

Feb. 14, 1950

T. A. LOGASHKIN  
FORCED DRAFT AIR-COOLING SYSTEM  
FOR INTERNAL-COMBUSTION ENGINES

2,497,781

Filed July 13, 1948

3 Sheets-Sheet 1

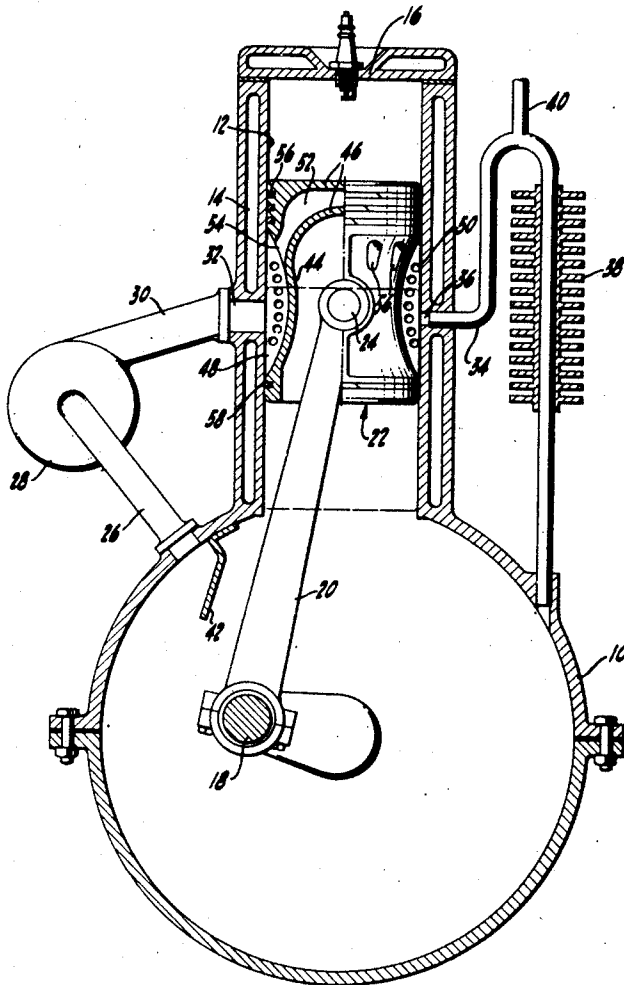


Fig. 1

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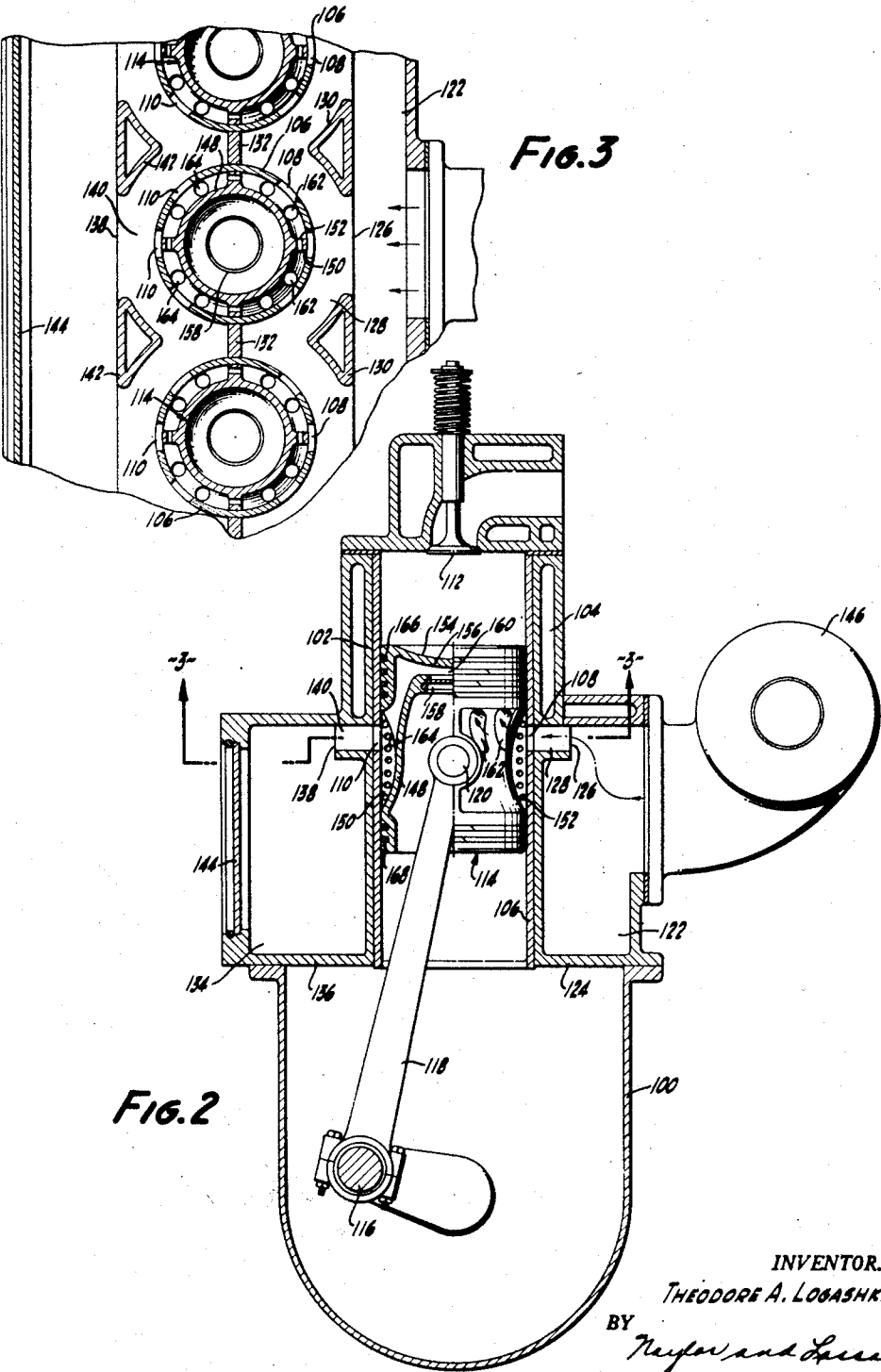
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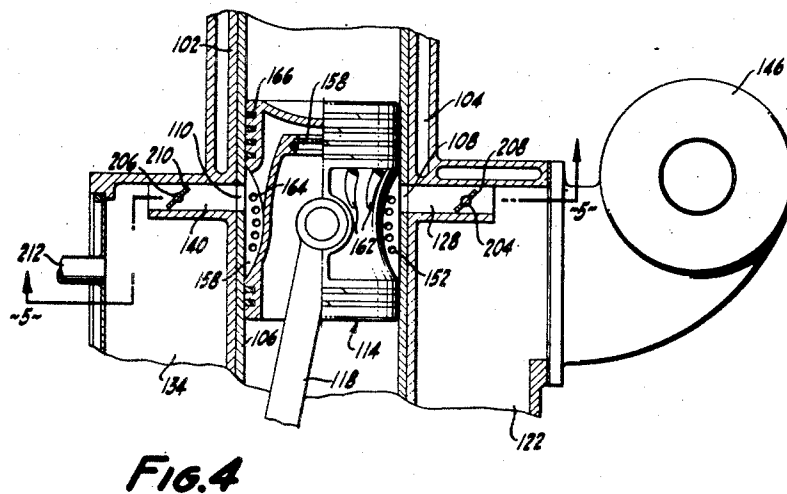
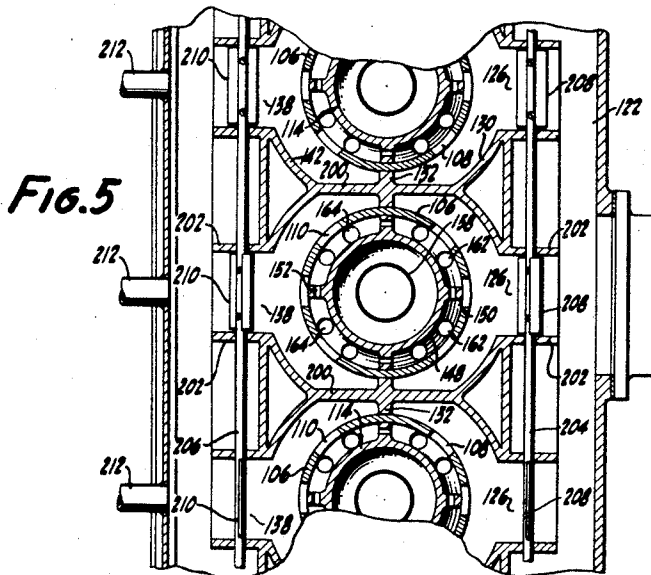
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3 Sheets-Sheet 3



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## UNITED STATES PATENT OFFICE

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FORCED DRAFT AIR-COOLING SYSTEM FOR  
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8 Claims. (Cl. 123-171)

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This invention relates to cooling systems for internal combustion engines, and more particularly to forced draft air-cooling systems for engines of either the two-cycle or four-cycle type.

