H. B. BLACK.

EXPLOSIVE ENGINE.

APPLICATION FILED DEC. 9, 1919.

1,424,798.

Patented Aug. 8, 1922.

3 SHEETS—SHEET 1.

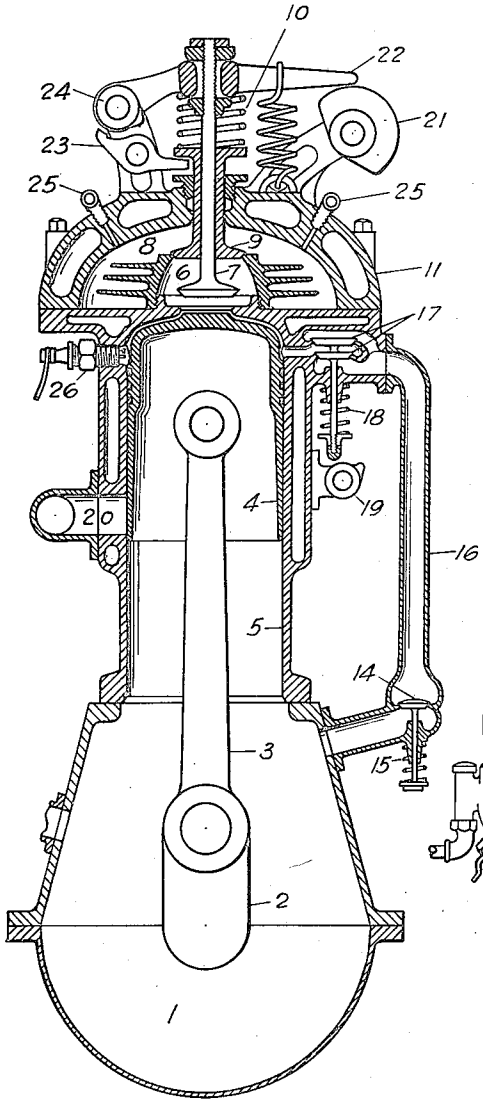


FIG. 1.

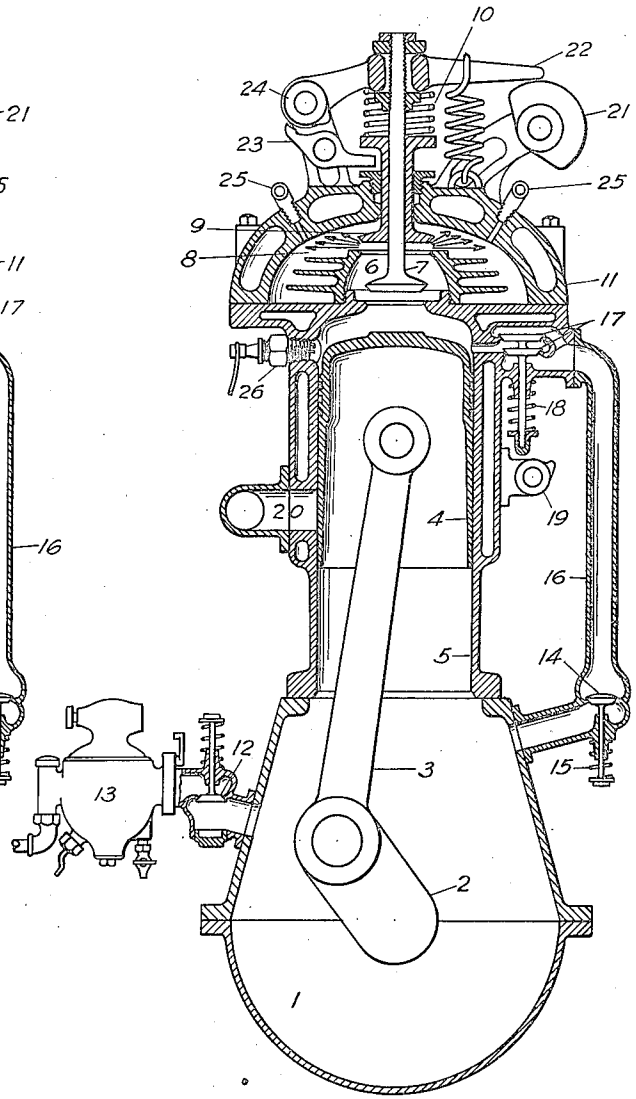


FIG. 2.

