A dual relief valve apparatus of a Balance Shaft and Oil Pump Module (BSM) of a vehicle engine may include the pump housing, and a primary relief valve and a secondary relief valve mounted inside the pump housing, wherein the primary relief valve and the secondary relief valve may be sequentially opened or closed, wherein the primary relief valve may be first opened to release a first oil by a first oil discharge pressure applied thereto and sequentially the secondary relief valve may be opened to release a second oil by a second oil discharge pressure applied thereto, the first oil discharge pressure being relatively smaller than the second oil discharge pressure.
DUAL RELIEF VALVE OF BSM FOR VEHICLE ENGINE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority to Korean Patent Application No. 10-2012-0154213 filed Dec. 27, 2012, the entire contents of which is incorporated herein for all purposes by this reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] The present invention relates to a dual relief valve of a BALANCE SHAFT & OIL PUMP MODULE (BSM) for a vehicle engine. More particularly, the present invention relates to a dual relief valve of a BSM for a vehicle engine, which can maintain the pressure of oil discharged from the BSM for the vehicle engine to be an appropriate pressure.
[0004] 2. Description of Related Art
[0005] In general, the lubrication of a vehicle engine is very important to reduce frictional resistance inside the engine and to cool the inside of the engine.
[0006] The lubrication of the vehicle engine is usually performed on all parts from a valve apparatus to a cylinder as well as a major moving part. For example, the lubrication places a great deal of weight on not only reduction in frictional resistance of a crank shaft, a connecting rod and a piston in the major moving part but also cooling of the piston and cylinder. The sealing performance of the piston and the cylinder is maintained by engine oil.
[0007] Engine oil for lubrication is injected into the engine. The engine oil is pressure-fed to each lubricating part by a BSM.
[0008] Here, the BSM represents an oil pump or a balance shaft & oil pump module having the oil pump as a module.
[0009] For example, the BSM is an apparatus that absorbs oil stored in an oil pan and supplies the absorbed oil to each lubricating part requiring lubrication. The oil pumped by the BSM is increased to a high pressure inside the BSM. The oil discharged in a high-pressure state from the BSM may apply impact and damage to an oil filter or lubrication circuit.
[0010] Therefore, a relief valve for maintaining the pressure of the pumping oil to be an appropriate pressure is provided to an oil discharge port of the BSM.
[0011] In a case where the pressure of oil discharged toward a main gallery of the engine from the BSM is increased to an appropriate pressure or more, the relief valve form a bypass flow path along which a portion of the oil discharged from the BSM is returned to the BSM or the oil fan, so that it is possible to maintain the pressure of the oil discharged from the BSM to be an appropriate pressure, and particularly to prevent the damage of the main gallery due to a high pressure of the oil discharged from the BSM.
[0012] FIGS. 1 and 2 are perspective and sectional views showing a conventional relief valve of a BSM.
[0013] As shown in FIGS. 1 and 2, the relief valve is a valve that is mounted at one side of a pump housing 100 to be opened/closed by the pressure of oil discharged from the BSM. The relief valve is configured to include a plunger 130 opening/closing a relief aperture (not shown) positioned in a valve groove 110 formed at the one side of the pump housing 100 to bypass a portion of the oil pumped from the pump housing 100, and a spring 140 elastically supporting the plunger 130 from the lower position thereof.
[0014] Here, undescribed reference numeral 120 represents a plug, and undescribed reference numeral 150 represent an oil discharge aperture.
[0015] Thus, the plunger of the relief valve directly receives the pressure of the oil pumped and discharged from the BSM. When the pressure of oil discharged from the BSM is remarkably increased, the plunger of the relief valve is pushed by the pressure of the oil discharged from the BSM, thereby opening the relief aperture.
[0016] If the plunger opens the relief aperture as described above, a portion of the pumping oil is bypassed through the relief aperture to be returned toward the BSM.
[0017] However, in the BSM to which a conventional single-type relief valve is applied, fuel efficiency and output loss occur due to excessive driving torque. Particularly, since the BSM uses a method in which the relief valve is simply opened or closed in response to the pressure of oil discharged therefrom, the amount of oil discharged from the BSM is not properly controlled, and therefore, the BSM cannot effectively deal with various operation regions, thereby causing loss of the BSM.
[0018] The information disclosed in this Background of the Invention section is only for enhancement of understanding of the general background of the invention and should not be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.

