June 30, 1964 R. A. BEUCHER 3,139,077

VALVE OPERATING MECHANISM

Filed March 19, 1963

FIG. 1.

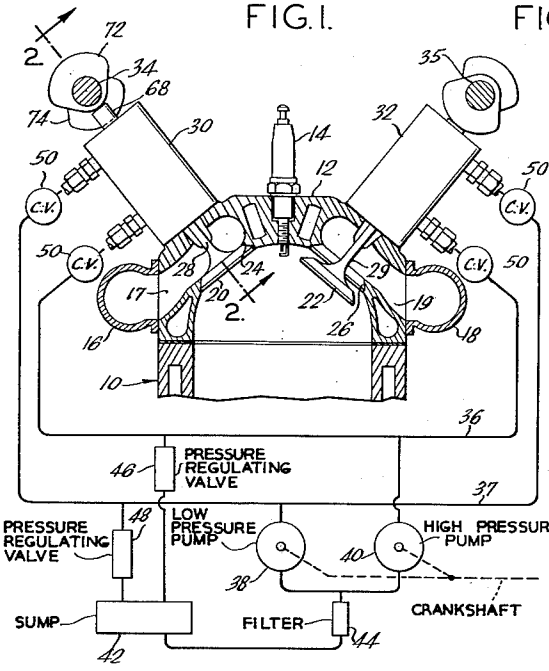


FIG. 2.

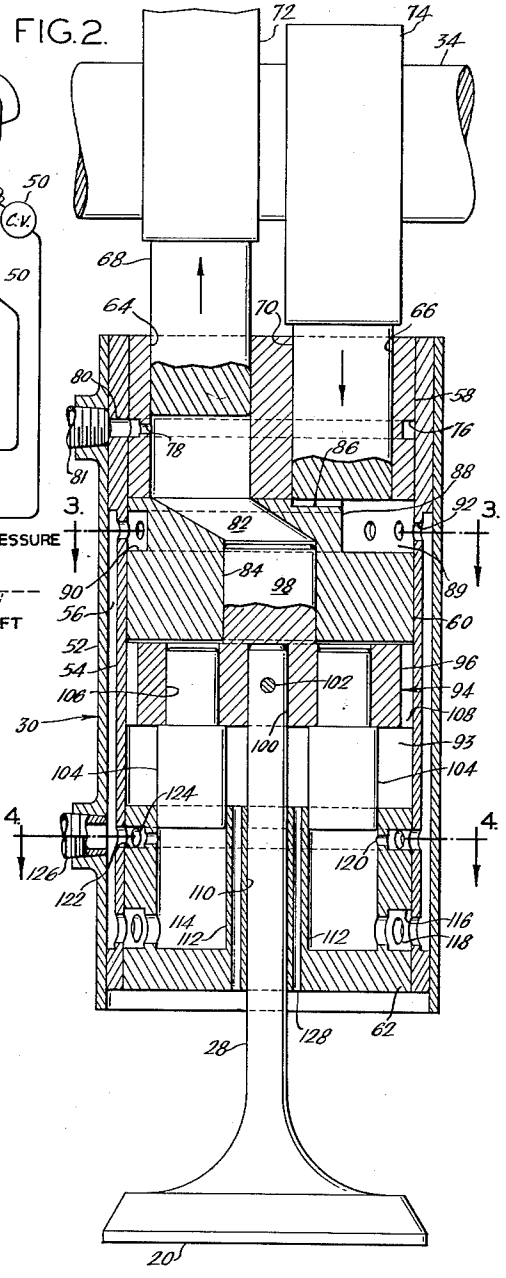


FIG. 3.

