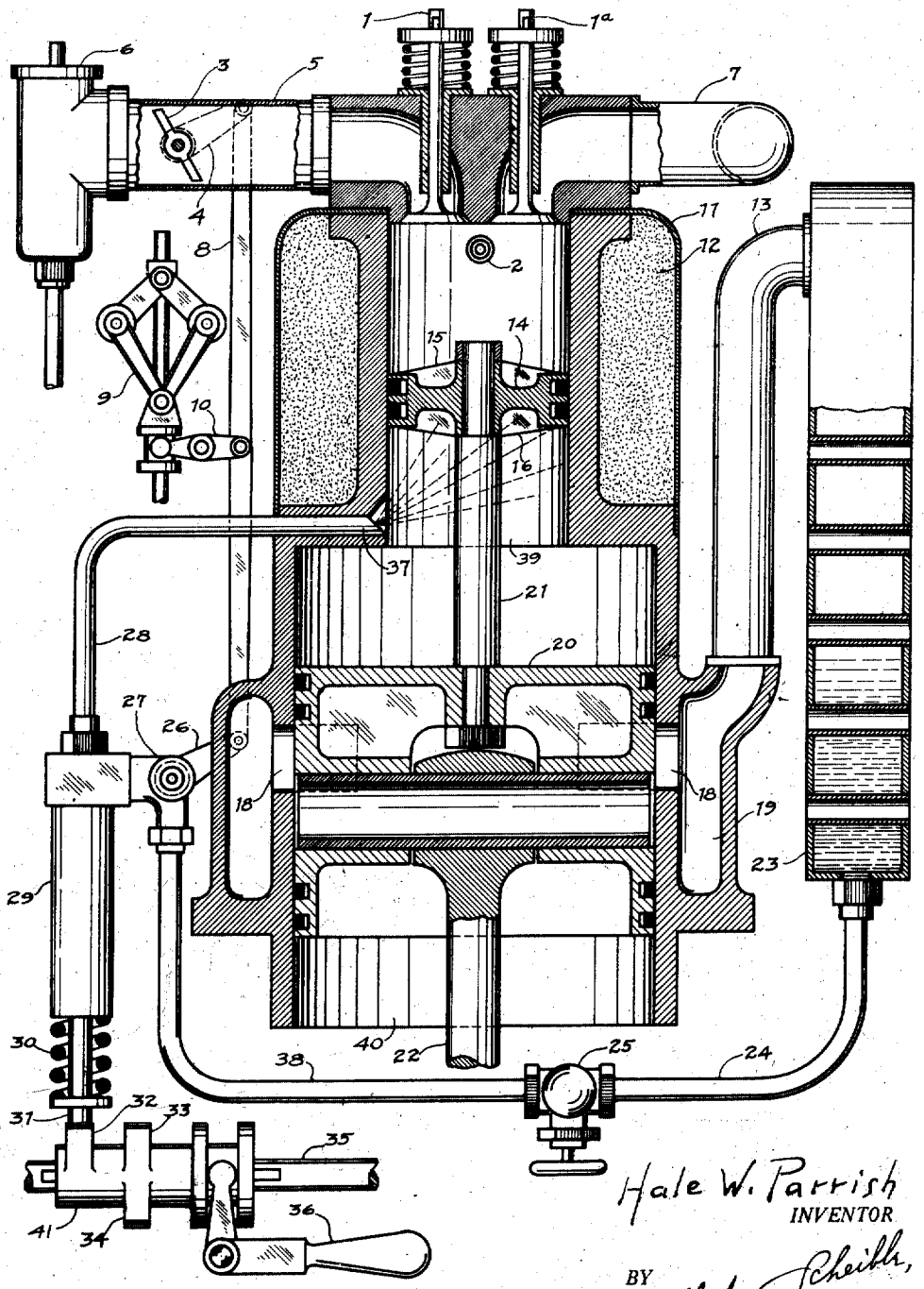
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ENGINE.

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1,319,679. Patented Oct. 21, 1919.



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ENGINE.

