Dec. 10, 1957 P. H. SCHWEITZER 2,815,993

PISTON AND CONNECTING ROD ASSEMBLY
FOR INTERNAL COMBUSTION ENGINES

Filed Nov. 26, 1954 2 Sheets-Sheet 1

FIG. 1

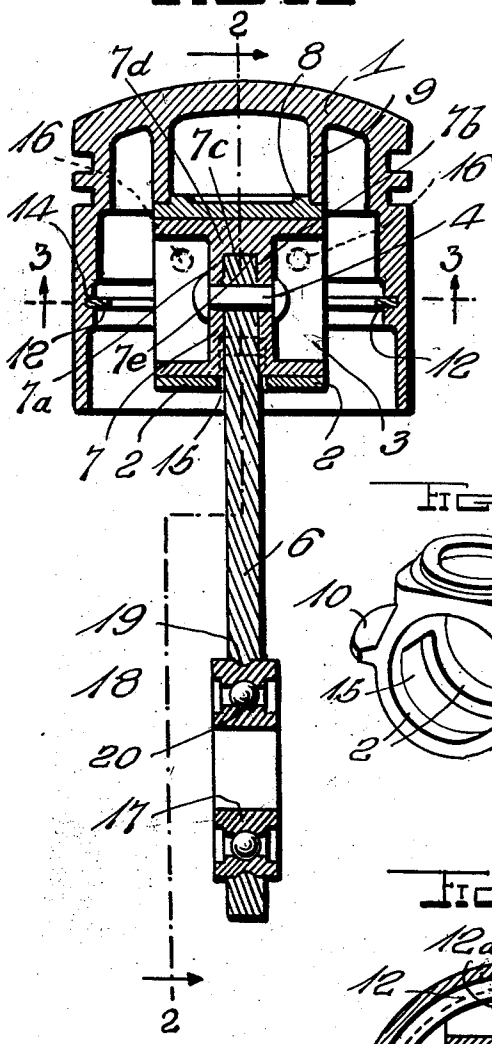


FIG. 2

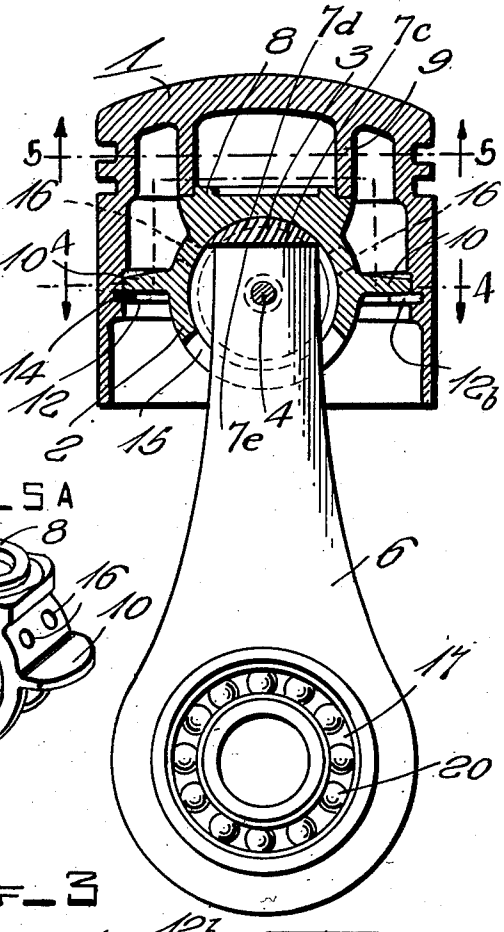


FIG. 5A

FIG. 3

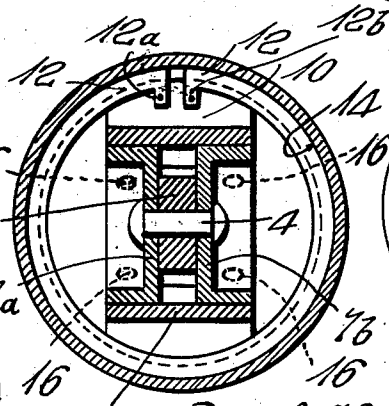


FIG. 5

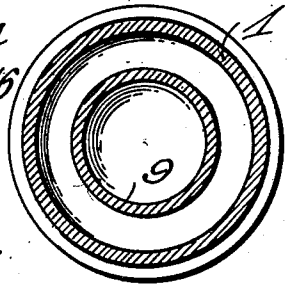
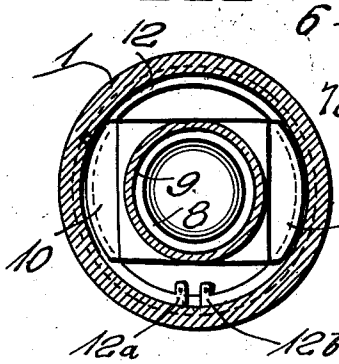


FIG. 4



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Filed Nov. 26, 1954 2 Sheets-Sheet 2

