H. W. PARRISH.

ENGINE.

APPLICATION FILED APR. 10, 1919.

1,332,633.

Patented Mar. 2, 1920.

2 SHEETS—SHEET 1.

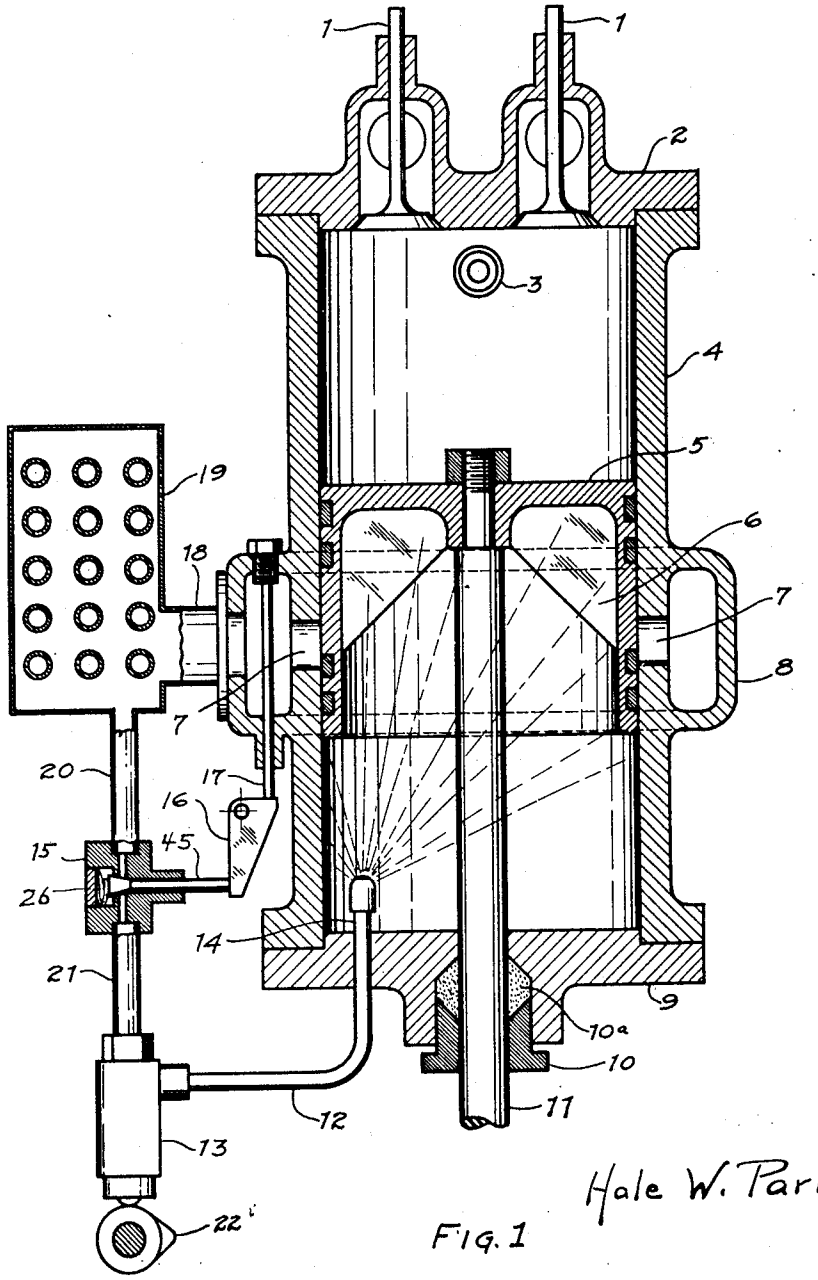


FIG. 1

Hale W. Parrish

INVENTOR.

