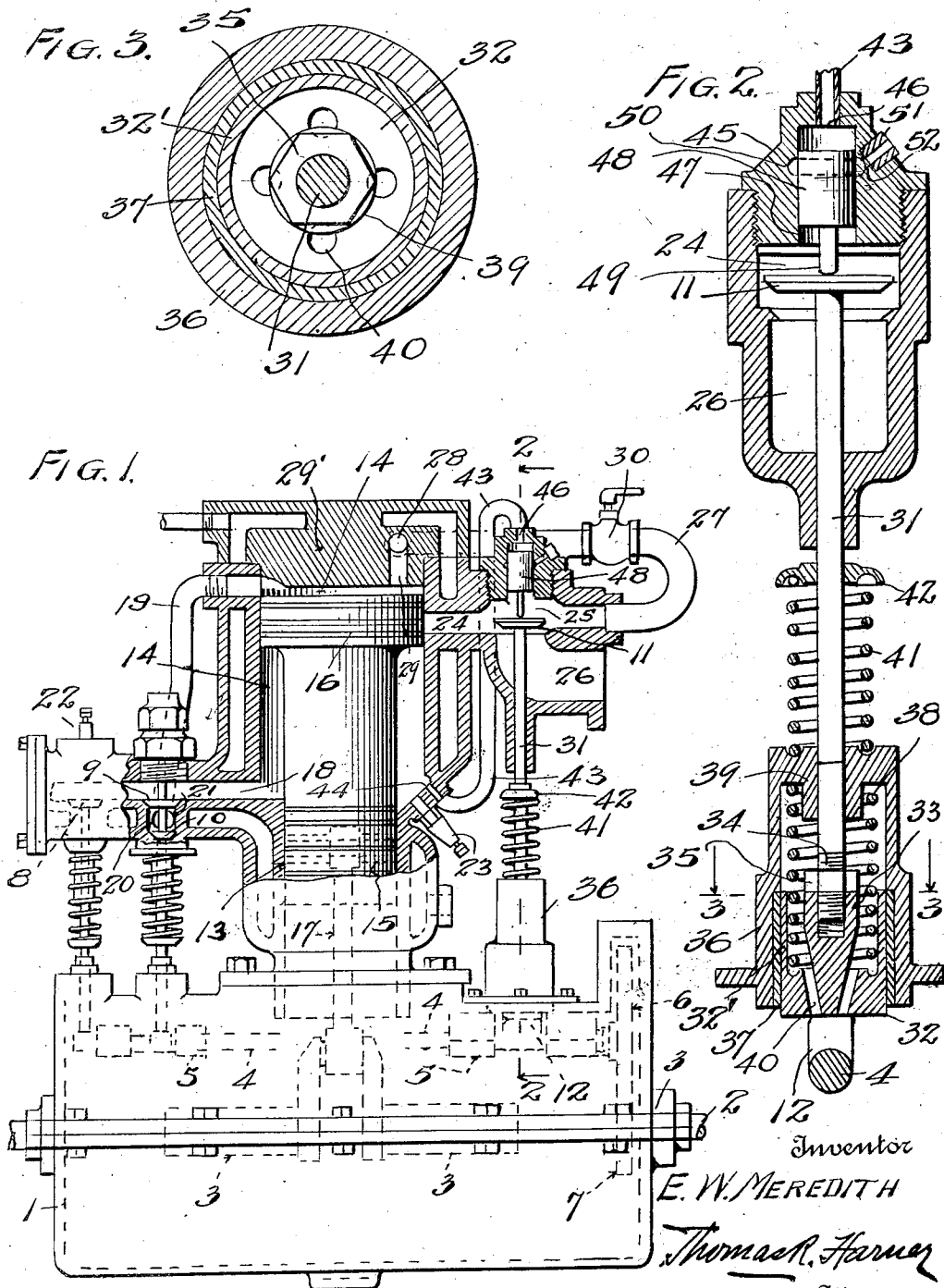


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VALVE OPERATING MECHANISM
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VALVE-OPERATING MECHANISM.

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To all whom it may concern:

Be it known that I, EDWARD W. MEREDITH, a citizen of the United States of America, residing at Punxsutawney, in the county of Jefferson and State of Pennsylvania, have invented certain new and useful Improvements in Valve-Operating Mechanism, of which the following is a specification.

