A. E. HALL.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED MAR. 14, 1911.

1,010,754.

Patented Dec. 5, 1911

2 SHEETS—SHEET 1.

Fig. 1.

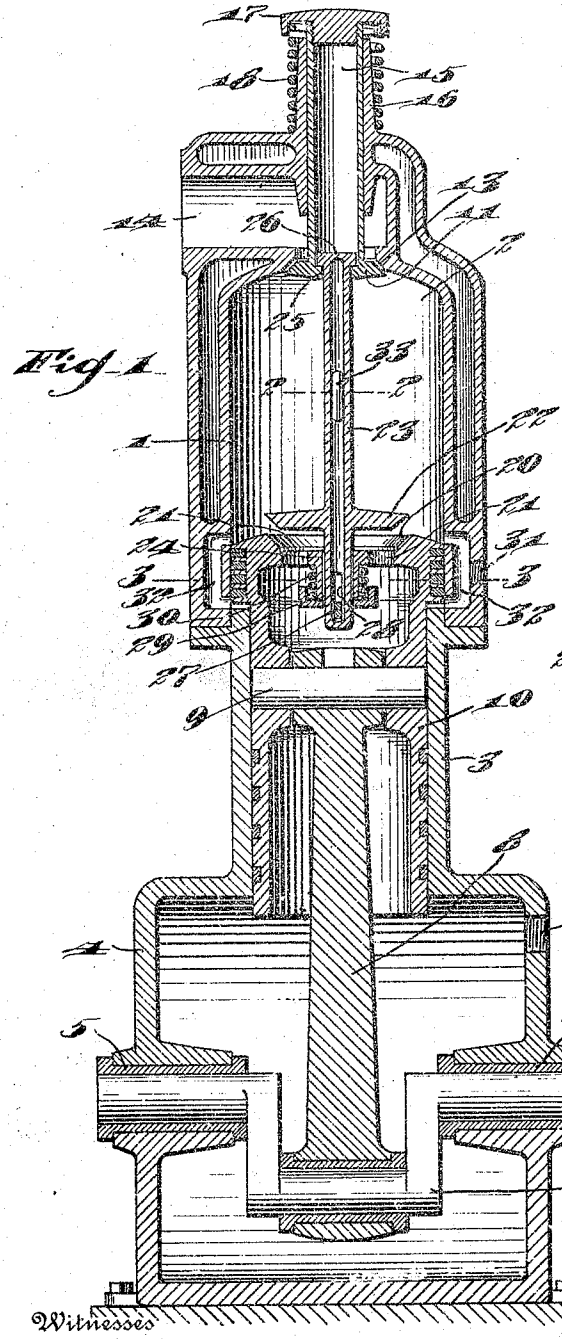
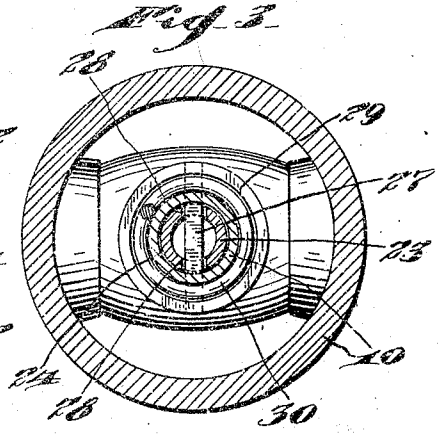


Fig. 2.

Fig. 3.



Witnesses

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2 SHEETS—SHEET 2.