BY Albert Scheible

ATTORNEY

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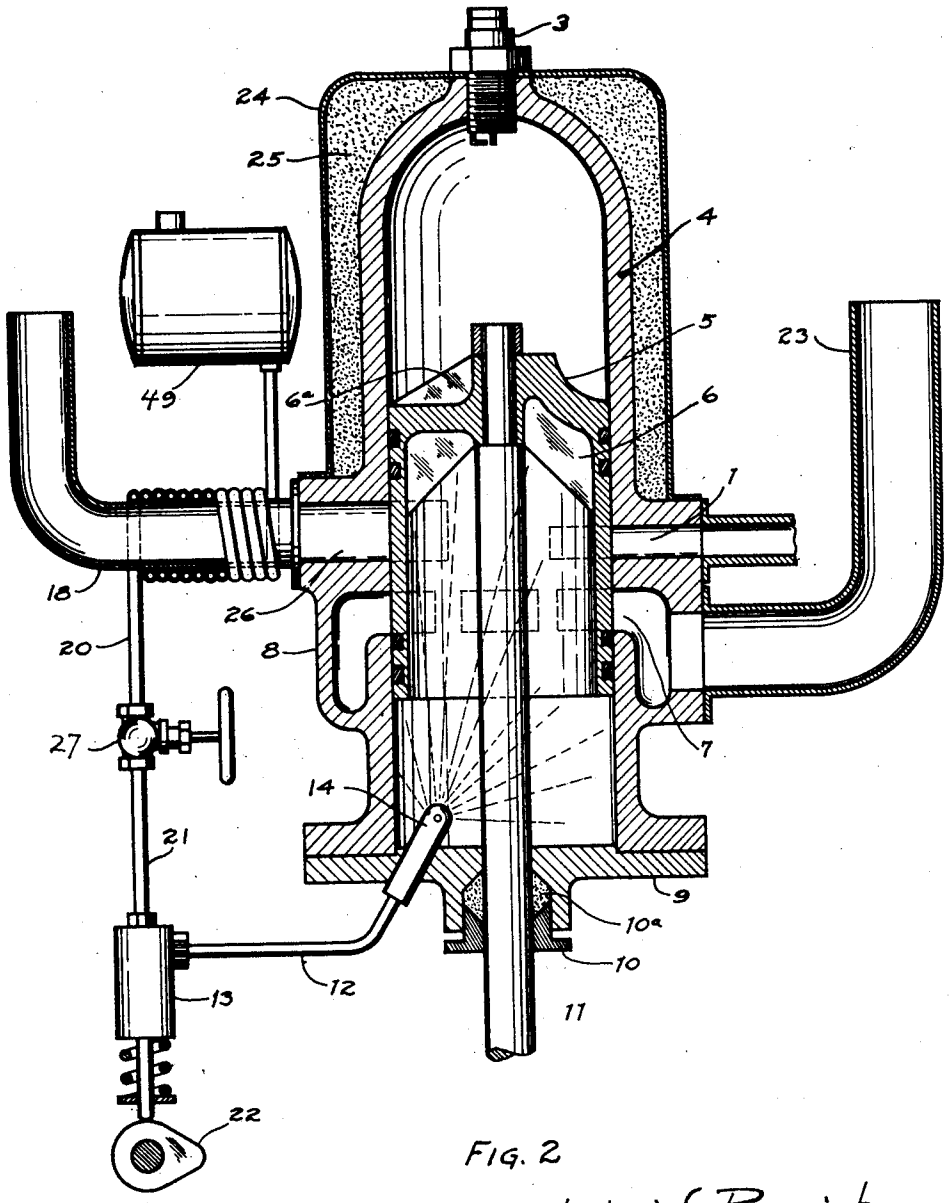


FIG. 2

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UNITED STATES PATENT OFFICE.

HALE W. PARRISH, OF CHICAGO, ILLINOIS.

ENGINE.

1,332,633. Specification of Letters Patent. Patented Mar. 2, 1920.

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To all whom it may concern:

Be it known that I, HALE W. PARRISH, citizen of the United States, residing at Chicago, Illinois, have invented certain new and useful Improvements in Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to internal combustion engines, its general objects being to improve the efficiency, uniformity of torque and lubrication of the engine; to increase the output obtainable from engine cylinders of given displacement; to secure an effective cooling of the engine and particularly of the hottest parts thereof, and desirably to do this without employing water jackets or other constructions involving complicated castings; to utilize the heat imparted to engine parts, and particularly to the piston during the operation of the internal combustion engine, for producing energy for increasing both the output and the uniformity of torque of the engine; to secure more effective cooling by vaporizing the cooling liquid and thereby utilizing the greater heat absorption required for such vaporizing; to control the supply of the vaporizable liquid automatically in accordance with the temperature of the engine and the demands on the latter; and in general to provide an exceedingly simple and smoothly operating engine affording a great output of power both in proportion to the amount of fuel used and in proportion to the piston displacement.

