Oct. 19, 1937. A. A. HANDLER 2,096,513

UPSET PISTON

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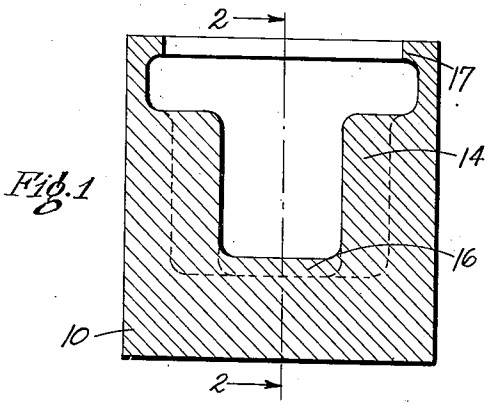


Fig. 1

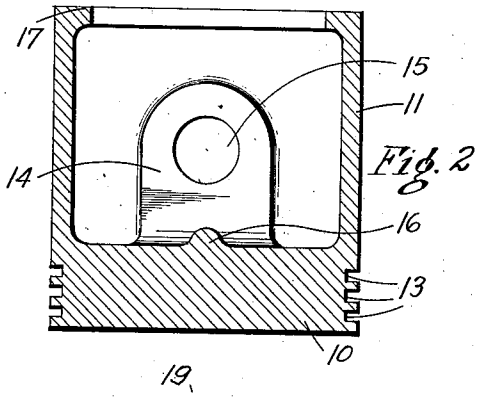


Fig. 2

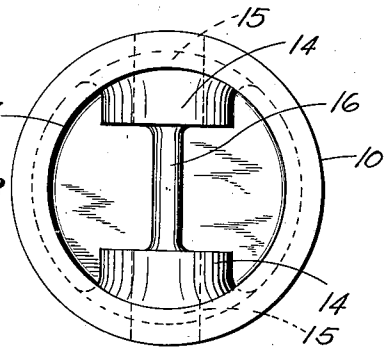


Fig. 3

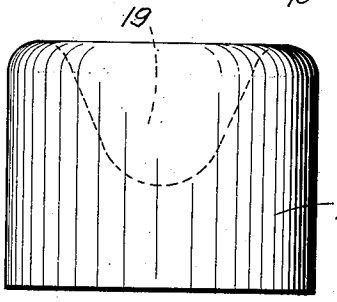


Fig. 4

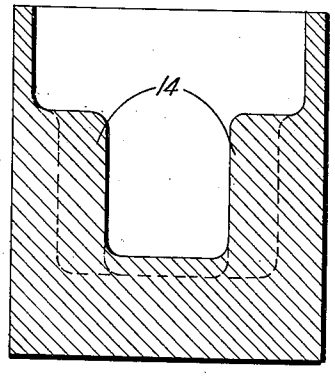


Fig. 5

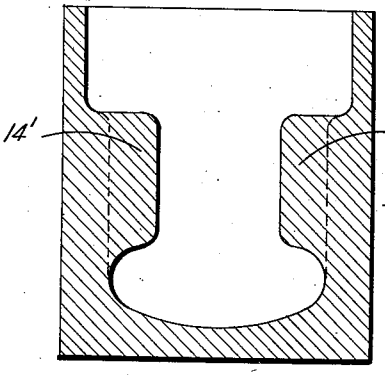


Fig. 6

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UPSET PISTON

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Application March 25, 1931, Serial No. 525,277

5 Claims. (Cl. 309—10)

This invention relates to hollow or cup shaped light metal articles, such as pistons, and particularly to internal combustion engine pistons composed of aluminum and its alloys or other light metals or alloys.

It has heretofore been customary to manufacture pistons and the like from light metals and alloys by chill casting the same in permanent molds to produce a fine grained structure free from porosity and having a network of eutectic substantially surrounding the excess material of the alloy, in accordance with the method disclosed and claimed in United States Letters Patent to Joseph H. Bamberg, No. 1,296,589, March 4, 1919, to produce the metallic structure claimed in said patent and in United States Patent to Bamberg No. 1,296,591, March 4, 1919. These pistons have been manufactured in large quantities, amounting to several million a year, and have been found to be successful in carrying the forces to which internal combustion engine pistons are subjected and in resisting wear and deformation to such a degree as to have replaced to a substantial extent other types of pistons in the motor vehicle internal combustion engine field.

Continued use of pistons of this type over a period of years, however, has indicated lines along which further improvement might be made. For example, it has been found that greater tensile strength and higher resistance to fatigue than can be obtained in this type of piston without sacrificing other important factors, such as weight and hardness, would be desirable in the skirt of the piston.

