March 30, 1943. H. H. DILLON 2,315,403

COMPOSITE PISTON

Filed Sept. 24, 1940

Fig.1

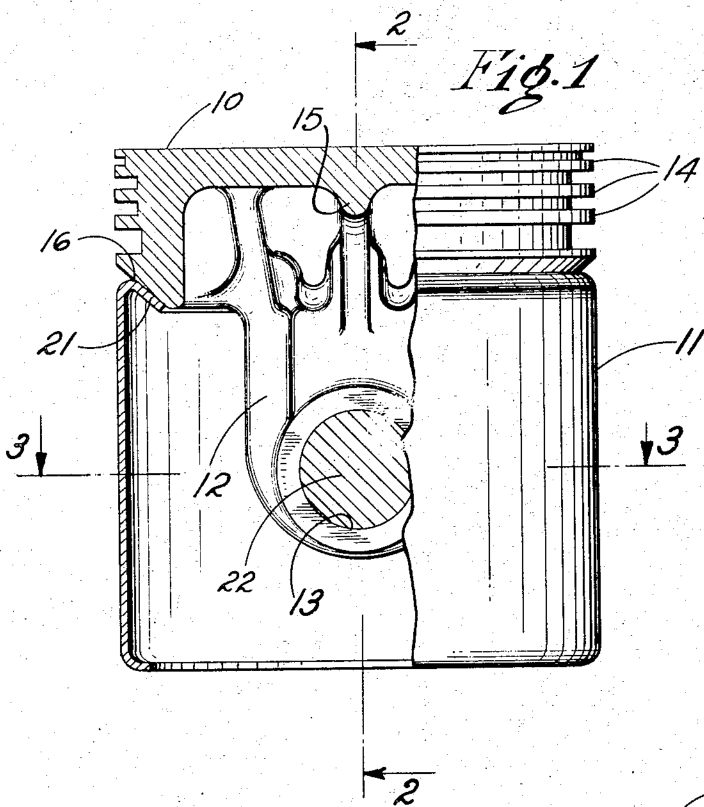


Fig.4

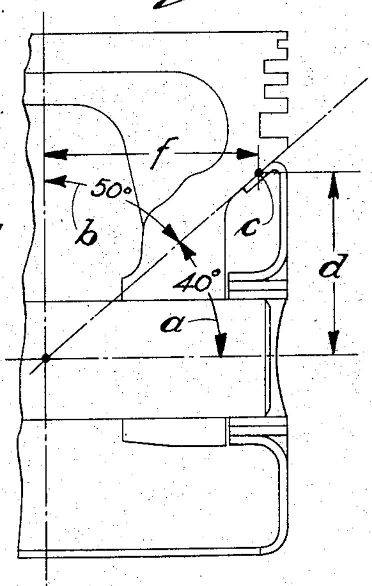


Fig.2

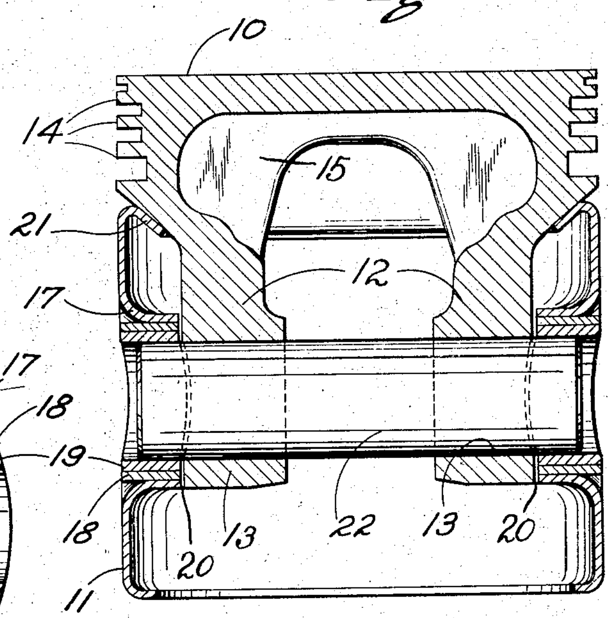
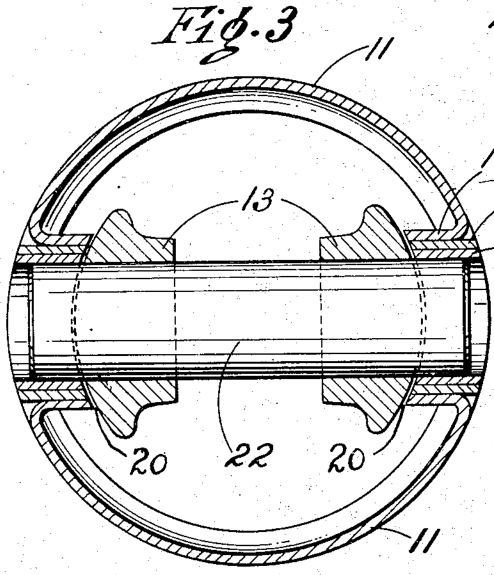


