May 6, 1941. W. M. VENNER ET AL 2,240,967

PISTON

Filed March 11, 1940

Fig. 1.

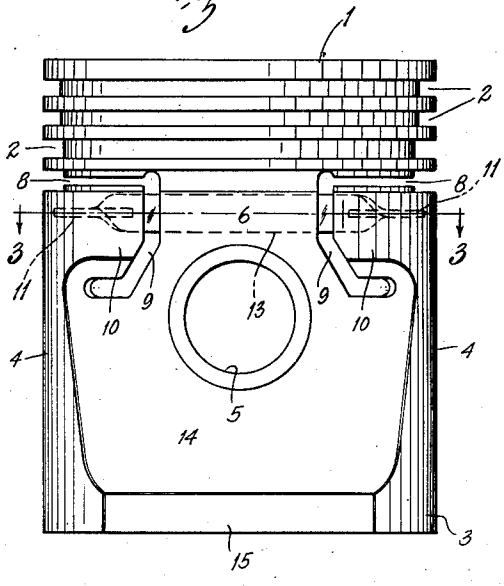


Fig. 2.

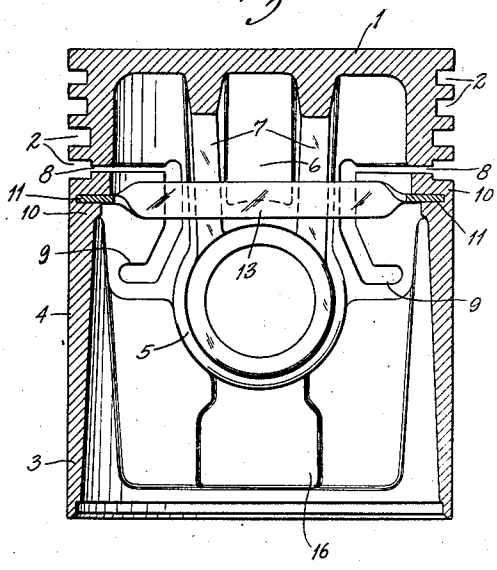


Fig. 3.

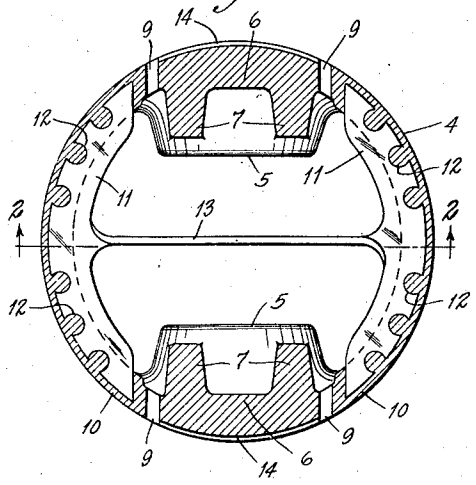
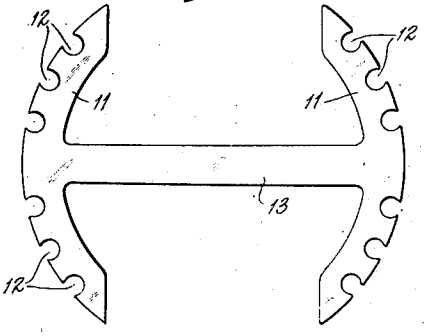


Fig. 4.



INVENTORS:
WILLIAM M. VENNER
PERCY L. BOWSER, JR.,

By Brumbaugh & Sutherland

ATTORNEYS

Patented May 6, 1941 2,240,967

UNITED STATES PATENT OFFICE

2,240,967

PISTON

William M. Venner, Richmond Heights, and Percy L. Bowser, Jr., University City, Mo., assignors to The Sterling Corporation, St. Louis, Mo., a corporation of Delaware

Application March 11, 1940, Serial No. 323,326

10 Claims. (Cl. 309—13)

This invention pertains to pistons for internal combustion engines, and more particularly to pistons constructed of light metal, such as aluminum, magnesium, or alloys thereof. The major problem in the design of aluminum pistons for internal combustion engines has always been that of compensating for the greater rate of thermal expansion of aluminum than that of cast iron, of which the cylinder is universally constructed. Two general methods of attack have been followed heretofore. In one of these the piston skirt, and particularly those portions which bear upon the cylinder wall, is rendered resilient so that it may yield under the pressure exerted against the cylinder wall when thermal expansion takes place. Such yieldability is provided by cutting certain portions of the piston free of the expanding parts for a portion of their extent so that they may yield by flexure of other parts. Instead of completely severing the yieldable parts, loops of metal have been interposed between the bearing portions and their supporting parts, which loops are intended to yield by flexure when the pressure comes on.

