Aug. 16, 1927. 1,639,062

E. A. SPERRY

PISTON FOR INTERNAL COMBUSTION ENGINES

Filed July 20, 1921

Fig. 1.

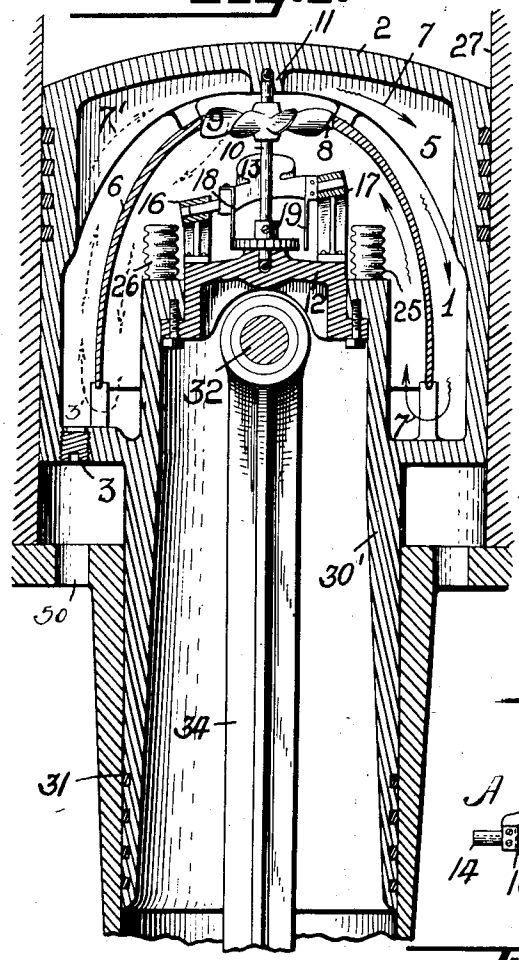


Fig. 2.

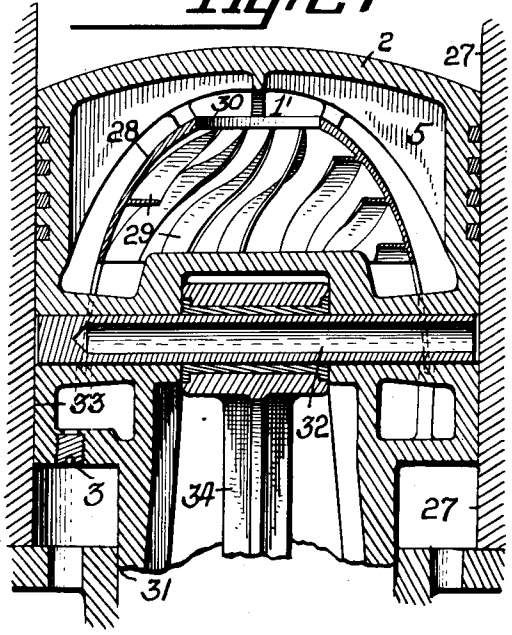


Fig. 4.

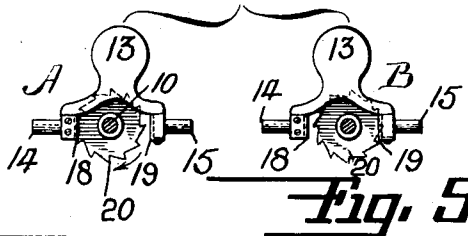


Fig. 5.

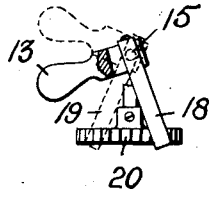


Fig. 3.

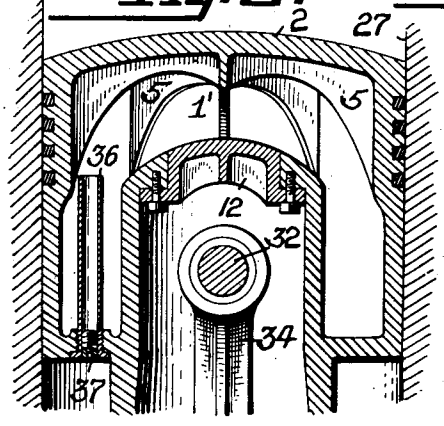
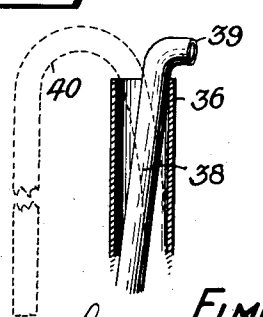


Fig. 6.



