ENGINE BRAKE LASH ADJUSTER DEVICE AND METHOD

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ABSTRACT

A compression brake device and method are provided that include a lash member coupled to a rocker arm. The lash member has a first position that forces opening of the valve when the rocker arm is at the lower position. The brake also includes a lost motion cylinder at least partially defined within the rocker arm. The cylinder is biased towards a position of greatest internal displacement volume. The lost motion cylinder has a first operational mode wherein the lost motion cylinder permits compression thereof such that the ability of the rocker arm to open an exhaust valve is a function of the position of the lash member. The lost motion cylinder has a second operational mode wherein the lost motion cylinder retards compression thereof such that the ability of the rocker arm to open an exhaust valve is independent of the position of the lash member.
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CROSS-REFERENCE OR RELATED APPLICATION

[0001] The present application claims priority to U.S. provisional patent application, Ser. No. 61/859,598, filed Jul. 29, 2013, the disclosure of which is expressly incorporated by reference.

BACKGROUND OF THE DISCLOSURE

[0002] This disclosure relates to an exhaust valve actuation mechanism in an internal combustion engine and an engine brake lash adjuster device associated with the exhaust valve actuation mechanism.

[0003] Engine brakes or engine compression brakes take advantage of the compression and expansion of gases in an engine cylinder to induce a resistance to movement of a piston in the engine cylinder by opening and closing valves associated with the piston at appropriate times. In order for engine brakes to function properly, conventional systems use various unique components and require certain precise tolerances.

[0004] Advantages and features of the embodiments of this disclosure will become more apparent from the following detailed description of exemplary embodiments when viewed in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a view of an engine brake lash adjuster device in accordance with an exemplary embodiment of the present disclosure.

[0006] FIG. 2 is a view of the engine brake lash adjuster device of FIG. 1 in a position to actuate an exhaust valve.

[0007] FIG. 3 is a view of the engine brake lash adjuster device of FIG. 1 with a compression brake actuated.

DETAILED DESCRIPTION OF THE DRAWINGS

[0008] According to one embodiment, a compression brake is provided. The brake includes a rocker arm pivotable about a rocker arm shaft to selectively force an exhaust valve to an open condition. The rocker arm has a lower position, an upper position, and a plurality of positions intermediate the lower and upper positions. The brake further includes a lash member coupled to the rocker arm. The lash member is configurable to define a plurality of positions relative to the rocker arm. The lash member has a first position that forces opening of the valve when the rocker arm is at the lower position. The brake includes a lost motion cylinder at least partially defined within the rocker arm. The cylinder is biased towards a position of greatest internal displacement volume. The lost motion cylinder has a first operational mode wherein the lost motion cylinder permits compression thereof such that the ability of the rocker arm to open an exhaust valve is a function of the position of the lash member. The lost motion cylinder has a second operational mode wherein the lost motion cylinder retards compression thereof such that the ability of the rocker arm to open an exhaust valve is independent of the position of the lash member.

[0009] In another embodiment, a compression brake mechanism is provided including a rocker arm operable to selectively engage an engine valve; a lash member having a plurality of settings that define lash between rocker arm movement and engine valve movement; and a lost motion mechanism disposed between the lash member and the engine valve; the lost motion mechanism having a first operational mode and a second operational mode, the first operational mode providing an ability to open an engine valve as a function of the lash member setting, the second operational mode providing an ability to open an engine valve independent of the lash member setting.

[0010] In another embodiment, a method of operating an exhaust valve on an internal combustion engine is provided including: providing a lost motion cylinder at least partially within a rocker arm operable to open the exhaust valve; providing a lash member to define a maximum travel of a piston of the cylinder that defines a first internal volume of the cylinder; providing a seal valve within the rocker arm to selectively seal and open the internal volume of the cylinder; closing the seal valve when the internal volume of the cylinder is a second internal volume that is greater than a first volume defined by the lash member thereby sealing fluid within the cylinder; rotating the rocker arm with the seal valve closed to force open the exhaust valve; and opening the seal valve to release fluid from the cylinder; and rotating the rocker arm with the seal valve open such that the cylinder assumes the first internal volume to force open the exhaust valve.