Another method has been to insert in the piston structure at appropriate places elements of a material having a lower rate of thermal expansion than aluminum such as steel, the location of such steel inserts being such that their expansion takes the place of aluminum expansion and at a rate more nearly that of the cylinder.

None of these schemes have been able to compensate for the expansion of aluminum to a sufficient degree of accuracy to provide a piston which will be entirely free from danger of injury due to over expansion. A definite problem, therefore, still exists in this field of controlling the expansion of the bearing portions of the skirt to such a degree of exactness that a substantially uniform clearance between the skirt and the cylinder wall is maintained while both piston and cylinder rise in temperature under the normal operation of the engine.

One of the objects of this invention, therefore, is to provide a piston structure in which an increased accuracy of the control of expansion of the bearing portions of the skirt may be obtained.

Another object is to provide a structure in which the controlling effect of elements having a lower rate of expansion than aluminum may be so coordinated as to control with improved accuracy the expansion of the entire bearing area of the skirt.

Another object is to provide a structure coordinating the action of controlling elements of less expansibility, acting both as thermostatic control elements and as elements directly limiting the expansion of the skirt.

The invention of this application is an improvement on that of our application, Serial No. 299,050, filed October 12, 1939.

Further objects will appear from the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a side view taken along the wrist pin axis of a piston embodying this invention.

Figure 2 is a vertical section of the same taken at right angles to the wrist pin axis and about on line 2—2 of Figure 3.

Figure 3 is a horizontal section taken on line 3—3 of Figure 1, and

Figure 4 is a plan view showing one way in which the control elements may be formed.

Referring to the drawing, the piston illustrated comprises a head 1 having the usual piston ring grooves 2 and a skirt indicated generally at 3. In the piston illustrated the skirt is provided with cylinder bearing portions 4 which are machined to fit the cylinder wall. In the regions between the cylinder bearing portions 4 are provided wrist pin bearings 5 for the usual piston pin. These bearings are supported from the head 1 by connectors 6 extending upwardly to the head, and these connectors may be reinforced by ribs 7.

One or both of the bearing portions 4 are separated from the head by horizontal slots 8. The slots 8 communicate at their ends with downwardly extending slots 9. In the arrangement illustrated, the slots 9 extend vertically at the upper part of the skirt and then turn laterally toward the bearing portion 4, having an intermediate angular portion and a lower horizontal portion. These slots may also be curved instead of angular, as shown, and their curvature may be greater or less according to the design of piston required. They may even extend downwardly at any suitable angle to a point below the bearing 5. This arrangement provides at the sides of the bearing portion 4 outwardly extending wing portions 10 which are free of both the head and the connectors 6. This renders these wing portions free for flexure in a horizontal plane, the degree of flexibility being controllable by varying the shape and depth of the slots 9.

One or both of the bearing portions 4 may be provided, as shown in the drawing, with a control element 11 constructed of a material having a lower rate of thermal expansion than that of the piston metal. These elements 11 are cast into the piston skirt, as shown in Figures 2 and 3, in a position extending circumferentially along and within the upper part thereof and so as to extend along the wing portions 10. These elements may be provided with recesses 12 of any suitable form so that the piston metal may upon casting interlock securely with these elements, as may be seen in Figure 3. It will be seen that the upper part of each bearing portion 4 with its extending wings 10, together with the elements 11, form a

bimetallic member which may act thermostatically to vary the curvature of this portion of the bearing face in a horizontal plane, flexing the bearing portion inwardly as the temperature thereof rises.

Extending across the interior of the piston skirt is a second control element 13 also constructed of a material having a lower rate of thermal expansion than the piston metal. This element is anchored at its ends to the upper parts of the thrust bearing portions 4. This element 13 may be formed as a separate member secured at its ends to the piston skirt either by casting the ends into the piston metal or attaching them in any other suitable manner to the piston skirt or to the elements 11. A convenient and economical way of making these elements is to form a punching, such as shown in Figure 4, having the elements 11 and 13 included in a unitary integral structure which may be formed by a single punching operation. This both secures the element 13 to the elements 11 and provides for accurately spacing the latter. Before assembling this composite member in the piston the cross bar 13 may be twisted relatively to the elements 11, as shown in Figures 2 and 3 so as to lie in a plane parallel to the piston axis. In this position it is easier to mount the element in a mold in such a manner that the core may be easily withdrawn.

