

The present invention relates to a method for manufacturing a plastic fuel tank with improved creep strength.

Plastic fuel tanks intended for motor vehicles have to meet specifications that specify maximum permissible amplitudes of deflection on their lower skin.

5 The deflections stated in these specifications usually have to be met during ageing tests in which the tank contains a certain quantity of fuel for a given period of time (typically several weeks) and at temperature (usually 40°C). The purpose of these specifications is to ensure that vehicles maintain their road clearance and to prevent the skin of the tank coming into contact with hotspots of
10 the vehicle.

At the present time, plastic fuel tanks are generally fixed to the chassis of the vehicle via plastic lugs and are supported by metal straps. The latter are used in particular on the more capacious tanks where compliance with maximum permissible deflections is more difficult. However, recourse to these straps
15 involves an additional attachment step and is therefore not very economical.

Solutions have been proposed in the prior art with a view to enhancing the mechanical strength (including the creep strength) of fuel tanks.

Thus, it has been proposed (particularly in US Patents 3,919,373 and 4,891,000) that an insert be secured inside the tank at the time of its blow-
20 moulding from a cylindrical parison. However, it is not easy to position the insert accurately using this technique.

It has also been proposed (in US Application 2002/0100759) that the two walls of the tank be secured together directly by welding. However, this results in a loss of useful tank volume (as a result of the inflection of the said walls at the welding seam).

25 It is therefore an object of the invention to provide a method that is able to strengthen a fuel tank and, more specifically, increase its creep strength and to do so easily and reliably without any loss in useful volume.

To this end, the invention relates to a method for manufacturing a plastic fuel tank with improved creep strength, whereby:

- 30 a) a plastic parison comprising two distinct parts is inserted into an open two-cavity mould;
- b) a core is inserted inside the parison, the said core bearing at least part of a

reinforcing element capable of securing (creating a link between) the two parts of the parison;

- c) the parison is pressed firmly against the mould cavities (by blowing through the core and/or creating suction behind the cavities);
- 5 d) (the part of) the reinforcing element is fixed to at least one of the parts of the parison using the core;
- e) the core is withdrawn;
- f) the mould is closed again, bringing its two cavities together in such a way as to grip the two parts of the parison around their periphery in order to weld
- 10 them together;
- g) a pressurized fluid is injected into the mould and/or a vacuum is created behind the mould cavities in order to press the parison firmly against the mould cavities;
- h) the mould is opened and the tank is extracted.

15 The term "fuel tank" is intended to denote a sealed tank able to store fuel under diverse and varying environmental and usage conditions. An example of this tank is a tank fitted to motor vehicles.

The fuel tank produced according to the method according to the invention is made of plastic, that is to say of a material comprising at least one synthetic

20 resin polymer.

All types of plastic may be suitable. Particularly suitable plastics come from the thermoplastics category.

The term "thermoplastic" denotes any thermoplastic polymer, including thermoplastic elastomers, as well as blends thereof. The term "polymer" denotes

25 both homopolymers and copolymers (especially binary or ternary copolymers). Examples of such copolymers are, nonlimitingly, random copolymers, linear block copolymers, other block copolymers and graft copolymers.

Any type of thermoplastic polymer or copolymer whose melting point is below the decomposition temperature is suitable. Synthetic thermoplastics that

30 have a melting range spread over at least 10 degrees Celsius are particularly suitable. Examples of such materials include those that exhibit polydispersion in their molecular weight.

In particular, polyolefins, thermoplastic polyesters, polyketones, polyamides and copolymers thereof may be used. A blend of polymers or

35 copolymers may also be used, as may a blend of polymer materials with inorganic, organic and/or natural fillers, such as, for example, but nonlimitingly,

carbon, salts and other inorganic derivatives, natural fibres or polymeric fibres. It is also possible to use multilayer structures consisting of stacked layers bonded together comprising at least one of the polymers or copolymers described above.

