

Nov. 6, 1934.

E. MAHLE

1,979,335

PISTON

Filed May 4, 1932

2 Sheets-Sheet 1

Fig. 1.

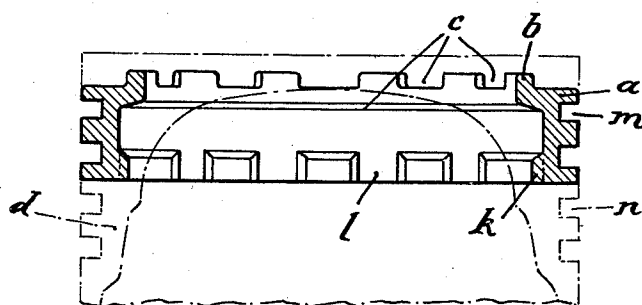


Fig. 2.

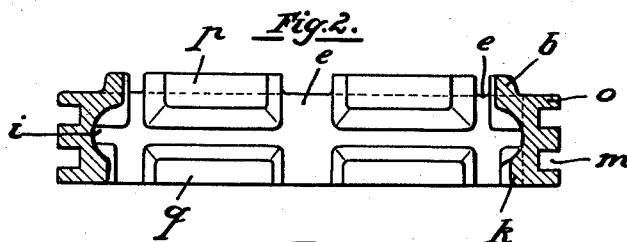


Fig. 3.

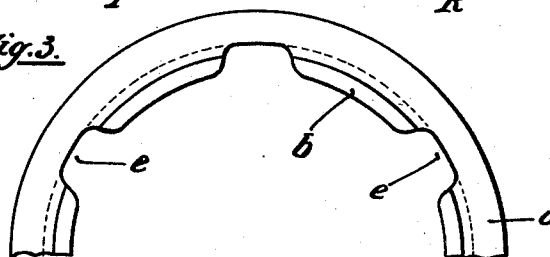
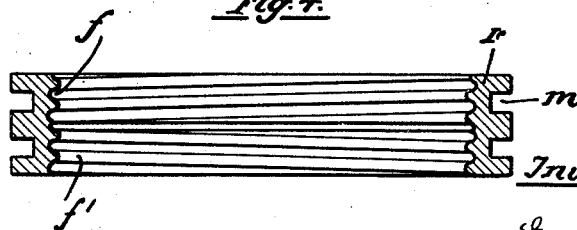


Fig. 4.



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Fig. 5.

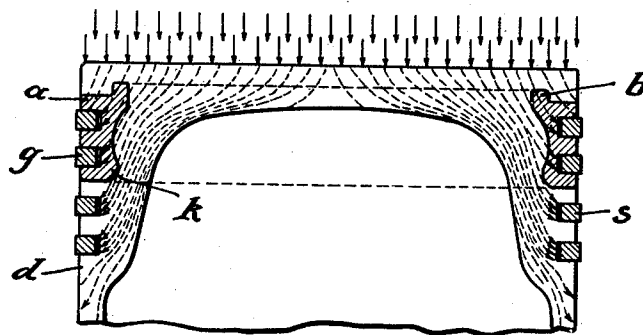
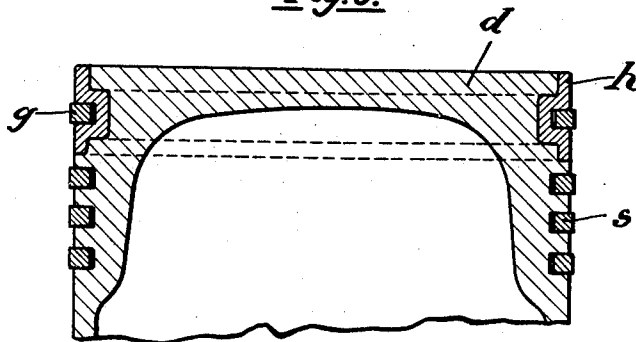


Fig. 6.



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UNITED STATES PATENT OFFICE

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PISTON

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6 Claims. (Cl. 309—14)

My invention relates to pistons for instance for internal combustion engines, and more particularly to a piston having a body of light metal or an alloy of such metal or metals and a piston-ring carrier of iron alloy, such as gray cast iron or steel having substantially the same coefficient of expansion as the piston body.

Pistons for internal combustion engines were formerly made almost exclusively of gray cast iron, but recently light metal pistons have been suggested. Such pistons, however, involve the drawback of softening at the high temperature to which the piston head is exposed, and therefore the wear of the piston rings in the comparatively soft material is excessive.

