

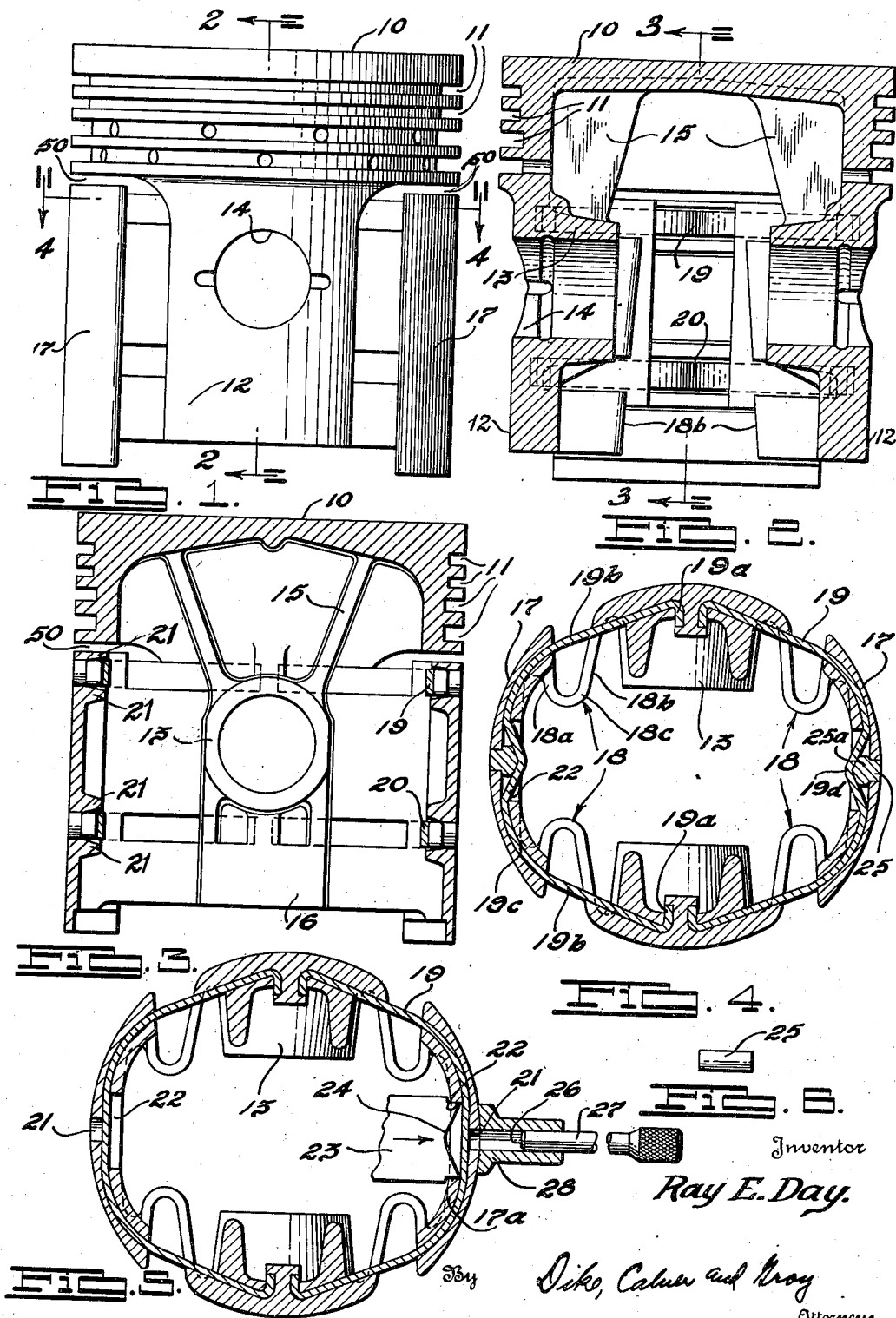
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PISTON

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PISTON

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This invention relates to pistons for internal combustion engines, an object of the invention being to provide a piston which may be fitted relatively closely within the engine cylinder, the construction of the piston, however, being such that the diameter of the skirt bearing faces will be effectively controlled to maintain a more nearly uniform clearance between the thrust bearing faces and the cylinder wall while at the same time permitting yieldability of the skirt under thermal loads and adequate support thereof against mechanical loads.

