Aug. 15, 1967 J. T. WENTWORTH 3,335,643

INTERNAL COMBUSTION ENGINE HAVING PISTON WITH SEALED COMPRESSION RING

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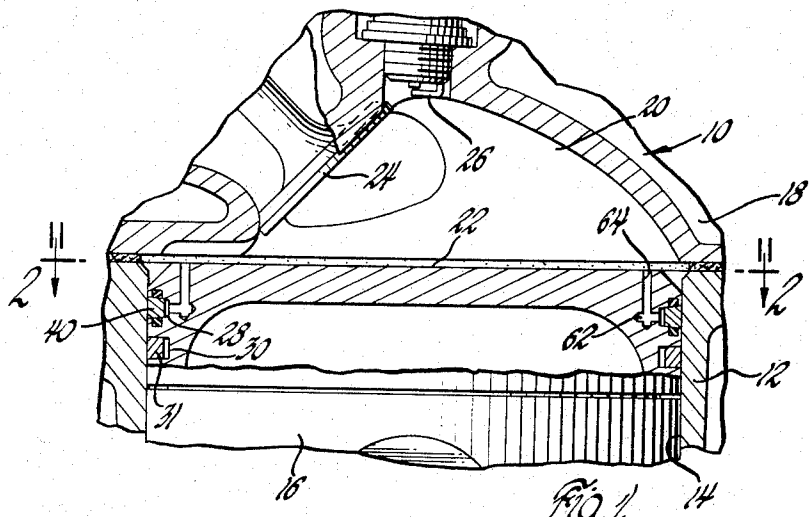

Fig. 1

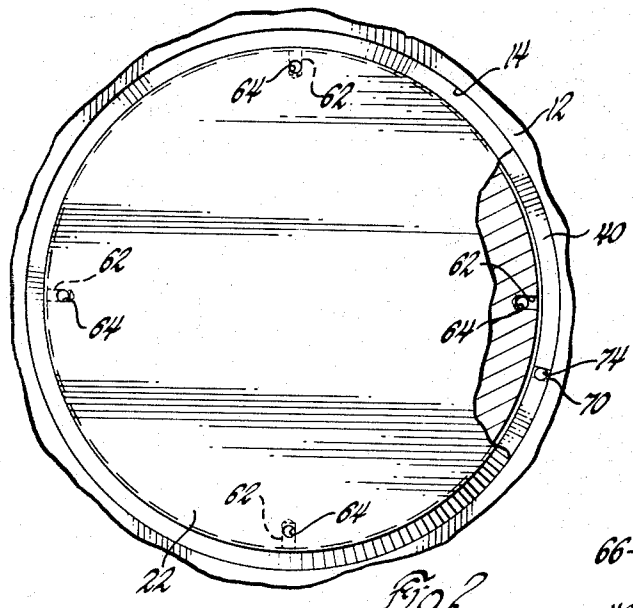

Fig. 2

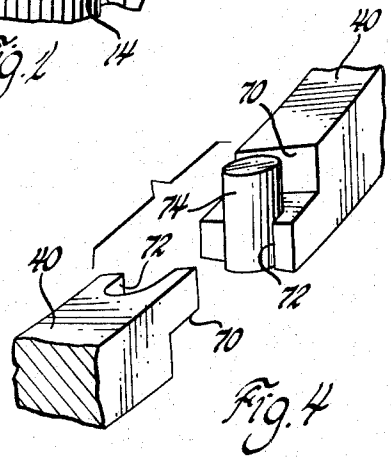

Fig. 4

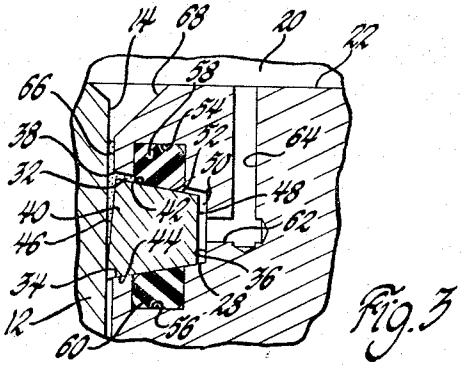

Fig. 3

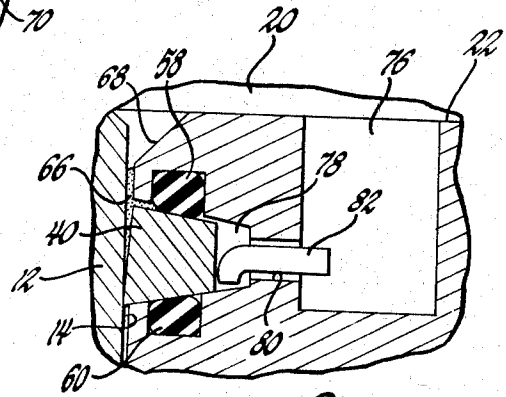

Fig. 5

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INTERNAL COMBUSTION ENGINE HAVING PISTON WITH SEALED COMPRESSION RING

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14 Claims. (Cl. 92—182)

ABSTRACT OF THE DISCLOSURE

An internal combustion engine having a piston assembly arranged to reduce crevice volume surrounding the upper end of the piston and in the top ring groove. This is accomplished by sealing the sides of the top compression ring and, further, by providing a generous chamfer at the edge of the piston crown. Passages connect the crown of the piston with the ring back clearance to equalize pressures on the ring. The arrangement reduces the emission of unburned hydrocarbons from the engine exhaust and improves oil control.