BRIEF SUMMARY

[0019] Various aspects of the present invention are directed to providing a dual relief valve of a BSM for a vehicle engine, which is configured with the combination of a primary relief valve and a secondary relief valve so that the amount of oil discharged from the BSM can be efficiently controlled while each relief valve is operated in connection with a low-speed region, a middle-low speed region and a high-speed region, thereby minimizing loss of the BSM.
[0020] In an aspect of the present invention, a dual relief valve apparatus of a Balance Shaft and Oil Pump Module (BSM) of a vehicle engine, which is a valve mounted inside a pump housing to be opened/closed by pressure of oil discharged from the BSM, may include the pump housing, and a primary relief valve and a secondary relief valve mounted inside the pump housing, wherein the primary relief valve and the secondary relief valve are sequentially opened or closed, wherein the primary relief valve is first opened to release a first oil by a first oil discharge pressure applied thereto and sequentially the secondary relief valve is opened to release a second oil by a second oil discharge pressure applied thereto, the first oil discharge pressure being relatively smaller than the second oil discharge pressure.
[0021] The primary relief valve may include a primary plunger slidably positioned inside a primary valve groove formed in the pump housing to operate therein, and a primary elastic member disposed beneath the primary plunger inside the primary valve groove to elastically support the primary plunger.
[0022] The dual relief valve apparatus may further include a first relief aperture formed in the pump housing and connected to the primary valve groove.
[0023] The dual relief valve apparatus may further include an oil flow path through which the first oil is configured to
pass is formed inside the primary plunger of the primary relief valve, wherein the second oil flowed from a high pressure region in the pump housing through an upper portion of the primary plunger to the oil flow path is released through the first relief aperture via the oil flow path according to a movement of the primary plunger.

[0024] The first oil is released through the first relief aperture in starting to move the primary relief valve in a middle-low speed region at the same time when movement of the primary relief valve is started in a low-speed region, and the opening of the primary relief valve is finished before opening of the secondary relief valve.

[0025] The secondary relief valve may include a secondary plunger positioned inside a secondary valve groove formed in the pump housing to operate therewith, and a secondary elastic member disposed beneath the secondary plunger inside the secondary valve groove to elastically support the secondary plunger.

[0026] The dual relief valve apparatus may further include a second relief aperture formed in the pump housing and connected to the secondary valve groove.

[0027] The first relief aperture is positioned higher than the second relief aperture.

[0028] The second oil in the secondary valve groove is released through the second relief aperture by starting to move the secondary relief valve in a high-speed region formed in the pump housing.

[0029] Other aspects and exemplary embodiments of the invention are discussed infra.

[0030] Advantages of the relief valve of the BSM for the vehicle engine according to the present invention are described as follows.

[0031] The dual relief valve of the BSM is configured with a combination of a primary relief valve and a second relief valve, so that oil is released through a primary relief valve at a low pressure in a low-speed region and a middle-low speed region, and the oil is released through a secondary relief valve at a high pressure in a high-speed region. Thus, the amount of oil discharged from the BSM can be pumped as much as the amount of oil required in an actual vehicle engine, and accordingly, loss of the BSM can be minimized. As a result, it is possible to reduce driving torque, to improve fuel efficiency and to minimize output loss.

[0032] The methods and apparatuses of the present invention have other features and advantages which will be apparent from or are set forth in more detail in the accompanying drawings, which are incorporated herein, and in the following Detailed Description, which together serve to explain certain principles of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] FIG. 1 is a perspective view showing the mounting position of a conventional relief valve of a BSM.

[0034] FIG. 2 is a sectional view showing the conventional relief valve of the BSM.