My present invention relates to improvements in valve operating mechanism for internal combustion engines of the reciprocating type, and particularly to the means for actuating the exhaust valve thereof. The invention involves certain novel features of construction and combinations and arrangements of parts in the construction and operation of the exhaust valve mechanism whereby the valve which is normally held open under tension of a spring when the usual cam and tappet device are inoperative, may be closed by motive fluid pressure at predetermined intervals. As herein illustrated the valve operating mechanism is utilized in a four cycle, compound engine, wherein the combustion charge enters a single working cylinder, and after ignition at high pressure expansion below the piston head on the upstroke of the piston, the burned gases of combustion, before being exhausted are transferred and utilized at a lower pressure expansion on the top of the piston head for applying power to the succeeding down stroke of the reciprocating piston. After the second expansion the gases of combustion are exhausted through the exhaust outlet with comparatively slight noise. Oppositely arranged supply and exhaust valves of the puppet type are utilized, and means are provided, operable during the low pressure movement of the piston, but at a high pressure for positively closing the exhaust valve to prevent escape of the low pressure gases of combustion.

In the accompanying drawings I have illustrated one complete example of the physical embodiment of my invention wherein the valve operating mechanism is adapted for use with the type of engine heretofore referred to, but it will be understood that the valve operating mechanism of my invention is applicable for use with other types of engine, the exemplification herein illustrated showing the best form of adaptation I have so far devised for the practical

application of the principles of my invention.

Figure 1 is a view showing partly in side elevation and partly in section the parts of an internal combustion engine necessary for an understanding of my invention.

Figure 2 is an enlarged, detail, sectional view at line 2—2 of Figure 1 of the exhaust valve and its operating mechanism and connections.

Figure 3 is an enlarged, transverse sectional view at line 3—3 of Figure 2.

For a clear understanding of the construction and operation of the related parts of the internal combustion engine I have illustrated in Figure 1 a single cylinder engine having the usual crank case 1 and crank shaft 2 supported in bearings 3, and the cam shaft 4 shown in dotted lines is supported in journal bearings 5 in suitable manner. The cam shaft is properly timed with relation to the crank shaft and actuated therefrom by the large gear 6 on the cam shaft and the pinion 7 on the crank shaft for opening the inlet valve 8, the transfer valve 9 and balance valve 10, and the exhaust valve 11, one of the cams being indicated at 12 (for the exhaust valve) in Figure 2.

The engine or motor illustrated comprises a differential cylinder having a lower chamber 13 of small diameter and an upper larger working chamber 14 in the cylinder casting, in which the piston 15 reciprocates with its enlarged head 16 in the working chamber of the engine. The piston is operatively connected with the crank shaft through the rod 17 and is actuated by high pressure beneath the head on the upward working stroke, and by a lower pressure above the head on the downward stroke. The intake valve 8 regulates admission of the fuel charge to a supply conduit 18 which forms an extension of the working cylinder, and this exploded high pressure charge is then transferred by way of the supply conduit through the transfer conduit 19 to the upper end of the working cylinder above the piston head. Admission of the expanded charge to the transfer conduit is controlled through the port 20 and valve chamber 21 between the valves 9 and 10, by the valve 9 actuated at predetermined intervals from the cam shaft.

The charge is exploded simultaneously by

action of a spark plug 22 in the supply conduit and a second spark plug 23 located at the lower end of the working cylinder and on the side of the piston opposite to the supply conduit. The piston head controls the passage of exhaust gases from the upper end of the working cylinder through the exhaust port 24 to the exhaust chamber 25, and the exhaust valve 11 controls the exhaust of gases from the chamber 25 through the exhaust outlet 26, the chamber and outlet being located in a casting forming an extension of the cylinder casting.

For regulating the pressure above the piston with relation to high speed and low speed of the engine, I utilize a pressure equalizing pipe 27 having a port 28 opening to the working cylinder above the piston head through a vertical passage 29 in the cylinder head 29'. This equalizing pipe is provided with a regulating valve 30 and is connected to the exhaust chamber 25 for controlling movement of gases of combustion between the upper end of the working cylinder and the exhaust chamber. The valve 30 is preferably open at low speed and closed or partially closed at high speed of the engine, and inasmuch as the inertia of the reciprocating parts of the engine at low speed is not so great as under high speed conditions, the valve is utilized at low speed to open and relieve pressure from the upper end of the working cylinder to the exhaust connection of the engine.