Fig.3



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COMPOSITE PISTON

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3 Claims. (Cl. 309—14)

This invention relates broadly to pistons for internal combustion engines and more specifically to pistons comprising separately formed head and skirt portions.

The most commonly used pistons for internal combustion engines have been integral one piece castings of aluminum alloy in order to obtain, at a practical cost, the strength, ruggedness and durability essential for operation, combined with the advantages of the light weight and high heat conductivity of aluminum alloy. The problems that have arisen in connection with such pistons flow mainly from the relatively high coefficient of thermal expansion of the aluminum alloy as compared with the cast iron from which the engine cylinders are commonly made.

The principal object of the present invention is to combine in a practical manner a piston head portion, which may be a casting of aluminum or other light metal alloy, and a skirt portion which may be formed from sheet steel or other ferrous metal in such a manner that the assembled piston will be able at all times to properly transmit and withstand the explosion, inertia, and thrust forces to which it is subjected; a close clearance will be maintained at all temperatures between the skirt or guiding portion of the piston and the cylinder wall; and distortion or stressing of the skirt from the different thermal expansion and contraction of the material of the head portion will be prevented. Other objects are to connect the two portions of the piston together in a simple, practical and economical manner; to utilize the wrist pin by which the piston is connected to the usual connecting rod for holding the two parts of the piston together without subjecting the skirt to distorting forces resulting from the relative movement, during expansion and contraction, of the wrist pin bosses carried by the head; and to center the skirt portion with respect to the head portion and hold the two parts against relative movement along the wrist pin axis and against relative tilting about the wrist pin axis by engagement of the upper end of the skirt with the head, without imposing stresses on the skirt portion or permitting clearance to develop betwen the skirt and head during the differential expansion and contraction of the parts.

These and other objects which will appear hereinafter are attained by providing the head and skirt portions of the piston with aligned bosses receiving a wrist pin, with the skirt bosses spaced sufficiently from the head bosses to prevent the head bosses from exerting pressure on the skirt at any operating temperature; and by providing the upper end of the skirt and the head with angularly disposed abutting surfaces arranged so as to remain in firm sliding contact without stressing or distorting the skirt at all operating temperatures and acting to prevent relative sliding movement of the head and skirt portions along the wrist pin axis or relative tilting of the parts about this axis. In the preferred embodiment of the invention the abutting surfaces on the skirt and head are conical and arranged at an angle proportional to the ratio between the radius of a point on the conical surfaces and the vertical distance of the same from a horizontal plane through the wrist pin axis.

Referring to the drawing wherein the preferred embodiment of the invention is illustrated:

Fig. 1 is an elevational view of the piston embodied in the present invention with parts thereof shown in section for the sake of clarity;

Fig. 2 is a vertical sectional view of the piston showing the angle of the inclined surface between the head and skirt portion with a plane through the center of the wrist pin bosses, the section being taken on a line 2—2 of Fig. 1;

Fig. 3 is a transverse sectional view of the piston showing the wrist pin bosses in the skirt spaced from the bosses formed in the depending webs or pillars of the head portion, the section being taken on a line 3—3 of Fig. 1; and

Fig. 4 is a diagrammatic view of the piston showing the method of determining the angle of the inclined surfaces.

Referring to Fig. 2, the piston disclosed therein comprises a separately formed upper or head portion **10** and a lower or skirt portion **11**. The head portion has cast integral therewith webs **15** and depending pillars **12** which have wrist pin bosses **13** formed in the lower ends thereof.