[0035] FIG. 3 is a sectional view showing a dual relief valve of a BSM according to an exemplary embodiment of the present invention.

[0036] FIGS. 4A to 4C are sectional views showing an operating state of the dual relief valve of the BSM according to the exemplary embodiment of the present invention.

[0037] FIG. 5 is a graph comparing the performance of the dual relief valve of the BSM according to the exemplary embodiment of the present invention with the performance of the conventional relief valve.

[0038] It should be understood that the appended drawings are not necessarily to scale, presenting a somewhat simplified representation of various preferred features illustrative of the basic principles of the invention. The specific design features of the present invention as disclosed herein, including, for example, specific dimensions, orientations, locations, and shapes will be determined in part by the particular intended application and use environment.

[0039] In the figures, reference numbers refer to the same or equivalent parts of the present invention throughout the several figures of the drawing.

DETAILED DESCRIPTION

[0040] Hereinafter reference will now be made in detail to various embodiments of the present invention, examples of which are illustrated in the accompanying drawings and described below. While the invention will be described in conjunction with exemplary embodiments, it will be understood that present description is not intended to limit the invention to those exemplary embodiments. On the contrary, the invention is intended to cover not only the exemplary embodiments, but also various alternatives, modifications, equivalents and other embodiments, which may be included within the spirit and scope of the invention as defined by the appended claims.

[0041] FIG. 3 is a sectional view showing a dual relief valve of a BSM according to an exemplary embodiment of the present invention.

[0042] As shown in FIG. 3, the dual relief valve of the BSM is configured with the combination of a primary relief valve releasing a primary oil at a low pressure and a secondary relief valve releasing a secondary oil at a high pressure, to efficiently pump the amount of oil discharged in a low-speed region, a middle-low speed region and a high-speed region, thereby minimizing loss of the BSM.

[0043] To this end, two parallel vertical valve grooves for mounting the relief valve, i.e., a primary valve groove 13 and a secondary valve groove 18 are respectively formed at positions adjacent to one internal side of a pump housing 10, e.g., a place in which an oil discharge aperture 21 having pumping oil discharged therethrough is formed. Each of the primary and secondary valve grooves 13 and 18 communicates with a high-pressure region 22 at an upper portion thereof and simultaneously communicates with a low-pressure region 23 at a side portion thereof.

[0044] Accordingly, the oil from the upper portion communicating with the high-pressure region 22 can be released to the side portion communicating with the low-pressure region 23.

[0045] A primary relief valve 11 and a secondary relief valve 12 are mounted in the primary valve groove 13 and the secondary valve groove 18, respectively. The primary and secondary relief valves 11 and 12 mounted described above can release the oil while being sequentially opened/closed.

[0046] For example, the primary relief valve 11 is first opened under a low-pressure condition, i.e., an oil discharge pressure relatively smaller than that of the secondary relief valve 12 to release the oil. Continuously, the secondary relief valve 12 is opened under a high-pressure condition, i.e., an oil
discharge pressure relatively greater than that of the primary relief valve 11 to release the oil.

[0047] That is, the downward movement of the primary relief valve 11 is started in the low-speed region and releases the oil through a first relief aperture 17 at the same time when the opening of the primary relief valve 11 is started in the middle-low speed region.

[0048] Then, the primary relief valve 11 is further descended by the oil discharge pressure continuously applied so that the opening of the primary relief valve 11 can be finished before the secondary relief valve 12 is opened.

[0049] At the same time when the opening of the primary relief valve 11 is finished, the opening of the secondary relief valve 12 is started in the high-speed region, thereby releasing the oil through the relief aperture 17.

[0050] Here, the time at which the primary and secondary relief valves are sequentially opened/closed may be changed by differently adjusting the elastic coefficients of primary and secondary springs described later. In this case, the oil discharge pressure for opening each of the primary and secondary relief valves may be set through various calibrations linked with each of the high-speed region, the middle-low speed region and the high-speed region.