In order to eliminate this drawback, it has already been suggested to equip light metal pistons with a piston-ring-carrier of gray cast iron or steel which does not soften at the high temperatures so that the grooves do not wear to such an extent as in a light metal piston. It has, however been found difficult to effect a suitable connection between the piston and the sleeve by casting or threading, on account of the widely different heat-expansion coefficients of the two materials, so that the ring-carrier has had a tendency to work loose. Another drawback of the defective connection is the inefficient conduction of heat from the piston head which occurs principally through the packing rings.

It is an object of my invention to provide a part of machinery and quite particularly a piston for internal combustion engines, in which the connection between the piston body and the piston-ring-carrier is perfect. To this end I make the piston body of a light metal alloy of such composition that its heat-expansion coefficient is reduced, and a ring-carrier of an iron alloy of such composition that its heat-expansion coefficient is increased.

It has been found that the heat-expansion coefficient of light metals is reduced considerably by an addition of silicon. Thus for instance an alloy containing 20% silicon and 80% aluminium has a heat-expansion coefficient of 0.000018, and an alloy containing 12-13% silicon and 7% copper, the rest being aluminium, has a heat-expansion coefficient of 0.000019. By adding 13-25% silicon to an aluminium alloy its heat-expansion coefficient is reduced to 0.000017-0.000019 as against 0.000025 in a normal aluminium-copper alloy.

On the other hand it has been found that the heat-expansion coefficient of gray cast iron is increased by adding nickel and copper. Thus

gray cast iron alloys containing not less than 12% nickel and not less than 5% copper have a heat-expansion coefficient of 0.000016-0.000018. A suitable gray cast iron alloy with a heat-expansion coefficient of this order may have the following composition:

	Per cent
Nickel	12.5
Copper	5
Chromium	1.5
Silicon	1.5-2.5
Manganese	1.2
Total carbon	2.8
Balance iron	

It will appear from the above data that the heat-expansion coefficients of the light metal alloy of the piston and the iron alloy of the ring-carrier are practically equal and it is therefore possible to obtain a good connection between a light metal piston made, for instance, of an aluminium-silicon alloy, with a ring-carrier of an iron alloy, for instance, gray cast iron containing nickel and copper, and the connection may be effected by casting or threading, since the sleeve has no tendency to work loose, as in the case of materials having widely different heat-expansion coefficients.

In the drawings affixed to this specification and forming part thereof various kinds of ring-carriers and means for connecting them to the piston body are illustrated diagrammatically by way of example.

In the drawings
Fig. 1 is an axial section of a ring-carrier having channel section,

Fig. 2 is an axial section, and
Fig. 3 is a partial end elevation, of a ring-carrier which has a groove in its inner face, viewed from below in Fig. 2,

Fig. 4 is an axial section of a ring-carrier having round threads on its inner face,

Fig. 5 is an axial section of a piston head, with a ring-carrier and piston rings in the carrier and the body, showing the distribution of the heat flow to the rings in the carrier and to the rings in the body of the piston, and

Fig. 6 is an axial section of a piston having a ring-carrier of T-section.

It may be assumed that the ring-carrier is made of a gray cast-iron alloy but I do not wish to be limited to this particular material.

Referring now to the drawings and first to Fig. 1, *a* is a ring-carrier of channel section. The piston *d* is indicated in dot-and-dash lines. *b* is

an annular member extending toward the end face of the piston *d* from the outer flange of the carrier *a*. The outer edge of the annular member *b* is serrated at *c*. The inner flange *k* of the channel is of smaller inside diameter than the outer flange and serrated at *l*. *m* are two grooves for piston rings in the carrier *a*, and *n* are two grooves for piston rings in the piston *d*. Any number of piston rings may be provided in the carrier and in the piston, but preferably as few rings as possible are arranged in the carrier and as many as possible in the piston, because the heat flow through the piston is more efficient, as will be explained with reference to Fig. 5.

When the piston *d* is cast about the carrier *a*, the light metal alloy of the piston *d* penetrates into the serrations *c* and *l* and holds the carrier *a* against turning. Chattering is prevented by the substantially equal heat-expansion coefficients of the two members.

Preferably the piston is cast in a permanent mold and the carrier *a* is heated before being placed in the mold, so that the light metal alloy solidifies uniformly where it is in contact with the carrier *a*.