Inventor

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By his Attorney

Herbert H. Thompson

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UNITED STATES PATENT OFFICE.

ELMER A. SPERRY, OF BROOKLYN, NEW YORK, ASSIGNOR TO SPERRY DEVELOPMENT COMPANY, OF DOVER GREEN, DELAWARE, A CORPORATION OF DELAWARE.

PISTON FOR INTERNAL-COMBUSTION ENGINES.

Application filed July 20, 1921. Serial No. 486,181.

This invention relates to pistons for internal combustion engines especially to engines employing very high pressures and temperatures, such as multiple expansion and Diesel engines.

As is now well understood, the solution of the problem of cooling the piston of such an engine lies in abstracting heat from the head of the piston as rapidly as possible. For this purpose it has been proposed to water cool the under surface of the piston head by circulating water through the top of the piston from an external source. This method, however, involves the use of sliding parts and introduces serious complications. I prefer, therefore, to transfer the heat from the head of the piston to the cooled cylinder walls by utilizing a fluid sealed within the piston head which rapidly conveys the heat from the piston head to the thin walls thereof which lie in close contact with the water cooled cylinder walls.

Referring to the drawings in which what I now consider the preferred form of my invention is shown:

Fig. 1 is a vertical section of one form of my improved piston.

Fig. 2 is a similar view of an alternative form; the section also being taken at right angles to the section shown in Fig. 1.

Fig. 3 is a view similar to Fig. 1 of a third alternative form.

Fig. 4 is a detail showing two positions, A and B, of the operating mechanism of Fig. 1 for causing circulation of the liquid.

Fig. 5 is a detail taken at right angles to Fig. 4.

Fig. 6 is a detail showing one method of filling the piston shown in Fig. 3.

According to one form of the invention, I completely fill the interior 1 of the piston 2 with a non-volatile liquid of fairly good heat conductivity and low viscosity. For this purpose I have found certain grades of oil having the above characteristics as an excellent liquid.

A filling plug (or plugs) 3 is shown as threaded in aperture 3′ in the piston through which the liquid is forced into the piston. Said aperture 3′ preferably registers with valve or equivalent openings 50 in the cylinder cavity below, so that ready access may be had through such opening to the filling aperture. Preferably, the under surface of the piston head is provided with heat radiating fins 5 or baffle plates which project into the oil. Also within said base is a separating diaphragm 6 shown as dome-shaped. The purpose of said diaphragm is to assist the natural circulation of the oil upwardly along the hotter portion of the piston and downwardly in the cooler parts thereof, as indicated by the arrows 7′. Said dome-shaped diaphragm is open at the bottom and also has a hole 8 at the top thereof in which may be placed a propeller 9 also for assisting the circulation of the oil. Said propeller is shown as mounted on a shaft 10 journaled at the top in the boss 11 of the piston head and at the bottom in the block 12 supporting the crank pin 32.

For rotating said propeller I prefer to employ inertia means operated by the continuous stopping and starting of the piston as it reciprocates. Said means is shown as a small weight 13 mounted on stub shafts 14 and 15 slidably and rotatably journalled in inclined bearings 16 and 17 on top of the block 12. Secured to said weight are a pair of downwardly extending arms 18 and 19 which are adapted to engage alternately ratchet wheel 20 on the shaft 10 of said propeller. The propeller is rotated in the same direction when the weight is moved upwardly as when it is moved downwardly since when the weight is flopped upwardly by a sudden stopping of the piston on its upward stroke, or by the sudden starting of the piston on the downward stroke, the weight will also slide upwardly in the inclined bearings 16 and 17 or to the right in Fig. 1, so that the pawl 18 will be brought into engagement with the ratchet wheel 20 at that time, as shown in Fig. 1 and view A of Fig. 4. This, it will be seen, will rotate the ratchet wheel clockwise in Fig. 4, view A. On the other hand, when the piston suddenly stops at the end of its downward stroke, or starts on its upward stroke, the weight will flop downwardly and also slide to the left in Fig. 1, thereby bringing the pawl 19 into engagement with the ratchet wheel (see view B, Fig. 4). This, it will be seen, will also rotate the ratchet wheel clockwise in Fig. 4.