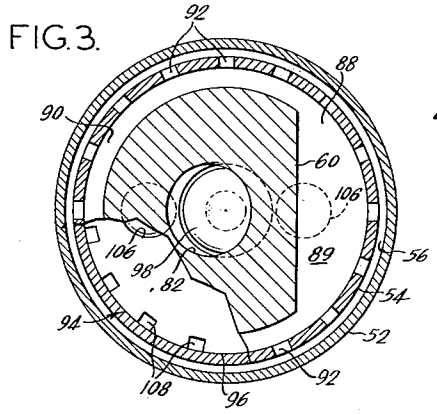
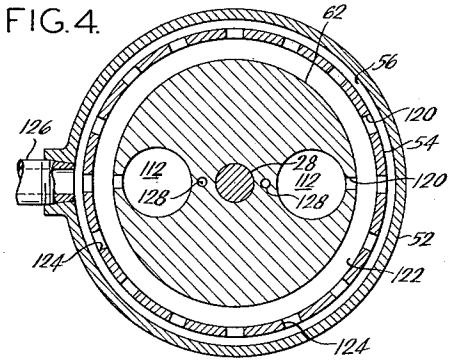


FIG. 4.



INVENTOR:
ROBERT A. BEUCHER

BY Howson & Howson

ATTYS.

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VALVE OPERATING MECHANISM

Robert A. Beucher, 934 12th Ave., Prospect Park, Pa.

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4 Claims. (Cl. 123—90)

The present invention relates generally to hydraulic valve operating mechanisms and more particularly to a valve operating mechanism adapted for use in high-speed internal combustion engines.

The conventional use of lifters, push rods, rocker arms and valve springs for opening and closing the intake and exhaust valves of overhead valve internal combustion engines is accompanied by disadvantages which result in low engine output. Due to the inertia of the spring-loaded valves, and the return characteristics of the springs, it is possible to hold the valves at a maximum open position for only a few degrees of cam travel. As a consequence, considerable power is lost due to the inability of the valves to efficiently vacate the cylinder exhaust gases and recharge the cylinder with fuel mixture. It is well known that an improvement in valve operation will directly affect engine output.

Conventional spring-loaded valve constructions require a considerable force to open and thus impart high stresses on all the valve operating components. Not only is a substantial amount of energy expended in operating the valves, but in addition the friction due to the high stresses causes wear and sometimes breakage of the operating elements.

At high speeds, conventional spring-loaded valves cannot retain the valve lifter in constant contact with the surface of the cam lobe, resulting in valve "bounce" or "float" which severely limits engine speed and output.

An additional disadvantage of spring-loaded valves is the possibility of the springs reaching a resonant vibration known as "surging" which can produce spring breakage.

To overcome the above disadvantages of spring-loaded valves, it is an object of the present invention to provide a valve operating mechanism which eliminates the conventional lifters, push rods, rocker arms, and valve springs of an overhead valve engine by maintaining a continuous positive hydraulic control of the valves.

A further object of the invention is to provide a valve operating mechanism as described in which the hydraulic actuating units are light-weight, compact, individual units which are driven directly by an adjacent camshaft.

An additional object of the invention is to provide a valve operating mechanism as described which due to low inertia and rapid acceleration by means of positive hydraulic control can maintain the valves in a full open position for a considerably greater period than is possible with conventional valve operating mechanisms.

A still further object is to provide a mechanism as described which may be inexpensively manufactured by simple turning, drilling, and milling operations.

Additional objects and advantages of the invention will be more readily apparent from the following detailed description of embodiments thereof when taken together with the accompanying drawings in which:

FIG. 1 is a schematic view showing an embodiment of the invention installed on an overhead valve engine;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 2; and

FIG. 4 is a sectional view taken along line 4—4 of FIG. 2.

Referring to the drawings, FIG. 1 shows a portion of an engine block 10 and head 12 having a conventional spark plug 14 and intake and exhaust manifolds 16 and 18. Although a "dome" type cylinder head is illustrated,

it should be understood that the invention may suitably be used with any type of head chamber.

Intake valve 20 and exhaust valve 22 coact with the respective valve seats 24 and 26 of the head to operatively connect the intake manifold 16 and intake port 17 as well as exhaust manifold 18 and exhaust port 19 with the combustion chamber.

The valve stems 28 and 29 pass through the cylinder head into the respective valve operating assemblies 30 and 32, the internal structure of which is shown in FIGS. 2–4 and which will be considered in detail herebelow. The valve operating assemblies, which are identical for the intake and exhaust valves, are actuated by separate intake and exhaust camshafts 34 and 35 which are suitably mounted in the present instance above the engine and may be either gear or chain driven from the engine crankshaft.

