

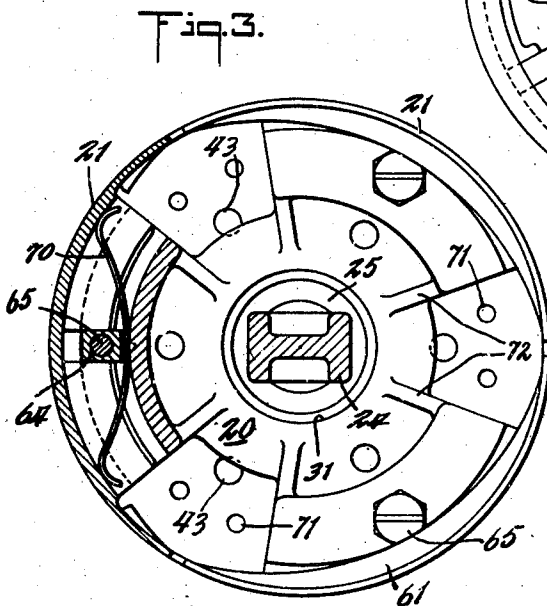
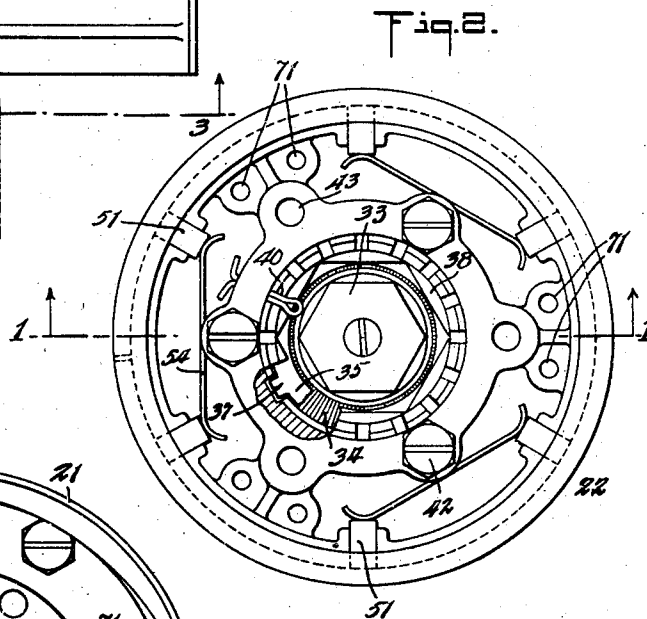
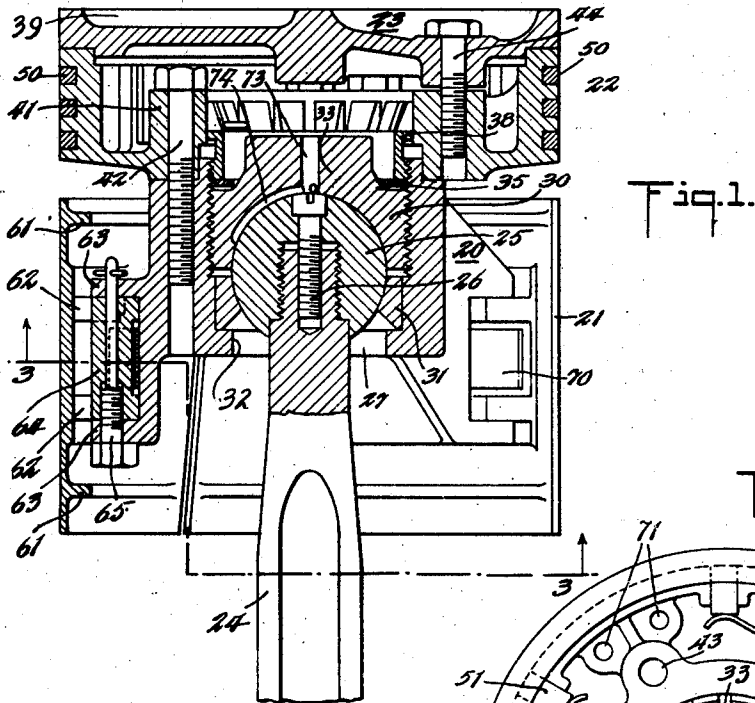
Oct. 12, 1937.

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2,095,381

PISTON

Original Filed April 14, 1933 4 Sheets-Sheet 1



Oct. 12, 1937.

