A. J. WEST.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED APR. 27, 1906.

1,101,893. Patented June 30, 1914.

3 SHEETS—SHEET 1.

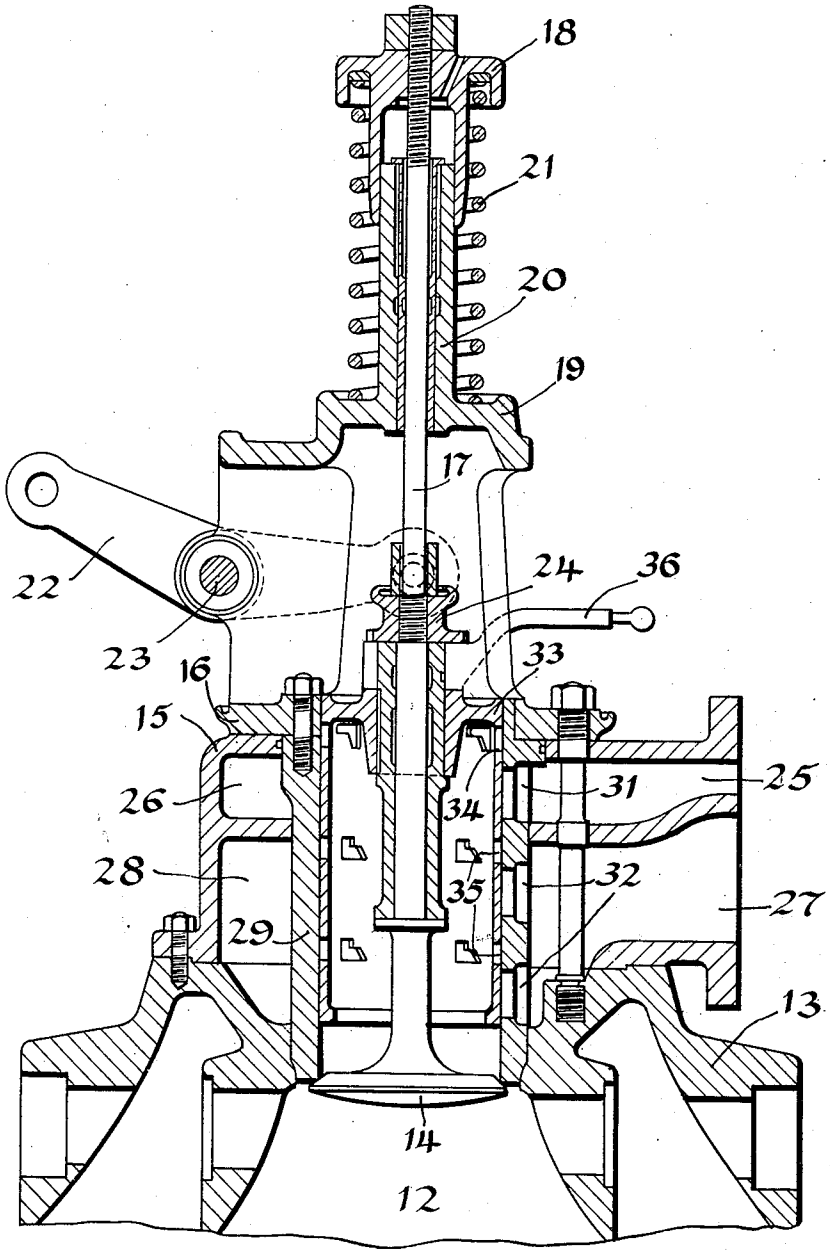


Fig. 1.

WITNESSES:

Bert M. Fero

E. W. McAllister

INVENTOR

Arthur J. West

BY Jno. S. Green

ATTORNEY

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3 SHEETS—SHEET 2.

Fig. 2.