This invention relates to internal combustion engines and, more particularly, to an internal combustion engine piston having a ring groove carrying a compression ring and sealing means for preventing leakage of fluids between the outer diameter of the piston and the bottom of the piston ring groove for the purpose of minimizing the emission of unburned hydrocarbons in the engine exhaust and improving oil control.

The minimization of unburned hydrocarbons in the exhaust gases of internal combustion engines is considered desirable in reducing problems of air pollution and smog existing in some metropolitan areas. I have discovered that a substantial reduction in the construction of hydrocarbons in the exhaust of piston type internal combustion engines can be made by sealing the sides and end gap of the top compression ring so as to prevent the leakage of combustion gases and other fluids from the face of the cylinder walls adjacent the ring to the clearance volume behind the ring adjacent the bottom of the piston ring groove.

In order to permit the successful operation of such a construction without creating excessive blowby, means must be provided to prevent the collapse of the compression ring due to combustion pressures exerted on the face of the ring. Many possible means of accomplishing this could be utilized; for example, use of a ring of extremely high face pressure, spring devices behind the ring to increase its face pressure, or means to pressurize the clearance volume behind the ring to balance the pressures exerted on the ring face. While all such means are considered to be within the scope of this invention in certain of its broader aspects, I have solved the problem by providing an alternate path for the admittance of combustion pressures behind the compression ring. This path has, for example, taken the form of a drilled passage through the piston crown connecting the clearance volume behind the ring with the combustion chamber. The resulting construction has been found not only to substantially reduce the amount of hydrocarbons present in the exhaust gases of the engine, but has also been shown to reduce the amount of lubricating oil leaking past the top compression ring into the combustion chamber.

The reasons for the foregoing are not yet completely clear, but it is thought to be in part a result of the reduction in crevice volume surrounding the piston which communicates with the cylinder wall above the top ring groove. Apparently, hydrocarbons entering clearance

volumes above and behind the top ring, from the adjacent cylinder wall, are not completely consumed during the combustion cycle of the engine but are at least partially exhausted in an unburned state, whereas the sealing of this portion of the crevice volume from connection with the cylinder wall and its connection with the combustion chamber through the piston crown permits the burning of an increased percentage of hydrocarbons entering this volume during operation of the engine. In addition, it appears that the sealing of the sides and gap of the top compression ring reduces the passage of oil around the back of the ring, thereby resulting in better oil control.

Further objects and advantages of the present invention will be apparent from the following description and drawings of a preferred embodiment in which;

FIGURE 1 is a fragmentary cross-sectional view of an internal combustion engine including a piston embodying the invention;

FIGURE 2 is a fragmentary cross-sectional view taken generally along the line 2—2 of FIGURE 1 and partially broken away to show details of the piston orifice and piston ring;

FIGURE 3 is an enlarged cross-sectional view of a portion of FIGURE 1 showing the construction of the piston, piston ring, sealing means and orifice;

FIGURE 4 is a fragmentary perspective view of a portion of a top compression ring according to the invention showing the means of sealing the end gap; and

FIGURE 5 is a fragmentary cross-sectional view similar to FIGURE 3 but showing an alternative arrangement for connecting the back clearance of the ring with the combustion chamber.

Referring now to the drawings, numeral **10** generally indicates an internal combustion engine which, as illustrated, is of the spark ignition type but may also, within the scope of the invention, be of the compression ignition type. The engine includes a cylinder block **12** including a cylinder **14** in which is reciprocably disposed a piston **16**. The upper end of the cylinder **14** is closed by a cylinder head **18** which includes a combustion chamber cavity **20** open at its lower edge to the crown **22** of the piston. The cylinder head carries the usual valves **24** and spark plug **26** which extend into the combustion chamber.

The piston **16** may be of generally conventional construction with certain exceptions to be noted subsequently and is shown in the illustration to include a flat crown **22** and to have upper and lower ring grooves **28** and **30** respectively for receiving compression rings. Suitable oil ring grooves (not shown) may also be provided in the piston. The lower ring groove **30** may be arranged to receive a compression ring **31** of any suitable type or, if desired, the lower ring and its ring groove may be completely dispensed with or it may be made in a manner similar to the top ring groove to be subsequently described.