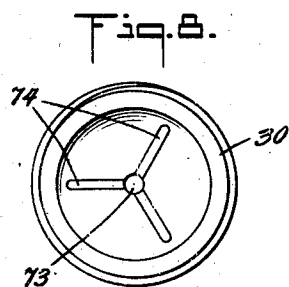
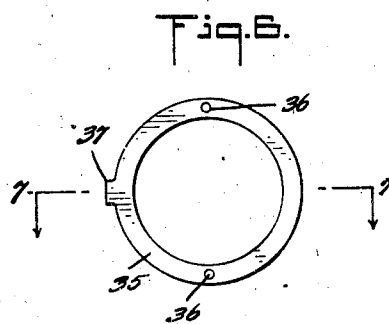
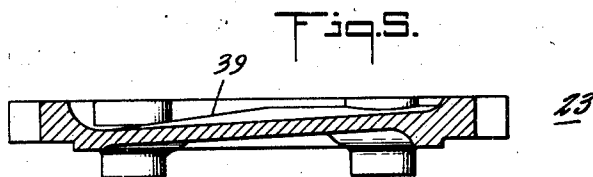
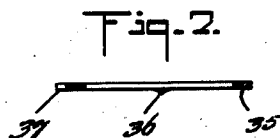
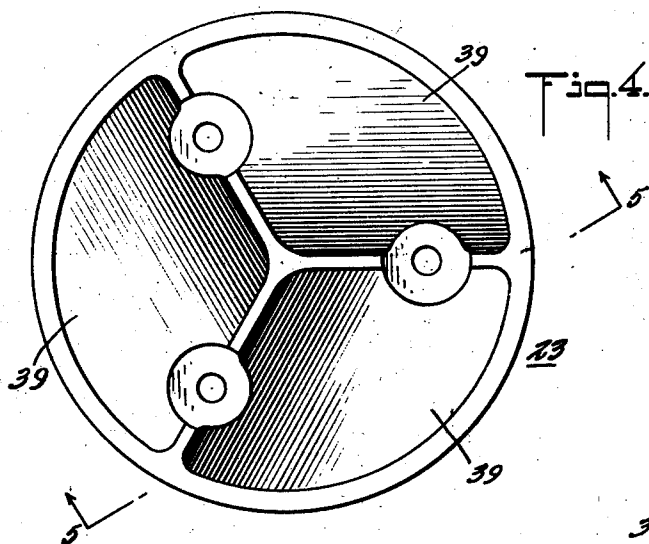
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4 Sheets-Sheet 3

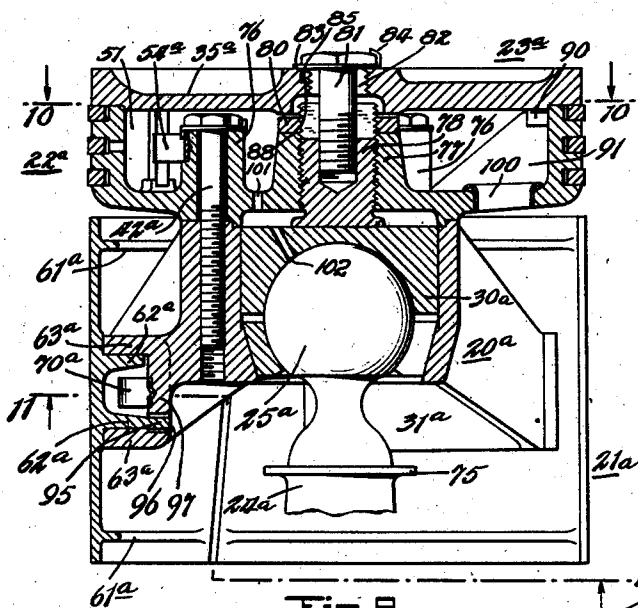


Fig. 9.

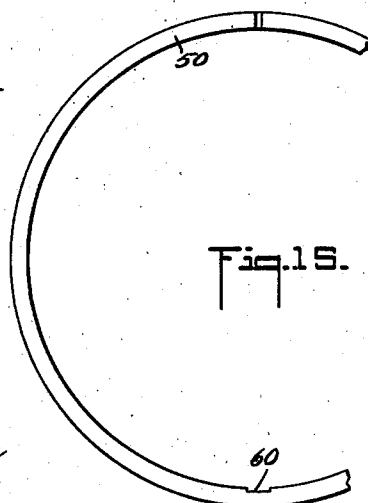


Fig. 15.

