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(54) Title: FUEL SYSTEM FOR COMBUSTION ENGINE AND A METHOD FOR EXCHANGING A FILTER MEMBER IN A FUEL SYSTEM

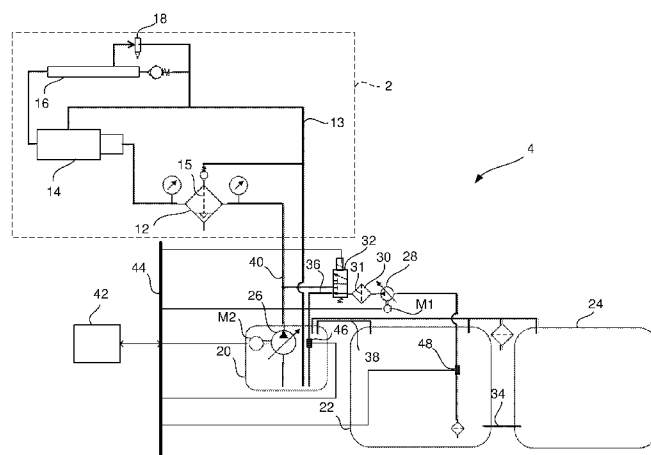


Fig. 2

(57) Abstract: A fuel system (4) for a combustion engine (2) comprises a first fuel tank (20), a second fuel tank (22), a first fuel pipe (36) arranged in connection with the first fuel tank (20) and the second fuel tank (22), a second fuel pipe (40) arranged in connection with the first fuel tank (20), two fuel pumps, of which one is a main feed pump (26) and one is a transfer pump (28). The main feed pump (26) is arranged to feed fuel from the first fuel tank (20) through the second fuel pipe (40), and the transfer pump (28) is arranged to feed fuel from the second fuel tank (22) to the first fuel tank (20) via the first fuel pipe (36). A first electric engine (M1) is arranged to drive the transfer pump (28), and a second electric engine (M2) is arranged to drive the main feed pump (26). A pre-filter (30) is arranged downstream of the transfer pump (28), and a main fuel filter (12) is arranged downstream of the main feed pump (26). At least one of the fuel pumps (26, 28) may be redirected so that the direction of the flow through at least one of the fuel filters (12, 30) may be reversed. The fuel system prevents non-filtered fuel, in connection with a replacement of the filter element in a fuel filter, from bypassing the fuel filter. Thus a method is provided for filter replacement in a fuel system (4) which prevents the supply of non-filtered fuel to the combustion engine. This secures the operation of the combustion engine (2) and a vehicle (1) equipped with such a fuel system.

Fuel system for a combustion engine and a method to replace a filter element in a fuel system

BACKGROUND OF THE INVENTION AND PRIOR ART

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The invention pertains to a fuel system for a combustion engine and a method to replace a filter element in a fuel system according to the enclosed independent patent claims' respective preambles. The invention also pertains to a combustion engine and a motor vehicle according to the dependent patent

10 claims.

A combustion engine, such as a diesel engine or an Otto engine, is equipped with a fuel system to transport fuel from one or several fuel tanks to the combustion engine's injection system. The fuel system comprises one or several

15 fuel pumps which may be driven mechanically by the combustion engine or be driven by an electric engine. The fuel pumps create a fuel flow and pressure to transport the fuel to the injection system, which supplies the fuel to the combustion engine's combustion chamber.

20 The fuel system also comprises a fuel filter for filtration of the fuel before it reaches the injection system. The combustion engine and its injection system are sensitive to contaminations and may be negatively affected if the fuel is too polluted. Contaminations may mean solid particles, gas or liquid. Even if the fuel only comprises a small amount of contaminations, the consequence may

25 be that the combustion engine may not be driven by the fuel. Fuel systems therefore comprise a fuel filter, which both filters away particles and separates water occurring in the fuel. The fuel filter may be a so-called insert fuel filter, which comprises a replaceable filter element arranged inside a filter house. When the fuel filter is clogged or inoperative, the filter element needs to be re-

30 placed. Polluted fuel may then remain at the fuel filter because of inadequate reflux back to the fuel tank. The inadequate reflux may be due to the difference in height between the fuel filter and the fuel tank being insufficient for the fuel

filter to be emptied effectively with the help of gravity. If polluted fuel remains at the fuel filter, there is a risk that the clean side of the new filter element, which is arranged inside the filter house, may come into contact with the polluted fuel, and non-filtered fuel may be led further inside the fuel pipes to the engine.

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This may entail that the fuel system's injection system or the combustion engine's aftertreatment system are impacted. A fuel system where there is no fuel at the fuel filter when the filter is replaced would minimise the risk of impacting the injection system and thus reduce the risk of operational disruptions.

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According to prior art, a fuel pump that may be redirected to change the direction of the flow in a fuel system may be arranged, which thus cleans the fuel filter.