Harvey B. Black INVENTOR.

BY

Seward Davis

HIS ATTORNEY.

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3 SHEETS—SHEET 2.

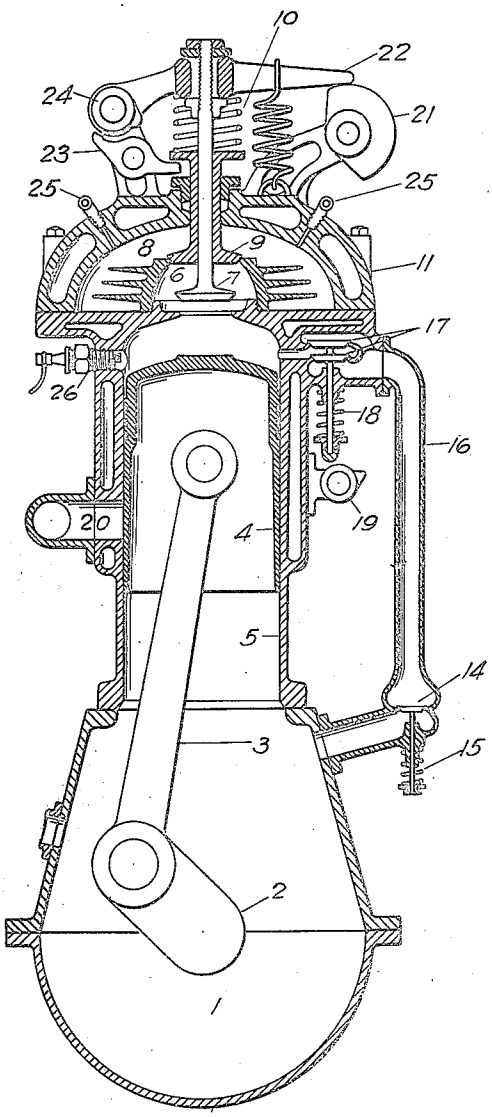


Fig. 3.

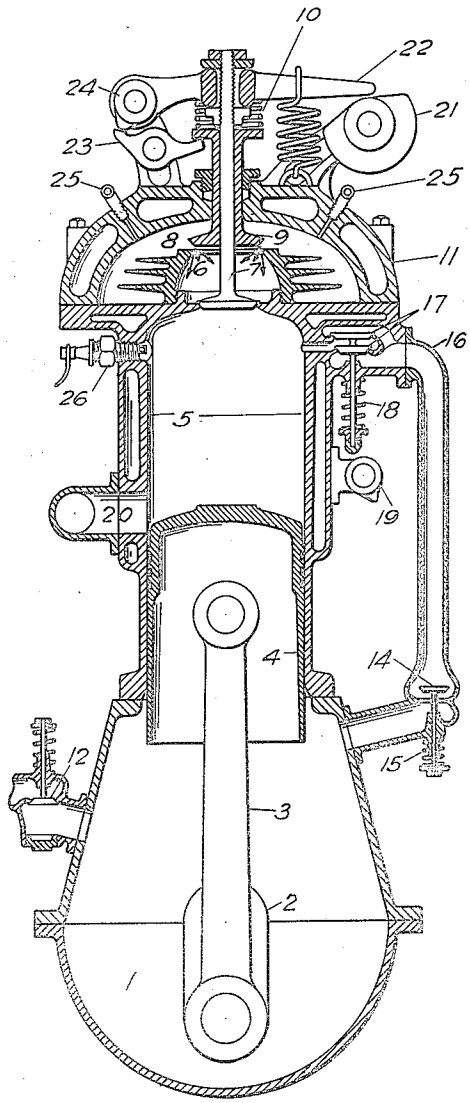


Fig. 4.

