Sept. 24, 1968 G. J. MAAT 3,402,643

PISTON HAVING PIN BORE RELIEF AND METHOD OF MANUFACTURE

Filed June 17, 1966

FIG. 1.

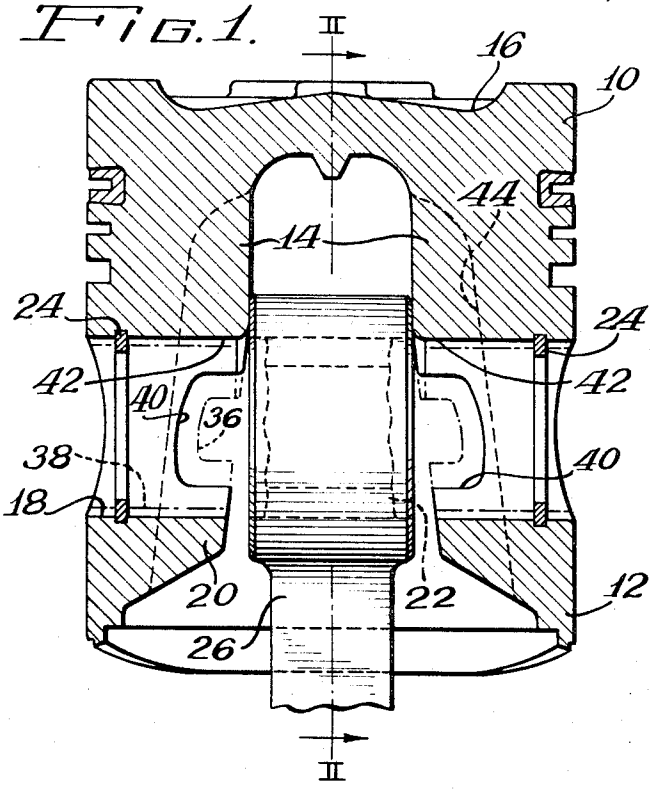



FIG. 4.

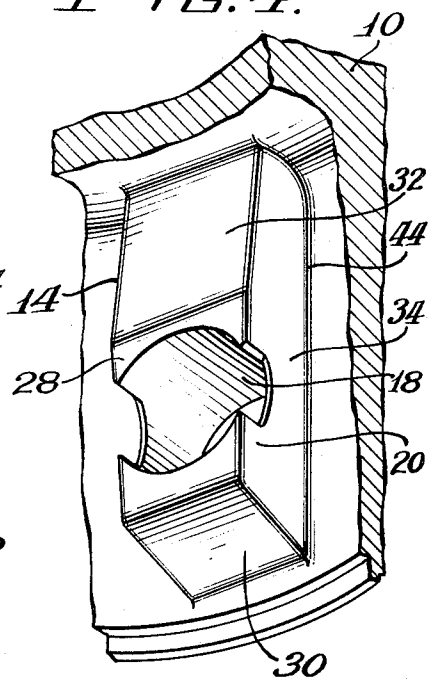



FIG. 2.

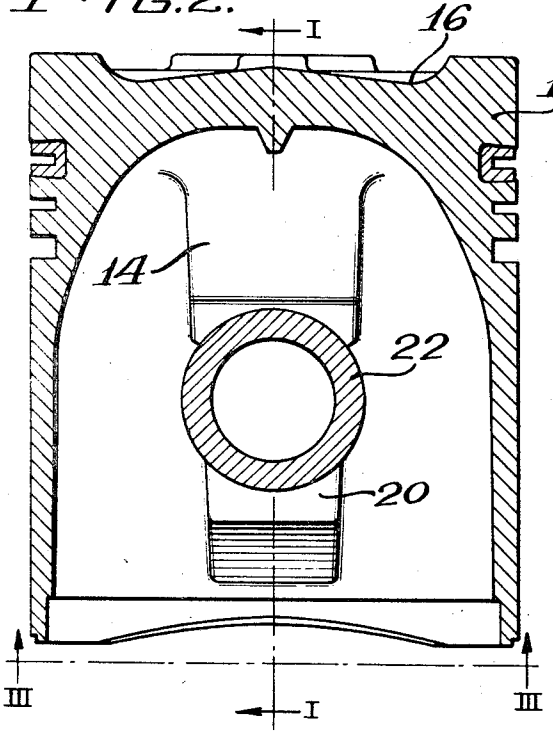
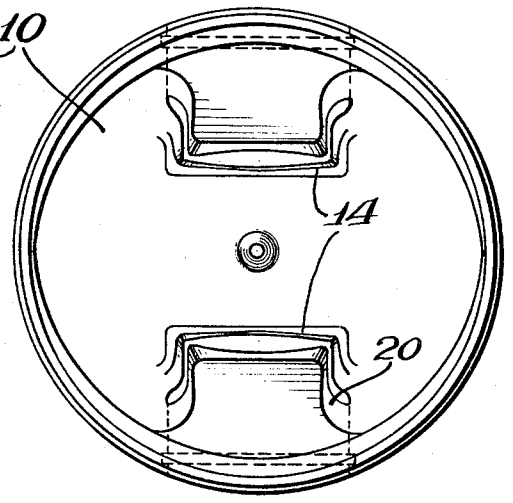



FIG. 3.