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Document US-B2-6619303 displays a fuel system for a combustion engine, which comprises a fuel pump and a fuel filter arranged in a fuel tank. The fuel pump's main task is to pump fuel through the fuel filter, which filters out impurities in the fuel. When the fuel filter needs to be cleaned, the direction of the fuel pump is changed, so that the direction of the flow through the fuel filter changes. Fuel is then pumped from the fuel tank via a second fuel pipe through the fuel filter from the other direction. In this manner, impurities in the fuel filter are transported to the fuel pump and further to a collection container. Document US-B2-6619303 thus shows a method to purify a fuel filter by using a reversible fuel pump.

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Prior art also provides for arranging reversible fuel pumps to change the direction of the flow in a fuel system for safety purposes and thus emptying the injection system of fuel.

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Document US-A-4726335 shows a fuel system for a combustion engine, which comprises two electrically driven fuel pumps, which supply the fuel system's

injection system with fuel. The fuel pumps are controlled with regard to the fuel requirement of the combustion engine. In the event of a risk situation arising, the fuel pumps' direction changes, so that they suck out the fuel inside the injection system and thus the combustion engine stops.

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Despite prior art solutions in the area, there is a need to further develop a fuel system, which reduces the risk of complications and operational disruptions in connection with filter replacement.

10 SUMMARY OF THE INVENTION

The objective of the present invention is to achieve a fuel system for a combustion engine which reduces the risk of operational disruptions caused by impurities in the fuel.

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Another objective is, in connection with fuel filter replacement, to prevent that non-filtered fuel may be led further in fuel pipes after the filter.

Another objective is to achieve a fuel system for a combustion engine which, in the event of a filter replacement, reduces the risk of polluted fuel remaining inside the fuel filter.

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Another objective is to achieve a fuel system for a combustion engine which prevents that the person who replaces the filter comes into direct contact with fuel.

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Another objective is to achieve a fuel system for a combustion engine which reduces the environmental impact of filter replacement.

Another objective is to achieve a fuel system for a combustion engine, which simplifies the handling of filter replacements.

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Another objective is to achieve a fuel system which is simple and non-bulky.

These objectives are achieved with the fuel system of the type specified at the beginning and which is characterised by the features specified in the characterising portion of patent claim 1. Corresponding objectives are also achieved with a method to replace a filter element in a fuel system according to the characterising portion of patent claim 11. Corresponding objectives are also achieved with a combustion engine and a vehicle with such a fuel system.

By arranging at least one reversible fuel pump in a low pressure circuit inside the fuel system for a combustion engine, a fuel system which reduces the risk of complications and operational disruptions in connection with filter replacement is achieved. Preferably, the fuel filters comprise replaceable filter elements, which are arranged inside filter houses. Preferably, the main feed pump is a reversible low pressure pump. When the filter element in the main fuel filter, which is arranged downstream of the main feed pump, needs to be replaced, polluted, non-filtered fuel may remain in the main fuel filter. When the old filter element is removed from the main fuel filter, the contaminated fuel may flow to the side of the fuel filter which contains filtered fuel. If a new filter element is then arranged in the main fuel filter, the clean side of the new filter element risks coming into contact with the polluted fuel. This may entail that polluted fuel reaches the fuel system's injection system, which may thus be impacted and the risk of operational disruptions due to polluted fuel increases. By changing the direction of the main feed pump before a new filter element is arranged in the main fuel filter, the fuel occurring in the main fuel filter is sucked out with the help of the main feed pump and is fed further to the first fuel tank. In this manner, a fuel system is provided that reduces the risk that polluted fuel remains in the fuel filter, and thus the risk of operational disruptions caused by impurities in the fuel is reduced.

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Suitably, a reflux pipe is arranged between the main fuel filter and the second fuel pipe. Further, a first check valve is arranged in the reflux pipe, and a sec-

ond check valve is arranged in the second fuel pipe, downstream of the connection to the reflux pipe and upstream of the main fuel filter. When the filter element in the main fuel filter needs to be replaced, the main feed pump's direction is changed and the first and the second check valves cause the fuel
5 remaining in the main fuel filter to be sucked out with the help of the main feed pump and fed via the reflux pipe to the second fuel pipe and further to the first fuel tank. In this manner, the main fuel filter is substantially emptied when the new filter element is arranged in the main fuel filter, and the risk of polluted fuel coming into contact with the clean side of the new filter element is reduced. In
10 this manner, the risk of polluted fuel impacting the injection system is also reduced.

Preferably, the transfer pump is a reversible low pressure pump. The transfer pump's main task is to supply the first fuel tank with fuel, which occurs by the
15 transfer pump feeding fuel from the second fuel tank through the pre-filter and via the first fuel pipe further to the first fuel tank. The fuel reaching the main feed pump controlled by the electric engine is thus pre-filtered, which entails that the main feed pump is protected against impurities in an advantageous manner, which reduces the risk of operational disruptions in the main feed
20 pump. When the filter element in the pre-filter, which is arranged downstream of the transfer pump, needs to be replaced, polluted fuel may remain in the pre-filter. When the old filter element is removed from the pre-filter, the polluted fuel may flow to the side of the pre-filter, which contains filtered fuel. If a new filter element is then arranged in the pre-filter, the clean side of the new filter
25 element risks coming into contact with the polluted fuel. This may entail that polluted fuel reaches the main feed pump. By changing the transfer pump's direction before a new filter element is arranged in the pre-filter, the fuel remaining in the pre-filter is sucked out with the help of the transfer pump and fed along to the second fuel tank. In this manner, a fuel system is provided that
30 reduces the risk that polluted fuel reaches the main feed pump in connection with a filter replacement, and thus the risk of operational disruptions caused by impurities in the fuel is reduced.