For allowing for the expansion and contraction of the oil filling said space in the piston, I have shown flexible wall airtight

members 25, 26 which expand and contract to allow for the contraction and expansion of the oil.

By inspection of the arrows in Fig. 1, it will be seen that the cooler oil may be drawn up through the center of the space by the propeller and forced against the under surface of the hot piston head from whence it flows downwardly against the walls of the piston and imparts the heat acquired from the piston head to said thin walls from where it is transferred by conduction to the water cooled cylinder walls 27, as shown by full line arrows 7, or, if desired, the oil may be caused to flow in the opposite direction as shown by dotted line arrows 7′ by varying the pitch of the blades.

I do not limit myself, however, to the employment of a liquid within the piston, but may employ any fluid, including air or other gas, in connection with the form shown in Fig. 1, i. e., when a positive means such as fan 9 is employed to cause continuous circulation of the fluid within the piston.

In the form shown in Figs. 2 and 3 I prefer to only partially fill space 1′ within the piston by oil or similar liquid. In this form of the invention since the space is only partially filled, no artificial means for circulating the oil need be employed as the reciprocation of the piston will serve to splash the oil over all surfaces, rapidly throwing the oil from the hotter upper surface of the piston against the cooler walls thereof. I find it preferable, however, to provide within said space a baffle member 28 for assisting in distributing the oil and for imparting a swirling motion thereto. For this purpose I have shown the interior of said member 28 as provided with spiral ribs 29. The oil will then emerge from the restricted opening 30 therein in a swirling condition, so that it will spread out against the entire end surface of the top of the piston and over the downwardly projecting ribs connected thereon.

It should also be noted that I prefer to construct the piston itself with a large downwardly extending trunk 30′ which is guided in the guide 31 secured or formed as a part of the lower portion of the cylinder.

It should be noted then that the piston is supported and guided by two spaced surfaces. In addition, I prefer to extend the piston below the point where the wrist pin 32 is mounted therein, as shown at 33. By this means a three point guide is secured for the piston, two of which, at least, are near and on opposite sides of the wrist pin connection, so that there is no tendency to twist the piston out of alignment with the cylinder. The connecting-rod 34 extends downwardly from said pin to the usual crank shaft (not shown).

It should be noted that the type of engine illustrated is one wherein the connecting rod 34 is pivoted within the cylinder itself on wrist pin 32, the piston possessing no piston rod or cross head. In this type of engine, the connecting rod exerts lateral pressure on the piston, first to the right and then to the left (Fig. 1), or in other words, at right angles to the axis of the wrist pin, as the rod reciprocates with the piston and oscillates with the revolving crank. This lateral pressure serves to bring the piston walls into intimate contact with the cylinder walls along the surfaces affected, thereby greatly assisting the transfer of heat from the piston to the water jacketed cylinder. As is well known, an appreciable clearance is allowed between the piston and cylinder walls, which is usually filled with a film or films of oil, the thickness of which depends upon the clearance and upon the direction of pressure of the cylinder. With an engine of the type described, the thickness of the oil film is reduced to a minimum when pressure is exerted against that side of the piston, thereby decreasing thermal resistance of the parts. It is for this reason also that I prefer to circulate the oil or other fluid along these surfaces which lie normal to the crank pin, (see Figs. 1 and 2), since it is these surfaces which are brought into most intimate contact with the cylinder walls. While the three-point guide hereinbefore described prevents twisting of the longitudinal axis of the piston-head relative to the longitudinal axis of the cylinder, it does not prevent lateral movement of said first axis parallel to said second axis due to thinning out of the oil film between the piston and cylinder due to the thrust of the connecting rod. This displacement is, however, extremely small, but in thinning out the oil film the transfer of heat is greatly facilitated.

