Jan. 9, 1923. 1,441,468

C. H. WILLS.

COMPOSITE METAL STRUCTURE FOR INTERNAL COMBUSTION ENGINES AND METHOD OF FORMING THE SAME.

FILED AUG. 12, 1918.

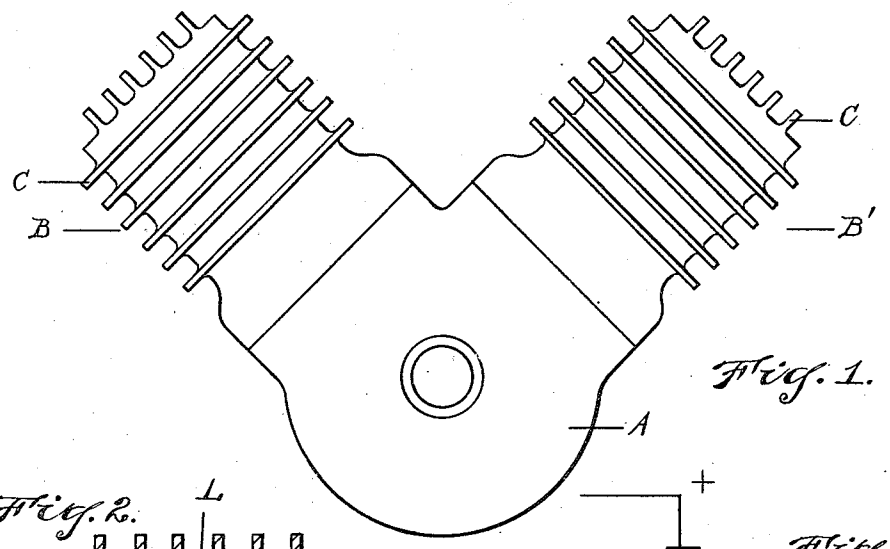


Fig. 1.

Fig. 2.

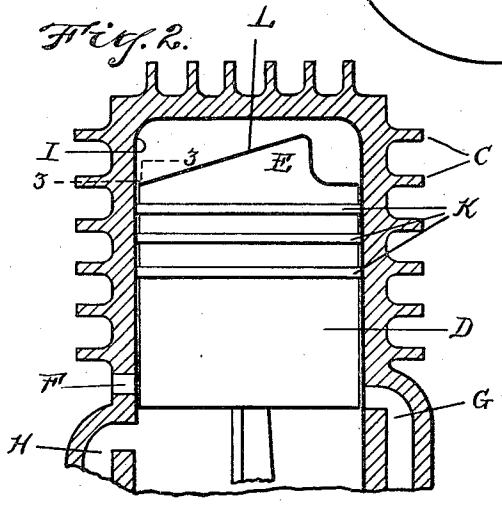
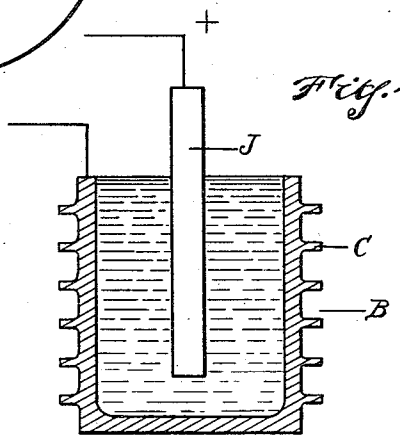


Fig. 4.



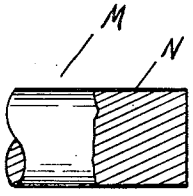


Fig. 5.

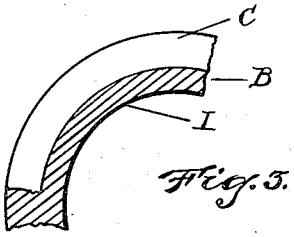


Fig. 3.

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UNITED STATES PATENT OFFICE.

CHILD HAROLD WILLS, OF DETROIT, MICHIGAN.

COMPOSITE METAL STRUCTURE FOR INTERNAL-COMBUSTION ENGINES AND METHOD OF FORMING THE SAME.

Application filed August 12, 1918. Serial No. 249,394.

To all whom it may concern:

Be it known that I, CHILD HAROLD WILLS, a citizen of the United States of America, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Composite Metal Structures for Internal-Combustion Engines and Methods of Forming the Same, of which the following is a specification, reference being had therein to the accompanying drawings.

