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(54) Title: A SWITCHING SYSTEM FOR BLOCKING THE COOLANT CIRCULATION FOR WATER COOLED INTERNAL COMBUSTION ENGINE

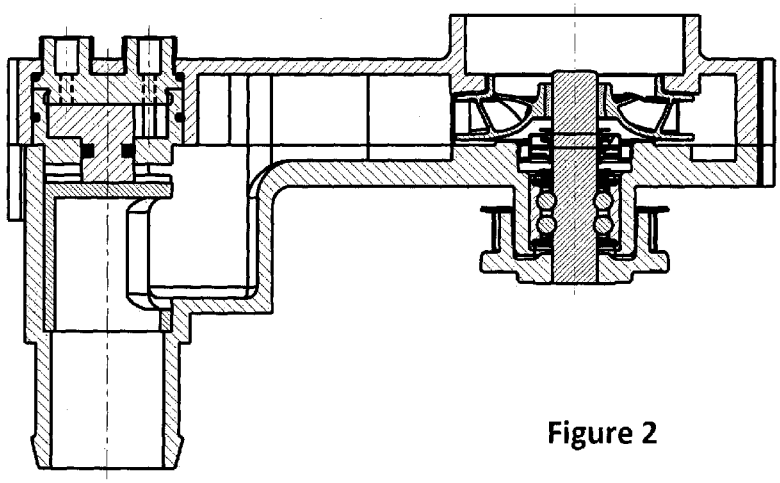

Figure 2

(57) Abstract: This invention relates to a Switchable Water Pump and it's hydraulically or pneumatically actuated valve assembly which is able to block coolant circulation of the water cooled internal combustion engine, even though water pump is continuously rotating. By the actuation of valve mechanism; blocked coolant circulation will cause a rapid warm up of engine coolant which helps to reduce harmful exhaust emission. By using this logic, it is possible to create an independent block able circuit which is connected to the common water pump pressure line or suction line. By this advantage water pump main flow can be divided in to different cooling circuits and any of cooling circuit can be blocked while other circuit (such as EGR system cooling circuit) have flow by actuation of dedicated on/off valve assembly. Required power is obtained from existing hydraulic power sources on vehicle engine (such as engine lubrication oil pump or hydraulic steering pump or vacuum pump). Actuation control should be done by ECU via activating a dedicated micro solenoid valve.

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DESCRIPTION

A SWITCHING SYSTEM FOR BLOCKING THE COOLANT CIRCULATION FOR WATER COOLED INTERNAL COMBUSTION ENGINE

Technological Area:

This invention relates to a Switchable Water Pump and it's hydraulically or pneumatically actuated valve structure which is able to block coolant circulation of the water cooled internal combustion engine, even though water pump is continuously rotating. By the actuation of valve mechanism; coolant circulation should be blocked which cause a rapid warm up of engine coolant for the aim of harmful exhaust emission reduction.

Known Situation of the Art:

An Internal Combustion Engine with liquid cooling should have a water pump to circulate a pressurized coolant liquid through the cooling channels of engine block and cylinder head. This water pump is continuously drived from crank shaft of engine via a pulley and belt coupling. Normally water pump always rotates if engine crank shaft is rotating. By this way, water pump creates a pressurized coolant circulation for collecting the heat which is generated in the engine due to burning of fuel. Therefore water pump helps to cool down engine temperature by creating a coolant circulation in the engine.

On the other hand, Engine is designed to run at a certain warm condition where the exhaust gas emissions are lowest and fuel burning efficiency is highest with respect to the operating condition of engine at lower temperatures. Nowadays, decreasing of total emissions of toxic gases while engine is running is a very important law requirement for caring environment.

European emission standards define the acceptable limits for exhaust emissions of new vehicles sold in EU member states. The emission standards are defined in a series of European Union directives staging the progressive introduction of increasingly stringent standards. Currently, emissions of Nitrogen oxides, Total hydrocarbon, Non-methane hydrocarbons, and Carbon monoxide are regulated for most vehicle types including cars, lorries, trains, tractors and similar machinery

Due to these emission directives, engine temperature should reach its optimum operating temperature in a short time period after cold start up of engine for achieving a reduced total emission of toxic gases. At this point, it will be very logical to block the coolant circulation of engine or to stop the rotation of water pump for reducing engine warming time period at cold starting of engine.