Fig. 1

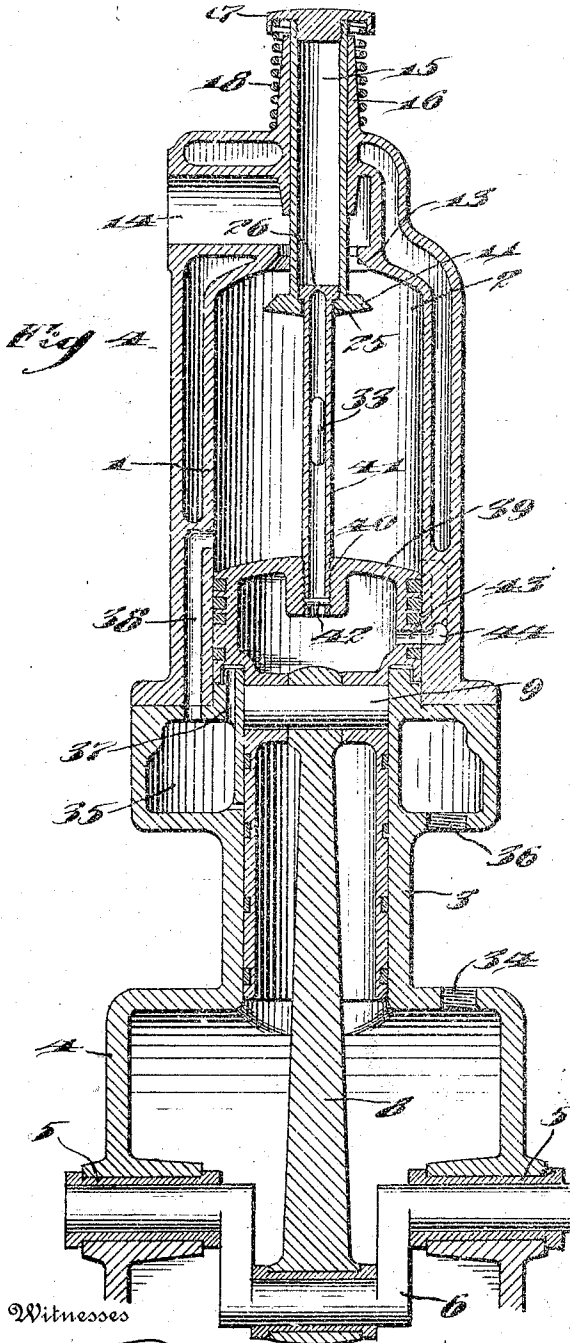
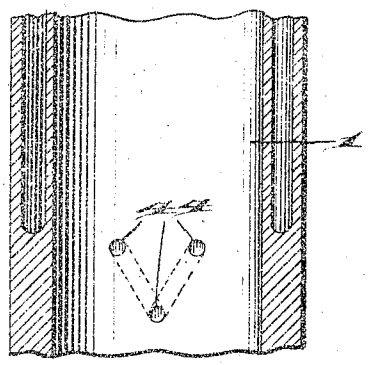


Fig. 5



Witnesses

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ALLEN E. HALL, OF PHILADELPHIA, PENNSYLVANIA.

INTERNAL-COMBUSTION ENGINE.

1,010,754. Specification of Letters Patent. Patented Dec. 5, 1911.

Application filed March 14, 1911. Serial No. 614,298.

To all whom it may concern:

Be it known that I, ALLEN E. HALL, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention relates to improvements in internal combustion engines, the object of the invention being to provide an improved engine of this character of the two cycle type, in which a piston of two diameters moves in a cylinder of two diameters, and said piston acts to compress the air on its outward stroke, and when at the end of its outward stroke, releases said air into the cylinder, and also releases gas to commingle with the air to form an explosive mixture.

A further object is to provide a piston with an air cooled rod telescoping in the tubular stem of an exhaust valve, and serving to open the exhaust valve when the piston reaches a predetermined point in the cylinder, said exhaust valve normally held in closed position, and returned to such position by means of a spring.

A further object is to provide an improved exhaust valve having a hollow stem, and a tubular rod telescoping in said stem, and connected with the engine piston, said rod controlling the opening movement of the exhaust valve, and provide in said rod improved means for compelling a movement of air or gas therein to keep the rod cool.

With these and other objects in view, the invention consists in certain novel features of construction and combinations and arrangements of parts, as will be more fully hereinafter described and pointed out in the claims.

In the accompanying drawings: Figure 1, is a view in longitudinal section illustrating one form of my improvements. Fig. 2, is a view in section on an enlarged scale on the line 2—2 of Fig. 1. Fig. 3, is a view on an enlarged scale on the line 3—3 of Fig. 1, but which is taken through the piston only. Fig. 4, is a view in longitudinal section illustrating a modified form of engine, and Fig. 5, is a fragmentary view in longitudinal section through the cylinder only, taken at right angles to Fig. 4 so as to show the location and arrangement of gas inlet 44.

1, represents the cylinder of my improved engine, which is of two diameters as illustrated, the upper larger diameter constituting an explosion chamber 2, and the lower smaller diameter 3 communicating with a crank housing 4 supporting the same.