FIG. 6

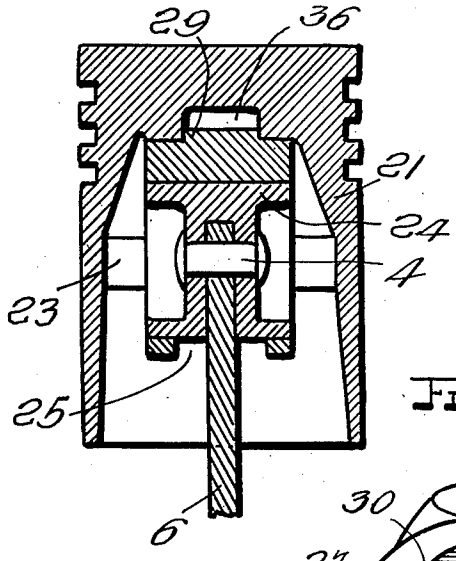


FIG. 11

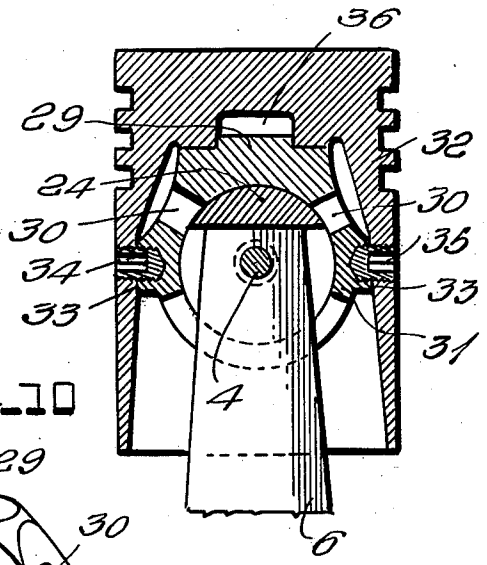


FIG. 10

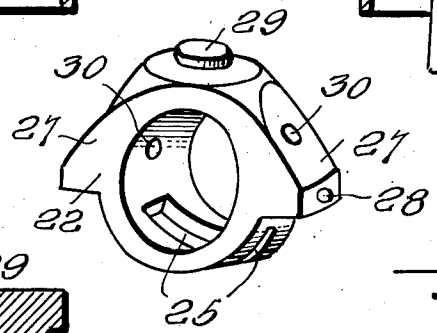


FIG. 7

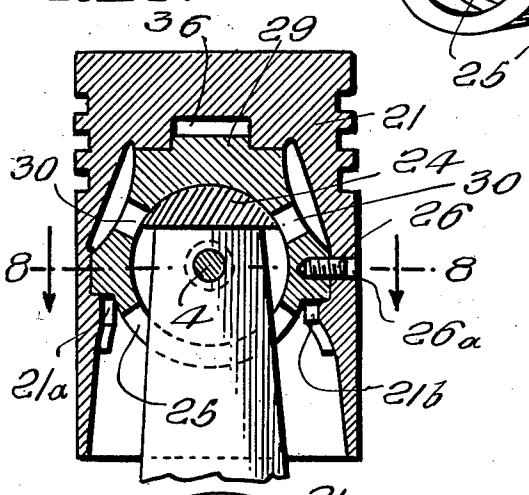


FIG. 9

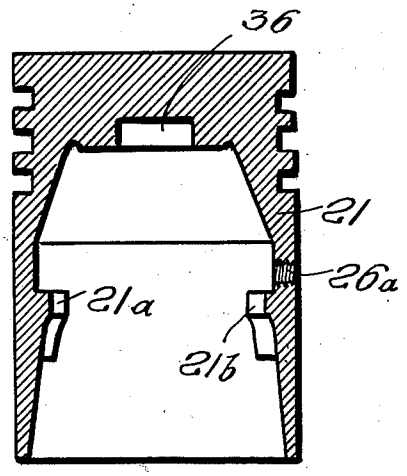
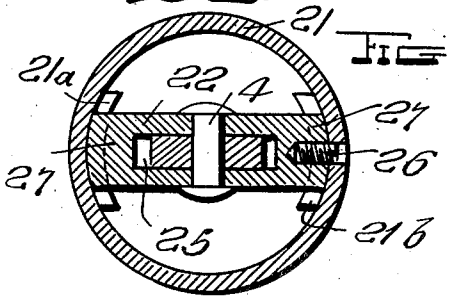


FIG. 8



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PISTON AND CONNECTING ROD ASSEMBLY FOR INTERNAL COMBUSTION ENGINES

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Application November 26, 1954, Serial No. 471,287

7 Claims. (Cl. 309—19)

My invention relates broadly to engines and more particularly to an improved piston and connecting rod assembly.

One of the objects of my invention is to provide an improved construction of piston having a symmetrical rotative contour capable of inexpensive manufacture on a mass production scale by casting, forging or machining.

Another object of my invention is to provide a construction of piston in which the deformation under heat and mechanical stresses leads to only small but symmetrical distortions.

A further object of the invention is to provide a construction of piston and connecting rod which simplifies the assembly of the piston and associated connecting rod.

A still further object of the invention is to provide a construction by which a much larger bearing surface is insured in the wrist-pin of a piston and wherein the gas forces acting upon the piston crown are conducted directly to the wrist-pin bearing and connecting rod without being subjected to losses in the piston skirt which would cause distortion in the piston and in the wrist-pin.

