March 13, 1928. 1,662,097

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TWO-CYCLE INTERNAL COMBUSTION ENGINE

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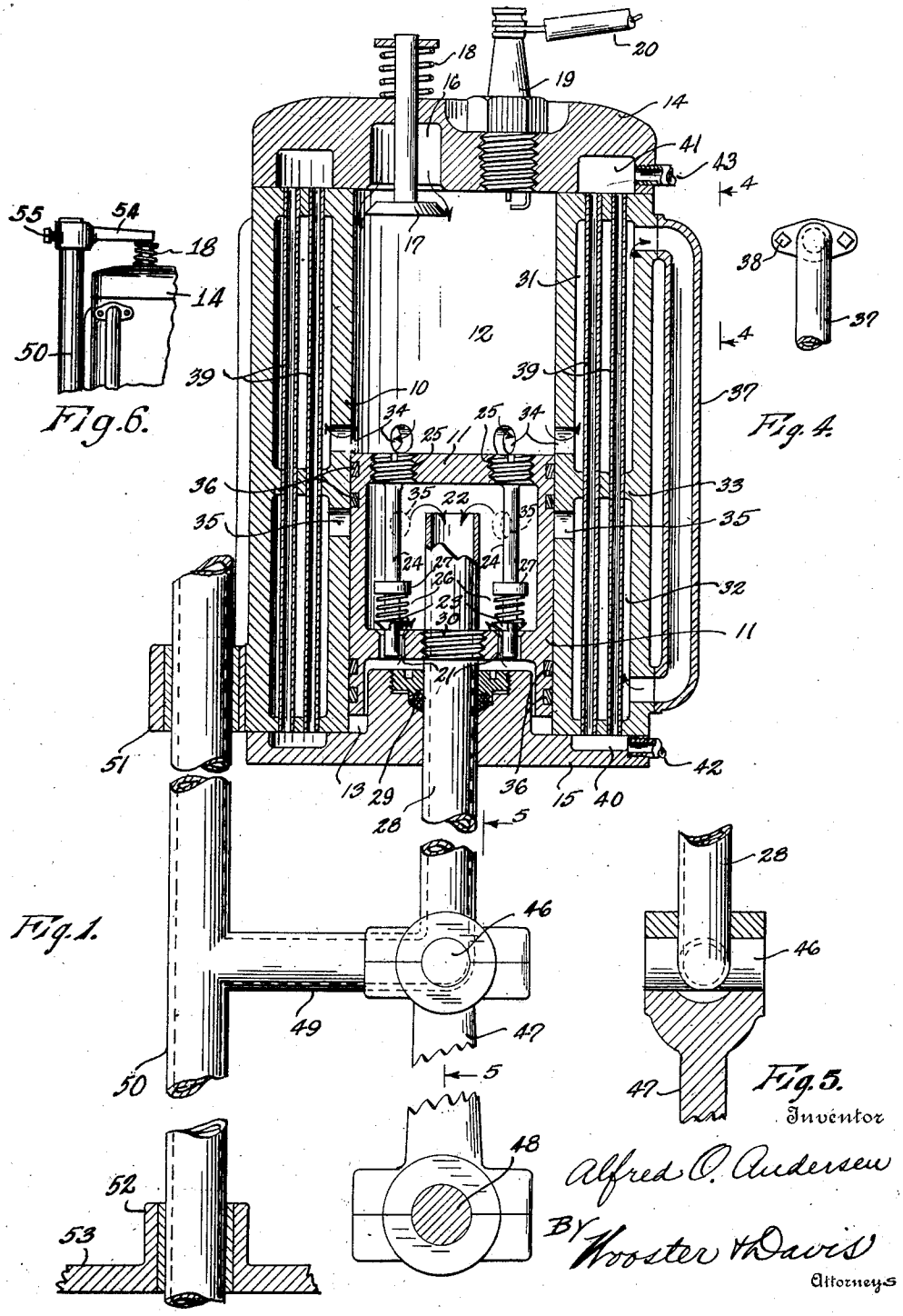


Fig. 1.

Fig. 6.

Fig. 4.

Fig. 5.

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Fig. 2.

