June 13, 1967 P. WITTSTOCK 3,324,772

PISTON

Filed May 29, 1964 2 Sheets-Sheet 1

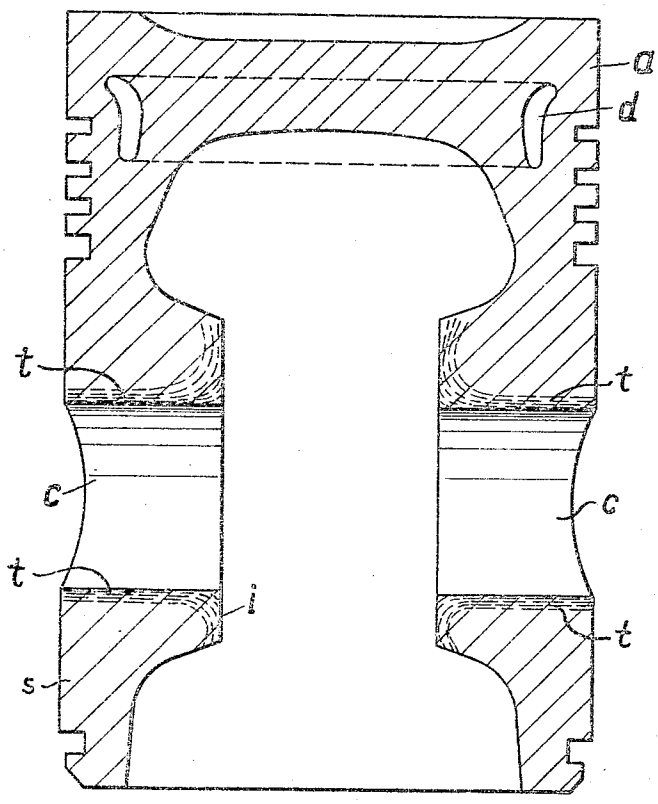


Fig. 1

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June 13, 1967 P. WITTSTOCK 3,324,772

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Filed May 29, 1964 2 Sheets-Sheet 2

