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PISTON FOR INTERNAL COMBUSTION ENGINES

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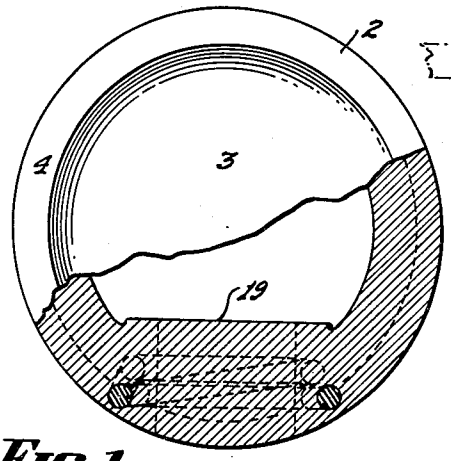


FIG. 1.

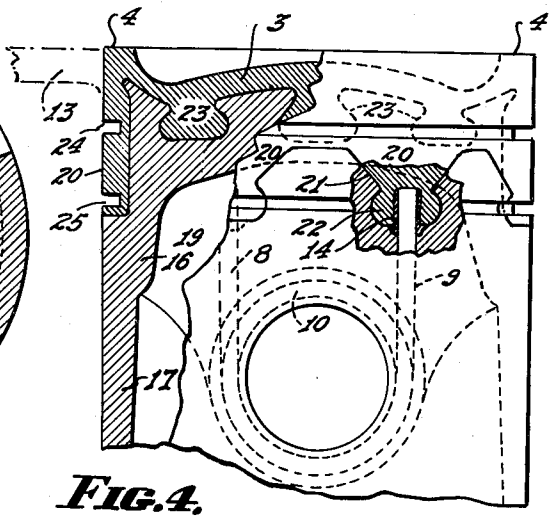


FIG. 4.

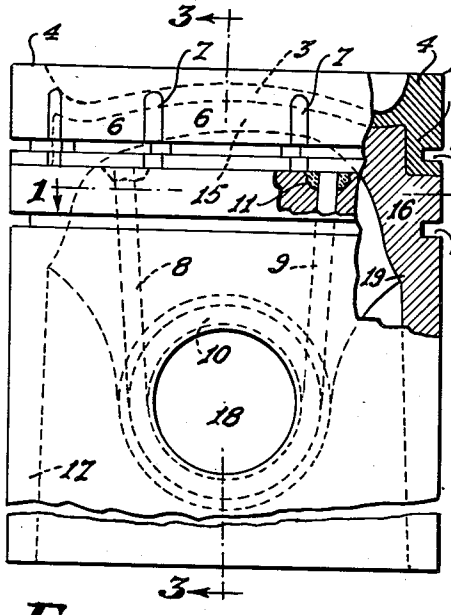


FIG. 2.

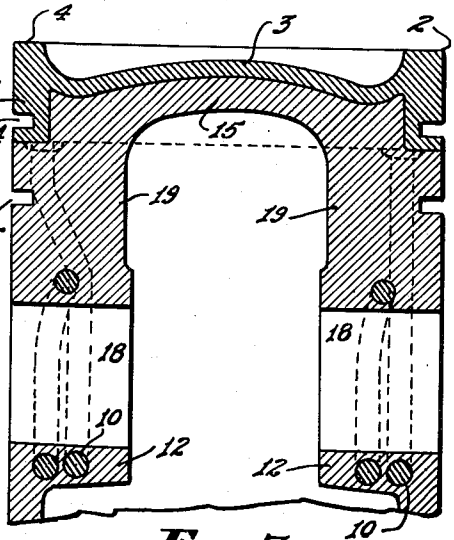


FIG. 3.

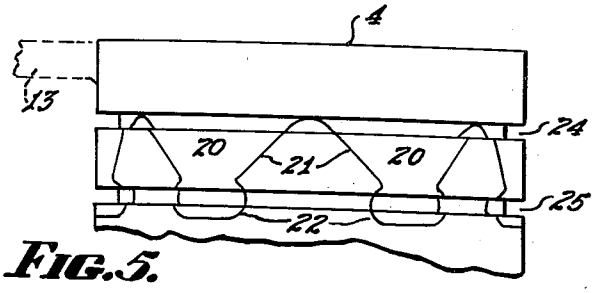


FIG. 5.