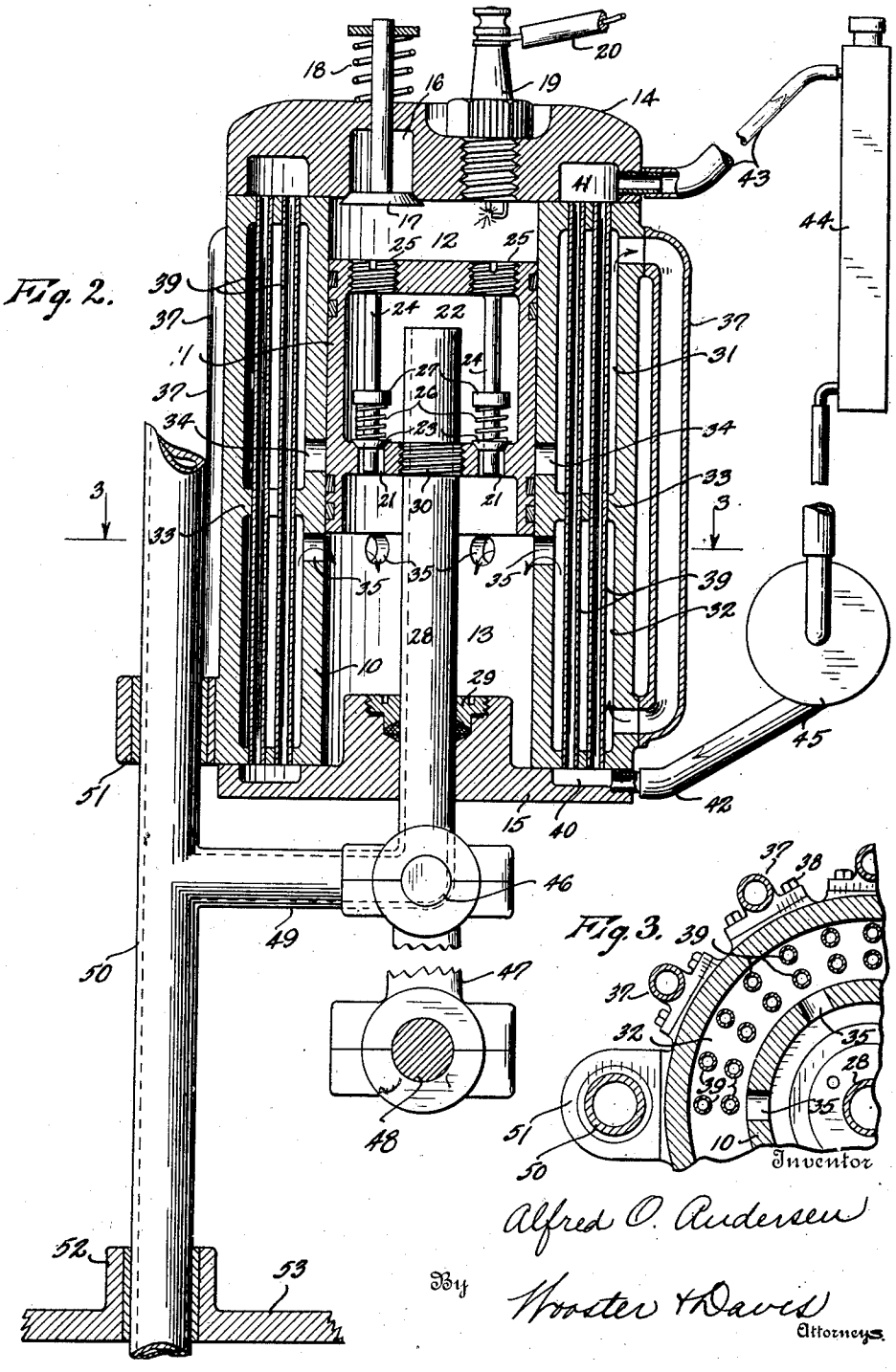


Fig. 3.

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UNITED STATES PATENT OFFICE.

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TWO-CYCLE INTERNAL-COMBUSTION ENGINE.

Application filed December 5, 1923. Serial No. 678,609.