One polymer which is often used is polyethylene. Excellent results have
5 been obtained with high density polyethylene (HDPE). As a preference, the tank also comprises a layer of a resin impermeable to the fuel, such as EVOH, for example (a copolymer of ethylene and partially hydrolysed vinyl acetate). Alternatively, it may be subjected to a surface treatment (fluorination or
sulphonation) the purpose of which is to render it impermeable to the fuel.

10 According to the invention, the parison is introduced into a mould comprising at least two cavities (external parts) and one core (internal part). This mould is generally based on metal, and, as a preference, based on separate and assembled metal blocks.

In the method according to the invention, the core allows at least part of a
15 reinforcing element intended to secure (create a link between) the two parts of the parison (the future upper and lower walls of the tank) to be fixed. For convenience and in order to shorten the terms used, the term "reinforcing element" will be used hereinafter, it being understood that this may be just part of such an element. This reinforcing element is preferably substantially rigid, i.e.
20 not very deformable.

The method according to the invention therefore uses a core. That means a part of a size and a shape suitable for insertion between the mould cavities. Such a part is described, for example in Patent GB 1,410,215, the content of which for this purpose is incorporated by reference into the present application. The core
25 may be equipped with heating parts (mirrors for example) enabling a part of the accessory that is to be welded (which is generally preheated, for example by infrared heating, beside the core) to be kept hot. It may also be equipped with heating parts (for example filaments) in the region or regions to be in contact with the parison during placement of the reinforcing elements (see later).

30 The core may also serve to lower pressurized gas into the mould in order to press the parison firmly against the mould cavities.

Finally, the core may also be used to at least partially effect process control. To do this, it is possible, for example to incorporate a camera into the mould in order to watch and monitor the quality of the fixing of the reinforcing
35 elements (and any other accessories there might be) through image analysis. One or more sensor(s) for measuring (a) parameter(s) such as the force, the travel, the

pressure and the temperature may also be installed on the core in order to better monitor the attachment of the elements to the parison.

According to the invention, the parison (or molten or softened plastic component ready for moulding) is made up of at least two separate parts which preferably have a similar structure. What this means is that they comprise a number of layers that do not differ from one another by more than 3 units and, for preference do not differ by more than 2 units and that the nature of the polymers involved in the layers that correspond to one another is compatible from a chemical viewpoint and from the point of view of its ability to be assembled by welding. Structures having the same number of layers and, in particular, identical structures, are preferred. These two separate parison parts are intended to form the upper wall and the lower wall of the tank respectively.

In the method according to the invention, the tank is moulded in a single piece (in a single step after which a one-piece tank is obtained without having to resort to an additional step of assembling separate shells) from a parison made in at least two parts, this generally being achieved by welding the two parison parts together as the mould is closed. In particular, advantageously the tank is moulded by:

- blowing, i.e. expanding and firmly pressing a tubular parison comprising at least one cut-out against the walls of a mould using a pressurized fluid (as described in EP Application 1 110 697, the content of which is incorporated for this purpose by reference into the current application);
- thermoforming sheets, i.e. pressing these firmly against the walls of a mould for example by sucking (creating a vacuum) behind them.

In the method according to the invention, the actual shaping of the parison (i.e. deforming it so that it substantially acquires the shape of the tank) chiefly occurs during step c). During step f) (during which the aforementioned welded seam is made) the pressure (or suction) is simply maintained in order to maintain the dimensional stability of the tank.

In the case of a blow-moulded tank (blown using a pressurized fluid injected into the mould), as a preference the parison consists of two separate parts resulting from the patterning of one and the same extruded cylindrical parison as described in EP Application 1 110 697 in the name of the Applicant company and the content of which for this purpose is incorporated by reference into the current application. According to this variant, having extruded a single parison, the latter is cut along its entire length along two diametrically opposed

lines to obtain two separate parts (sheets). By comparison with the blow-moulding of two separately extruded sheets, the thickness of which is constant, this approach makes it possible to use parisons of varying thickness (that is to say of a thickness that is not constant along their length) obtained by an
5 appropriate extrusion device (generally an extruder equipped with a die, the position of the punch of which can be adjusted). Such a parison takes account of the reduction in thickness that occurs during blow-moulding at certain points on the parison as a result of non-constant rates of deformation of the material in the mould.