[0051] Each of the primary and secondary relief valves 11 and 12 is configured with the combination of a plunger and a spring, and can release the oil using the plunger that performs a vertical operation by being elastically supported by the spring in each valve groove.

[0052] To this end, the primary relief valve 11 includes a primary plunger 14 vertically operated while being positioned inside the primary valve groove 13 of the pump housing 10, and a primary spring 15 supporting the bottom surface of the primary plunger 14 at the inner bottom of the primary valve groove 13.

[0053] Accordingly, if the oil discharge pressure greater than a predetermined value is applied to an upper portion of the primary plunger 14, the primary plunger 14 is descended downward while pressing the primary spring 15. As a result, the oil can be released to the low-pressure region 23 through the first relief aperture 17 formed at a side surface of the primary valve groove 13.

[0054] Particularly, an oil flow path 16 communicating from the top end to the side end of the primary plunger 14 is formed inside the primary plunger 14, so that oil flowed from the upper portion of the primary plunger 14 through the oil flow path 16 can be discharged to the first relief aperture 17 through the side portion of the primary plunger 14.

[0055] In this case, the primary plunger 14 may be divided into an upper plunger head body and a lower plunger support body. The plunger head body and the plunger support body may be integrally connected by a horizontal rib, except the portion at which the vertical oil flow path 16 is formed.

[0056] The secondary relief valve 12 includes a secondary plunger 19 vertically operated while being positioned inside the secondary valve groove 18 of the pump housing 10, and a secondary spring 20 supporting the bottom surface of the secondary plunger 19 at the inner bottom of the secondary valve groove 18.

[0057] Accordingly, when the oil discharge pressure greater than a predetermined value is applied to an upper portion of the secondary plunger 19, the secondary plunger 19 is descended downward while pressing the secondary spring 20. As a result, the oil can be released to the low-pressure region 23 through the second relief aperture 27 formed at a side surface of the secondary valve groove 18.

[0058] In an exemplary embodiment of the present invention, the first relief aperture 17 is positioned higher than the second relief aperture 27.

[0059] The operating state of the relief valve of the BSM, configured as described above, will be described as follows.

[0060] FIGS. 4A to 4C are sectional views showing are sectional views showing an operating state of the dual relief valve of the BSM according to the exemplary embodiment of the present invention.

[0061] As shown in FIG. 4A, in the operation of a vehicle engine, the movement of the primary plunger 14 of the primary relief valve 11 is started in the low-speed region. Continuously, the primary plunger 14 is further moved downward in the middle-low speed region. As the oil flow path 16 of the primary plunger 14 communicates with the first relief aperture 17 formed in the primary valve groove 13, the oil can be primarily released while flowing from the high-pressure region 22 to the low-pressure region 23 via the oil flow path 16 and the relief aperture 17.

[0062] As shown in FIG. 4B, when the operation region of the vehicle engine reaches the high-speed region, the primary plunger 14 of the primary relief valve 11 is further moved downward as the oil pressure increases. Accordingly, the first relief aperture 17 formed in the primary valve groove 13 is blocked, so that the oil cannot be released through the relief aperture 17.

[0063] As shown in FIG. 4C, at the same time when the operation region of the vehicle engine reaches the high-speed region, the secondary relief valve 12 operates to release the oil.

[0064] That is, the secondary plunger 14 of the secondary relief valve 12 is moved downward by the oil discharge pressure. As the second relief aperture 27 formed in the secondary valve groove 18 is opened by the secondary plunger 19, the oil can be secondarily released while flowing from the high-pressure region 22 to the low-pressure region 23 via the second relief aperture 27.

[0065] FIG. 5 is a graph comparing the performance of the dual relief valve of the BSM according to the exemplary embodiment of the present invention with the performance of the conventional relief valve.

[0066] As shown in FIG. 5, the pressure of oil is changed depending on an increase in speed (rpm)

[0067] In the dual relief valve of the present invention, the amount of oil discharged from the BSM can be variably controlled by the slashed portion in the variable graph as compared with the existing single relief valve. Thus, an unnecessary loss of the BSM can be minimized by pumping the amount of oil discharged from the BSM as much as the amount of oil required in an actual vehicle engine.