This invention relates to internal combustion engines, particularly of the two-cycle type, and has for an object to provide an internal combustion engine which will run better with a simple type of carburetor than will the usual four-cycle engine, that will have a greater efficiency and operate at a greater economy over a large range of power, which will give a greater horse power for a given weight of engine, which can be throttled down much further than the ordinary four-cycle engine, thus reducing the frequency of the necessity for shifting gears when the engine is employed for automobile use and which will have a more rapid pickup.

It is also an object of the invention to provide an improved means of cooling the piston and the cylinder.

With the foregoing and other objects in view, I have devised the construction illustrated in the accompanying drawings, forming a part of this specification, similar reference numerals being employed throughout the various figures to indicate corresponding elements. In these drawings,

Fig. 1 is a cross section through a cylinder of an engine embodying my invention, showing the piston at the end of the power stroke.

Fig. 2 is a similar view showing the piston at the end of the compression stroke.

Fig. 3 is a transverse section through a portion of the cylinder substantially on line 3—3 of Fig. 2.

Fig. 4 is a side elevation of one of the gas conducting means, the view being substantially on line 4—4 of Fig. 1.

Fig. 5 is a partial section and elevation of the connection between the piston rod and the crank, the section being substantially on line 5—5 of Fig. 1, and

Fig. 6 is a side elevation of a portion of the cylinder on a smaller scale showing a means for actuating the inlet valve.

In the drawings I have shown a single cylinder but, of course, the number of cylinders may be increased as found desirable. In the cylinder indicated at 10 is a reciprocating piston 11 dividing the space enclosed by the cylinder into two chambers located on opposite sides of this piston. In the present case the upper chamber 12 is the combustion chamber and the lower chamber 13 I have for convenience termed the pump chamber. The upper end of the cylinder is closed by the head 14 and the lower end by the head 15. In the upper head is the fuel inlet passage 16 leading from any suitable type of carburetor (not shown) and controlled by the inlet valve 17 normally held closed by the usual spring 18. Also carried by this head is the spark plug 19 connected by lead 20 to the usual ignition controlling device.

I prefer to make the piston hollow in the present construction and provide the lower wall of the piston with one or more exhaust passages 21 leading to the chamber 22 in the piston, these exhaust passages being controlled by the exhaust valves 23. These valves may be mounted in different ways but I prefer that substantially as shown wherein guide rods 24 are threaded into the upper wall of the piston, as shown at 25, and extend through the valves 23, the valves being adapted to slide on these rods and are normally held in closed position by the springs 26 embracing the rods and engaging the collars 27. The piston rod 28 in the present instance is a tube leading from the chamber 22 in the piston, and the entrance to this tube is preferably located adjacent the upper wall of the piston, that is, the wall of the piston next to the combustion chamber, and it leads through the lower head 15 wherein it is surrounded by a suitable stuffing box 29 to prevent leakage of gas about this rod. The rod is connected to the piston by any suitable means, such as by threading it into the lower wall thereof, as shown at 30.

Surrounding the walls of the cylinder are chambers or passages 31 and 32 for the gases or products of combustion, which chambers are separated by a cross wall 33. Leading from the combustion chamber 12 to the upper gas chamber 31 are a pluralty of openings or ports 34 spaced about its periphery adjacent the lower end of this chamber and passing through the walls of the cylinder. These openings are so located that they are uncovered by the piston only when the piston is adjacent the end of the working stroke or its extreme outer position, as shown in Fig. 1, but at other times are closed by this piston. Leading from the lower or pump chamber 13 to the lower gas chamber 32 are a series of similar openings or ports 35, and these ports are so located as to be uncovered by the piston only when it is adjacent its extreme upper position or, that is, at the end of the compression stroke. It will be noted that the openings 34 and 35 are located on

opposite sides of the cross wall 33 and are alternately uncovered and closed by the piston as the piston reciprocates. In order to prevent leakage of gas by the piston the cylindrical walls thereof are provided with suitable grooves for carrying the usual packing rings 36. These rings are preferably placed adjacent the opposite ends of the piston substantially as shown.