10 Alternatively, the tank may be moulded by thermoforming two sheets (or by creating a vacuum behind the mould cavities). Such a method generally leads to little or no non-uniform reductions in thickness and can therefore cope with a parison of constant thickness (extruded sheets, for example).

As a preference, the tank is blow-moulded. This is because thermoforming
15 generally entails heating the moulds to 60°C so that the deep deformations (the corners of the tank, for example) can be achieved. This results in longer cycle times than are needed with blow-moulding where this constraint does not exist.

To do this, the mould cavities are generally closed on to the core - i.e. are brought into contact with it and delimit a sealed region on either side of the core
20 - during steps c) and d). More precisely, since these cavities bear the parison, the core is in contact with the parison which is therefore sandwiched between the core and the mould cavities. This then is a kind of first closing of the mould, with the core interposed between and in contact with the cavities, and in which pressurized gas (generally air) is blown in.

25 In this case, the method according to the invention also comprises a degassing step which is performed before each opening of the mould. The degassing step may be done in any appropriate way. Generally, the parison is first of all punctured (for example by pricking it with a needle) and then the fluid is discharged from the mould (for example using a valve).

30 When the tank is moulded by thermoforming, there is no need for the mould to be closed onto the core in order to press it firmly onto the cavities (because this is done by suction under these cavities rather than by blowing via the core). In this case, all that is required is for the cavities to be positioned around (in the broadest sense: in the vicinity of) the core.

35 During the method according to the invention, there is preferably a device to prevent the edges of the parts of the parison from becoming welded together

during the first closure of the mould onto the core, if necessary. This device is advantageously incorporated into the core. For this purpose, the core preferably has a size and a shape that are appropriate for its being partly (generally over at least part of its periphery) inserted between the two parts of parison that are to be
5 welded together.

To facilitate the welding during step f), the mould cavities are advantageously provided with a thermal regulating device allowing the welding region to be heated during the steps involved in the first closure of the mould, if necessary. As a quite particular preference, the core also has such a device (a
10 thermal regulating device) in its region(s) of contact with the parison, and this particularly when the latter comprises the aforementioned welding region. This variant could further improve the quality of the welded seam of the tank (by reducing the internal bead and therefore improving the impact strength of the tank). Such a setup is described, for example in application FR 04.13407 in the
15 name of the Applicant company, the content of which for this purpose is incorporated by reference into the current application.

According to the invention, the core is equipped with the said reinforcing element before it is introduced into the parison which is itself placed in the mould. To attach the element to the parison, the core advantageously comprises a
20 hydraulic ram capable of moving the element that is to be attached and of exerting pressure thereon.

As mentioned previously, the reinforcing element may be attached to the parison in any known way. It may be done by welding the said element directly to the parison (when the material of which it is made in the fixing region is
25 compatible with that of the tank), by staking (as described in Patent FR 04.11550 in the name of the Applicant company and the content of which for this purpose is incorporated by reference into the current application), by clip-
fastening/screw-fastening (in which case the core first of all fixes a clip or an element equipped with a screw thread onto the parison and then clips/screws the
30 reinforcing element onto this), etc. One advantage of the method according to the invention is therefore that it is able to cope with various methods of attachment (welding, staking, clip-fastening, etc.) and therefore, also allows the choice of any possible material for the reinforcing element.

The expression "reinforcing element" is intended to denote any object (bar,
35 rod, cable, baffle, unit, etc. which, once the tank has been moulded, connects its lower (the one mounted facing downwards in the vehicle and which is likely to

creep under the weight of the fuel) and upper (the one mounted facing upwards and subject to little or no creep during use) walls of the tank together.