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3 SHEETS—SHEET 3.

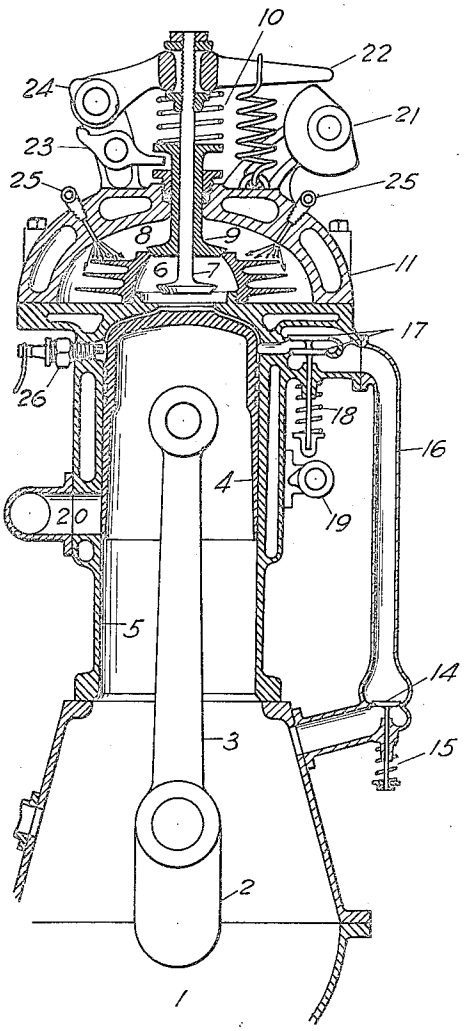


Fig. 5.

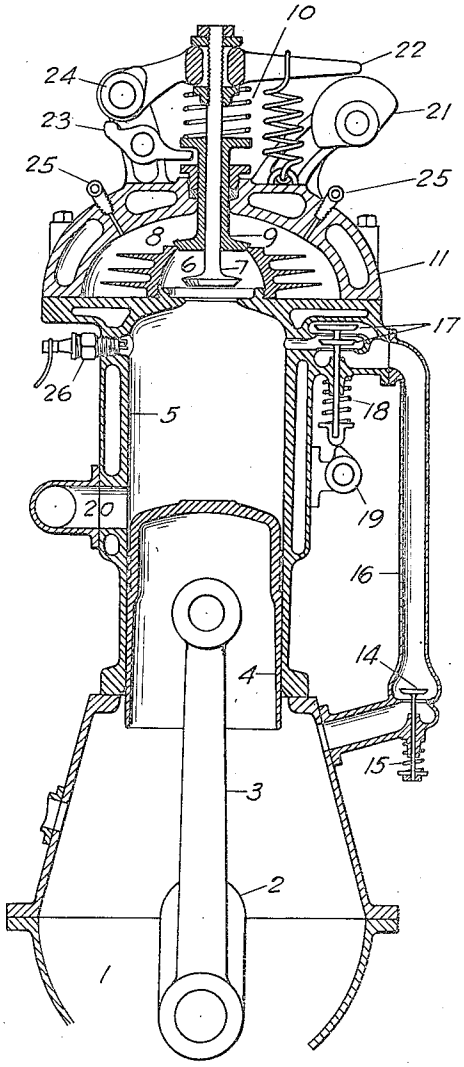


Fig. 6.

Harvey B. Black INVENTOR.

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UNITED STATES PATENT OFFICE.

HARVEY B. BLACK, OF BOGOTA, NEW JERSEY.

EXPLOSIVE ENGINE.

1,424,798. Specification of Letters Patent. Patented Aug. 8, 1922.