In the formation of the piston it is desirable that the head and integral pillars **12** be formed of a light, strong and durable metal which possesses a relatively high heat conductivity. Thus it is preferable that the head and pillar portions of the piston be cast of some high expanding metal such as aluminum or an aluminum alloy. A plurality of grooves **14** are provided in the peripheral surface of the piston head for the reception of the conventional piston rings, not shown. Formed on the lower circumferential edge of the head subjacent the lowermost ring grove **14** there is an inclined or tapered surface **16** which is adapted to engage a complemental surface provided on the upper edge of the skirt **11**.

The skirt portion **11** which is formed by pressing, spinning or welding a low expanding metal such as steel, encompasses the depending pillars 12 and is disposed in abutting relation with the head 10. Formed in opposed sides of the skirt portion and in axial alignment with the bosses 13 in the pillars 12 are wrist pin bosses 17 which have steel bushings 18 inserted therein and brazed thereto. Pressed within the steel bushings 18 are bronze bushings 19 which are adapted to receive the wrist pin 22. The wrist pin also extends through the bosses 13 to hold the head and skirt together, in addition to providing for a pivotal connection of the piston to the connecting rod of the engine in the usual manner. The outer edges of the bosses 13 are separated from the inner edges of the bosses 17 by spaces 20. The upper circumferential edge of the skirt has an inturned, inclined surface 21 formed thereon upon which the tapered surface 16 of the head is disposed to provide for a sliding engagement between the head and skirt portions.

In the manufacture of the piston the head is preferably cast in a permanent mold from aluminum or other light metal alloy and the wrist pin bosses 13 in the pillars 12 are cored out in the usual manner. The inclined surface 16 on the skirt and the mating surface 21 on the head are finish machined separately at the desired angle before finishing the openings in the bosses 13 or 17 and prior to the finishing of the exterior surface of the skirt. The parts are then assembled with the mating inclined surfaces 16 and 21 pressed together into firm yet slidable contact in substantially the relation desired in the completed piston, and while the head and skirt portions are held in their desired concentric relation in a suitable jig or fixture the holes in both sets of wrist pin bosses 13 and 17 are finish bored simultaneously. The piston is then assembled with a snug wrist pin in place after which the exterior surface of the skirt is ground to the desired diameter and finish.

By finish boring the bosses in both portions of the piston at the same time, in this manner, the desired contact between the inclined surfaces is obtained with the axes of the two sets of bosses in exact alignment, providing a true surface contact and a free sliding movement between the head and skirt at all temperatures in the completed piston. The inclined surfaces on the head and skirt are pressed together, preferably with just sufficient force to hold the head against rocking or sliding laterally with respect to the skirt, which is guided in the cylinder, and with insufficient force to distort the skirt or hinder the sliding of the surfaces during expansion and contraction.

The proper inclination of the surfaces 16 and 21 with respect to the wrist pin axis is determined by the ratio of the vertical height of the pillars 12, from the wrist pin axis to a point on the inclined surfaces, divided by the radius of the piston at that point. During heating, the pillars expand vertically, causing the wrist pin and the skirt to move downwardly with respect to the head. At the same time the head expands radially, tending to move the inclined surface 16 of the head radially outward. The skirt, being composed of a material of a lower coefficient of expansion, expands both vertically and radially to a lesser extent than the head. With the inclined surfaces disposed at the proper angle, the two expansions act to slide the inclined surface of the head over the inclined surface of the skirt without increasing or decreasing the contact pressure between these surfaces. Theoretically, assuming a uniform heating of all parts, the correct inclination is reached when the tangent of the angle of the inclined surfaces from the horizontal is equal to the ratio of the height from a horizontal plane through the wrist pin axis to any point on the inclined surface and the radius of the piston to said point on the inclined surface.

This relationship is illustrated in Fig. 4 of the drawing. In the particular embodiment illustrated, the angle a of the inclined surfaces with the wrist pin axis is approximately 40° while the angle b of the inclined surfaces with the vertical axis of the piston is approximately 50°. Thus with the inclined surfaces disposed at such an angle the height of the pillars, designated as d, from the wrist pin axis to a point c on said surfaces is the tangent of angle a multiplied by the radius, designated f, of the piston to the point c.