The explosion chamber 2 is suitably water jacketed as shown, and while a vertical cylinder is illustrated, the invention is not limited to a vertical cylinder as my improvements may be employed with the cylinder in any position.

The crank housing 4 provides bearings 5 for a crank shaft 6, on which a fly wheel 7 is secured, and this crank shaft 6 is connected by a connecting rod 8 with a cross pin 9 in my improved piston 10. It is to be understood, that the crank casing is air and gas tight as is customary with engines of the two cycle type.

Referring to the construction shown in Figs. 1, 2, and 3, it will be noted that an exhaust valve 11 is provided and adapted to close against a seat 13, communicating with a passage 14 for the exploded gases. This valve 11 is provided with a tubular stem 15 mounted to slide in a cylindrical bearing 16 which extends through the head of cylinder 1, and is provided on its outer end with a cap 17 against which a coiled spring 18 bears. This spring 18 is positioned between cap 17, and the end of cylinder 1, and is adapted when permitted, to move valve 11 to closed position, and hold it in such position.

My improved piston 10 is of cylindrical hollow form constituting an air chamber or compartment, communicating with the crank casing 4 into which air is supplied through a port 19. The inner end of the piston 10 is provided with a circular valve seat 20, below which a plurality of openings 21 are provided through which the air passes into the explosion chamber 2 when permitted by a valve 22. This valve 22 is preferably made integral with a tubular valve stem 23, which extends through a central opening 24 in piston 10, and also extends throughout the length of the explosion chamber, and through an opening 25 in valve 11, and is provided with a head 26, which is movable in valve stem 15, and is adapted to move valve 11 as will hereinafter appear.

A cross pin 27 is projected through slots 28 in the lower end of rod 23 inside of piston 10, and below a cap ring 29 located around rod 23 and between which, and the

end of piston 10, a coiled spring 30 is located and tends always to move valve 22 to closed position.

31, represents an inlet for gas, which communicates with a passage 32 having its ends communicating with the cylinder, and spaced apart a distance approximating the length of the larger diameter of piston 10. One other of such passages 32 is shown at the opposite side of the cylinder, but any number of these passages may be provided as desired, it being understood of course, that the gas inlet communicates directly with one only.

The operation of this form of engine above described is as follows: The piston 10 is shown in its extreme outward position, and valve 11 is slightly open, so that the exploded gases are still escaping through the passage 14. Air is passing upward through the openings 21, and gas is entering through the passages 32 to commingle with the air and form an explosive mixture, the air and the gas rushing into the cylinder tending to force out practically all of the exploded mixture, and thoroughly scavenging the engine. When the piston 9 begins its upward or compression stroke, as spring 18 is stronger than spring 30, exhaust valve 11 will be seated before air valve 22 closes, but the operation of the latter will follow shortly after the closing of the exhaust valve, and the piston will move upwardly closing the passages 32, and as the rod 23 telescopes in the stem 15, this rod will move upwardly with the piston on its compression stroke. This upward motion of the piston, by reason of the larger diameter in combustion chamber 2, forms an elongated annular chamber around the piston, serving to suck in the gas in a quantity sufficient to supply the next charge, so that when the piston moves downward on its firing stroke, it will compress this gas until the piston reaches the position shown in Fig. 1, when such gas will escape through the passages 29 into the combustion chamber. When the piston reaches the inner end of its stroke, and the explosive mixture is highly compressed, it is ignited by any suitable mechanism (not shown), causing the explosion of the mixture, and driving the piston outward. It will be noted that valve 22 is of greater diameter than valve 11, hence the pressure of the exploded gases on valve 22 tends to hold the latter on its seat, and when the piston approaches the outer end of its stroke, enables valve 11 to be opened before valve 22 is opened, hence the expanded and exploded mixture will rapidly escape through the passage 14, and as the piston nears the outer end of its stroke, valve 22 will be opened, and a supply of cool compressed air will rush into the cylinder and assist in scavenging the engine. As the piston reaches the outer end of its stroke, the gas will rush through the passages 32 to mix with the air, and the operation above described will be repeated. As the rod 23 extends through the combustion chamber, and is liable to become hot by reason of the burned gases, this rod is made hollow as shown, and in this hollow rod a cylindrical plunger 33 loosely fits. This plunger 33 is reciprocated in the tubular rod by the movement of the rod, and serves to induce a flow of air in and out of the rod to keep the same cool, it being understood that such air enters through the slots 28 in the end of the rod.

