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HYDRAULIC LASH ADJUSTERS

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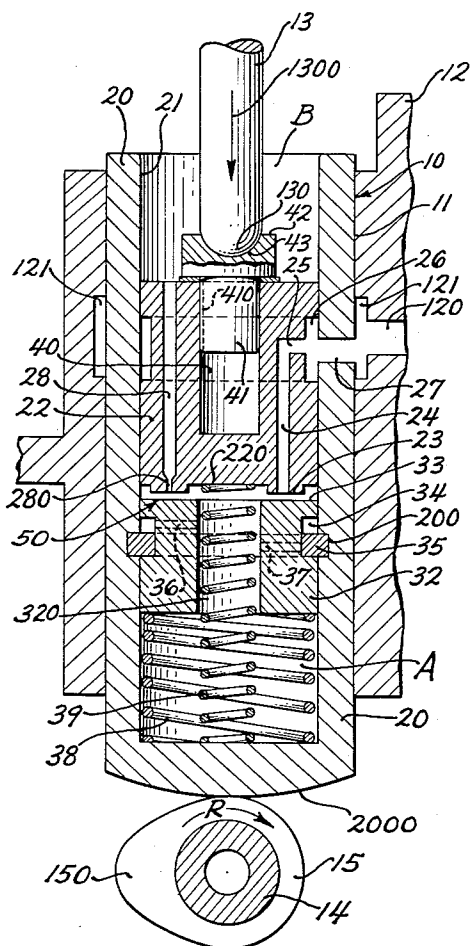


FIG. 1

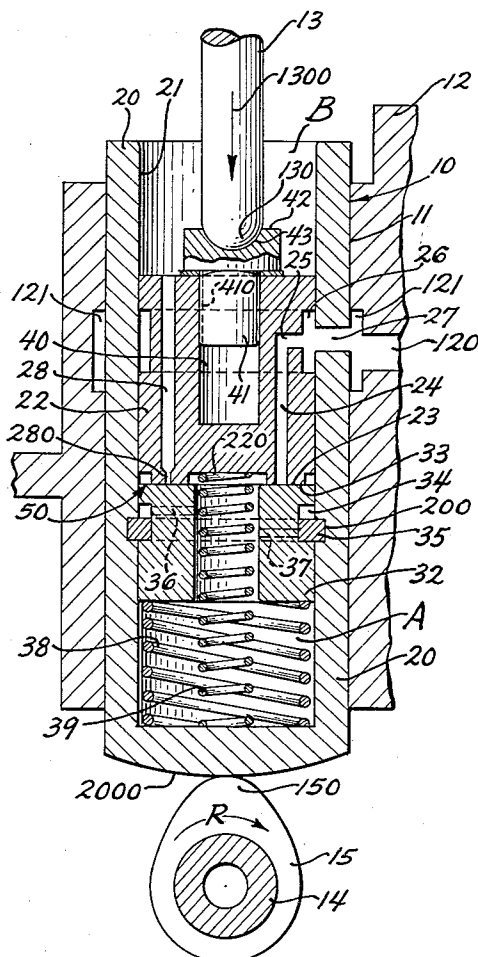


FIG. 2

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HYDRAULIC LASH ADJUSTERS

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3 Claims. (Cl. 123—90)

This invention relates to hydraulic lash adjusters for automatically taking up the play inherent in valve trains of internal combustion engines, and is an improvement over and simplification of the hydraulic lash adjuster disclosed in Patent No. 2,887,996 entitled Hydraulic Lash Adjusters issued on May 26, 1959.

Internal combustion engine poppet valve operating mechanisms generally include a train of several elements which transfer motion from the valve actuating cam to the valve stem to open the valve against spring pressure constantly urging the valve to its closed position. Inasmuch as the operating clearances in the valve train may vary in accordance with the engine operating temperature variations, and because of wear between elements of the valve train, it has been generally accepted practice to employ lash adjuster means to automatically take up and compensate for the variable clearances in the valve train.

Earlier hydraulic lash adjusters employed in internal combustion engines have not proven to be entirely satisfactory due to malfunctioning occasioned by gummy deposits which accumulate therewith. The deposit of such gummy substances in hydraulic lash adjusters is known as "varnishing." It has been found that the more complex the construction of hydraulic lash adjusters, the more difficult they are to service and maintain.

With the foregoing in view, the primary object of the instant invention is to provide an improved and simplified hydraulic lash adjuster for internal combustion engine valve trains through which oil flows continuously except during the valve lifting portion of the engine cam actuated movement of the engine valve train into which the hydraulic lash adjuster is incorporated, the said hydraulic lash adjuster including only a single self-cleaning valve means closing off the flow of engine oil through the hydraulic lash adjuster during the said valve lifting portion of the cam actuated movement of the engine valve train, all arranged to operate freely and silently against oil cushioning whereby to substantially eliminate valve train noises normally occurring in internal combustion operation.