Another object of the invention is to provide a construction of wrist-pin end connecting rod which may be inexpensively manufactured and assembled with the connecting rod connected with the wrist-pin by inserting the wrist-pin in the wrist-pin carrier within the piston.

Other and further objects and advantages of my invention will become apparent from the following specification by reference to the accompanying drawings in which preferred forms of my present invention are shown, wherein:

Figure 1 is a vertical sectional view taken through a preferred form of my invention;

Fig. 2 is a vertical sectional view taken on line 2—2 of Fig. 1 and showing the connecting rod in elevation;

Fig. 3 is a horizontal section of the piston and connecting rod assembly on line 3—3 of Fig. 2;

Fig. 4 is a horizontal view taken substantially on line 4—4 of Fig. 2;

Fig. 5 is a horizontal sectional view taken substantially on line 5—5 of Fig. 2;

Fig. 5A is a perspective view of the wrist-pin carrier used in the form of my invention shown in Figs. 1–5 and showing particularly the annulus at the top which fits into a circular seat formed in the undersurface of the top of the piston;

Fig. 6 is a vertical sectional view taken through a modified form of my invention;

Fig. 7 is a vertical sectional view taken at 90° to the view shown in Fig. 6 and illustrating the connecting rod in elevation;

Fig. 8 is a horizontal sectional view taken substantially on line 8—8 of Fig. 7;

Fig. 9 is a vertical sectional view of the piston skirt (body) of the piston shown in Figs. 7–8;

Fig. 10 is a perspective view of the wrist-pin carrier as used in the form of my invention shown in Figs. 6–9; and

Fig. 11 is a vertical sectional view through a further modified form of my invention.