Current known solutions for stopping the water pump and its circulation is based on switchable pulley concept. Most of switchable pulley solutions are using a magnetic coil for disengaging friction disks which is placed in the mechanism of pulley. Friction disks are tightly engaged by some spring force and by this way, pulley and water pump impeller shaft rotates together. Friction disks are disengaged by means of an electrically actuated magnetic coil which cause stopping of impeller shaft while pulley rotates. On some application a wrap spring is used instead of friction disks. Also a "Friction Wheels" usage is well known solution for drive water pump pulley where "Friction Wheels" is in contact with both of pump pulley and driver (in most case it is crankshaft pulley) pulley. By the linear (retract) movement of "Friction Wheels" slider, water pump pulley will lost its contact with driver pulley which cause stopping.

Current solutions have 2 main concerns. First concern is not being compact. Current known solutions are not able to offer a reliable switchable pulley if required diameter of water pump pulley is less than 70mm. Second main concern on switchable pulley solution is occurred issues observed on some engine application since whole flow and circulation has been stopped due to disengaging of clutch. If engine occupied with EGR system, stopping the rotation of water pump and its cooling effect may cause some damage on EGR system. Therefore, on some applications it is not recommended to fully stop water pump rotation. Required solution should offer a partial blocking of coolant circulation while some systems are continuously cooled by coolant circulation. Our innovation is also supporting this requirement which is not solved yet.

Description of the Figures:

This invention is explained by following figures detailed. Figures are only for example. On these figures:

Figure 1 Cross-section view of a sample Water Pump Assembly using a Rotary Valve which is used for blocking the coolant circuit. Picture is showing blocked position of valve assembly with no flow.

Figure 2 Cross-section view of a sample Water Pump Assembly using a Rotary Valve which is used for blocking the coolant circuit. Picture is showing unblocked position of valve assembly allowing free circulation.

Figure 3 Cross-section view of a sample Water Pump Assembly using a Gate Valve which is used for blocking the coolant circuit. Picture is showing blocked position of valve assembly with no flow.

Description of the References shown on Figures

1- Water pump pulley
2- Impeller shaft
3- Water Pump Cover
4- Impeller
5- Water Pump Inlet (Suction side)
6- Water Pump Outlet (Pressure side)
7- Water Pump Housing
8- Rotary Valve Piston
9- Rotary Valve or Ball Valve
10- Rotary Valve Hydraulic Pressure Connection Port A
11- Rotary Valve Hydraulic Pressure Connection Port B
12- Spring for piston retracting
13- Single Acting Cylinder Piston
14- Gate Valve

Description of Invention:

Our invention is related with blocking the engine coolant circulation while water pump is rotating. Coolant circulation is blocked by means of a hydraulically or pneumatically actuated on/off valve gate which is placed on water pump inlet (suction line) or water pump outlet (pressure line).

Required hydraulic pressure is obtained from engine lubrication oil pump or hydraulic power steering pump which is already installed on a standard engine or a vacuum air pressure can be used if it is exist at vehicle.

Attached figures are showing a cross sectioned view of a sample water pump assembly which consists a valve assembly for blocking the pressure outlet of water pump. A closed position of rotary valve (9) is shown on Figure-1 and this position does not allow a coolant circulation even water pump rotates. On Figure-2, rotary valve is shown as opened position and does not block the coolant circulation. A rotary piston (8) is used for CW and CCW rotation of rotary valve (9). Required hydraulic pressure should be sent to rotary piston ports by a solenoid valve which is controlled by ECU. The solenoid valve is not shown on figures. An alternative valve design is shown on Figure-3; a Gate Valve (14) is used instead of Rotary Valve (9) and a Single Acting Cylinder Piston (13) is used instead of Rotary Piston (8) for actuation of Gate Valve (14). Therefore different kind of valve and piston may be used for blocking the circulation.