A further object of the invention is to provide hydraulic lash adjusters for internal combustion engines employing but a few extremely simple parts requiring only readily manufacturable tolerances and incorporating floating valve seat construction, easily cleanable valve passages, shim adjustment, a reservoir oil cover for the oil outlet passage, and other features making the hydraulic lash adjuster of the invention the utmost in simplicity, inexpensive to manufacture, positive and reliable in performance, substantially noiseless in operation, substantially free from varnishing, and requiring little or no maintenance.

Other objects of the invention will become apparent by reference to the following detailed description taken in connection with the accompanying drawing wherein:

Fig. 1 is a vertical sectional view of a hydraulic lash adjuster embodying the invention operatively mounted in the block of an internal combustion engine, the said hy-

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draulic lash adjuster being shown in a position assumed by it when the engine valve is closed.

Fig. 2 is a vertical sectional view similar to Fig. 1 except that the hydraulic lash adjuster is shown in the position normally assumed by it when the engine valve timing cam has fully opened the engine valve.

Referring now to the drawing where like reference numerals refer to like and corresponding parts throughout the several views, the hydraulic lash adjuster 10 disclosed for the purpose of illustrating the invention is reciprocally mounted in a suitable bore 11 provided in the block 12 of an internal combustion engine, the said bore 11 is preferably axially aligned with a push rod or valve stem 13 and is disposed normal to the longitudinal axis of a cam shaft 14 over an engine valve operating cam 15 thereof. As the cam shaft 14 rotates, the lobe 150 of the cam 15 raises the hydraulic lash adjuster 10 from the position shown in Fig. 1 to the position shown in Fig. 2 whereby to move the push rod 13 upwardly and open the engine valve; the said push rod 13 being a part of an engine valve train generally employed in conventional internal combustion engines. The engine valve train to which reference is made usually consists of the push rod 13 and a rocker arm which opens a spring loaded closed engine valve responsive to the movement of the push rod 13 by the cam 15. As illustrated in the drawing, the push rod 13 of the engine valve train is constantly spring loaded in the direction indicated by the arrow 1300, and the cam shaft 14 preferably turns in the direction of the arrow R. Inasmuch as the engine valve train construction is conventional and is not a part of the instant invention, it has not been shown in the drawing. However, it is important to note that the engine valve spring operating though the valve train constantly urges the push rod 13 in a direction indicated by the arrow 1300 thereon. Because of necessary clearances in the engine valve train required to permit expansion and contraction therein occasioned by extreme differences in non-operating and operating temperatures of the engine, the hydraulic lash adjuster 10 is employed to automatically and continuously take up the normal clearances or lash in the valve train.

The improved hydraulic lash adjuster 10 preferably consists of a cylinder 20 reciprocally mounted in the bore 11 provided in the engine block 12, the said cylinder 20 being bored at 21 from its upper or outer end to reciprocally accommodate a piston 22 including an annular valve element 23 formed integral therewith at the bottom thereof. The said piston 22 is provided with an axially disposed oil inlet passage 24 extending upwardly from the annular valve element 23 at the bottom thereof and is connected by a radial bore 25 to a circumferential oil receiving groove 26 therearound in communication with a radially disposed oil inlet aperture 27 through the cylinder 20 which in turn is in communication with an oil pressure groove 120 and oil pressure port 121 provided in the engine block 12 at the said bore 11 therein. The said piston 22 is also provided with an axially disposed oil outlet passage 28 which extends upwardly from the annular valve element 23 at the bottom thereof to the top thereof. The said oil outlet passage 28 is preferably restricted at the lower end thereof as indicated at 280.

A valve spool 32 having a central axially disposed aperture 320 therethrough and at its upper or outer end a flat annular valve seat 33 is mounted for limited reciprocating movement in the oil pressure chamber A of the said cylinder bore 21 consisting of the space axially inwardly of the piston 22 therein. The annular valve element 23 of the piston 22 is ground to seat on the annular valve seat 33 of the valve spool 32 for the purpose of shutting off the flow of hydraulic fluid through

the hydraulic lash adjuster 10. As shown in the drawing, the valve spool 32 is circumferentially grooved at 34 to accommodate a retainer ring 35 disposed in a suitable groove 200 provided in the interior wall of the bore 21 of the hydraulic lash adjuster cylinder 20. The circumferential groove 34 in the periphery of valve spool 32 is of a selected axial length to permit the said valve spool 32 to reciprocate for a limited distance within the bore 21 of the hydraulic lash adjuster cylinder 20. The said valve spool 32 is preferably provided with upper and lower radially disposed bleed apertures 36 and 37 extending from the circumferential groove 34 to the central axially disposed aperture 320 therethrough whereby to prevent entrapment of air in the said groove 34 which would adversely affect the operation of the hydraulic lash adjuster 20.