The outer portion of the piston skirt in the regions opposite the ends of the wrist pin may be recessed slightly, as indicated at 14, so as to permit the pin bearings to expand without danger of coming against the cylinder walls. The lower rim of the skirt may be circumferentially continuous with the bearing portions 4 so as to maintain a bearing on the cylinder wall, or these portions of the skirt may be ground elliptical, or a slight recess 15 may be formed also at the rim portion.

The interior of the piston may be provided with lugs 16 of any desired shape to provide some excess metal which may be removed in order to balance a set of pistons according to the usual practice.

While it is not desired to limit this invention in detail to any particular theory of action, it is believed that the behavior of this piston when heated during the normal operation of the engine is as follows:

The normal tendency of the bearing portions 4 to expand in accordance with the rate of expansion of aluminum is restrained at the upper part of the skirt by the element 13 which has a lower rate of expansion and probably operates at a somewhat lower temperature. As the heat which causes expansion of the bearing portions 4 must flow to those portions from the head 1 through the piston metal, the only path of flow available is along the connectors 6. This path of flow is lengthened by the slots 9 which compel the heat to travel around those slots to a point in the piston illustrated near the middle of the bearing portion 4 and from that point upwardly toward the top of the skirt and to the wing portions 10. This tends to keep this upper portion of the skirt and the wing portions at a considerably lower temperature than they would attain in the absence of the slots 9. This, therefore, reduces the amount which the upper part of the piston would expand if unrestrained, while in addition thereto the cross bar 13 forcibly restrains expansion for the reason that its own expansion is less for the same temperature while its actual temperature is probably less than that of the portion of the skirt to which it is connected. The difference between the tendency of the skirt to expand and its actual expansion probably causes flexure of the portion 4 adjacent the lower ends of the slots 9. The extreme lower end of the skirt is believed to operate at a lower temperature than the upper end on account of the longer path of flow for the heat to reach the lower end. Accordingly, restraint of the tendency to expand is not required at the lower end to as great an extent as at the upper end and may be taken care of by providing the recesses 15 or the elliptical form, as pointed out above, to permit a slight change of shape under pressure against the cylinder wall.

When the piston skirt heats up the upper portion adjacent the slot 8 on account of the thermostatic action of the two metals which are intimately interlocked along this part of the skirt tends to change its curvature slightly by bending inwardly at the wing portions 10. Experience has shown that one of the most difficult points of the piston skirt to control is the upper side corners of the bearing face, namely at the wing portions 10. This arrangement of thermostatic action, therefore, may be adjusted so as to bend these wing portions inward as the piston heats up and the proportions of the two metals may be adjusted to control the amount of bending with great accuracy. Accordingly, the curvature of the upper portion of the piston skirt may be made to conform very accurately to that of the cylinder wall at all temperatures. In addition to this, since the slot 9 renders the wing portions 10 free for flexure radially, in case the control of the curvature is not quite exact or in case the cylinder should become warped, as is often the case, any excess pressure of the cylinder wall on the wing portions 10 may flex those portions inwardly without generating sufficient pressure to score or injure the bearing surface. At the same time these wing portions extend laterally to a considerable spread on each side of the center line of the bearing portion 4, and, accordingly, the lateral position of the piston in the cylinder is firmly controlled and any tendency to rock is thereby greatly reduced.

While it has been found advisable in most cases to provide slots 8 and 9 on both sides of the piston, the advantages of this invention may be obtained to a proportionate extent if one of the bearing portions 4 is made integral with the piston head or the slots 9 omitted on one side.

It will be seen, therefore, that this invention provides a piston in which the fit of the thrust bearing portion is controlled by controlling both its lateral curvature by means of the elements 11 and the outward movement of the two portions 4 by means of the element 13. Accordingly, both the diameter and the curvature of the bearing portions of the piston are controlled, particularly at the upper part thereof where the control is most important because the expansion is usually greater at that point.

It is obvious that various changes may be made in the details of construction within the scope of the appended claims without departing from the spirit of this invention, and it is understood therefore that the invention is not limited to the specific details shown and described.

The invention having thus been described, what is claimed is:

1. A light-metal piston of the character described, having a head, wrist pin bearings connected with said head, a skirt connected with said

bearings but having a cylinder-bearing portion separated from said head in the region between said bearings, a control element of a material having a lower rate of thermal expansion than the piston metal cast into said cylinder-bearing portion so as to extend circumferentially along and within the upper part thereof but terminating near the lateral limits of said bearing portion in order to form therewith a bimetallic member, and a second control element having a lower rate of thermal expansion than the piston metal connected to said separated portion of the skirt near the middle thereof and extending radially inwardly from said connection and anchored at its other end.