The operation of the exhaust valve 11 is timed with relation to the operation of the intake and transfer and balance valves, the exhaust valve being positively opened once at each revolution of the cam shaft through the action of the cam 12 and the valve operating mechanism as will now be described. The puppet valve 11 is fashioned with a depending stem 31 slidable or reciprocable in the exhaust extension of the cylinder casting and it co-acts with a tappet having a head 32 for engagement by the rotating cam 12 of the cam shaft 4. The tappet head is fashioned with a central socket member 33 having an interior thread in which the tappet-stem 34 is threaded, and the lock nut 35 is employed to hold the stem in adjusted position with relation to the socket member or head. The tappet-head is fashioned with a cylindrical bearing cup 32' which is reciprocable in the hollow, fixed casting 36 having a bearing bushing 37 therein for the cup. The tappet stem and tappet are normally forced downwardly and the tappet maintained in operative relation to its cam by means of a spring 38 bearing on the tappet-head and interposed between the head and the closed upper end 39 of the casting.

The interior of the casting 36 is lubri-

cated from the crank case by way of oil ducts 40 arranged in an annular series around the center of the tappet and affording communication between the crank case and the interior of the casting.

In Figure 2 the valve 11 is shown in open position being supported from the cam 12 through the tappet-stem and valve-stem the adjoining ends being alined and the two stems being enclosed and guided within the end 39 of the casting. As the cam revolves the tappet is forced down by its spring 38 and the tappet head 32 continues in engagement with the cam or cam shaft at all times. Normally the spring 41, which surrounds the valve stem and is interposed between the washer 42 fixed on the stem and the casting, holds the valve in open position. But during the downward movement of the piston on its low pressure stroke, the exhaust port 24 is exposed, and means are thus required to close the exhaust valve during the low pressure expansion action above the piston head.

This closing of the exhaust valve against the tension of its spring 41 is accomplished by high pressure gas from the working cylinder 14, and a high pressure pipe 43 having an outlet port 44 from the cylinder is utilized to convey the gas under pressure to be used as a motive fluid. The upper end of the exhaust chamber 24 is closed by a plug 45 threaded into the exhaust extension of the cylinder casting, and the plug is provided with an inlet port 46 from the upper end of the motive fluid pipe 43. The plug is fashioned with a cylinder 47 opening at its lower end into the exhaust chamber, and a pressure actuated piston 48 is reciprocable in the cylinder, said piston having a short stem 49 bearing against the upper face of the exhaust valve.

The piston is lubricated through the annular groove 50 in the wall of the cylinder, and the plug 51 for an oil cup (not shown) supplies the lubricant to the groove through the duct 52 of the larger plug 45. Thus when the fuel charge is exploded in the working cylinder a charge of expanded gas is passed through the pipe 43 to the cylinder 47, to act as a motive fluid, and by pressure in the cylinder 47 force the piston 48 downwardly with its stem against the exhaust valve. This movement of the piston closes the valve against the tension of the spring 41, and the entire assembly of the valve operating mechanism is thus brought together without lost motion or noise or shock, the cam rolling from under the tappet head 32 at the required instant. On the up stroke, the valve 11 closes immediately after firing, but not before the piston head 16 has closed the exhaust port 24 against escape of expanded gas at low pressure.

Briefly stated the operation of the several valves with respect to the different strokes of the engine piston is as follows: The fuel charge is admitted through the intake valve 8 at predetermined intervals through the action of the shaft 4 and cam operating mechanism for said valve. The fuel charge is admitted to the transfer chamber 18 and is drawn into the cylinder of the engine on the up stroke of the piston. On its succeeding down stroke this admitted charge of fuel is compressed, the intake valve 8 and transfer valve 9 being closed. The compressed fuel charge is now fired causing the working or up stroke of the piston. Upon its next down stroke (with valve 8 closed and transfer valve 9 opened by its operating mechanism) the piston forces this low pressure, expanded gas through chamber 18 and pipe 19 to the upper part of the cylinder above its piston head for further expansion at low pressure to assist in moving the piston on its down stroke. During the transfer of low pressure gas to the upper end of the cylinder, the exhaust valve 11 is closed by pressure from the lower end of the cylinder through pipe 43, which pressure acts upon piston 48 to close the exhaust valve. After the piston uncovers port 24 the exhaust valve is opened for outlet of the spent gas.

During the suction stroke of the piston the transfer valve 9 is closed and consequently the upward movement of the piston forces spent gas to the exhaust chamber through port 24 and also through pipe 27 and its valve 30 (if open) to said chamber.

By compressed low pressure fluid in the upper end of the cylinder above the port 24, the action of a dash pot is effected and this fluid assists in starting the piston on its down stroke.