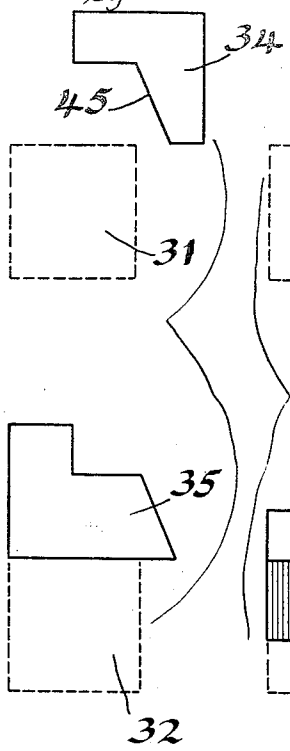


Fig. 3.

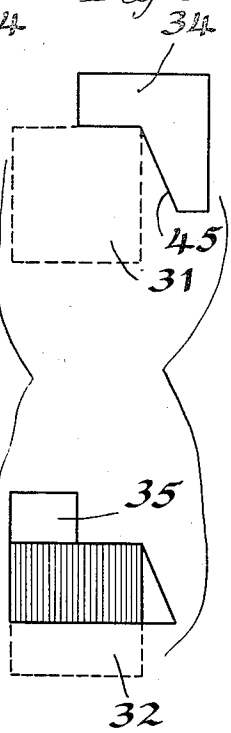


Fig. 4.

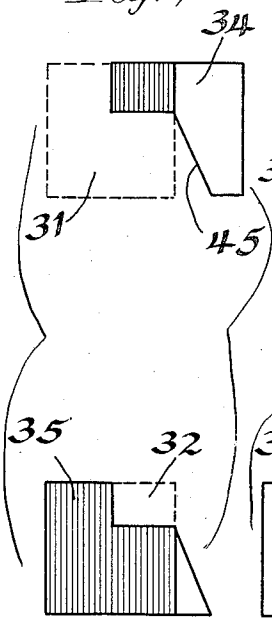
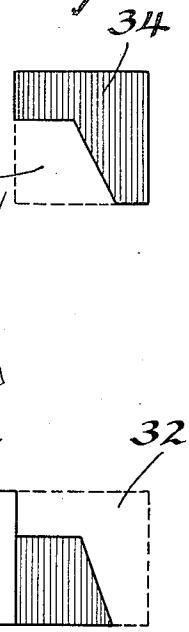
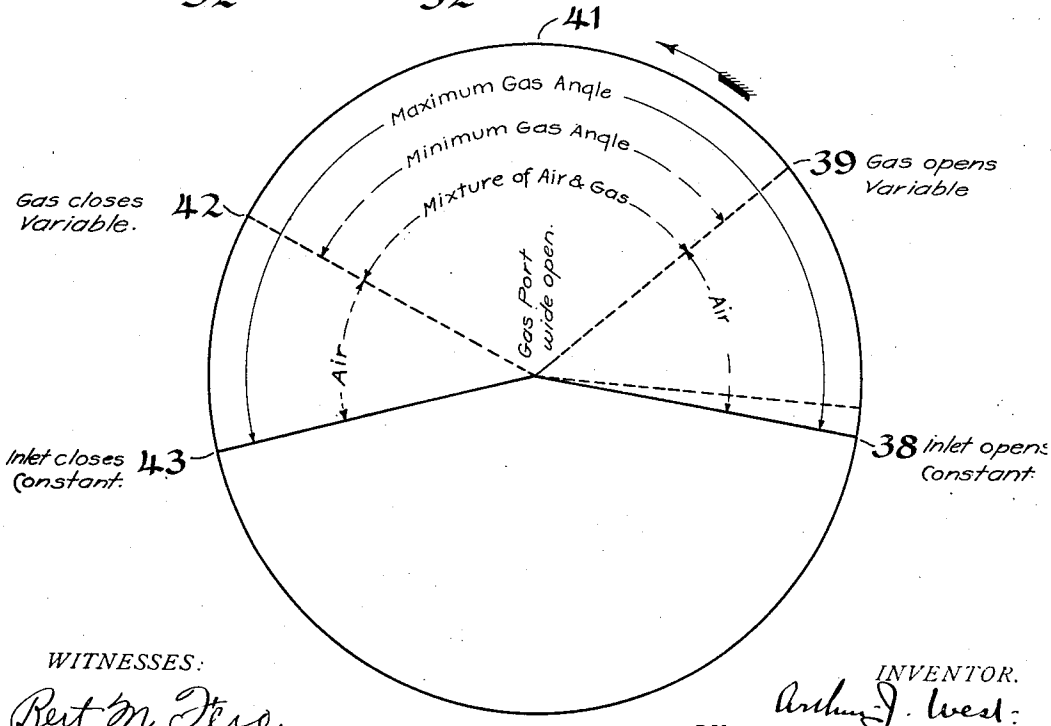


Fig. 5.