In the modification shown in Fig. 4, the engine structure is similar in many particulars to that above described, and illustrated in Figs. 1, 2, and 3, and for convenience I have employed the same reference characters to indicate the same parts, in so far as such parts are alike in construction. Where however, the parts differ, I have employed different reference characters. In this modification, the crank housing 4 constitutes a receptacle for gas, which is admitted through an inlet 34, and an annular air chamber 35 is provided around the cylinder 1 at the end of its larger diameter. Air is supplied to this chamber 35 through a port 36, and communicates with the combustion chamber below the larger diameter of the piston by means of a passage 37, and with the combustion chamber between the piston and the exhaust valve by means of a passage 38. The piston 39 has a solid head made with a central opening 40, in which a tubular rod 41 is secured. This tubuular rod 41 corresponds to the rod 23 of the preferred form, and the plunger 33 in said rod is prevented from escaping by means of a cross-pin 42. In this rod 41, the gas will circulate to keep it cool, instead of the air, as in the preferred form. Piston 39 is provided in one side of its larger diameter with a port 43 which, when the piston is in its extreme outer position, will register with one end of a V-shaped passage 44, so that the gas in the piston may flow through said passage indicated more clearly in Fig. 5 into the combustion chamber. This passage 44 is made V-shape so that the port 43 only registers therewith when the piston is in its extreme outward position.

The operation of this modification is as follows: In Fig. 4, the piston 39 is shown in its extreme outward position, that is, ready to begin its compression stroke. When in this position, it will be noted that exhaust valve 11 is held open and the air is rushing into the explosion chamber through passages 38, and gas through passage 44. it will be noted that the inner end of passage 38 is nearer the closed end of the cylinder than is the outlet passage 44, so that the air rushes into the cylinder first. This in-rush-

ing air causes the exploded gases to be forced out of the cylinder as the valve 11 is maintained open, until the piston begins its inward stroke, and is held open long enough to allow the air to force out all of the exploded gases, and thoroughly scavenges the engine. The inward stroke of the piston cuts off both passages 38 and 44, and sucks in under the piston air through the port 37. When the piston is forced outward by means of the exploded gases, the air in the cylinder under the larger diameter of the piston will be compressed in chamber 35, and will find its exit through passage 38, when the piston moves far enough in its outward stroke. The operation above described will then be repeated.

In the several supply ports which connects the engine with the series of gas supply, and with the outside air, any suitable form of check valve (not shown) may be employed, but as this is well known in the art, it is needless to illustrate or describe the same.

It is to be understood of course that the engine above described is not limited to any arrangement of valves or other coöperating features, but is broadly to the idea of a piston of two diameters, which at one stroke of the piston compresses separately air and gas.

Various slight changes might be made in the general form and arrangement of parts described without departing from my invention, and hence I do not limit myself to the precise details set forth, but consider myself at liberty to make such changes and alterations as fairly fall within the spirit and scope of the appended claims.

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

1. In an internal combustion engine, the combination with a cylinder, of a piston in the cylinder, an exhaust valve in the head of the cylinder having a tubular stem, a source of cooling agent supply, a hollow rod telescoping in the tubular stem of the exhaust valve and connecting the exhaust valve and the piston, said rod communicating at one end with the cooling agent source of supply, substantially as described.

2. In an internal combustion engine, the combination with a cylinder, of an exhaust valve in the end of the cylinder having a hollow stem, a piston in the cylinder, a source of cooling air supply, and a tubular air circulating rod connecting the piston and the valve, communicating at one end with the source of air supply, and telescoping in the tubular stem of the latter, and a movable device in said tubular rod reciprocated by the motion of the piston, substantially as described.

3. In an internal combustion engine, the combination with a cylinder, of an exhaust valve in the end of the cylinder having a hollow stem, a piston in the cylinder, a source of cooling air supply, a tubular air circulating rod connecting the piston and the valve, communicating at one end with the source of air supply, and telescoping in the tubular stem of the latter, and a movable device in said tubular rod reciprocated by the motion of the piston, and a spring normally holding said valve on its seat, substantially as described.

