June 10, 1930. C. A. BAUER ET AL 1,763,082

AIR COOLED CYLINDER

Filed April 18, 1929

Fig. 1.

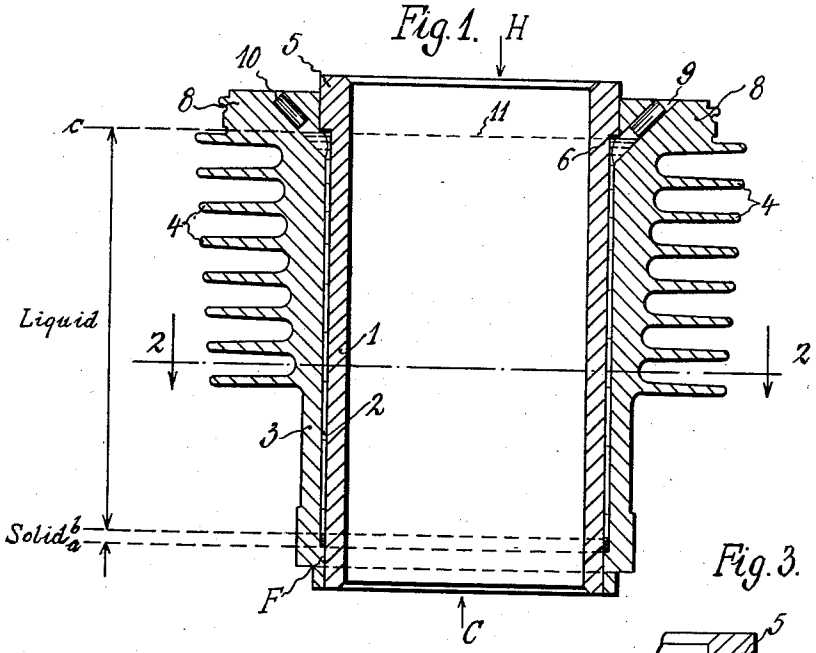


Fig. 3.

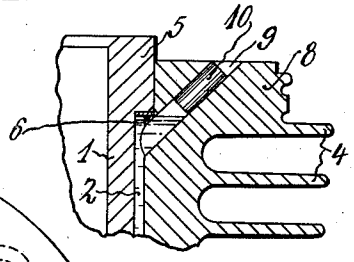
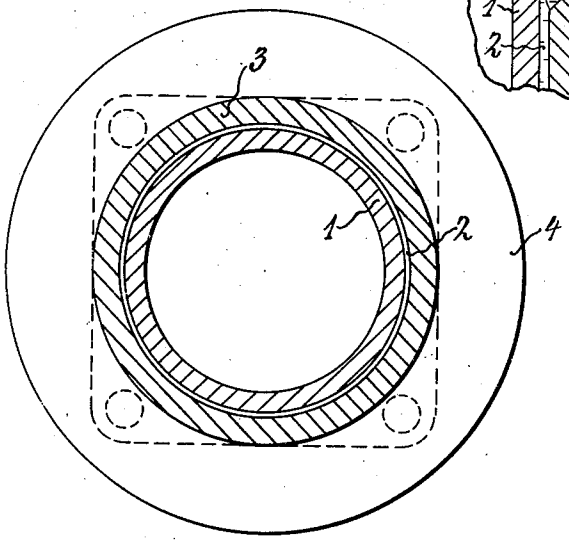


Fig. 2.



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UNITED STATES PATENT OFFICE

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AIR-COOLED CYLINDER

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This invention relates to an improvement in heat dissipating means for the cooling of internal combustion engine cylinders and the like, and more particularly cylinders which comprise a liner and shell of different metals.

In air cooled engines, such as for motorcycles and aircraft, the outside shells of the cylinders are frequently made of aluminum or one of its alloys in order to obtain light weight and because such metals possess very satisfactory heat dissipating qualities, while the liner or inside shell of such cylinders is usually a ferrous product for wearing purposes. Heretofore, various constructions of such cylinders assembled from two such separate and different materials have been attempted and no thoroughly satisfactory product has yet been attained. The present improvement aims at overcoming the difficulties which have been encountered in such structures.

A cylinder of two piece construction wherein the shell is of one metal and the liner of another should provide for the easy flow of heat from the interior to the exterior of the cylinder, and one of the chief difficulties heretofore met with is in securing good conduction of heat across the joint or contacting surfaces between the inner and outer members of the cylinder. Abutting contact between the metal surfaces even under high pressure does not provide a high degree of efficiency for heat flow and when, as is often the case, the metals have a different coefficient of expansion, an air gap occurring between the surfaces will become more efficient as an insulator for heat than as a conductor therefor.

In order to secure low thermal resistance between the liner and the shell, we have found it desirable to provide a relatively narrow space, substantially cylindrical, between the two members and to fill this space with a liquid substance such as an easily fusible metal or a salt of low melting but sufficiently high boiling point to remain liquid under all conditions of operation. No provision is made for any intended circulation of the filler within its space, which in depth is made as small as is practicable and yet provide room for the different expansion of the liner and shell. A liquid filler furnishes a more intimate contact with the surfaces of the cylinder members for the efficient conduction of heat than would a solid filler. The latter, even if in itself an excellent heat conductor, would not be so satisfactory since, due to the different expansion of such a solid filler material and the two cylinder members, fissures or voids would form to considerably impair the thermal conduction.