WITNESSES:

Bert. M. Fero.

E. W. McAllister.

Fig. 6.

INVENTOR.

Arthur J. West.

BY

Jno. S. Green

ATTORNEY.

A. J. WEST.
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3 SHEETS—SHEET 3.

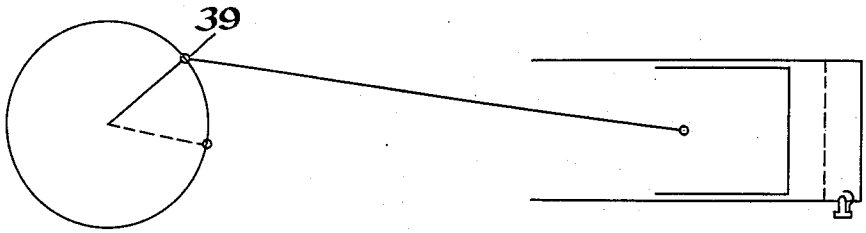


Fig. 7.

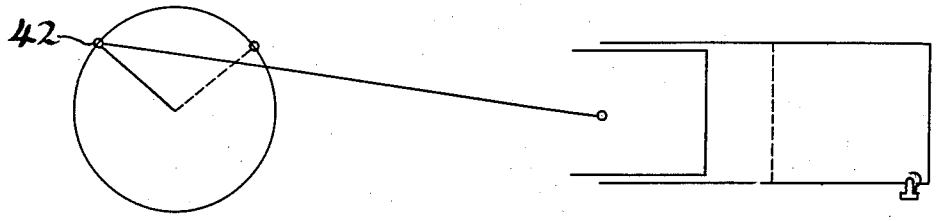


Fig. 8.

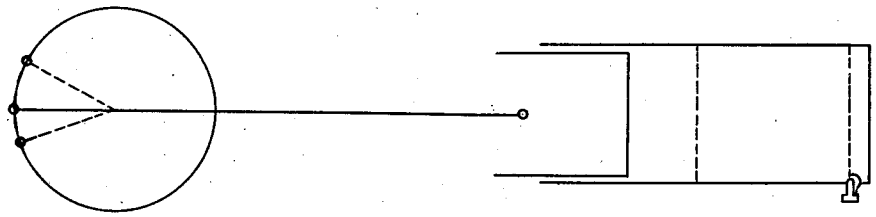


Fig. 9.

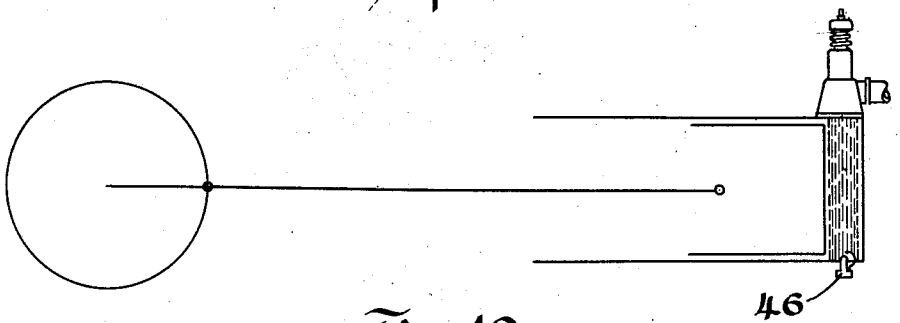


Fig. 10.

WITNESSES:

Burt M. Fero

E. W. McCallister.

INVENTOR

Arthur J. West.

BY Jno. S. Green

ATTORNEY

UNITED STATES PATENT OFFICE.