This relationship remains true and determines the proper angle of inclination for any size or relative proportion of the piston. However, in certain designs the operating temperature of the webs may vary slightly from the operating temperature of the head, requiring a corresponding adjustment of the angle of inclination.

The space 20 between the wrist pin bosses 13 and the bosses 17 in the skirt permits the bosses 13 to be carried outwardly along the wrist pin by the diametrical expansion of the head without imposing any stress upon the skirt. The pillars 12 are made relatively rigid with the head in order to properly withstand and transmit the explosion and inertia forces between the head disc and the wrist pin. Thus the bosses 13 are separated during expansion in accordance with the diametrical expansion of the head disc, while the skirt bosses 17 move apart in accordance with the lesser expansion of the skirt. Such relative movement of the bosses 13 along the wrist pin axis is permitted because the bosses 13 are freely rotatable and slidable longitudinally on the wrist pin. The bosses 13 are held equally spaced or centered with respect to the skirt bosses 17 at all temperatures by the engagement of the inclined surfaces 16 and 21 which, as previously explained, remain in contact at all temperatures not only to hold the head and skirt against relative tilting movement but also to hold the skirt centered with respect to the head. The wrist pin may be held from sliding out of the piston into engagement with the cylinder wall by being secured to the connecting rod or may be of the full floating type with suitable means (not shown) to prevent the pin escaping from the bosses 17.

By this construction a strong and durable piston is provided in which the inertia and explosion forces transmitted between the head and the wrist pin are carried by the pillars 12 integral with the head portion and bearing directly on the wrist pin through the bosses 13. The lateral thrust forces are transmitted from the wrist pin directly to the skirt bearing in the cylinder through the bosses 17 bearing upon the wrist pin. The skirt is preferably made of sheet steel or other ferrous metal so that its coefficient of thermal expansion is substantially the same as that of the cylinder. Thus the skirt can be ground to a substantially circular sectional contour with but a small clearance from the cylinder wall and this close clearance will be maintained at all temperatures. The separate head and skirt portions are secured together solely by the wrist pin while the sliding joint between the inclined surfaces 16 and 21 as previously explained maintains the parts in correct concentric relation without transmitting any of the large forces to which the piston is subjected.

Although the foregoing description is necessarily of a detailed character, in order that the invention may be completely set forth, it is to be understood that the specific terminology is not intended to be restrictive or confining, and that various rearrangements of parts and modifications of detail may be resorted to without departing from the scope or spirit of the invention as herein claimed.

I claim:

1. A piston comprising a head having depending pillars carrying wrist pin bosses, a separate skirt having aligned wrist pin bosses formed therein, a wrist pin passing through said bosses and holding said skirt and head together, said head and skirt being formed with inclined complemental engaging surfaces disposed above said wrist pin bosses, said surfaces being inclined at an angle the tangent of which is proportional to the ratio of the height of a point on the inclined surface above the wrist pin axis to the distance from said point to the axis of the piston.

2. A piston comprising a head having depending pillars carrying wrist pin bosses, a separate skirt having aligned wrist pin bosses formed therein, a wrist pin passing through said bosses and holding said skirt and head together, said head and skirt being formed with inclined complemental engaging surfaces disposed above said wrist pin bosses, said surfaces being inclined at an angle the tangent of which is the ratio of the distance of a point on the inclined surface to a horizontal plane through the wrist pin axis, to the radius of the piston to that point, the outer edges of the said bosses carried by the head being spaced inwardly along the wrist pin from the inner edges of the bosses formed in said skirt when the piston is cold.

3. A piston comprising a head having depending pillars carrying wrist pin bosses formed of a single piece of aluminum alloy, and a separate skirt formed of ferrous metal having aligned wrist pin bosses, the upper portion of said skirt having an inclined bearing surface engaging a complemental bearing surface formed on the head, and a wrist pin passing through the wrist pin bosses carried by said head and the bosses formed in said skirt and constituting the sole means holding the head and skirt together, the outer edges of the bosses carried by the head being spaced inwardly along the wrist pin from the inner edges of the bosses formed in the skirt when the piston is cold, and said inclined bearing surface being arranged at such an angle that the differential radial expansion of said head and said skirt is compensated by the differential axial expansion of said skirt and said pillars, so that said bearing surfaces maintain said skirt centered with respect to the head at all temperatures.

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