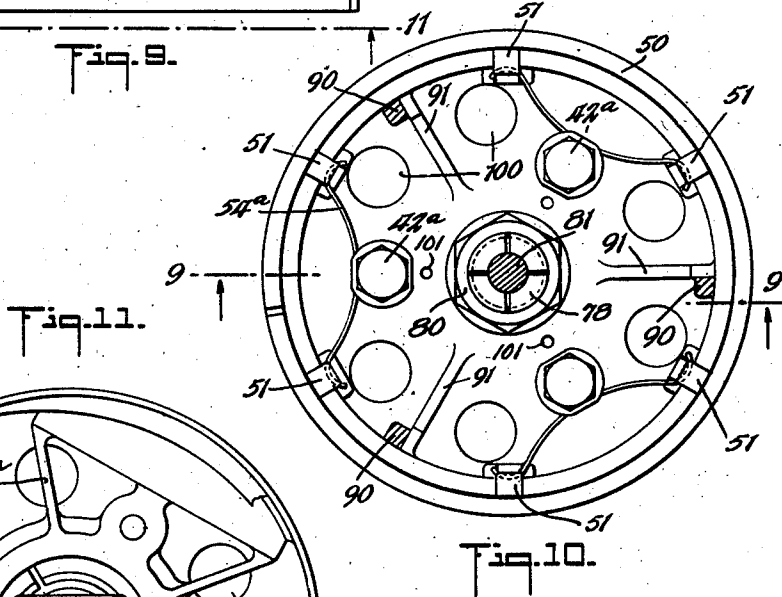


Fig. 10.

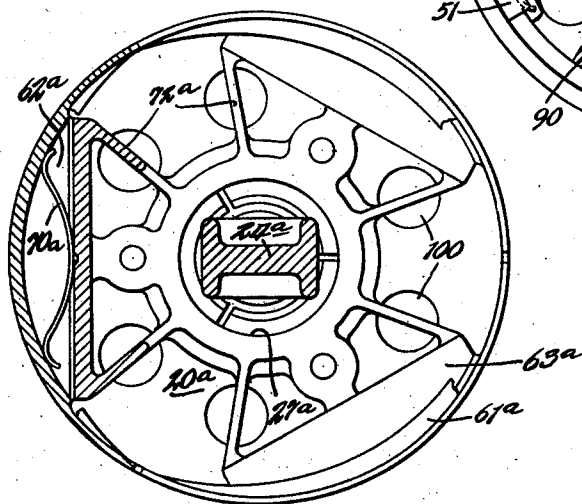


Fig. 11.

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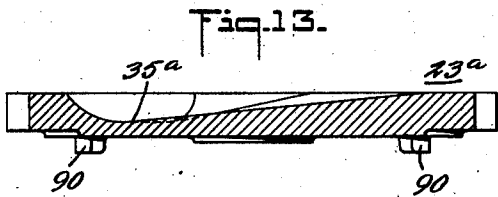
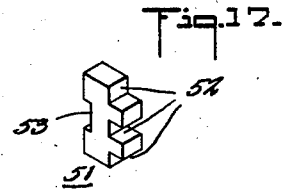
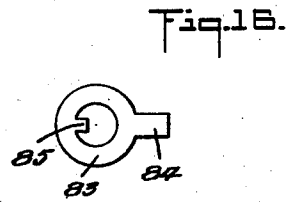
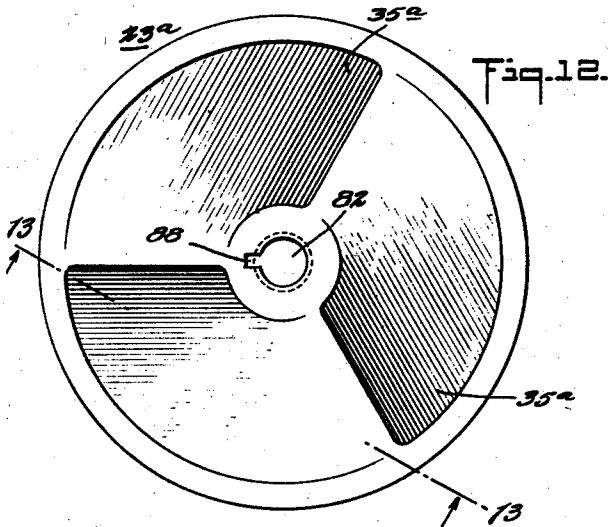
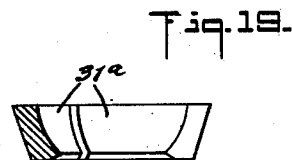
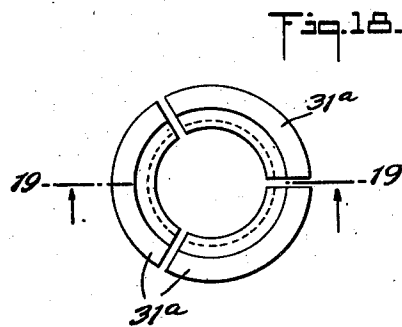
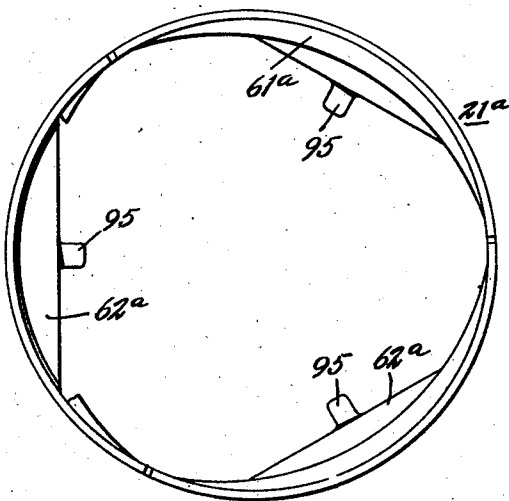


Fig. 14.



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2,095,381

PISTON

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Application April 14, 1933, Serial No. 666,106
Renewed February 24, 1937

6 Claims. (Cl. 309-20)

This invention relates to pistons, and more particularly pistons for use in internal combustion engines.

It is necessary for proper operation of an internal combustion engine to have a piston which fits the cylinder reasonably well at all times. If either the cylinder or the piston or both wear, the well known piston slap develops. If the piston is made of a light alloy, such as an aluminum-base alloy, having a different, usually higher, coefficient of heat expansion from that of the cylinder, the piston will, as a result, not fit perfectly at all times. If it fits when hot and expanded, it will be loose and slap when cold and contracted; if it fits when cold, it will bind and seize when hot.

One of the objects of the present invention is to provide a piston which will automatically take up wear.

A further object of the invention is to provide a piston constructed so that relative expansion and contraction of the piston and cylinder are automatically compensated for.

Another object of the invention is the provision of a piston which may be removed and reinserted either wholly or in part through the top of the cylinder for renewing the rings or other purposes.

An additional object of the invention is the provision of a piston having separable skirt and ring portions, the skirt portion being connected to the head of a connecting rod in such a way that the ring portion may be detached from the skirt portion without interfering with the connection between the skirt portion and the connecting rod.

Other objects and advantages of the invention will appear from the following description of two approved embodiments of the invention shown, by way of example, in the accompanying drawings. The invention accordingly consists in the various features of construction, combinations of elements and arrangements of parts which are exemplified by the constructions hereinafter set forth. The scope of the invention is indicated by the appended claims.

In the accompanying drawings:

Fig. 1 is a vertical sectional view of one form of piston on the line 1-1 of Fig. 2, with parts in elevation;

Fig. 2 is a plan view of the piston with the cap removed and parts broken away;

Fig. 3 is a view taken on the line 3-3 of Fig. 1 showing two skirt sections in bottom plan view and the other skirt section in cross section;

Fig. 4 is a top plan view of the piston cap;

Fig. 5 is a sectional view on the line 5-5 of Fig. 4;

Fig. 6 is a plan view of the lock washer which holds the upper part of the connecting rod head bearing in adjusted position;

Fig. 7 is a sectional view on the line 7-7 of Fig. 6;

Fig. 8 is a bottom plan view of the upper part of the connecting rod head bearing;

Fig. 9 is a vertical sectional view of a modified form of piston on the line 9-9 of Fig. 10, with parts in elevation;

Fig. 10 is a sectional view on the line 10-10 of Fig. 9;

Fig. 11 is a view taken on the line 11-11 of Fig. 9, showing two skirt sections in bottom plan view and the other skirt section in cross section;

Fig. 12 is a top plan view of the cap of the modified form of piston;

Fig. 13 is a sectional view on the line 13-13 of Fig. 12;

Fig. 14 is a top plan view of the piston skirt sections of the modified form of piston, with a part broken away;

Fig. 15 is a plan view of one of the piston rings for both forms of construction;

Fig. 16 is a plan view of the lock washer which holds the cap screw in place in the modified form of construction;

Fig. 17 is a perspective view of one of the piston ring pusher blocks for both forms of construction;

Fig. 18 is a top plan view of lower bearing block for the connecting rod head in the modified form of construction; and

Fig. 19 is a sectional view on the line 19-19 of Fig. 18.

The piston shown in Figs. 1 to 8, inclusive, comprises four main parts, a central body 20, a skirt 21 surrounding such body and formed of three separate sections, a cup-shaped head, or ring portion, 22 and a cap 23. The body is connected to a connecting rod 24 by a ball and socket joint, the ball 25 of which is detachably mounted on the end of the connecting rod.

The end of the connecting rod is formed with a right-hand thread adapted to engage a corresponding thread in a recessed portion of the ball. A left-hand screw 26 extends slidably through an aperture in the top of the ball and engages a threaded central recess in the end of the rod. In assembling these parts, the ball is screwed down on the top of the connecting rod. Then the screw 26 is screwed in until its head engages the

shoulder of the aperture in the ball. The latter cannot then unscrew from the end of the connecting rod since any unscrewing movement of the ball tends to urge the screw 26 further into its recess.

The body 20 is formed with a central cylindrical chamber 27 therethrough for the reception of upper and lower bearing blocks 30 and 31, respectively. The upper block has threaded engagement with the wall of this chamber, so that by rotating this block its axial position within such chamber may be adjusted. The lower bearing block rests on a shoulder 32 at the lower end of this chamber. The lower bearing block is annular in form, the inner diameter of the annulus being large enough, not only to permit the passage of the end of the connecting rod therethrough, but also to permit the latter to move laterally to the desired extent. This block has a spherically curved annular inner surface adapted to contact with the under surface of the ball. The upper bearing block is provided with a spherical under surface adapted to contact with the top of the ball. The top 33 of this block has a hexagonal or similar shape so that the block may be turned by a socket wrench or the like.

The upper surface of the upper bearing block around the hexagonal top 33 is formed with a series of radial corrugations or grooves 34 (see Fig. 2). After the upper bearing block has been brought into adjusted position, it is locked in such position by an annular washer 35 provided with two projections 36 on its under surface. Each of these projections extends into one or other of the corrugations or grooves 34, so that, so long as these projections are held in engagement with any given pair of corrugations, the bearing block cannot turn relatively to the washer. Turning of the latter with respect to the body 20 is prevented by forming the washer with a peripherally projecting lug 37 which engages a vertical slot in the wall of the chamber 27 (Fig. 2). To hold the washer with its projections in engagement with the corrugations on the upper bearing block, an annular castellated lock nut 38 is provided having threaded engagement with the walls of the chamber 27. Accidental unscrewing of this nut is prevented by a cotter pin 40 inserted through a hole in the body 20 and one of the slots in the castellated portion of the nut. The interior portion of the lower part of this nut is given hexagonal form for engagement with a suitable form of wrench.

There are about 84 of the grooves 34, so that the position of the upper bearing block 30 may be adjusted to $\frac{1}{84}$ of a revolution. This delicate adjustment allows relatively coarse and hence strong threads to be used on the bearing block 30. The castellated nut has only 16 slots, so that its position can be adjusted only to $\frac{1}{16}$ of a revolution, or only one-fifth as accurately as the bearing block and washer. Hence, the interposition of the washer 35 between the upper bearing block 30 and the lock nut 38 increases the delicacy of adjustment of the bearing block about five times for threads on the block 30 of equal pitch.

The cup-shaped head 22 of the piston is provided with an upstanding portion 41, apertured for the passage of bolts 42 by which such part 22 is detachably secured to the body.

The head 22 is also formed with three threaded apertures 43 for bolts 44 by which the cap 23 is detachably secured to the head 22. The cap 23 may, therefore, be detached from the head with-

out interfering with either the setting of the connecting rod end bearing blocks or the connection of the head to the body 20. After the cap has been removed, the head 22 can be removed without disturbing the setting of the connecting rod bearing blocks.

A part of the body 20 is formed with an annular recess to receive the lower body portion of the head 22 so that these body portions of the piston are thereby held in concentric relation to each other independently of the bolts 42. Similarly, the cap 23 is formed on its under side with an annular recess to receive the upstanding edge of the cup-shaped head 22 and is thereby held in concentric relation therewith.

The top surface of the cap is formed with three recesses 39, the bottoms of which slope downwardly in directions transverse with respect to the radii of the piston. Looking down on the top of the cap, the direction of downward slope is clockwise. Intermediate each of these sloping surfaces are surfaces lying in radial axial planes. It has been found that a piston constructed, and associated with a connecting rod, as previously herein described, rotates intermittently through angles of a varying number of degrees. It has been observed that this rotation in the normal operation of the engine is in a clockwise direction, viewing the piston from above. The cause of the intermittent rotation of the piston through varying angles is believed to be due to forces developed in the power cycle of the engine acting upon the upper surface of the piston. It is believed that the initial impact of the explosive wave against the surface rising from the base of whichever one of the recesses 39 rests in appropriate position causes a movement of the piston about its axis and that this movement is irregular owing to variations in the explosive forces and varying angular positions of the radial rising surfaces of the piston head when the forces are applied. Whatever the correct theory may be in regard to this, the fact is that the piston rotates in variable increments, distributing wear and eliminating the possibility of wearing grooves or scores as would result from rotating the piston in definitely fixed angles or from holding it against rotation.

The turning of the piston tends to equalize the wear on the piston and/or cylinder, unless the cylinder is unequally worn at the time the present form of piston and connecting rod are installed, in which case the wear on the parts of the cylinder having the smallest diameter tends to be the greatest, and vice versa.

The piston rings 50 are carried by the head 22 and may, therefore, be replaced without removing the entire piston, and therefore, without disconnecting the body 20 and the skirt 21, carried thereby from the connecting rod. All that is necessary is to take off the cylinder head by removing bolts 44, cap 23 and bolts 42. The ring portion or head 22 may then be lifted out of the cylinder.

The piston rings are mounted in grooves in the head 22. The peripheral wall of the head is vertically slotted at six equidistant points, and in each of these slots a pusher block 51 is slidably mounted. As shown in Fig. 17, the outer face of each pusher block has three recesses 52 to receive the piston rings. The inner face of each block is formed with a recess 53 for the reception of the rounded end of one of three leaf springs 54. The latter press the pusher blocks outwardly and thereby exert a symmetrically distributed pressure on the piston rings. The mid-points of

these springs are seated in recesses in the up-standing portion 41 of the part 22. The springs are held in place longitudinally by punching a projection on the center of each spring without perforating the latter. A hole or recess is drilled in each of the spring seats in the portion 41 to receive such projection.

Each piston ring is desirably formed of a single piece and it is advantageous to arrange the point at which the ends of each ring overlap at about 120° from the corresponding point for the other two rings. This is accomplished by forming shallow vertical grooves or recesses 60 on the inner faces of the rings to receive the pusher blocks 51 and so prevent rotation of the rings with respect to the piston and keep the rings in the desired relative position.

The skirt of the piston is formed of three sections 21, each comprising a thin curved outer wall, stiffened top and bottom by horizontal inwardly extending webs or flanges 61. Adjacent the center of each section is a pair of flanges 62, adapted to fit slidably between a corresponding pair of flanges 63 on the central body 20. Lateral movement of each pair of the flanges 62 with respect to the flanges 63 is prevented by a rectangular block 64 held in position between the flanges 63 by a threaded pin 65. The flanges 62 are slotted vertically to receive this block. The skirt sections are, therefore, free to slide radially in and out, but are restrained from moving laterally or longitudinally with respect to their supporting body 20. These skirt sections are yieldingly pressed outwardly against the walls of the cylinder by leaf springs 70 seated at their centers in shallow depressions in the blocks 64 and bearing at their ends against the skirt sections between the flanges 62, 62. These springs are held in place longitudinally by forming projections thereon for engagement with small recesses in the frame 20 (Fig. 3).

The piston skirt is conveniently formed from a single casting which is machined to fit the cylinder and body 20 and then slit longitudinally to form the three sections. If the piston did not rotate and the sections were cut exactly parallel to the axis of the cylinder, ridges would be formed on the walls of the cylinder opposite the spaces between the sections. While rotation of the piston substantially prevents the formation of such ridges, wear may be more certainly equalized by inclining the slots between the skirt sections downwardly in an anti-clockwise direction for a piston designed to turn in a clockwise direction on the explosion stroke.

The piston as shown is designed for splash lubrication. For this purpose the bottom of the cup-shaped head 22 has a series of apertures 71 therein, through which drops of oil may pass. It will be noted that the body 20 is cut away between each pair of vertically and radially arranged webs or fins 72 which support the flanges 63, and through these cut away parts oil is thrown inwardly and through the apertures 71. This construction permits oil to be thrown upwardly from the crank-case into the head, from which it finds its way down through a central aperture 73 in the upper bearing block 30 to grooves 74 which distribute the oil at the bearing.

The same open construction of the body and the apertures 71 in the head which permits passage of oil also allows air to circulate and flow in and out of the chamber formed by the head 22 and the cap 23. This circulation and flow of air aids very materially in keeping the springs 54

cool and is sufficient to prevent the latter reaching such a temperature that they lose their elasticity.

It will also be noted that the head 22 and the body 20 are in contact over a relatively very small area as compared with the effective cross-sectional area of the piston. This construction restricts flow of heat from the upper part of the piston to the lower central body. Further, the webs 72 of the latter serve as cooling fins so that little heat is transmitted through the body to the skirt sections 21.

The body, skirt, head and cap may all be made of a light alloy, although such alloy may have a considerably higher coefficient of heat expansion than the metal of the cylinder. The cap and the head have a diameter small enough so that there is still clearance at the maximum piston temperatures, as these parts do not have to fit the cylinder walls closely. The piston is guided in its travel up and down in the cylinder by the skirt, and the passage of gases around the cap and head 22 is prevented by the piston rings. The skirt is constructed so that it can expand or contract radially, the springs 70 maintaining the outer surface of the skirt in constant contact with the cylinder walls at all times and under all conditions.

A suitable alloy has the following typical composition: copper 4%, magnesium 1.5%, nickel 2%, and aluminum the balance. Other alloys having different proportions and/or ingredients may also be employed.