This may be an element used expressly for this purpose (a rod, a cable, etc.) or any functional device or object generally associated with the fuel tank in its customary method of use or operation and which is voluminous enough to extend from one wall to the other.

An example of such a structure which is particularly suitable is the tank pump/gauge module.

In this variant (functional element as reinforcing element) it is advantageous that, during the method according to the invention, only the support of the functional element in question be placed on the core (and therefore on the parison). This is because since tanks that do not meet the standards are ground up, it is not very economical to also have to grind up functional elements which are often expensive. In this case, therefore, the method according to the invention allows the support of the functional element which will be introduced later into the tank through an opening made therein, and then fixed to the support on the one hand and to the opening in the tank on the other hand (for example using a threaded ring) to be fixed (by clip-fastening onto a pre-moulded shape (clip) on the wall of the tank by welding, staking, etc.) using the core. Such an approach is particularly suitable for a pump/gauge module by way of functional element.

Alternatively, the reinforcing element may consist of a part specially used for this purpose and therefore small in size, such as a bar, a rod, a cable, etc., that will be denoted hereinafter under the general term (rod). This is generally an element of substantially elongate shape and substantially constant cross section, preferably round.

Recourse to HDPE rods is particularly advantageous when the tank is also based on HDPE because then the said rods can be made using tank production waste (scraps) which can therefore be put to economical use. More generally, therefore, in this variant, it is advantageous for the rods to be made from waste from the production of similar tanks.

In the case of rods, their number and mechanical strength will be tailored to suit the desired result. For example, they may be assembled to form a network (where, for example, the rods alternately connect the lower and upper walls and define triangular shapes at the nodes). A material compatible with that of the tank so that they can be fixed directly by welding to the parison will

advantageously be chosen by way of a material from which to make these rods. According to this aspect therefore recourse to scraps is particularly suitable also.

In the case of the "rods" as defined hereinabove, one practical way of fixing them in the context of the invention is to split them into two, to equip
5 them with a clip and to fix the parts, not clip-fastened together, one on each side, on a part of the parison each, using the core, but without clip-fastening them. In this case, either the shrinkage of the tank after release from the mould is enough for the two parts to clip-fasten of their own accord or alternatively, external pressure is applied (manually or via a machine) to the walls of the tank in order
10 to perform/enhance the clip-fastening.

Alternatively, when the rod is made as a single piece, it is preferably fixed to one of the parts of the parison during step d) and fixed to the other part during step f). This variant is, however, less advantageous because the post-moulding shrinkage is liable to introduce tension to the points of attachment of the rods to
15 the tank. In the case of a welded attachment, the core is then advantageously equipped with a ram comprising a heating element (mirror, filament etc.) to keep the second end (the one secured second) of the reinforcing element hot while the 1st is being welded.

The reinforcing element that is to connect the walls of the tank is generally
20 mounted substantially perpendicular to the walls of the tank when there is just one of them. When recourse is had to several reinforcing elements (several rods, for example) these may be inclined. The person skilled in the art on the basis of calculation (simulation) of mechanical strength, will seek to optimise the mounting (point of attachment; orientation) of the reinforcing element(s)
25 according to the desired result.

He will preferably also ensure that there is little (or preferably no) inflection in the walls at the points of attachment of the reinforcing element so as not to adversely affect the free volume of the tank and so as not to create unnecessary dead spots and/or stress raisers. From this point of view, therefore,
30 two-part reinforcing elements assembled in situ after shrinkage (such as the rods mentioned earlier) give better results.

Generally, fuel tanks are fixed to the chassis of vehicles by straps, generally metal ones. These straps also have the advantage of enhancing the creep strength of the tank, but they also have the disadvantage of a relatively
35 high cost. As a result, there is a desire to replace them with other devices such as fixing lugs present around the periphery of the tank. However, these tanks have

then to be equipped with additional reinforcing elements, and the object of the present invention is particularly suited to this context. Specifically, this method with a parison made in two parts welded together generally leads to a welded seam in which the excess material or sprue is generally removed during the so-called trimming operation. All that is then required, during this operation, is to leave some portions or pads which can act as tank fixing lugs. As a result, in a preferred variant of the invention, the welding in step f) generates a welded seam which is partially removed during step i) so as to leave pads or lugs for attaching the tank to a motor vehicle chassis.