My invention is directed to an assembly for a piston and piston rod which facilitates mass production at relatively low cost. The construction of my invention consists of a connecting rod and a piston inside of which a carrier element is arranged for supporting the wrist-pin. The piston is thereby supported by coaxial annular surfaces perpendicular to the piston axis at the same distance from the piston crown and, towards the crankshaft side, by a surface of relatively larger diameter. The piston of my invention has the advantage over conventional pistons in that the piston skirt can expand without distortion because there are no bosses for supporting the wristpin. The piston therefore retains centricity and is thermocentric, resulting in necessity for smaller radial clearances, in lower oil consumption and, thereby, in an essential improvement in performance and life over conventional piston structures. The fact that the piston surface is not interrupted by holes for the piston pins, makes the piston construction of my invention especially suitable for port controlled two-stroke cycle engines because of the improved control of the oil consumption.

Heretofore in piston structures the piston skirt has been rotatable against the wrist-pin carrier and is supported at the lower end by means of a snap-ring. The wrist-pin is supported at both ends in the carrier while the center portion supports the connecting rod. The bearing for the connecting rod is generally a sleeve or a roller bearing. The disadvantage in such structures is that, because of the small space available, the wrist-pin diameter and the bearing surface must be very small. This results in a rapid wear of the bearings. Moreover, the wrist-pin on the carrier is often exposed through the external side surfaces of the piston which gives rise to wear and leakage with resulting losses of compression and engine efficiency.

The present invention avoids these disadvantages by connecting the wrist-pin rigidly with the connecting rod. Thereby the bearing surface for the connecting rod on the wrist-pin can be saved, and, at the same time, it becomes possible to increase the wrist-pin diameter substantially since the connecting rod does not enclose the wrist-pin fully. In this way the supporting bearing surface of the wrist-pin can be increased 2.5 to 3 times compared to conventional structures. Rapid wear of the wrist-pin bearing can thereby be avoided.

According to a preferred form of the invention, the wrist-pin is, for the purpose of connecting the wrist-pin with the connecting rod, solid, at least in the center section, carrying a slot in the center through which the connecting rod, having, at least at the piston end, a rectangular cross-section, is inserted and connected to the wrist-pin.

There is a special advantage in supporting the upper part of the wrist-pin over its entire lineal dimension in the wrist-pin carrier and to provide in the carrier only a slot for inserting the connecting rod. In this case the wrist-pin has to be connected to the connecting rod after inserting the connecting rod into the carrier. Such a construction is especially suitable for four-cycle engines in which the direction of bearing forces cyclically changes its sign.

For two-cycle engines in which the wrist-pin bearing is loaded only on the side towards the piston crown, it is sufficient if the lower part of the carrier consists only of two small bands, which are necessary for safety reasons only. This is especially true for small engines, wherein it is practicable to make the wrist-pin carrier without a special bearing shell, per se, of bearing material throughout, e. g., of bronze.

The connecting rod can, in a preferred form of my invention, be made by a cold stamping from sheet metal whereafter on the one end of the wrist-pin, and on the other end the crankpin bearing are attached rigidly and undetachably by means of riveting, welding, etc. Fastening the crank-pin bearing, e. g., a ball bearing, can be accomplished by providing a circular external groove in the bearing and after inserting the bearing into a corresponding hole in the connecting rod, the connection is made by cold deformation (coining) of the connecting rod. Thus the material of the connecting rod in the immediate neighborhood of bearing is deformed at several spots or along the whole periphery of the bearing, whereby the material flows into the circular external groove of the bearing forming a permanent connection therewith.