The top ring groove **28** is preferably located as close to the piston crown as is consistent with good design practice and, as best shown in FIGURE 3, is formed with inwardly converging upper and lower side walls **32** and **34** respectively which result in the bottom **36** of the groove being slightly narrower than its outer portion **38**.

Carried within the top ring groove is a compression ring **40** having tapered upper and lower faces **42** and **44** respectively extending generally parallel to and adapted to seat against groove side walls **32** and **34** respectively. The outer face **46** of the piston ring may also be tapered slightly to engage the wall of cylinder **14** at its lower edge.

With the piston and ring installed in the cylinder, suitable clearance, commonly known as back clearance,

is provided between the back face **48** of the ring and the groove bottom **36** resulting in a clearance volume **50** behind the ring. During the compression and combustion portions of each cycle, the compression ring **40** is forced downwardly against lower groove side wall **34** so that clearance volume **50** connects with an adjacent clearance volume **52** between the upper side wall **32** and upper face **42** of the groove and ring respectively.

Intermediate the inner and outer extremities of the ring groove **28**, annular seal grooves **54** and **56** are provided in the upper and lower side walls **32** and **34** respectively. These grooves receive O-ring seals **58** and **60** contacting the upper and lower faces respectively of the compression ring and preventing the passage of fluids from clearance volumes **50** and **52** to the outer portion of the groove adjacent the cylinder wall.

Clearance volumes **50** and **52** are, however, connected with the combustion chamber cavity **20** through intersecting drilled passages **62** and **64** extending through the upper surface of the piston crown. If desired, a plurality of such drilled passages may be provided as shown in FIGURES 1 and 2 to connect the clearance volume **50** with the combustion chamber at various locations around the piston crown.

Also, the crevice volume **66** adjacent the cylinder wall is preferably reduced by providing a large chamfer **68** around the edge of the piston crown and extending downwardly toward the first ring groove surface as far as is practical.

In order to prevent the leakage of fluids through the ring gap, the gap is stepped as shown at **70** in FIGURE 4 and rounded slots **72** are provided in the extending portions of the stepped gap to receive a cylindrical seal member **74**. When the gap is then closed to its proper dimension as seen in FIGURE 2, overlapping of the stepped gap prevents the vertical passage of gases through the gap and the seal member **74** prevents leakage between the inner and outer faces of the ring.

In FIGURE 5 an alternative embodiment is shown which is similar to that of FIGURE 3 except for the passages connecting the ring back clearance volumes with the combustion chamber. In this arrangement, a large passage **76** is provided in the piston crown conecting with the combustion chamber cavity **20**. Passage **76** is connected with the ring back clearance volume **78** by a smaller drilled orifice **80** in which is disposed a jiggle pin **82** arranged to keep the orifice free of deposits by its jiggling motion in operation.

The size of the passage or orifice connecting the ring back clearance volume with the combustion chamber cavity is important in that it must be sufficiently large to permit combustion gas pressures behind the piston ring to closely match the same pressures applied on the face of the ring. If the passage is too small, pressure build-up behind the ring will lag that on the ring face, causing the ring to collapse momentarily on each cycle with resulting blowby and poor performance.

In the FIGURE 5 embodiment, the orifice size is held constant by the cleaning action of the jiggle pin. This construction, or a suitable alternative, would be required in engines where plugging of the passage by deposits is a problem and frequent cleaning is not possible. If, however, the passage through the piston crown can be made sufficiently large or the engine deposit level is low, such self-cleaning constructions may not be required.

The foregoing disclosure relates to only preferred embodiments of the present invention and it is intended to cover all changes and modifications which may be made within the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. In combination with an internal combustion engine having a cylinder and a combustion chamber at one end of said cylinder, a piston assembly installed for reciprocation in said cylinder and comprising

a cylindrical piston having a peripheral groove,

a compression ring in said groove and contacting said cylinder to seal said combustion chamber, said ring and said groove defining a clearance volume behind said ring and

seal means extending between said piston and said ring and sealing said clearance volume against fluid leakage from the outer surface of said piston.

2. The combination of claim **1** wherein said piston includes a chamfered edge, said chamfer extending as far as practical toward said peripheral groove to reduce the crevice area between said piston and said cylinder.

3. In combination with an internal combustion engine having a cylinder and a combustion chamber at one end of said cylinder, a piston assembly installed for reciprocation in said cylinder and comprising

a cylindrical piston having a peripheral groove,

a compression ring in said groove and contacting said cylinder to seal said combustion chamber, said ring and said groove defining a clearance volume behind said ring,

seal means extending between said piston and said ring and sealing said clearance volume against fluid leakage from the outer surface of said piston and

passage means through said piston and connecting with said groove inwardly of said seal means to permit the conducting of combustion chamber pressures to said clearance volume.