A modified form of construction is shown in Figs. 9 to 19, inclusive. As in the first form of construction, the piston comprises four main parts, a central body 20a, a skirt 21a surrounding such body formed of three separate sections, a cup-shaped head or ring portion 22a and a cap 23a. The body is connected to a connecting rod 24a by a ball and socket joint, the ball 25a of which is mounted on the end of the connecting rod. This ball 25a is not detachable, as in the first form shown, but is made an integral part of the connecting rod. The socket consists of an upper bearing block 30a having a cylindrical outer surface so that it may slide vertically in a chamber 27a in the body, arranged concentrically with respect to the piston as a whole, and a lower bearing block formed of a plurality of separate sections 31a. The lower part of the wall of the chamber 27a converges downwardly and the outer surfaces of the bearing sections 31a are formed complementarily so that such sections are firmly supported thereby. Both the upper and lower bearing blocks are formed with spherically curved inner surfaces for engagement with the head 25a of the connecting rod.

The minimum diameter of the chamber 27a is greater than the maximum diameter of the ball 25a, so that, by lowering or raising the piston, the ball may be introduced into or removed from such chamber. The lower bearing block is made in a plurality of sections fitted together around the base of the ball. The sections are put in place and removed by dropping the piston body relatively to the ball.

The connecting rod 24a is formed with an annular projection 75 with a flat upper surface at right angles to the axis of the connecting rod. The function of this projection can best be explained by describing the method of disconnecting the piston and connecting rod. The first step, after removing the cylinder head, is to turn the engine over until the piston is at the top of

its stroke. This is done not only to bring the piston into its most accessible position, but also to bring the connecting rod into vertical position and thereby bring the upper surface of the projection 75 into horizontal position. The next step is to remove the cap 23a and head 22a. Then the body 20a is pushed down to force the ball 25a through the chamber and with it push the upper bearing block out of such chamber. Further downward movement of the body causes the projection 75 to engage the lower surfaces of the sections 31a. As the top of the projection 75 is horizontal, it engages all of the sections simultaneously and then lifts them, without disturbing their position around the connecting rod. The sections can then be removed by the fingers. The parts are re-assembled by placing the sections 31a on the projection 75, and finally raising the body to seat the sections on the lower part of the chamber and then seat the ball 25a on such sections, as shown in Fig. 9.

The head or ring portion 22a of the piston is provided with three upstanding bosses 76, centrally apertured for the passage of bolts 42a by which the head is detachably secured to the body.

The head is also formed with a central boss 77 with a threaded axially located aperture for the reception of a threaded member 78. The member 78 is vertically above the upper bearing block 30a, so that, by turning such member, the upper bearing block may be set in adjusted position with respect to the ball 25a. The top of the member 78 is slotted for engagement with a screw-driver. A lock nut 80 is provided for clamping the member 78 in adjusted position.

The cap 23a is formed on its under side with an annular recess to receive the upstanding edge of the head 22a and is thereby held in concentric relation therewith. It is releasably clamped down on the top of the head by a bolt 81 engaging a threaded aperture in the member 78.

The aperture 82 through which the bolt 81 passes is made of considerably greater diameter than the bolt and is tapered, so that, should the cap stick to the head after the bolt 81 has been removed, a bolt which fits the aperture 82 may be screwed into the latter until its end engages the top of the member 78. Further rotation of such bolt will force the cap 23a away from the head.

The bolt 81 is held in place by means of a washer 83 having a lateral projection 84 extending from its outer periphery and a projection 85 extending from its inner periphery. The aperture 82 has a keyway 88 cut therein of a width sufficient to receive the projection 85 when the latter is bent downward. The engagement of the projection 85 with the keyway 88 prevents turning of the washer. After the bolt 81 has been screwed home, the projection 84 is bent upwardly against the adjacent face of the head of the bolt to prevent the bolt turning relatively to the washer and thereby to the cap.

The top surface of the cap is formed with three recesses 35a the bottoms of which, as in the first form of construction, slope downwardly in directions transverse with respect to the radii of the piston. Looking down on the top of the cap, the direction of downward slope is clockwise. As in the first described construction, the piston is caused to rotate through variable angles under normal operating conditions of the engine. Thus the piston has a rotary, as well as a longitudinal, movement.

To ensure that the piston turns as a unit instead of the cap only turning, the under side of the latter is provided with three downwardly extending lugs 90 (Figs. 10 and 14), which engage with opposite sides, respectively, of radially disposed webs 91 on the head.

The piston rings 50 and their pusher blocks 51 are of the same construction as in the first form of piston and, hence, need not be described again. It will be noted, however, that, while the two lower rings are mounted in grooves in the head, the top ring is arranged in a groove formed by a recess in the head and the adjacent part of the cap 23a.

The pusher blocks are pressed outwardly by leaf springs 54a. These springs are held in place longitudinally by punching a projection on the center of each spring without perforating the latter. A hole or recess is drilled in each of the spring seats in the bosses 76 to receive such projection.