More particularly, my invention aims to provide an engine in which the cylinder is divided by the piston into two compartments operating respectively as internal combustion engine cylinders and as vapor-expansion engine cylinders; to provide the expansible vapor within one end of the cylinder by the direct heating effect of the piston, and to automatically control the amount of the vaporized liquid in proportion to the heating of the engine; to inject the vaporizable liquid at such a time that the resulting vapor will cushion the end of the piston stroke actuated by the internal combustion part of the engine; to utilize the resulting pressure in performing useful work by actuating the same piston, and to employ the reduction in pressure in further lowering the temperature of the piston and cylinder; to condense the vaporized liquid and employ the partial vacuum resulting from such condensation in actuating the piston, thereby operating the piston from one end of the cylinder as a condensing vapor-expansion engine; while cooling the piston and cylinder through the reduction in temperature of the vapor during its condensation; and to provide an exceedingly simple and cheaply manufactured construction for a two-compartmental cylinder engine employing the above named principles. Still further objects will appear from the following specification and from the accompanying drawings, in which—

Figure 1 is a longitudinal section through the cylinder of a puppet valve engine embodying my invention, and of parts associated therewith, including a condenser and a thermostatically controlled valve for regulating the supply of the vaporizable liquid.

Fig. 2 is a similar view of parts of a valveless engine in which the vapor-expansion portion is noncondensing and in which the vaporizable liquid is heated by the exhaust and controlled by a hand valve.

In the ordinary internal combustion engine, about half of the energy of the fuel is lost in the water jackets, which jackets also complicate the manufacture of the engine and cannot readily be applied in ordinary sizes of engines to the piston. Since the piston is decidedly the hottest part of the engine, this means that the jacketing of the cylinder must be planned to cool the piston indirectly by conduction of the heat through the metal parts and through the film of lubricant between the latter. In one of its important aspects, my invention aims to apply the cooling medium directly to the piston and to utilize the heat of the piston in vaporizing an expansible liquid, which I then employ for producing energy to increase the output and efficiency of the engine.

For example, in the embodiment of Fig. 1, I show an engine cylinder having intake and exhaust valves 1 controlled by suitably arranged tappets through stems sliding in the rear head 2 of the cylinder 4, and having a spark plug 3 disposed within the cylinder. Sliding within this cylinder is a piston 5, which is desirably tubular and open at its lower or forward end, and which desirably has reinforcing ribs 6 connecting the piston head with the tubular

wall of the piston. This piston is fastened to a piston rod 11 sliding through a suitable packing nut 10 and packing 10ª forward head 9 of the cylinder.

The piston is of such a length that during the uppermost portion of its travel it uncovers a series of lateral ports 7 in the side of the cylinder, which ports lead to an annular chamber 8 connected by an outlet tube 18 to a condenser 19. This condenser is connected by pipes 20 and 21 through a control valve 15 with a pump 13 operated by a cam 22 rotated by the engine, so that liquid from the condenser may be forced by the pump through a pipe 12 into the interior of the cylinder. This pipe 12 is here shown as extending through the forward cylinder head 9 and terminating in a nozzle 14 whereby the stream of liquid may be directed into the interior of the hollow piston, or against both the forward surface of the piston head and the webs 6. To control the amount of vaporizable liquid projected against the piston, I desirably employ means responsive to some operative condition of the engine. For example, I may use an expansion rod 17 connected through a bell-crank 16 with the plunger 45 of the valve 15. The thermostat rod 17 extends across the chamber 8 and is fastened to the latter at one end, while its other end extends slidably through a bore in the wall of this chamber and projects into engagement with the lever 16. This rod 17 is made of a material having a considerably higher coefficient of expansion than the metal of the chamber 8, so that with the rise in temperature, the free end of this rod will force the valve stem 45 inwardly and hence will open the valve. Normally, the valve is kept either partly or entirely closed by a suitably arranged spring 26 which also holds the valve stem 15 in continuous engagement with the lever 16.

