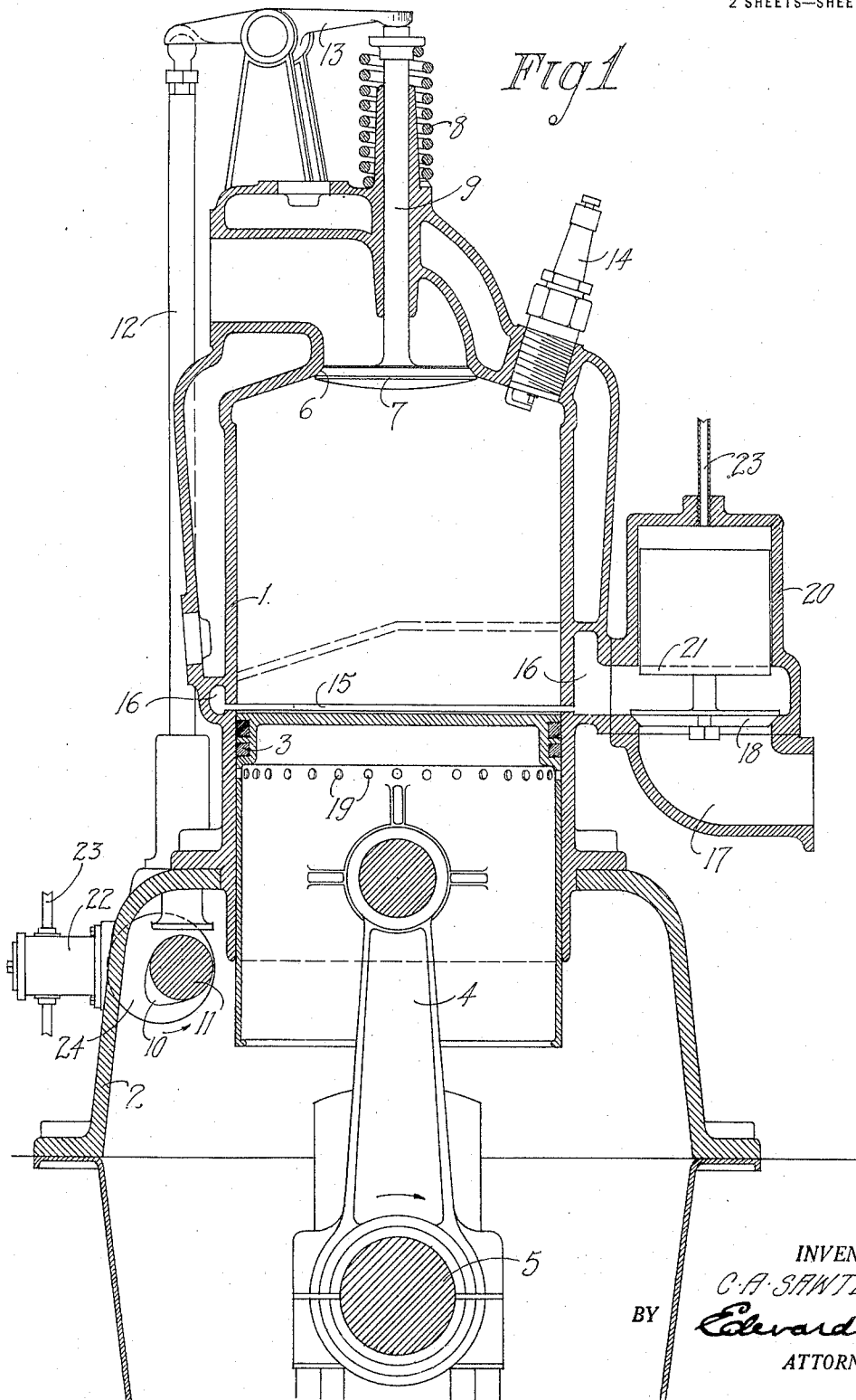


C. A. SAWTELLE.
INTERNAL COMBUSTION ENGINE.
APPLICATION FILED JULY 27, 1918.

1,305,172.

Patented May 27, 1919.