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PISTON FOR INTERNAL COMBUSTION ENGINES

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16 Claims. (Cl. 309—14)

The invention relates to pistons primarily intended for internal combustion engines of the fuel injection type. The use of the pistons in such engines made entirely of light metal such as aluminum or aluminum alloy has not proved satisfactory due to the erosion characteristics of the fuel injection system employed by the engines. In some instances the light metal was actually melted around the top of the piston causing early failure. Various suggestions have hitherto been made looking toward the inclusion of head inserts of harder metal, particularly inserts located at the point of impingement of the fuel jet. These have performed some service but have not been fully satisfactory. Covering the entire top of the piston with a ferrous metal body has likewise proved disappointing, primarily because of a danger of loosening and separation. For the most part, pistons made entirely of iron have been employed in such engines.

It is an object of the invention to provide a piston for this and similar uses which will provide, in a lighter construction, a very greatly prolonged service life.

It is an object of the invention to provide a piston construction resulting in lower oil temperatures, lower bearing loads, and simplified pin-bearing structure.

It is an object of the invention to provide a piston for the above and similar uses wherein a heavy metal, such as iron, is combined with a light metal in such fashion as to attain the above objects and at the same time prevent such loosening and separation as has hitherto adversely affected service life.

It is another object of the invention to provide a structure in which thermal stresses occurring in one direction are offset by thermal stresses in an opposite direction.

These and other objects of the invention, which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, are accomplished in that structure and arrangement of parts, of which certain exemplary embodiments will hereinafter be described. Reference is made to the accompanying drawings wherein:

FIG. 1 is a plan view of a piston from the head end with a part in section, the section being taken transversely at a position just above the pin boss.

FIG. 2 is a side elevation of the piston with certain parts in section.

FIG. 3 is a vertical sectional view of the piston taken along the section line 1—1 of FIG. 2.

FIG. 4 is an elevational view of a modified form of piston with parts in section.

FIG. 5 is a partial elevational view of a piston somewhat modified from the showing of FIG. 4.

In the specifications which follow, the term "heavy metal" will be used to designate portions formed of iron, cast iron, iron alloys, or steel. These parts are prefabricated structures, which may be made by casting, forging or the like, and which are located in molds for the casting of the light metal against them. The term "light metal" is used herein to designate aluminum and aluminum alloys. Without limiting the generality of the foregoing, an alloy of aluminum, silicon, nickel, copper, magnesium, vanadium, and antimony, as described in the now expired Patent 2,131,076 to Schwarz, is particularly useful

for this type of service because it greatly minimizes expansion differences between the light metal and ferrous portions and provides great high temperature strength. It is hereinafter referred to as "Vanasil."

Briefly, in the practice of the invention, a piston head of heavy metal is provided, which head has portions extending downwardly along the cylindrical side walls of the piston to a point well above the pin bosses, but of sufficient depth to encompass at least the upper one of the piston ring grooves. The depending portion of the heavy metal head is divided circumferentially by grooved or other configurations into a plurality of parts between which the light metal may flow upon casting. The head has an upper surface shaped as desired but usually concave in configuration to coact with the fuel injection jet. The top portion of the head may be relatively thin. In a preferred embodiment it is provided with downwardly extending bosses, the shape and purpose of which will hereinafter be described.

To the head there is attached a pair of elements made of relatively heavy iron wire which are so shaped as to have a coiled portion lying in the area of and reinforcing the pin bosses, and a pair of legs extending upwardly to their points of attachment to the head. If desired, the head may have interior crossed wire elements or screen elements integral with it for embedding in the light metal, but this is not ordinarily necessary. The divisions of the depending portion of the head are, in a preferred embodiment, shaped to provide for anchoring in the light metal.

After suitable treatments hereinafter described, the head element will be placed in a suitable mold and the light metal cast against it to form the remainder of the piston structure. The molding may be done in sand molds or in permanent molds, as desired. The head may be provided with one or more extensions for the purpose of locating it accurately in the mold, and these extensions will be removed when the piston is finished. The finishing is done conventionally by surfacing the cylindrical side walls of the piston including the heavy metal and light metal portions, in a turning operation, accompanied by the milling of the piston ring grooves.

Referring now to FIGS. 1, 2, and 3, there is shown a piston having a head portion of heavy metal **2**. This head has a central top portion **3** of suitable configuration and a relatively heavier rim portion **4** having a depending part **5** of substantially the same thickness. The depending portion of the head is in this instance divided into a plurality of portions **6** by a series of radially disposed slots **7**, as illustrated.