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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 a 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 the piston and cylinder during the operation of the internal combustion engine for producing additional energy, and to apply this energy through the same piston for increasing both the output and the uniformity of torque of the engine; to utilize heat stored in the engine for steadying the torque of the engine in case the charge misses fire; to secure more effective cooling by vaporizing the cooling liquid and thereby utilizing the greater heat absorption required for such vaporizing; to control the vaporizable liquid automatically in accordance with some operative condition of the engine, such as its speed; to provide simple means for increasing the effective use of the vapor-expansion part of the engine for enabling the latter to take care of overloads; and in general, to provide a simple engine affording a great output of power both in proportion to the amount of fuel used and in proportion to the piston displacement.

In my copending application for a U. S. patent on engines, filed April 10, 1919 as Serial No. 289,163, I have disclosed an internal combustion engine in which I employ the heat of the piston and cylinder for vaporizing water or other liquid, and in which I utilize the pressure of the resulting vapor for urging the piston in an opposite direction from that in which it is moved by the explosion of the gases in the internal combustion part of the engine. While this construction offers decided advantages over the engine constructions heretofore known in the art, it has the disadvantage of being limited in the amount of energy obtainable from the expanded vapor, owing to the comparatively small piston area. My present invention aims to overcome this limitation by employing the resulting vapor in a relatively larger cylinder portion in which a greater expansion may be effected, and by employing simple means for increasing the heat conduction through the piston head. It also aims to obviate the use of the stuffing box required with the construction of the said copending application, thereby eliminating both leakage and the attention needed by a stuffing box; and to provide a construction permitting of larger ports for the speedy and effective exhausting of the expanded vapor, thereby reducing the wire-drawing effect. Furthermore, my present invention aims to employ a piston having a surface of large diameter at the end to which the connecting rod is fastened, thereby reducing the tendency to tilt the piston and consequently reducing both the friction and the wear. Moreover, my present invention aims to provide simple means for employing the vapor-expansion part of the engine to an increased extent for taking care of overloads, thereby affording an overload capacity not heretofore obtainable with internal combustion engines. My present invention also aims to provide simple means for regulating the admission of the vaporizable liquid in an inverse ratio to the speed of the engine, and desirably for simultaneously controlling the supply of fuel for the internal combustion part of the engine and the supply of vaporizable liquid for the vapor-expansion part of the engine, thereby increasing the economy of operation. Still further objects will appear from the following specification and from the appended drawing, which shows a longitudinal section through the cylinder and piston of a four-stroke cycle engine embodying my invention, and a somewhat diagrammatic view of other parts associated therewith.

In the engine of the drawing, I employ a differentially bored cylinder having a rear portion 39 equipped with puppet valves 1 and 1^a (operated by any well known means) for controlling the admission of a gaseous mixture from the inlet 5 and the exhaust of the products of combustion through the exhaust pipe 7, the cylinder having a spark plug 2 near its rear end. The internal com-

bustion cylinder 39 is connected at its forward end to a vapor cylinder 40 of larger bore, which larger cylinder has intermediate of its ends a series of lateral ports 18 connected by an annular chamber 19 and a pipe 13 to a condenser 23. Slidably mounted for reciprocation within the two alined cylinder portions 39 and 40 is a piston comprising a rear head 14 which fits the smaller bore cylinder 39, and a stem 21 connecting this head to a forward head 20 which fits the larger bored cylinder 40. This larger head is so disposed with respect to the ports 18 that it normally overruns these ports and opens them only when the piston is at the extreme forward end of its travel. Mounted in the wall of the cylinder 39 near the forward end of the latter is a spray nozzle 37 through which a vaporizable fluid (such as hot water) may be forced by a pump 29 through a pipe 28 controlled by a valve 27. The engine piston is suitably connected (as through a connecting rod 22) with the crank shaft of the engine, which in turn is operatively connected to the pump 11 and through a centrifugal governor 9 by suitable means such as are too familiar in engine practice to require illustrating.