Referring now to Figs. 2 and 3, the carrier *o* has a groove *i* of curved, for instance semi-circular section in its inner face. The flange *b*, instead of being serrated only in its outer edge, as shown at *c* in Fig. 1, is cut away at intervals as far as the bottom of the groove *i* and the cut-away portions or notches *e* extend also through the flange *k* at the inner end of the carrier *o*. In this manner blocks *p* and *q* are formed on the inner face of the carrier extending inwardly from the respective flanges. It has been found that this type of carrier is best for obtaining a favourable flow of the piston alloy into the clearances on the carrier.

Instead of blocks or serrations I may provide a thread on the inner face of the carrier and a carrier of this type is illustrated in Fig. 4. This carrier *r* is a plain cylinder with internal threads *f* and *f'* of opposite hands extending inwardly from the ends of the carrier. The threads are shown round by way of example because the flow of the light metal alloy is facilitated by this form of thread, but any other suitable section of the thread might also be provided.

Referring now to Fig. 5, this illustrates the distribution of the heat flow from the end face of the piston head to the piston rings *g* in the carrier *a* and to the piston rings *s* in the piston *d*. While excessive wear of the grooves for the piston rings is prevented by forming the grooves not in the light metal alloy of the piston (which, as mentioned, becomes too soft in the zone of highest temperature, i. e. at the piston head) but in the harder material of the carrier *a*, the conditions of heat conduction are not as favourable for the rings *g* in the carrier *a* as for the rings *s* in the piston *d*. This is illustrated in Fig. 5 by showing two heat-flow lines per ring *g* and four lines per ring *s*. The unfavourable conditions for the rings *g* are made up for by the more favourable conditions of the rings *s* and more rings may obviously be provided in the piston body than in the carrier. In the region of the rings *s* the piston *d* is not as hot as at the piston head and therefore the grooves of the rings *s* will not wear excessively.

Referring now to Fig. 6, *h* is a carrier of T-section of uniform outer diameter, the end of which extends as far as the end face of the piston *d*. This carrier prevents direct contact of the piston head with the cylinder wall. The transverse pres-

sure at the gudgeon pin applies the piston head alternately to opposite sides of the cylinder and the soft metal of the piston does not stand the wear. By extending the carrier *h* to the end face of the piston *d* as shown in Fig. 6 direct contact is prevented and the life of the piston is prolonged.

In all cases, and not only in the case of the comparatively complicated carrier configurations illustrated in Figs. 1, 2 and 3, it is desirable to heat the carrier before casting the piston, as and for the purpose specified.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

I claim:—

1. A composite piston having a body portion fabricated of a light metal alloy cast around a ring-carrier fabricated of an iron alloy retaining its hardness at high operating temperatures, the heat expansion coefficients of said light metal alloy and of said iron alloy being substantially equal.

2. A composite piston having a body portion fabricated of aluminum alloyed with at least one metal reducing its coefficient of expansion and a ring-carrier fabricated of iron alloyed with at least one metal serving to increase its coefficient of expansion to a value substantially equal to that of said aluminum alloy.

3. A composite piston for internal combustion engines comprising a body portion of an aluminum-silicon alloy containing from about 12 to 25 per cent silicon cast around a ring-carrier of grey cast iron alloy containing sufficient nickel and copper to provide a coefficient of expansion substantially equal to that of the said aluminum-silicon alloy.

4. A composite piston for internal combustion engines comprising a body portion of an aluminum-silicon alloy, containing from about 12 to 25 per cent silicon and having a coefficient of expansion of from about 0.000017 to 0.000019, cast around a ring-carrier of grey cast iron alloy containing not substantially less than 12 per cent nickel and 5 per cent copper and having a coefficient of expansion of from about 0.000016 to 0.000018.

5. A composite piston for internal combustion engines comprising a body portion of aluminum alloyed with at least one metal reducing its coefficient of expansion cast around a ring-carrier of grey cast iron alloyed with at least one metal serving to increase its coefficient of expansion to a value substantially equal to that of said aluminum alloy; said ring-carrier having a portion of its inner face concave with at least one flange protruding inwardly, said carrier being cut away in sections thus providing a favorable flow of said aluminum alloy during the casting operation.

6. A composite piston for internal combustion engines comprising a body portion of aluminum alloyed with at least one metal reducing its coefficient of expansion cast around a ring-carrier of grey cast iron alloyed with at least one metal serving to increase its coefficient of expansion to a value substantially equal to that of said aluminum alloy; said ring-carrier being provided on its inner face with round threads of opposite hands serving to rigidly hold said carrier to said body portion and providing a favorable flow of said aluminum alloy during the casting operation.