The construction also involves a pair of heavy wire members each comprising a pair of legs **8** and **9** and a coiled body portion **10**. The legs are attached to appropriate ones of the parts **6** of the head. This may be done by casting or by butt welding as shown at **11** in FIG. 2, but it is also possible to bring the legs inside the portions **6** and weld them there as illustrated in FIG. 4. The body portion **10** is so located as to surround the pin boss **12** and reinforce it. The head may have an integral arm **13**, as shown in FIGS. 4 and 5, whereby it may be definitely located in a mold.

The head is placed in a suitable mold and the light metal is cast against it. It is advisable to make provision for a suitable bond between the light metal of the body and the heavy metal of the head. In one procedure, the cleaned head is electrically coated with tin to a thickness of about .0002 in., more or less. In the casting operation the mold is so constructed and the pouring is accomplished in such a way that the molten metal flows past the surfaces of the ferrous metal body against which it is cast for a substantial interval, carrying away oxides and impurities. In this procedure a sound bond is produced with a minimum of interface alloy, and in many

instances no visible interface alloy. Especially where an aluminum alloy is employed high in alloying constituents, such as the Vanasil above referred to, it is preferred to have the head portion at a temperature which is sufficiently below the temperature of the molten metal to produce a chilling action, which results in precipitation of the alloying constituents such as silicon in a finely divided condition, without interfering with the effect of the flow-by. This practice is that outlined in the copending application of Marshall G. Whitfield, Serial No. 309,773, filed September 16, 1952, entitled Casting Light Metal Against Iron and Article Formed Thereby, now Patent No. 2,797,460 issued July 2, 1957.

In another procedure the cleaned surfaces of the head, against which the molten metal is to be cast, are coated with molybdenum or tungsten. This may be done by spraying or in other ways. After the coating with the interface metal, the head may, if desired, be dipped into a bath of molten aluminum or aluminum alloy, prior to the casting of the light metal against it. Such a procedure is generally outlined in the copending application of Marshall G. Whitfield et al., Serial No. 240,446, filed August 4, 1951, and entitled Coated Ferrous Bodies and Processes of Making Them, now Patent No. 2,800,707 issued July 30, 1957. In the latter procedure an excellent bond is formed without the formation of any aluminum-iron interface alloy.

The precise shape and dimensions of the piston form no limitation on the invention, as will be understood, and may be varied in accordance with different designs for different services. The light metal will underlie the central portion of the head, as shown at **15**. It will also lie inwardly of the depending portions of the head, as at **16**, being thick enough to impart sufficient strength and rigidity to the upper part of the piston. The piston will normally have a skirt portion **17** which is relatively thinner and may be as long as required by the particular design. The piston will be characterized by openings **18** in which the wrist pin is engaged, these being provided with the inwardly extending wrist pin bosses **12**. It is usual in the design of many pistons to connect the wrist pin bosses with the upper part of the piston by relatively thickened portions or wrist pin ribs **19** which may have a variety of shapes. In the designs shown herein the leg portions **8** and **9** of the wrist pin boss reinforcements are essentially embedded in these ribs. The wire reinforcements may be bent or configured as shown particularly in FIG. 3 to insure complete embedding.

In casting the light metal against the head, i.e. between the head, outer mold walls, and a suitable core element or elements, the molten light metal will coat the entire interior portion of the head, will wholly embed the wrist pin boss reinforcements and be bonded thereto, and will flow into the interstices **7** between the downwardly projecting elements of the head. An interlocked design is thus produced in addition to the bonding aforesaid; and it will be understood that the wrist pin boss reinforcements also serve to anchor the heavy metal head to the light metal body of the piston.

A modified form of structure is shown in FIG. 4 in which like parts have been given like index numerals. Here the downwardly projecting portion of the head has been divided into spaced extensions **20** which are preferably so shaped as to provide downwardly converging portions **21** terminating in end enlargements **22**. This not only minimizes weight for a given downward extension of the head, but also provides an anchoring structure, as will be evident.