For the purpose of conducting the gases from the upper gas chamber 31 to the lower gas chamber 32 I provide a series of conducting pipes 37 spaced about the walls of the cylinder. I prefer to place them outside the gas chambers, as shown, and they may be secured to the walls of the chamber by any suitable means, such as screws 38. They are also preferably connected with the gas chambers 31 and 32 adjacent the upper and lower ends thereof respectively or, that is, at the opposite ends of these chambers from the openings 34 and 35. Extending longitudinally through these gas chambers are a number of pipes 39 which are preferably cast in position when the cylinder is cast, and there are preferably a large number of these tubes provided as indicated to give a large cooling surface. These tubes are adapted to conduct through the gas chamber a cooling fluid, such as water, and provide a condenser or cooling means for the exhaust gases after they leave the combustion chamber. To facilitate flow of cooling fluid, such as water, through these pipes the opposite ends thereof communicate with an annular chamber 40 in the lower head 15 and a similar chamber 41 in the upper head 14, and the cooling water may be conducted to the lower chamber 40 by a suitable supply pipe 42 and conducted from the upper chamber by pipe 43. It is generally desirable to employ a closed circulating system for this cooling water so that it may be used continuously as in the usual automobile practice, in which case the outlet pipe 43 may be led to the upper end of the usual radiator 44 and the cool water from the radiator conducted back to the chamber 40 by the pipe 42 in which may be located a circulating pump 45.

The piston rod 28 is connected by a suitable pivotal connection 46 to a connecting rod 47 which in turn has the usual connection with a crank pin 48 on the crank shaft, but as the exhaust gases are conducted from the piston through the piston rod a branch conductor 49 leads laterally from this rod to a conductor 50 adapted to slide in suitable guides 51 and 52. These guides may be suitably located as desired, but in the drawing one is shown on the exterior of the cylinder and the other in the bottom wall 53 of the crank case. The gases are discharged through this conductor beneath the crank case, the upper portion above the branch 49 being closed. This upper portion may be extended, as shown in Fig. 6, to carry a finger 54 for operating the inlet valve 17, if it is desired to give this valve positive actuation. I have found that positive actuation of this valve is, however, not necessary as there is sufficient suction in the combustion chamber to open it to draw in the combustible mixture. The finger 54 when used may be adjustably secured to the extension of conductor 50 by means of a suitable set screw 55.

The operation is as follows:

Beginning with the piston in its lowermost positon or at the end of power stroke, as shown in Fig. 1, and assuming that a charge of combustible mixture from the carburetor, not shown, has been drawn through the inlet 16 into the combustion chamber 12, as piston 11 moves upwardly it will close the ports 34, the valve 17 will close, and the combustible mixture will be compressed in the chamber 12. When the piston approaches its extreme upper position, as shown in Fig. 2, the charge will be ignited by the spark plug 19 and the piston forced again to its lowermost position. As the piston moves upwardly, however, it creates a vacuum in pump chamber 13, and as the piston uncovers the openings 35 at the upper end of its stroke this vacuum in the chamber 13 will be transmitted to the exhaust gas chamber 32 tending to reduce the pressure in this chamber and the upper chamber 31, and will draw burned gases from these chambers into the chamber. 13. Now, when the piston is forced downwardly under the action of the explosion the openings 35 will be closed and the exhaust gases in the chamber 13 will be compressed until the pressure is sufficient to open the discharge or outlet valves 23 and force these exhaust gases into the chamber 22 in the piston and through the conductor pipe 28, branches 49 and 50 to the atmosphere. Immediately the piston approaches the lower end of the stroke the openings 34 are uncovered allowing the exhaust gases to pass into chamber 31. However, the gases in the chambers 31 and 32 are in contact with the cooling or condenser pipes 39, and so the gases are cooled reducing the pressure in these gas chambers and producing a partial vacuum therein which is augmented by the vacuum produced in the chamber 13 on the up stroke of the piston. Thus when the openings 34 are uncovered, as there is a partial vacuum in the chamber 31, the exhaust gases are immediately drawn through the openings 34 into this chamber and the new charge of combustible mixture is drawn in through the inlet valve 17. By placing the cross wall 33 between the openings 34 and 35 and by connecting the conductor pipes 37 to the chambers 31 and 32 at the upper and lower ends thereof respectively, the hot gases are given extended contact with the cooling