[0011] In yet another embodiment, a method of adjusting lash between an exhaust valve and a rocker arm on an operating internal combustion engine including: providing a rocker arm having a first lash member defining a first lash amount between the rocker arm and the exhaust valve, the first lash amount defining a first point during downward travel of the rocker arm at which the exhaust valve is opened; providing a lash variance member defining a second lash amount between the rocker arm and the exhaust valve that is smaller than the first lash amount, the second last amount defining a second point in the downward travel of the rocker arm at which the exhaust valve is opened, the second point being higher than the first point; and toggling between the first and second lash amounts within a cycle of the engine.

[0012] Referring to FIG. 1, a portion of an internal combustion engine is shown and generally indicated at 10. Engine 10 includes an engine brake or engine compression brake, which provides the ability to retard movement of a crankshaft (not shown) of engine 10 when actuated. Engine compression brakes provide a valuable capability in a variety of situations where a friction brake, such as might be found in conjunction with a vehicle wheel, could easily overheat or rapidly wear out. Such situations include high loads and steep hills. While engine compression brakes provide a valuable capability, they are expensive and complex, requiring additional components and precise component tolerances. The engine brake of the present disclosure includes an exhaust valve actuation mechanism with a lash adjuster device or mechanism that provides the ability to reduce the number of components associated with an engine compression brake and the ability to reduce the tolerances of certain components associated with the engine compression brake disclosed in U.S. Pat. No. 6,253,730, the entire contents of which are hereby incorporated by reference.

[0013] Engine 10 includes a rocker arm assembly 12 having a rocker arm body 14, an exhaust valve 16 moved by the action of rocker arm assembly 12, a control shaft 18 that extends through rocker arm body 14, a rotatable camshaft 20, and an engine body 22. The function of rocker arm assembly 12 is to control or actuate exhaust valve 16. Thus, rocker arm
assembly 12 is part of an exhaust valve actuation mechanism. Rocker arm assembly 12 includes a reset valve 24, a lash adjuster device 26, a compression brake or engine brake hydraulic cylinder or piston 28, and a bearing 30. Reset valve 24 includes a reset pin 32, a detent pin 34, and a reset member or ball 36, each of which is positioned at least partially within a reset valve cavity 38 formed in rocker arm body 14. Reset valve cavity 38 includes a reset valve seat 86 that provides a mating surface for reset ball 36 when reset valve 24 is actuated. Reset valve 24 may also include a bias spring 40 and a bias spring cup 42 positioned between bias spring 40 and reset ball 36. Bias spring 40 and bias spring cup 42 bias reset ball 36 toward a proximate end of reset in 32, contacting reset pin 32 during normal or non-compression braking operation of engine 10. Because this contact prevents reset ball 36 from contacting reset valve seat 86, fluid is able to flow past reset ball 36 toward engine brake piston 28. Reset valve 24 functions to cause the opening and closing of exhaust valve 16 at a time that is independent of the position of lash adjuster device 26, explained further hereinbelow. Lash adjuster device 26 includes a distal end 84 and a threaded exterior surface 74. Engine brake piston 28 is positioned in a body cavity 44 formed in rocker arm body 14 and having a body cavity longitudinal axis 46. Engine brake piston 28 includes a portion 48 having a spherical shape on which is positioned a piston shoe 50 having a mating spherical shape and a shoe contact surface 52, which contacts a proximate end 54 of exhaust valve 16. Shoe contact surface 52 may be a planar surface and proximate end 54 mates with the planar surface of shoe contact surface 52. Engine brake piston 28 includes an interior surface 56 that forms a piston cavity 58. Interior surface 56 includes an interior distal surface 70 that extends in a direction that is at an angle to body cavity longitudinal axis 46 that may be 90 degrees. A piston bias spring 80 is positioned between rocker arm body 14 and interior distal surface 70 and functions to bias engine brake piston 28 toward piston shoe 50 and thus biases piston shoe 50 into contact with exhaust valve 16, which is biased into the position shown in FIG. 1 by an exhaust valve spring (not shown). Lash adjuster device 26 extends along body cavity longitudinal axis 46 through a threaded passage 60 formed in rocker arm body 14 into body cavity 44 and then into piston cavity 58. Lash adjuster device 26 is adjustable along body cavity longitudinal axis 46 and is secured in position with a jam nut or locking nut 62. As described further hereinbelow, lash adjuster device 26 functions to actuate exhaust valve 16 during normal operation of engine 10. Bearing 30 is positioned on rocker arm body 14 and contacts camshaft 20. During operation of engine 10, camshaft 20 rotates, causing pivotal oscillating motion of rocker arm assembly 12 about control shaft 18.