With the parts thus arranged, the engine may be started as an internal combustion engine in the usual manner, the inlet and the exhaust being controlled through the valves 1 through a suitable mechanism, which need not be illustrated here as it is well known to those familiar with internal combustion engines. When the rotating cam 22 momentarily actuates the pump 13, water from the bottom of the condenser is forced through the pipe 12 in an amount controlled by the valve 15, and for a time interval dependent on the shape of the cam 22. The shaft carrying this cam rotates at half the speed of engine shaft, and the cam is desirably so placed as to actuate the pump when the piston is at the end of the explosively urged forward stroke. Consequently, a fine stream of liquid from the condenser 19 will be sprayed into the latter, and the liquid thus engaged against the hot surface will be vaporized and expanded. With the vaporizable liquid thus injected before the end of the explosively urged forward stroke, the forward compartment of the cylinder will be instantly filled with a vapor which will be compressed during the completion of the stroke, thereby cushioning the piston during the extreme forward portion of its travel. Then the expansive tendency of the vapor will force the piston upwardly, so that the engine operates after the manner of a non-condensing steam engine until the lower edge of the tubular piston uncovers the ports 7 and permits the expanded vapor to exhaust into the condenser during the upper portion of the travel of the piston. The resulting condensation of the vapor within the condenser produces a partial vacuum, thereby not only exhausting most of the vapor from the lower portion of the cylinder, but also creating a partial vacuum in this lower portion. Consequently, when the piston has traveled far enough to close the ports 7, the vacuum below the piston head will tend to draw the piston downwardly, thus adding to the energy output of the engine. As the piston moves farther, the vaporizing of liquid projected through the nozzle 14 overcomes this vacuum and again produces vapor under pressure for forcing the piston upward. Consequently, the piston is actuated alternately from the lower compartment of the cylinder by the expansive force of the steam, and by the partial vacuum due to the subsequent condensation of the steam, after the manner of a condensing steam engine.

As the temperature of the piston and the cylinder rise, the temperature within the annular chamber 8 is likewise increased. Consequently, the expansion of the thermostatic rod 17 will open the valves 15 wider, so that the amount of cooling liquid injected through the nozzle 14 is increased in direct response to the temperature increase in the engine, this being true regardless of whether or not this temperature rise is due partly to the climate or the weather. Likewise, when the temperature falls, the rod 17 shrinks in length and the spring pressed plunger reduces the supply of the cooling liquid. Consequently, the amount of this supply of liquid is automatically responsive to the temperature of the engine.

To secure high efficiency, I desirably construct the piston of a material having a high rate of heat conductivity, preferably employing aluminum since the latter also reduces the weight of this reciprocating part, and preferably provide a sufficiently large number of ribs 6 to afford a large radiating surface against which the liquid is projected. If water is used as the vaporizable liquid,

the temperature of the engine is preferably kept above the boiling point of water, thereby improving the economy of the internal combustion end of the cylinder. However, I may employ some other vaporizable liquid, such as naphtha, alcohol or carbon bisulfid. In any case, since the amount of heat required for changing the temperature of a liquid for a given number of degrees through a temperature range including its vaporizing point is very much greater than that required for raising the liquid for the same number of degrees without vaporizing the same, the heat absorption which I obtain from a given quantity of liquid is very much greater than that which could be secured by merely using the same in a jacketing of the engine parts. Consequently, I can operate with a much smaller quantity of water or other liquid and can greatly reduce the size of the condensing and radiating apparatus over that which would be required if the liquid merely served as a cooling medium without also being employed for useful power-producing. Moreover, since both the injected liquid and the vapor from the same act as lubricants, I can improve the lubrication over that ordinarily obtained in an internal combustion engine.

