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ALUMINUM PISTON WITH ALUMINUM ALLOY RING CARRIER

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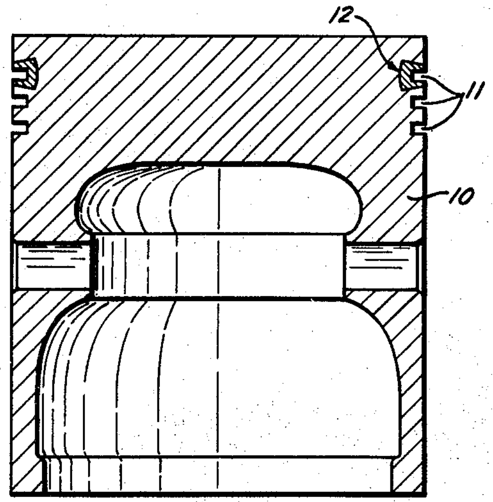

Fig. 1

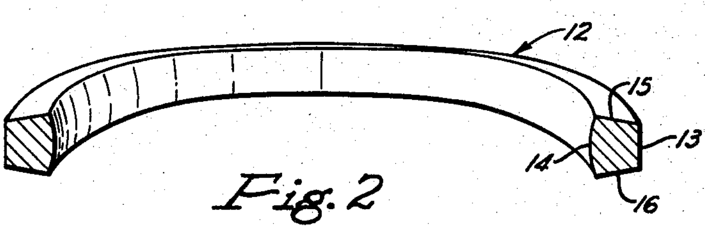

Fig. 2

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ALUMINUM PISTON WITH ALUMINUM ALLOY RING CARRIER

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7 Claims. (Cl. 309—14)

This invention relates to an aluminum piston with a ring-carrier insert embedded in its head.

Alloys of aluminum have many qualities that make them suitable for use in pistons of internal combustion engines. However, in such pistons the upper piston ring is subjected to pounding by the explosions in the combustion chamber, and this pounding results in excessive wear of the upper ring groove.

To remedy this situation ring carriers of cast iron or other hard ferrous material have been inserted in the piston head to carry the top piston ring. But these ferrous ring carriers have a number of objectionable features. The present invention obviates these objections by providing a ring carrier formed of an aluminum alloy which is harder than the alloy of the piston body, and which closely approaches in some of its physical properties, those of the piston alloy.

These and other objects and advantages of the invention will become apparent as the description proceeds.

In the drawing:

Fig. 1 is a vertical cross section through a piston embodying the invention.

Fig. 2 is a perspective view of part of a ring carrier.

The advantages of lightness of weight and good thermal conductivity of aluminum for use in cast pistons for such engines is generally recognized; however the tendency of the piston ring-grooves, and particularly the upper ring groove, to change its shape and dimensions due to wear and impact is detrimental to the best performance of the aluminum piston, causing the upper ring to bind in the groove or to incline from its normal position vertical to the cylinder wall. Under such conditions the piston ring permits the fuel-air mixture to pass below the ring, without complete combustion; the result of such "blow-by" reducing the pressure in the combustion chamber above the piston head with resultant loss of compression and reduction of engine efficiency. In extreme cases piston rings have broken, with serious scoring of the cylinder wall or breakage of the piston. Periodic inspection of aluminum pistons shows that the wearing and distortion of upper ring grooves is progressive during engine operation.

Resort has been made to the use of cast iron or "ni-resist" ring inserts embedded into the piston with or without an alloyed bond. These iron rings are positioned at the location of the upper ring groove and are of a cross-section suitable to having the upper piston ring groove machined into them. The use of iron inserts in an aluminum piston is open to several objections although the hardness of such iron rings is desirable in a ring groove

material. One objection is that the iron ring insert has a specific gravity of 7.08 to 7.3 compared to 2.74 for an aluminum alloy, SAE 332, commonly used for piston castings; the iron insert being 2.63 times heavier than the piston alloy. A second objection to iron ring inserts is that their thermal conductivity is much less than that of the piston body proper, in the ratio of grey cast iron (SAE–111) 0.11 c.g.s. (centigrade-gram-second) units to cast aluminum piston alloy (SAE–332)—0.26 c.g.s. units. A third objection to the use of iron ring inserts is that the thermal expansion coefficient of cast iron SAE–111 is 7.22×10^{-6}, whereas that of the cast piston alloy SAE 332 is 12.4×10^{-6}, a ratio of 1.7 to 1 greater expansion of the piston than of the iron ring as the piston becomes heated during engine operation. Thus it is apparent that the hardness advantage of iron ring inserts is offset by various disadvantages, whereas a ring insert more closely resembling the aluminum piston body material in respect to its specific gravity, coefficient of thermal expansion and heat conductivity but having a hardness closer to that of cast iron would be ideal for such piston ring inserts.

To produce a castable material closely approaching the ideal requirements set forth I preferably use aluminum base-alloys of which the following or their equivalents would be typical.

	Copper, percent	Manganese, percent	Iron, percent	Nickel, percent	Aluminum	Brinell Hardness (500/10/30)
Alloy A	25–26	2	1.75	None	Remainder	160–175
Alloy B	25–26	2	1.75	2	Remainder	170–185

These alloys may be case into ring inserts of suitable dimensions by any suitable method although I prefer that they be cast in iron molds in which case their hardness without heat treatment will be within the hardness range of grey cast iron which is from 175 to 210 Brinell hardness (500/10/30).