In attempting to reduce the differential expansion between aluminum pistons and cast iron cylinders which results from the relatively high coefficient of expansion of aluminum, considerable research work has been directed to the production of alloys having lower coefficients of expansion than aluminum or ordinary casting alloys of aluminum and other physical properties meeting the requirements of a material for internal combustion engine pistons. Certain alloys of aluminum have been developed as a result of this work which possess relatively low coefficients of expansion and satisfactory hardness and tensile strength, but which have been found to be difficult to cast into pistons, particularly pistons having substantial variations in the thickness of contiguous sections. There has been in recent years in internal combustion engine design a tendency toward higher compression ratios, resulting in higher cylinder and piston temperatures and greater stresses on the pistons. This has necessitated the use of thicker head sections to provide greater heat conductivity and increased strength at high temperatures. In order to retain the basic advantage of light metal alloy pistons, it has been found desirable to decrease the thickness of other portions of the pistons, such as the skirt, reinforcing webs, and the piston pin boss carrying walls, thereby increasing the variations in thickness of contiguous sections in the piston. In casting this type of piston, particularly from these newly developed alloys, it is found that the high temperatures of the molten metal required to permit proper flow into the thin sections of the mold result in excessive shrinkage from crystallization and cooling in the thick sections of the mold, producing draws, internal voids, porosity, and the like in the thick sections of the completed article.

I have discovered that the tensile strength, resistance to fatigue, and useful life of light metal alloy pistons can be greatly increased by mechanically deforming the grains of metal in the piston particularly in the skirt portion. I have succeeded in altering the mechanical structure in this manner and in producing a sound, close grained article substantially free from porosity or other defects by extruding a skirt from a slug of metal. The slug is initially formed by casting preferably in accordance with the process of the aforesaid Patent No. 1,296,589, the piston head and ring land section retaining some desirable characteristics of a cast structure and the skirt acquiring increased tensile strength and greater resistance to fatigue and fracture, the absence of brittleness being evidenced by an increased elongation.

I have also discovered that the alloys referred to above, although difficult to cast into articles of varying section, when cast into slugs of substantially uniform section and upset or extruded into shape, produce pistons of sound close grained structure free from porosity or other defects and having unusual characteristics of tensile strength, hardness, expansion, and elongation.

My invention also comprehends the provision of internally projecting bosses, webs, ribs or other extensions in an upset hollow article such as a piston.

Other objects and advantages of my invention relating to details of structure and construction and economies of manufacture will appear hereinafter.

In the accompanying drawing:

Fig. 1 is a vertical medial section of a piston embodying this invention before being machined.

Fig. 2 is a section taken on the line 2—2 of Fig. 1 showing a machined piston.

Fig. 3 is an end view of the piston shown in Fig. 2.

Fig. 4 is an elevation of a slug of metal from which the improved piston is formed.

Fig. 5 is a view similar to Fig. 1 of a piston without a peripheral flange.

Fig. 6 is a similar view of a different form of the piston.

Referring to the drawing, the invention is illustrated in Figs. 1 and 2 as embodied in an engine piston consisting of a head 10 and an integral cylindrical skirt 11. The head may be provided with the usual piston ring grooves 13.

Piston pin bosses 14 are formed on the interior of the skirt 11 and extend to the head 10 in substantially uniform section. Apertures 15 are formed in the bosses to provide piston pin bearings. If desired, one or more ribs or webs such as 16 may be formed on the interior of the head or at other points within the piston to assist in dissipating heat or for strengthening any particular part.

The skirt may be upset to form an inwardly projecting flange 17 to reinforce the skirt against collapse and to check the spraying of oil against the under side of the head. This construction is particularly desirable in certain types of pistons for aircraft or other high speed engines. As shown, the flange 17 is formed at the lower edge of the skirt, but it is to be understood that it may be spaced therefrom if desired.

This form of piston is preferably constructed by the process disclosed and claimed in my Patent No. 2,024,285 December 17, 1935, and with the apparatus disclosed and claimed in my Patent No. 2,024,286, December 17, 1935, the applications for which patents were copending herewith.

In carrying out this process a slug of metal such as 18, having a recess 19 in one end is cast in any suitable manner or machined or otherwise formed from stock previously cast and placed in a confining die of any feasible construction, the interior surfaces of which conform to the desired exterior surface of the article. The slug 18 may be chill cast in a permanent mold in accordance with the method claimed in the aforesaid Patent No. 1,296,589 to substantially the internal dimensions of the confining die. A plunger is then forced by suitable machinery into the recessed end of the slug 18 and the metal is caused to flow upwardly at the sides, forming in the case of a piston, a cylindrical skirt 11 and bosses 14. Upon removal from the die, the piece has the form illustrated in Fig. 6. This piece may then be machined to form a completed piston, or the flange 17 may be formed in the manner disclosed in my aforesaid patents.

For purposes of illustration two methods of forming the flange are cited but other methods will be obvious and I desire not to be limited to the product of the methods described for illustration. For instance, the piston may be again placed in a confining die and a divided core, having an external surface conforming to the desired internal surface of the piston is assembled therein. A plunger is then forced against the end of the skirt to upset the same against the core and form the flange.

