March 19, 1957 R. MILLER 2,785,667

HYDRAULIC MECHANISM FOR ACTUATING AN ENGINE VALVE WITH VARIABLE TIMING

Filed Nov. 18, 1953

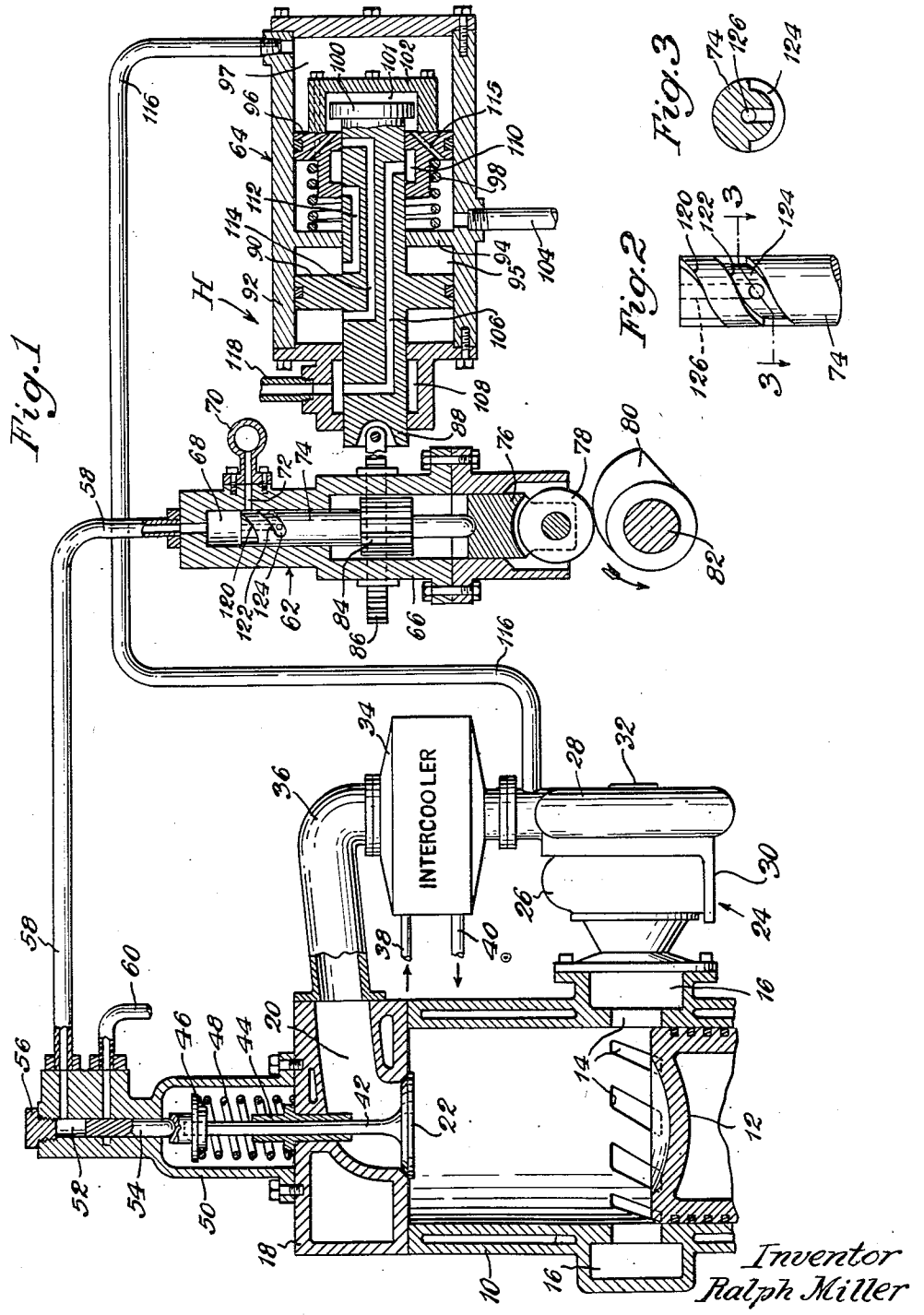


Fig. 1



Fig. 2



Fig. 3

Inventor
Ralph Miller
by Parker & Carter
Attorneys

United States Patent Office

2,785,667

Patented Mar. 19, 1957



2,785,667

# HYDRAULIC MECHANISM FOR ACTUATING AN ENGINE VALVE WITH VARIABLE TIMING

Ralph Miller, Milwaukee, Wis., assignor to Nordberg Manufacturing Company, Milwaukee, Wis., a corporation of Wisconsin

Application November 18, 1953, Serial No. 392,881

8 Claims. (Cl. 123—90)

This is a continuation, in part, of application Serial No. 242,372, filed August 17, 1951.

