July 7, 1936. A. B. NORTON 2,046,789

PISTON

Filed Aug. 1, 1933

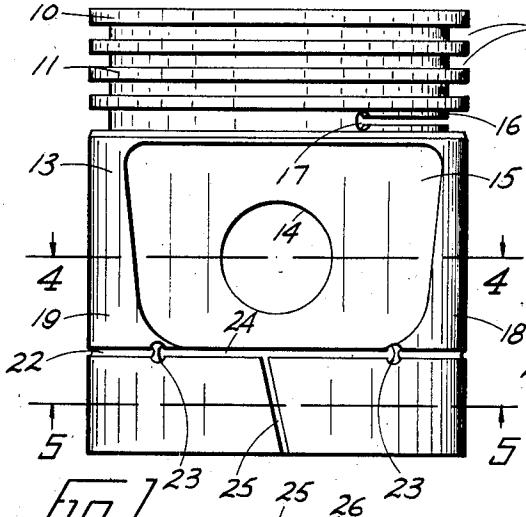


Fig 1

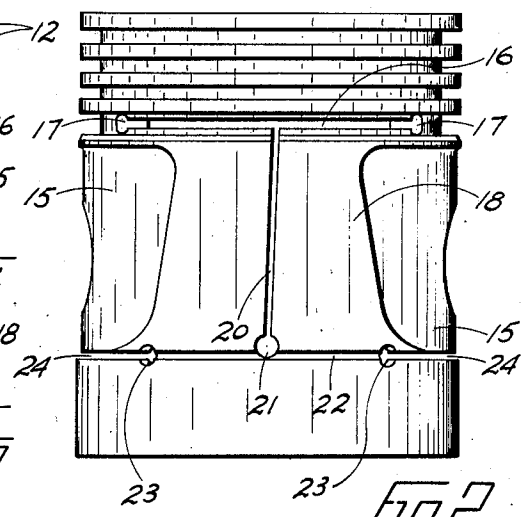


Fig 2

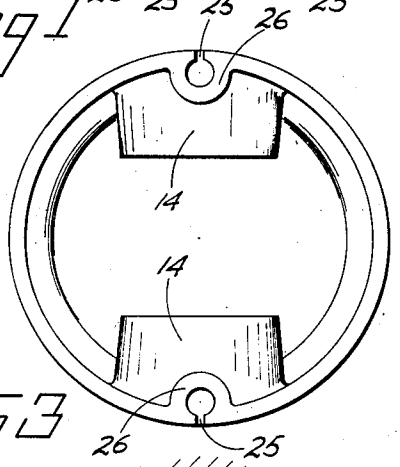


Fig 3

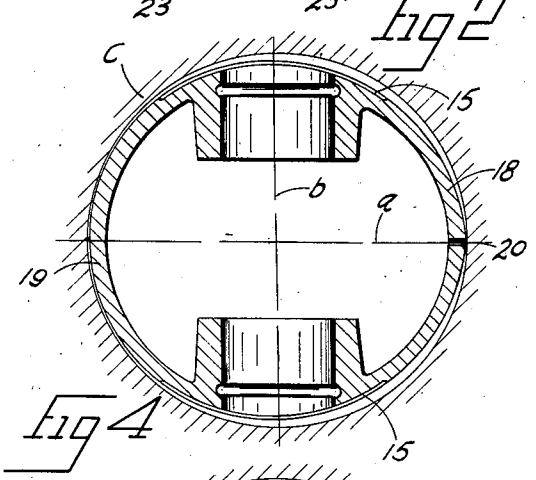


Fig 4

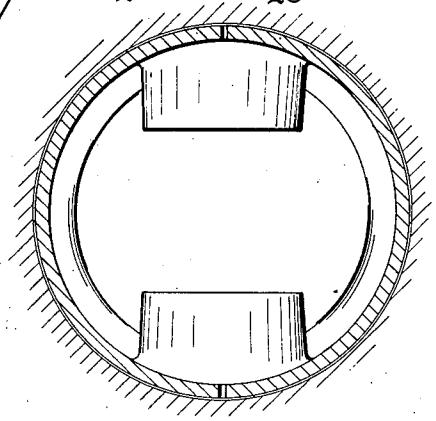


Fig 5

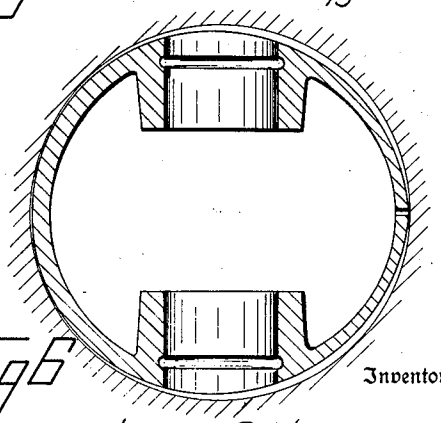


Fig 6

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2,046,789

PISTON

Allen B. Norton, Cleveland, Ohio, assignor, by mesne assignments, to The Cleveland Trust Company, Cleveland, Ohio, a corporation of Ohio, as trustee

Application August 1, 1933, Serial No. 683,134

7 Claims. (Cl. 309—11)

This invention relates to pistons for internal combustion engines and the like, and particularly to pistons composed of aluminum alloy or other metal alloy having a higher co-efficient of thermal expansion than the material of the cylinder in which the piston is to operate.