Suitably, the main fuel pump is reversible by changing the rotational direction of the electric engine connected to the main fuel pump. Suitably, the transfer pump is also reversible by changing the rotational direction of the electric engine connected to the transfer pump.

By emptying the pre-filter and/or the main fuel filter of fuel in connection with filter replacement before a new filter element is arranged in the fuel filter, a fuel system is provided which prevents the person replacing the filter coming into direct contact with fuel, which is disadvantageous from the point of view of health. Without fuel remaining in the fuel filter it is easier to replace filters, there is less spillage and contamination, and thus a fuel system is provided which allows for simpler management of filter replacements and which reduces the environmental impact of filter replacements. Preferably, the fuel filter is emptied of fuel before the old filter element is removed from the filter house. Alternatively, the old filter element is removed before the fuel filter is emptied.

Preferably, the pre-filter comprises a fine mesh water-separating filter element.

Suitably, a valve is arranged downstream of the transfer pump and downstream of the pre-filter. The valve has an inlet connected with the transfer pump, a first outlet connected with the first fuel pipe and a second outlet connected with the second fuel pipe, so that the transfer pump is connected with the first fuel pipe when the valve is arranged in a first position, and so that the transfer pump is connected with the second fuel pipe when the valve is arranged in a second position. In this manner, the first fuel tank may be bypassed and the transfer pump may feed fuel from the second fuel tank to the second fuel pipe, downstream of the first fuel tank and the main feed pump, and further to the combustion engine.

Alternatively, the valve is arranged in its second position when the filter element of the main fuel filter needs to be replaced. In this manner, the transfer

pump is connected with the second fuel pipe and the transfer pump may thus suck out the fuel remaining in the main fuel filter, and feed it further along to the second fuel tank. In this manner, contamination of the fuel in the first fuel tank with polluted fuel is prevented, which means that the main feed pump is protected from impurities. It is also possible to bypass the pre-filter with a by-pass pipe in this embodiment, so that the transfer pump does not suck out the polluted fuel through the pre-filter on the way to the second fuel tank.

Preferably, the main feed pump, the transfer pump and the valve are connected to a control device via a CAN bus. Thus, a compact fuel system is achieved, which is easy to control and thus provides for a correct fuel supply to the combustion engine.

Suitably, the first fuel tank is designed to hold a lesser volume than the second fuel tank. Preferably, the first fuel tank holds 20-50 litres and the second fuel tank holds 300-1,000 litres. Thus, a non-bulky fuel system is achieved.

By arranging the main feed pump in the first fuel tank, the main feed pump is protected from the environment and a natural cooling of the fuel in the first fuel tank is obtained. Alternatively, the transfer pump, the pre-filter and the valve are also arranged inside the first fuel tank. With the main feed pump, the transfer pump, the pre-filter and the valve arranged inside the first fuel tank, a non-bulky fuel system is achieved.

Other advantages of the invention are set out in the detailed description below.

BRIEF DESCRIPTION OF DRAWINGS

Below is a description of, as examples, preferred embodiments of the invention with reference to the enclosed drawings, in which:

- Fig. 1 shows a schematic side view of a vehicle, which comprises a fuel system for a combustion engine according to the present invention,
- Fig. 2 shows a coupling diagram for a fuel system according to a first embodiment,
- Fig. 3 shows a coupling diagram for a fuel system according to a second embodiment, and
- Fig. 4 shows a flow chart of a method to replace a filter element in a fuel system according to the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS ACCORDING TO THE INVENTION

Fig. 1 shows a schematic side view of a vehicle 1, a vehicle which comprises a fuel system 4 for a combustion engine 2. The combustion engine 2 is connected to a gearbox 6, which is further connected to the vehicle's 1 driving wheels 8 via a transmission. The vehicle also comprises a chassis 10.

Fig. 2 shows a coupling diagram for a fuel system 4 in a combustion engine 2 according to a first embodiment. The fuel system 4 is of the type which is also known as a common rail and comprises several components of which one main fuel filter 12, a high pressure pump 14, an accumulator in the form of a so-called common rail 16, and an injection system 18 schematically displayed in the form of a fuel injector are arranged in the combustion engine 2. Alternatively, the fuel system may be replaced by another form of an injection system, e.g. a piezo or a unit injection system. The fuel system 4 also comprises a first fuel tank 20, a second fuel tank 22, a third fuel tank 24, a main feed pump 26, a transfer pump 28, a pre-filter 30, and a valve 32. These components may be arranged at the vehicle's chassis 10. The main fuel filter 12 is arranged downstream of the main feed pump 26 and upstream of the high pressure pump 14 in the fuel system 4. The main fuel pump 26 is a low pressure pump which

supplies the high pressure pump 14 with fuel at a low pressure.