Among the objects of invention are the following: to provide a cooling system for combustion engines in which the cooling medium is passed through the cylinder and pistons of the engines during the operation of the engines; to provide a cooling system wherein the cooling medium is effective to prevent substantial transfer of heat from the combustion chamber to the crank case; to provide for a combustion engine piston of novel form for the passage through the piston during its operation of a gaseous cooling medium; to provide a cooling system comprising a closed path circuit for the cooling medium between the crank case and cylinders of the engine, whereby the cooling medium in passing through this circuit will entrain oil from the crank case and deposit it on the cylinder walls; to provide a cooling system particularly adapted for a two-cycle engine, whereby the cooling medium is passed through the cylinder and pistons during the operation of the latter and the cooling medium is then used to scavenge the cylinders of combustion gases; and to provide a cooling system for the passage of a gaseous cooling medium through the cylinders and pistons of an engine in which means are provided under the control of the crank shaft to shut off the supply of cooling medium to the cylinder in timed relation with the operation of the pistons.

These and other objects of the invention will be apparent from the following description taken in conjunction with the drawings forming part of this specification, and in which:

Fig. 1 is a sectional view of the essential elements of a combustion engine embodying a form of the cooling system of the invention;

Fig. 2 is a sectional view of a combustion engine embodying a different form of the cooling system of the invention;

Fig. 3 is a view in section taken along lines 3-3 of Fig. 2, showing details of the cylinder and piston structure of the engine, and particularly the passage ways formed in the elements for passage of the cooling medium therethrough;

Fig. 4 is a partial view in section of an engine embodying still a further modification of the cooling system of the invention.

Fig. 5 is a view in section taken along line 5-5 of Fig. 4.

Referring to the drawings for details of the

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invention, Fig. 1 shows a combustion engine comprising a crank case 10, a cylinder 12 having water jackets 14 for auxiliary cooling, a cylinder head 16, a crank shaft 18 carrying a connecting rod 20, and a piston indicated generally at 22 secured to the connecting rod by wrist pin 24. The cooling system provided for the engine comprises a conduit 26 communicating at one end with the space within the crank case 10 and at the other end with a blower 28 which may be of the simple vane type, a conduit 30 leading from the blower to the cylinder and communicating with the cylinder space through a passage 32 in the cylinder wall, a conduit 34 communicating at one end with the cylinder space through a passage 36 in the cylinder wall and communicating at the other end with the space within the crank case 10. The conduit 34 is provided with a plurality of cooling fins 38 and with a branch conduit 40 leading to the carburetor, not shown, of the engine, and a baffle 42 carried within the crank case 10 adjacent the mouth of conduit 26 is provided for a purpose hereinafter described. The piston 22 constitutes the essential and intermediate element of the cooling system and comprises a spool shaped body having a head 46 and ribs 48 extending radially from the piston body 44 and preferably located at 90° intervals. The ribs 48 are provided with a plurality of apertures 50, and the head 46 on the piston is provided with a plurality of passageways 52 having inlets 54 and outlets 56. The piston 22 is further provided with a plurality of rings 58 at the head portion thereof and a ring 58 adjacent the lower end of the skirt portion thereof.

When the engine is in operation, the stroke of the piston 22 is such that when the piston is in its lowermost position within the cylinder 12 the rings 58 are adjacent the cylinder wall opening 32, and the lowermost portions of the ribs 48 are in alignment with the opening 32 when the piston is in its uppermost position. Except for a slight period during the full stroke of the piston, the opening 32, and also the opening 36, is in continuous communication with the subdivided annular space defined by the cylinder wall 12, the spool body 44 of the piston, and the ribs 48 of the piston. Upon actuation of the crank shaft 18 and the blower 28 to operate the engine and initiate action of the cooling system, air is withdrawn from the crank case 10 into the conduit 26 and blower 28, and then the air is forced through the conduit 32 and into the subdivided annular space between the piston and the cylinder. The air stream is then sub-