2 SHEETS—SHEET 1.



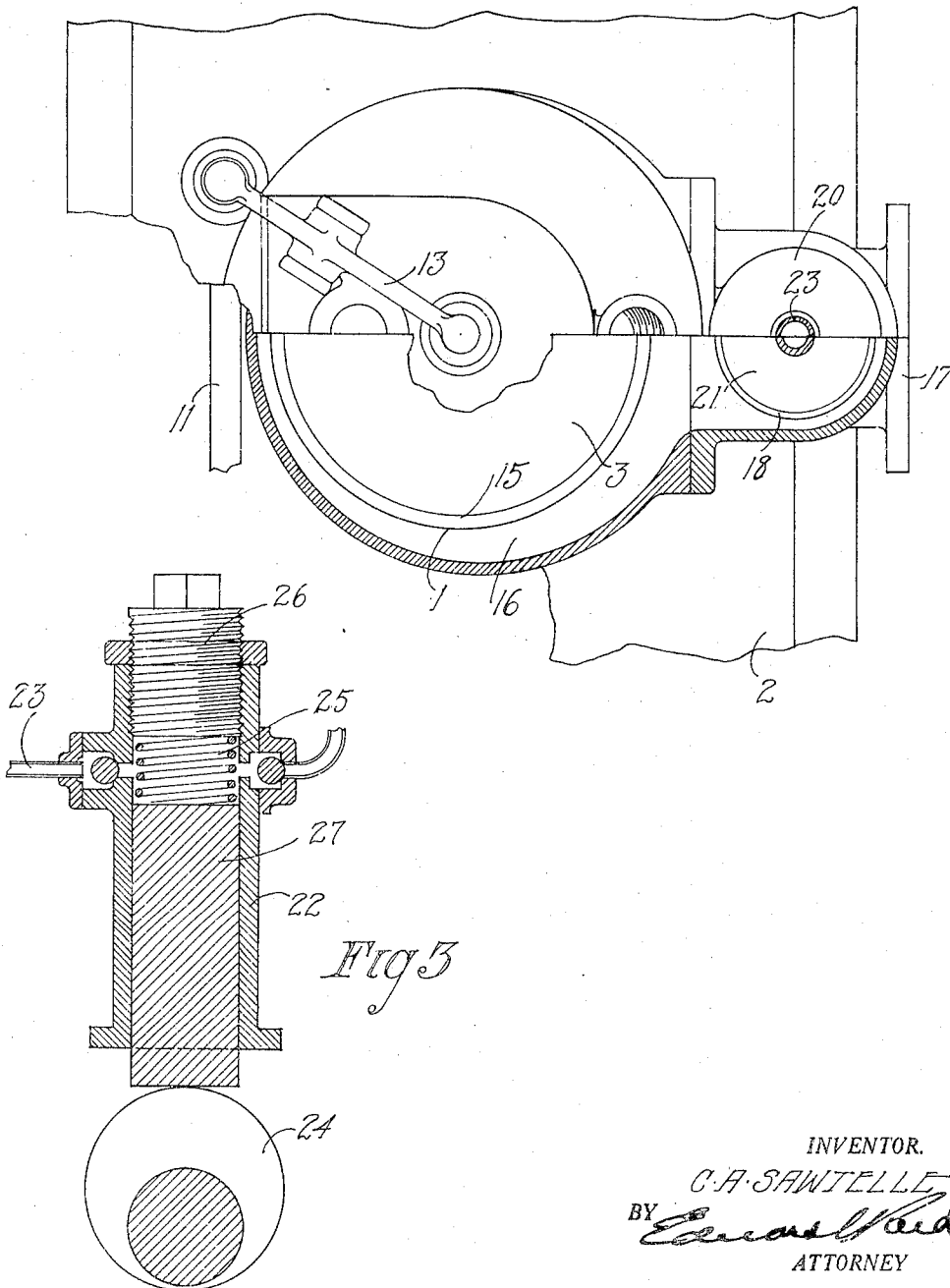
INVENTOR.
C. A. SAWTELLE
BY *Edward H. Reed*
ATTORNEY

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Fig 2



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UNITED STATES PATENT OFFICE.

CHARLES A. SAWTELLE, OF DETROIT, MICHIGAN, ASSIGNOR OF ONE-HALF TO SARAH J. PORTER, OF DETROIT, MICHIGAN.