Application filed December 9, 1919. Serial No. 343,683.

To all whom it may concern:

Be it known that I, HARVEY B. BLACK, a citizen of the United States, residing in the State of New Jersey, county of Bergen, and town of Bogota, have invented certain new and useful Improvements in Explosive Engines, of which the following is a specification.

My invention has for its object the utilization of the heat of combustion in an internal combustion engine, and particularly the latent energy now lost through the radiation of heat from the cylinder of an internal combustion engine; the absorption thereof by a vaporizable fluid brought into contact therewith; the translation thereof into kinetic energy and its useful application as a prime mover therein; and, particularly, the generation of steam and its application as a prime mover to the idle stroke of the piston in a plural cycle internal combustion engine, in the same cylinder and upon the same side of the piston; and, further, the avoidance of the necessity for independent cooling of the cylinder walls of an explosive engine. These and further objects hereinafter specified are attained by the method and apparatus to be disclosed.

My invention consists broadly in the method of driving a piston in an engine cylinder of the internal combustion type by alternating the power impulses due to the expansion of the explosive fuel, with power impulses derived from the expansion of steam generated by the heat of combustion of such fuel in contact with water intermittently supplied to and injected upon the cylinder parts immediately affected by the products of combustion.

My invention further consists in structural means adapted to interpolate a steam-expansion impulse between the combustion-expansion impulses of an explosive engine and in means for translating the heat created within the combustion chamber by the explosion of fuel therein into steam, and in means for applying the pressure of the steam so generated as a prime mover between explosion strokes, whereby an alternate explosive and steam cycle of applied powers is obtained in the same cylinder upon a common piston working therein.

My invention particularly consists in the application of the principles underlying my broad discovery to internal combustion engines of the two cycle type and in means whereby the excessive heating of the cylinder walls is avoided, the objectionable excess being usefully applied to the conversion of the water employed as a cooling medium therefor into steam, and in means whereby the generated steam is applied to power production in the same cylinder in alternate power cycles, thus producing in a two cycle type of internal combustion engine, here chosen for illustration, an alternative explosive and steam power cycle.

For the purpose of illustrating a structural embodiment of my invention, I have shown its application to a two cycle engine in the accompanying drawings, in which Figure 1 is a vertical sectional view, showing the piston at the top of the compression stroke, and the position of the valves and timing mechanism operating same, the power connections to the valve-operating mechanism being omitted; fuel and water connections being shown to sources of supply not illustrated. Figure 2 is a similar view illustrating the position of the valves at explosion of the charge and showing the piston beginning the power stroke due thereto, the admission of a portion of the expanded gases into the steam chamber being indicated by arrows; a conventionalized carbureter is also shown in association with the fuel intake. Figure 3 is similar to Figure 2, illustrating the positioning of the valves after explosion and as the power stroke due thereto is begun. Figure 4 is a similar view, illustrating the position of the valves at the bottom of the power stroke. Figure 5 is a similar view, illustrating the positioning of the valves and the piston at the top of the third or expansion stroke for the admission of steam thereto. Figure 6 is a similar view, showing the piston at the bottom of the third stroke, and the position of the valves during the admission of the explosive charge to be compressed on the ensuing up stroke of the piston.

Referring to the drawings in detail, the numeral 1 is the crank-case, 2 is the crank-shaft, 3 is the connecting rod connected to piston 4 reciprocating in cylinder 5. In order to use the same cylinder for both the explosive and steam strokes, it is desirable to have such a construction of the cylinder and valves as will permit a clearance space at top of the piston of the proper dimension for the compressed explosive gases, and it is also desirable to have the least possible clearance on top of piston before steam admis-