The clearance space above the exhaust port 24 is of such capacity as to bring the compression of fluid therein to the required pressure in order that it will overcome the inertia of the piston at the highest engine speed. By this utilization of the clearance space between the piston head and cylinder head, transfer conduit 19, exhaust port 24 and exhaust chamber 25, equalizing pipe 27 and its port 28 (which parts are filled with compressed fluid) the whipping action of the piston is absorbed. When this clearance space is filled with compressed fluid more pressure is obtained from the high pressure gas as it is equalized throughout the cylinder, for the reason that the clearance space has been filled with motive fluid at a pressure sufficient to overcome the inertia of the piston at the speed at which the engine is operating. This compression pressure is regulated by the valve 30 in the equalizing pipe 27. The higher the speed of the engine the greater the pressure re-

quired to cushion it, and the lower the speed of the engine, a lesser pressure is required to cushion it.

The function of the equalizing pipe is to convey the released, excess, fluid from the chamber above the piston to the exhaust chamber 25 and thence to the atmosphere, on every stroke of the piston except the working, down stroke. On this latter stroke the exhaust valve is closed and the fluid is thereby retained in the exhaust chamber 25 which space is filled with the compressed fluid from above the piston through pipe 27. The quantity of fluid thus passing through the pipe 27 is regulated by the valve 30.

It will be seen by reference to the drawings that the exhaust port 24 and chamber 25 would not be filled with the compressed fluid if the pipe 27 were not present, as the compression takes place between exhaust port 24 and the top of the cylinder.

The effect of the operation and arrangement of the parts thus described is to produce conditions in a gas engine approaching as nearly as possible to similar conditions existing in a reciprocating steam engine.

When the gases expand below atmospheric pressure in the cylinder, the spring 41 automatically lifts valve 11 from its seat to permit equalization of pressure through port 26 for the purpose of breaking a vacuum or partial vacuum existing in the engine cylinder. Thus under normal conditions the valve 11 is operated from the cam shaft, but should a vacuum or partial vacuum exist or be formed in the engine cylinder the valve is automatically opened by the spring 41. Under these automatically operating conditions the engine is enabled to deliver more power and at the same time economize in the consumption of fuel.

This automatic action is especially valuable in an aircraft engine in case the power fails and a vacuum or partial vacuum should result in the engine cylinder. Under such conditions the pistons in the engine will perform the functions of brakes to dangerously retard the revolution of the propeller. By the automatic opening of the valve this dangerous condition is overcome and consequently the aircraft is enabled to drift until power can again be applied, or a landing effected.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is—

1. In an internal combustion engine the combination with a cylinder having an intake valve, an intake port in the upper end of the cylinder, and an exhaust port below the intake port, of an exhaust chamber communicating with the exhaust port and provided with a valve seat, an exhaust valve and its stem, positively actuated means for open-

ing the exhaust valve, a fluid pressure actuated device for periodically holding said exhaust valve in its seat, means for conveying motive fluid from said cylinder to said pressure actuated device and means for automatically opening the exhaust valve to equalize pressure of gases expanded below atmospheric pressure in the engine.

2. The combination with a cylinder having an intake valve, an intake port, and an exhaust port adapted to be closed by the engine piston, of an exhaust chamber having a valve seat, an exhaust valve and its stem, a co-axial tappet and rotary cam for opening said exhaust valve, an auxiliary cylinder and its piston alined with the exhaust valve, means for supplying motive fluid to the auxiliary cylinder for closing the exhaust valve at predetermined intervals and means for automatically opening the exhaust valve to equalize pressure of gases expanded below atmospheric pressure in the engine.

3. The combination with a cylinder having an intake valve and an intake port at its upper end, an exhaust chamber having a valve seat, and an exhaust port below the intake port adapted to be closed by the engine piston, of an exhaust valve and its stem, a co-axial tappet and rotary cam for posi-

tively opening the exhaust valve, an auxiliary cylinder and its piston alined with the exhaust valve, means for supplying motive fluid to the auxiliary cylinder for closing the exhaust valve at predetermined intervals and resilient means for normally holding said exhaust valve open when released.

4. In combination with a valve and its stem and a hollow casing, of a tappet within said casing and an actuating cam therefor, resilient means for holding the tappet in operative relation to the cam, resilient means for opening the valve when said tappet is inoperative, and pressure actuated means above the valve for closing the valve at predetermined intervals.

5. In combination with a valve and its stem and a hollow casing, of a tappet within the casing and an actuating cam therefor, a spring within the casing for holding the tappet in operative position relative to the cam, a spring between said casing and the valve for opening the valve when said tappet is inoperative, and pressure actuated means above the valve for positively closing the valve at predetermined intervals.

In testimony whereof I have affixed my signature.

EDWARD W. MEREDITH.