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divided, part of it passing around the body of the piston through the apertures 50 in ribs 48 to conduit 34, and the remainder of the air stream passing through the passageways 52 in the head 46 of the piston and into the conduit 34. The splitting of the air stream causes the air traveling around the body of the piston to cool both the piston body and the adjacent cylinder wall, and this action continues throughout substantially the full stroke of the piston, to, in effect, cool successive portions of the cylinder wall, while the diversion of the remainder of the air stream through the passages 52 serves to cool the head 46 of the piston which is in direct contact with the combustion gases. The passing of the air through the passage 52 sets up a cool air barrier between the upper portion of the head 46 and the lower head portion thereof, and thus prevents substantial transmission of heat to the lower portion of the head 46, which is in communication with the crank case space. Deleterious effects on the crank case oil through high temperature action are thus inhibited.

As the air leaves the cylinder and enters the conduit 34, it may carry therewith unburned fuel vapors which may have bypassed the rings 56 to enter the sub-divided annular space between the piston and the cylinder, and in this case the unburned vapors are removed by slight suction applied to conduit 40 to pass to the carburetor. Since the crank case space is under a pressure slightly lower than atmospheric pressure, the cooling air in conduit 34 will not be removed through conduit 40, as this would result in a reduction in pressure of the cooling air atmosphere in crank case 10. The cooling air entering conduit 34 from the cylinder has been considerably raised in temperature by its passage through the cylinder and it is thereafter cooled before re-entering the crank case 10 by the cooling fins 38.

In passing through the crank case, the air entraps a certain amount of oil, and the baffle 42 serves to reduce the amount of entrapped oil so that the air entering conduit 26 contains oil vapor only. When the rings 56 are opposite the cylinder wall openings 32 during each complete stroke of the piston, the oil vapor in the cooling air is directly applied to these rings with the result that an oil film is being continually applied to both the piston and the cylinder during operation of the engine.

Figs. 2 and 3 illustrate a modification of the cooling system of the invention as embodied in a two-cycle Diesel engine. The engine is comprised of a crank case 100, cylinders 101 having an auxiliary water cooling jacket 104, cylinder sleeve liners 106 having a plurality of spaced apertures 108 around half of their circumferences and similar apertures 110 around the other half of their circumferences, cylinder head valves 112, pistons indicated generally at 114, a crank shaft 116, connecting rods 118, and wrist pins 120 forming connections between the rods and the pistons 114. A chamber 122 extending longitudinally of the bank of pistons and maintained out of communication with the crank case space by partition 124 has a series of openings 126 providing for communication between the chamber and semi-circular chambers 128 defined by liners 106, members 130, and partition members 132 interconnecting adjacent liners 106. Another chamber 134 extending longitudinally of the bank of pistons is maintained out of communication with the crank case space by partition 136, and openings 138 provide for communication between the

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chamber 134 and semi-circular chambers 140 defined by cylinder liners 106, members 142 and partition members 132. The chamber 134 is provided with a closure member, preferably of the snap ring removable type, such as 144, and chamber 122 has a blower 146 in communication therewith.

The piston 114 is similar in form to the piston structure of Fig. 1, being comprised of a spool-like body 148, ribs 150 provided with a plurality of apertures 152, a head 154 comprising an upper dish portion 156 and a removable snap ring partition 158 defining therebetween passages 160 extending transversely of the piston head and having inlet openings 162 and outlet openings 164. The piston is provided with a plurality of rings 166 at the head portion thereof and a plurality of rings 168 at the bottom of the skirt portion.

The cylinder liner apertures 108 and 110 providing for communication between semi-circular chambers 128 and 140 and the annular space between the body 148 of the piston and cylinder liner 106 are so located in relation to the stroke of the piston 114 that the piston at the bottom of its stroke allows for communication between the chambers 122 and 134 and the combustion space within the cylinders above the pistons. When the pistons are at their uppermost position the cylinder liner apertures 108 and 110 remain in communication with the sub-divided annular space defined by the body 148 of the piston and the cylinder liner.