sion on the steam stroke. To meet these conditions, I have provided what I term a combustion chamber 6 at top of the cylinder 5 which is adapted to be closed off from cylinder 5 by valve 7. I also provide a communicating chamber 8 surrounding the combustion chamber 6 and which I term a steam chamber, which is adapted to be closed off from the combustion chamber 6 by valve 9, forming a separate chamber. When valve 7 is raised as shown in Figure 1, the necessary space for the compressed explosive gases is provided, and when valve 7 is down on its seat as in Fig. 4, the small clearance on top of piston which is desirable is afforded. Valve 9 is held to its seat by a spring 10 which allows valve 9 to open automatically when pressure due to the explosion of the gases in combustion chamber 6 is greater than the pressure in steam chamber 8, as shown in Fig. 2. Steam chamber 8 is enclosed by cap-piece 11 which is attached to top of cylinder 5. As I have shown the preferred construction, it is arranged to operate in conjunction with the explosive and compressive strokes of a two cycle engine, but by proper timing of the valve system, my principle is equally applicable to any plural cycle. On the up strokes of piston 4 in cylinder 5, a partial vacuum is formed in crank-case 1 which draws in a mixture of gas and air through valve 12 from the carbureter 13, shown in Figure 2. On the down stroke this gas mixture is put under compression and forced up through valve 14 as shown in Fig. 6, which is held to its seat by spring 15 and automatically operated, into tube 16 which connects top of cylinder 5 through a passage in said cylinder containing and controlled by balanced valves 17 which are held to their seats by the spring 18 and are mechanically operated by cam 19, as shown in Fig. 6. In Fig. 1 the piston is shown at the top of the compression stroke on the point of firing by spark plug 26. It will be noted that valve 7 is raised from its seat so that a chamber is formed with an opening into cylinder 5 which contains the compressed gas mixture. Fig. 2 shows the piston 4 just started on down stroke due to the explosion of the compressed gases with valve 9 raised from its seat by the force of the explosion, and a quantity of the exploded gases forced into chamber 8, represented by arrow lines radiating from between valve 9 and its seat. Immediately the piston 4 has traveled down on its stroke far enough to allow the combust gases to expand to a pressure less than the pressure of the gases in chamber 8, valve 9 drops to its seat due to the spring 10, thereby closing off the gases in chamber 8 and isolating them, as shown in Fig. 3. Piston 4 continues down on its stroke due to the expansion of the gases remaining in cylinder 5, and at the bottom of its stroke these gases are exhausted from cylinder through a port 20, as shown in Fig. 4. On the start on the next stroke, which is an up stroke, valve 7 closes due to operation of cam 21, as shown in Fig. 4, which allows lever arm 22 to drop, thereby operating said valve 7; this closes off chamber 6 from cylinder 5. Immediately after valve 7 closes, valve 9 is lifted from its seat by rocker arm 23 which is operated by cam 24 and is held open long enough to allow an inrush of gas and steam mixture from chamber 8, filling chamber 6, and then closes before piston 4 has reached the top of its stroke, as shown in Fig. 5. When piston 4 has reached the top of this second stroke, valve 7 is again lifted by cam 21 and the gas steam mixture contained in chamber 6 enters cylinder 5, putting a pressure on piston 4, forcing it on down stroke which is the third stroke. At the bottom of the third stroke the gas steam mixture is exhausted through port 20. The exhaust of this gas steam mixture is helped by the inrush of fresh gas mixture from carbureter 13 through which it is admitted to cylinder 5 at top by opening of valve 17 before described. As this fresh gas mixture enters the top of cylinder 5 and the gas steam mixture is exhausted at bottom through port 20, the inrush of fresh gas not only helps to force out the low pressure gas steam mixture but because it does enter at the top it clears the cylinder of the low pressure gases and in addition very little of this fresh gas can escape through port 20 due to the fact that it enters at the far side and the greatest distance from this port. Thus I have described the method by which I charge cylinder 5 with fresh gas which is compressed on the next or fourth stroke of the piston, which brings us again to the top of compression and the beginning of the first or explosion stroke.