In the drawings which show a preferred embodiment of our invention:

Fig. 1 shows in cross-section an improved cylinder construction according to this invention;

Fig. 2 is a horizontal section on line 2—2 of Fig. 1; and

Fig. 3 is a fragmentary enlarged view in section of the shoulder abutting joint between the liner and shell.

Referring to the drawings in detail, in Fig. 1 H and C indicate the head end and the crank end of the cylinder, respectively. 1 is the liner which may be of iron, steel or kindred product, 3 is the shell having cooling ribs 4 and usually of lighter material, such as aluminum or the like, than the liner, and 2 is a relatively narrow cylindrical space left between the liner and shell adapted to be filled up to the level 11 with a liquid filler. It will be understood that the space 2 will extend entirely around the cylinder and axially substantially the full length of the cylinder. But this space 2 is much narrower than the usual water jacket space of water cooled cylinders. It need only be wide enough to insure a clearance between the two surfaces of the liner and shell, which will be bridged by the liquid filler.

The liner and the shell of the cylinder are subjected to different temperatures and they have besides different expansion coefficients. This is usually taken care of by a flexible joint between the two members at one of their ends. For mechanical and other reasons, this flexible joint is preferably located

at the crank or lower end of the cylinder, while the head or upper end connection of the two members may be by some sort of fixed joint.

In the present embodiment, the liner at its head end is provided with a shoulder portion 5 which forms a butt joint with a flange of the shell 3 at 6. Bores 9, of which several may be circumferentially disposed in the flange 8 of the shell, serve for pouring the filler in place and may be hermetically sealed after the filling procedure by plugs or other suitable means, as indicated at 10. The liner and shell are preferably joined at their lower portions by a concentric lap joint, as shown at F. This concentric lap joint permits the lower portions of the shell to freely expand or contract in axial direction.

It is contemplated that the space 2 between the liner and shell is to be hermetically sealed against the ingress of air or egress of filler material. The butt joint at the upper end of the cylinder will for this purpose be made air tight, and the lower joint at F can also be made both air tight and flexible by suitable mechanical means (not shown). Ordinarily a simple lap joint F (such as shown in the drawings) would, due to the unequal expanson of the materials, not remain tight under all conditions of operation. Further mechanical means, well known in the art but not here shown, would be required to keep such a joint tight. However, if a filler material of proper characteristics is chosen, the lower joint F may be kept sealed at all times without the necessity of any special mechanical means, and thus simplicity and economy of construction is attained. For this purpose, we provide a filler which, during the operation of the engine, will be liquid in the hotter head-end portions of the cylinder and substantially solid in the cooler crank-end portions, whereby a lower small portion of the filler acts automatically as a perfect seal for the lap joint F and the remainder of the filler acts as a good heat conducting bridge. In practice, almost the entire vertical length of the filler will be liquid with its solid portion extending only a short distance from the bottom. This has been roughly indicated on the drawings (Fig. 1) wherein the dotted line "*a*" indicates the lower end of the solid portion, "*b*" the upper end of the solid portion, and "*c*" the upper end of the liquid portion of the filler.

The temperature distribution on the outer wall of the liner will be one of rising degrees from the crank end to the head end. The temperature near the head end varies considerably with changing loads, while the temperature near the crank end is comparatively little variable and always lower than even the lowest head end operating temperature. This is readily explained by the fact that the crank end portion is not under the direct influence of the high temperatures of the exploding and expanding mixtures, but in close contact with the surrounding air.

A low melting composition of potassium nitrate and sodium nitrate has been found to be very suitable in motorcycle engines to meet the aforementioned requirements for the filler material. It is well known that such and similar compositions of two salts may have a very wide continuous range of freezing temperatures, varying with proportions of the constituents, the lowest freezing or so-called eutectic temperature lying far below the freezing temperatures of the constituents. By mixing the two constituents in the proper ratio, any desired freezing temperature between the eutectic and the highest constituent freezing temperature can be obtained. A composition may be readily selected which will be normally solid and remain so up to the temperatures experienced at the lower end of an operating cylinder, but which liquefies at higher temperatures although it does not boil at any temperature in the operating cylinder.

Inasmuch as the filler space 2 is to be hermetically sealed, this space should not be completely filled with the filler material at low temperatures so as to give room for expansion thereof at the higher temperatures of operation. Also to prevent setting up of any undue pressure within the filler space due to expansion of the filler, we prefer to evacuate the air from said space to a considerable extent so that a highly rarefied condition will obtain therein. We find that a very suitable way of accomplishing these results is to introduce the filler into the filler space when in a highly heated condition, viz., at a much higher temperature than will be experienced in any operation of the cylinder. For example, the cylinder with the sealing plugs 10 removed may be immersed in a tank of the highly heated filler material so as to completely fill the space 2 while venting the air out through one of the bores 9. Then, while still so immersed, the plugs 10 may be inserted to close the bores 9 and seal the filler in its space. The subsequent withdrawal of the cylinder and the cooling and contraction of the filler material therein will accomplish the results desired.