Referring to the drawings more particularly, a typical piston shown in Fig. 1 has a body **10** formed of a suitable aluminum piston alloy. These alloys must have considerable tensile strength in order to carry the heavy work loads to which the piston is subjected. These qualities cannot be obtained in aluminum alloys which possess high hardness, and it is therefore necessary to form the piston body of an alloy suitable for pistons. A typical piston alloy, SAE 332, has the folowing nominal composition:

Silicon	8.5–10.5.
Copper	2.0–4.0.
Iron	1.2 max.
Magnesium	0.5–1.5.
Nickel	0.5–1.5.
Manganese	0.5 max.
Zinc	0.5.
Titanium	0.2.

Fig. 2 illustrates in perspective part of an insert ring **12** adapted to serve as a ring carrier. It will be noted that the outer face **13** is flat, and that the inner face **14** is rounded to avoid sharp edges. The flat upper and lower faces **15** and **16** converge toward the outer face **13**, so that the insert has a cross section which is shaped somewhat like a keystone. This insert ring is formed of one of the alloys, A or B, mentioned above, and is cast in an iron mold. After trimming, this insert ring **12** is located in proper position in a piston mold, and the piston alloy, for example SAE 332 alloy, is then poured into the mold.

As the piston alloy cools it shrinks to grip the insert ring **12**, the keystone-shape of the ring helping to lock the ring against displacement. The piston casting may then be trimmed, heat treated, and machined in the usual manner.

It will be noted that the outer face **13** of the insert ring **12** is located so that in the finished piston it lies flush with the outer surface of the piston head. In machining the ring grooves **11**, the upper groove is cut into the insert ring **12**, so that this groove is entirely located in the insert of hard aluminum alloy.

If desired, the insert ring **12** may be made to extend vertically of the piston a distance to accommodate more than one of the ring grooves.

An alternate procedure is to heat the ring insert of alloy A or B by dipping it in a bath of molten zinc, heated to 800–850° F., until its temperature reaches that of the molten metal as indicated by the wetting of the surfaces of the ring insert by the molten zinc. After thus coating, the ring is quickly positioned in the piston mold and the piston is cast. By this zinc-dipping procedure the ring insert is joined to the surrounding piston body by an alloyed bond.

I prefer to use for the carrier ring **12** aluminum alloys which, as cast, have Brinell hardnesses within the range 165 to 210. I have found that below 165 they are not hard enough and above 210 they are too brittle. The hardness of the insert increases when the piston is heat-treated, but some of this extra hardness is lost at operating temperatures in an engine, and as this temperature varies somewhat in different engines, I prefer to use the as-cast hardness as the measure of the hardness.

In pistons made according to the present invention the ring-carrier is formed of an aluminum alloy whose properties in general, (i.e., specific gravity, thermal conductivity and thermal expansion) are of the same order as those of the piston alloy. But their hardness, especially at elevated temperatures, materially exceeds the hardness of the piston alloy.

The latter fact was clearly demonstrated by tests, during which samples of alloy A, mentioned above, and alloy SAE 332, were heated under identical conditions. At 550° F. the 332 alloy had a Brinell hardness of 48, whereas alloy A had a hardness of 96.

Pistons made by my described method will have an upper ring groove in metal the hardness of which approaches that of grey iron, without appreciable increase in piston weight and without changing the heat dissipating qualities or the thermal expansion characteristics of the piston as a result of locating a harder metal body within the piston head. The advantages of an upper ring

groove in such a hard metal insert are thereby retained and the proper functioning of the upper piston ring are consequently assured.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. A piston having a body and head formed of an aluminum-base alloy, the head being formed with a plurality of piston ring grooves,

a circular ring carrier cast into the piston head and surrounded by the piston metal on three sides, and having at least one of the piston ring grooves formed therein,

the ring carrier being formed of an aluminum-base alloy that is substantially harder than the piston body.

2. A piston as set forth in claim 1 in which the ring carrier has an as-cast Brinell hardness in the range of 165–210.

3. A piston as set forth in claim 2 in which the ring carrier is joined to the surrounding metal by an alloyed bond.

4. A piston as set forth in claim 2 in which the ring carrier is formed of an aluminum-base alloy containing copper, iron and manganese.

5. A piston as set forth in claim 2 in which the ring carrier is formed of an aluminum-base alloy containing copper, iron, manganese and nickel.

6. A piston as set forth in claim 2 in which the ring carrier is formed of a cast aluminum-base alloy which comprises by weight, copper 24–25%, manganese 1.75–2.25% and iron 1.5–2%.

7. A piston as set forth in claim 2 in which the ring carrier is formed of a cast aluminum-base alloy which comprises by weight, copper 24–26%, manganese, 1.75–2.25%, iron 1.5–2% and nickel 1.75–2.25%.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,956,846 October 18, 1960

William E. McCullough

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 34, for "case" read -- cast --; column 4, line 34, for "24-25%" read -- 24-26% --.

Signed and sealed this 11th day of April 1961.

(SEAL)
Attest:

ERNEST W. SWIDER

Attesting Officer

ARTHUR W. CROCKER

Acting Commissioner of Patents