INTERNAL-COMBUSTION ENGINE.

1,305,172.

Specification of Letters Patent.

Patented May 27, 1919.

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To all whom it may concern:

Be it known that I, CHARLES A. SAWTELLE, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to internal combustion engines, and more particularly to internal combustion engines of the four cycle type.

One object of the invention is to provide an engine of this kind which will permit a substantially complete expansion, in the cylinder, of the gases produced therein by the explosion of the compressed charge, thereby utilizing the full power of the explosion and materially increasing the efficiency of the engine and enabling the same power to be secured from a smaller charge than is secured from the larger charge that is required in the ordinary internal combustion engine, which exhausts the gases before they are completely expanded. Further, the gases, having fully expanded within the cylinder, are exhausted with less velocity, as well as in smaller quantity, and the noise caused by the exhaust is greatly reduced.

A further object of the invention is to automatically regulate the volume of gas which enters the cylinder according to atmospheric pressure, or altitude, thus maintaining a uniform compression at all altitudes.

Other objects of the invention will appear as the mechanism is described in detail.

In the accompanying drawings Figure 1 is a sectional view taken vertically of an engine embodying my invention; Fig. 2 is a plan view, partly in section, of the engine shown in Fig. 1; and Fig. 3 is a sectional detail view of the air pump.

In carrying out my invention I so construct the engine and so control the operations of the several parts thereof that the suction stroke of the piston will create a partial vacuum in the cylinder and that the charge of combustible mixture which enters the cylinder, at maximum load, will be insufficient to completely destroy this partial vacuum, thus causing the charge in the cylinder to be maintained, at the beginning of

the compression stroke of the piston, at less than atmospheric pressure. The compression space is reduced in size to enable the necessary compression to be had. As a result the cylinder is of sufficient capacity to permit of the full expansion of the exploded charge and the full force of the explosion is converted into power, the exhaust valve being retained in its closed position until the piston has completed, or practically completed, its power stroke.

The intake valve may be of any suitable character, but I prefer a valve which will be automatically opened by the suction in the cylinder, although a positively operated valve may be used. This valve may be controlled in various ways, as by means of a yieldable controlling medium which will yield, under the suction in the cylinder, to permit the valve to open but which will maintain such pressure on the valve that the latter will be moved to its seat when the combustible mixture has entered the cylinder in sufficient quantities to reduce the vacuum in the cylinder to the desired extent, without entirely destroying the same. By adjusting the controlling means to regulate this pressure the closing of the valve can be timed to regulate the volume of combustible mixture which enters the cylinder, that is, to regulate the size of the charge.

Where the engine is intended for use at varying altitudes as in airplane work, I prefer to employ air as the controlling medium for the intake valve. The air in the controlling device will be subjected to the same variations of pressure, at different altitudes, to which the mixture in the cylinder is subjected and will, therefore, automatically accommodate itself to the needs of the engine, and will yield to a greater or lesser extent to admit a larger or smaller charge, as may be necessary to secure a uniform compression of the successive charges at different altitudes.

In the present drawings I have, for the purpose of illustration, shown the invention as embodied in a single cylinder engine, with the intake port at the bottom of the cylinder, and an air controlled intake valve. It will be understood, however, that engines of various kinds, either single cylinder or multiple cylinder, may be used; that the intake port is not necessarily located at the bottom of the cylinder; and that controlling devices

of different kinds may be used. For example, a non-yieldable controlling device can be timed to maintain the partial vacuum in the cylinder at the beginning of the compression stroke of the piston, although it would not perform all the other functions of the yieldable controlling device.

In these drawings the engine is shown as comprising a cylinder 1 mounted on a base 2 and having therein a piston 3, which is connected by a connecting rod 4 with a crank shaft 5. The cylinder has a single exhaust port 6 arranged centrally in the cylinder head, which is shown as formed integral with the cylinder proper. An exhaust valve 7 controls the port 6 and is held normally on its seat by a spring 8 coiled about the stem 9 of the valve. The exhaust valve is opened in properly timed relation to the movements of the other parts of the engine by a cam 10 mounted on a cam shaft 11 which is driven from a moving part of the engine, and is preferably geared to the crank shaft in the usual manner. The cam 10 acts on a rod which is operatively connected by means of a lever 13 with the valve stem 9. In the present construction the operation of the exhaust valve is so timed that it will not open until the piston has completed, or nearly completed, its power stroke. As here shown the spark plug, 14, is mounted in the cylinder head at one side of the exhaust port.