[0068] Accordingly, in an exemplary embodiment of the present invention, the dual relief valve releasing oil while being sequentially opened/closed according to the low-speed region, the middle-low speed region and the high-speed region is implemented, so that it is possible to efficiently control the amount of oil discharged from the BSM, thereby minimizing loss of the BSM.

[0069] For convenience in explanation and accurate definition in the appended claims, the terms “upper”, “lower”, “inner” and “outer” are used to describe features of the exemplary embodiments with reference to the positions of such features as displayed in the figures.
The foregoing descriptions of specific exemplary embodiments of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teachings. The exemplary embodiments were chosen and described in order to explain certain principles of the invention and their practical application, to thereby enable others skilled in the art to make and utilize various exemplary embodiments of the present invention, as well as various alternatives and modifications thereof. It is intended that the scope of the invention be defined by the Claims appended hereto and their equivalents.

What is claimed is:

1. A dual relief valve apparatus of a Balance Shaft and Oil Pump Module (BSM) of a vehicle engine, which is a valve mounted inside a pump housing to be opened/closed by pressure of oil discharged from the BSM, the dual relief valve apparatus comprising:

   a) a pump housing, and
   b) a primary relief valve and a secondary relief valve mounted inside the pump housing, wherein the primary relief valve and the secondary relief valve are sequentially opened or closed, wherein the primary relief valve is first opened to release a first oil by a first oil discharge pressure applied thereto and sequentially the secondary relief valve is opened to release a second oil by a second oil discharge pressure applied thereto, the first oil discharge pressure being relatively smaller than the second oil discharge pressure.

2. The dual relief valve apparatus of claim 1, wherein the primary relief valve includes:

   a) a primary plunger slidably positioned inside a primary valve groove formed in the pump housing to operate therein; and
   b) a primary elastic member disposed beneath the primary plunger inside the primary valve groove to elastically support the primary plunger.

3. The dual relief valve apparatus of claim 2, further including:

   a) a first relief aperture formed in the pump housing and connected to the primary valve groove.

4. The dual relief valve apparatus of claim 3, further including:

   an oil flow path through which the first oil is configured to pass is formed inside the primary plunger of the primary relief valve, wherein the second oil flowed from a high pressure region in the pump housing through an upper portion of the primary plunger to the oil flow path is released through the first relief aperture via the oil flow path according to a movement of the primary plunger.

5. The dual relief valve apparatus of claim 4, wherein the first oil is released through the first relief aperture in starting to move the primary relief valve in a middle-low speed region at the same time when movement of the primary relief valve is started in a low-speed region, and the opening of the primary relief valve is finished before opening of the secondary relief valve.

6. The dual relief valve apparatus of claim 3, wherein the secondary relief valve includes:

   a) a secondary plunger positioned inside a secondary valve groove formed in the pump housing to operate therein; and
   b) a secondary elastic member disposed beneath the secondary plunger inside the secondary valve groove to elastically support the secondary plunger.

7. The dual relief valve apparatus of claim 6, further including:

   a) a second relief aperture formed in the pump housing and connected to the secondary valve groove.

8. The dual relief valve apparatus of claim 7, wherein the first relief aperture is positioned higher than the second relief aperture.

9. The dual relief valve apparatus of claim 1, wherein the secondary relief valve includes:

   a) a secondary plunger positioned inside a secondary valve groove formed in the pump housing to operate therein; and
   b) a secondary elastic member disposed beneath the secondary plunger inside the secondary valve groove to elastically support the secondary plunger.

10. The dual relief valve apparatus of claim 9, further including:

    a) a second relief aperture formed in the pump housing and connected to the secondary valve groove.

11. The dual relief valve apparatus of claim 10, wherein the second oil in the secondary valve groove is released through the second relief aperture by starting to move the secondary relief valve in a high-speed region formed in the pump housing.