However, while I have heretofore described my invention as embodied in an internal combustion engine of the four-stroke cycle type and as operating the vapor-expansion portion condensingly, I do not wish to be limited to these or other details of the construction and arrangement here disclosed, it being obvious that the same might be varied in many ways without departing from the spirit of my invention. For example, Fig. 2 shows a construction suitable for small and low priced engines, namely a valveless two-stroke cycle engine in which the gaseous mixture from the inlet enters through a lateral port 1 in the cylinder after the explosion compartment of the cylinder has already begun to exhaust through the port 26 and the exhaust pipe 18. In this embodiment, the water or other vaporizable liquid is taken from a tank 49 through a pipe 20 coiled around the exhaust pipe 18, so that the liquid is also preheated with waste heat from one exhaust of the engine, but the supply of this liquid is controlled merely by a hand valve 27. In this case, the cam-operated pump is so arranged as to inject liquid only in short squirts while the piston is approaching the end of each forward stroke.

With each of the pictured embodiments, I preferably use a nozzle affording a so-called solid cone spray, which spray is indicated as to its range in dotted lines in the drawings, although these drawings do not show the pistons in the positions during which the spray is injected. By thus finely dividing the spray and by distributing it over the large bore of the hollow piston and over the webs within the latter, I not only vaporize the liquid effectively in a very short time, but also cool the piston to a considerable extent and avoid the cracking of the metal which might result from a concentrated jet of liquid. Likewise, I avoid the risk of cracking the cylinder walls which is met when the cooling is accomplished by a flow of heat transversely through the same. Moreover, some of the heat of the forward end of the cylinder will be imparted to the expanding vapor, thus utilizing heat conducted from the rear end of the cylinder, which rear end may be housed by a suitable heat insulator, such as a packing of asbestos 25 housed by a jacket 24. Moreover, the heat storage will continue to vaporize the injected liquid during several successive impulses in case of a misfiring, thereby steadying the torque of the engine in case the ignition means are not in proper working order.

With the first of the illustrated embodiments, it will be obvious that the extent to which the output of the engine is augmented by the steam part of the same depends automatically on the temperature of the engine, and since this in turn depends on the output of the engine, the admission of the hot water and the increase in power due to the same will be directly related to the demands on the engine. With the second embodiment, a manipulating of the hand valve will likewise permit a greater use of the steam-engine part of my appliance, thus also permitting me to take care of momentary overloads, even though the resulting cooling of the piston might lower the temperature of the engine to a point which would not be desirable for good operating economy.

In either case, since I actuate the piston from both ends of the cylinder and utilize a considerable proportion of the heat in doing useful work right within the engine, I greatly increase the energy output obtainable with a given piston displacement and correspondingly decrease the cost of both manufacture and operation for an engine of a given output. Furthermore, since I subject the piston to an actuating impulse from the steam end of the cylinder with every stroke of the piston, I greatly steady the torque of the engine even when the internal combustion portion part of the latter is of the four-cycle type. This steadying is further enhanced by the cushioning effect of the entrapped steam on the down stroke of the piston, so that I can secure extremely smooth running qualities.

I claim as my invention:

1. The method of operating an internal combustion engine in which the piston is moved forwardly by the explosion of a gaseous mixture in the rear compartment of the

cylinder housing the piston, which includes the vaporizing of a liquid within the forward compartment of the engine cylinder, working the resulting vapor expansively within the forward compartment of the engine cylinder during the return stroke immediately following the explosion-actuated stroke, then condensing the expanded vapor from without the cylinder, and utilizing the resulting vacuum in the forward compartment of the engine cylinder for urging the piston forwardly during its intake stroke.

2. The method of operating an internal combustion engine in which the piston is moved forwardly by the explosion of a gaseous mixture in the rear compartment of the cylinder housing the piston, which includes the vaporizing of a liquid within the forward compartment of the engine cylinder, working the resulting vapor expansively within the forward compartment, of the engine cylinder during the return stroke immediately following the explosion-actuated stroke; exhausting the major part of the expanded vapor and condensing the exhausted part of the vapor without the cylinder but while maintaining connection to the forward cylinder compartment to produce a partial vacuum in the latter, and utilizing the resulting vacuum in the said forward cylinder compartment for urging the piston forwardly during its intake stroke.