pipes 39 so that they are thoroughly cooled before they reach the openings 35. By providing a large number of cooling pipes 39, equally spacing the conductor pipes 37 around the cylinder and also equally spacing the openings 34 and 35 around the cylinder, there is a uniform flow of the gases through all parts of the chambers 31 and 32 and there is a large cooling surface to which these gases are exposed. It will also be noted that the conductors 37 communicate with the chambers 31 and 32 on the opposite sides of the chambers from the communication therewith of the openings 34 and 35 so that the gases in passing from the openings 34 to the pipes 37 or from the pipes 37 to the openings 35 must pass laterally across the cooling pipes. It is still further to be noted that the cooling water at its lower temperature is in the portion of the pipes 39 which are in the lower or cooler chamber 32 and that the warmer water in the cooling pipes is in the portion of these pipes which is in the hotter chamber 31, so that we secure by this arrangement the counterflow principle which gives a greater cooling effect.

Another important feature of my invention is the cooling of the piston especially the end wall which is in contact with the gases in the combustion chamber. The gases are thoroughly cooled in the chambers 31 and 32, and as they pass through the chamber 22 in the piston and out the conductor 28 they thoroughly cool the walls of the piston preventing carbonization of the oil on the piston walls and the formation of other carbon deposits. This insures a tight piston with no piston ring trouble and better compression.

It is also to be noted that, unlike the usual method of cooling in which the cooling water is in direct contact with the walls of the cylinder, in my construction the cooling water is not in direct contact with the walls of the cylinder 10. Thus my engine will pick up much more rapidly than the ordinary four-cycle engine with the cooling water in direct contact with the cylinder walls, that is, where the cooling water is in direct contact with the cylinder walls this water must be heated before the walls of the cylinder can be raised to the proper temperature to give the proper combustion in the combustion chamber, and in such a construction the heat generated by the compression of the gases can not be sufficient to give the required temperature to the cylinder walls. In my construction, however, the cylinder walls are very quickly heated as no heating of the cooling water is required and the heat generated in compressing the charge in the chamber 12 will quickly heat the cylinder walls to the proper temperature. Thus my engine will not only pick up more rapidly but it may be throttled down much further, so that this engine will run without shifting gears where the other engine would not and I secure a much greater range of operation, or a greater flexibility.

I secure another material advantage over the four-cycle engine because in my engine the pressure in the combustion chamber at the beginning of the compression stroke is always the same and thus the compression secured is always the same regardless of the position of the throttle valve, which is not true in the four-cycle engine. In idling or travelling along a level road the throttle or intake valve is partly closed. Under these conditions the four-cycle engine during its suction stroke creates a partial vacuum over the piston as usual, but the partly closed throttle valve does not allow the cylinder to be filled with the combustible mixture and thus no compression is secured throughout the first part of the compression stroke. Compression is not secured until the piston approaches the upper end of its stroke. The result is that in the four-cycle engine under these conditions very little compression is secured and the mixture will burn very slowly. In fact, it is not thoroughly burned at all and considerable power is lost by escape of unburned gases from the cylinder. Furthermore, the cylinder walls did not have a chance to heat up thoroughly during the compression stroke as little heat was generated, and they, therefore, absorbed considerable of the heat generated by the combustion, still further reducing the efficiency. This effect is further increased by the fact that the cooling water is directly in contact with the cylinder walls.

In my engine, however, the pressure in the combustion chamber 12 is always practically the same at the beginning of the compression stroke because it is determined by the pressure in the gas chambers 31 and 32 which is practically constant. Therefore, if the throttle valve is partly closed a portion of the burned gases will not be withdrawn from this combustion chamber and the amount of the fresh incoming charge will be determined by the amount of the exhaust gases which have been withdrawn. I will, therefore, always have practically the same amount of compression regardless of the position of the throttle valve so that the gases are burned under the best conditions, and I secure a thorough and rapid combustion of these gases under all conditions of operation as I secure substantially the same high compression under all conditions. The cylinder walls are heated practically as much by the compression when the throttle valve is partly open as when this valve is fully open. Thus the cylinder walls do not absorb a greater proportion of the heat under these conditions than they do when operating

with the throttle valve fully open. Still further, as I have pointed out above, in my engine the cooling water is not in direct contact with the cylinder walls so that the walls may heat up to the proper temperature, and the cooling water does not absorb such a large amount of heat during the expansion stroke. Thus I secure practically as great efficiency when idling or running with the throttle valve partly closed as when running with this valve fully open. It will also be apparent the engine will pick up much more rapidly and may be throttled down much further.