4. The combination of claim **3** wherein said compression ring in discontinous at a point of its circumference to permit installation of said ring in said piston groove and said assembly includes means for sealing said discontinuity to prevent leakage therethrough into said clearance volume.

5. A piston assembly for use in an internal combustion engine having a cylinder and a combustion chamber at one end of said cylinder, said piston assembly being adapted to be installed for reciprocation in said cylinder and comprising

a cylindrical piston having a peripheral groove,

a compression ring in said groove and adapted to contact said cylinder to seal said combustion chamber, said ring and said groove defining a clearance volume behind said ring,

seal means extending between said piston and said ring and sealing said clearance volume against fluid leakage from the outer surface of said piston and

passage means through said piston and connecting with said groove inwardly of said seal means to permit the conducting of combustion chamber pressures to said clearance volume,

said compression ring including upper and lower faces and said seal means comprising annular members extending between said upper and lower faces and said piston.

6. The combination of claim **5** wherein said peripheral groove includes upper and lower side walls, each of said side walls having an annular seal groove opening therethrough, said annular members comprising resilient seal rings disposed one in each of said annular seal grooves and extending therefrom into sealing contact with the upper and lower side faces of said compression ring.

7. The combination of claim **6** wherein said compression ring is discontinuous at a point of its circumference to permit installation of said ring in said piston groove and said assembly includes means for sealing said discontinuity to prevent leakage therethrough into said clearance volume, said means for sealing said discontinuity comprising vertical grooves in the ends of said ring and resilient seal means received in said vertical grooves and extending between said upper and lower faces of the ring.

8. The combination of claim **7** wherein said passage means includes an orifice portion and jiggle pin means through said orifice portion to clean said orifice portion during reciprocation of said piston assembly.

9. A piston assembly for use in an internal combustion engine having a cylinder and a combustion chamber at one end of said cylinder, said piston assembly being adapted to be installed for reciprocation in said cylinder and comprising

a cylindrical piston having a peripheral groove,

a compression ring in said groove and adapted to contact said cylinder to seal said combustion chamber, said ring and said groove defining a clearance volume behind said ring,

seal means extending between said piston and said ring and sealing said clearance volume against fluid leakage from the outer surface of said piston and

passage means through said piston and connecting with said groove inwardly of said seal means to permit the conducting of combustion chamber pressures to said clearance volume,

said passage means including an orifice portion and said assembly including means to clean said orifice portion during reciprocation of said piston assembly.

10. The combination of claim 7 wherein said piston includes a chamfered edge, said chamfer extending as far as practical toward said peripheral groove to reduce the crevice area when said piston is installed in the cylinder.

11. In an internal combustion engine having a cylinder and closure means at one end of said cylinder,

a cylindrical piston reciprocably disposed in said cylinder and having a diameter less than said cylinder so as to leave a predetermined piston-to-cylinder clearance, said piston having an end facing said closure means and cooperating therewith to define a combustion chamber,

a peripheral groove around said piston near said end and having upper and lower side walls and a bottom wall,

a compression ring in said groove and being urged into contact with said cylinder to prevent the leakage of combustion gases from said combustion chamber through said piston-to-cylinder clearance, said compression ring having upper and lower faces spaced apart a lesser distance than said groove upper and lower side walls so as to permit clearance therebetween and having an inner diameter spaced from said groove bottom wall to form a clearance volume, said compression ring being discontinuous at a point on its circumference to provide for normal expansion and installation of the ring,

first seal means between said ring upper face and said piston to prevent direct communication of said clearance volume with said piston-to-cylinder clearance above said piston ring,

second seal means between said ring lower face and said piston to prevent direct communication of said clearance volume with said piston-to-cylinder clearance below said piston ring and

passage means through said piston closed end and connecting with said clearance volume to communicate said volume with said combustion chamber.

12. The combination of claim 11 wherein said piston ring includes overlapping tongues at said point of discontinuity to prevent passage of fluid from the top to the bottom of said ring, said overlapping tongues including vertically aligned slots extending therethrough and seal means received in said slots to seal said ring discontinuity to prevent communication between said clearance volume and said piston-to-cylinder clearance through said discontinuity.

13. The combination of claim 11 wherein said first and second seal means comprise annular seal grooves in said upper and lower groove side walls and resilient seal means disposed in each of said seal grooves and extending therefrom into sealing contact with the upper and lower faces of said compression ring.

14. The combination of claim 13 wherein said compression ring upper and lower faces and said groove upper and lower side walls are slightly tapered tending to converge radially inwardly.

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EDGAR W. GEOGHEGAN, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,335,643 August 15, 1967

Joseph T. Wentworth

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 30, for "purpose" read -- purposes --; line 37, for "construction" read -- concentration --; column 4,line 30, for "in" read --is --.

Signed and sealed this 13th day of August 1968.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents