

June 26, 1945.

E. W. KETTERING

2,379,359

PISTON

Filed Jan. 9, 1943

2 Sheets-Sheet 1

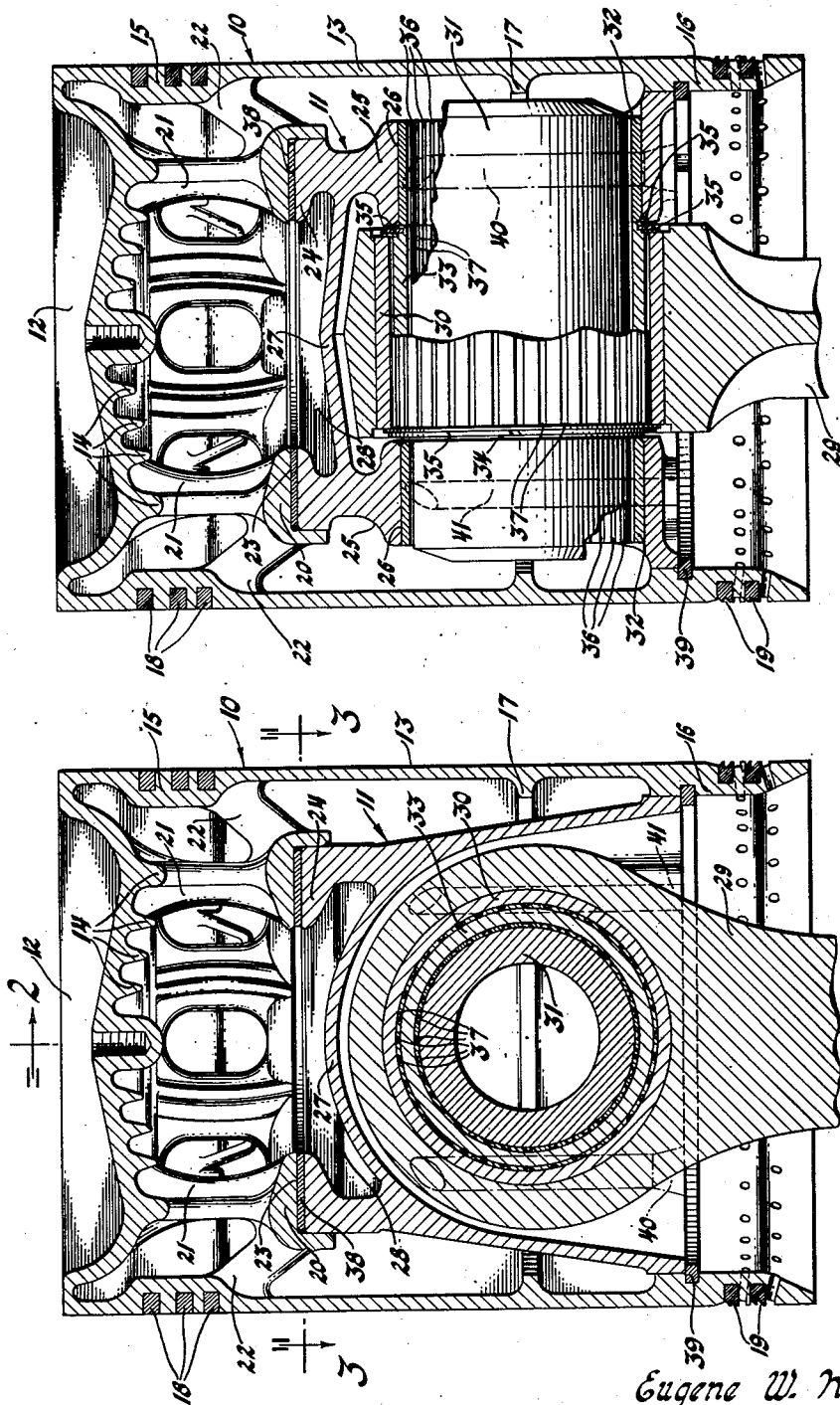


Fig. 2

Fig. 1

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2 Sheets-Sheet 2

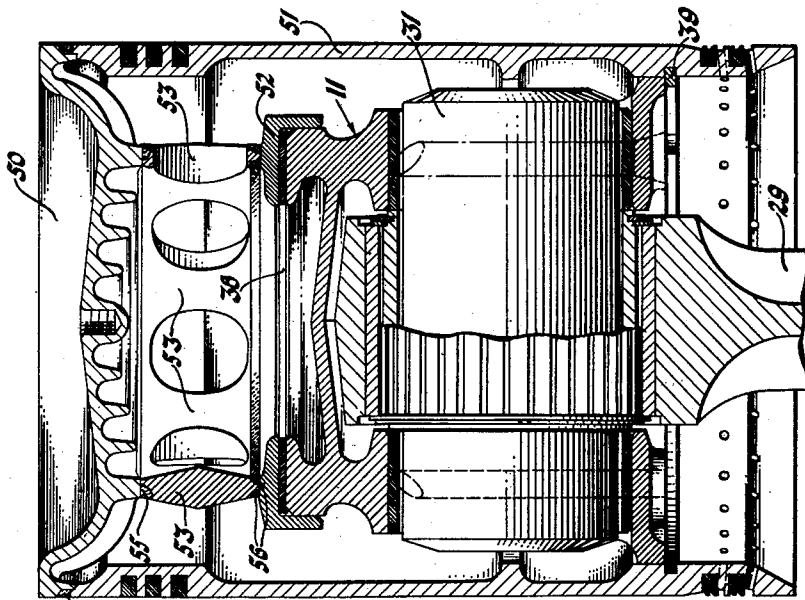


Fig. 5

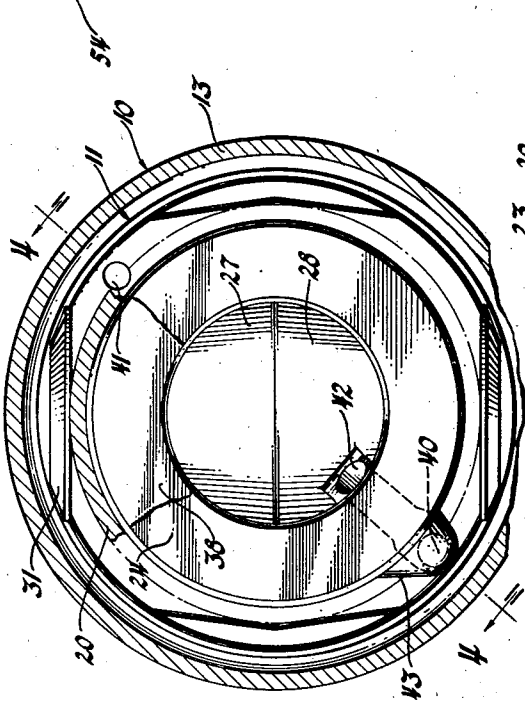


Fig. 3

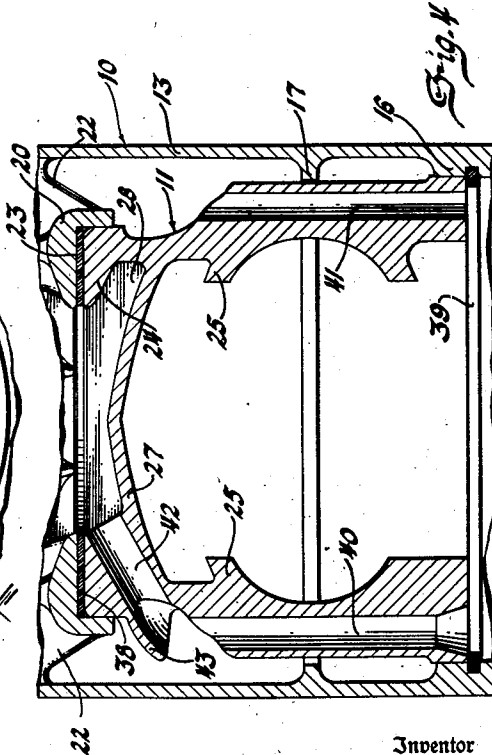


Fig. 4

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UNITED STATES PATENT OFFICE

2,379,359

PISTON

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23 Claims. (Cl. 309—19)

Many of the outstanding defects of pistons of the type usually found in internal combustion engines are basically attributable to the location of the bearings for the piston pins on the skirts of the pistons. This location of the bearings for the piston pins entails transmission of loads from one to the other of the crowns and the connecting rods through the skirts of the pistons and distortion of the skirts in the zones through which the loads are transmitted unless in these zones the skirts are made so thick that there is danger of transmission to the zones in which the piston rings are located of enough heat to carbonize lubricating oil and stick the piston rings.

The non-symmetrical construction, which the location of the bearings for the piston pins on the skirt of the pistons entails imparts to the pistons different expansion characteristics in different directions. These different expansion characteristics in different directions, in turn, aggravate the stresses which arise in the pistons when their temperatures are raised or lowered, makes it necessary to increase the clearances between the pistons and the cylinders in order to obviate seizing of the pistons when the engines are hot, which results in rocking of the pistons in the cylinders, blow-by, and oil pumping, and also results in uneven wear of the pistons at different points in their circumferences.

The fixed position, diametrically, of the bearings for the piston pins, which the location of them on the skirts of the pistons also entails, gives rise to the tendency to concentrate the wear on the pistons and promotes the tendency to concentrate the wear on the cylinders on the sides at right angles to the axes of the piston pin bearings, and this and the uneven wear which results from the different expansion characteristics in different directions and the hammering which results from rocking aggravate each other and the other defects which have been mentioned.

All of the mentioned defects, which reduce the efficiency and shorten the lives of the engines in which the pistons are installed, are exaggerated in the cases of the pistons of two-stroke cycle engines because these pistons operate at higher temperatures than do the pistons of four-stroke cycle engines.

This invention has to do with pistons, particularly with pistons for two-stroke cycle engines, although certain and, it may be, most features of it are applicable to pistons for four-stroke cycle engines.

The principal object of the invention is to pro-

vide pistons which are so constructed and in which the piston pins are so mounted that the defects mentioned above are obviated.

To improve further in the respects mentioned, 5 pistons in which are incorporated the features of my invention referred to above, I preferably construct the pistons so as to provide for internal cooling by a liquid, particularly the lubricating oil of the engine in which the pistons are installed.

Another object of the invention is to improve 10 pistons, particularly pistons in which are incorporated the features of my invention first referred to above, in respect to internal cooling by a liquid, particularly the lubricating oil of the engine in which the pistons are installed.

Still another object of the invention is to improve pistons, particularly pistons in which are 20 incorporated the features of my invention referred to above, in respect to lubrication of the piston pins.

For a better understanding of the nature and objects of this invention reference is made to the following specification and accompanying 25 drawings in which are described and illustrated the preferred embodiments of my invention.

In the accompanying drawings:

Figure 1 is an axial section at a right angle to the axis of the piston pin through a piston 30 in which is embodied my invention and the upper end of its connecting rod.

Figure 2 is, in the main, an axial section through the piston and connecting rod in the plane of the axis of the piston pin looking in the direction indicated by the arrows 2—2 in 35 Figure 1 but with parts in advance of the plane in elevation with parts broken away.

Figure 3 is a section through the piston at a right angle to its axis at the level indicated by 40 the line 3—3 of Figure 1.

Figure 4 is an axial section through the piston taken as indicated by the line 4—4 of Figure 3 with the connecting rod, piston pin and piston pin bushings removed and the ends of the 45 piston broken away.

Figure 5 is a view similar to Figure 2 of another piston in which is embodied my invention and the upper end of its connecting rod.

The piston shown in Figures 1 to 4 of the drawings includes a body 10 and a piston pin carrier 11. The body includes a concave crown 12 and a cylindrical skirt 13 which depends from the crown. On the underside of the crown there are formed coaxially with the body of the piston circular reinforcing and heat dissipating ribs 14. 55

The wall of the skirt is of uniform thickness throughout its circumference at all points in its length but there are on the inside of the skirt at its lower end and a short distance below its upper end protuberant bands 16 and 15 which increase the thickness of its wall in these zones and between these bands an annular rib 17. In outwardly opening annular grooves in the skirt opposite the bands 15 and 16 are installed split compression and oil control rings 18 and 19.

Within the body of the piston just below the band 15 there is an annular foot 20 which is coaxial with the body but spaced radially from the wall of the skirt. The foot 20 is connected to the crown in the region of the outermost of the ribs 14 and to the skirt in the region of the lower edge of the band 15 by eight similar vertically and eight similar diagonally upwardly extending equidistantly spaced struts 21 and 22. The body 10, foot 20 and struts 21 and 22 are, as the drawings indicate, cast in one piece of iron. In the lower face of the foot 20 there is formed an internal annular rabbet 23 which is coaxial with the body of the piston and whose faces are disposed at a right angle to the axis and coaxial with the body of the piston and finished to provide end and cylindrical lateral bearing surfaces for the upper end of the pin carrier 11. The inner face of the band 16 of the skirt is finished to provide a cylindrical lateral bearing surface coaxial with the body of the piston for the lower end of the pin carrier.

The pin carrier 11 is, as the drawings indicate, a one-piece casting, preferably of steel, shaped generally like a frusto-conical shell. Its length is somewhat greater than the distance from the end face of the rabbet 23 in the foot 20 to the band 16 of the skirt and it tapers from a diameter slightly less than the internal diameter of the band 16 at its lower end to a diameter slightly less than the diameter of the cylindrical face of the rabbet 23 at its upper end. On the upper end of the carrier there is formed an annular inwardly projecting lip 24 to increase its end bearing at that end to a value equal to that of the end face of the rabbet 23. At points diametrically opposite each other there are formed on the side wall of the carrier piston pin bosses 25 with aligned bores 26 in them. Across the interior of the carrier at a sufficient distance above the bosses 25 to clear the extremity of a connecting rod oscillatorily connected to the carrier by a piston pin installed in the bores 26 in the bosses 25 but below the lip 24 on the upper end of the carrier extends a partition 27 shaped generally like a segment of a cylinder coaxial with the bores 26. The partition 27 with the portions of the side wall of the carrier which extend upwardly beyond it define an upwardly open chamber 28 which at its perimeter increases in depth from points directly above the axis of the bores 26 to points at a right angle thereto.

The upper end of the carrier 11 is finished to provide a cylindrical lateral bearing surface coaxial with the carrier and an end bearing surface at a right angle thereto. The lower end of the carrier is finished to provide a cylindrical lateral bearing surface coaxial with the carrier. The carrier is preferably electroplated with cadmium or some other suitable metal to improve the bearing qualities of its bearing surfaces.

The small end of the connecting rod 29 through which extends a bore in which is fixed a case hardened steel sleeve 30 is disposed within the interior of the pin carrier 11 below the partition

27 and is connected to the pin carrier by the piston pin 31 which extends through the bores 26 in the piston pin bosses 25 and the sleeve 30. The piston pin 31 is journaled in bushings 32 pressed into the bores 26 in the bosses 25 and in a bushing 33 which is free to rotate in the sleeve 30 and is retained in place therein by retainer rings 34 and split snap rings 35 which hold them in place. In the inner surfaces of the bushings 32 there are formed lubricant grooves 36 which extend from end to end of the bushings and in both inner and outer surfaces of the bushing 33 there are formed lubricant grooves 37 which extend from end to end of the bushing.

As the drawings show the pin carrier 11 is disposed within the body of the piston with its upper end in the rabbet in the foot 20 and an anti-friction washer 38, preferably of sintered bronze, between its end bearing surfaces and the corresponding bearing surface of the rabbet and its lower end extending well into the band 16 of the skirt. It is held in this position by a plane split snap ring 39, preferably of cast iron, disposed in an annular groove in the band 16 below it. The rib 17 on the interior of the skirt 13 is located so that it will be at the level of the axis of the piston pin 31 when the pin carrier is installed in the body of the piston and serves to limit endwise movement of the piston pin.

The pin carrier is installed in the body of the piston by inserting it into it through its lower end and then springing the ring 39 into its groove in the band 16. The pin carrier and the body can, of course, be disassembled upon removal of the ring 39. This makes it possible, upon removal of the cylinder head of the engine, to remove the body of the piston from the cylinder without disassembling the connecting rod from the crankshaft. It also makes it possible to remove the connecting rod and pin carrier from the engine through the crankcase without removing the body of the piston from the cylinder or removing the cylinder head. The piston pin 31 and the connecting rod 29 are assembled with the pin carrier before it is installed in the body of the piston and may be disassembled from it after the pin carrier is removed from the body. There is, consequently, no occasion for providing in the skirt 13 openings through which the piston pin may be inserted into and withdrawn from its bearings in the pin carrier and connecting rod.

The fit of the pin carrier 11 in the body 10 of the piston, both lengthwise and radially, while not loose, is such that the body may rotate freely on the carrier. While I do not consider the values critical, I mention by way of example, that in pistons in which the pin carrier was approximately six inches (6") in diameter at its upper end, seven and one-half inches (7½") in diameter at its lower end and six inches (6") long total clearances of five to seven thousandths of an inch (0.005"-0.007") on the diameters and one to seven thousandths of an inch (0.001"-0.007") on the length were found satisfactory.

The space confined by the pin carrier 11 and the crown 12 and skirt 13 of the body 10 of the piston accommodates lubricating oil to cool the piston and lubricate the bearings of the pin carrier 11 and the piston pin 31. To provide for the introduction and escape of lubricating oil into and from this space there are provided in the wall of the pin carrier, which in the regions in which they are located is formed to accommodate them, bores 40 and 41 which extend through the pin carrier parallel to its axis from its lower end to

points at about the level of the uppermost portions of the bores 26 in the piston pin bosses. One of the bores 40 and 41 is disposed on one side of and as near as practicable to the bore 26 in one of the piston pin bosses and the other on the opposite side of and as near as practicable to the bore 26 in the other of the piston pin bosses. The bore 41 through which the oil escapes from the space is a plain cylindrical bore and the bore 40 through which oil is introduced into the space is like it except that its lower end is chamfered to facilitate the introduction of oil into it. Through the pin carrier there also extends upwardly and radially with respect to it, from a point just above the upper end of the bore 40 into the chamber 28 at its perimeter at a point above the lowest level of its bottom a bore 42 whose axis intersects the axis of the bore 40. To direct oil from the bore 40 into the bore 42 and, thence, into the chamber 28, there is formed on the pin carrier a baffle 43 which extends from the upper side of the bore 42 over the upper end of the bore 40.

The body, the foot and the struts which connect the foot to the body of the piston shown in Figures 1 to 4 may be formed, instead of in one piece, of several pieces suitably secured together. In Figure 5 of the drawings there is shown an example of a piston of this type.

The piston shown in Figure 5 includes a crown 50, a skirt 51, a foot 52 and seven struts 53 formed separately of steel and secured together by welding, as indicated at 54, 55 and 56, in the same relation as are the corresponding elements of the piston shown in Figures 1 to 4. To facilitate handling of the struts 53 and assembly of them with the crown 50 and foot 52, the struts 53 are, preferably, as shown in the drawings, formed as parts of a one-piece element of ring-like form. The struts 53, of course, correspond to the vertically disposed struts 21 but there are in the piston shown in Figure 5 no struts which correspond to the diagonally disposed struts 22 of the piston shown in Figures 1 to 4. Except in the indicated respects, the piston shown in Figure 5 is like that shown in Figures 1 to 4.

The pistons shown in the drawings and hereinbefore described were designed for installation in two-stroke cycle internal combustion engines with nozzles in their crankcases aligned with the bores 40 in the pin carriers 11 and connected to the lubricating systems of the engines so that when the engines are operating streams of lubricating oil are continuously squirted from the nozzles into the bores. The oil squirted into the bore 40 is deflected by the baffle 43 into the bore 42 and, thence, into the chamber 28. The hiatus at the junction of the bores 40 and 42 permits oil which drains from the chamber 28 through the bore 42 to flow into the space between the side wall of the pin carrier and the skirt of the piston instead of into the bore 40 and thus obviates interference by oil draining from the chamber 28 through the bore 42 with introduction of further oil into the chamber. Location of the inner end of the bore 42 at a point above the lowest level of the bottom of the chamber 28 insures that the volume of oil in the chamber will never be reduced below a fixed value by drainage through the bore 42.

Upon deceleration of the piston in the direction toward which the chamber 28 faces or acceleration of the piston in the opposite direction, the oil in the chamber 28 is dashed by inertia onto the portion of the crown 12 (or 50) directly

above the chamber and onto the struts 21 (or 53) and, through the openings between the struts, onto the band 15 of the skirt and the portion of the crown between the skirt and the struts. The chamber 28 is, of course, in the interest of uniformity and adequacy of cooling, made of sufficient capacity to hold enough oil to drench the crown, the struts and the band 15 of the skirt when it is dashed onto them. It may be that the oil which is dashed onto the crown is momentarily held against it by inertia. In any event, immediately or after a moment, the oil which has been dashed out of the chamber 28 drops, or flows down the skirt 13 or the struts 21 (or 53) or splashes or is dashed by inertia back into the chamber or into the space between the side wall of the pin carrier and the skirt. To reach the last mentioned space, the oil, in the case of the piston shown in Figures 1 to 4, passes through the spaces between the skirt and the foot 20 and the struts 22 or flows over the struts 22 or, in the case of the piston shown in Figure 5, passes through the space between the skirt and the foot 52. In this way the space between the side wall of the pin carrier and the skirt is kept filled with oil up to the level of the upper end of the bore 41 through which the excess escapes into the crankcase of the engine.

Of course, upon deceleration of the piston in the direction toward which the chamber 28 faces or acceleration of the piston in the opposite direction, the oil in the space between the side wall of the pin carrier and the skirt is also dashed upwardly by inertia. Besides moving about in the space confined by the pin carrier and the body of the piston in the particular manners which have been mentioned the oil in this space drops, and flows and is dashed and splashed and welters around more or less at random. The total result of all this movement and the continuous replacement with cooler oil of the oil heated by contact with the interior of the piston is to efficiently and uniformly cool the whole of the piston. The efficiency and uniformity of the cooling, particularly of the crown, is augmented by conducting the oil introduced through the bore 40 into the chamber and dashing it therefrom onto the crown, instead of squirting it directly onto the crown, since the former results in more general and even application of the oil to the crown.

Side thrust is transmitted from one to the other of the connecting rods and the skirts of the pistons shown in the drawings through the pin carriers and their lateral bearings on the bands 16 of the skirts and the feet 20 and 52. In the case of the piston shown in Figure 5, the portion of the side thrust transmitted through the lateral bearing of the pin carrier on the foot 52 is transmitted from one to the other of the foot and the skirt through the vertically disposed struts 53 and the crown 50. In the case of the piston shown in Figures 1 to 4, the portion of the side thrust transmitted through the lateral bearing of the pin carrier on the foot 20 is transmitted from one to the other of the foot and the skirt, partly through the vertically disposed struts 21 and the crown 12, but mainly through the diagonally disposed struts 22.

Loads are transmitted from one to the other of the connecting rods and the crowns of the pistons, not through the skirts of the pistons, but through the pin carriers, their end bearings on the feet 20 and 52, the feet 20 and 52 and the vertically disposed struts 21 and 53. Consequently, the skirts need be only thick enough to withstand

safely without distortion the portion of the side thrust transmitted to them through the crowns of the pistons. This makes it possible to reduce the skirts in thickness in the zones between the crowns and the bands 15 in which the compression rings are located, to the end of reducing the amount of heat transmitted from the crowns to the bands through these zones, without danger of distortion of the skirts in these zones. This and the cooling of the bands 15 in which the compression rings are located by the oil splashed on them minimizes danger of these bands attaining a sufficiently high temperature to carbonize lubricating oil and stick the rings.

Since the bodies, the feet and the struts which join the feet to the bodies of the pistons shown in the drawings are symmetrical with respect to all planes within which the axes of the bodies lie and the bodies are not fixed to the pin carriers, the bodies of the pistons will expand uniformly in all directions radially and the stresses which arise in the first mentioned elements when the temperatures of the pistons are raised or lowered are minimized. The uniformity of expansion of the bodies of the pistons in all directions radially and the minimization of the stresses which arise in the bodies, the feet and the struts of the pistons when the temperatures of the pistons are raised or lowered, of course, makes it possible to fit the pistons in the cylinders with less clearance without incurring danger of seizing when the pistons are hot, with the advantages hereinbefore indicated, and lengthens the lives of the pistons. The properties mentioned are, of course, augmented by the efficient and uniform cooling of the pistons.

When the pistons shown in the drawings and hereinbefore described are installed in an internal combustion engine and the engine is operating the bodies of the pistons rotate about their axes on the pin carriers under the influence of a force to which the pistons are inherently subjected as a result of operation of the engine. To what this force is attributable I have not ascertained but it has been suggested that it is attributable to the unavoidable minute lateral play of the pistons in the cylinders. However this may be, the rotation has the very desirable effect of eliminating the tendency to concentrate the wear on two sides of the pistons and reducing the tendency of the cylinders to wear out of round since it naturally results in uniformizing the wear of the pistons at all points in their circumferences and maintaining them of the same shape as the cylinders. Also, particularly in engines whose cylinders are not vertically disposed, the rotation has the further very desirable effect of promoting uniformity of cooling of the pistons by the oil introduced into their interiors.

The upper end and lateral bearings of the pin carriers are kept thoroughly lubricated by the oil which drops and flows and is dashed and splashed and welters around in the spaces confined by the pin carriers and the bodies of the pistons. The lower lateral bearings of the pin carriers, the bearings of the piston pins and the bearings of the bushings 33 on the sleeves 30 are kept thoroughly lubricated by seepage of oil from the supplies in the spaces between the side walls of the carriers and the skirt. In the cases of the bearings of the piston pins and the bearings of the bushings 33 on the sleeves 30, the seepage is through the oil grooves in the surfaces of the bushings 32 and, thence, to the oil grooves in the surfaces of the bushings 33. However, to in-

sure that the mentioned bearings will be adequately lubricated until sufficient oil reaches them from the supplies in the spaces confined by the pin carriers and the bodies of the pistons, I consider it desirable to lubricate these bearings thoroughly before the pistons are installed in an engine.

Offhand, the rings 39 may appear inadequate to hold the pin carriers in the pistons. But when it is considered that in two-stroke cycle internal combustion engines the load transmitted from one to the other of the pistons and the connecting rods is always compressive, it will be seen that there is actually no need for anything to hold the piston carriers in the pistons while the engines are operating normally. And further, it has been found that the rings 39 are adequate to hold the pin carriers in the pistons even when the pistons seize badly in the cylinders.

I claim:

1. In a piston, a body, and means for transmitting motion from one to the other of the body and a connecting rod including an element on which the connecting rod may oscillate with respect to the body, and a member interposed between the element and the body but not fixed with respect to the body.

2. In a machine, a piston which includes a body, and means for transmitting motion from one to the other of the body and a crank including a rod with respect to which the body is rotatable under the influence of a force to which it is inherently subjected as a result of operation of the machine.

3. In a piston, a body, and means for transmitting motion from one to the other of the body and a connecting rod including an element on which the connecting rod may oscillate with respect to the body, and a member with respect to which the body is rotatable interposed between the element and the body.

4. In a piston, a body which is substantially symmetrical with respect to all planes within which its axis lies and within which there is an end bearing surface which faces away from its crown and a cylindrical lateral bearing surface coaxial with the body, and means for transmitting motion from one to the other of the body and a connecting rod including a member which is disposed within the body and on which there are end and cylindrical lateral bearing surfaces disposed opposite the corresponding bearing surfaces on the body so that the body may rotate with respect to the member.

5. In a piston, a body which is substantially symmetrical with respect to all planes within which its axis lies and within which there is at a distance from its crown a cylindrical lateral bearing surface coaxial with the body, a member within the body which is disposed between its crown and the mentioned bearing surface and is substantially symmetrical and joined to the body substantially symmetrically with respect to all planes within which the axis of the body lies and on which there is an end bearing surface which faces away from the crown and a cylindrical lateral bearing surface coaxial with the body, means for transmitting motion from one to the other of the body and a connecting rod including a member which is disposed within the body and on which there are end and cylindrical lateral bearing surfaces disposed opposite the corresponding bearing surfaces on the body and the first specified member so that the body may rotate with respect to the second specified mem-

ber under the influence of a force to which it is inherently subjected as a result of operation of the piston, and means to retain the second specified member within the body disposed at the end of the second specified member most distant from the crown but movable to a position in which the second specified member may be removed from the body.

6. In a piston, a body which includes a crown and a skirt, a chamber within the body opposite the center of the crown with an open side which faces the crown and through which cooling liquid may be dashed from the chamber onto the center of the crown by inertia as a result of deceleration of the piston in the direction toward which the chamber faces or acceleration of the piston in the opposite direction, and a passage through which cooling liquid may be introduced into the chamber without first striking the crown.

7. In a piston, a body which includes a crown and a skirt, a chamber within the body with an open side which faces the crown and through which cooling liquid may be dashed from the chamber onto the crown by inertia as a result of deceleration of the piston in the direction toward which the chamber faces or acceleration of the piston in the opposite direction, a passage through which cooling liquid may be introduced into the chamber including a section into which cooling liquid may be squirted and a section through which cooling liquid may pass from the first mentioned section into the chamber, and a hiatus in the passage at the junction of the sections through which cooling liquid which drains from the chamber into the second mentioned section of the passage may escape therefrom to obviate interference of it with introduction of further cooling liquid into the chamber.

8. In a piston, a body which includes a crown and a skirt, a member with an opening through it disposed within and crosswise of the body and fixed with respect to the body with spaces between it and the crown and the skirt, a member through which and the first specified member motion is transmitted from one to the other of the body and a connecting rod disposed within the body, a chamber in the second specified member with an open side which faces the crown and registers with the opening in the first specified member and through which and the opening in the first specified member cooling liquid may be dashed from the chamber onto the crown by inertia as a result of deceleration of the piston in the direction toward which the open side of the chamber faces or acceleration of the piston in the opposite direction, a passage through which cooling liquid may be introduced into the chamber and drained therefrom without interfering with the introduction of further cooling liquid into the chamber including a section which extends lengthwise through the second specified member from its end which is most distant from the crown to a point nearer the region in which the chamber is located and into which cooling liquid may be squirted and a section which extends laterally through the second specified member into the chamber from a point beyond the last mentioned end of the first mentioned section, and means for deflecting cooling liquid squirted out of the last mentioned end of the first mentioned section into the second mentioned section and, thence, into the chamber.