This governor is here shown as connected by a lever 10 and a rod 8 to a valve 3 disposed in the inlet pipe 5 between the carbureter 6 and the internal combustion cylinder 39, and also through the same rod 8 and a lever 26 to a valve 27 controlling the supply of fluid to the pump 29. The parts just mentioned are so connected that an excessive speed of the governor will cause the latter to throttle both the supply of the gaseous mixture and the supply of hot water through the spray nozzle 37. This latter supply is further controlled by the driving connections to the pump, which are so arranged as to force liquid through the nozzle only during a relatively short portion of each revolution of the engine shaft, namely while the piston is approximately at the rear end of its travel.

In operation, the engine is operated by the pressure of the exploded mixture in the smaller bore cylinder 39, which acts on the smaller piston head 14 after the ordinary manner of internal combustion engines; in doing which, the entire cylinder and the piston are heated to a temperature far above the boiling point of water. In starting, the supply of liquid may be entirely shut off by any suitable means (such as a hand valve 25) until the engine has warmed up, after which this valve is opened. Then as soon as the piston is approximately at the rear end of its travel, the pump injects water in a fine spray through the nozzle 37, this nozzle being desirably of such a type as to produce a finely divided and socalled "solid" spray directed against the forward end of the head 14 of the piston and the parts immediately adjacent thereto. The finely divided spray thus injected is instantly vaporized by the heat of the piston and cylinder, thus filling the entire space between the two pistons with steam, and this steam acts differentially on the opposed faces of the two piston heads. Consequently, owing to the differences in diameters of the two piston heads, I obtain an effective forward pressure exerted between the outer portion of the larger piston head and the annular shoulder connecting the two bores of the cylinder. This pressure urges the piston forwardly during the forward stroke in which a fresh supply of the gaseous mixture is admitted to the smaller bore 39, thus utilizing some of the heat of the engine parts in adding to the power of the engine, and also somewhat cooling the piston and cylinder during the expanding of the steam while thus performing useful work.

As soon as the rear end of the larger piston head clears the ports 18, the expanded steam issues through these ports and the annular chamber 19 into the condenser 23 where it is condensed, thus producing a partial vacuum within the larger bore 40. Owing to this partial vacuum, the pressure of the outer air then urges the piston upon its next rearward stroke, so that I secure both a forward thrust by expansively utilizing the steam, and a subsequent rearward thrust through the partial vacuum produced by the condensation of the steam.

In normal operation, I desirably inject water only at the end of every alternate rearward movement of the piston, so that the actuating effect of the steam will alternate with the actuating effect of the gaseous explosion in the four-stroke engine, thus greatly steadying the torque of the engine. However, by also admitting the spray of liquid at the end of the intermediate rearward strokes, I can utilize still more of the heat in the steam chamber of my engine, thus affording additional energy for taking care of overloads on the engine, even though this may cool the engine parts to an extent which would not be desirable for the economical operation of the internal combustion part of the engine.

To provide for such overload capacity, I arrange suitable means under control of the operator, whereby the injection of the liquid may be made either with every reciprocation of the engine, or only with the alternate reciprocations of the same. For example, I may actuate the plunger 31 of the pump by either a single cam 32, or a pair of opposed cams 33 and 34, all of which cams are mounted on a cam shaft 35 which rotates at half the speed of the engine shaft, this cam shaft being arranged so that it can be slid longitudinally by means of a lever 36 to

bring either the said single cam or the said pair of opposed cams into operative relation to the plunger of the pump. Normally, the cam shaft is in the position of the drawing, so that the single cam 31 actuates the plunger of the pump against the pressure of a spring 30 only during every alternate reciprocation of the piston. However, by sliding the cam shaft 35 over so as to bring the pair of opposed cams into operative relation with the plunger of the pump, the latter will be actuated during every reciprocation of the pump. Hence the operator can increase the energy output of the engine in case of overloads by simply manipulating the lever 36.