2. A light-metal piston of the character described, having a head, wrist pin bearings connected with said head, a skirt connected with said bearings but having a cylinder-bearing portion separated from said head in the region between said bearings, a control element of a material having a lower rate of thermal expansion than the piston metal cast into said cylinder-bearing portion so as to extend circumferentially along and within the upper part thereof but terminating near the lateral limits of said bearing portion in order to form therewith a bimetallic member, and a second control element having a lower rate of thermal expansion than the piston metal connected to said separated portion of the skirt near the middle thereof and extending across the interior of said skirt and anchored to the opposite wall thereof.

3. A light-metal piston of the character described, having a head, wrist pin bearings connected with said head, a skirt connected with said bearings but having cylinder-bearing portions separated from said head in the regions between said bearings, control elements of a material having a lower rate of thermal expansion than the piston metal cast into said cylinder-bearing portions so as to extend circumferentially along and within the upper parts thereof but terminating near the lateral limits of said bearing portions in order to form therewith bimetallic members, and a control element having a lower rate of thermal expansion than the piston metal extending across the interior of said skirt and anchored to the upper parts of said cylinder-bearing portions.

4. A light-metal piston of the character described, having a head, wrist pin bearings connected with said head, a skirt connected with said bearings but having cylinder-bearing portions separated from said head in the regions between said bearings, control elements of a material having a lower rate of thermal expansion than the piston metal cast into said cylinder-bearing portions so as to extend circumferentially along and within the upper parts thereof but terminating near the lateral limits of said bearing portions in order to form therewith bimetallic members, and a control element having a lower rate of thermal expansion than the piston metal extending across the interior of said skirt and anchored to said first control elements.

5. A light metal piston of the character described, having a head, wrist pin bearings connected with said head, a skirt connected with said bearings but having a cylinder-bearing portion separated from said head and said bearings in the region between said bearings so as to provide laterally extending wing portions free for radial flexure, a control element of a material having a lower rate of thermal expansion than the piston metal cast into said cylinder-bearing portion so as to extend circumferentially along and within said wing portions but terminating near the lateral limits of said bearing portion in order to form therewith a bimetallic member, and a second control element having a lower rate of thermal expansion than the piston metal connected to said separated portion of the skirt near the middle thereof and extending radially inwardly from said connection and anchored at its other end.

6. A light-metal piston of the character described, having a head, wrist pin bearings connected with said head, a skirt connected with said bearings but having cylinder-bearing portions separated from said head and said bearings in the regions between said bearings so as to provide laterally extending wing portions free for radial flexure, control elements of a material having a lower rate of thermal expansion than the piston metal cast into said cylinder-bearing portions so as to extend circumferentially along and within the wing portions thereof but terminating near the lateral limits of said bearing portions in order to form therewith bimetallic members, and a control element having a lower rate of thermal expansion than the piston metal extending across the interior of said skirt and anchored to the upper parts of said cylinder-bearing portions.

7. In a piston of the character described, a control element comprising, relatively separated arcuately extending end members of a material having a lower rate of thermal expansion than the piston metal connected medially thereof by an expansion-restraining tie member of similar material.

8. A light metal piston of the character described, comprising, a head, a skirt, wrist pin bearings connected with said head and said skirt, said skirt having cylinder-engaging portions separated from said head and constructed to flex inwardly in the regions of said bearings, and an element extending circumferentially inside of and attached to each of said cylinder-engaging portions, said element having a rate of expansion lower than that of said portion and adapted to flex said portion inwardly in said regions thermostatically, said elements having connecting means extending across the piston.

9. A light metal piston of the character described, comprising, a head, a skirt, wrist pin bearings, connectors between said head and said skirt, said skirt having cylinder-engaging portions separated from said head circumferentially and separated from said connectors terminally, constructed to flex inwardly in the regions of said bearings, and elements having a rate of expansion lower than that of said cylinder-engaging portions, one of said elements extending circumferentially inside of and cast to each of said portions and terminating therewith, adapted to flex each said portion inwardly in said regions thermostatically, said elements having connecting means extending across the piston.

10. In a piston of the character described, a control element comprising, an expansion-restraining cross member, and an arcuate skirt-bending member connected to and extending in opposite lateral directions from the end of said cross member, said members being constructed of material having a lower rate of thermal expansion than the piston metal.

WILLIAM M. VENNER.
PERCY L. BOWSER, JR.