The principle object of this invention is to provide a relatively simple and cheap piston construction which may be fitted when cold to a cylinder with a sufficiently small clearance to avoid piston slap and to reduce oil pumping and which will yield to permit thermal expansion without binding in the cylinder while at the same time being designed to operate in a cylinder at all temperatures without excessive friction and without premature fatigue failure from the lateral thrust loads.

The present invention is an improvement over that disclosed and claimed in the prior co-pending applications of George L. Moore, Serial No. 462,761, filed June 21, 1930 and Frank Jardine, Serial No. 619,947, filed June 29, 1932. The invention embodies the broad combination of a piston skirt having a substantially vertical slot terminating above the bottom of the piston and a band below the end of the slot which is yieldable to absorb expansion at the lower end of the skirt as disclosed and claimed in said application of George L. Moore, Serial No. 462,761, filed June 21, 1930, and also a non-symmetrical oval grinding of the upper portion of the piston skirt in the zone of the substantially vertical slot of the type disclosed and claimed in said application of Frank Jardine, Serial No. 619,947, filed June 29, 1932. The present invention consists primarily in an improvement in this combination to obtain in a different manner a yieldable portion at the open end of the piston to absorb expansion and prevent binding while providing a good bearing on the cylinder wall and being constructed to avoid excessive flexing and consequent fatigue from the thrust loads. This invention also permits an arrangement of the piston skirt so that the extent of the cam grinding may be reduced and if desired the portion of the skirt at the open end of the piston, or in some instances, the full length of the skirt may be ground to a true circular contour. Other features of this invention are the arrangement of a pair of relatively short horizontal slots below and in the vertical zone of the wrist pin bosses intersecting substantially vertical slots extending to the open end of the piston skirt to provide the necessary flexibility at the open end of the skirt and limit the heat flow to this portion of the skirt.

Other objects and advantages of this invention relating to details of construction and economies of manufacture will appear hereinafter.

In the accompanying drawing which illustrates a preferred embodiment of this invention:

Figure 1 is a side elevation of a piston constructed in accordance with this invention;

Figure 2 is an elevation of the piston taken from a point at right angles to Figure 1;

Figure 3 is a bottom plan view looking at the open end of a piston and illustrating a slight modification;

Figure 4 is a sectional view taken substantially on the plane indicated by the line 4—4 in Figure 1 and also showing in exaggerated form the clearance relationship between the piston skirt and a cylinder wall;

Figure 5 is a view similar to Figure 4 taken on the line 5—5 of Figure 1;

Figure 6 is a view corresponding to Figure 4 illustrating a slightly modified form of piston.

Referring to the drawing, the piston as illustrated in Figures 1, 2, 4 and 5 includes a head 10 having a substantially cylindrical depending ring flange 11 provided with a series of grooves 12 for the reception of piston rings. The piston is preferably cast in the form of the conventional full trunk type of piston including a skirt 13 circumferentially integral at its upper edge with the lower edge of the ring flange 11 and having formed therein opposed wrist pin bosses 14. As illustrated relatively large wedge shaped reliefs 15 may be cast into the piston about the wrist pin bosses. In machining the piston a horizontal slot 16 is cut through the piston wall on one side, preferably, as illustrated, in the lower-most ring groove 12. This slot terminates as illustrated in holes 17 drilled through the piston wall and spaced from the vertical plane through the wrist pin axis, so that the slot 16 extends less than half way around the piston and is located centrally above one side of the piston between the wrist pin bosses. This side of the piston 18 is termed the minimum thrust face, since it is designed to be positioned in the engine cylinder to receive the lateral thrust of the piston on the compression stroke and the inertia thrusts, while the opposite side of the piston 19 is arranged to receive the lateral thrust of the power stroke. A substantially vertical slot 20 is cut through the minimum thrust face 18, intersecting the horizontal slot 16 at about its center and terminating in a hole 21 positioned above the open end of the piston and about on a level with the lower edges of the reliefs 15.