9. In a piston, a body which includes a crown and a skirt, a member with piston pin bearings in it disposed within the body with an annular

chamber closed at its end most distant from the crown into which open the piston pin bearings between it and the skirt, grooves which extend lengthwise of the bearings and open into the chamber in the surfaces of the bearings, and a passage through which lubricant may be introduced into the chamber and, thence, into the grooves in the bearings.

10. In a machine, a piston which includes a crown and a skirt, a member with piston pin bearings in it disposed within the body with an annular chamber closed at its end most distant from the crown into which open the piston pin bearings between it and the skirt, a connecting rod with a piston pin bearing in it, a piston pin journaled in the bearings in the member and the connecting rod, grooves in the surfaces of the bearings which extend from ends to ends of the bearings, and a passage through which lubricant may be introduced into the chamber and, thence, successively, into the grooves in the bearings in the member and the grooves in the bearing in the connecting rod.

11. In a piston, a body which includes a crown and a skirt and is substantially symmetrical with respect to all planes within which its axis lies, an annular member which is substantially symmetrical with respect to all planes within which its axis lies disposed within the body substantially coaxially therewith and with spaces between it and the crown and skirt and joined to the body substantially symmetrically with respect to all planes within which the axis of the body lies, an end bearing surface which faces away from the crown on the annular member, cylindrical lateral bearing surfaces on the annular member and the skirt farther distant from the crown than the annular member, means for transmitting motion from one to the other of the body and a connecting rod including a member which is disposed within the body and on which there are end and cylindrical lateral bearing surfaces disposed opposite the corresponding bearing surfaces on the annular member and the skirt so that the body may rotate with respect to the second specified member under the influence of a force to which it is inherently subjected as a result of operation of the piston, a chamber in the second specified member with an open side which faces the crown and registers with the opening in the annular member and through which and the opening through the annular member lubricant may be dashed onto the crown by inertia as a result of deceleration of the piston in the direction in which the open side of the chamber faces or acceleration of the piston in the opposite direction, a passage through which lubricant may be introduced into the chamber and supplied to the mentioned bearing surfaces and drained from the chamber without interfering with the introduction of further cooling liquid into the chamber including a section which extends lengthwise through the second specified member from its end which is most distant from the crown to a point nearer the region in which the chamber is located and into which cooling liquid may be squirted and a section which extends laterally through the second specified member into the chamber from a point beyond the last mentioned end of the first mentioned section, means for deflecting cooling liquid squirted out of the last mentioned end of the first mentioned section into the second mentioned section and, thence, into the chamber, and means to retain the second specified member within the

body disposed at the end of the second specified member most distant from the crown but movable to a position in which the second specified member may be removed from the body.

12. In a piston, a body, means for transmitting motion from one to the other of the body and a connecting rod including an element on which the connecting rod may oscillate with respect to the body, a member with respect to which the body is rotatable interposed between the element and the body, and a passage through which lubricant may be introduced into the body to cool the piston and lubricate the bearings on which the body is rotatable with respect to the member and the connecting rod oscillates with respect to the body.

13. In a machine, a piston which includes a body which includes a crown and a skirt and is substantially symmetrical with respect to all planes within which its axis lies, an annular member which is substantially symmetrical with respect to all planes within which its axis lies disposed within the body coaxially therewith and with spaces between it and the crown and the skirt and joined to the body substantially symmetrically with respect to all planes within which the axis of the body lies, an end bearing surface on the annular member which faces away from the crown, cylindrical lateral bearing surfaces on the annular member and the skirt farther distant from the crown than the annular member, means for transmitting motion from one to the other of the body and a crank including a member with piston pin bearings in it disposed within the body with an annular chamber closed at its end most distant from the crown into which open the piston pin bearings between it and the skirt, a chamber in the second specified member with an open side which faces the crown and registers with the opening through the annular member and through which and the opening through the annular member lubricant may be dashed onto the crown by inertia as a result of deceleration of the piston in the direction in which the open side of the chamber faces or acceleration of the piston in the opposite direction, end and cylindrical lateral bearing surfaces on the second specified member disposed opposite the corresponding bearing surfaces on the annular member and the skirt so that the body may rotate with respect to the second specified member under the influence of a force to which it is inherently subjected as a result of operation of the machine, a connecting rod with a piston pin bearing in it, a piston pin journaled in the bearings in the second specified member and the connecting rod, grooves in the surfaces of the bearings, a passage through which lubricant may be introduced into the second mentioned chamber and, thence, supplied to the first mentioned chamber and the mentioned bearing surfaces and drained from the second mentioned chamber without interfering with the introduction of further lubricant into it including a section which extends lengthwise through the second specified member from its end which is most distant from the crown to a point nearer the region in which the second mentioned chamber is located and into which lubricant may be squirted and a section which extends laterally through the second specified member into the second mentioned chamber from a point beyond the last mentioned end of the first mentioned section, means for deflecting lubricant squirted out of the last mentioned end of the first mentioned section into the second

mentioned section and, thence, into the second mentioned chamber, and means to retain the second specified member within the body disposed at the end of the second specified member most distant from the crown but movable to a position in which the second specified member may be removed from the body.