Further, the fuel system 4 comprises a reflux pipe 13, through which excess fuel re-flows from the injection system 18, the common rail 16, the high pressure pump 14, and the main fuel filter 12 back to the first fuel tank 20. The main fuel filter 12 comprises a filter element 15 and the pre-filter 30 comprises a filter element 31. The main fuel filter 12 also comprises in this example a filter house in which the filter element 15 is housed, and the filter house of which is designed with connections for the pipes which lead the fuel to and from the filter.

The first fuel tank 20 is designed to contain a lesser volume than the second fuel tank 22 and also a lesser volume than the third fuel tank 24. The second fuel tank 22 and the third fuel tank 24 hold substantially the same volume and have a self-regulating flow between each other via a connection pipe 34 arranged between the lower part of the second fuel tank 22 and the third fuel tank 24. The transfer pump 28 is according to Fig. 2 arranged between the first fuel tank 20 and the second fuel tank 22. The transfer pump 28 is reversible, driven by a first electric engine M1 and its main task is to supply fuel from the second fuel tank 22 to the first fuel tank 20 via a first fuel pipe 36. Between the first fuel tank 20 and the second fuel tank 22 an excess pipe 38 is arranged, so that fuel may be transported across from the first fuel tank 20 to the second fuel tank 22 if the first fuel tank 20 becomes overfilled. The main feed pump 26 is arranged inside the first fuel tank 20 and is thus protected from the environment and cooled by the fuel. The main feed pump 26 is reversible, driven by a second electric engine M2, and its main task is to feed the fuel from the first fuel tank 20 via a second fuel pipe 40 through the main fuel filter 12 and further to the high pressure pump 14. The fuel is then fed, at a high pressure, to the common rail 16 and further along to the injection system 18. The main feed pump 26 and the transfer pump 28 are controlled by a control device 42 via a CAN bus 44.

The pre-filter 30 is arranged downstream of the transfer pump 28 and the filter element 31 arranged in the pre-filter 30 is preferably finely meshed. The transfer pump 28 sucks fuel from the second fuel tank 22, pressurises the fuel and then feeds it through the pre-filter 30, via the first fuel pipe 36, further along to the first fuel tank 20. The main feed pump 26, which is arranged inside the first fuel tank 20, is thus protected from impurities.

When the filter element 15 in the main fuel filter 12 needs to be replaced, it is removed from the filter house. If this has not previously been fully drained of fuel that has not passed through the filter, polluted fuel may remain inside the filter house in the main fuel filter 12. When the old filter element 15 is removed from the main fuel filter 12, non-filtered fuel may flow to the side of the main fuel filter 12 which is intended for filtered fuel. When the new filter element 15 is arranged in the main fuel filter 12, the clean side of the new filter element 15 risks coming into contact with the polluted (non-filtered) fuel. This may entail that polluted fuel reaches the fuel system's injection system 18, which may thus be impacted and the risk of operational disruptions due to polluted fuel increases. By changing the direction of the main feed pump 26 before a new filter element 15 is arranged in the main fuel filter 12, the fuel occurring in the main fuel filter 12 is sucked out with the help of the main feed pump 26 and is fed further along to the first fuel tank 20. Suitably, the fuel is sucked out of the main fuel filter 12 already before the filter element 15 is disassembled, but this may also be done after the filter element 15 has been dismantled. In this manner, the main fuel filter 12 (the filter house) is substantially emptied when the new filter element 15 is arranged in the main fuel filter 12, and the risk of polluted fuel coming into contact with the clean side of the new filter element 15 is reduced. In this manner, the risk of polluted fuel impacting the injection system 18 is also reduced.

The above description relating to the main fuel filter 12 also applies similarly to the pre-filter 30. In the event the filter element 31 in the pre-filter 30 needs to be replaced, polluted fuel may remain in the pre-filter 30. When the old filter

element 31 is removed from the pre-filter 30, polluted (non-filtered) fuel may flow to the side of the pre-filter 30, which is intended for filtered fuel. If a new filter element 31 is then arranged in the pre-filter 30, the clean side of the new filter element 31 risks coming into contact with the polluted fuel. This may entail that polluted fuel is transported to the first fuel tank 20, which may entail that the main feed pump 26 is impacted by contaminations. By changing the transfer pump's 28 direction before a new filter element 31 is arranged in the pre-filter 30, the fuel remaining in the pre-filter 30 is sucked out with the help of the transfer pump 28 and fed along to the second fuel tank 22. In this manner, the pre-filter 30 is substantially emptied when the new filter element 31 is arranged in the pre-filter 30 and the risk of polluted fuel coming into contact with the clean side of the new filter element 31 is reduced. In this manner, the risk of polluted fuel causing operational disruptions in the main feed pump 26 is reduced.

The valve 32 is arranged downstream of the pre-filter 30 and comprises an inlet connected with the transfer pump 28, a first outlet connected with the first fuel pipe 36, and a second outlet connected with the second fuel pipe 40. The valve 32 is connected to the CAN bus 44, and is at an initial position controlled so that the transfer pump 28 is connected with the first outlet and is thus connected with the first fuel pipe 36. In a second position, the valve 32 is controlled so that the transfer pump 28 is connected with the second outlet and thus connected with the second fuel pipe 40. In this manner, the first fuel tank 20 may be bypassed and the transfer pump 28 may feed fuel from the second fuel tank 22 to the second fuel pipe 40, downstream of the first fuel tank 20 and the main feed pump 26, and further to the combustion engine 2.

In the first fuel tank 20, a first level sensor 46 is arranged to identify the fuel level in the first fuel tank 20. A second level sensor 48 is arranged in the second fuel tank 22 to identify the fuel level in the second fuel tank 22. The first level sensor 46 and the second level sensor 48 are connected to the CAN bus

44 and the control device 42, which controls the transfer pump 28 and the main feed pump 26.

Fig. 3 shows a coupling diagram for a fuel system 4 according to a second embodiment which to a great extent corresponds to the first embodiment. In addition to the description with reference to Fig. 2, a reflux pipe 41 is arranged between the main fuel filter 12 and the second fuel pipe 40. Furthermore, a first check valve 43 is arranged in the reflux pipe 41, the first check valve 43 of which entails that fuel and water may only flow through the reflux pipe 41 in a direction from the main fuel filter 12 to the second fuel pipe 40. In the second fuel pipe 40, downstream of the connection to the reflux pipe 41 and upstream of the main fuel filter 12, a second check valve 45 is arranged. When the filter element 15 in the main fuel filter 12 needs to be replaced, the direction of the main feed pump 26 is changed before a new filter element 15 is fitted in the main fuel filter 12. The first and the second check valve 43, 45 entail that the fuel remaining in the main fuel filter 12 is sucked out with the help of the main feed pump 26 and fed via the reflux pipe 41 to the second fuel pipe 40 and further to the first fuel tank 20. In this manner, the main fuel filter 12 is substantially emptied when the new filter element 15 is arranged in the main fuel filter 12, and the risk of polluted fuel coming into contact with the clean side of the new filter element 15 is reduced. In this manner, the risk of polluted fuel impacting the injection system 18 is also reduced.

Fig. 4 shows a flow chart of a method to replace the filter element in the fuel system 4. The method comprises the step (a) to change the rotational direction of at least one fuel pump 26, 28, so that at least one fuel filter 12, 30, downstream of the fuel pump 26, 28 is emptied of fuel. Furthermore, the method comprises the step (b) to dismantle (remove) a filter element 15, 31 arranged in the fuel filter 12, 30 and the step (c) to fit (arrange) a new filter element 15, 31 in the fuel filter 12, 30. In this manner, the risk that the clean side of the new filter element 15, 31 comes into contact with polluted fuel is reduced, which reduces the risk of operational disruptions caused by polluted fuel. According

to one embodiment of the method, the said fuel filter is the main fuel filter 12 and the said fuel pump is the main feed pump 26. According to a second embodiment of the method, the said fuel filter is the pre-filter 30 and the said fuel pump is the transfer pump 28.

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Suitably, the step (a) is carried out before the step (b), but it is also possible to carry out the step (b) before the step (a). Thus the filter element 15, 31 is first removed from the fuel filter 12, 30, following which the fuel filter 12, 30 is emptied of fuel by changing the rotational direction of at least one of the fuel pumps 26, 28. In another alternative embodiment it is possible to first carry out the step (a) to drain the main part of the fuel which is inside the filter, and then the step (b) when a filter element 15, 31 is removed, and then another step (a) in order to drain away fuel which may remain inside the filter before the step (c) is carried out.

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According to the embodiment, the rotational direction of the fuel pump 26, 28 is changed preferably by changing the rotational direction of the electric engine M1, M2 connected to the fuel pump 26, 28.

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The components and features specified above may within the framework of the invention be combined between different embodiments specified.

PATENT CLAIMS

1. The fuel system for a combustion engine (2), the fuel system (4) of which comprises a first fuel tank (20), a second fuel tank (22), a first fuel pipe (36) arranged in connection with the first fuel tank (20) and the second fuel tank (22), a second fuel pipe (40) arranged in connection with the first fuel tank (20), and two fuel pumps, of which one is a main feed pump (26) and one is a transfer pump (28), in which the main feed pump (26) is arranged to feed fuel from the first fuel tank (20) through the second fuel pipe (40), and in which the transfer pump (28) is arranged to feed fuel from the second fuel tank (22) to the first fuel tank (20) via the first fuel pipe (36), **characterised in** that a first electric engine (M1) is arranged to drive the transfer pump (28) and that a second electric engine (M2) is arranged to drive the main feed pump (26), a pre-filter (30) is arranged downstream of the transfer pump (28) and a main fuel filter (12) is arranged downstream of the main feed pump (26), in which at least one of the fuel pumps (26, 28) is reversible, so that the direction of the flow through at least one of the fuel filters (12, 30) may be reversed.
2. Fuel system according to claim 1, **characterised in** that at least one of the fuel pumps (26, 28) is reversible by changing the rotational direction of its electric engine (M1, M2).
3. Fuel system according to any of claims 1 or 2, **characterised in that** the main feed pump (26) is arranged inside the first fuel tank (20).
4. Fuel system according to any of the previous claims, **characterised in that** the transfer pump (28) is arranged inside the first fuel tank (20).
5. Fuel system according to any of the previous claims, **characterised in that** the pre-filter (30) is arranged inside the first fuel tank (20).

6. Fuel system according to any of the previous claims, **characterised in** that each of the pre-filter (30) and the main fuel filter (12) comprises a replaceable filter element (15, 31).
- 5 7. Fuel system according to any of the previous claims, **characterised in** that a valve (32) is arranged downstream of the transfer pump (28) and downstream of the pre-filter (30), in which the valve (32) has an inlet connected with the transfer pump (28), a first outlet connected with the first fuel pipe (36) and a second outlet connected with the second fuel pipe (40), so that the transfer
10 pump (28) is connected with the first fuel pipe (36) when the valve (32) is arranged in a first position, and so that the transfer pump (28) is connected with the second fuel pipe (40) when the valve (32) is arranged in a second position.
- 15 8. Fuel system according to any of the previous claims, **characterised in** that the first fuel tank (20) is designed to hold a lesser volume than the second fuel tank (22).
- 20 9. Combustion engine (2) **characterised in** that it comprises a fuel system (4) according to any of claims 1-8.
- 25 10. Vehicle (1) **characterised in** that it comprises a fuel system (4) according to one of the claims 1-8.
- 30 11. Method to replace a filter element in a fuel system (4) for a combustion engine (2), the fuel system (4) of which comprises: a first fuel tank (20), a second fuel tank (22), a first fuel pipe (36) arranged in connection with the first fuel tank (20) and the second fuel tank (22), a second fuel pipe (40) arranged in connection with the first fuel tank (20), and two fuel pumps, of which one is a main feed pump (26) and one is a transfer pump (28), where the main feed pump (26) is arranged to feed fuel from the first fuel tank (20) through the second fuel pipe (40), and where the transfer pump (28) is arranged to feed fuel

from the second fuel tank (22) to the first fuel tank (20) via the first fuel pipe (36),

characterised by the steps to:

- 5 a) change the rotational direction of at least one fuel pump (26, 28), so that at least one fuel filter (12, 30), arranged downstream of the fuel pump, (26, 28) is emptied of fuel,
- b) remove a filter element (15, 31) arranged in the fuel filter (12, 30), and
- c) arrange a new filter element (15, 31) in the fuel filter (12, 30).

10 12. Method according to claim 11, **characterised in** that the said fuel filter is the main fuel filter (12), and the said fuel pump is the main feed pump (26).

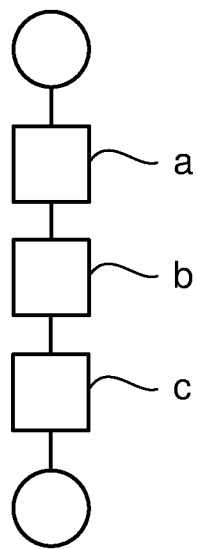
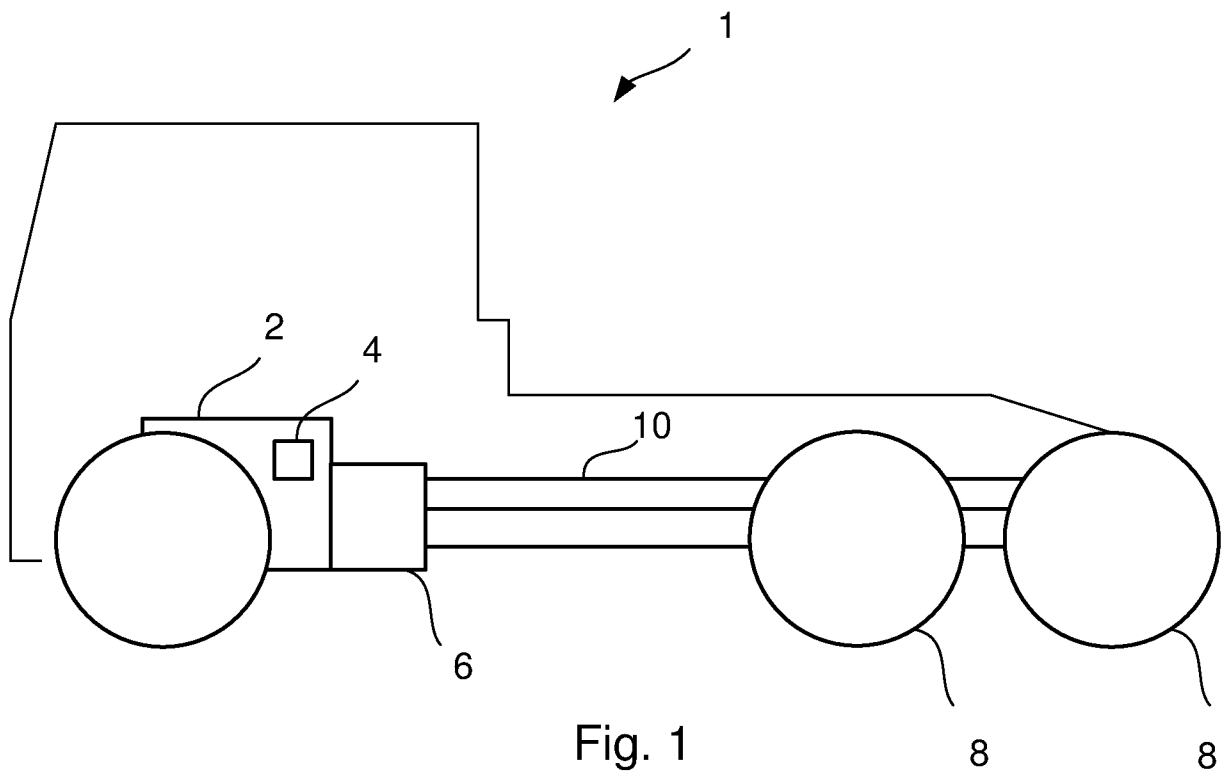
13. Method according to claim 11, **characterised in** that the said fuel filter is the pre-filter (30), and the said fuel pump is the transfer pump (28).

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14. Method according to claim 11, **characterised in** that the step (b) is carried out before the step (a).

15. Method according to claim 11, **characterised in** that the rotational direction of the fuel pump (26, 28) is changed by changing the rotational direction of an electric engine (M1, M2) connected to the fuel pump (26, 28).

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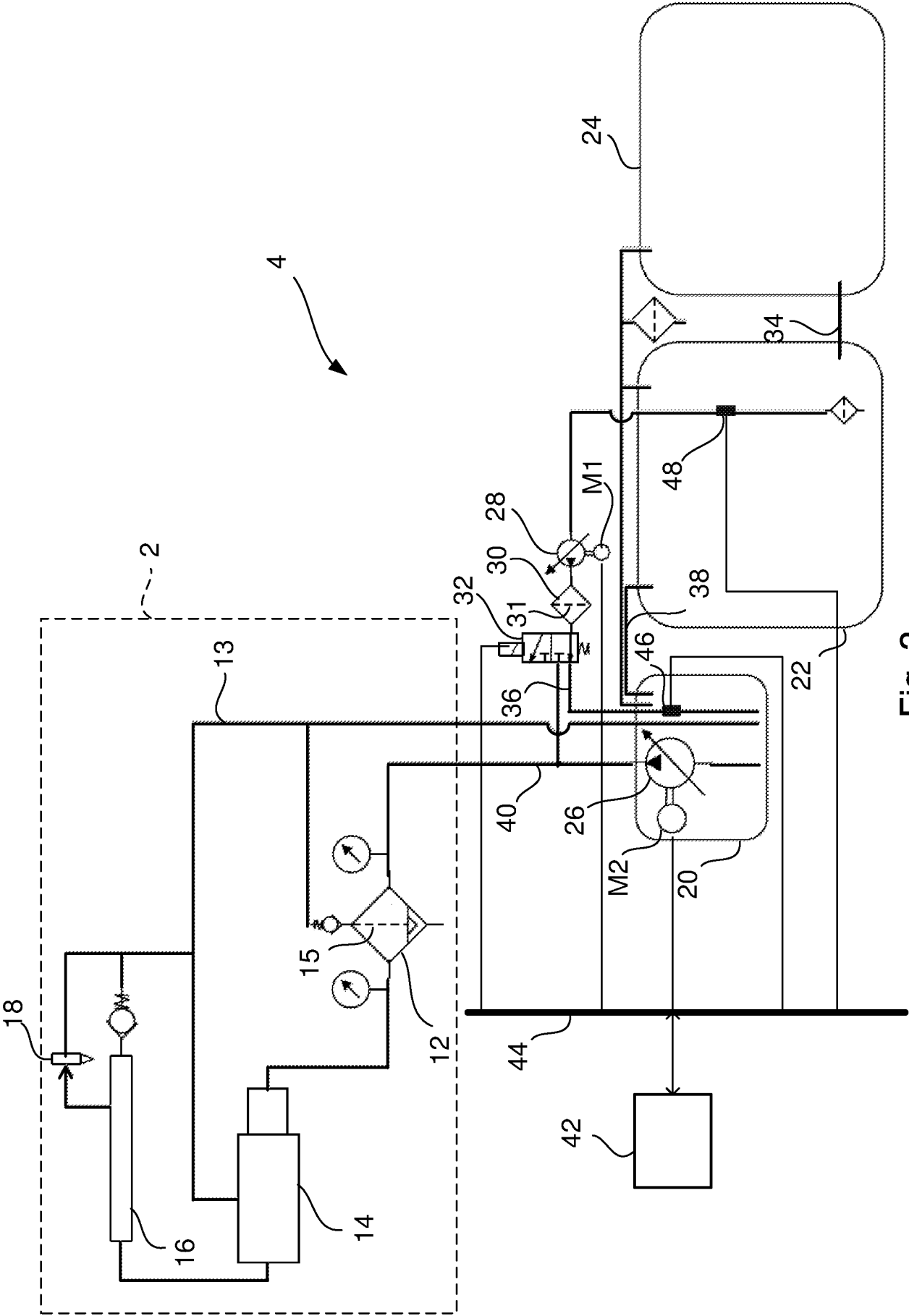


Fig. 2

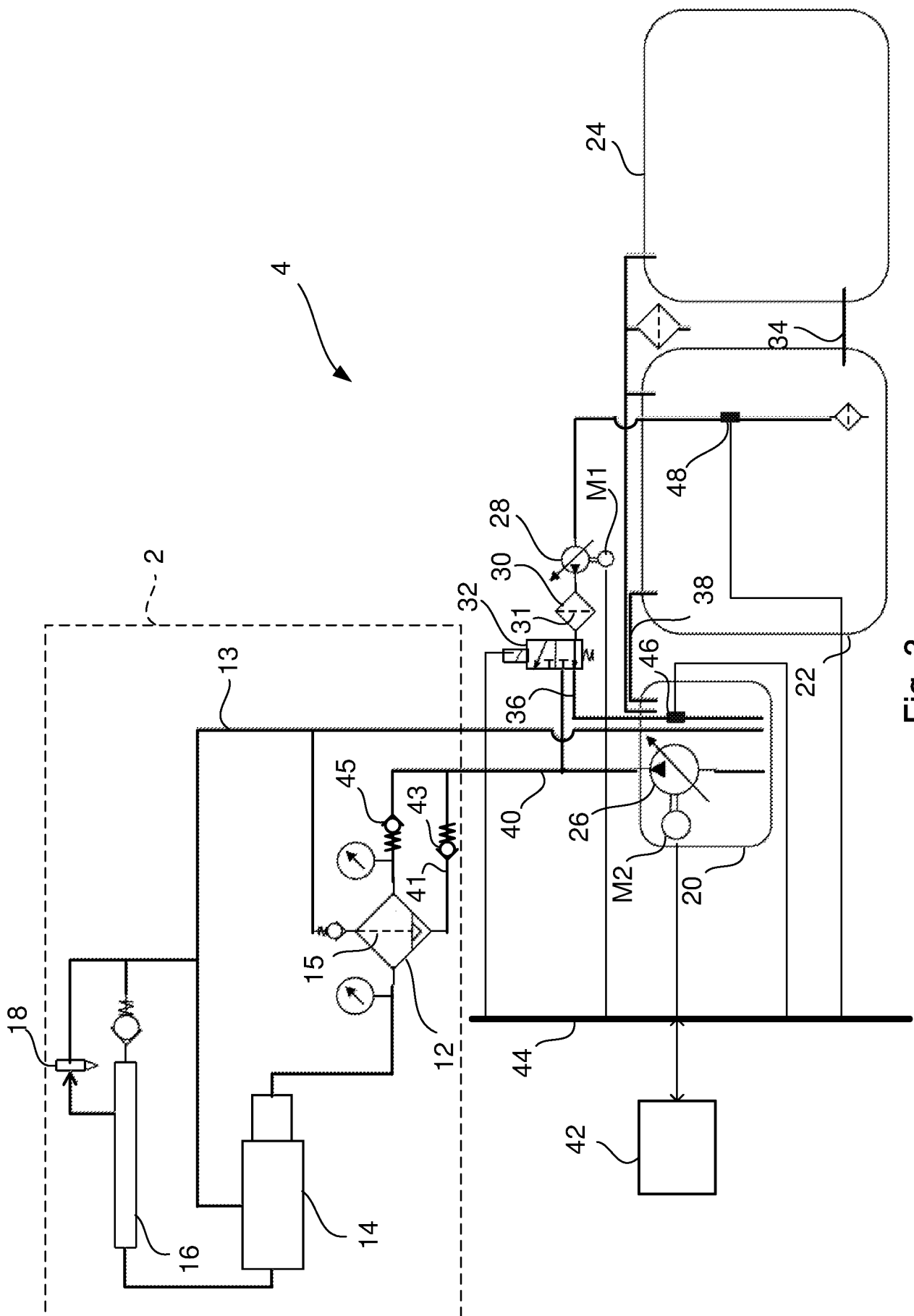


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2014/050302

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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: B60K, F02M

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

SE, DK, FI, NO classes as above

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

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 7546835 B1 (HILDITCH JAMES), 16 June 2009 (2009-06-16); abstract; column 5, line 36 - column 6, line 47; figure 2 --	1-15
A	US 20110088800 A1 (CORE PHILLIP R), 21 April 2011 (2011-04-21); abstract; paragraphs [0040]-[0042]; figure 1 --	1-15
A	US 6619303 B2 (HULTQVIST JAN), 29 November 2001 (2001-11-29); abstract; column 3, line 17 - column 4, line 53; figures 1,2 --	1-15



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

“E” earlier application or patent 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

Date of the actual completion of the international search

25-06-2014

Date of mailing of the international search report

26-06-2014

Name and mailing address of the ISA/SE

Patent- och registreringsverket

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2014/050302

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2004037595 A1 (FEDERAL MOGUL CORP), 6 May 2004 (2004-05-06); abstract; paragraphs [0018], [0046]-[0049]; figure 4 -- -----	7

Continuation of: second sheet**International Patent Classification (IPC)*****F02M 37/22*** (2006.01)***B60K 15/03*** (2006.01)***F02M 37/10*** (2006.01)***F02M 37/18*** (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2014/050302

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			US	20030056824 A1	27/03/2003