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# PISTON HAVING PIN BORE RELIEF AND METHOD OF MANUFACTURE

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## ABSTRACT OF THE DISCLOSURE

Piston cast with narrow struts such that, when the wrist pin bore is formed to its final size transversely through the struts and skirt of the piston, the bore walls forming the skirt sides of the bore are left with no appreciable thickness, i.e., the bore walls are either thin or, if present at all, they amount to no more than partial walls at the skirt sides of the bore.

In a piston having pin bore relief as shown in the accompanying drawing, a head **10** and a skirt **12** thereon are integrally joined by an internal pair of mutually confronting, longitudinally extending piston struts **14** therebetween. The relation of the several views in the drawing is indicated by various section lines. The head has a gas-loaded face **16** recessed according to conventional construction in piston engines.

A transversely disposed wrist pin bore **18** is located in the narrow pin boss portions **20** of the individual struts **14**. The bore **18** accepts a hollow wrist pin **22** of circular cross-section which is between and engages two snap rings **24** provided in opposite ends of the bore and which pivotally secures the piston to the outer end of a crankshaft-connected connecting rod **26**.

The wrist pin connection is a vulnerable point in the piston because of the cracking problem hereinafter described. The system of forces accommodated through that connection consists of the longitudinal gas force exerted in the direction of movement of the piston, the reaction force of the connecting rod **26** which is at a constantly varying angle generally opposing the gas force, and the reaction of the cylinder wall, not shown, on both the thrust and antithrust sides of the piston in a direction perpendicular to piston movement.

The wrist pin **22**, conventionally made of tubular steel, deflects among other ways in the portions intermediate its ends so as to oval, or more technically take an elliptical shape in cross-section, under maximum gas loadings on the piston. That is to say, there is perceptible local flattening of the wrist pin **22** in a direction perpendicular to piston movement, all in a manner more particularly described in Cook et al. U.S. Patent No. 3,357,318, which is assigned to the assignee of the present application and the disclosure of which is incorporated in entirety herein by reference.

The conventional aspects of the piston are apparent. The emphasis herein is on the particular structure of the struts **14**, each bounded on the exposed surfaces by an end face or plane **28** at the inner end of the boss portion, an obliquely disposed strut end wall **30** intersecting said plane and being at the bottom of the strut, an upper inner wall **32** of the strut intersecting said plane, and lateral sides or walls **34** which are on the skirt sides of the bore **18** and which, in the vicinity of the boss portion **20**, either disappear completely or are relieved enough to render them walls of no appreciable thickness. The referred to local flattening of the pin **22** is encountered by the walls **34**. But these boss walls as indicated are of only slight thickness at most and are incapable of transmitting sufficient stress to oval the bore to the point that the crystalline structure in the metal surface on the head side of the bore is placed under cracking-producing tension stress.



The piston is preferably a die-casting of aluminum or an alloy thereof, with the struts **14** being cast to final size and the bore formed by a core, not shown, present in the dies during casting. No bearing insert is essential in the final piston because, as part of the last tool operations enlarging the bore, the bore surface can be worked by a turning arbor, not shown, carrying a set of rotatably mounted, work-hardening rollers about its periphery.

The crystalline structure of the bore is thus work hardened to a depth of several thousandths of an inch, or slightly more, due to pressure of the rollers which rotate as they are being revolved about the arbor axis. The contact pressures are not excessive but the rolling is nevertheless effective to work-harden aluminum.

The foregoing operation can be performed with good results after the cored-in bore **18** has been finish machined. The work hardening is deliberately not strenuous, because of the possibility that the bore would become out of round or lose the accuracy of its finished dimension.

In case the wrist pin bore **14** is rough machined but not finish machined prior to hardening, the work hardening operation is a little more rigorous and penetrates for slightly more than several thousands of an inch in depth within the worked metal of the boss portions **20**. Thereafter, the bore **144** is finish machined, the cutting or honing being shallow, e.g., to a depth of only one or two or three thousandths of an inch so as not to machine away the entire work hardened metal.

Due to the narrow shape of each bore boss portion at the skirt sides thereof, the coring of the bore leaves the side dimensions at **36** and the bore dimensions at **38** having outlines indicated by broken lines. The last tool operation, be it final machining step or the work hardening step if employed, cuts through the skirt sides of the bore portion to leave the final outline of intersection as shown in solid lines **40**. Hence, pin bore relief is an inherency of the last tool operation, which saves the manufacturer from the necessary relief step or steps in comparable procedures. This work saving aspect obviating metal removal in difficult places is one of the primary features of my invention.