The oil pressure chamber A in the inner end of the cylinder 20 inwardly of the piston 22 therein also serves to accommodate two compression springs 38 and 39. The larger diameter but shorter spring 38 acts against the bottom of the valve spool 36 and constantly urges the said valve spool 36 axially outwardly toward its outer limit of movement permitted by the retainer ring 35 as best shown in Fig. 1. The smaller diameter but longer spring 39 extends through the central axially disposed aperture 320 of the valve spool 32 and acts against the bottom of the piston 22 at a central recess 220 provided therein and constantly urges the said piston 22 axially outwardly as best shown in Fig. 1.

The cylinder 20 of the hydraulic lash adjuster 10 is preferably of sufficient length to provide at all times an oil reservoir B above the piston 22 reciprocatingly mounted in the said cylinder 20. The top or outer end of the piston 22 is preferably centrally axially bored at 40 to accommodate a shim pin 41 having a head 42 spherically grooved at 43 to receive the spherical end 130 of the push rod 13 of the engine valve train. As hereinbefore mentioned the engine valve train is spring loaded so that a constant pressure in the direction of the arrow 1300 is applied to the push rod 14. One side of the shim pin 41 is preferably slightly flattened as indicated at 410 to permit the said shim pin 41 to closely fit the bore 40 of the piston 22 and yet be readily received therein. If and when desired, adjustments may be made in the effective length of the piston 22 of the hydraulic lash adjuster 10 by inserting one or more annular shims 44 around the shim pin 41 and under the head 42 thereof.

The bottom of the cylinder 20 of the hydraulic lash adjuster 10 is preferably domed at 2000 to follow the cam surface of the engine valve operating cam 15 mounted on the cam shaft 14. The said cam shaft 14 and cam 15 preferably rotate in the direction of the arrow R in Figs. 1 and 2.

For convenience in describing the operation of the hydraulic lash adjuster 10, the single valve thereof consisting of the annular valve element 23 of the piston 22 and the valve seat 33 of the valve spool 32 will be designated as the through flow shut-off valve 50. The said through flow shut-off valve 50 controls the flow of oil under pressure from the oil pressure port 120 to the oil pressure chamber A through the oil inlet passage 24 and from the said oil pressure chamber A through the oil outlet passage 28 which discharges into the small oil reservoir B located in the top of the said cylinder 20 above the piston 22 therein. In normal engine operation oil from the oil outlet passage 28 of the piston 22 fills the said reservoir B from whence it overflows into the engine crankcase. Oil in the said reservoir B covers the upper end of the oil outlet passage 28 and the top of the piston 22, and provides oil to the chamber A through the said oil outlet passage 28 in the event of low engine oil pressure, as for example, when the engine is first started.

When installed in a valve train of an internal combustion engine, the hydraulic lash adjuster 10 assumes the position indicated in Fig. 1 during the period of time the

engine valve is closed. In the said engine valve closed position, the cam follower dome 200 of the cylinder 20 of the hydraulic lash adjuster 10 follows the normal surface of the cam 15 responsive to oil under pressure entering the oil pressure chamber A of the said hydraulic lash adjuster 10 from the oil pressure port 121 and through the oil inlet passage 24 of the piston 22. As the cam shaft 14 rotates, the lobe 150 of the cam 15 lifts the hydraulic lash adjuster 10 by cam pressure applied on the cam follower dome 200 of the cylinder 20 thereof from its position shown in Fig. 1 to its position shown in Fig. 2 to close the engine valve.

In the engine valve closed position of the hydraulic lash adjuster as shown in Fig. 1, the through shut-off valve 50 is open with the annular valve element 23 spaced from the valve seat 33 of the valve spool 32. The said valve spool 32 is urged by the compression spring 38 to its upper or outer limit of movement against its retainer ring 35. Accordingly, when the said through shut-off valve 50 is open, oil under the usual engine oil pressure is applied to the piston 22 and moves it upwardly as viewed in Fig. 1 to take up any play or lash in the engine valve train. During the time the through shut-off valve 50 is open, there is a continuous flow of oil under pressure through the hydraulic lash adjuster 10 as indicated by the arrows in Fig. 1, which flow is restricted by the restriction 280 in the said oil outlet passage 28. Thusly, the hydraulic lash adjuster 10 hydraulically takes up the play in the engine valve train during the period the engine valve is open.