By suitably preheating the supply of liquid (as for example by taking it from the condenser 23), I can readily secure this at a temperature approaching the boiling point of water, thus permitting the temperature of the parts against which the liquid is sprayed to convert the water into steam at a considerable pressure; and, by suitably proportioning the relative sizes of the two bores of the cylinder, I am able to use this steam expansively to a far greater extent than would be possible with the engine construction of my copending application. Moreover, I entirely avoid the use of stuffing boxes, as well as the leakage common with the same and the attendance demanded by them. So also, the larger diameter of the steam cylinder allows me to employ exhaust ports of a much larger size than would be feasible in a cylinder of the diameter corresponding to the internal combustion part of the engine, while the large diameter of the forward head and the length which I am free to give this head make the latter form a substantially cross-head for resisting any tilting strain on the part of the pitman.

At the same time, I obtain other advantages also common to the construction of my copending application, such as the improvement of the lubrication by the intermingling of the steam with the same. Moreover, since the steam is in contact with a relatively large cylinder surface, I am able to utilize a large amount of the heat of the engine cylinder, this heat being radially conducted by the metal from one portion of the cylinder to the other, and am able to do this without the use of water jackets or other arrangements involving complicated castings and difficulties of construction. To increase this conduction of heat from the internal combustion portion of the engine, I desirably employ heavy cylinder walls and also provide the smaller piston head both with rearward webs 15 for absorbing heat from the exploding mixture and with forward webs 16 against which some of the spray impinges. These webs enable me to impart heat quickly to the spray, and as this spraying takes place within the smaller or directly heated cylinder, I am able to utilize the surplus heat much more effectively than the old expedients of water-jacketing.

However, the smaller bored portion of the cylinder may desirably be jacketed with a suitable heat insulator, such as a packing of asbestos 12 within a sheet metal casing 11, thereby preventing outward radiation of the heat from the hottest part of the cylinder. The walls of the smaller cylinder may also be made rather heavy, so as to increase the conduction of heat to the larger bore in which the greater portion of the generated steam is reduced in temperature while expanding.

Even if the condenser were omitted, I would obtain two actuating impulses during every four-stroke cycle, and with the vapor-expansion part of the engine operating as a condensing engine, I secure three such impulses during every cycle. Consequently, I not only secure an increased output and a more economical operation from an internal combustion cylinder of a given displacement, but also secure a much more uniform torque. Likewise, since the vacuum-urged rearward stroke of the piston is that during which the fresh charge is compressed in the smaller end of the cylinder, I secure an adequate compression without tending to slow down the engine during this part of the cycle. Furthermore, after the engine has warmed up the heat stored in the piston and cylinder will normally be sufficient for vaporizing several successive injections of water in case the spark plug misses fire, so that I also secure a steadying effect which is of great importance in case the ignition apparatus is not working perfectly.

However, while I have illustrated and described the engine of my invention as having its internal combustion portion of the four-stroke cycle type and as having the overload-affording liquid supply provided through an extra pair of cams which are normally inoperative, 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 as set forth in the appended claims. Neither do I wish to be limited to the use of water as the vaporizable liquid, as other liquids might be employed, such as naphtha, alcohol, or carbon bisulfid.

I claim as my invention:—

1. In an engine, a differentially bored cylinder, a single piston member having heads respectively fitting the two bores, means for actuating the piston from the smaller bore of

the cylinder by the explosion of a gaseous mixture therein, and means for injecting a vaporizing liquid into the portion of the cylinder between the two piston heads.

2. In an engine as per claim 1, a piston having its smaller head equipped on both faces with webs for conveying heat from the explosion to the said head and from the latter to the vaporizable liquid.

3. An engine as per claim 1, in combination with coöperating means for controlling the supply of the said liquid and the supply of the gaseous mixture.

4. An engine as per claim 1, in combination with means responsive to the operative condition of the engine or controlling the supply of both the gaseous mixture and the said liquid.

5. An engine as per claim 1, in combination with means responsive to the speed of the engine for controlling both the supply of gaseous mixture and the supplying of the said liquid.

6. An engine as per claim 1, in which the last named means include a pump timed for injecting the liquid during a predetermined part of the cycle, and means responsive to the operative condition of the engine for controlling the amount of liquid injected by the pump.