ARTHUR J. WEST, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE COLONIAL TRUST COMPANY, TRUSTEE, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

INTERNAL-COMBUSTION ENGINE.

1,101,893. Specification of Letters Patent. Patented June 30, 1914.

Application filed April 27, 1906. Serial No. 313,991.

To all whom it may concern:

Be it known that I, ARTHUR J. WEST, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have made a new and useful Invention in Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines and more particularly to governing means for such engines.

The power delivered by an internal combustion engine is dependent on the intensity of the explosions occurring in the engine cylinders and since the intensity of an explosion is dependent upon the amount and quality of the explosive mixture admitted to the cylinders, governing is usually accomplished by automatically varying the amount of combustible mixture or the proportional amounts of combustible gas or vapor and air admitted to the cylinder. In engines in which governing is accomplished by varying the proportion of combustible and air admitted to the cylinder and which operate under constant compression, it is difficult to obtain a wide range of variations in the power delivered, since a charge lean in the combustible ingredients will not fire except when highly compressed, and since a charge rich in hydrocarbon vapors or gases will fire spontaneously if subjected to moderately high compression.

An object of this invention is to produce means in connection with an internal combustion engine utilizing constant compression whereby the engine is rendered effective and efficient in operation for a wide range of loads.

An important feature of this invention is to provide means whereby air may be initially admitted into the combustion chamber of the motor and then a mixture of air and fuel and finally air preferably in a stratified condition; that is to say, the mixture of air and fuel is preferably confined between two stratas of air.

A further object is to produce means in connection with an internal combustion engine for proportioning both the amount of combustible mixture admitted to the cylinder and the proportions of combustible and air comprising the mixture.

A further object is to produce a governor-controlled mixing valve in which automatic means are utilized for proportioning, in accordance with the load demand, the mixture admitted to the cylinders of an internal combustion engine.

These and other objects I attain in an apparatus embodying the features herein described and illustrated.

In the drawings accompanying this application and forming a part thereof, Figure 1 is a partial section of the walls of a gas engine cylinder in connection with a vertical section of a valve embodying my invention; in Figs. 2, 3, 4 and 5, a diagrammatic representation of the admission ports forming a part of this invention is shown and the relative positions of the ports are illustrated; Fig. 6 is a diagram illustrating different positions of the engine crank; and Figs. 7, 8, 9 and 10 are diagrams to be utilized in connection with Figs. 2, 3 and 4 and 5 in illustrating the operation of the valve in connection with the different positions of the engine crank and piston.

An admission port 12 is formed in the walls 13 of a cylinder of an internal combustion engine and is provided with a reciprocating puppet valve 14, which is adapted to control the flow of fluid therethrough. The valve 14 is preferably of the mushroom type and is provided with a casing 15, mounted on the walls 13 of the cylinder. A valve stem 17, rigidly mounted on the valve 14, extends through the casing 15 and is provided with suitable guide-ways 20, formed integrally with an end wall 16 of the casing. A bonnet 18 is screwed or otherwise secured to the stem 17 and a spring 21, located between it and a suitable pad 19 formed on the casing, is arranged to hold the valve 14 against its seat and close the port 12.

A cam-actuated lever 22, fulcrumed at 23 on a bracket formed integrally with the end wall 16 of the casing, is pivotally connected to a collar 24, rigidly mounted on the stem 17, and is adapted to reciprocate the stem 17 at regular intervals during an operating cycle of the engine and open and close the valve 14.

The valve casing 15 is provided with a gas inlet port 25, which communicates with an annular passage 26, formed within the casing, and an air inlet port 27, which communicates with an annular passage 28,

formed within the casing. The passages 26 and 28 surround and are partially formed by a cylindrical wall 29, which is secured by screws or otherwise within the casing 15 and is provided with two series of ports 31 and 32. The ports 31 are arranged in an annular row and communicate with the chamber 26 and the ports 32 are arranged, for convenience, in two annular rows and communicate with the passage 28.