For reasons appearing hereinafter, the valve operating assemblies require high and low pressure hydraulic lines 36 and 37 which as schematically illustrated in FIG. 1 are supplied by a low pressure pump 38 and a high pressure pump 40. The pumps may be driven directly by the camshafts, a belt drive from the crankshaft, or in any other convenient manner. A sump 42 is provided for the hydraulic fluid which passes through a filter 44 before entering the high and low pressure pumps. Pressure regulating valves 46 and 48 are provided to respectively maintain the desired high and low hydraulic fluid pressures in the system. Check valves 50 are provided in the hydraulic lines leading into the valve operating assemblies to permit fluid flow only into the assemblies.

Referring to the enlarged sectional view of FIG. 2, the assembly comprises an outer cylindrical casing 52 into which is press fitted or otherwise secured inner sleeve 54. The inner sleeve is turned down along a substantial portion of its outer surface to form a cylindrical high pressure fluid passage 56.

Press fitted within the inner sleeve 54 are upper, intermediate, and lower piston bodies 58, 60, and 62. The upper piston body 58 includes spaced bores 64 and 66 within which are slidably disposed valve extending piston 68 and upper valve retracting piston 70. The pistons 68 and 70 are at all times maintained in contact with cams 72 and 74 on the camshaft 34 by hydraulic pressure as will be described below. A slot 76 centrally located around the outer surface of the upper piston body 58 communicates by means of inlet port 78 with bore 64. Substantially in alignment with the inlet port 78 are inlet ports 80 in the inner sleeve and inlet connection 81 in the outer cylinder casing.

The intermediate piston body 60 abuts the upper piston body 58 and is bored to provide continuation of the spaced bores 64 and 66 of the upper piston body. A diagonal bore 82 connects with the bore 64 and leads into a central vertical bore 84. The bore 66 is continued vertically in a shallow bore 86 in the intermediate piston body. As shown in FIGS. 2 and 3, a transverse slot 88 is milled in the intermediate piston body to form a chamber 89 connecting with the bore 66. A circumferential slot 90 leads into the transverse slot 88. A plurality of circumferentially spaced ports 92 in the inner sleeve 54 provide fluid connection between the circumferential slot 90 and the cylindrical high pressure fluid passage 56.

The lower piston body 62 is spaced from the intermediate piston body 60 within inner sleeve 54 to form a valve actuating piston chamber 93. Slidably disposed within the chamber 93 is the valve actuating piston assembly 94 which includes a valve actuating piston body 96 having an upwardly extending central piston portion 98 slidably disposed within the central vertical bore 84. Concentric bore 100 of body 96 receives valve stem 28

which is secured therein by means of pin 102. Lower valve retracting pistons 104 are press fitted within bores 106 in the valve actuating piston body 96. A plurality of vents 108 around the periphery of the valve actuating piston body 96 permit air and leakage fluids to freely pass from one side of the piston body to the other.

Lower piston body 62 is press fitted within the lower end of inner sleeve 54 and is centrally bored at 110 to permit sliding passage of valve stem 28. Lower valve retracting piston bores 112 in the lower piston body 62 receive the lower valve retracting pistons 104. Ports 114 at the bottom of the bores 112 lead into circumferential slot 116. A plurality of ports 118 in the inner sleeve 54 provide a fluid connection between the slot 116 and the cylindrical high pressure fluid passage 56.

Ports 120 of a relatively small size located toward the upper end of the bores 112 so as to be below the pistons 104 when the pistons are in the raised position, connect the bores with the circumferential slot 122. Ports 124 in the inner sleeve 54 provide a fluid passage from slot 122 into high pressure fluid passage 56. High pressure fluid connection 126 in the outer casing 52 is positioned in opposed relation from ports 124. Drain passages 128 in the lower piston body 62 permit drainage of leakage fluids and gases from the valve actuating piston chamber 93.

For operation, the valve operating assemblies 30 and 32 are mounted in an appropriate manner on an engine so that the valves 20 and 22 are actuatable within the combustion chamber such as is shown in FIG. 1. It should be understood that the present invention may be used with a varity of engine types, the arrangement of FIG. 1 in an overhead valve engine being shown only by way of example and not as a limitation on the scope of the invention.

