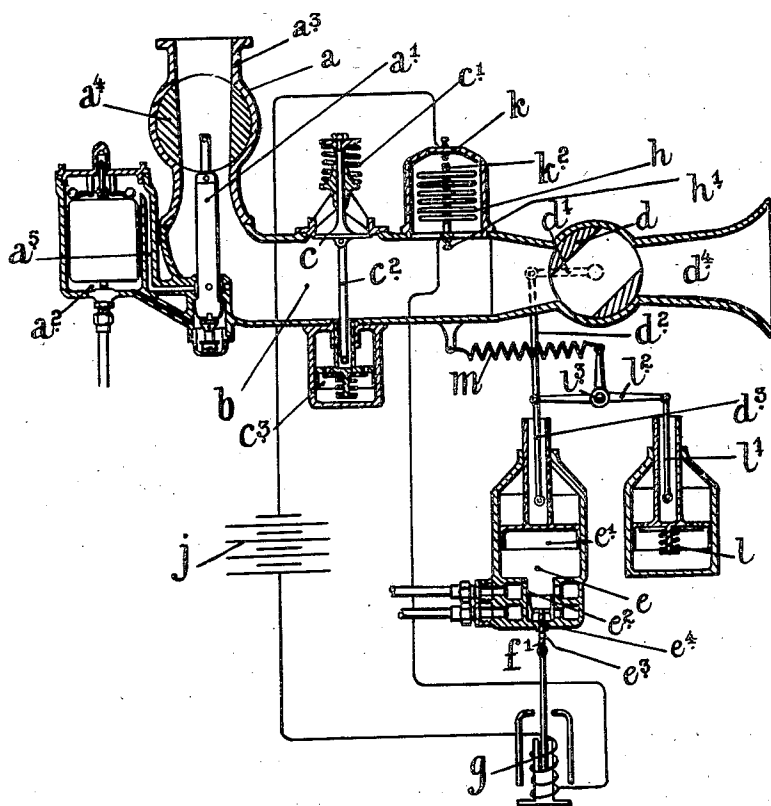


F. H. ROYCE.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED AUG. 6, 1918.

1,304,808.

Patented May 27, 1919.



Inventor:
Frederick Henry Royce.
by his Attorney: Mauney

UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

1,304,808.

Specification of Letters Patent.

Patented May 27, 1919.

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To all whom it may concern:

Be it known that I, FREDERICK HENRY ROYCE, a subject of the King of Great Britain and Ireland, of Osmaston, Derby, England, have invented certain new and useful Improvements Relating to Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines particularly those used on aircraft, in which difficulties are experienced owing to a reduction of the pressure of the air drawn into the induction pipe consequent on a decrease of atmospheric pressure at higher altitudes. The invention has for its object to maintain a constant induction pressure in the air supply to the engine notwithstanding a considerable reduction of atmospheric pressure due to increased altitude and although more especially intended to work with an engine designed for a pressure less than sea-level pressure, it may also be adapted for use with engines designed for other atmospheric pressures.

In considering the size of such engines it is observed that the cubic capacity of the cylinders for a given power will be larger or smaller according to whether the engine is designed for a lower or higher induction pressure but in the former case the cylinders would be of lighter construction than in the latter case owing to the stresses being lighter.

Previous devices other than the one referred to below have aimed at securing and maintaining the required pressure in the induction pipe (whether at or above sea-level atmospheric pressure) by means of a pump, blower, or other device capable of producing a pressure at all altitudes in excess of the required pressure, with a relief valve operated to open (by means of an aneroid subjected to the pressure in the induction pipe) when the pressure therein is in excess of that required, and in one device the supply to the induction pipe was from a chamber containing air at a pressure in excess of the required pressure through a valve actuated to open by means of a solenoid and an electric circuit which has alternately broken and completed by the contraction and expansion of an aneroid subjected to the pressure in the induction pipe, so that the required supply of air in said induction pipe was dependent upon the fre-

quency with which the valve opened and the duration of the openings.