A piston valve 33, rotatably mounted on and surrounding the valve stem 17 operates within the cylindrical casing 15 and is provided with a series of ports 34 and a series of ports 35 which are adapted to respectively register with the ports 31 and 32 of the wall 29 when the valve 14 is moved to open the port 12. The piston valve 33 is provided with an arm 36, which is adapted to be connected to a speed-responsive governor with which the engine is provided and which is arranged to revolve the valve 33 to certain definite positions about the valve stem 17 to correspond to different speeds of the engine, thereby varying, in accordance with the load on the engine, the relative positions of the ports 31 and 34 and the ports 32 and 35.

The port 12 of the gas engine cylinder communicates with the ports 25 and 27 of the casing 15 through the ports 31 and 32 respectively and the ports 34 and 35 of the piston valve 33 are so formed and located that they, in conjunction with the ports 31 and 32, vary the proportional amounts of air and gas admitted to the cylinder in such a manner that a definite and constant amount of fluid is admitted during each suction stroke of the engine. This is accomplished by throttling down the supply of air to the cylinder as the supply of gas is increased and vice versa.

The ports 34 and 35 of the piston valve 33 are so formed and located, relative to the ports 31 and 32 of the wall 29, that for light loads on the engine, the supply of gas component of the charge is cut off during the first and last part of the suction stroke and air only is admitted. As the load on the engine increases, the gas admission period increases and the air supply correspondingly decreases until at some predetermined load on the engine gas is admitted throughout the entire suction stroke.

In Figs. 2, 3 and 4 the operation of the piston valve 33 is diagrammatically illustrated, the ports 34 and 35 of the piston valve being shown in full lines and the ports 31 and 32 of the casing 29 in dotted lines.

Fig. 6 illustrates diagrammatically different positions of the engine crank-pin which correspond to different positions of the valve shown in Figs. 2, 3 and 4.

The operation of the engine is as follows: While operating under light loads the valve 14 begins to open when the crank-pin occupies a position corresponding to 38 and the piston valve 33 is moved by the governor to such a position that the ports of the piston valve and the ports of the wall 29 occupy the relative positions illustrated in Fig. 2. The gas and air ports are so proportioned and arranged that as the crank travels in the direction of the arrow (Fig. 6) air only is admitted to the cylinder of the engine. At a crank-pin position corresponding to 39, the gas port 34, as illustrated in Fig. 3, begins to uncover the port 31 and admit gas along with the air to the cylinder. When the piston is at mid-stroke and the crank-pin occupies a position corresponding to 41, the gas and air ports occupy the relative positions illustrated in Fig. 4 and the valve 14 is fully opened. As the crank proceeds in the direction of the arrow, the valve 14 begins to close and at a crank-pin position corresponding to 42 the piston valve 33, in raising, again occupies the position illustrated in Fig. 3 and the gas supply is cut off. When the crank-pin has reached a position corresponding to 43, the valve 14 is closed and the ports 31 and 32 are closed by the piston valve 33 and compression begins.

The ports of the piston valve 33 are so arranged that as the valve is oscillated by the governor about the stem 17 to correspond to an increasing load on the engine, greater areas of gas ports 31 are uncovered by the ports 34 during the reciprocation of the valve 14, the air ports 32 are correspondingly throttled and the gas admission period is advanced until at some predetermined load on the engine, the gas and air ports open simultaneously.

The ports of the piston valve are also of such shape that the charge entering the engine cylinders during full or overloads on the engine increases in amount of combustible ingredients supplied until the crank-pin occupies a position corresponding to 41 of Diagram 6, when the charge of maximum density, relative to the gas component, and then decreases in combustible mixture as the crank proceeds to the end of the suction stroke. The ports 34 of the piston valve 33, which operate to open the gas port 31 in the casing 29, as shown in Figs. 2, 3, 4 and 5, are more or less L shaped, one arm of the L being provided with an inclined edge 45. As the valve 33 moves to different positions about the stem 17 in response to a decrease of speed of the engine, the inclined edge 45 moves, during the reciprocation of the valve to open the ports 31 earlier in the stroke. The ports 35, which operate to open the air ports 32 are also L shaped and are arranged to decrease the supply of air admitted to the cylinder as the supply of gas is increased.