10 The present invention also relates to plastic fuel tanks that can be obtained using the method according to the invention.

According to one aspect, it relates to a plastic fuel tank comprising a lower wall and an upper wall which are assembled by welding, and at least one rod situated inside the tank and connecting its lower wall to its upper wall.

15 As a preference, this rod is made in two parts (preferably of substantially equal lengths) each having two ends of which one is fixed (preferably by welding) to one of the walls of the tank and the other is clipped to the other part of the rod.

20 According to another aspect, the present invention relates to a plastic fuel tank comprising a lower wall and an upper wall which are assembled by welding, and at least one functional element situated inside the tank and connecting its lower wall to its upper wall. This functional element is as described hereinabove in the context of the method according to the invention.

25 Finally, according to a last aspect, the invention relates to a plastic fuel tank comprising a lower wall and an upper wall assembled by welding, and at least one reinforcing element situated inside the tank and connecting its lower wall to its upper wall, the welding connecting the walls being extended by a welded seam that is interrupted in places to form lugs so that the tank can be fixed to a motor vehicle chassis in particular.

30 The purpose of Figures 1 and 2 is to illustrate certain concrete aspects of the invention without in any way wishing to restrict its scope.

They each depict a section (on a plane perpendicular to the surface of the tank at this point) through a tank to which one or more rods have been fixed. These rods are made of a plastic that has a certain rigidity in tension.

35 In Figure 1, a single rod (3) connects a point of the upper wall (1) of the tank to a point of the lower wall (2) of a tank which contains fuel (4). This

rod (3) has been fixed at these two points by welding (firstly, on one side of the parison using the core and then, on the other side, as the mould is closed). Its overall orientation is vertical without necessarily being perfectly aligned with the vertical. As a result of this rod (3) the deflection of the lower wall (2) is limited
5 because it is constrained at least in part by the upper part (1).

In Figure 2, two rods (3) have been fixed in such a way as to define a triangular ridge. They have first of all been stake-fastened at one end (to part of the parison) in such a way as to depict a "V". Next, they have been welded at two points to the other part of the parison upon mould closure.

C L A I M S

1. Method for manufacturing a plastic fuel tank with improved creep strength, whereby:
- a) a plastic parison comprising two distinct parts is inserted into an open two-cavity mould;
 - b) a core is inserted inside the parison, the said core bearing at least part of a reinforcing element capable of securing (creating a link between) the two parts of the parison;
 - c) the parison is pressed firmly against the mould cavities (by blowing through the core and/or creating suction behind the cavities);
 - d) (the part of) the reinforcing element is fixed to at least one of the parts of the parison using the core;
 - e) the core is withdrawn;
 - f) the mould is closed again, bringing its two cavities together in such a way as to grip the two parts of the parison around their periphery in order to weld them together;
 - g) a pressurized fluid is injected into the mould and/or a vacuum is created behind the mould cavities in order to press the parison firmly against the mould cavities;
 - h) the mould is opened and the tank is extracted.
2. Method according to the preceding claim, characterized in that the tank is moulded by injecting a pressurized fluid into the mould and in that the parison is made of 2 separate parts resulting from the cutting of an extruded cylindrical parison.
3. Method according to Claim 1, characterized in that the tank is moulded by creating a vacuum behind the mould cavities and in that the parison is made of two extruded sheets.
4. Method according to any one of the preceding claims, characterized in that the core comprises a hydraulic ram which fixes the reinforcing element to the parison.
5. Method according to any one of the preceding claims, characterized in

that the reinforcing element is a functional element of the tank and that only its support is introduced into the tank at the time of moulding, the functional element itself being introduced into the tank after it has been released from the mould through an opening made in the wall of the tank.