At the level of the hole 21 and lower edges of the reliefs 15 the piston skirt is preferably provided with a circumferential groove 22. Below each boss relief 15 holes 23 are drilled through the piston wall in the groove 22 and are connected by a horizontal slot 24. A substantially vertical slot 25 intersects each horizontal slot 24 and extends downwardly to the open end of the piston.

The ring flange 11 of the piston is, in accordance with the usual practice, ground to a diameter small enough so that it does not contact the cylinder wall at any temperature. The upper part of the skirt, between the lower edge of the ring flange 11 and the circumferential groove 22 is preferably cam ground so as to have a generally oval contour with its greatest diameter at right angles to the wrist pin axis as indicated in Figure 4.

The preferred contour of this upper part is indicated in exaggerated form in Figure 4. In this figure C designates an engine cylinder shown as accurately circular in cross section. On the diameter *a* which is perpendicular to the wrist pin axis the piston fits closely to the cylinder preferably with only sufficient clearance to permit an oil film, which may be about .001 of an inch. The clearance of the thrust face 18 from the cylinder increases relatively rapidly in both directions from the diameter *a* up to and past the adjacent edge of the relief 15 on each side. On the opposite side of the piston the clearance of the thrust face 19 from the cylinder increases in both directions from the diameter *a* but less rapidly than the increase in clearance of the corresponding parts of the thrust face 18. At points about 45 degrees on each side of the diameter *a* the thrust face 19 has a greater clearance from the cylinder wall than at the diameter *a*, but such clearance remains sufficiently small to prevent an audible slap of the piston laterally along the wrist pin axis. At the corresponding points on the thrust face 18 the clearance from the cylinder wall is relatively large and if the piston were not otherwise restrained would be sufficient to permit an audible slap by sliding of the piston along the wrist pin axis, indicated by the diameter *b*.

The clearance of the respective thrust faces from the cylinder wall as described above and as shown in Figure 4 exists only when the piston is cold. As the piston heats up to operating temperature the expansion in the line of the wrist pin axis, that is along the diameter *b*, is permitted by the relatively large clearance about the outer ends of the wrist pin bosses. This expansion also has a tendency to mechanically distort the thrust face 18 from its initial ovate form toward a circular form. This tendency has the effect of reducing the diameter of the piston along the diameter *a*, Figure 4, and therefore compensates for a certain amount of circumferential expansion of the skirt. Additional thermal expansion of the skirt is accommodated by the substantially vertical slot 20, the cut edges of which may move closer together to absorb expansion. The slightly ovate form of the thrust face 19 permits this thrust face to bear fully on the cylinder wall at operating temperatures, the wall of the cylinder at operating temperatures normally being slightly out of round with its major axis perpendicular to the wrist pin axis of the piston.

The lower portion of the skirt between the circumferential groove 22 and the open end of the piston skirt may conveniently be ground to a true circular sectional contour. This portion of the skirt is rendered yieldable to absorb circumferential expansion by means of the intersecting slots 24 and 25 disposed under each wrist pin boss. Circumferential expansion of this lower portion of the skirt is accommodated by the edges of the slots 25 approaching each other, the movement of the portions adjacent the slot 25 being permitted by the horizontal slots 24. The portion of the lower part of the piston skirt in the vertical zone of the thrust faces 18 and 19, however, is relatively rigid under the lateral thrusts along the diameter *a* as shown in Figure 4 by reason of the location of the ends of the horizontal slots 24. The thrusts of the power stroke, for example, are applied to the thrust face 19 initially in the horizontal plane through the wrist pin axis and in the direction of the diameter *a*. In order for such a thrust to flex the lower portion of the skirt, it would be necessary for the lower portion of the skirt to bend with respect to the upper part of the thrust face 19 about on the line of the groove 22. Such bending is resisted by the curvature of the piston wall. Accordingly, the lateral thrusts applied to the piston skirt have but an extremely slight tendency to flex the lower portion of the skirt in such a manner as to give rise to premature fatigue failure.

A slightly modified form of the invention is illustrated in Figure 3 in which culvert shaped bridges 26 are illustrated spanning the slots 25 below the wrist pin bosses. These bridges are flexible to permit closing of the slots 25 to absorb expansion and at the same time aid in stiffening the split portions of the skirt, and assist materially in preventing relative vertical movement of the portions separated by the slots 25.

A further modification of the invention is illustrated in Figure 6 in which the cast reliefs 15 as shown in Figures 1 and 2 are omitted. The contour of the upper portion of the skirt in this embodiment is preferably about the same as that previously described and illustrated in Figure 4 except that the piston wall is preferably ground, in the zone of the wrist pin bosses, to a slightly greater clearance with less variation in order to compensate for the omission of the cast relief 15.

Although a specific embodiment of the invention has been described, it will be understood that various rearrangements of parts and modifications of structural detail may be resorted to without departing from the scope of the invention as defined in the following claims.