During the up stroke as shown in Fig. 5, water is injected into chamber 8 through openings 25. This water comes into direct contact with the hot gases of combustion which have been forced into this chamber 8 during the first or explosion stroke, as hereinabove described, which raises the temperature of this water and evaporates it into steam, forming in chamber 8 a mixture of the gases of combustion and steam under pressure, heretofore referred to as a gas-steam mixture.

The function of the two chambers at top of piston cylinder, more in detail, is as follows: The lower or combustion chamber receives the compressed gases on the compression stroke, and also serves to isolate a portion of the gas steam mixture for the steam stroke; the upper or steam chamber acts as a reservoir for the steam mixture which is generated therein by the direct contact of a portion of the gases of combustion under

pressure with water, both of which have been forced into this chamber under pressure, the gases of combustion by the expansion of the gases due to combustion, and the water by mechanical means. During the explosion stroke the high temperature of the gases of combustion heats the walls of the cylinder and the top of the piston. During the steam stroke on the alternate cycle, the heat contained in the cylinder walls and piston is taken up by the steam which will raise the temperature of the steam, and thereby raise its pressure and prevent the losses heretofore encountered in a steam stroke due to the cylinder walls having a temperature less than the entering steam temperature. By taking up the heat contained in the cylinder walls due to an explosion stroke, in the steam stroke, the excess heat which would accumulate in a number of explosion strokes is prevented. The entrance of steam on an alternate cycle cools these walls sufficiently to allow a continuation of this cycle. Thus it will be seen that I have an explosion engine in which it is not necessary to cool the cylinder walls, as those walls are cooled by steam on the alternate cycle. I also have an ideal steam stroke inasmuch as the steam enters a cylinder in which the temperature is equal to or greater than the entering steam temperature.

From the foregoing description, it will be obvious to those skilled in the art that my invention is an improvement in the method of operation of explosive engines employing an idle piston stroke, inasmuch as I have divided a cycle to use part of the heat energy in an alternate stroke. By using a part of the gases under pressure of combustion in a chamber to generate steam in direct contact and using this steam mixture in the same cylinder in which I have the explosive stroke, I am able to save the greater part of the heat energy lost in the cylinder due to radiation on both cycles, as there is an explosive stroke operated under what is known as the two cycle principle and an alternate unidirectional-flow steam stroke, making one explosive stroke and one steam stroke every four strokes, constituting the two cycles, the compression and explosion stroke exhausting at the end of the explosion stroke.

The foregoing and other features of operative advantage inhere in the method and arrangement of structure shown and described, and result in material power conservation with consequent high efficiency of operation and economy of fuel consumption.

Having thus described a particular application of my invention, but without intending to be understood as circumscribing the general applicability thereof to internal combustion engines, I claim:

1. The method of operating an internal combustion engine consisting in generating steam therein by mixing the gaseous products of combustion, resultant from the explosion of the vaporized fuel, directly with water preheated by contact with the engine parts normally heated by such explosion; separately confining said steam during its generation and during the explosion impulse stroke of the piston; admitting said steam to the piston upon its return therefrom; permitting the expansion of said steam to drive said piston upon its next stroke and repeating said steam cycle in alternation with the explosive cycle.

2. The method of operating an internal combustion engine consisting in injecting a heat-absorbent fluid against the exterior wall of the combustion chamber contacting the the heated fluid directly with the gases of combustion, confining the resultant vapor during the explosive power cycle of the piston, then admitting said vapor through the combustion chamber to the cylinder and permitting it to expand therein during the piston stroke succeding the power cycle upon the same side of the piston as that receiving the explosive impulse and in alternation therewith, and permitting its expansion to drive said piston.

3. The method of operating an internal combustion engine, consisting in producing an explosion in a chamber in open communication with the cylinder, trapping a part of the products of combustion in a second chamber in communication with said first chamber, injecting water therein, confining the generated steam in said second chamber during the power stroke of the piston due to such explosion, and then permitting the steam to enter the cylinder and to expand upon the same side of the piston as that receiving the explosive impulse and in alternation therewith, and permitting its expansion to drive said piston.