The cooling system is operative in the following manner. Air from the blower 146 is introduced into the chamber 122, and passes through the openings 126 to semi-circular chambers 128. The air then passes through apertures 108 in the liners 106 to reach the sub-divided annular space between the spool-like body of each piston and liner 106. The air stream is then sub-divided, one portion passing into the openings 162 of passages 160 in the head 154 of the piston, and the remaining portion passing around the spool body of the piston through the apertures 152 of ribs 150. The air issuing from the outlet openings 164 of the passages 160 is combined with the air passing around the body of the pistons to pass through the openings 110 of the liners 106 and into the semi-circular chambers 140. From the chambers 140 air passes into the chamber 134. During all portions of the strokes of the pistons 114 while the heads 154 thereof are above the liner openings 108 and 110, the heads and the bodies of the pistons are being cooled by the air, and the air is being stored in chambers 122 and 134 at a slight pressure corresponding to the back pressure of the blower 146. As the pistons 114 reach their lowermost position at the conclusion of the explosion stroke, the openings 108 and 110 are brought into communication with the combustion space above the pistons, whereupon the air stored in chambers 122 and 134 passes into the combustion space to scavenge the cylinders of combustion gases while the valves 112 are opened to their exhaust position.

Figs. 4 and 5 illustrate the specific adaptation of the cooling system of Figs. 2 and 3 to a four-cycle engine, with the structural elements of Figs. 4 and 5 similar to the corresponding elements of Figs. 2 and 3 being denoted by similar reference numbers. The essential distinctions of the cooling system of Figs. 4 and 5 over the above described cooling system of Figs. 2 and 3 are as follows: the members 130 and 132 have been inter-

connected by partitions 200 intersecting the partitions 132, thus isolating the semi-circular chambers 128 from each other, and similarly isolating the semi-circular chambers 140; the openings 126 and 138 have been provided with laterally extending side wall members 202; shafts 204 and 206 are journaled for rotation in the side walls 202, and each of the shafts 204 and 206 carry a plurality of damper valves 208 and 210, the valves 208 being located within the openings 126 and the valve 210 being located within the openings 138; and the chamber closure member 144 has been provided with exhaust pipes 212. The damper valves 208 and 210 are caused to rotate at one half the speed of the crank shaft through a connection, not shown, between the shafts 204 and 206 and a valve timing gear, also not shown, having a take-off from the crank shaft. Each damper valve 208 is affixed to the shaft 204 in a different position, said valves being predisposed in accordance with the firing cycle of the piston adjacent thereto, while each of the damper valves 210 is similarly disposed, with the setting of each on shaft 206 corresponding to the particular setting of the damper valve 208 opposed thereto.

The pistons of Figs. 4 and 5, similarly to those of Figs. 2 and 3, are so located in their lowermost positions that the openings 108 and 110 are brought into communication with the combustion space within the cylinder above the pistons, and the pistons are in this position at the end of their explosion stroke and also at the end of their suction stroke. The damper valves 208 and 210 are operable through rotation in timed relation to the crank shaft to sequentially close the openings 126 and the openings 138 to prevent the passage of air into the chambers 128 and 140 when their respective pistons are at the end of their suction strokes, thus preventing any passage of air through the openings 108 and 110 into the combustion space to disturb the combustion mixture in the cylinder. The valves 208 and 210 and the partitions 200 thus serve to sequentially isolate each of the chambers 128 and its corresponding chamber 140 from the air in the cooling system during the period when the pistons are at their lowermost positions in the suction stroke.

The fact that the chamber 134 is provided with exhaust pipes 212 prevents the building up of back pressure in the chambers 122 and 134, so that when the piston reaches the bottom of its explosion stroke and the ports 108 and 110 are disclosed to the combustion space within the cylinder, these ports serve as exhaust ports for the combustion gases to admit a portion thereof into the chamber 134 where it is mixed with the relatively cool air of the cooling system, thus providing an exhaust mixture of moderate temperature for issuance from the exhaust pipes 212 and consequently preventing localized overheating of the pipes and the walls of chamber 134. The exhaust pipes 212, being of relatively small diameter, prevent practically instantaneous emission of the air-gas mixture from the chamber 134 and enable an intimate mixing of the air and gas and consequent heat exchange between these components, with the result that a mixture of substantially uniform and moderate temperature passes through the pipes 212. The remainder of the combustion gases is exhausted from the combustion space by the piston during its upward or exhaust stroke.

It will thus be seen that I have provided a cooling system for internal combustion engines of

either the two-cycle or four-cycle type, which systems have the following desirable functions and advantages: the provision of internal cooling of the pistons whereby they are cooled from the inside to the outside, rather than in the conventional manner from the outside to the inside; the prevention of the passage of heat to the crank case oil system by the interposition of a continuously operating low temperature barrier between the high temperature areas of the piston and cylinder and the crank case; the provision of a combination cooling and lubrication system, as exemplified in the embodiment of Fig. 1; and the enabling of a considerable reduction in the weight of a combustion engine by making it possible to dispense with large water jackets and air cooling fins.