7. In an engine, a differentially bored cylinder, a single piston member having heads respectively fitting the two bores, means for actuating the piston from the smaller bore of the cylinder by the explosion of a gaseous mixture therein, means for injecting a vaporizable liquid into the portion of the cylinder between the two piston heads, and means for utilizing the pressure of the resulting vapor in actuating the piston.

8. In an engine, a differentially bored cylinder, a single piston member having heads respectively fitting the two bores, means for actuating the piston from the smaller bore of the cylinder by the explosion of a gaseous mixture therein, and means for spraying a vaporizable liquid against the face of the smaller piston head opposed to the larger piston head.

9. In an engine, a differentially bored cylinder having the larger bore at its forward end, a single piston member having heads respectively fitting the two bores, means for actuating the piston forwardly from the small bore of the cylinder by the explosion of a gaseous mixture in said bore, and means for injecting a vaporizable liquid into the cylinder between the two piston heads while the piston is approximately at the rear end of its stroke.

10. In a four-stroke cycle engine, a differentially bore cylinder having the larger bore at its forward end, a single piston member having heads respectively fitting the two bores, means for actuating the piston forwardly from the small bore of the cylinder by the explosion of a gaseous mixture in said bore, and means for injecting a vaporizable liquid into the cylinder between the two piston heads while the piston is approximately at the end of the return stroke immediately following the explosively urged forward stroke.

11. In a four-stroke cycle engine as per claim 10, means for also injecting the liquid approximately at the end of the next return stroke of the piston.

12. An engine as per claim 1, in combination with means for utilizing the surplus heat of the vaporized liquid for preheating the injected liquid.

13. In an engine, a differentially bored cylinder, a single piston member having heads respectively fitting the two bores, means for actuating the piston from the smaller bore of the cylinder by the explosion of a gaseous mixture therein, and means for actuating the piston by the differential action on the piston heads of an expansible vapor generated within the cylinder between the said heads by the direct action of the heat of the piston and cylinder on liquid injected into the cylinder between the said heads.

14. In a four-stroke cycle engine, a differentially bored cylinder, a single piston member having heads respectively fitting the two bores, means for actuating the piston forwardly from the smaller bore of the cylinder in four-stroke cyclic manner, and means for actuating the piston from the cylinder space between the piston heads by the expansion of vapor generated directly by the heat of the engine parts from liquid injected into the said space substantially at the end of the return stroke immediately following the explosively urged forward stroke of the piston.

15. In an engine as per claim 13, means for controlling the number of injections of liquid per cycle of operation of the engine.

16. In an engine as per claim 13, means controlled by the operator of the engine for injecting the vaporizable liquid either at the end of alternate return strokes, or at the end of every return stroke of the piston.

17. In an engine, a differentially bored cylinder, a single piston member having heads respectively fitting the two bores, means for actuating the piston from the smaller bore of the cylinder by the explosion of a gaseous mixture therein, means for injecting a vaporizable liquid into the portion of the cylinder between the two piston heads, and means for utilizing the pressure of the resulting vapor in actuating the piston, means for condensing the expanded vapor, and means for utilizing the resulting vacuum in thereafter actuating the piston.

18. In a four-stroke cycle engine arranged

for utilizing heat within the engine by expansively working a vapor generated from liquid injected into the engine cylinder, liquid-injecting means comprising a pump, two actuating members adapted respectively to actuate the pump once and twice during each cycle, and means for shifting the operative connection of the pump from one to the other of the actuating members.

19. An engine as per claim 18, in which the two actuating members respectively comprise a single cam and a pair of opposed cams all fast upon a cam shaft rotating at half the speed of the engine shaft.

20. In an engine, a differentially bored cylinder, a single piston member having heads respectively fitting the two bores, means for actuating the piston from the smaller bore of the cylinder by the explosion of a gaseous mixture therein, and means for injecting a vaporizable liquid into the portion of the cylinder between the two piston heads, means responsive to the operative condition of the engine for controlling the amount of injected liquid, and separate means for controlling the frequency of the injections.

21. In a four-stroke cycle engine, means for utilizing heat within the engine during two strokes other than the explosively urged stroke of the piston, by expansively working a vapor generated from liquid injected into the engine cylinder, and by thereafter condensing the expanded vapor and utilizing the resulting vacuum.