My invention resides in the field of internal combustion engines and is an improvement on prior mechanisms for actuating and timing the opening and closing of an engine valve. More specifically, my valve actuating mechanism varies the timing of the valve in accordance with a specific factor of the engine.

My invention is a hydraulic mechanism of a new and novel type for varying the time of any engine valve, although I have shown and described it as specifically applied to a particular type of engine and a particular valve arrangement. Specifically, I have illustrated my invention in connection with a uniflow scavenging two-stroke cycle engine with a series of exhaust ports around the cylinder wall and an intake port in the cylinder head, the exhaust ports being opened and closed by the piston.

A primary object of my invention is a pneumatic or hydraulic control and actuating mechanism for an engine valve to control the timing of the valve in accordance with the load on the engine.

Another object of my invention is a pneumatic or hydraulic control and actuating mechanism for an engine valve which responds to variations in the pressure of the air supplied to the engine from a scavenging and/or supercharging blower.

Other objects will appear from time to time in the ensuing specification and drawings in which:

Figure 1 is a diagrammatic view of a cylinder of a two-stroke cycle engine, partly in section, and a hydraulic or pneumatic mechanism for actuating the engine valve, partly in section, with various other associated mechanism;

Figure 2 is an enlarged view of the actuating plunger shown in Figure 1; and

Figure 3 is a section taken along lines 3—3 of Figure 2.

In Figure 1, a two-stroke cycle engine is illustrated. A cylinder 10 has a piston 12 which is mounted for reciprocation in it in a conventional manner. A plurality of exhaust ports 14 are positioned around the cylinder wall and are enclosed by the conventional exhaust manifold 16. The cylinder head 18 has an inlet port 20 which is controlled by an inlet valve 22.

The hot exhaust gases from the cylinder exhaust through the ports 14 into a conventional turbocharger, indicated generally at 24, the gases driving a turbine 26 which, in turn, drives a supercharging blower 28. The hot gases exhaust from the fan by an outlet 30.

The supercharging blower 28 draws in air through an inlet 32 and, after it is compressed to an elevated temperature and pressure, it is carried through an intercooler 34 and through a conventional inlet manifold 36 to the inlet port 20 and to the cylinder. The intercooler substantially reduces the temperature of the air by withdrawing the heat of compression from it that was generated in the supercharging blower. The cooling fluid for the intercooler enters through an inlet, indicated generally at 38, and exits through an appropriate connection 40.



The inlet valve 22 has a valve stem 42 which slides in a valve stem guide 44. The upper end of the valve carries a ring member 46, and a conventional valve spring 48 biases the valve closed.

A cage 50 is bolted to the top of the cylinder head around the valve stem and the spring 48. The upper part of the cage 50 has a cylinder 52, and a plunger 54 slides in the cylinder and engages the top of the ring member 46 on the valve stem. The cylinder is closed at the top by a plug 56. Fluid is conveyed to the hydraulic cylinder 52 by an appropriate pipe 58 and is discharged from it by an overflow spill pipe 60.

Fluid is pumped through the pipe 58 to the cylinder 52 by an actuating mechanism, indicated generally at H. Variable quantities of fluid are pumped through the pipe 58 by the actuating mechanism to force the plunger 54 down and open the inlet valve 22. The opening excursion of the valve 22 is determined by the overflow spill pipe 60, it being understood that the spill pipe leads back to the low pressure side of the system. As long as fluid is being forced through the pipe 58 to the cylinder 52 by the actuating mechanism H, the valve 22 will stay open and the excess fluid will flow off through the spill pipe 60.

The actuating mechanism H includes a pump 62 and a pump controlling mechanism 64. The pump has a housing 66 with a chamber 68 which is connected to the pipe 58 leading to the cylinder 52. A low pressure source of supply 70 for the fluid communicates with the chamber 68 through a passage 72. This passage is closed and opened by the surface of a plunger 74 which is reciprocably mounted in the chamber. The lower end of the plunger rides on a crosshead 76 which carries a cam follower 78. The follower rides on a cam 80 on the conventional engine cam shaft 82, the direction of the rotation of the cam shaft being counterclockwise, as shown.

A gear 84 carried by the plunger is engaged and rotated by a rack 86 on the outside of the plunger housing, so that movement of the rack rotates the plunger. The rack is connected at one end to the stem 88 of a fluid piston 90 in the housing 92 of the hydraulic actuating mechanism 64.