Referring to the drawings in more detail:

The preferred form of piston assembly of my invention is shown in Figs. 1–5 and includes a piston body **1**, a wrist-pin carrier **2**, a wrist-pin **3** and a rivet **4** fastening the wrist-pin **3** to the connecting rod **6**. The wrist-pin **3** is hollow with the exception of the center section **7** which contains a pair of spaced walls **7*a*** and **7*b*** with a rectangular pocket therebetween. The pocket **7*c*** terminates in segmental portion **7*d*** having chordal face **7*e*** thereon. The linear connecting rod **6** is of flat rectangular cross-section and is, at the piston end, inserted into the pocket **7*c*** between walls **7*a*** and **7*b*** in the center part **7** of the wrist-pin **3**, and is rigidly connected to the wrist-pin **3** by means of a rivet **4**. The end of the connecting rod **6** abuts against the chordal face **7*e*** of the segmental portion **7*d*** substantially throughout the length of the chordal face of the segmental portion.

The piston body **1** is supported centrally at one end by the carrier **2** which contains the wrist-pin **3**, by means of an annular shoulder **8** which engages the inwardly extending tubular part **9** of piston **1**, which centers the carrier **2** with respect to the piston **1**. The piston skirt is in addition centered by means of two ears **10** extending from carrier **2** and engaging the snap-ring **12** that fits within the internal annular groove **14** within the piston. The two ears **10** are arranged perpendicular to the wrist-pin axis. I may provide a full circular flange instead of the two ears **10** which are segments of a full circular flange.

The wrist-pin carrier **2** in the present instance is made of one piece and contains for the connecting rod **6** a slot **15** which is only as large as is necessary for the free movement of the connecting rod **6** relative to the carrier **2**. The form of the invention shown in Figs. 1–5 is especially intended for four-cycle engines; for two-cycle engines the slot **15** may be made much wider and can be extended up to the ears **10** so that the lower part of the carrier **2** consists then only of two small bands. The upper part of the carrier **2** contains two symmetrical oil holes **16**.

The crank-pin ball bearing race **17** is fastened to the connecting rod **6** by arranging a circular groove **18** at the periphery of the outer bearing race and by cold deforming the connecting rod **6** in groove in the location **19** immediately adjacent to the bearing. The material of the connecting rod **6** flows during the cold deforming into the groove **19** and connects in this way the bearing **20** with the connecting rod **6** undetachably.

The construction of the piston **1** in the form of my invention shown in Figs. 1–5 is such that there are no inner shoulders, so that in casting or forging, permanent molds or dies can be used effectively. I have indicated the arrangement of snap ring **12** engaging an annular groove **14** interiorly of the hollow piston and supporting the ears **10**. Instead of the snap ring **12**, shoulders in segment form may be provided at the inside of the skirt of the piston and the connection between the piston skirt and carrier **2** may be accomplished by means of a bayonet hook. In this case the two parts must be secured against turning. Where the snap ring **12** is used there are inwardly extending ears **12*a*** and **12*b*** on the ends thereof, each apertured for the insertion of the end of a pointed plier for facilitating assembly and disassembly.

Fig. 6 shows a modified form of my invention in which the piston body **21** is of extremely simple and fully symmetrical shape. It can be easily die-cast with a one-piece core or inexpensively manufactured by any other process.

The wrist-pin carrier **22** is centered in the piston at the land **23** near the plane of the center of the wrist-pin **24**, transmitting side-thrust forces immediately to the piston skirt and cylinder wall. A second centering is provided at the recess **36** in the top of the piston which receives the annular projection **29** on the wrist-pin carrier **22**.

The invention provides for the use of a wrist-pin of a very much larger diameter than it would be possible with conventional constructions as the drawings clearly show. The bearing surface is thereby greatly increased with the additional advantage, that the gas forces from the piston crown are transmitted immediately from the piston through the wrist-pin carrier **22** and the wrist-pin **24** to the connecting rod without causing distortion of the piston or bending distortion of the wrist-pin.