Additionally, it is preferred to provide the central head portion **3** with downward extensions **23**, of which three have been shown in FIG. 4, although more may be provided as will readily be understood. In a symmetrical construction in accordance with the design of FIG. 4, there would be five such downward extensions. The downward extensions preferably comprise head portions connected to the top of the piston head by necks of relatively smaller cross-sectional dimension, and are roughly mushroom shaped. This provides a structure in which thermal stresses in one direction are offset by thermal stresses in the opposite direction, whether under the particular thermal conditions the light metal or the heavy metal is expanding more rapidly. The reduction in area also relieves stress on the bond. The cap remains tight at all times during the operation of the engine.

In the structure of FIG. 4, the upper piston ring groove **24** is formed entirely in the downward projection of the head. The groove **25** in this instance is formed partly in the downward head extensions **20** and partly in the light metal body of the piston. In FIG. 5 there is shown a modification in which the spaces between the extensions **20** are carried upwardly so as to cut the upper piston ring groove **24**. The anchoring action is the same, but a still further saving in weight is effected.

Piston ring grooves which are not formed in or partially in the depending portions of the head may be wire reinforced as taught in the copending application of Whitfield, Serial No. 353,501, filed May 7, 1953, and entitled Light Metal Piston With Reinforcement, and the Like, now Patent 2,793,922 issued May 28, 1957, or as taught in the copending application of Whitfield and Cheney, Serial No. 484,127, filed January 26, 1955, and entitled Reinforced Light Metal Piston, now Patent 2,793,923 issued May 28, 1957. The entire light metal body of the piston may also be reinforced, if desired, with relatively fine wire reinforcements or mesh. It is characteristic of reinforcements of small section that they bond more easily and faster with the light metal than do heavier sections, since the small section permits almost instant heating.

Modifications may be made in the invention without departing from the spirit of it. The invention having been described in certain exemplary embodiments, what is claimed as new and desired to be secured by Letters Patent is:

1. A piston having a heavy metal head portion and a light metal body, in which the head portion has a top covering the end of the piston and a portion extending downwardly along the cylindrical side walls of the piston, said head portion having wire members integrally attached to it and embedded in said light metal body.

2. The structure claimed in claim 1 wherein the downwardly extending portion of said head is divided into peripherally spaced elements embedded in the said light metal.

3. The structure claimed in claim 1 wherein the downwardly extending portion of said head is divided into peripherally spaced elements embedded in the said light metal, and in which the said divided elements are of dove-tail shape.

4. The structure claimed in claim 1 wherein the downwardly extending portion of said head is divided into peripherally spaced elements embedded in the said light metal, and in which the said divided elements are of dove-tail shape, and wherein the top portion of said head is provided interiorly with downward extensions which are generally dove-tailed in cross-section.

5. The structure claimed in claim 1 wherein said wire reinforcements constitute elements having a coiled body and at least one leg, said leg being attached to said head and located in a position to be embedded in and reinforce a wrist pin boss formed in said light metal body.

6. A piston comprising a heavy metal head and a light metal body thereagainst, said head comprising a top covering portion for said piston and a downwardly depending peripheral portion extending along the cylindrical side walls of said piston, said downwardly depending portion being divided peripherally into parts having individual engagement in said light metal body.

7. The structure claimed in claim 6 wherein said parts have a dove-tail shape.

8. The structure claimed in claim 6 wherein the covering portion of said head has downward extensions of generally mushroom shape embedded in the said light metal body.

9. The structure claimed in claim 6 wherein the covering portion of said head has downward extensions of generally mushroom shape embedded in the said light metal body, and in which said divided parts of said head are of dove-tail shape.

10. A piston comprising a heavy metal head and a light metal body thereagainst, and anchoring means fastened to said head and embedded in said body, said anchoring means comprising wire elements each having legs attached to said head and a coiled body located to be embedded in and to constitute a reinforcement for wrist pin bosses formed in said body.

11. The structure claimed in claim 6 wherein said light metal body is bonded to said head.

12. The structure claimed in claim 8 wherein said light metal body is bonded to said head and reinforcements.

13. A ferrous head element for a light metal piston comprising a covering portion for the top of the piston, and a depending annular portion for forming a part of the cylindrical side walls of said piston, said depending

annular portion being divided circumferentially into a plurality of anchoring elements.

14. The structure claimed in claim 13 in which said anchoring elements are of dove-tail shape.

15. The structure claimed in claim 13 wherein said downward extension traverses the position of at least one piston ring groove to be formed in said piston.

16. The structure claimed in claim 13 in which said anchoring elements are of dove-tail shape, and in which said spaced elements traverse the position of at least one piston ring groove to be formed in said piston.

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