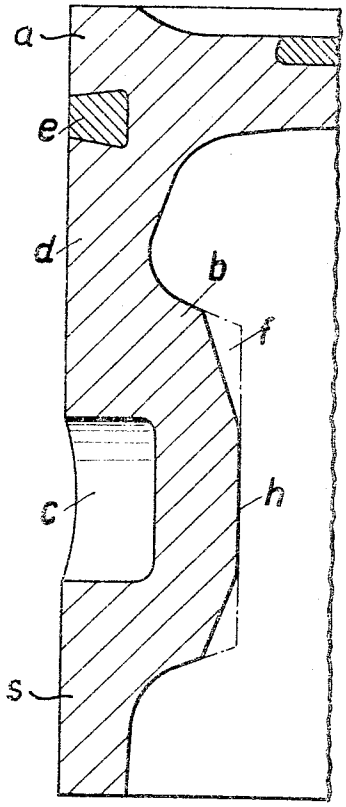


Fig. 2

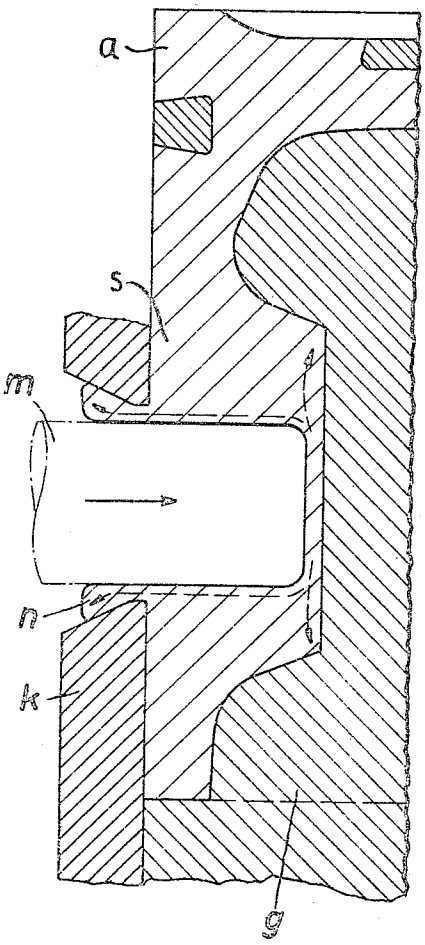


Fig. 3

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PISTON

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The invention relates to metal pistons for internal combustion engines and compressors, especially for high-speed, highly supercharged internal combustion engines, such as diesel engines.

In view of the thermal and mechanical stresses on the pistons in such engines, it is in the prior art to use two different light-metal alloys in their construction. The one is distinguished by great hardness and thermal stability in comparison with the other, which has a better elongation. The former has accordingly been used to make the head of the piston, and the latter as a friction surface for the manufacture of the skirt of the piston. In this case the head of the piston is appropriately given a cast structure, while a kneaded structure is preferred for the skirt. To achieve such differences of structure, it is known that it is possible to manufacture a rough casting from an aluminum alloy by cooling or chilling at different rates of speed in different areas of the casting, and to follow up the casting operation immediatly, i.e., while the casting is still hot, with a kneading process.

Pistons of the above-mentioned prior-art design do have a better elongation in the piston skirt area than in the head. It has developed, however, that the forged or pressed structure has poorer friction qualities and hence a poorer resistance to wear than the cast structure. Also, the thermal stability of the kneaded structure above certain temperatures in constant operation is poorer than the cast structure, when one and the same alloy composition is used for the manufacture of the piston. Lastly, in a piston with different kinds of structures, the tendency to slap increases, and with it the danger of flaring the grooves of the compression rings. Therefore such pistons are not good for diesel operation, in which an annual running time of 6,000 to 7,000 hours of operation is desired, and hence a piston life of at least 40,000 total hours of operation. Furthermore, if a piston has a pressed or forged structure exclusively, the grain direction produced in the wrist-pin bosses by the kneading process is oriented parallel to the long axis of the piston. The grain fibers are cut in the machining of the rough forging, which produces a hole in the wrist-pin bosses to receive the wrist pin. Consequently, the orientation of the grain structure is very unfavorable precisely in that portion of the wrist pin bosses that is close to the piston head and which constantly bears the greatest mechanical stresses.

To eliminate these deficiencies, and also to meet other requirements in regard to the manufacture and the structure of light-metal pistons, especially those for diesel engines, and also to overcome the difficulty of creating coolant chambers in the head of the piston in back of the ring portion, the piston has been made according to the invention from a casting whose structure has a coarser grain than a kneaded structure, in a known manner, so that the skirt has the highest possible wear resistance in constant operation, and which is kneaded only in the immediate vicinity of the internal cheeks and around the wrist-pin holes, so that the fibers run from the skirt surface inward in the axial direction of the wrist pin and extend to adjacent the cheeks, being distributed perpendicularly to the axis of the wrist pin over the same surfaces.

The drawings represent the process of the manufacture of the piston in the manner of the invention. In the drawings:

FIG. 1 is a longitudinal section and shows the way the fibers run in a finished piston;

FIG. 2 is a longitudinal section of the rough casting; and

FIG. 3 is a longitudinal section depicting the arrangement of the tools.

In the manufacture a light-metal piston *a*, especially for diesel engines, the process begins with a rough casting as shown in FIG. 2. The rough casting includes the piston head *a*, piston skirt *s*, and wrist pin boss preforms *b*. At least some of the space corresponding to the unit pin bores *c* is cast full, and spaces *f* corresponding to radially outwardly disposed portions of the inner cheeks *h* of the bosses are left free of metal. The rough casting is forged to press metal filling the bore spaces inwardly to cause metal to flow into spaces *f*.