The skirt itself on the skirt sides of the wrist pin and bore provides an adequate uninterrupted surface for transmitting piston side thrust to the engine cylinder walls. Immediately on the inner side of each pin retaining snap ring **24**, the wrist pin stays essentially circular in cross-section, and the ellipticalness principally occurs only in the vicinity of the platen **28** of the inner end of the bore boss portion.

The piston cracking problem is materially alleviated in the present piston, such undesired cracks normally appearing as longitudinally extending cracks in regular pistons beginning on the head side of the bore at **42** (FIGURE 1). The intersection **40** of the bore with each boss portion at the skirt side defines a semicircular arc (technically, an ellipse), with the outer end of the relief falling at no more than approximately half way to the outer end of the bore. Preferably, the relief falls slightly short of the inside corner of the strut and the skirt indicated at **44**.

There is a minor inward taper, not shown, of the struts so that at their skirt sides the opposite walls **34** converge slightly inwardly toward the center of the piston. The same walls **34** also have a slight convergence downwardly, i.e., they taper away from the head of the piston.

I claim:

1. Piston comprising:
a head having a gas-loaded face;
a skirt;
longitudinally extending struts in the piston joined between the head and skirt and having bored pin boss portions (20); and
a hollow wrist pin in the bore of the pin boss portions, said pin having skirt sides spaced 90° from both the side thereof adjacent the head and the side of the pin opposite the piston head;
at least the pin boss portions of said struts being no wider than approximately the pin diameter adjacent to the skirt sides of the pin, such that said pin boss portions adjacent to the skirt sides of the pin are not of appreciable thickness and local outward expansion of the pin as a result of temporary pin flattening by gas loads will not be significantly opposed by the boss walls.

2. The invention of claim 1 characterized by:
said bore cutting completely through the boss side walls, and forming a path of intersection between the bore walls and the boss side walls falling for at least a portion between the inner ends of the boss portions and the piston skirt;
said pin being essentially in circular shape in cross section, and retaining such a shape in the vicinity of the skirt and being flattened from such shape in the vicinity of the inner ends of the boss portions when said piston is subjected to axial gas loads.

3. The invention of claim 2 characterized by:
said path of intersection (40) falling approximately at the inside corners (44) between the pin boss portions and the skirt.

4. The invention of claim 3 characterized by:
said path of intersection having approximately an elliptical form, inside of which the wrist pin is exposed by the bore.

5. In a piston for use in a reciprocating engine and having struts and a head and a skirt joined by the struts, the piston having a bore in the struts transversely disposed therein and having the piston head at one side of the bore spaced 90° from the skirt sides of such bore:
the improvement wherein the bored portions of said struts are no wider than approximately the bore diameter adjacent to the skirt sides of the bore such that the bore walls forming the skirt sides of the bore are not of appreciable thickness.

6. The invention of claim 5, characterized by the bore cutting through the sides of the struts adjacent to the skirt sides of the bore.

7. The invention of claim 6, characterized by the path of intersection between the bore walls and the strut sides being generally a semicircular arc.

8. The invention of claim 7, said arc being coextensive in length with at least a major part of the bored portions of the struts.

9. The invention of claim 5, characterized by the struts being cast to final size and the bore being cored-in to initial size.



10. The method, in piston manufacture, of forming a piston pin bore so as to provide relief in the skirt sides of bore boss portions of a piston, said piston having a head and a skirt joined by said portions, the head side of the bore being spaced 90° from the skirt sides of the bore, said method comprising:
casting the piston with a cored-in pin bore in the boss portions; and
enlarging the bore such that said bore boss portions on their skirt sides are no wider than approximately the bore diameter and the skirt sides of the bore are not of appreciable thickness.

11. The invention of claim 10, characterized by enlarging the bore such that at least part of the boss portions on their skirt sides are no wider than the cored-in bore diameter.

12. The invention of claim 10, characterized by:
work hardening the bore and finally machining the bore.

13. The invention of claim 10, characterized by casting bore boss portions to final size at the time of casting the cored-in pin bore.

14. The manufacture of a cross bored strut part having walls of no appreciable thickness at the lateral sides of the bore, comprising:
a strut part having generally longitudinally extending sides including an inner face and opposite lateral sides (34) each making a dihedral angle with the inner face, said lateral sides being tapered so as to converge at least in one direction; and
a cross bore (18) in the strut in a direction transverse to and passing through the inner face thereof, and cut at least partly through the converging sides of the strut part.

15. The invention of claim 14, the provision of the strut part and the bore formation being cast.

16. The invention of claim 15, characterized by the converging sides of the strut part being cast with a two-way taper so as to converge both in the direction of the inner face and in a longitudinal direction of the part.


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