I claim:

1. A piston comprising a head having a depending ring flange, and a skirt having aligned wrist pin bosses formed therein, said skirt being separated from said ring flange on one side by a substantially horizontal slot and the remainder of the upper edge of said skirt being continuously integral with the lower edge of said ring flange, the upper portion of said skirt being formed with a substantially vertical slot intersecting said horizontal slot and extending toward but terminating short of the open end of said skirt, the opposite side of said skirt presenting an unslotted continuous bearing surface and the lower portion of said skirt below the lower end of said substantially vertical slot being formed with a T-slot disposed in the vertical zone of one of said wrist pin bosses and extending to the open end of said skirt, the horizontal portion of said T-slot being disposed in the plane of the lower end of said sub-

stantially vertical slot and overlapping circumferentially the horizontal portions of said first mentioned horizontal slot.

2. An internal combustion engine piston composed of light metal alloy and comprising a head having a substantially cylindrical depending ring flange and a skirt formed with aligned wrist pin bosses and opposed thrust faces between said bosses, the upper edge of said skirt above one of said thrust faces being separated from said ring flange by a substantially horizontal slot and the remainder of the upper edge of said skirt being continuously integral with the lower edge of said ring flange, said skirt being formed through a portion of its height with a substantially vertical slot extending toward but terminating short of the open end of said skirt and intersecting said horizontal slot and through said portion of its height having thrust faces formed with an ovate sectional contour with its major axis perpendicular to the axis of said wrist pin bosses, said ovate contour having a constantly diminishing radius on each side of said major axis and said skirt being circular in cross section and flexible below the lower end of said substantially vertical slot by means of slots disposed below and in the vertical zone of said wrist pin bosses extending to the open end of said skirt.

3. A piston comprising a head and a skirt integral therewith and having wrist pin bosses formed therein, said skirt having opposed thrust faces, one of which is separated at its upper edge from said head by a circumferential slot, a substantially vertical slot intersecting said circumferential slot and extending toward the open end of said piston but terminating in a plane perpendicular to the vertical axis of the piston spaced from the open end of the skirt, said skirt between said plane and its upper edge having an ovate sectional contour with its major axis perpendicular to the axis of the wrist pin bosses said ovate contour having a constantly diminishing radius on each side of said major axis, and said skirt below said plane having a substantially circular sectional contour, and a substantially vertical slot formed in said skirt below each of said wrist pin bosses and extending upwardly into said skirt from the open end thereof.

4. A piston comprising a head and a skirt integral therewith and having wrist pin bosses formed therein, said skirt having opposed thrust faces, one of which is separated at its upper edge from said head by a circumferential slot, a substantially vertical slot intersecting said circumferential slot and extending toward the open end of said piston but terminating in a plane perpendicular to the vertical axis of the piston spaced from the open end of the skirt, said skirt between said plane and its upper edge having an ovate sectional contour with its major axis perpendicular to the axis of the wrist pin bosses, said ovate contour having a constantly diminishing radius on each side of said major axis and said skirt below said plane having a substantially circular sectional contour, short circumferential slots disposed in the vertical zones of said wrist pin bosses and lying in said plane and having their ends spaced apart from each other and from said substantially vertical slot, and a short substantially vertical slot intersecting each of said short circumferential slots and extending to the open end of the piston.

5. A piston comprising a head and a skirt integral therewith and having wrist pin bosses therein, said skirt being circular in the lower portion and having non-circular thrust faces intermediate the said lower portion and said head, said thrust faces arranged on a diameter normal to the pin boss axis, one of said thrust faces provided with a T-shaped slot in the non-circular portion and said skirt provided with a T-shaped slot in the circular portion below the pin bosses, the horizontal portions of said T-shaped slots overlapping circumferentially.

6. A piston comprising a head and a skirt integral therewith and having wrist pin bosses formed therein, said skirt having opposed thrust faces, the top portion of each of said thrust faces being oval in cross section and having a common major axis normal to the wrist pin axis, said oval cross section having a constantly diminishing radius on each side of said major axis and the lower portion of each of said thrust faces being circular in cross section, T-slot means provided on the major axis of said oval thrust face portion to compensate for expansion therein and T-slot means formed in the lower portion of said skirt on an axis normal to said major axis to compensate for expansion in the lower portion of the skirt.

7. A piston comprising a head and a skirt integral therewith and having wrist pin bosses therein, said skirt being circular in the lower portion and having non-circular thrust faces intermediate the said lower portion and said head, said thrust faces arranged on a diameter normal to the pin boss axis, one of said thrust faces provided with a T-shaped slot in the non-circular portion to compensate for thermal expansion in said portion and said skirt provided with a T-shaped slot in the circular portion below each of the pin bosses to compensate for thermal expansion at the open end of the piston skirt.

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