In accordance with one important aspect of the invention there is provided a piston having opposed skirt bearing members or slippers preferably separated from each other and the piston head, the skirt members being supported from the bosses or boss carrying supports by goose-neck struts or webs extending from the outer edges of the skirt members to the outer sides of the supports, these webs effecting by toggle action a control of the skirt diameter when the bosses move apart slightly as a result of thermal expansion of the head. The construction, moreover, is such that when the piston is fitted in the cylinder an increased stiffness is imparted to the lower end of the skirt in order to compensate for the normally greater yieldability of this part of the piston as compared with the upper end which is supported nearer the bosses and, therefore, normally less yieldable. This is accomplished, by way of example, by making the goose-neck webs wider at the top than at the bottom, although it may also be accomplished in other ways, such as by providing webs of uniform width or cross-section but increasing in wall thickness toward the lower ends thereof.

In accordance with another aspect of the invention there is provided a piston having opposed skirt bearing members, such as slipper sections, which are yieldably supported from the bosses preferably, although not necessarily, by means of webs of the type above described, the skirt sections being tied to the bosses or boss carrying supports by metal bands, preferably having a lower coefficient of thermal expansion than the skirt. The bands may be cast in the piston skirt so that a portion of the skirt may slide freely thereon, there being a smooth curvilinear path formed in the skirt. The bands preferably are anchored to the boss carrying supports. These bands are in pre-stressed taut condition at normal temperatures of the piston below operating temperatures, i. e. when the piston is substantially unheated and at approximate room temperatures,

The bands are preferably pre-stressed after casting the piston, but in any case are normally under sufficient tension to hold the skirt sections in toward each other or contracted under compression or compressive stresses with the flexible webs or other resilient connections between the skirt and bosses also under compression. By virtue of this construction very effective control of the skirt diameter under operating conditions is achieved.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawing forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is a side view of a piston embodying the several features of the present invention.

Fig. 2 is a vertical section taken through line 2—2 of Fig. 1 in the direction of the arrows.

Fig. 3 is a vertical section taken through lines 3—3 of Fig. 2 in the direction of the arrows.

Fig. 4 is a horizontal section taken through lines 4—4 of Fig. 1 in the direction of the arrows.

Fig. 5 is a view similar to Fig. 4 illustrating one method by which the metal bands may be tightened and pre-stressed in order to hold the skirt sections under compression.

Fig. 6 is an elevational view of the plug or rivet prior to its application to the piston.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawing, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

It will be understood that the drawing is illustrative of present preferred embodiments of the present invention and that various changes in design and arrangement of the parts may be made without departing from the broad scope of the invention. It is contemplated that for certain types of engines the pre-stressed steel bands which tie the skirt sections to the boss carrying extensions or hangers may be omitted, whereas in other types of engines the additional control of the skirt achieved by means of the pre-stressed bands will be found to be highly desirable. Such bands may extend completely around the skirt or

a portion thereof as may be desired. If the bands do not extend completely around the skirt they may be anchored or otherwise secured in the portions thereof necessary to effect the desired control. The present invention, therefore, contemplates in one embodiment thereof a piston, such as herein illustrated, having the pre-stressed bands either encircling the skirt or secured to a portion thereof for holding the skirt sections under compression and in another embodiment thereof a piston, such as herein illustrated, in which the steel bands are omitted, the construction otherwise being substantially the same as herein shown and described, or the equivalent thereof.

The piston shown in the drawing may be cast in one piece in a permanent mold and is preferably, although not necessarily, of an aluminum alloy. Such an alloy may have a relatively high coefficient of thermal expansion as compared, for example, to the materials used in the control bands. The illustrated piston comprises a cup-shaped head 10, the annular sides of which are provided with ring grooves 11. Integrally depending from the head at two opposite sides thereof are hangers or extensions 12 into which are cast the wrist pin bosses 13. These bosses have aligned wrist or gudgeon pin openings 14. The bosses are additionally reinforced by means of stiffening webs or ribs 15 connecting the same to the head and the lower ends of the hangers 12 below the bosses are also ribbed or thickened at 16 to increase the stiffness thereof. The piston is provided below the head with a bearing skirt which in the present instance takes the form of two opposed arcuate skirt or slipper sections 17 which provide the entire thrust bearing surfaces for the piston, the outer surfaces of the boss carrying extensions 12 being relieved so as not to engage the cylinder wall. The skirt sections 17 are separated from the head by means of slots 50 and are also preferably entirely separated from each other thereby permitting the same to contract and expand freely, one with relation to the other.