In that form of the invention here illustrated the intake port is located near the inner end of the cylinder so that it will be uncovered by the piston just before the latter reaches the end of its inward travel, and comprises a narrow slot 15 extending circumferentially of the cylinder. The intake port or slot, 15 opens into a circumferential intake chamber 16 which communicates with a conduit 17 leading to a source of fuel supply, such as the carbureter. The intake chamber 16 is, preferably, gradually reduced in size toward that side of the cylinder opposite the intake conduit to provide a more equal distribution of the combustible mixture, or fuel. The intake conduit is controlled by an intake valve 18 which is held on its seat by a yieldable pressure which permits it to be automatically opened by the suction in the cylinder but again closes it when the suction, or vacuum, in the cylinder is so reduced by the entering mixture that it will no longer hold the valve against the pressure of the controlling device. Obviously, by regulating the pressure on the valve the length of time that the valve will remain open can be varied and the amount of combustible mixture, that is, the size of the charge, entering the cylinder can be regulated.

As is well understood, in the operation of a four cycle engine the exhaust port re-

mains closed during the suction stroke of the piston, and inasmuch as the intake port is not uncovered until the piston has nearly completed its suction stroke, it will be apparent that the pressure in the cylinder will be reduced to a very low degree, and a partial vacuum created therein, before the intake port is opened. When the intake port is opened the unequal pressures will cause the intake valve to open and the combustible mixture to pass from the intake conduit to the cylinder. The mixture continues to enter the cylinder until the pressure therein has risen to such a point that the valve controlling device is able to seat the intake valve. The pressure exerted on the intake valve by its controlling device is so regulated that the valve will be seated before atmospheric pressure has been restored in the cylinder. Consequently, with the engine operating at maximum load, less than atmospheric pressure, or a partial vacuum, will be maintained in the cylinder at the beginning of the next outward stroke, the compression stroke, of the piston. To secure the necessary compression of the charge the compression space is made smaller than is usual in engines of similar capacity. Because of the fact that the charge is compressed from less than atmospheric pressure a relatively large expansion of the exploded charge is possible within the cylinder and by retaining the exhaust valve closed until the piston has reached, or nearly reached, the end of its power stroke the full expansion of the gases is caused to act on the piston and is converted into power, thus materially increasing the power derived from a given quantity of fuel, that is, the efficiency of the engine.

To prevent the possibility of the combustible mixture which remains in the intake chamber 16 being ignited when the intake port is opened on the power stroke of the piston, I admit air to this chamber so as to form a wall of air between the combustible mixture and the intake port, or, should the air so admitted intermingle with the combustible mixture, to so dilute the mixture that it will not ignite. This may be accomplished in various ways, but I prefer to provide a series of ports 19 in the wall of the piston just below its head, which ports will be brought into alinement with the intake port on the compression stroke of the piston, and, inasmuch as the contents of the chamber are at less than atmospheric pressure, air will pass from the interior of the piston to the chamber. This arrangement of the air ports has the additional advantage of causing the air to circulate in contact with the head of the piston, and thereby tending to cool the latter. It will also be noted that the combustible mixture enters the cylinder across the face of the piston and

has a cooling action thereon. As a result the piston is very effectively prevented from overheating.