According to the present invention the engine has interposed between the induction pipe and the air supply (the air supply being either from the atmosphere direct or from a compressed air reservoir according to the design of the engine) and in connection with the induction pipe, a chamber furnished with a valve opening to the air supply, which valve can assume, within its operable limits, any degree of opening, and which will, in any conditions of air pressure on the outer side thereof assume and (subject to minuate oscillations) maintain the degree of opening required to control the inflow so as to produce the required predetermined pressure within the chamber and consequently in the induction pipe. The valve aforesaid is operated by means of an aneroid or other instrument actuatable by its pressure of environment, and subjected to the pressure in the chamber with intervening or connecting mechanism. A second or supplemental valve may be used opening to the external atmosphere and controlled by a spring or other suitable mechanism adjustable to open when the external pressure exceeds the internal pressure either actually or by a predetermined amount according to whether the engine is designed for an induction pressure equal to or exceeding that of sea-level atmospheric pressure or for an induction pressure less than that of sea-level atmospheric pressure.

In the preferred form of the invention the movement of the aneroid or other mechanism is utilized by the making or breaking of an electric circuit energizing a solenoid which controls the piston of an oil pressure cylinder mechanically connected to and adapted to open or close the first mentioned or main valve. By this means there is ample force available for operating the regulating valve and retaining it in the desired position with certainty and reliability.

The drawing accompanying this specification is a vertical section showing an example of the invention applied to an engine in which the induction pressure is below that of sea-level atmospheric pressure.

a designates the carbureter, a^1 the petrol nozzle thereof; a^2 the float tank, a^3 the flange for connection to the induction pipe of the engine, and a^4 the throttle valve. b

designates the air chamber, c is the second or supplemental valve opening inwardly and normally held closed by the spring e^1 which is adjusted to allow the valve to open when the difference between sea-level atmospheric pressure and the predetermined pressure for which the engine is designed is exceeded; c^2 designates a connecting rod connecting the valve c to a dash pot e^3 ; d is a valve between the air chamber b and the main air inlet and connected by the rod system d^1 , d^2 and d^3 to the piston e^1 of the oil pressure cylinder e ; e^2 and e^3 are respectively the inlets and outlets for supply and exhaust of the oil to and from said pressure cylinder, the supply being for example supplied from the forced lubrication system of the engine. e^4 is the valve controlling said inlet and outlet and connected by a rod f^1 to the core of a solenoid g , h is an aneroid box fixed at its lower extremity and adjusted to make contact between the contact points or terminals k and k^2 when the pressure in the chamber b is below the predetermined amount, j is a battery having one pole connected with the terminal k of the aneroid and the other through the solenoid g with the aneroid at k^1 and through the aneroid with the terminal k^2 , l is a dash pot piston connected by means of rod l^1 and lever l^2 pivoted at l^3 to the rod d^2 to modify the movement of the valve d . m is a spring which operates the piston e^1 in cylinder e in one direction when the oil exhaust is open.

The operation of the mechanism described is as follows:—Assuming the valve d to be closed, on rotating the crank shaft in order to start the engine, a reduction of pressure takes place in the chamber b causing the automatic valve c to open. The engine will then start by drawing air through said valve c and will continue to run until the valve d comes into operation. While the engine is obtaining supply of air through the valve c and the pressure in the chamber b is below the predetermined amount, the electrical contacts k and k^2 will be closed, and accordingly the solenoid g will be operated to move the valve e^4 to open the inlet port e^2 and close the exhaust port e^3 . As the pressure increases in the oil pressure system of the engine the valve d will be opened by the piston e^1 , and this opening movement will continue until the pressure in the chamber b reaches the predetermined pressure whereupon the valve c will be closed by its spring e^1 and the air supply to the chamber b will be entirely controlled by the valve d . Should the pressure in the chamber b exceed the predetermined amount, the aneroid or other mechanism provided will separate the contacts k and k^2 whereby the solenoid will be deenergized; the supply and exhaust valves e^2 , e^3 of the oil pressure cylinder e will be respectively closed and opened and the valve d under the influence of the spring m will

be closed until the consequent reduction of pressure in chamber b reverses the action of the aneroid or other instrument and appurtenant parts and again opens the valve d . As a result of this action the valve c will adopt the correct position to maintain the pressure within the reservoir as predetermined and the power of the engine will be constant for all altitudes up to the point where the atmospheric pressure is less than the pressure in the chamber.

In case of failure on the part of the aneroid or other instrument and mechanism operating the valve d the engine will continue to run by drawing air through the valve c but the power of the engine under these conditions will vary inversely to its altitude.