When the said through flow shut-off valve 50 is open during the time the engine valve is open as indicated in Fig. 1, the flow of oil through the said hydraulic lash adjuster 10 provides a self-cleaning effect and maintains it substantially free from harmful deposits from the engine oil. Because of the fact that the oil outlet passage 28 through the piston 22 is relatively restricted at 280, sufficient oil pressure is developed at the bottom of the piston 22 to maintain it in its UP position as shown in Fig. 1. The separation between the valve element 23 of the piston 22 and the valve seat 33 of the valve spool 32 of the through shut-off valve 50 represents the amount of clearance or play to which the engine valve train is adjusted to compensate for expansion of the elements thereof and to provide a minimum of operating clearances therein.

As the cam shaft 14 and cam 15 thereon rotate clockwise as indicated by the arrow R in Fig. 1, the cam lobe 150 lifts the hydraulic lash adjuster 10 upwardly from its engine valve closed position shown in Fig. 1 to its engine valve open position shown in Fig. 2. During the initial portion of the said upward movement of the hydraulic lash adjuster 10, the cylinder 20 thereof moves upwardly in respect to the piston 22 closing the through flow shut-off valve 50 interrupting the flow of oil under pressure through the said hydraulic lash adjuster 10. During this initial upward movement of the hydraulic lash adjuster 10, the oil below the piston 22 and above the valve seat 33 is forced both out of the oil outlet passage 28 and out of the oil inlet passage 24, the restriction 280 of the oil outlet passage 28 causing the majority of the said oil below the piston 22 and above the valve seat 33 to be forced back through the relatively larger oil inlet passage 24 overcoming the engine oil pressure behind the oil entering the said hydraulic lash adjuster 10. Any air that might possibly enter the cylinder 20 of the hydraulic lash adjuster 10 below the piston 22 thereof is forced out of the said cylinder 20 through the oil outlet passage 28 of the said piston 22 during the first portion of each upward movement of the hydraulic lash adjuster 10.

The said initial portion of the upward movement of the hydraulic lash adjuster 10 takes up the clearance or play in the engine valve train, and further upward lifting of the said hydraulic lash adjuster 10 by the lobe 150 of the cam 15 opens the engine valve controlled by the engine

valve train. The seating of the valve element 23 of the piston 22 of the through flow shut-off valve 50 against the valve seat 33 of the valve spool 32 thereof is always sufficiently oil cushioned to assure substantially noiseless operation of the hydraulic lash adjuster 10, and the oil positively entrapped in the oil pressure chamber A of the cylinder 20 of the hydraulic lash adjuster 10 below the piston 22 assures at all times a complete oil cushioned operation of the hydraulic lash adjuster 10 and the through flow shut-off valve 50 thereof.

The closing of the engine valve of the engine valve train is accomplished by a compression spring which is generally incorporated in the engine valve train. As the cam lobe 150 of the cam 15 moves clockwise as indicated by the arrow R from its position shown in Fig. 2 to its position shown in Fig. 1, the hydraulic lash adjuster 10 again assumes the position shown in Fig. 1, as it functions as hereinbefore described for its engine valve closed position.

If for any reason oil under pressure is not available to the hydraulic lash adjuster 10, and should there be a leakage past the piston 22 or out of the oil pressure chamber A, then both the piston 22 and the valve spool 32 may travel downwardly together to the extent permitted by the retainer ring 35, and there remain until oil under pressure is again supplied to the hydraulic lash adjuster 10 and fills the oil pressure chamber A of the cylinder 20 thereof whereupon the said hydraulic lash adjuster will resume its normal operation.

The improved hydraulic lash adjuster 10 not only provides a trouble free unit which operates efficiently and quietly over long periods of engine operation without frequent adjustment of engine valve train clearances, but has only a few simple parts and is readily adjustable in the valve train according to the clearances required therein. The improved hydraulic lash adjuster employs but a single operating valve and eliminates back flow check valves which have been a major source of malfunctioning in other hydraulic lash adjuster mechanisms. The improved hydraulic lash adjuster operates under oil cushioning at all times that oil under pressure is available to it, and is economically manufactured and readily installed, assembled, disassembled, and serviced.