With my construction of engine I secure more horse power for a given weight of engine than in the four-cycle engine, as there are only two cylinders to secure the same power generated by four cylinders in the four-cycle engine. For the same reason there is only half the piston displacement for the same power.

In my engine while running there is always a reduced pressure or partial vacuum in the cooling or condenser chambers 31 and 32, and this vacuum is sufficient to operate vacuum brakes, vacuum gear shifts and so forth.

The power and efficiency of my engine is also increased because the back pressure on the exhaust gases as they leave the combustion chamber is greatly reduced. In fact, the back pressure is reduced below atmospheric pressure, while in the four-cycle engine it is considerably above atmospheric pressure. Another advantage of my engine is that no muffler is required as the pressure of the gases as they are discharged into the atmosphere is only slightly above atmospheric pressure. The pressure generated in the chamber 13 is only that required to open the exhaust valves 23.

Having thus set forth the nature of my invention, what I claim is:

1. In an internal combustion engine, a cylinder, a piston mounted to reciprocate in said cylinder and forming a combustion chamber at one side thereof and a pump chamber at the other side thereof, means for conducting a combustible mixture to the combustion chamber, means for conducting exhaust gases from the pump chamber; means for conducting burned gases from the combustion chamber to the pump chamber including a gas chamber in the walls of the cylinder extending substantially the length of the combustion chamber and substantially surrounding it so that the cylinder walls are cooled by transfer of heat from these walls to the gases within said chamber, means forming a communication from the combustion chamber to the gas chamber, and means forming a communication from the gas chamber to the pump chamber; and means in the gas chamber for cooling the gases in said chamber.

2. In an internal combustion engine, an upright cylinder, a piston in said cylinder forming a combustion chamber at one end of the cylinder and a pump chamber at the other end of the cylinder, an inlet to said combustion chamber at the top thereof, an outlet from the pump chamber, means for conducting gases from the combustion chamber to the pump chamber comprising a gas chamber in the cylinder walls extending substantially the length of the combustion chamber and substantially surrounding it so that the cylinder walls are cooled by transfer of heat from these walls to the gases within the chamber, said gas chamber communicating with the combustion chamber at the lower end thereof, and means for cooling the gases in said gas chamber.

3. In an internal combustion engine, an upright cylinder, a piston in said cylinder forming a combustion chamber and a pump chamber, means for conducting fuel to the combustion chamber at the top thereof, means for conducting exhaust gases from the pump chamber, said cylinder being provided with a plurality of openings communicating with the combustion chamber at the lower part thereof and with the pump chamber at the upper part thereof, conducting means for gases comprising a gas chamber in the walls of the cylinder extending substantially the length of the combustion chamber and substantially surrounding it so that the walls of said combustion chamber are cooled by transfer of heat from said walls to the gases in the gas chamber, said gas chamber extending between said openings, said piston being arranged to cover and uncover said openings to control the flow of the gases, and cooling means for the gases in said chamber.

4. In an internal combustion engine, an upright cylinder, a piston in said cylinder forming a combustion chamber and a pump chamber respectively on opposite sides of the piston, means for conducting fuel to the upper part of the combustion chamber, means for conducting exhaust gases from the pump chamber, means for conducting gases from the lower part of the combustion chamber to the pump chamber including a gas chamber in the walls of the cylinder extending substantially the length of the combustion chamber and substantially surrounding it so that the walls of the combustion chamber are cooled by transfer of heat from said walls to the gases in the gas chamber, a plurality of pipes in said gas chamber and arranged to be surrounded by said gases, and means for causing flow of cooling fluid through said pipes.

5. In an internal combustion engine, a

cylinder, a piston in said cylinder forming a combustion chamber and a pump chamber respectively on opposite sides of the piston, means for conducting fuel to the combustion chamber, means for conducting exhaust gases from the pump chamber, a gas chamber in the walls of the cylinder forming a cooling means for said walls by transfer of heat from said walls to the gases in said chamber, said cylinder being provided with openings leading to said gas chamber from the combustion and pump chambers, and arranged to be respectively exposed by said piston alternately at the extremes of its stroke, a partition in the gas chamber between the openings leading from the combustion and pump chambers, gas conducting means communicating with the gas chamber adjacent the opposite ends thereof, and pipes for cooling fluid extending through the gas chamber.