While specific embodiments of the cooling system of the invention have been illustrated and described in connection with both two-cycle and four-cycle engines, it is to be understood that the cooling system is subject to modification within the spirit of the invention and the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. A cooling system for an internal combustion engine having a cylinder and a piston reciprocally movable therein comprising, for the piston, head and skirt portions in wiping engagement with the cylinder and an intermediate reduced diametral portion of substantial length defining with the cylinder an annular chamber, a passageway extending through the head portion, said passageway being out of communication with the internal space of the piston below the head portion and having an inlet and an outlet in communication with said chamber, and a plurality of radially extending ribs subdividing said chamber into a plurality of sub-chambers, and, for the cylinder, an inlet and an outlet port in the wall thereof, each in communication with said chamber and so located with respect to the stroke of movement of the piston as to be in communication with said chamber throughout the predominant portion of the piston stroke, and blower means associated with said inlet port and operable to blow air into said port during the operation of the engine, said ribs being adapted to channel the air received in said chamber from said inlet port to the inlet of said passageway.

2. A cooling system as set forth in claim 1 wherein said ribs are provided with a plurality of apertures to allow a portion of the air received in said chamber to circulate through said chamber to said outlet port.

3. For an internal combustion engine of the two-cycle type, a cooling system comprising a piston and a cylinder, said piston being reciprocally movable in said cylinder and having an intermediate peripheral portion of substantial height defining with the cylinder an annular chamber, a passageway within the upper portion of the piston extending transversely thereof and having an inlet and outlet in communication with said chamber, an inlet port in the cylinder wall and an outlet port in the cylinder wall each communicable with said chamber and so located with respect to the stroke of movement of the piston as to be in communication with said chamber throughout the predominant portion of the piston stroke and to be disclosed to the combustion space within said cylinder when said piston is in its lowermost position, blower means associated with said inlet port and operable to

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blow air into said port during the operation of the engine, and a storage chamber in communication with said outlet port adapted to capture air from said outlet port, store said air under pressure, and release said air in the cylinder space above the piston to scavenge the same when said outlet port is disclosed to said cylinder space.

4. For an internal combustion engine of the four-cycle type, a cooling system comprising a piston and a cylinder, said piston being reciprocably movable in said cylinder and having an intermediate peripheral portion of substantial height defining with the cylinder an annular chamber, a passageway within the upper portion of the piston extending transversely thereof and having an inlet and outlet in communication with said chamber, an inlet port in the cylinder wall and an outlet port in the cylinder wall each communicable with said chamber and so located with respect to the stroke of movement of the piston as to be in communication with said chamber throughout the predominant portion of the piston stroke and to be disclosed to the combustion space within said cylinder when said piston is in its lowermost position, blower means associated with said inlet port and operable to blow air into said port during the operation of the engine, a movable damper valve at said inlet port between said blower and cylinder, means for driving the piston, and means having a connection with said driving means and adapted to move said damper valve in timed relation to the movement of said piston to close said inlet port to the passage of air when said port is disclosed to the combustion space of the cylinder at the end of the suction stroke of the piston.

5. A cooling system as set forth in claim 4 wherein a similar damper valve is provided for said outlet port and synchronized for movement with said inlet port valve to close said outlet

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port simultaneously with the closure of said inlet port.

6. For an internal combustion engine, a piston comprising equal diametral head and lower skirt portions and an intermediate portion of lesser diameter, a passageway, closed to the internal space of the piston, formed within the head portion and having an inlet and an outlet in surfaces of the piston defining said cored portion.

7. For an internal combustion engine, a piston comprising equal diametral head and lower skirt portions and a cored intermediate portion, a passageway, closed to the internal space of the piston, formed within the head portion, the intermediate portion of said passageway extending transversely of said head portion and the end portions of said passage extending downwardly to terminate respectively in an inlet and an outlet in surfaces of the piston defining said cored portion.

8. For an internal combustion engine, the piston structure of claim 7, wherein said piston is further provided with a plurality of spaced ribs extending lengthwise of said cored portion and radially therefrom to the diametral limits of said head and lower skirt portions, said ribs being provided with apertures therethrough.

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