The skirt or slipper sections 17 are supported from the bosses or boss carrying extensions 12 by means of pairs of webs or struts generally designated by the numeral 18, a pair of these webs or struts joining each skirt section 17 to the boss carrying extensions or hangers. Each strut or web 18 is substantially in the form of a gooseneck having reversely extending portions. The struts or webs 18 of each pair comprise relatively short converging portions 18a extending inwardly from the opposite outer edges of the skirt section and also comprise widely diverging longer portions or walls 18b extending preferably to the outer sides or faces of the extensions or hangers 12. The web portions 18a and 18b are joined by an intermediate bowed or curved portion 18c. Thus, the skirt sections are supported from the boss extensions 12 by means of bowed or gooseneck type struts diverging from the outer edges of each skirt section to the bosses. As a result, during operation when the piston head becomes hotter than the skirt sections, a certain amount of toggle action will be exerted by the struts or webs 18 upon outward movement of the bosses due to thermal expansion of the head, and this toggle action will tend to offset outward expansion of the skirt sections against the cylinder wall. In other words, the normal tendency of the skirt sections to expand against the cylinder wall, sometimes causing seizure or scoring, is

at least in part restrained by the toggle action exerted by the struts.

In the present embodiment the reversely formed webs or struts 18 are constructed so as to have greater stiffness at their lower ends than at their upper ends. This may be accomplished by making each strut wider in cross-section at the top than at the bottom. As shown in Fig. 2 at 18b, each strut 18 in cross-section progressively becomes narrower toward the lower end of the piston. This construction causes each strut to have greater stiffness at the lower end than at the top. Since the top of the skirt is nearer the connection of the head to the bosses and is nearer to the gudgeon or wrist pin it is normally stiffer than the lower end. Hence, by progressively varying the width of the struts this differential stiffness is compensated for. In the present embodiment it is also contemplated that the struts or webs be cast so as to increase in wall thickness toward the lower ends thereof thereby further compensating for the relative weakness or greater flexibility of the lower end of the skirt as compared to the upper end thereof.

In accordance with a further embodiment of the present invention the skirt or slipper sections 17 are also tied to the boss carrying extensions 12 by means of metal bands. These bands may be of suitable metal as, for example, a ferrous alloy having high tensile strength and are substantially inextensible under the conditions of use to which the piston is subjected. In the present instance each skirt section 17 is tied to the members 12 by means of a pair of upper and lower bands 19 and 20, the bands being cast so as to extend in part through ribs 17a in the skirt. The upper bands 19 may lie just above the upper edges of the webs 18 and the lower bands 20 may extend freely through slots in these webs. Each band emerges from the edges of the skirt section on a smooth curve and thence has substantially straight portions 19b spanning the skirt section and the hangers 12. The portions 19b extend straight into the hangers 12 and have bent terminal ends 19a anchoring and locking them in the hangers or extensions 12.

To eliminate the possibility of warping a portion of the skirt by an action similar to that of a bimetallic thermostat under heat, ribs or bosses 51 are formed as a part of the skirt and extend around the upper and lower edges of the bands 19 and 20. The ribs or bosses 51 are of a sufficient size to counteract the tendency of the metal in the skirt to warp due to the difference in the coefficients of thermal expansion between the skirt and the bands.

After the piston has been cast with the bands 19 and 20 incorporated therein, these bands may be tightened in any suitable manner. As shown, each skirt section 17 has upper and lower holes or apertures 21 opposite the bands and the stiffening ribs 17a of the skirt have recesses or notches 22 therein, thereby exposing a portion of each band at opposite sides thereof through the medium of the aperture 21 and the recess 22. An anvil 23 having its end adapted to fit within the recess 22 and having a wedge shaped recess 24 is positioned as illustrated in Fig. 5. A plug or rivet 25 (Fig. 6) of soft aluminum or other material is inserted in the aperture 21 and engaged by the end 26 of a tool 27, the rivet being guided in proper position by means of a guide collar 28 loosely mounted on the end of

the tool. If desired a boss may be cast on the piston skirt to provide sufficient material to hold the rivet 25 in place, the boss being ground off when finishing the piston. Before inserting the rivet in the aperture 21 a tool similar to the tool 27 is forced through the aperture against the anvil 24 to distort the band 22 in the manner shown at 19d in Fig. 4, the band thereby being pulled up tight and the skirt drawn in or contracted. The band will remain temporarily in this distorted condition as shown at 19d and thereupon the rivet 25 is inserted in the aperture and forced inwardly by tool 27 against the band and also the anvil 23 under sufficient pressure to swage the inner end thereof by causing the metal to flow laterally and produce an upset head 25a overlapping the inner edges of the aperture 21, thereby securely locking the distorted portion 19d of the band and holding it in pre-stressed condition.