The housing 92 of the hydraulic mechanism has a chamber which is divided by a wall 94, the piston 90 being in the left compartment 95. An air piston 96 is positioned in the right compartment 97 of the housing and straddles a plurality of openings for a group of central passages in the piston stem 88. A spring 98 bears against the wall 94 in the housing and biases the air piston toward the opposite end of the housing. A collar 100, positioned on the end of the stem to limit the travel of the air piston 96, is positioned in a chamber 101 defined by a housing 102 mounted on the air piston.

The stem 88 has a plurality of longitudinal fluid passages with ports on its surface. Fluid is discharged through an appropriate connection 104 in the right compartment 97 on the left side of the air piston. One of the control passages 106 in the piston stem conducts fluid from an outside chamber 108 to a chamber 110 in the air piston. Another one of the central passages 112 in the stem leads from the right side of the fluid piston 90, and the other central passage 114 leads from the left side of the piston 90, and their other ends open into the right compartment 97 and are controlled by the air piston 96. Passages 115 in the air piston communicate the chamber 101 with the left side of the air piston.

The discharge pressure from the supercharging blower 28 is conveyed through an appropriate pipe 116 to the right compartment 97 on the right side of the air piston. As this pressure varies, it tends to move the air piston. As the pressure increases, the air piston moves to the left compressing the spring 98, and as the pressure decreases, the spring moves the air piston back to the right. Move-

ment of the air piston controls the communication that is established between the various chambers through the central passages 106, 112, and 114, as explained herein below. A source of high pressure hydraulic fluid 118 communicates with the chamber 108 and the passage 106. This source of fluid could be the engine's lubricating system.

The plunger 74 has helixes formed on its upper surface, as shown in detail in Figures 2 and 3. The upper helix 120 forms closing edge for the passage 72 and the lower helix 122 forms an opening edge. As the plunger moves up, the helix 120 closes the passage 72 and traps fluid in the chamber 68. This fluid is forced through the pipe 58 and opens the valve 22. The chamber 68 communicates with a groove 124 cut into the plunger through a central passage 126 so that when the lower helix 122 opens the passage 72, the pressure in the chamber 68 will be relieved through the central passage.

As shown in Figure 2, the two helixes are adapted to close and open the port 72 at different times during the engine cycle, depending upon the position to which the plunger has been rotated by the actuating mechanism H. If the plunger has been turned so that the lower ends of the helixes 120 and 122 are aligned with the passage 72, fluid will not be conveyed to the chamber 52 until relatively late during the engine cycle, and the valve 22 will open and close late. If the upper ends of the helixes are aligned with the passage 72, fluid will be conveyed to the chamber 52 early in the engine cycle, and the valve will open and close early. Because of the helical contour of the opening and closing edges on the plunger, the time of opening and closing of the valve 22 can be adjusted to any desired conditions and this adjustment is effected by the actuating mechanism H in accordance with the pressure of the supercharging air.

The use, operation, and function of my invention are as follows:

The pressure of the supercharging air is conveyed through the pipe 116 to the compartment 97 on the right side of the air piston. As the load increases, this pressure will increase and the air piston 96 will move to the left compressing the spring 98. This left position of the air piston places the source of the fluid 118 in communication with the passage 112 and the right side of the fluid piston 90 through the chamber 108, passage 106, chamber 110, and passage 112. This causes the stem 88 of the piston to move to the left in Figure 1, and the lower end of the helixes will control the port 72. The discharge connection 104 is placed in communication with the left side of the fluid piston through passages 115, chamber 101, and passage 114, and the time of opening and closing of the valve 22 will be retarded during the engine cycle.

When the load decreases, the pressure of the air conveyed through the pipe 116 to the chamber 118 will decrease, and the spring 98 will force the air piston 96 to the right. This places the source of the fluid 118 in communication with the left side of the fluid piston through the chamber 108, passage 106, chamber 110 and the passage 114. At the same time, the discharge conduit 104 will be placed in communication with the right side of the fluid piston 90 through the passage 112. This forces the fluid piston and its stem 88 to the right, and aligns the upper end of the helixes of the plunger 74 with the port 72. Thus, the opening and closing of the valve 22 will be advanced during the engine cycle.

The position of the air piston 96 controls which side of the fluid piston 90 is placed in communication with the high pressure source of fluid so that the fluid piston 90 will shift its stem 88 and the rack 86 in either one direction or the other. The position of the air piston is controlled by its spring 98 and the pressure of the air from the supercharger 24. Shifting of the rack aligns a different portion of the helix on the plunger with the port 72, and the timing of the valve 22 will accordingly be varied during the engine cycle.