The skirt of the piston is formed of three sections 21a, each comprising a thin curved outer wall, stiffened top and bottom by horizontal inwardly extending webs or flanges 61a. Adjacent the center of each section is a pair of flanges 62a, adapted to fit slidingly between a corresponding pair of flanges 63a on the central body 20. Lateral movement of each pair of the flanges 62a with respect to the flanges 63a is prevented by the engagement of a projection 95 on the lower of the two flanges 62a with an aperture 96 in the web 97 of the body. The skirt sections are, therefore, free to slide radially in and out, but are restrained from moving laterally or longitudinally with respect to their supporting body 20. These skirt sections are yieldingly pressed outward against the walls of the cylinder by leaf springs 70a, seated at their centers in shallow depressions in the webs 97 and bearing at their ends against the skirt sections between the flanges 62a, 62a. These springs are held in place longitudinally by forming projections thereon for engagement with small recesses in the webs 97 (Fig. 11).

The piston is designed for splash lubrication. For this purpose the bottom of the head 22a has a series of apertures 100 therein, through which drops of oil may pass. It will be noted that the body 20 is cut away between each pair of vertically and radially arranged webs or fins 72a which support the flanges 63a, and through these cut away parts oil is thrown upwardly and into the apertures 100. This construction permits oil to be thrown upwardly from the crankcase into the head, from which it finds its way through apertures 101 and 102 in the head and upper bearing block, respectively, to the bearing surface of the connecting rod. As in the first form of piston, this open construction of the body and the apertures 100 in the part 22a which permits passage of oil also allows air to circulate and flow in and out of the chamber formed by the head 22a and the cap 23a.

What is claimed is:

1. A piston comprising a central body portion, a skirt portion and a piston ring portion above the skirt portion removably attached to the central body portion, and upper and lower bearing means in the central body portion shaped to receive the ball head of a connecting rod, the upper bearing means being removable in an upward direction from the ball head and the lower bearing means being sectional to permit removal from or placement in bearing position when the ball

head and central body portion are given a certain relative axial movement permitted by removal of the piston ring portion and the upper bearing means.

- 5 2. A piston comprising a central body portion having a seat for a bearing, and means for slidably mounting a sectional skirt and means for locating a piston ring portion thereon in vertically spaced relation from the sectional skirt, a skirt comprising sections slidable respectively toward and from the central body portion and spring pressed therefrom, lower bearing means for a connecting rod head seated in said central body portion, upper bearing means for said head adjustably fitted in said central body portion, means for securing the upper bearing means in adjusted position, a piston ring portion, and means for detachably attaching the piston ring portion in position on the central body portion, the said central body portion being shaped to permit removal of the piston ring portion in an upward direction and to permit removal in an upward direction of the upper bearing means and its securing means whereby access to the connecting rod head and lower bearing means is provided, and the piston ring portion being shaped to permit removal of the upper bearing means when said portion is in located position on the central body portion.
- 30 3. A piston having a central body portion, adjustable bearing means for the ball head of a connecting rod, said means being removably mounted in the central body portion, means in the central body portion for securing the said bearing means in position, a ring portion removably secured to the upper part of the central body portion, a skirt comprising a plurality of separately movable sections slidably mounted on said central body portion for movement toward and from said central body portion and spaced below said ring portion, and spring means urging the skirt sections outwardly.

4. A piston having a central body portion provided with circumferentially spaced means for mounting skirt sections, adjustable bearing means for the ball head of a connecting rod, said bearing means being removably mounted in the central body portion, a piston ring portion removably attached to the upper part of the central body portion, a skirt comprising sections respectively mounted on the said circumferentially spaced means, and spring means pressing the skirt sections outwardly.

5. A piston having a central body portion provided with means for receiving a ball head of a connecting rod, a ring portion mounted on the upper part of the central body portion, a skirt comprising at least three sections each spring pressed outwardly from the central body portions and mounted thereon to locate the top of the skirt sections downwardly spaced from the ring portion, and at least three spring pushers in the ring portion adapted to bear at as many points on the inner side of rings in the ring portion.

6. The combination of a piston and connecting rod, the piston comprising a body carrying a skirt portion and a piston ring portion, means for detachably securing the ring portion to the body, said body having a central chamber therein, a ball head on the connecting rod, upper and lower bearing blocks in said chamber for the engagement of the upper and lower surfaces of said ball head, the upper block having threaded engagement with the walls of said chamber, means for locking said upper block in adjusted position, the upper surface of the upper block being formed with a series of indentations, a ring having a projection on the under side adapted to enter one of said indentations, an outwardly projecting lug on said ring adapted to extend into a vertical recess in the wall of said chamber, and means for holding said ring against the upper surface of the upper block to prevent rotation of the latter.

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