As shown in FIG. 1, the high pressure line 36 of the hydraulic system is connected with the high pressure fluid connections 126 of the valve operating assemblies. Similarly, the low pressure line 37 is connected by appropriate fluid conduits to the low pressure inlet connections 81 of the assemblies. The pressure regulating valves are set to provide the desired high and low pressure. Operating pressures might be, for example, 100 p.s.i. for the low pressure line and 400 p.s.i. for the high pressure line.

In operation the rotating camshaft 34 rotates the cams 72 and 74 which act to alternately depress the valve extending piston and upper valve retracting piston. In the position shown in FIG. 2, the cam 74 has just completed depression of the upper valve retracting piston 70, thereby forcing high pressure fluid from the bore 66 through chamber 89, cylindrical fluid passage 56 and into bores 112. The hydraulic fluid being substantially incompressible, the result as shown is the movement of the lower valve retracting pistons 104 into the raised position, thereby raising the valve actuating piston assembly 94 and the attached valve 20. Raising of the assembly 94, by action of the central piston 98 on the low pressure fluid within the diagonal bore 82 and bore 64, raises the valve extending piston 68, the piston 68 being held in contact with the surface of the cam 72 at all times.

When the mechanism is in the position shown in FIG. 2, which is the closed position of the valve 20, the ports 120 open into the lower valve retracting piston bores 112 and by means of slot 122 and ports 124, permit the high pressure fluid connection 126 to provide the desired maximum fluid pressure to the pistons 104 to insure a full pressure sealing of the closed valve. This arrangement prevents a leakage of fluids from the high pressure system or a possible accumulation of gases within the system from affecting positive closure and sealing of the valve.

In a similar manner, when the valve extending piston 68 is in the raised position shown in FIG. 2, the low pressure inlet connection 81 by means of inlet port 80, slot 76, and inlet port 78, maintains the desired pressure within the low pressure region thereby holding the piston 68 in contact with cam 72.

Upon further rotation of the camshaft 34, the cam 72 moves the piston 68 downwardly thereby effecting a downward movement of the valve actuating piston assembly 94 and the attached valve 20. Downward movement of the pistons 104 forces high pressure fluid from the bores 112 through ports 114 and ports 118 into the cylindrical fluid passage 56, upwardly into ports 92, into chamber 89 and bore 66, thereby forcing the upper valve retracting piston 70 upwardly against cam 74. The large number of ports and the relatively large size of the ports, slots, passages and chambers through which the high pressure fluid passes insures a minimum amount of fluid friction and an extremely rapid movement of the operating elements. The inertia of the moving elements and fluids is small in contrast to an equivalent spring actuated valve mechanism and a correspondingly decreased amount of power is thereby required to actuate the valves.

Internal leakage of hydraulic fluids is drained from the assembly through drain passages 128 in the lower piston body 62. The vents 108 in the valve actuating piston assembly 94 permit gases and leakage fluids from above the assembly 94 to drain into the passages 128 and then into the engine combustion chamber or exhaust manifold. Since the mechanism is designed for high speed use, and in view of the high pressures utilized to effect the hydraulic linkage, leakage is to a certain degree expected and is utilized to lubricate the moving parts of the mechanism. The leakage is compensated for by the high and low pressure inlet connections 126 and 81 and is relieved by the vents and passages 108 and 128. Frictional wear and resultant increased leakage can thus in no way impair the efficient operation of the valve operating mechanisms.

The use of high and low pressure systems as illustrated is preferred to provide a maximum closing force on the valve. Since the valve actuating piston assembly 94 is acted on from above and below by pressurized fluids, it is desirable to use a substantially higher pressure fluid acting below the assembly to overcome the fluid pressure acting above to thus provide an effective sealing force.

Although the shape of the cams 72 and 74 may be varied to effect the desired engine performance, it is possible due to the unusually rapid acceleration characteristics of the present mechanism to maintain the valves in the full open and correspondingly full closed positions for a far greater length of cam travel than is possible with conventional spring operated valve mechanisms. It is accordingly possible as shown in FIG. 1 to hold the valves in the maximum open position for as long as 70 or 80 degrees of cam travel as compared to 6 to 8 degrees which is conventionally considered the maximum permissible full opening. This results in a direct increase in the volumetric efficiency of the engine, particularly at high engine speeds.