The piston is so processed that the wrist-pin boss *b* is provided with a pressed or forged structure in the area in which the hole *c* for receiving the wrist pin is located, with an optimum fiber orientation in the areas to bear heavy loads, while the other areas of the piston have a cast structure which, as is known, has good friction properties and great resistance to wear. The metal fiber structure is indicated by lines *t* in FIG. 1. If desired, a coolant chamber *d* (FIG. 1) can be formed in the casting process, in a prior-art manner. Furthermore, special ring holders *e* (FIG. 2) can be cast in.

According to experience, the point most in danger of breakage in the wrist-pin boss is the area where the wrist-pin hole meets the internal cheek of the boss, because the wrist pins not only bend elastically under the effect of the alternating inertia forces, but also undergo oval deformation in the plane of the internal cheeks of the wrist-pin bosses, and the elastic oval deformation of the wrist pin in the upper area of the boss facing the piston head, cause excessive tensile stress. In order to absorb the latter, in accordance with the invention, the material behind and in the vicinity of the internal cheeks is, according to the invention, kneaded, for example by pressing or forging.

To this end, the rough piston casting is preworked in the manner shown in FIG. 2. The hole *c* for receiving the piston pin is pre-cast only partially or, if desired, not at all, so that the amount of material which at the beginning still fills the hole is available for the pressing process. The contour of the wrist-pin boss facing the interior of the piston is not pre-cast in final form either, but is truncato-conical as is shown in FIG. 2, and provides an annular space *f* between each wrist-pin boss and a die such as the die *g* shown in FIG. 3. The die *g* is made insofar as possible in the form of a steel core. The center portions *h* in the wrist-pin bore area of the boss preforms *b* extend as far as the plane in which the respective internal cheeks will be located in the final form, and which is designated as *i* in FIG. 1. The diameter of these already flat cheeks *h* is smaller than the final diameter of the wrist-pin bore. The metal forming the inner cheek *h* terminates short of the radially inwardly, inner periphery of the wrist pin bore.

The casting of FIG. 2 is pre-heated and placed in a die *k* which permits the entry of two press rams *m*. Between these rams and the die *k* for each boss, there is an annular gap which permits excess material *n* to flow out during the pressing process.

Under the effect of the two press rams on the left and right the material of the pre-heated casting flows into the above-mentioned annular space *f* and, by filling the said space, completes the shaping of the wrist-pin bosses. At the same time, the excess material of the boss preform flows out around the press rams in a direction opposite that of the pressing, passing through the above-mentioned annular gap *n*. The size of the annular space *f* is such that the final contour of the wrist-pin bosses can develop in

the pressing process, that is, that the annular space *f* can be completely filled out.

Thus the invention provides for production of a piston including as integral elements thereof a piston head, piston skirt, and unit pin bosses, characterized by increased strength of the unit pin bosses. The invention finds particularly advantageous improvements in the case of light metal pistons e.g. aluminum, aluminum alloys, etc. The piston, after casting and forging according to the invention can be subjected to machining to provide the finished dimensions.

While the invention has been described with respect to particular embodiments, these are merely representative and do not serve to define the limits of the invention.

What is claimed is:

1. Piston comprising as integral elements thereof a piston head, piston skirt, and wrist pin bosses, characterized by a metal fiber structure in the bosses, the fiber extending inwardly parallel to the axes of the wrist pin bosses toward the inner ends thereof and then turning outwardly of the bores and running radially outwardly toward the outer peripheries of the inner sides of the bores.

2. Piston comprising as integral elements thereof a piston head, piston skirt, wrist pin bosses, characterized in that the piston head and piston skirt are cast metal structure, and in that the bosses comprise a metal fiber structure, the fibers extending inwardly parallel to the axes of the wrist pin bosses toward the inner ends thereof and then turning outwardly of the bores and running outwardly toward the outer peripheries of the inner sides of the bores.

3. Piston according to claim **2**, and means defining a passageway therein for receiving a cooling agent.

4. Piston according to claim **3**, and including a ring holder cast therein.

No references cited.

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