4. In an internal combustion engine, the combination with a cylinder of two diameters, and a piston of two diameters fitting the cylinder, of an exhaust valve in the end of the cylinder, a tubular stem on said valve projecting through the cylinder, a cap on the end of said tubular stem, a coiled spring exerting outward pressure on the cap to normally hold said valve in closed position, a source of cooling air supply, and a tubular air circulating rod connecting said valve with the piston, whereby the movement of the piston controls the movement of said valve, said rod communicating at one end with the source of air supply, and a movable device in said rod reciprocated by the motion of the piston, substantially as described.

5. In an internal combustion engine, the combination with a cylinder of two diameters, and a piston of two diameters fitting the cylinder, of an exhaust valve in the end of the cylinder, a tubular stem on said valve projecting through the cylinder, a cap on the end of said tubular stem, a coiled spring exerting outward pressure on the cap to normally hold said valve in closed position, a source of cooling air supply, a tubular air circulating rod connected to the piston, and a head on said rod mounted to telescope in the tubular stem of the valve, whereby when said piston approaches the extreme of its outward stroke, said rod will open the valve, said rod communicating at one end with the source of air supply, and a movable device in said rod reciprocated by the motion of the piston, substantially as described.

6. In an internal combustion engine, the combination with a cylinder of two diameters, and a piston of two diameters fitting the cylinder, of an exhaust valve in the end of the cylinder, a tubular stem on said valve projecting through the cylinder, a cap on the end of said tubular stem, a coiled spring exerting outward pressure on the cap to normally hold said valve in closed position, a rod connected to the piston, a head on said rod mounted to telescope in the tubular stem of the valve, whereby when said piston approaches the extreme of its outward stroke, said rod will open the valve, a source of cooling agent supply, said rod tubular in form and communicating at one end with

the source of cooling fluid, and a loosely fitting plunger in said rod, substantially as described.

7. In an internal combustion engine, the combination with an inclosed crank case, and a cylinder of two diameters communicating with said case, of a piston of two diameters fitting the cylinder and having an opening in its end, an exhaust valve normally closing an outlet in the end of the cylinder, said exhaust valve having a tubular stem, an inlet valve normally closing the openings in the piston, and a rod fixed to said inlet valve and having a head on one end telescoping in the tubular stem of the exhaust valve, substantially as described.

8. In an internal combustion engine, the combination with an inclosed crank case, and a cylinder of two diameters communicating with said case, of a piston of two diameters fitting the cylinder and having an opening in its end, an exhaust valve normally closing an outlet in the end of the cylinder, said exhaust valve having a tubular stem, an inlet valve normally closing the openings in the piston, a tubular rod fixed to said inlet valve and having an enlarged head mounted to telescope in the stem of the exhaust valve, said tubular rod projecting through an opening in the piston, a cap on said rod inside of the piston, a coiled spring between the end of the piston and said cap exerting downward pressure on said rod, a cap on the outer end of the tubular valve stem, and a spring exerting outward pressure on said cap, said last-mentioned spring stronger than the first-mentioned spring, substantially as described.

9. In an internal combustion engine, the combination with an inclosed crank case, and a cylinder of two diameters communicating with said case, of a piston of two diameters fitting the cylinder and having an opening in its end, an exhaust valve normally closing an outlet in the end of the cylinder, said exhaust valve having a tubular stem, an inlet valve normally closing the openings in the piston, a rod fixed to said inlet valve and having a head on one end telescoping in the tubular stem of the exhaust valve, said crank case having an inlet for air, and said cylinder having open ended passages in its larger diameter with one of which a gas inlet communicates, the ends of said passages being spaced apart a distance equal to the longitudinal dimension of the enlarged inner end of said piston, substantially as described.

10. In an internal combustion engine, the combination with an inclosed crank case, and a cylinder of two diameters communicating with said case, of a piston of two diameters fitting the cylinder and having an opening in its end, an exhaust valve normally closing an outlet in the end of the cylinder, said exhaust valve having a tubular stem, an inlet valve normally closing the openings in the piston, a tubular rod fixed to said inlet valve and having an enlarged head mounted to telescope in the stem of the exhaust valve, said tubular rod projecting through an opening in the piston, a cap on said rod inside of the piston, a coiled spring between the end of the piston and said cap exerting downward pressure on said rod, a cap on the outer end of the tubular valve stem, a spring exerting outward pressure on said cap, said last-mentioned spring stronger than the first-mentioned spring, said crank case having an inlet for air, and said cylinder having open ended passages in its larger diameter with one of which a gas inlet communicates, the ends of said passages being spaced apart a distance equal to the longitudinal dimension of the enlarged inner end of said piston, substantially as described.