Control shaft 18 includes a control shaft oil passage 64, which connects with a first rocker arm oil passage 66 formed in rocker arm body 14 that fluidly connects to reset valve cavity 38. Rocker arm body 14 further includes a second rocker arm oil passage 68 that extends between reset valve cavity 38 and body cavity 44, fluidly connecting reset valve cavity 38 to body cavity 44. An engine oil pump (not shown) that provides oil pressure for various engine functions, such as lubrication, also provides pressure to the oil that flows into control shaft oil passage 64, which then flows into first rocker arm body oil passage 66. Under normal engine operating conditions, the oil in control shaft oil passage 64 and first rocker arm body oil passage 66 provides lubrication to the various components fluidly connected to control shaft oil passage 64 and rocker arm body oil passage 66. These passages provide a control function to certain components of rocker arm assembly during engine compression braking, described further hereinbelow.

[0015] The longitudinal position of lash adjuster device 26 is set during assembly of engine 10, and because of the ability to identify the distance exhaust valve 16 needs to open empirically, setting the lash is easily accomplished through an automated process. With rocker arm assembly 12 in the position shown in FIG. 1, and with jam nut 62 in a position to permit movement of lash adjuster device 26, lash adjuster device 26 is driven or moved longitudinally downward toward interior distal surface 70 of engine brake piston 28. Once lash adjuster device 26 contacts interior distal surface 70 of engine brake piston 28, the drive torque to move lash adjuster device 26 increases non-linearly, which indicates that lash adjuster device 26 has contacted interior distal surface 70 of engine brake piston 28. Once an automated assembly mechanism (not shown) detects the contact between lash adjuster device 26 and interior distal surface 70, lash adjuster device 26 is moved longitudinally away from interior distal surface 70 of engine brake piston 28 by a predetermined amount. Once movement of lash adjuster device 26 by the predetermined amount has been accomplished, jam nut 62 is secured against a jam nut contact surface 72 of rocker arm body 14 to lock lash adjuster device 26 in a fixed position. In the exemplary embodiment, lash adjuster device 26 includes exterior threaded surface 74 that mates with a similar thread formed in threaded passage 60 of rocker arm body 14, and longitudinal movement of lash adjuster device 26 is accomplished by rotating lash adjuster device 26 about body cavity longitudinal axis 46, which moves lash adjuster device 26 longitudinally along body cavity longitudinal axis 46. The ability to set the position of lash adjuster device 26, which determines when exhaust valve 16 is actuated, reduces the tolerances that would otherwise be required in the fabrication of rocker arm body 14.

[0016] During normal operation of engine 10, as camshaft 20 rotates, camshaft 20 contacts rocker assembly bearing 30. Camshaft 20 includes a cam profile 76 that causes oscillating pivotal motion of rocker arm assembly 12 about control shaft 18. In the exemplary embodiment, cam profile 76 of camshaft 20 is shown as having only one lift event per revolution of camshaft 20. It should be understood that camshaft 20 can have any number of lift events to achieve various performance conditions, which includes control of exhaust emissions. Reset pin 32 includes a recess, undercut, or engaging feature 78, that is engaged by detent pin 34 during normal operation of engine 10. The position of detent pin 34 is maintained by a bias spring mechanism (not shown), until a solenoid or other actuation mechanism (not shown) moves detent pin 34 to a position where detent pin 34 disengages from reset pin 32, which permits reset pin 32 to move toward a contact pad 80 formed on engine body 22, as shown in FIG. 3, which permits reset valve 24 to close, described further hereinbelow.

[0017] As rocker arm assembly 12 rotates in a counterclockwise direction through contact of bearing 30 with cam profile 76, as shown in FIG. 2, engine brake piston 28 compresses piston bias spring 82 until interior distal surface 72 of engine brake piston 28 contacts lash adjuster device 26. This actuation of exhaust valve 16 is sometimes called lost motion. Further counterclockwise motion of rocker arm assembly 12 moves exhaust valve 16, causing exhaust valve 16 to open, which permits exhaust gases to escape from engine body 22 in
a known manner. Cam profile 76 of camshaft 20 is configured to provide for rapid movement of lash adjuster device 26 toward interior distal surface 70 of engine brake piston 28 until distal end 84 of lash adjuster device 26 approaches interior distal surface 70 of engine brake piston 28, at which point cam profile 76 provides a decreased velocity of lash adjuster device 26 to minimize the impact of lash adjuster device 26 with interior distal surface 70 of engine brake piston 28. By reducing the impact, the life and reliability of lash adjuster device 26 and engine brake piston 28 are extended.

When the engine brake function is engaged, as shown in FIG. 3, detent pin 34 is moved to disengage from engaging feature 78, permitting reset pin 32 to move longitudinally toward contact pad 80 of engine body 22. Oil pressure present in rocker arm oil passage 66 and reset valve cavity 38 forces reset pin 32 longitudinally toward contact pad 80, which permits reset valve ball 36 to move toward and contact reset valve seat 86 by the action of bias spring 40, trapping oil in second rocker arm oil passage 68 and in body cavity 44. With oil trapped in second rocker arm oil passage 68 and body cavity 44, engine brake piston 28 is unable to move as rocker arm assembly 12 moves in a counterclockwise direction, because engine brake piston 28 is unable to compress the trapped oil, and thus movement of rocker arm assembly 12 causes engine brake piston 28 to move exhaust valve 16 sooner than would otherwise happen by contact of lash adjuster device 26 with interior distal surface 70 of engine brake piston 28. To disengage the give compression brake, detent pin 34 is moved along its axis to engage with recess 78 reset pin 32 as reset pin 32 moves toward reset ball 36 through contact with contact pad 80. As reset pin 32 moves off reset valve seat 86, oil compressed by engine brake piston is able to flow from body cavity 44 into second rocker arm oil passage 68, and then through reset valve cavity into first rocker arm oil passage 66, and then into control shaft oil passage 64, permitting engine brake piston 28 to move toward lash adjuster 26, restoring normal, or non-braking operation, of rocker arm assembly 12.

Thus, lash adjuster device 26 in combination with reset valve 24 permits the ability to combine functions in rocker arm assembly 12 to provide movement of exhaust valve 16 during operation of engine 10 as well as a different timing of the motion of exhaust valve 16 during engine braking events. By combining two functions in rocker arm assembly 12, cost and complexity of engine 10 is reduced significantly while providing an engine compression brake for engine 10.

While various embodiments of the disclosure have been shown and described, it is understood that these embodiments are not limited thereto. The embodiments may be changed, modified and further applied by those skilled in the art. Therefore, these embodiments are not limited to the detail shown and described previously, but also include all such changes and modifications.

1. A compression brake including:
   a rocker arm pivotable about a rocker arm shaft to selectively force an exhaust valve to an open condition, the rocker arm having a lower position, an upper position, and a plurality of positions intermediate the lower and upper positions;
   a lash member coupled to the rocker arm, the lash member being configurable to define a plurality of positions relative to the rocker arm, the lash member having a first position that forces opening of the valve when the rocker arm is at the lower position, and
   a lost motion cylinder at least partially defined within the rocker arm, the cylinder biased towards a position of greatest internal displacement volume, the lost motion cylinder having a first operational mode wherein the lost motion cylinder permits compression thereof such that the ability of the rocker arm to open an exhaust valve is a function of the position of the lash member, the lost motion cylinder having a second operational mode wherein the lost motion cylinder retards compression thereof such that the ability of the rocker arm to open an exhaust valve is independent of the position of the lash member.

2. The engine of claim 1, wherein the second operational mode of the lost motion cylinder is an engine compression braking mode and the first operational mode of the lost motion cylinder is a non-engine compression braking mode.

3. The engine of claim 1, further including a seal valve within the rocker arm that, when closed, places the lost motion cylinder into the second operational mode.

4. The engine of claim 3, wherein the seal valve is biased towards a closed position.

5. The engine of claim 3, wherein the seal valve includes an actuator that abuts a portion of an engine when the rocker arm is in the lower position to place the seal valve in the open position and to place the lost motion cylinder in the second operational mode.