As has been stated the controlling device for the intake valve may take various forms, but where the engine is intended for use at different altitudes I prefer an air actuated controlling device. In the present embodiment of the engine I have shown an air chamber, or cylinder, 20 mounted at one side of the engine cylinder and having therein an air actuated member, such as a piston 21, which is operatively connected with the intake valve. Any suitable means may be provided to maintain the desired pressure in the air chamber. In the present instance I have provided an air pump 22 which is connected with the air chamber by a pipe 23 and is driven by the engine itself. As here shown the piston 27 of the air pump is acted upon by a cam 24, on the cam shaft 11, which imparts the compression stroke thereto, and by a spring 25 which imparts the return stroke thereto. The degree of pressure at which the air in the chamber 20 is maintained may be varied, preferably by adjusting the pump to vary the size of its compression space. The pump here illustrated has its cylinder head in the form of a screw threaded plug 26 having a squared end which may be gripped by a wrench to adjust the plug. Only a certain amount of air can enter the cylinder of the pump and by varying the size of the compression space the degree of pressure to which this air will be subjected by the piston may be varied. The compression of the air in the air chamber 20 will be affected by the different altitudes in the same manner that the compression of the charge in the engine cylinder is affected thereby, and consequently any falling off of the compression in the engine cylinder will be met by a corresponding reduction of pressure in the air chamber, which will permit the intake valve to remain open a longer time and a larger charge to enter the engine cylinder, thus maintaining a uniform compression therein at all altitudes.

While I have shown and described one embodiment of my invention, I wish it to be understood that I do not desire to be limited to the details thereof, as various modifications may occur to a person skilled in the art.

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

1. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, valves to control the intake and exhaust through the respective ports, a piston in said cylinder, and means for so controlling said intake valve that the charge will be admitted to said cylinder near the end of the suction stroke of

the piston and, at maximum load, will be less than the displacement of said piston, thereby causing a partial vacuum to exist in said cylinder at the beginning of each compression stroke of said piston.

2. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, valves to control the intake and exhaust through the respective ports, a piston in said cylinder, and means to cause a partial vacuum to be created in said cylinder by the suction stroke of said piston, when said engine is operating at maximum load, and to cause a charge of combustible mixture to enter said cylinder through said intake port when said piston is near the end of its suction stroke and before it begins its compression stroke, without completely destroying said vacuum.

3. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, valves to control the intake and exhaust through the respective ports, a piston in said cylinder, means to cause a partial vacuum to be created in said cylinder by the suction stroke of said piston, when said engine is operating at maximum load, and to cause a charge of combustible mixture to enter said cylinder through said intake port, when said piston is near the end of its suction stroke, and means for controlling said intake valve to prevent said mixture from entering said cylinder in sufficient volume to establish atmospheric pressure therein at the beginning of the compression stroke of said piston.

4. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, valves to control the intake and exhaust through the respective ports, a piston in said cylinder, means to cause a partial vacuum to be created in said cylinder by the suction stroke of said piston, when said engine is operating at maximum load, and to cause a charge of combustible mixture to enter said cylinder through said intake port, when said piston is near the end of its suction stroke, and yieldable means for controlling said intake valve to prevent said mixture from entering said cylinder in sufficient volume to establish atmospheric pressure therein at the beginning of the compression stroke of said piston.

5. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, valves to control the intake and exhaust through the respective ports, a piston in said cylinder, means to cause a partial vacuum to be created in said cylinder by the suction stroke of said piston, when said engine is operating at maximum load, and to cause a charge of combustible mixture to enter said cylinder through said intake port when said piston is near the end of its suction stroke, and ad-

justable means for controlling said intake valve to prevent said mixture from entering said cylinder in sufficient volume to establish atmospheric pressure therein at the beginning of the compression stroke of said piston.

6. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, a piston mounted in said cylinder, a valve to control the flow of fuel through said intake port, and means controlled by the pressure in said cylinder to automatically close said intake valve when a predetermined quantity of fuel has entered said cylinder.

7. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, a piston mounted in said cylinder, a valve to control the flow of fuel through said intake port, and a yieldable device controlled by the pressure in said cylinder to close said intake valve when the fuel entering said cylinder has raised the pressure therein to a predetermined point.

8. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, a valve for said exhaust port, a piston in said cylinder adapted to create a partial vacuum in said cylinder upon the suction stroke thereof, a valve to control the flow of fuel through said intake port and arranged to be opened by the suction in said cylinder, when said piston is near the end of its suction stroke, and a device acting on the last mentioned valve to seat the same when the vacuum in said cylinder has been reduced to a predetermined degree.

9. In an internal combustion engine of the four cycle type, a cylinder having a normally closed exhaust port, a piston adapted to create a partial vacuum in said cylinder upon its suction stroke, said cylinder also having an intake port arranged to be opened by said piston near the end of the suction stroke thereof, a valve to control the flow of fuel through said intake port and arranged to be opened by the suction in said cylinder, and a device to exert a constant pressure on the last mentioned valve in a direction opposed to the suction in said cylinder.