3. A combined internal combustion and vapor-expansion engine in which a piston reciprocating in a single cylinder is actuated from one side by the expansion of an exploded gaseous mixture; and actuated from its other side alternately by the expansive force of vapor vaporized from liquid within the cylinder by the heat of the piston, and by the suction of the partial vacuum created by the condensation of the expanded vapor.

4. In an internal combustion engine, means for utilizing the heat of the piston by employing the same to vaporize a liquid, then condensing the vapor and using the suction of the partial vacuum due to the said condensation for moving the piston in the same direction in which the piston is moved by the expansion of the exploded gaseous mixture.

5. In an engine, a cylinder, and a piston reciprocating therein and dividing the cylinder into two compartments; the piston being actuated from one of the compartments by the explosion of the gaseous mixture therein, and from the other compartment alternately by the expansive force of vapor generated within this compartment from a liquid by heat imparted to the piston from the said explosion, and by the suction of the partial vacuum produced by subsequently condensing the expanded vapor.

6. In an engine, a cylinder, a piston reciprocating therein and dividing the cylinder into two compartments; means associated with one compartment for actuating the piston in the cylinder as the piston of an internal combustion engine; means for projecting into the other compartment a liquid vaporizable at a temperature lower than that to which the piston is heated by the combustible mixture; and means for utilizing the resulting vapor expansively in the last named compartment to move the piston in the cylinder.

7. In an internal combustion engine having a cylinder closed at both ends and a piston propelled in one direction by the explosion of the gaseous mixture in one end of the cylinder; means associated with the other end of the cylinder for projecting into the latter end and against the piston a liquid adapted to be vaporized by the heat of the piston.

8. A combined internal combustion and vapor-expansion engine in which a piston reciprocating in a single cylinder is actuated from opposite sides respectively by the explosion of a gaseous mixture and by the expansive force of vapor generated from liquid within the said cylinder by the heat of the piston, in combination with means for controlling the supply of the said liquid in response to the operative condition of the engine.

9. A combined internal combustion and vapor-expansion engine in which a piston reciprocating in a single cylinder is actuated from opposite sides respectively by the explosion of a gaseous mixture and by the expansive force of vapor generated from liquid within the said cylinder by the heat of the piston, in combination with means for using the expanded vapor to preheat the supply of liquid.

10. A combined internal combustion and vapor-expansion engine in which a piston reciprocating in a single cylinder is actuated from opposite sides respectively by the explosion of a gaseous mixture and by the expansive force of vapor generated from liquid within the said cylinder by the heat of the piston, in combination with means for controlling the supply of the said liquid in response to the heating of the engine.

11. A combined internal combustion and vapor-expansion engine in which a piston reciprocating in a single cylinder is actuated from opposite sides respectively by the explosion of a gaseous mixture and by the expansive force of vapor generated from liquid within the said cylinder by the heat of the piston, in combination with means for controlling the supply of the said liquid in response to the energy produced by the internal combustion portion of the engine.

12. A combined internal combustion and vapor-expansion engine in which a piston

reciprocating in a single cylinder is actuated from opposite sides respectively by the explosion of a gaseous mixture and by the expansive force of vapor generated from liquid within the said cylinder by the heat of the piston, in combination with means for condensing the vapor produced by the said vaporization.

13. A combined internal combustion and vapor-expansion engine in which a piston reciprocating in a single cylinder is actuated from opposite sides respectively by the explosion of a gaseous mixture and by the expansive force of vapor generated from liquid within the said cylinder by the heat of the piston, in combination with means for condensing the vapor produced by the said vaporization, and means associated with the condensing means for supplying the liquid.

14. In an engine as per claim 6, a hollow piston having its open end directed toward the liquid-projecting means.

15. In an engine as per claim 6, hollow piston equipped on its interior with heat-radiating webs and having the said webs disposed in the path of the projected liquid.

16. An engine as per claim 6, in combination with means normally throttling the supply of liquid, and means responsive to an increase in temperature of the engine for retracting the throttling means.