In the example shown in Fig. 6, the wrist-pin **24** is constructed to have a milled slot **25** into which the end of connecting rod **6** is fitted. The wrist-pin and connecting rod are connected in the example by the rivet **4** which has to be done after inserting the wrist-pin in the wrist-pin carrier **22**. The wrist-pin carrier **22** is fixed to the piston body by means of a removable dowel-pin or set screw **26**, screw-threaded through the wall of piston **21** as shown at **26*a***. This structure is particularly suitable for small two-cycle engines where the gas forces resulting from compression and expansion are always larger than the inertia forces so that the net force is always pointing to the crankshaft. The force to be transmitted through the dowel-pin or set screw **26** is very small. The dowel-pin or set screw **26** does not leave an opening in the side wall of the piston but constitutes a plug in the side wall.

The ears **27** on the wrist-pin carrier **22** are curved on their opposite ends as shown in Fig. 10, and fit snugly against the annular land **23**. The end **27** is tapped at **28** to receive the set screw or the recess **28** may be smooth walled for the insertion of a dowel-pin at the position **26**. The top of carrier **22** has an annular projection **29** thereon for engaging and fitting into recess **36** in the interior of the top of the piston **1**. Oil holes **30** are provided in carrier **22**. In Fig. 9 the interior construction of the piston **21** is more clearly shown as including arcuate projections **21*a*** and **21*b*** on which ears **27** of carrier **22** engage. In assembling the wrist-pin carrier **22** within the piston it is introduced by orienting the carrier to escape the projections **21*a*** and **21*b***. A turn of 90° of the wrist-pin carrier against the piston body brings the whole assembly to the position shown in Figs. 7 and 8 where the wrist-pin carrier **22** rests against the projections **21*a*** and **21*b*** in the piston. In this construction any negative forces (as they occur in four-cycle engines due to inertia forces) are transmitted from the piston body through the projections **21*a*** and **21*b*** to the wrist-pin carrier **22**. The wrist-pin carrier **22** is prevented from turning by the set screw or dowel-pin **26** as shown in Fig. 7.

Many modifications of the construction described in Figs. 1–11 are possible without departing from the invention disclosed. Instead of a rivet, for instance, a nut and bolt connection may be applied or any other suitable connecting rod-wrist-pin assembly could be used.

Fig. 11 shows a piston assembly with a different type of connection between the wrist-pin carrier represented

at **31** and the piston body **32**. The piston body contains on the inside a pair of flat surfaces **33** against which the wrist-pin carrier **31** rests. These two flats extend only to the width of the wrist-pin carrier while they are left out either in the casting or milled out for the rest of the circumference as the Fig. 11 shows. The procedure of assembling is the following: The connecting rod **6**, wrist-pin **4** and wrist-pin carrier **31** are assembled first in the manner heretofore explained.

The whole assembly is then inserted into the piston body so that the wrist-pin carrier rests firmly against the upper part of the piston by the interfitting relation of projection **29** with recess **24**. Screw-threaded plugs **34—35** are then introduced through screw-threaded apertures in opposite walls of the piston **32** and enter screw-threaded recesses in opposite ends of carrier **31** to secure carrier **31** inside the piston and prevent it from turning. The plugs do not permit leakage into the piston.

The structure of my invention provides:

(1) A piston of rotationally symmetrical contour. Such form can be manufactured easily, it stays round under mechanical and thermal stresses, when other pistons would distort and become unround;

(2) A large bearing surface;

(3) Ample space at the ends of the wrist-pin and carriers for the cooling oil jets;

(4) A piston skirt which can rotate and so equalize piston and cylinder temperatures and minimize scuffing;

(5) Low manufacturing cost. The connecting rod can be a cold stamping;

(6) Easy assembly of piston and rod.