The present construction completely eliminates the possibility of "valve float" due to the fact that the high pressure fluids are acting to continually bias the pistons 68 and 70 against the cams 72 and 74. Not only are "floating" and "bouncing" of the valves eliminated, but since the mechanism does not involve the use of springs, there can be no valve "surge" as a result of resonant spring vibration.

In order to prevent shock and the resultant wear and noise, it may be desirable to make the valves of spring steel to increase the resilience of the system without detracting from the rapid and effective valve sealing action.

It may be observed that all of the elements of the present mechanism may be made by simple turning, boring, or milling operations without the need of special equipment. The units may thus be inexpensively manufactured and maintained. By eliminating the lifters, push rods, rocker arms and valve springs of the conventional overhead valve engine and replacing the same by a light-

weight compact unit operable from an immediately adjacent camshaft, engine design may in fact be simplified while at the same time providing engines of substantially increased efficiency.

Minor changes in details of construction can be effected by those skilled in the art without departing from the spirit and scope of the invention as defined in and limited solely by the appended claims.

I claim:

1. In an internal combustion engine having valve controlled intake and exhaust ports opening into the engine combustion chamber, a separate valve operating mechanism for each valve-controlled port comprising a casing mounted on the engine, a valve actuating piston assembly slidably mounted in said casing, a valve extending within the combustion chamber of the engine adapted to control a port thereof, the stem of said valve extending into said casing and being secured to said valve actuating piston assembly, a valve extending piston slidably mounted in said casing remote from said valve actuating piston assembly, means defining a closed fluid passage extending between said valve extending piston and a first face portion of said valve actuating piston assembly, an upper valve retracting piston slidably mounted in said casing remote from said valve actuating piston assembly, means defining a closed fluid passage extending between said upper valve retracting piston and a second face portion of said valve actuating piston assembly, means for filling said fluid passages with a substantially non-compressible fluid and for maintaining said passages in a filled condition, a camshaft driven in rotation by the engine mounted on said engine proximate said casing, a first cam on said camshaft in engagement with said valve extending piston, and a second cam on said camshaft in engagement with said upper valve retracting piston, said cams acting to alternately depress said valve extending piston and said upper valve retracting piston thereby effecting an opening and closing of the corresponding valve port through movement of said fluid in said closed fluid passages between said pistons and the faces of said valve actuating piston assembly thus effecting resultant reciprocating movement of said valve actuating piston assembly and said valve attached thereto, said cams being shaped so as to remain in continuous engagement with said pistons during operation of the mechanism whereby said valve is maintained under continuous positive cam control.

2. The invention as claimed in claim 1 including means for maintaining the fluid in said fluid passages at a predetermined pressure.

3. The invention as claimed in claim 2 including means for maintaining the fluid in the closed fluid passage connecting said upper valve retracting piston with said second face of said valve actuating piston assembly at a higher pressure than the fluid in the closed fluid passage connecting said valve extending piston with the first face of said valve actuating piston assembly thereby effecting a sealed closure of the valve ports upon depression of said upper valve retracting piston.

4. A valve operating mechanism comprising a cylindrical casing, an inner sleeve secured within said casing, upper, intermediate and lower piston bodies secured within said inner sleeve, said intermediate and lower piston bodies being spaced to form a valve actuating piston chamber, a valve actuating piston assembly slidably disposed within said valve actuating piston chamber, a valve extending from said casing, the stem of said valve passing through said lower piston body and being secured to said valve actuating piston assembly; a first bore in said upper piston body, a valve extending piston slidably disposed in said first bore, means defining a closed fluid passage in said intermediate piston body extending between said first bore and a first face of said valve actuating piston assembly, a second bore in said upper piston body spaced from and parallel to said first bore, an upper valve retracting piston slidably disposed in said second bore, means defining a closed fluid passage extending between said second bore and a second face of said valve actuating piston assembly, substantially non-compressible fluid filling said fluid passages, means for maintaining said fluid passages filled with fluid at a constant predetermined pressure, and means for alternately depressing said valve extending piston and said upper valve retracting piston thereby effecting reciprocation of said valve through movement of said fluid between said pistons and the faces of said valve actuating piston assembly.

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