Although but a single embodiment of the invention has been disclosed and described in detail, it is obvious that many changes may be made in the size, detail and arrangement of the various elements thereof, all without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. A hydraulic lash adjuster for a cam operated valve train of an internal combustion engine comprising a cylinder having one end open and one end closed, a piston including a central annular valve element at the inner end thereof reciprocatingly mounted in said cylinder forming an oil chamber therein, a centrally apertured valve spool reciprocatingly mounted in said cylinder having a flat valve seat formed on the outer end thereof against which said valve element may seat, the said valve spool having a circumferential groove formed around the periphery thereof, a retainer ring fixed in said cylinder and disposed in said valve spool groove limiting the axial movement of said valve spool in said cylinder, spring means in said oil chamber constantly urging said valve spool toward said piston within the limits of its axial limited movement, spring means in said oil chamber constantly urging said piston in a direction to maintain the valve element thereof from seating on the valve seat of said valve spool, the said cylinder having an oil inlet therein and said piston having oil inlet and outlet passages therein providing a normal flow of engine oil under pressure through said hydraulic lash adjuster and maintaining said oil chamber filled with engine oil, the said piston outlet passage being restricted in respect to the said inlet passage, the said normal flow of engine oil through said

hydraulic lash adjuster being interrupted by the seating of the said piston valve element on said valve seat of said valve spool when axial valve train pressure is applied on the closed end of the cylinder and the outer end of the piston of said hydraulic lash adjuster.

2. A hydraulic lash adjuster for a cam operated valve train of an internal combustion engine comprising a cylinder having one end open and one end closed reciprocatingly mounted in a bore in the crank case of said engine, a piston including a central annular valve element at the inner end thereof reciprocatingly mounted in said cylinder forming an oil chamber therein, a centrally apertured valve spool reciprocatingly mounted in said cylinder having a flat valve seat formed on the outer end thereof against which said valve element may seat, the said valve spool having a circumferential groove formed around the periphery thereof, a retainer ring fixed in said cylinder and disposed in said valve spool groove limiting the axial movement of said valve spool in said cylinder, spring means in said oil chamber constantly urging said valve spool toward said piston within the limits of its axial limited movement, spring means in said oil chamber constantly urging said piston in a direction to maintain the valve element thereof from seating on the valve seat of said valve spool, the said cylinder having a pressure oil port therein through which oil is received from said engine under pressure, the said piston having a pressure oil inlet passage therein communicating between said oil pressure port and the annular valve element of said piston, said piston having an oil outlet passage therethrough communicating between said annular valve element of said piston and the top thereof, the said piston outlet passage being restricted in respect to the said piston inlet passage, said port and passages through said cylinder and said piston providing a normal free flow of engine oil under pressure through said hydraulic lash adjuster and maintaining said oil chamber filled with engine oil, the said normal flow of engine oil through said hydraulic lash adjuster being interrupted by the seating of the said piston valve element on said valve seat of said valve spool when axial valve train pressure is applied on the closed end of the cylinder and the outer end of the piston of said hydraulic lash adjuster.

3. A hydraulic lash adjuster for a cam operated valve train of an internal combustion engine comprising a cylinder having one end open and one end closed reciprocatingly mounted in a bore in the crankcase of said engine, a piston including a central annular valve element at the inner end thereof reciprocatingly mounted in said cylinder forming an oil chamber therein, the said cylinder being of sufficient length to provide an open oil reservoir at the top thereof within said engine crankcase, a centrally apertured valve spool reciprocatingly mounted in said cylinder having a flat valve seat formed on the outer end thereof against which said valve element may seat, the said valve spool having a circumferential groove formed around the periphery thereof, a retainer ring fixed in said cylinder and disposed in said valve spool groove limiting the axial movement of said valve spool in said cylinder, spring means in said oil chamber constantly urging said valve spool toward said piston within the limits of its axial limited movement, spring means in said oil chamber constantly urging said piston in a direction to maintain the valve element thereof from seating on the valve seat of said valve spool, the said cylinder having a pressure oil port therein through which oil is received from said engine under pressure, the said piston having a pressure oil inlet passage therein communicating between said oil pressure port and the annular valve element of said piston, said piston having an oil outlet passage therethrough communicating between said annular valve element of said piston and the top thereof, the piston outlet passage being restricted in respect to the said piston inlet passage, said port and passages in said cylinder and said piston providing a normal free flow of

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engine oil under pressure through said hydraulic lash adjuster and maintaining said oil chamber filled with engine oil the said normal flow of engine oil through said hydraulic lash adjuster being interrupted by the seating of the said piston valve element on said valve seat of said valve spool when axial pressure is applied on the

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closed end of the cylinder and the outer end of the piston of said hydraulic lash adjuster, oil from said piston oil outlet passage maintaining the said open oil reservoir filled.

No references cited.