While I have described my invention in certain preferred embodiments I realize that further modifications may be made and desired that it be understood that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A piston-connecting rod assembly comprising a wrist-pin, the two ends of which are hollowed while the center part is solid with a transverse slot therein extending somewhat deeper than the axis of the wrist-pin, a connecting rod, the upper end of which forms a blade which fits closely into the slot of said wrist-pin, means for rigidly fastening the upper end of said connecting rod in the transverse slot in said wrist-pin, a wrist-pin carrier disposed transversely beneath the interior of the crown of a piston in a position spaced from opposite interior walls of the piston body and containing a cylindrical bearing surface to receive and journal said wrist-pin, said wrist-pin carrier having a transversely extending slot in the lower peripheral portion thereof for the passage of the end of said connecting rod to permit oscillation of the connecting rod and for the passage of oil therethrough, said wrist-pin carrier containing passages for oil in the upper peripheral portion thereof aligned with the slot in said wrist-pin carrier and opening beneath the interior of the crown of the piston, a piston body having an interior annular thrust surface, a coacting thrust surface on the upper end of said wrist-pin carrier, said piston body having at least one cylindrical thrust surface on the interior side wall thereof and a segmental thrust surface on the wrist-pin carrier forming an abutment with the cylindrical thrust surface on the interior side wall of said piston body, and means to maintain the wrist-pin carrier in the piston body in contact with said cylindrical thrust surface on the interior side wall of said piston body.

2. A piston-connecting rod assembly as set forth in claim 1 in which the slot in the solid center part of said wrist-pin extends to the opposite cylindrical edges of the wrist-pin and terminates in a transversely extending chordal face forming a segmental thrust surface against which the upper end of said connecting rod abuts substantially throughout the transverse length of the chordal face of said wrist-pin.

3. A piston-connecting rod assembly as set forth in claim 1 wherein the interior side wall of said piston body includes an annular recess below the cylindrical thrust surface on the interior side wall of said piston body and wherein the means to maintain the wrist-pin carrier in the piston body consists of a resilient snap ring engageable within the annular recess in the interior side wall of said piston body in a position to engage said wrist-pin carrier immediately adjacent the segmental thrust surface thereon.

4. A piston-connecting rod assembly as set forth in claim 1 in which said wrist-pin carrier is orientatable in position interiorly of said piston body in a plane laterally of the piston body for engaging the cylindrical thrust surface on the interior side wall of the piston body, and securing means attached to at least one side of said piston body and engaging at least one portion of the segmental thrust surface of the wrist-pin carrier.

5. A piston-connecting rod assembly as set forth in claim 1 in which said wrist-pin carrier is orientatable within said piston to engage the cylindrical thrust surface on the interior side wall of said piston body, and projections extending inwardly from the opposite interior surface of the side wall of said piston body over which the segmental thrust surface on the wrist-pin carrier is engageable.

6. A piston-connecting rod assembly as set forth in claim 1 in which the cylindrical thrust surface on the interior side wall of said piston body is provided with inwardly directed projections and wherein the segmental thrust surface on the wrist-pin carrier consists of oppositely directed ears, said wrist-pin carrier being orientatable in a plane laterally of the piston body whereby the ears thereon engage said projections and wherein the means to maintain the wrist-pin carrier in the piston body includes a fastening between at least one of said ears and the side wall of said piston body.

7. A piston-connecting rod assembly as set forth in claim 1 in which there are projections on the interior wall of said piston body adjacent the annular thrust surface thereon and wherein the segmental thrust surface on the wrist-pin carrier is formed by a pair of oppositely directed ears, said wrist-pin carrier being orientatable within said piston body whereby said ears move in a plane laterally of the piston body for effecting an engagement over said projections, and in which the means to maintain the wrist-pin carrier in the piston body with the segmental thrust surface thereof in contact with the cylindrical thrust surface on the interior side wall of said piston body consists of fastening means extending between each of said ears and the interior side wall of said piston body.

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