11. In an internal combustion engine, the combination with a cylinder, of a piston in the cylinder, an exhaust valve in the head of the cylinder having a tubular stem, a hollow rod telescoping in the tubular stem of the exhaust valve and connecting the exhaust valve and the piston, a source of cooling agent supply, said rod communicating at one end with the cooling agent source of supply, and a movable device in said hollow tube reciprocated by the movement of the piston, whereby the cooling agent is compelled to move into and out of the tube, substantially as described.

12. In an internal combustion engine, the combination with a cylinder, of a piston in the cylinder, an exhaust valve in the head of the cylinder having a tubular stem, a hollow rod telescoping in the tubular stem of the exhaust valve and connecting the exhaust valve and the piston, a source of cooling agent supply, said rod communicating at one end with the cooling agent source of supply, said source of supply constituting a hollow crank housing, and said piston hollow and communicating with said crank housing and said tubular stem, substantially as described.

13. In an internal combustion engine, the combination with a cylinder, of a piston in the cylinder, an exhaust valve in the head of the cylinder having a tubular stem, a hollow rod telescoping in the tubular stem of the exhaust valve and connecting the exhaust valve and the piston, a source of cooling agent supply, said rod communicating at one end with the cooling agent source of supply, and a movable device in said hollow tube reciprocated by the movement of the piston, whereby the cooling agent is compelled to move into and out of the tube, said source of supply constituting a hollow crank housing, and said piston hollow and com-

municating with said crank housing and said tubular stem, substantially as described.

14. In an internal combustion engine, the combination with a cylinder, of a piston in the cylinder, an exhaust valve in the head of the cylinder having a tubular stem, a hollow rod telescoping in the tubular stem of the exhaust valve and connecting the exhaust valve and the piston, a source of cooling agent supply, said rod communicating at one end with the cooling agent source of supply, a head on said rod movable within the hollow exhaust stem, and a coiled spring around said stem exerting pressure on the stem to normally hold the exhaust valve on its seat, substantially as described.

15. In an internal combustion engine, the combination with a cylinder, of a piston in the cylinder, an exhaulst valve in the head of the cylinder having a tubular stem, a hollow rod telescoping in the tubular stem of the exhaust valve and connecting the exhaust valve and the piston, a source of cooling agent supply, said rod communicating at one end with the cooling agent source of supply, a movable device in said hollow tube reciprocated by the movement of the piston, whereby the cooling agent is compelled to move into and out of the tube, a head on said rod movable within the hollow exhaust valve stem, and a coiled spring around said stem exerting pressure on the stem to normally hold the exhaust valve on its seat, substantially as described.

16. In an internal combustion engine, the combination with a cylinder, of a piston in the cylinder, an exhaust valve in the head of the cylinder having a tubular stem, a hollow rod telescoping in the tubular stem of the exhaust valve and connecting the exhaust valve and the piston, a source of cooling agent supply, said rod communicating at one end with the cooling agent source of supply, said source of supply constituting a hollow crank housing, and said piston hollow and communicating with said crank housing and said tubular stem, a head on said rod movable within the hollow exhaust valve stem, and a coiled spring around said stem exerting pressure on the stem to normally hold the exhaust valve on its seat, substantially as described.

17. In an internal combustion engine, the combination with a cylinder, of a piston in the cylinder, an exhaust valve in the head of the cylinder having a tubular stem, a hollow rod telescoping in the tubular stem of the exhaust valve and connecting the exhaust valve and the piston, a source of cooling agent supply, said rod communicating at one end with the cooling agent source of supply, and a movable device in said hollow tube reciprocated by the movement of the piston, whereby the cooling agent is compelled to move into and out of the tube, said source of supply constituting a hollow crank housing, and said piston hollow and communicating with said crank housing and said tubular stem, a head on said rod movable within the hollow exhaust valve stem, and a coiled spring around said stem exerting pressure on the stem to normally hold the exhaust valve on its seat, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ALLEN E. HALL.

Witnesses:
R. H. KRENKEL,
S. W. FOSTER.