When casting the bands in the skirt sections the bands are preferably coated, except at the terminal anchorage points 19a, with a lubricant material, such as a graphite mixture, to prevent adhesion of the aluminum alloy to the surfaces of the bands and to permit slight compressibility of the coating so that the band will not be clamped by the shrinkage of the aluminum when it cools in the mold. Since each band extends on a smooth curved path or line through the side edge portions of the skirt section 17 and is relatively free in the skirt, it can be readily tightened so as to draw in the skirt sections. The differential expansion of the skirt and bands is permitted by the relative sliding of the skirt and the bands. It is probable that the action is for the skirt to slide on the band as a guide member since the crimping of the band tends to lock the band and skirt together at the point of crimping of the band.

In accordance with the illustrated arrangement each skirt or slipper section is independent of the other, this by reason of the fact that a pair of bands 19 independently tie each skirt section to the bosses. Although not essential, this method of independently tying each section to the bosses by pre-stressed bands is preferred since it affords somewhat better control of the skirt sections and prevents the release of the entire skirt if a single band should break.

I claim:

1. A piston comprising a head having depending boss carrying extensions, opposed skirt sections separated from the head, a pair of yieldable webs or struts connecting each skirt section to the extensions, the webs of each pair being substantially of goose-neck formation having relatively short converging portions extending inwardly from the outer edges of the skirt section and widely diverging longer portions extending to the boss carrying extensions, said converging and diverging portions being joined by intermediate bowed portions, the cross-section of the skirt section and webs varying from top to bottom thereby imparting increased stiffness to the lower end of the skirt section against mechanical loads during operation.

2. A piston as defined in claim 1 in which the lower ends of said webs are stiffer than the upper ends.

3. A piston as defined in claim 1 in which the webs decrease in width from the upper end toward the lower end thereof.

4. A piston as defined in claim 1 in which the walls of the webs are thicker and therefore stiffer

at or near the lower ends thereof than the upper ends.

5. A piston comprising a head, boss carrying extensions depending from said head, a pair of skirt sections at opposite sides of the piston, means for connecting the skirt sections to the head in such a manner that they are resiliently movable in towards each other, and a relatively inextensible band or bands holding a skirt section in toward the other under compressive stress and being pre-stressed under tension at temperatures less than operating temperatures of the piston.

6. A piston comprising a head, boss carrying extensions depending from said head, a pair of skirt sections at opposite sides of the piston, means for connecting the skirt sections to the head in such a manner that they are resiliently movable in towards each other, and a relatively inextensible band or bands holding a skirt section in toward the other under compressive stress and being pre-stressed under tension at temperatures less than operating temperatures of the piston, said band or bands being anchored to said boss carrying extensions.

7. A piston as defined in claim 5 in which each band is distorted to pre-stress the same and held in pre-stressed condition by a headed plug element anchored in the skirt section.

8. A piston as defined in claim 6 in which said headed plug element extends through an aperture in the skirt section and is headed over at the inner face thereof.

9. A piston as defined in claim 5 in which said band extends transversely along the inner wall of the skirt section to permit relative sliding in a curvilinear path between said bands and said skirt section.

10. A piston as defined in claim 1 in which each skirt section is independently tied to the boss carrying extensions by means of a relatively inextensible band or bands, each band being anchored in the boss carrying extensions, extending transversely from one edge to the other of the skirt section, and slidably mounted thereon.

11. A piston as defined in claim 1 in which each skirt section is independently tied to the boss carrying extensions by means of a metal band or bands anchored at opposite ends to the boss carrying extensions and pre-stressed and held taut under tension through the medium of means carried by the skirt section.

12. A piston as defined in claim 5 in which each band is pre-stressed and held taut by means carried by the skirt section.

13. A piston as defined in claim 5 in which each skirt section is held in toward the other under compression by means of a pair of bands each pre-stressed at a point on the skirt.

14. A piston as defined in claim 5 in which said band or bands are formed of metal having a lower coefficient of thermal expansion than the metal of the piston.

15. A piston comprising a head, boss carrying extensions depending from said head, a pair of skirt sections at opposite sides of the piston, means for connecting the skirt sections to the head in such a manner that they are resiliently movable in towards each other, a relatively inextensible band or bands holding a skirt section in toward the other under compressive stress and being pre-stressed under tension at temperatures less than operating temperatures of the piston, said bands extending through a portion

of said skirt sections and permitting relative sliding movement of the skirt and bands, and means for preventing warpage of a portion of the skirt due to the unequal thermal expansion of a bi-metallic member.

5 16. A piston as defined in claim 5 in which each skirt section is held in toward the other under compression by means of a pair of bands

each pre-stressed at a point on the skirt, said means comprising ribs formed in the skirts adjacent said bands, said ribs extending over the edges of said bands to provide a sufficient body of the metal of said skirts to modify the bi-metallic thermal action thereof. 5

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