6. In an internal combustion engine, a cylinder, a hollow piston in said cylinder forming a combustion chamber and a pump chamber respectively on opposite sides of the piston, means for conducting fuel to the combustion chamber, means for conducting gases from the combustion chamber to the pump chamber, means for cooling the gases in said conducting means, means for conducting the cooled gases from the pump chamber to the interior of the piston, and means for conducting said gases from the piston.

7. In an internal combustion engine, a cylinder, a hollow piston in said cylinder forming a combustion chamber and a pump chamber respectively on opposite sides of the piston, means for conducting fuel to the combustion chamber, means for conducting gases from the combustion chamber to the pump chamber, means for cooling the gases in said conducting means, one or more exhaust valves carried by the piston and adapted to control passage of said cooled gases from the pump chamber to the interior of the piston, and means for conducting the gases from the piston to a point of discharge.

8. In an internal combustion engine, a cylinder, a hollow piston in said cylinder forming a combustion chamber and a pump chamber respectively on opposite sides of the piston, means for conducting fuel to the combustion chamber, means for conducting gases from the combustion chamber to the pump chamber, means for cooling the gases in said conducting means, one or more valve controlled exhaust passages in the lower wall of the piston leading from the pump chamber to the chamber within the piston, and a conductor pipe for the gases projecting through said wall and terminating adjacent the other end wall of the piston.

9. In an internal combustion engine, a cylinder, a piston in said cylinder forming a combustion chamber and a pump chamber respectively on opposite sides of the piston, means for conducting gases from the combustion chamber to the pump chamber including a gas chamber in the walls of the cylinder extending substantially the length of the combustion chamber and substantially surrounding it so that the walls of said combustion chamber are cooled by transfer of heat from said walls to the gases in said chamber, a series of pipes extending through said gas chamber, heads at the opposite ends of the cylinder and provided with chambers in communication with the opposite ends of said pipes, means for conducting cooling fluid to one of said latter chambers and from the other chamber, a valve controlled inlet leading to the combustion chamber and a valve controlled outlet leading from the pump chamber.

10. In an internal combustion engine, a cylinder having a gas chamber in the walls thereof surrounding the cylinder and extending substantially the length of said cylinder so that the walls of the cylinder are cooled by transfer of heat from said walls to the gases in said chamber, a piston mounted to reciprocate in said cylinder, means for conducting a combustible mixture to said cylinder, a connection from the cylinder to the chamber for passage of exhaust gases, a pump connected to said chamber for withdrawing the exhaust gases therefrom, means for discharging exhaust gases from the pump, and means for cooling the gases in said chamber.

11. In an internal combustion engine, an upright cylinder, a piston mounted to reciprocate in said cylinder, means for conducting a combustible mixture to the upper part of said cylinder, an exhaust gas chamber in the walls of the cylinder and surrounding the cylinder and extending substantially the length of said cylinder so that the walls of the cylinder are cooled by transfer of heat from said walls to the gases in said chamber, conducting means for exhaust gases leading from the lower part of the cylinder to said chamber, means for reducing the pressure in said chamber to withdraw the exhaust gases from the cylinder including a pump for discharging the gases from said chamber, and means in the chamber for cooling the gases therein.

12. In an internal combustion engine, an upright cylinder, a piston in said cylinder forming a combustion chamber in the upper part thereof and a pump chamber in the lower part, means for conducting a combustible mixture to the upper part of the combustion chamber, a gas chamber in the walls of the cylinder and surrounding the cylinder and extending substantially the length of said cylinder so that the walls of the cylinder are cooled by transfer of heat from

said walls to the gases in said chamber, the walls of the cylinder being provided with openings leading from the lower part of the combustion chamber to the gas chamber and from the gas chamber to the upper part of the pump chamber, said openings being arranged to be controlled by the piston, a partition in the gas chamber between the two sets of openings, gas conductors leading from the upper part of the gas chamber to the lower part thereof, a series of pipes extending through the gas chamber, means for conducting cooling fluid to and from said pipes, and means for conducting exhaust gases from the pump chamber.

In testimony whereof I affix my signature.

ALFRED O. ANDERSEN.