5 6. Method according to the preceding claim, characterized in that the functional element is a pump/gauge module.

7. Method according to any one of Claims 1 to 4, characterized in that the reinforcing element comprises at least one rod.

10 8. Method according to the preceding claim, characterized in that the rod is made from waste from the production of similar tanks.

15 9. Method according to Claim 7 or 8, characterized in that the rod is made in two parts equipped with a clip-fastening device; in that the parts, not clip-fastened to one another, are fixed facing one another on a part of the parison each; and in that the shrinkage of the tank after release from the mould is enough for the two parts to clip-fasten of their own accord and/or external pressure is applied to the walls of the tank in order to perform/enhance the clip-fastening.

20 10. Method according to any one of the preceding claims, characterized in that the welding in step f) generates a welded seam which is partially removed during step i) so as to leave pads or lugs for attaching the tank to a motor vehicle chassis.

11. Plastic fuel tank comprising a lower wall and an upper wall which are assembled by welding, and at least one rod situated inside the tank and connecting its lower wall to its upper wall.

25 12. Plastic fuel tank comprising a lower wall and an upper wall assembled by welding, and at least one functional element situated inside the tank and connecting its lower wall to its upper wall.

30 13. Plastic fuel tank comprising a lower wall and an upper wall assembled by welding, and at least one reinforcing element situated inside the tank and connecting its lower wall to its upper wall, the welding connecting the walls being extended by a welded seam that is interrupted in places to form lugs so that the tank can be fixed to a motor vehicle chassis in particular.

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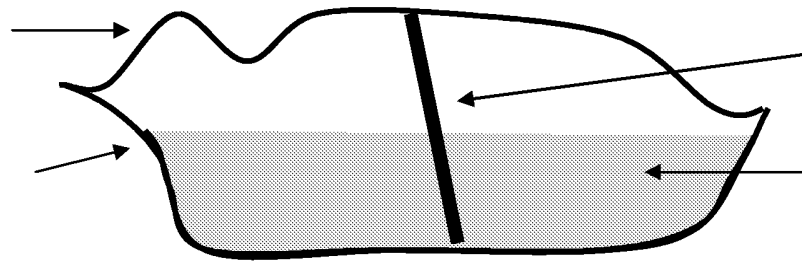


Figure 1

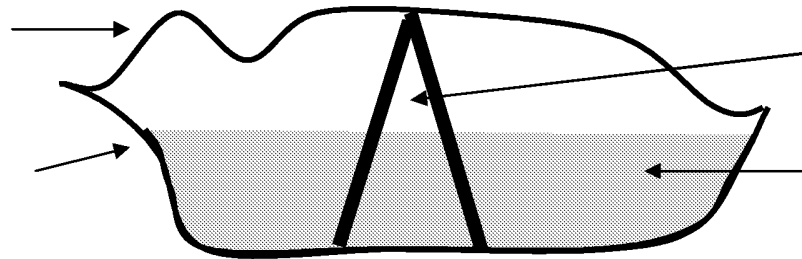


Figure 2.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2005/056750

A. CLASSIFICATION OF SUBJECT MATTER
B29C49/20 B29C51/12 B60K15/03
//B29L22:00,B29L31:30

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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 338 420 B1 (PACHCIARZ MAHLON RICHARD ET AL) 15 January 2002 (2002-01-15) column 4, lines 4-14	1-13
X	PATENT ABSTRACTS OF JAPAN vol. 004, no. 154 (M-038), 28 October 1980 (1980-10-28) & JP 55 105539 A (NISSAN MOTOR CO LTD), 13 August 1980 (1980-08-13) abstract	1-3
A		11,12
X	PATENT ABSTRACTS OF JAPAN vol. 004, no. 057 (M-009), 26 April 1980 (1980-04-26) & JP 55 025380 A (KODAMA KAGAKU KOGYO KK), 23 February 1980 (1980-02-23) abstract	1,2,9,10
A		9,10
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☒ 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

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"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

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