Even though I have shown the closing edge 120 and the opening edge 122 as approximately parallel, it should be understood that the closing edge could be perpendicular to the axis of the plunger, so that the time of closing of the valve 22 would be approximately constant regardless of the load on the engine, but the time of opening would be varied by the helical opening edge 122. In a similar manner the closing edge 120 could be a helix but it would not necessarily have to be parallel to the opening edge 122. These two edges could diverge downwardly or upwardly so that the period of time that the valve 22 stayed open would not be constant as the load varied, but at the same time both the time of opening and the time of closing of the valve would vary as the load changed. It should be understood that the closing and opening edges 120 and 122 on the plunger 74 can be designed in any convenient and well-known manner to produce any desired timing of the valve.

While I have shown and described the preferred form of my invention, it should be understood that various modifications, alternations, and changes can be made without departing from the functional theme of my invention. For example, I have stated that a high pressure source of fluid is used to actuate the mechanism H, and it should be understood that this could be oil, high pressure air, or any high pressure fluid that is readily available. In the claims, the term fluid should be interpreted to mean any one of these forms. I therefore desire that the invention be unrestricted except as by the appended claims.

I claim:

1. In an internal combustion engine cylinder having a port, an engine valve for controlling the port, yielding means biasing the valve to close said port, a hydraulic power cylinder, a plunger movable therein adapted to overcome the yielding means and open the valve, a pump cylinder, a duct joining the pump and the power cylinders, a plunger in the pump cylinder, means responsive to engine operation for displacing it to supply hydraulic pressure to open the engine valve, means for supplying air under pressure to the engine cylinder, and means responsive to variation in the pressure of said air for varying the time when the engine valve is operated.

2. In an internal combustion engine cylinder having a port, an engine valve for controlling the port, yielding means biasing the valve to close said port, a hydraulic power cylinder, a plunger movable therein, adapted to overcome the yielding means and open the valve, a pump cylinder, a duct joining the pump and the power cylinders, a plunger in the pump cylinder and means responsive to engine operation for displacing it to supply hydraulic pressure to open the engine valve, means for supplying air under pressure to the engine cylinder and means responsive to variation in the pressure of said air for varying the time when the engine valve is closed, a port in the hydraulic power cylinder adapted to be opened by the plunger when the engine valve is opened, the resistance to passage of hydraulic fluid through said port being adapted to hold the engine valve open as the plunger is moved by the engine toward valve opening position.

3. In an internal combustion engine cylinder having a port, an engine valve for controlling the port, yielding means biasing it to close said port, a hydraulic power cylinder, a plunger movable therein, adapted to overcome the yielding means and open the valve, a pump cylinder, a duct joining the pump and the power cylinders, a plunger in the pump cylinder, means responsive to engine operation for displacing it to supply hydraulic pressure to open the engine valve, and means responsive to a variable engine factor for varying the timing of the supplied hydraulic pressure.

4. In an internal combustion engine, means for supplying air under pressure thereto, an engine valve for admitting air and hydraulic means for opening it, includ-

ing a pump, means responsive to variation in the pressure of the air supplied to the engine for varying the cycle of pump operation.

5. In an internal combustion engine, an engine valve for admitting air and hydraulic means for opening it, including a pump, means responsive to a variable engine factor for varying the cycle of pump operation, said means including a pneumatically operated valve member controlled by the factor, and a hydraulic piston responsive to the valve member.

6. The structure of claim 5 wherein the pneumatically operated valve member and the hydraulic piston are generally aligned.

7. In an internal combustion engine, an engine valve for admitting air and hydraulic means for opening it, including a pump, means responsive to a variable engine factor for varying the cycle of pump operation, said means including a pneumatically operated valve member controlled by the engine factor, and a hydraulic piston responsive to the valve member, there being a pump



plunger having a release port therein, the piston being adapted to rotate the plunger to vary the time of uncovering the release port.

8. The structure of claim 7 wherein the hydraulic piston and pneumatically operated valve member are generally aligned.


**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,174,526 | Parker | Oct. 3, 1939 |
| 2,447,267 | Mock | Aug. 17, 1948 |
| 2,565,681 | Fleck et al. | Aug. 28, 1951 |
| 2,602,434 | Barnaby | July 8, 1952 |
| 2,621,640 | Reggio | Dec. 16, 1952 |
| 2,670,595 | Miller | Mar. 2, 1954 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 758,184 | France | Jan. 11, 1934 |
| 641,322 | Germany | Jan. 27, 1937 |