22. In an engine, a differentially bored cylinder, a piston having two heads respectively fitting the two bores of the cylinder, means for actuating the piston from the smaller bore of the cylinder by the explosion of a gaseous mixture therein, means for spraying a vaporizable liquid into the smaller bore and in front of the smaller diametered piston head while the piston is approximately at the rear end of its stroke, whereby the said liquid is vaporized by the heat of the piston and of the cylinder wall into an expansible vapor operating differentially on the two piston heads to urge the piston member forwardly, and means for condensing the expanded vapor substantially at the end of the forward stroke of the piston member, thereby producing a partial vacuum in the larger bore of the cylinder for acting differentially on the two piston heads to urge the return stroke of the piston.

23. In an engine, a differentially bored cylinder, a single piston member reciprocable in the cylinder and having two heads respectively fitting the two bores; inlet, exhaust and ignition means associated with the smaller bore of the cylinder for operating the piston from the latter as the piston of an internal combustion engine; and means for projecting a vaporizable liquid into the smaller bore of the cylinder while the piston is near the rear end of its stroke; the large bore of the cylinder having an exhaust port overrun by the larger diameter of the piston except when the latter is at the forward end of its stroke.

24. An engine as per claim 23, in combination with a condenser connected to the exhaust port.

25. An engine as per claim 23, in combination with a condenser connected to the exhaust port, and means associated with the condenser for supplying liquid for the said spraying.

26. 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, and utilizing the expansive force of the vapor in urging the piston in the same direction in which it was previously moved by the explosion-producing heat in the piston.

27. 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 in urging the piston in the same direction in which it was previously moved by the explosion producing heat in the piston, thereafter condensing the vapor, and utilizing the resulting partial vacuum in urging the subsequent return stroke of the piston.

28. The method of utilizing heat stored in the piston of an internal combustion engine by the explosion of a gaseous mixture, which consists in projecting liquid against the free face of the piston for a relatively short time substantially at the end of the return stroke thereof, and utilizing the expansive force of the vapor into which the liquid is converted by the heat of the piston for thereafter urging the piston in the same direction in which it was urged by the said explosion.

29. The method of utilizing heat generated in an internal combustion engine during the operation thereof, which consists in momentarily projecting liquid against the free face of the piston and the cylinder walls forwardly of the piston while the latter is approximately at the end of its return stroke, and utilizing the expansive force of the resulting vapor in urging the piston forwardly during the succeeding stroke.

30. The method of utilizing heat generated in an internal combustion engine during the operation thereof which consists in utilizing some of the said heat for preheating a liquid to a temperature approximating its vaporizing point, projecting the said liquid against the forward face of the piston and the inner wall of the cylinder forwardly

of the piston while the latter is approximately at the rear end of its travel, and utilizing the expansive force of the resulting vapor in urging the piston forwardly.

31. The method of utilizing heat generated in an internal combustion engine during the operation thereof, which consists in projecting a spray of liquid transversely of the axis of the cylinder and in front of the piston substantially at the rear end of the travel of the latter and during a relatively short portion of the stroke of the piston, and utilizing the expansive force of the resulting vapor in urging the piston forwardly.

32. The method of operating an engine having a differentially bored cylinder and a correspondingly two-diametered piston, which consists in urging the piston during its forward stroke alternately by the explosion of a gaseous mixture in the smaller bore of the cylinder and by the expansive force of a vapor generated within the cylinder and acting differentially on the two diameters of the piston.

33. The method of operating an engine having a differentially bored cylinder and a correspondingly two-diametered piston, which consists in urging the piston during its forward stroke alternately by the explosion of a gaseous mixture in the smaller bore of the cylinder and by the expansive force of a vapor generated within the cylinder and acting differentially on the two diameters of the piston, and in urging the piston rearwardly during its charge-compressing stroke by the vacuum produced by condensing the expanded vapor.

Signed at Chicago, Illinois, April 5, 1919.

HALE W. PARRISH.