From the foregoing explanation, it follows that the filler is solid over the entire length of the cylinder as long as the cylinder is not in operation and its temperature is not, for other reasons, too far above the temperature of the surrounding atmosphere. When the cylinder is set in operation, liquefaction of the head-end portions of the filler will begin, and this liquefaction will gradually proceed to the crank-end portions, the

axial extent of the liquefied portion mainly depending upon the load carried. But, under all possible operating conditions, there will always remain a broad enough solid portion near the crank end to insure a perfect hermetic seal for the liquid portions of the filler. If, under the action of the expanding adjacent walls, fissures should be formed in the solid filler portion, the liquid portion will quickly enter and perfectly clog the same by welding action and ensuing solidification. Thus the filler material coacts with the lap joint in providing a perfect hermetic seal.

The inherent conductivity of the filler will be of minor importance as long as the distance between the walls of the liner and the shell is kept very small, as described. The ease of heat transfer between two metallic walls separated by a thin layer of liquid filler is almost exclusively determined by the thermal resistance of a very thin film formed by the liquid on the metallic surfaces. Compared to the resistance of the film, the resistance of the remaining layer portions is negligible. This film resistance will assume very high values in liquids that communicate with the air. Any air absorbed by the liquid forms a gaseous film on the surrounding walls of very high thermal resistance. This furnishes a still further advantage in having the filler space 2 in the present construction rarefied of air and then hermetically sealed.

Summing up, the present invention provides a very narrow liquid and air-tight space between two heat exchanging walls such as the liner and the shell of an internal combustion cylinder, said space being occupied by a filler that becomes and remains liquid or, in other words, never boils under all operating temperature conditions, so that the filler forms a very conductive short bridge between the walls and also ideal heat contacting surfaces at all times, thereby obtaining a great ease of heat transmission. Furthermore, by rarefying the interspace there will never exist in it excessive pressures which prevents undue stresses in the wall materials and allows of employing sealing means otherwise impractical. Although we have mentioned eutectic salt mixtures as being particularly suitable for our purposes, we do not mean to be confined to such or similar compositions. Any substance or composition of matter answering the purposes as described before may be used.

Nor is our invention confined to air-cooled cylinders or cylinders of the structural details, shown in the illustrations. It may be found valuable to apply our principle to devices or apparatus outside the field of internal combustion engines. For instance, in a heating apparatus in which heat is transmitted from one body to another body by means of a wall separating these two bodies, it may be desirable to have different-material body-contacting surfaces on the two sides of the separating wall, and our invention would readily lend itself to the employment of such different-material contacting surfaces with excellent heat-transmitting qualities.

What we claim is:

1. A heat conducting wall for internal combustion engine cylinders and the like comprising inner and outer members of different metal with an air tight space between said members containing a filler which will be liquid and not boil at the operating temperatures of said cylinder.

2. A heat conducting wall for internal combustion engine cylinders and the like comprising inner and outer members of different metal with an air tight, air rarefied space between said members containing a filler which will be liquid and not boil at the operating temperatures of said cylinder.

3. An internal combustion engine cylinder comprising a liner of one metal and a shell of different and lighter metal with an air-tight space between said members, said space containing a filler which will be liquid and not boil at the operating temperatures of said cylinder.

4. An internal combustion engine cylinder comprising a liner and a shell with a space between them and joined at their head ends in fixed relation and at their crank ends in yieldable relation, and a filler contained in said space, this filler during operation of the cylinder being liquid in the head-end portions and solid in the crank-end portions.

5. An internal combustion engine cylinder comprising a liner and a shell with a substantially cylindrical narrow space between them joined at their head ends by means of a butt joint and at their crank ends by means of a concentric lap joint, and a filler contained in the cylindrical space, this filler during operation of the cylinder being liquid in the head-end portions and solid in the crank-end portions.

6. An internal combustion engine cylinder comprising a liner and a shell with a space between them and joined at their head ends in fixed and hermetically sealing relation and joined at their crank ends in yieldable relation, and a filler contained in the space, this filler during operation of the cylinder being liquid in the head-end portions and substantially solid in the crank-end portions for hermetically sealing the yieldable joining means.

7. An internal combustion engine cylinder comprising a liner and a shell with an air-rarefied space between them and joined at their head ends by a butt-joint hermetically sealing the rarefied space and at their crank ends by a concentric lap joint, and a

filler contained in the space, this filler during operation of the cylinder being liquid in the head-end portions and substantially solid in the crank-end portions for hermetically sealing the lap joint.

8. An internal combustion engine cylinder comprising a liner and shell of different metals with a hermetically sealed space therebetween and a filler in said space consisting of an easily fusible mixture of salts which will be liquid and not boil at operating temperatures of said cylinder.

In testimony whereof we have affixed our signatures.

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