Fig. 5 illustrates the relative positions of the ports in the wall 29 and the ports in the piston valve 33 for a maximum load, the crank-pin being in mid-position, corresponding to the position 41. As illustrated, the gas and air supply is simultaneously admitted to the cylinder at full load but the valve ports may be so arranged that the air will always be admitted previous to the admission of the mixed charge of gas and air.

In Figs. 7, 8 and 9, successive positions of the engine piston in the cylinder are shown which correspond to the successive positions of the crank, as illustrated in the diagram of Fig. 6, and the piston valve 33, as illustrated in Figs. 2, 3 and 4. In governing the speed of the engine, in accordance with the load demand, it is necessary to utilize means for proportioning the quantity of the combustible charge admitted to the engine cylinder at light loads, since there is a limit below which the quality cannot be efficiently varied. As before described, the mixing valve is adapted to proportion the amounts of air and gas admitted to the cylinder for normal loads and at a certain and predetermined light load operates to admit a quantity of air to the engine cylinders before and after the mixed charge of gas and air is admitted. In Fig. 7 the piston of the cylinder is shown in a position which corresponds to the position 39 of the crank-pin at which the piston valve begins to open the gas ports in the casing 29 and the clearance space in the cylinder and the portion of the cylinder uncovered by the piston is filled with air. Fig. 8 illustrates the position the piston occupies when the crank occupies a position corresponding to 42, the gas ports having opened an amount corresponding to the load, admitted a combustible mixture of gas and air and closed. The cylinder is shown partially filled with air which has moved along with the piston and partially filled with combustible mixture which has displaced the air. Fig. 9 shows the piston at the end of the suction stroke and at the beginning of the compression stroke. The piston valve 33 has admitted air to the cylinder which has displaced the combustible mixture and occupies the clearance space in the end of the cylinder.

Fig. 10 illustrates the position of the piston in the cylinder at the end of the compression stroke and also illustrates a stratified condition of the combustible mixture and air which exists in the cylinder, the combustible mixture being compressed between two layers of air. As before described, the valve is arranged to supply the richest mixture at mid-stroke and an igniter 46 is located in the cylinder to communicate with the richest portion of the compressed charge. Under such conditions, an explosion is always insured as the amounts of air and gas admitted at mid-stroke are proportioned to form a combustible mixture. After combustion is started it will spread throughout the charge until all the gas is burned.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means; and

What I claim is:

1. In an explosion engine, a mixing valve for constant compression engines comprising a casing having air and gas ports, a piston valve within the casing and having ports adapted to register with those in the casing, means for rotating said valve to vary the proportion of air and gas passing through said ports, and means for reciprocating said valve whereby the air ports are first opened, then the gas ports opened, while the air ports remain open, and whereby the gas ports are closed prior to closing the air ports.

2. In an explosion engine, a mixing valve for constant compression engines comprising a casing having air and gas ports, a valve within the casing having air and gas ports and adapted to both reciprocate and rotate, means for rotating said valve to vary the proportions of air and gas passing through said ports, and means for reciprocating said valve to open the gas ports between the opening and closing position of the air ports.

3. In an explosion engine, a mixing valve for constant compression engines comprising a casing having air and gas ports, a valve within the casing having air and gas ports adapted to register with those in the casing, and means for rotating said valve whereby the air port area will be decreased an amount equal to the increased port area of the gas, or vice versa.

In testimony whereof, I have hereunto subscribed my name this 25th day of April, 1906.

ARTHUR J. WEST.

Witnesses:

CHARLES W. McGHEE,

E. W. McCALLISTER.

Correction in Letters Patent No. 1,101,893.

It is hereby certified that in Letters Patent No. 1,101,893, granted June 30, 1914, upon the application of Arthur J. West, of Pittsburgh, Pennsylvania, for an improvement in "Internal-Combustion Engines," an error appears in the printed specification requiring correction as follows: Page 2, line 112, after the word "charge" insert the word *is;* and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of August, A. D., 1914.

[SEAL.]

J. T. NEWTON,

Acting Commissioner of Patents.