14. A piston comprising, in combination, a body having a head portion and a circular skirt, means including a plurality of symmetrically spaced struts adjoining the head portion and providing a bearing concentric with the skirt, said skirt having an inner bearing surface concentric with the outer surface of the skirt, a carrier disposed within the body and rotatably supported therein by said bearing and bearing surface, said carrier being spaced from the skirt intermediate the bearing surfaces and having therein a piston pin bearing, and means holding the carrier in place with respect to the body.

15. A piston comprising, in combination, a body having a head portion and a circular skirt, means including a plurality of struts adjoining the head portion and spaced radially inwardly and symmetrically with respect to the skirt providing an inner support element, said skirt having relatively thin walls which are substantially symmetrical with respect to planes passing through the axis thereof, a bearing surface on the inside of the skirt near the end thereof opposite said inner support element, and a carrier located by and supported between said support element and bearing surface and being spaced from the skirt except at said bearing surface, said carrier having a piston pin bearing therein.

16. In a piston adapted for reciprocating movement in a machine, the combination comprising a body having a head portion and a skirt which are both substantially symmetrical with respect to planes through the longitudinal axis of the skirt, and means within the body rotatably supporting the body and upon which said body rotates during reciprocation, said means providing a trap for cooling liquid adjacent and facing the inner surface of the head portion from which cooling liquid is dashed onto the head portion during deceleration of the piston in one direction of motion or acceleration of motion in the opposite direction.

17. In a piston adapted for reciprocating movement in a machine, the combination comprising, a body having crown and skirt portions, symmetrically disposed cooling ribs on the inner surface of the crown portion, and means within the piston body adapted to trap a quantity of cooling liquid sufficient to be dashed upon and cover the inner surface of the crown portion during deceleration of the motion of the piston in one direction or acceleration of the motion in the opposite direction, said means having an opening therein for the introduction of cooling liquid therinto without first striking the crown.

18. A piston comprising, in combination, a body having a head portion and a circular skirt, a carrier disposed within the body and having a piston pin bearing therein, said body and carrier having cooperating circular bearing surfaces through which the body is carried by the carrier and upon which the body is rotatable with relative freedom with respect to the carrier about the axis of the skirt, and means holding the carrier in place with respect to the body.

19. In a machine and in combination with a connecting rod and a cooperating piston pin, a piston comprising, in combination, a circular pis-

ton body which is substantially symmetrical with respect to the central axis thereof, means within the body providing a piston pin bearing, and means connecting said means and body in a manner such that the body rotates about its central axis under the influence of force to which it is subjected as a result of operation of the machine.

20. In a machine and in combination with a connecting rod and a cooperating piston pin, a piston comprising, in combination, a body having skirt and crown portions, said skirt portion having an open end opposite the crown portion, a carrier within the body having a piston pin bearing therein, means near and supported from the crown portion of the body providing a bearing concentric with the skirt portion and having plane and cylindrical surfaces, said skirt portion having an inner bearing surface near the open end thereof, said carrier having bearing surfaces engaging the surfaces of said bearing and said inner bearing surface rotatably to support the body, and removable means for holding the carrier in place axially with respect to the skirt without preventing rotation between carrier and body.

21. A piston comprising, in combination, a body having a head portion and a circular skirt, means including a plurality of struts adjoining the head portion and spaced radially inwardly and symmetrically with respect to the skirt providing an inner support element, a second group of struts symmetrically spaced and diagonally disposed with respect to the first mentioned struts for additionally supporting said support element, said skirt having relatively thin walls which are substantially symmetrical with respect to planes passing through the axis thereof, a bearing surface on the inside of the skirt near the end thereof oppo-

site said inner support element, and a carrier located by and supported between said support element and bearing surface and being spaced from the skirt except at said bearing surface, said carrier having a piston pin bearing therein.

22. In a piston, a body which includes a crown and a skirt, a member disposed within the body with a chamber in it with an open side which faces the crown and through which cooling liquid may be dashed from the chamber onto the crown by inertia as a result of deceleration of the piston in the direction toward which the chamber faces or acceleration of the piston in the opposite direction, a passage through which cooling liquid may be introduced into the chamber, and an annular space between the member and the body into which cooling liquid passes from the crown.

23. In a piston, a body which includes a crown and a skirt, means for transmitting motion from one to the other of the body and a connecting rod including a member which is disposed within the body, an annular member disposed within and joined to the body with spaces between it and the crown and the skirt through which the body is mounted on the first specified member so that it may rotate with respect thereto, a chamber in the first specified member with an open side which faces the crown and registers with the opening in the annular member and through which and the opening through the annular member cooling liquid may be dashed onto the crown by inertia as a result of deceleration of the piston in the direction in which the open side of the chamber faces or acceleration of the piston in the opposite direction, and a passage through which cooling liquid may be introduced into the chamber.

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