An on/off type valve gate (9) is installed in the line of coolant circulation either pressure line or suction line. This valve gate (9) is actuated by hydraulic piston (8 or 13) or hydraulically inflatable rubber cushion. Piston may create a linear movement or a rotary movement. Required hydraulic pressure should be supplied from existing pressure lines of engine lubrication oil pump or hydraulic steering pump with a hose or pipe connection. Hydraulic connection can be also obtained through an integrated connection line between water pump body and engine block. Hydraulic pressure from existing pump source should be directed to piston or cushion with a magnetic coil (solenoid) activated micro valve which can be placed on engine block or can be integrated into switchable water pump assembly. This solenoid valve should be controlled by ECU. By the same logic; a vacuum pressure can also be used as an alternative to hydraulic pressure. Piston (8 or 13) which will be used for valve actuation can be double acting or single acting. Single acting piston may have a spring like compression spring, torsion spring, volute spring, extension spring, wire form spring or any kind of them for retracting the piston. Valve structure is basically an on/off type stop valve which is used to control the flow of fluids and can be in a shape of a ball valve, a plug valve, a rotary valve, a butterfly valve, a diaphragm valve, a gate valve, a globe valve , a spool valve, a poppet valve , a knife valve or a thermal expansion valve.

Another advantage of invention is being able to block some portion of engine cooling circuit while some portion is freely circulating. Such as the cooling circuit of EGR (Exhaust Gas Recirculation) system should not be blocked while cylinder head cooling circuit is blocked with a dedicated on/off valve. By this approach EGR mechanism or turbo charging turbine may have more life time without having a overheating issue.

CLAIMS

1- Using a dedicated on/off valve assembly for blocking the coolant circulation while water pump pulley and impeller shaft are rotating together.

2- Using the hydraulic pressure which is already exist on vehicle engine hydraulic steering system (steering pump) or engine oil lubrication system (oil pump) for the actuation of on/off valve assembly of claim 1

3- Using the vacuum pressure which is already exist on vehicle brake system for the actuation of on/off valve assembly of claim 1

4- The concept of creating a separate block able circuit which is connected to the common water pump pressure line or suction line. By this advantage water pump main flow can be divided to different cooling circuits and any one of these separated cooling circuit can be blocked while other circuits have flow, by actuation of dedicated on/off valve assembly of claim 1

5- An on/off valve assembly for blocking the coolant circulation circuit of claim 1 comprises a piston actuator which drives valve opening and closing movement. Piston can be single acting or double acting linear cylinder or may be a rotary piston. If single acting is selected; retracting of piston is done by a spring which may be in the shape of compression spring, torsion spring, volute spring, extension spring, wire form spring or any kind of them.

6- An on/off valve assembly for blocking the coolant circulation circuit of claim 1 comprises a solenoid valve for controlling the on/off valve actuation.

7- An on/off valve assembly for blocking the coolant circulation circuit of claim 1 comprises an on/off valve for blocking the coolant flow. On/off valve structure may be in shape of a ball valve, a plug valve, a rotary valve, a butterfly valve, a diaphragm valve, a gate valve, a globe valve, a spool valve, a poppet valve, a knife valve or a thermal expansion valve.

8- An on/off valve assembly for blocking the coolant circulation circuit of claim 1 may be integrated in to water pump assembly or may be placed on any point of engine cooling circuit.

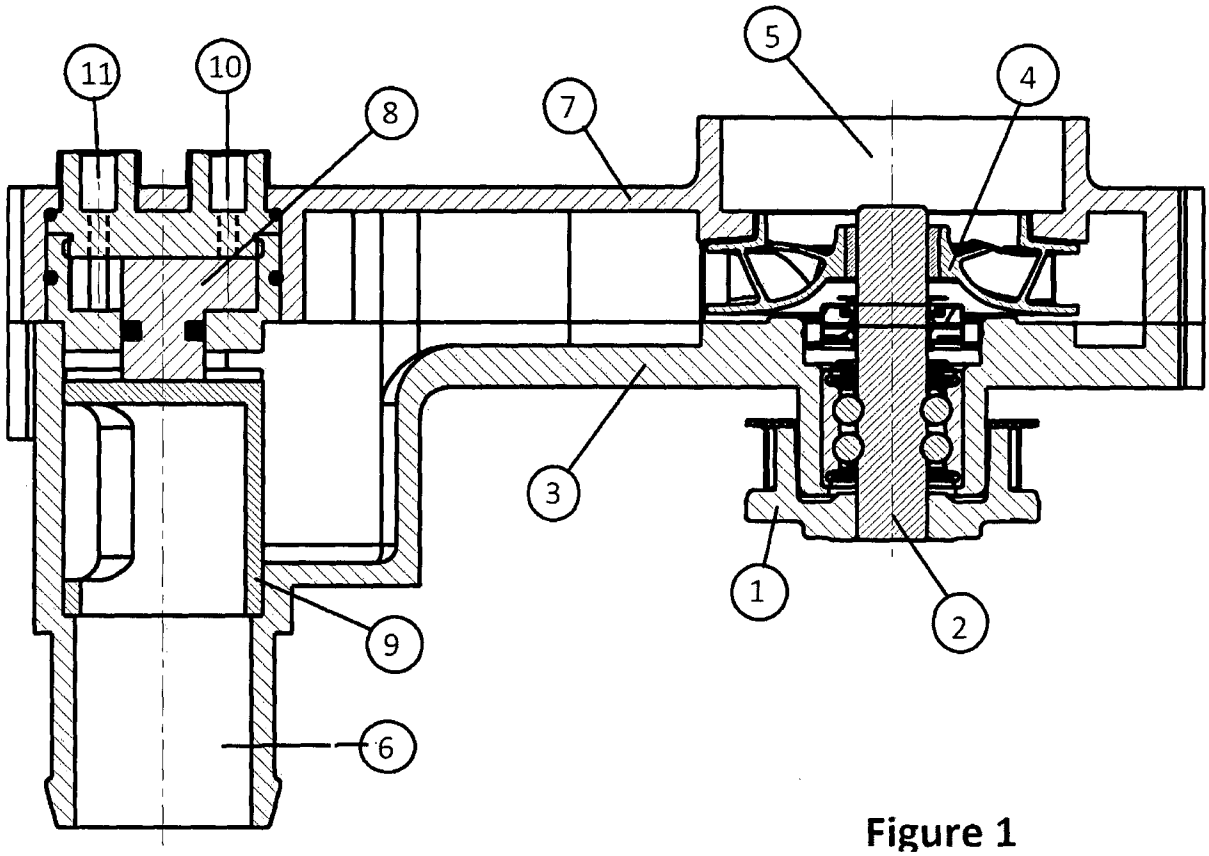

Figure 1

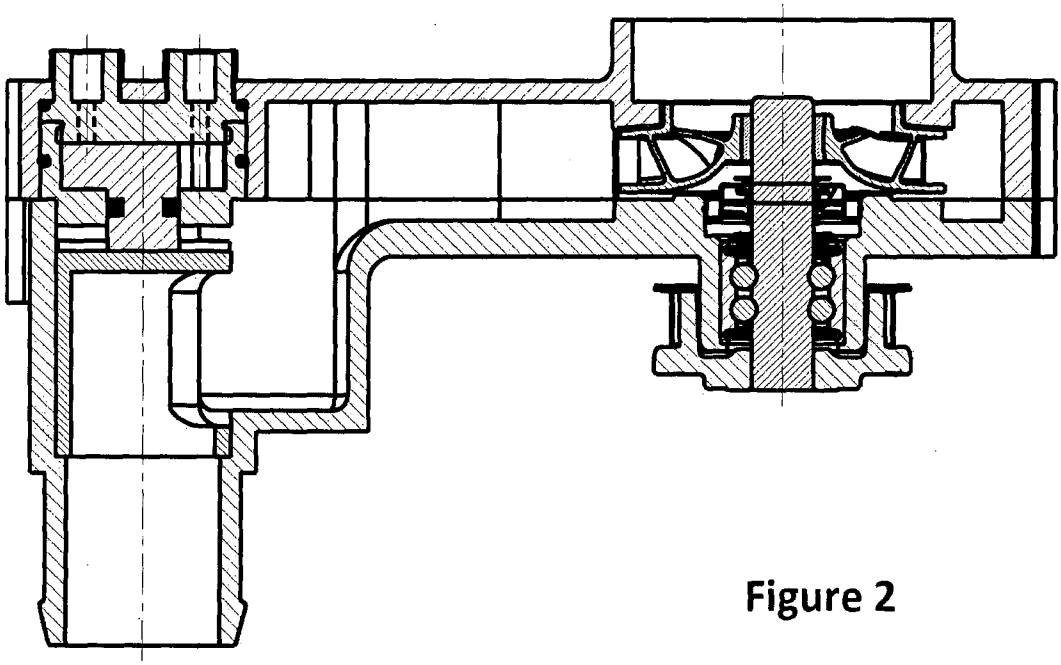

Figure 2

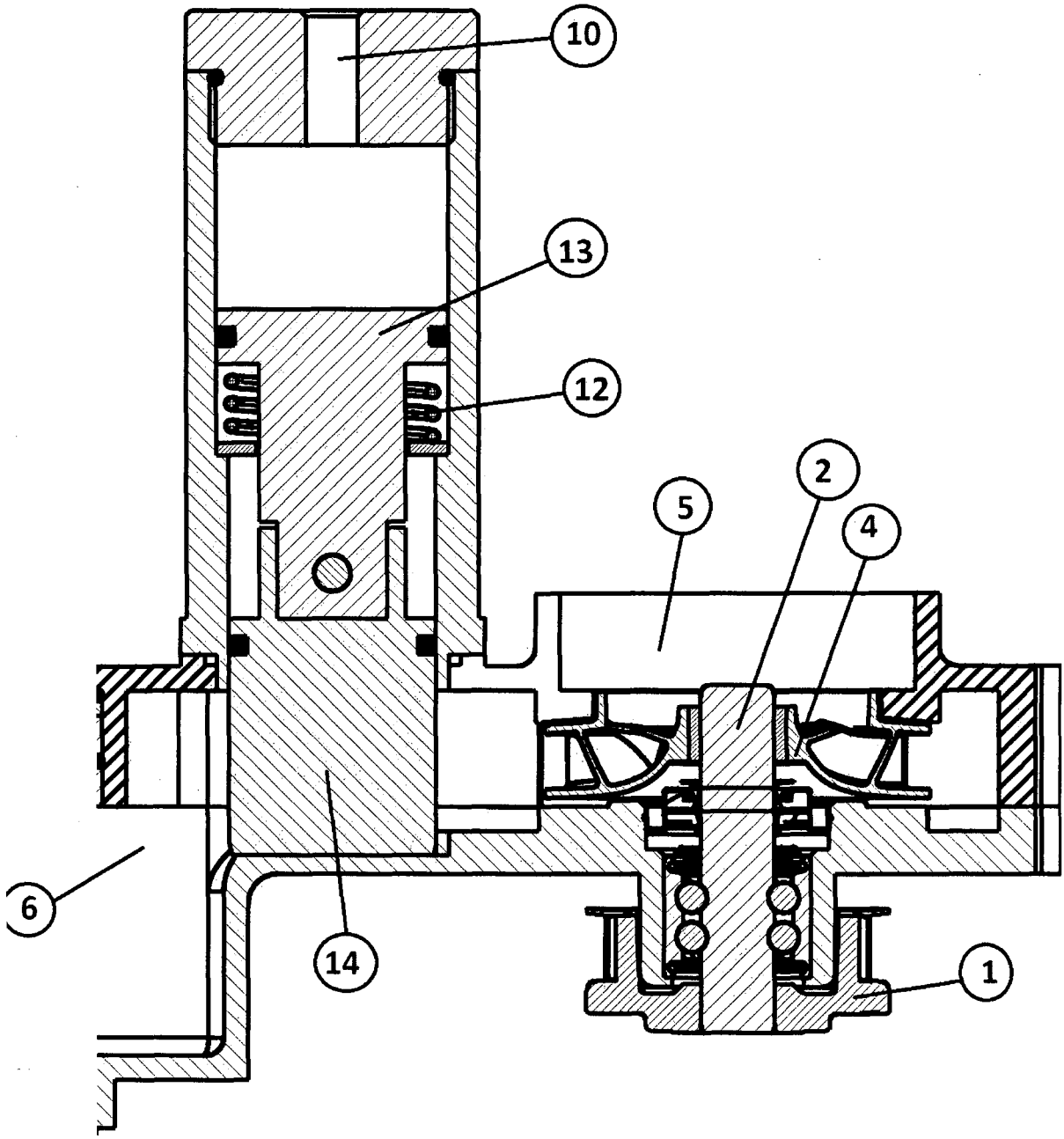

Figure 3