17. An engine as per claim 6, in which the liquid projecting means include a nozzle arranged for directing a finely divided spray against the piston.

18. An engine as per claim 6, in combination with means, responsive to the temperature of the expanded vapor, for controlling the supply of liquid.

19. In an internal combustion engine, means for spraying a vaporizable liquid against the inoperative face of the piston for a relatively short time interval approximately at the end of its forward stroke, and means for utilizing the pressure of the resulting vapor expansively to increase the energy output of the engine.

20. In a combined internal combustion and vapor-expansion engine, a cylinder having a lateral port; a piston reciprocating in the cylinder and uncovering the said port only at or near one end of its travel, thereby connecting the port with one end of the cylinder; means for spraying a liquid against the piston from the said end of the cylinder; and inlet means, outlet means and ignition means all associated with the other end of the cylinder.

21. The method of utilizing heat stored in the piston of an internal combustion engine during the operation thereof, which consists in converting liquid projected against the inoperative face of piston into vapor by the said heat, and utilizing the expansive force of the vapor within the same cylinder for urging the return stroke of the piston.

22. The method of utilizing heat stored in the piston of an internal combustion engine during the operation thereof, which consists in converting liquid projected against the inoperative face of the piston into vapor by the said heat, utilizing the expansive force of the vapor in urging the return stroke of the piston, and thereafter condensing the vapor and utilizing the resulting partial vacuum in urging the forward stroke of the piston.

23. The method of increasing the output and efficiency of an internal combustion engine which consists in subjecting the inoperative face of the piston during the return stroke thereof to the expansive force of vapor generated from liquid within the engine cylinder directly by the heat of the piston.

24. The method of increasing the output and efficiency of an internal combustion engine which consists in subjecting the inoperative face of the piston alternately to the expansive force of vapor generated directly by the heat of the piston and to the suction of a partial vacuum produced by the condensing of the expanded vapor.

25. The method of steadying the torque of an internal combustion engine which consists in subjecting the inoperative face of the piston during successively alternating strokes to the expansive force of vapor vaporized directly by the heat of the piston and to the pulling force of the partial vacuum produced by the subsequent condensation of the expanded vapor.

26. The method of cushioning the piston of an internal combustion engine at the end of its forward stroke within a cylinder closed at both ends, which consists in projecting against the forward face of the piston and prior to the end of its forward stroke a liquid vaporizable by the heat of the piston, thereby producing a compressible vapor in front of the piston.

27. The method of utilizing heat stored in the piston and cylinder of an internal combustion engine during the operation thereof, which consists in projecting a vaporizable liquid during a short portion of the stroke of the piston and approximately at the end of the forward stroke thereof against the forward face of the piston, and using the expansive force of the resulting vapor to exert pressure between the piston and the forward end of the cylinder for urging the return stroke of the piston.

28. The method of cooling an internal combustion engine which consists in first utilizing heat of the piston and cylinder for vaporizing liquid injected into the latter, working the resulting vapor expansively within the engine cylinder, condensing the

expanded vapor from without the cylinder, and utilizing the resulting vacuum within the cylinder.

29. The method of operating an internal combustion engine in which the piston is moved forwardly by the explosion of a gaseous mixture in the rear compartment of the cylinder housing the piston, which includes the admitting to the forward compartment of the same cylinder of a liquid proportioned in amount to an operative condition of the engine, vaporizing the liquid within the said forward compartment by the heat in the walls of the latter, and working the resulting vapor expansively within the said forward compartment to move the piston rearwardly.

30. The method of operating an internal combustion engine in which the piston is moved forwardly by the explosion of a gaseous mixture in the rear compartment of the cylinder housing the piston, which includes the admitting to the forward compartment of the same cylinder of a liquid proportioned in amount to an operative condition of the engine, vaporizing the liquid within the said forward compartment by the heat in the walls of the latter, utilizing the pressure of the resulting vapor to move the piston rearwardly, then condensing the expanded vapor and utilizing the resulting partial vacuum within the said forward compartment to urge a subsequent forward stroke of the piston.

Signed at Chicago, Illinois, April 5, 1919.

HALE W. PARRISH.