10. In an internal combustion engine of the four cycle type, a cylinder having a normally closed exhaust port, a piston adapted to create a partial vacuum in said cylinder upon its suction stroke, said cylinder also having an intake port arranged to be opened by said piston near the end of the suction stroke thereof, a valve to control the flow of fuel through said intake port and arranged to be opened by the suction in said cylinder, and a fluid operated device to exert a pressure on the last mentioned valve

in a direction opposed to the suction in said cylinder.

11. In an internal combustion engine of the four cycle type, a cylinder having a normally closed exhaust port, a piston adapted to create a partial vacuum in said cylinder upon its suction stroke, said cylinder also having an intake port arranged to be opened by said piston near the end of the suction stroke thereof, a valve to control the flow of fuel through said intake port and arranged to be opened by the suction in said cylinder, and a device to exert a constant pressure on the last mentioned valve in a direction opposed to the suction in said cylinder, said device comprising means to vary the pressure exerted on said valve in accordance with variations in atmospheric pressure.

12. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, a valve for said exhaust port, a piston in said cylinder adapted to create a partial vacuum therein upon the suction stroke of said piston, a valve to control the flow of fuel through said intake port and arranged to be opened by the suction in said cylinder, a controlling device for said last mentioned valve comprising an air chamber, a movable member mounted in said chamber and connected with said valve, and means for maintaining a constant air pressure within said chamber.

13. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, a valve for said exhaust port, a piston in said cylinder adapted to create a partial vacuum therein upon the suction stroke of said piston, a valve to control the flow of fuel through said intake port and arranged to be opened by the suction in said cylinder, a controlling device for said last mentioned valve comprising an air chamber, a movable member mounted in said chamber and connected with said valve, and means for maintaining a constant air pressure within said chamber, and for regulating the amount of said pressure.

14. In an internal combustion engine of the four cycle type, a cylinder having an intake port and an exhaust port, a valve for said exhaust port, a piston in said cylinder adapted to create a partial vacuum therein upon the suction stroke of said piston, a valve to control the flow of fuel through said intake port and arranged to be opened by the suction in said cylinder, a controlling device for said last mentioned valve comprising an air chamber, a movable member mounted in said chamber and connected with said valve, an air pump connected with said chamber, and an operative connection between said pump and said engine.

15. In an internal combustion engine of the four cycle type, a cylinder having an

intake port and an exhaust port, a valve for said exhaust port, a piston in said cylinder adapted to create a partial vacuum therein upon the suction stroke of said piston, a
5 valve to control the flow of fuel through said intake port and arranged to be opened by the suction in said cylinder, a controlling device for said last mentioned valve comprising an air chamber, a movable member
10 mounted in said chamber and connected with said valve, an air pump connected with said chamber, and means for adjusting said pump to cause different air pressures to be maintained in said chamber.

15 16. In an internal combustion engine of the four cycle type, a cylinder having a valve-controlled exhaust port, a piston mounted in said cylinder and adapted to create a partial vacuum therein on its suction stroke, said cylinder also having an
20 inlet extending circumferentially thereof near the inner limit of movement of said piston, and means to control the flow of fuel through said inlet.

25 17. In an internal combustion engine of the four cycle type, a cylinder having a valve-controlled exhaust port, a piston

mounted in said cylinder and adapted to create a partial vacuum therein on its suction stroke, said cylinder also having an inlet near the inner limit of movement of
30 said piston, means to control the flow of fuel through said inlet, and means to cause air to pass outward through said inlet after said piston has begun its compression stroke. 35

18. In an internal combustion engine of the four cycle type, a cylinder having a valve-controlled exhaust port, a piston mounted in said cylinder and adapted to create a partial vacuum therein upon its
40 suction stroke, said cylinder having an inlet extending circumferentially thereof and arranged to be uncovered by said piston when the latter is near the end of its suction stroke, means to control the flow of fuel
45 through said inlet, said piston having an apron provided with a circumferential series of openings arranged to register with said inlet after said piston begins its compression stroke. 50

In testimony whereof I affix my signature hereto.

CHARLES A. SAWTELLE.