6. The engine of claim 3, further including a lock that holds the seal valve in the open position.

7. The engine of claim 6, further including a solenoid that selectively releases the lock.

8. A compression brake mechanism including:
   a rocker arm operable to selectively engage an engine valve;
   a lash member having a plurality of settings that define lash between rocker arm movement and engine valve movement; and
   a lost motion mechanism disposed between the lash member and the engine valve; the lost motion mechanism having a first operational mode and a second operational mode, the first operational mode providing an ability to open an engine valve as a function of the lash member setting, the second operational mode providing an ability to open an engine valve independent of the lash member setting.

9. The brake mechanism of claim 8, further comprising an engine valve upon which the lash member acts, wherein the engine valve is an exhaust valve and the second operational mode provides engine compression braking.

10. The brake mechanism of claim 8, further including at least one seal valve within the rocker arm, the at least one seal valve being operable such that the second operational mode of the lost motion mechanism traps fluid within a portion of the rocker arm.

11. The brake mechanism of claim 10, wherein the trapping of fluid prevents loss of motion by the lost motion mechanism.

12. The brake mechanism of claim 10, further including a lock operable to hold the lost motion mechanism in the first operational mode.

13. The brake mechanism of claim 12, wherein the seal valve is biased to a closed position corresponding to the
second operational mode, and releasing the hold provided by the lock permits the biasing of the seal valve to assume the closed position.

14. The brake mechanism of claim 13, further including a reset pin that is selectively locked by the lock, the reset pin having a first portion extending outside of the rocker arm, force applied to the first portion urging opening of the seal valve.

15. The brake mechanism of claim 8, wherein the lost motion mechanism includes a cylinder, the first operational mode permitting egress of fluid from the cylinder, the second operational mode preventing egress of fluid from the cylinder.

16. The brake mechanism of claim 15, wherein the lash member provides a limit on the travel of the cylinder.

17. The brake mechanism of claim 15, wherein the lash member provides a limit on the minimum interior volume of the cylinder.

18. The brake mechanism of claim 8, wherein the brake is operational on a 4-stroke engine, wherein the lost motion mechanism is in the first operational mode during an exhaust stroke and the lost motion mechanism, when in the second operational mode, releases fluid compressed during a compression stroke.

19. The brake mechanism of claim 8, wherein the brake mechanism is part of an internal combustion engine.

20. A method of operating an exhaust valve on an internal combustion engine including:

a. providing a lost motion cylinder at least partially within a rocker arm operable to open the exhaust valve;

b. providing a lash member to define a maximum travel of a piston of the cylinder that defines a first internal volume of the cylinder;

c. providing a seal valve within the rocker arm to selectively seal and open the internal volume of the cylinder;

d. closing the seal valve when the internal volume of the cylinder is a second internal volume that is greater than a first volume defined by the lash member thereby sealing fluid within the cylinder;

rotating the rocker arm with the seal valve closed to force open the exhaust valve;

opening the seal valve to release fluid from the cylinder;

and

rotating the rocker arm with the seal valve open such that the cylinder assumes the first internal volume to force open the exhaust valve.

21. The method of claim 20, wherein rotating the rocker arm with the seal valve closed causes opening of the exhaust valve.

22. A method of adjusting lash between an exhaust valve and a rocker arm on an operating internal combustion engine including:

providing a rocker arm having a first lash member defining a first lash amount between the rocker arm and the exhaust valve, the first lash amount defining a first point during downward travel of the rocker arm at which the exhaust valve is opened;

providing a lash variance member defining a second lash amount between the rocker arm and the exhaust valve that is smaller than the first lash amount, the second last amount defining a second point in the downward travel of the rocker arm at which the exhaust valve is opened, the second point being higher than the first point; and
toggling between the first and second lash amounts within a cycle of the engine.

23. The method of claim 22, wherein the lash variance member includes a hydraulic piston.

24. The method of claim 23, wherein the hydraulic piston includes a displacement, the displacement being limited by the first lash member to define a first displacement.

25. The method of claim 23, wherein the second lash amount is defined by a second displacement of the hydraulic piston that is greater than the first displacement.