Where the pressure of the air in the induction pipe is to be maintained at sea-level atmospheric pressure or a higher pressure means are provided for supplying air at sea-level or a higher pressure to the outer side of the main valve d , one known method of effecting which is to interpose between the main air intake d^4 and the said main valve a compressed air chamber in which air at a sufficient pressure is maintained by a pump driven by the engine.

The constant pressure in chamber b may be utilized as a means of equalizing the pressure in the petrol feed system so that the pressure in the fuel tanks is not affected by changes of altitude. A convenient method of doing this is to connect the relief valve on the fuel tanks to the chamber b and also, if necessary, connect the relief valve of the air pump (if any), which supplies the fuel tank, to the chamber. By means of a pipe or passage shown in the drawing at a^5 pressure in the float chamber can be maintained the same as that in the chamber b . Thus the petrol supply to the jet is maintained at a constant pressure.

What I claim as my invention and desire to secure by Letters Patent of the United States is:—

1. In an internal combustion engine having an induction pipe and means for supply of air thereto, the combination of an air chamber interposed between said pipe and air supply means, an air valve in said chamber and means within the air chamber actuable by pressure of environment and including an electric circuit and solenoid adapted to cause said valve to assume and maintain an area of opening dependent on the pressure in the chamber: said area of opening increasing if the pressure falls and decreasing if said pressure exceeds a predetermined pressure.

2. In an internal combustion engine having an induction pipe and means for supply of air thereto, the combination of an air chamber interposed between said pipe and air supply means, an air valve in said cham-

ber, means within the air chamber actuatable by pressure of environment and including an electric circuit and solenoid adapted to cause said valve to assume and maintain an area of opening dependent on the pressure in the chamber: said area of opening increasing if the pressure falls and decreasing if said pressure exceeds a pre-determined pressure, and a supplementary valve adapted to admit air to said chamber when the external atmospheric pressure exceeds the internal pressure in the induction pipe.

3. In an internal combustion engine having an induction pipe and means for supply of air thereto, the combination of an air chamber interposed between said pipe and air supply means, an air valve in said chamber, means within the air chamber actuatable by pressure of environment and including an electric circuit and solenoid adapted to cause said valve to assume and maintain an area of opening dependent on the pressure in the chamber: said area of opening increasing if the pressure falls and decreasing if said pressure exceeds a pre-determined pressure, and a supplementary valve adapted to admit air to said chamber when the external atmospheric pressure exceeds the internal pressure in the induction pipe by a pre-determined amount.

4. In an internal combustion engine having an induction pipe and means for supply of air thereto, the combination of an air chamber interposed between said pipe and air supply means, an air-valve in said chamber and means for actuating said valve to cause same to assume and maintain an area of opening dependent on the pressure in the chamber said actuating means comprising an aneroid in the chamber, an electric circuit containing said aneroid, a solenoid in said circuit, an oil pressure cylinder having inlet and exhaust ports, a piston in said cylinder connected to said valve and adapted to operate same against spring reaction and a further valve operated by the solenoid to control the aforesaid ports.

5. In an internal combustion engine having an induction pipe and means for supply of air thereto, the combination of an air chamber interposed between said pipe and air supply means, an air-valve in said chamber and means for actuating said valve to cause same to assume and maintain an area of opening dependent on the pressure in the chamber, said actuating means comprising an aneroid in the chamber, an electric circuit containing said aneroid, a solenoid in said circuit, an oil pressure cylinder having inlet and exhaust ports, a piston in said cylinder connected to said valve and adapted to operate same against spring reaction, a further valve operated by the solenoid to control the aforesaid ports, and a supplemental spring-loaded air valve adapted to admit air to the chamber aforesaid when the external atmospheric pressure exceeds the internal pressure in the induction pipe.

6. In an internal combustion engine having an induction pipe and means for supply of air thereto, the combination of an air chamber interposed between said pipe and air supply means, an air valve in said chamber and means within the air chamber actuatable by pressure of environment and including an electric circuit and solenoid adapted to cause said valve to assume and maintain an area of opening dependent on the pressure in the chamber: said area of opening increasing if the pressure fails and decreasing if said pressure exceeds a pre-determined pressure, and means for providing a supplementary pressure of air equal to or in excess of the external pressure of the atmosphere on the outer side of the valve aforesaid.

In witness whereof I have signed this specification in the presence of two witnesses.

FREDERICK HENRY ROYCE.

Witnesses:

H. R. CUTTEN,
F. PARSONS.