One method of placing oil within the hollow piston is illustrated in Figs. 3 and 6. According to this method, a short pipe 36 is threaded within the piston and is normally closed by set screw 37 or other means. When it is desired to place oil within the piston a smaller pipe 38, preferably having a bent end 39, is inserted into the piston through the said pipe 36, as shown in Fig. 6 and the desired amount of oil then is forced through said pipe 38 and into the piston. On the other hand, when it is desired to remove the oil from the piston, a flexible pipe 40 is inserted through the pipe 38 until there is sufficient of the pipe to extend down to the bottom of the piston, as illustrated in dotted lines. The oil is then siphoned out of the piston. Said pipe may extend just above the normal level of the liquid and, hence, may be used as an overflow pipe to predetermine the level of the liquid. It will be understood that in this form of the invention also, aper-

tures (not shown) similar to openings 50 may be provided in the base of the cylinder to give access to the filling and overflow tube.

I find the following characteristics essential for the oil or other liquid employed:

Where the oil entirely fills the space, it is essential that it be absolutely free from either water or air. If any water is present, the high temperature conditions will generate steam very materially and perhaps dangerously increase the pressure within the cavity. If air is present, on the other hand, the oxygen of the air may oxidize a portion of the oil, leaving a carbon deposit on the cylinder wall. The oil employed should also have a low viscosity even when cooled so that it will circulate freely from the first and not wait until the parts get too hot before circulation starts in. Another requisite is that the oil must have as high heat conductivity as can be obtained. Next, the oil should have a high specific heat and an extremely high boiling point, so as not to generate pressure or cause overheating. The oil should also possess high vapor tension so as not to vaporize easily under its boiling point. Where the piston is only partially full and no diaphragm is employed or where partially full and a diaphragm is employed, the part not filled with oil should be filled with an inert or non-oxidizing gas, preferably a reducing gas, such as hydrogen. The trouble with air is that it oxidizes part of the hydrogen in the hydrocarbon, leaving the carbon free to deposit. The carbon deposits act as a charcoal filling in a refrigerated wall, i. e. as a non-conductor of heat and reduces the efficiency of cooling. The oil must also be such as will not yield metallic salts or emulsify in contact with the metal walls of the piston.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus, which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. The combination with an internal combustion engine, of a hollow piston therefor having sealed therein oil or liquid having similar physical characteristics and means for assisting the circulation of the oil within the piston comprising a rotary propeller fan.

2. The combination with an internal combustion engine, of a hollow piston therefor having sealed therein oil or liquid having similar physical characteristics and means for assisting the circulation of the oil within the piston comprising a rotary propeller fan and inertia operated means for rotating said propeller fan.

3. The combination with an internal combustion engine, of a hollow piston therefor forming a sealed chamber, said piston being completely filled with a heat-conducting fluid.

4. The combination with an internal combustion engine, of a hollow piston therefor having sealed therein a liquid of high vapor tension and low viscosity and compressible means permitting expansion and contraction of said liquid within said piston.

5. The combination with an internal combustion engine, of a hollow piston therefor forming a sealed chamber, said piston being completely filled with oil.

6. The combination with an internal combustion engine, of a hollow piston therefor having sealed therein oil or liquid having similar physical characteristics and means for assisting the circulation of the oil within the piston comprising guides and a rotary propeller fan for assisting convection currents.

7. The combination with an internal combustion engine, of a hollow piston therefor adapted to contain and have sealed therein a liquid and a normally closed filling pipe extending within said hollow piston.

8. The combination with an internal combustion engine, of a hollow piston therefor, said piston being completely filled with oil, and means within said piston for circulating the oil through a predetermined circuit.

9. The combination with an internal combustion engine having a cylinder, of a hollow piston therefor adapted to contain a liquid and having a filling aperture, and an opening in said cylinder registering with said aperture to provide access to the same.

10. The combination with an internal combustion engine, of a hollow piston therefor, said piston being completely filled with oil, and a rotary fan within said piston for circulating the oil.

11. The combination with an internal combustion engine, of a hollow piston therefor and means for cooling the same comprising a propeller, a movable weight operated by reciprocation of the piston and means connecting said weight and said propeller continuously to advance the propeller in one direction as the piston reciprocates.

In testimony whereof I have affixed my signature.

ELMER A. SPERRY.