4. The method of operating an internal combustion engine of the two cycle type, consisting in generating steam therein by direct contact of water with a portion of the gases of combustion which are forced into the steam-generating chamber on the explosion of the gas mixture, admitting steam under pressure to the piston cylinder and upon the same side of the piston as that receiving the explosive impulse, upon the first stroke of the second cycle.

5. In an internal combustion engine adapted to alternate explosive and steam impulses as power cycles, a piston cylinder, a chamber connected thereto in which steam is generated by direct contact of vapor with the gases of combustion, means adapted to utilize heat radiated from the combustion chamber in converting a heat-absorbing fluid into said vapor, and means adapted to

supply such vapor under compression to the combustion chamber and to apply the force of its expansion in driving the piston upon a power stroke intermediate the power strokes produced by explosion of fuel in the combustion chamber.

6. An internal combustion engine having a piston cylinder, a combustion chamber in communication therewith and a valve therebetween; a second chamber partially surrounding said combustion chamber and a valve therebetween; a piston reciprocating in said cylinder, means adapted to open and close said valves in timed relation to the stroke of said piston, and means adapted to generate steam in said second chamber by direct contact of water vapor with a portion of the gases of combustion, said means being adapted to separately introduce said water vapor and said gases into said chamber, the latter upon the explosion of the gas-producing fuel.

7. In an internal combustion engine of the two-cycle type, a piston chamber, a combustion chamber and a steam-generating chamber in direct alinement. means adapted to inject water within said steam generating chamber against the walls of the combustion chamber, whereby the heat radiated therefrom is applied to the generation of steam, means adapted to introduce a portion of the gases of combustion from said combustion chamber into said steam chamber and to superheat said steam by direct contact therewith, means adapted to supply said superheated steam to said piston chamber, and means adapted to time said supply in correspondence with the non-explosion stroke of the piston.

8. In an internal combustion engine of the two cycle type, a steam-generating chamber partially surrounding the combustion chamber intermediate a piston cylinder and the said steam-generating chamber, means for admitting water to said steam-generating chamber, a valve system adapted alternately to admit products of combustion from said combustion chamber into direct contact with said water in said steam-generating chamber and to permit the escape of steam therefrom into said piston cylinder by way of said combustion chamber and upon the same side of the piston as the explosive impulse, and means adapted to control said valve system in timed relation to the strokes of the piston whereby a steam-expansion impulse drives said piston on its normally idle stroke.

9. An internal combustion engine comprising a power cylinder and a piston working therein, a combustion chamber communicating with said cylinder, a steam chamber communicating with said combustion chamber, valves adapted to close the combustion chamber, the valve between the cylinder and combustion chamber being timed to open with relation to the opening of the valve between the steam chamber and the combustion chamber, and timing mechanism adapted to operate the latter upon the completion of the return stroke of the piston due to an explosion.

10. In an internal combustion engine of the two cycle type, a cylinder and a piston working therein, a combustion chamber at the end of the cylinder and communicating therewith, a steam chamber partially surrounding said combustion chamber and communicating with it, a valve between said cylinder and combustion chamber, and a valve between said chambers, the latter valve being adapted to be opened automatically by the explosion of the charge in said cylinder and to be closed before the closing of the valve between said combustion chamber and said cylinder, and means for operating said valves in timed relation, whereby the steam charge is held in the steam chamber until the closing of the communication between the cylinder and combustion chamber, is then admitted to the combustion chamber and held there until the closing of the communication between the steam chamber and combustion chamber, and is then admitted to the working cylinder.

11. In an internal combustion engine, means adapted to interpolate a steam-impulse cycle between explosive impulse cycles comprising a valved chamber intermediate the piston cylinder and a steam-generating chamber alined therewith, said valved chamber being adapted to apportion the steam to each steam stroke and to afford clearance on the compression and explosion stroke.

HARVEY B. BLACK.