If desired, the flange 17 may be formed in the manner disclosed and claimed in Patent No. 1,936,598, November 28, 1933. In this process, an annular external shoulder is formed adjacent the open end of the piston skirt in the initial upsetting step, and the piston is forced through a cylindrical die which upsets the shoulder inwardly, thereby producing the desired flange.

A further refinement of the process is disclosed in my Patent No. 2,024,285, to form the piston shown in Fig. 6. This piston is similar to that shown in Fig. 5 but is formed with bosses 14' partially separated from the head and overhanging the interior of the piston. This formation is produced by a suitably shaped divided core, into the recesses of which the metal is caused to flow.

All of the foregoing working operations may be performed with the metal either cold or if necessary heated to any desired temperature lower than the melting point of the most fusible eutectic. If a cold worked piston is preferred, it can be produced by this method, the cold working increasing the hardness of the metal slightly and avoiding any thermal shrinkage of the material against the core or plunger members. With most alloys the flange may be formed by either of the methods described while the piston is cold, although some alloys are too hard to be conveniently subjected to the initial upsetting step when the metal is cold. When the material is too hard to be worked cold and the shrinkage during working is sufficient to bind against the cores or plunger, these members may be heated sufficiently to minimize the tendency to seizure.

The flowing of the metal by the extrusion or upsetting in the various steps outlined above breaks down the eutectic network existing in the cast alloy and breaks up and refines the grains of metal and presses the same into closer proximity, greatly increasing the tensile strength and elongation, and producing a sound close grained skirt structure, which I term a forged metallic structure. The remaining portion of the slug from which the skirt is extruded constitutes the piston head and in the case of an initially cast slug, substantially retains its original cast structure. The head portion in this latter case has a fine crystalline or granular structure including a network of eutectic substantially surrounding the excess material and without any well-defined directional grain. This provides a desirable structure for the piston head, since the material surrounding the ring grooves 13 must be sufficiently hard and rigid to prevent deformation or battering of the ring grooves and to furnish a good bearing surface for the rings.

Pistons may be made in accordance with this disclosure from many types of aluminum alloys and also magnesium base alloys including many alloys which develop desirable properties when forged, but which contain sufficient quantities of expansion reducing or hardening constituents to interfere with the successful casting thereof in the form of pistons.

After the pistons are completed, but preferably before final machining they may be subjected to heat treatment in the usual manner to improve the physical qualities of the metal, the heat treatment consisting in the case of a well-known alloy of heating the articles to about 960 degrees F. for at least two hours followed by quenching and re-heating to about 340 degrees F. for eight to twelve hours. During the high temperature treatment the brittle constituents of the alloy are substantially dissolved in the body thereof and the combination treatment allows the metal to

attain its maximum hardness, tensile strength, and elongation.

During the heat treatment grain growth tends to occur where any substantial contrast in the sizes of adjacent grains exists. However, the initial upsetting step refines the grain of the metal substantially uniformly throughout the skirt and with a gradual variation where the amount of working changes as the heavier head section is reached, avoiding material grain size contrast and consequent excessive grain growth during the heat treatment.

It will be evident from the foregoing that the improved piston possesses marked advantages over ordinary cast pistons irrespective of the composition, and that the worked or drawn structure, particularly of the skirt, in combination with suitable alloys produces a piston superior in many respects to the best chill cast pistons.

Although the foregoing description is necessarily of a detailed character, in order that particular embodiments of my invention and the method of producing the same may be fully disclosed, it is to be understood that those skilled in the art may effect certain changes without departing from the scope of the invention as defined in the following claims and that the invention is not limited to the specific devices, methods and apparatus disclosed.

I claim:

1. A piston composed of a single piece of aluminum alloy comprising a head having a cast metallic structure and a single walled skirt integral at its upper edge with the head and having a forged metallic structure throughout.

2. A piston composed of a single piece of aluminum alloy comprising a head having a depending ring flange, the ring flange having a cast metallic structure and a single walled skirt integral at its upper edge with the ring flange and having a forged metallic structure throughout.

3. A piston composed of a single piece of aluminum alloy comprising a head having a cast metallic structure and a skirt having wrist pin bosses formed therein, said skirt being integral at its upper edge with said head, and said skirt and wrist pin bosses having a forged metallic structure throughout.

4. A piston blank composed of a single piece of aluminum alloy comprising a head having a depending ring flange, the ring flange having a cast metallic structure and a single walled skirt integral at its upper edge with the ring flange and having a forged metallic structure throughout.

5. A piston composed of a single piece of aluminum alloy comprising a head having a cast metallic structure and a single walled skirt having wrist pin bosses formed therein integral at its upper edge with the head, said skirt and wrist pin bosses having a forged metallic structure throughout and a re-inforcing rib integral with the underside of the head and having a forged metallic structure throughout.

ALFRED ADOLF HANDLER.