The invention relates to the manufacture of machines or machine elements from material having qualities peculiarly adapted for the structure but lacking in the hardness and other properties requisite for the working surface. More particularly the invention relates to internal combustion engines but in its broader features it is applicable to other structures.

In the manufacture of internal combustion engines and particularly those designed for use in aircraft, it is of the utmost importance to reduce the weight to the minimum, or, in other words, to have the lowest weight factor per unit of power. A very considerable reduction of the weight may be effected by the substitution of two cycle for four cycle, both on account of the doubling of the number of power impulses and also because of the elimination of parts, such as valves, valve operating mechanism, etc. A further weight reduction may be obtained by the substitution of air-cooling for water-cooling, and still further by the use of relatively light material such as aluminum in place of metal of higher specific gravity. There are, however, very serious difficulties encountered in the designing of an engine with the changes as above set forth. Among which is the difficulty of successfully dissipating the heat. For high power, high engine speed is necessary and the heat developed by successive explosions must be rapidly dissipated through the cylinder walls into the radiating fins. Cast iron, which is the material most used for cylinder construction, is relatively low in thermal conductivity and therefore limits the rate of heat dissipation. The metal, aluminum, has a much higher co-efficient of thermal conductivity and on account of its low specific gravity would be ideal for cylinder and piston construction, but the use of the same metal for both of these parts is objectionable as the two soft surfaces in working contact would rapidly wear. The placing of a bushing or lining sleeve of harder metal within the cylinder is objectionable; first, because any kind of mechanical joint will restrict the thermal conductivity; second, the two metals having different co-efficients of expansion will introduce objectionable stresses, causing distortion and leakage; third, the lower thermal conductivity of the bushing material in addition to the thermal resistance of the joint will limit dissipation of the heat.

It is the primary object of the present invention to retain the high thermal conductivity and low specific gravity of aluminum or similar material and at the same time to provide a working surface equal or superior to that of a cast iron cylinder. This I have accomplished by coating the working surface of an aluminum member with a thin film of iron or other relatively hard metal, the two materials being in molecular contact and integrated with each other. I have discovered that iron electrolytically deposited on an aluminum surface will be retained thereon when subjected to both mechanical stresses and varying temperatures and forms a harder surface than cast iron. I have further discovered that by machining or otherwise finishing the co-acting aluminum parts with a predetermined excess clearance the iron may be deposited on one of these parts to take up this clearance so as to form a working fit with the other part without the necessity of any further machining or finishing.

The specific construction of the engine or other structure to which my improvement is applied is immaterial to the invention. I have, however, illustrated a multi-cylinder internal combustion engine of the V-type, two cycle and air-cooled.

In the drawings:

Figure 1 is an end elevation of the engine;

Figure 2 is a vertical central section through one of the cylinders;

Figure 3 is a horizontal section on line 3—3 of Figure 2;

Figure 4 is a diagram illustrating the method of forming the electrolytic deposit;

Figure 5 is a sectional elevation showing a crank journal having an electrolytic film surface.

A is the crank case of a multi-cylinder

engine, B, B′, etc. are cylinders secured to the case and provided with heat radiating fins C integral therewith. D are the pistons within the cylinders formed with the usual deflector flanges E for use in two cycle operation, the cylinders being preferably of the three port type and having the exhaust port F, the transfer port G and intake port H.

Both the cylinders and pistons are formed of aluminum or equivalent material and are machined, ground or otherwise finished to form co-acting bearing surfaces with, however, a predetedmined clearance in excess of that required under working conditions. The cylinders are then internally coated with iron or other hard wearing material, and the thickness of coating corresponds to the excess clearance which has been provided, as indicated at I. The coating is effected by electrolytic deposition, the cylinder being emersed in a suitable electrolyte and forming the cathode, while an anode J of the metal to be deposited is inserted axially therein. Thus upon the flow of an electric current the metal will be uniformly deposited on all portions of the surface, as illustrated in Figure 4. A thin film of iron so deposited has a greater hardness than cast iron and is so firmly knit to the aluminum surface that it cannot be separated therefrom by either the heat or the mechanical stresses, incident to the operation of the engine. The surface of the deposit is as smooth and true as the finished surface on which it is placed, so that no further finishing is required. The wearing surface of the piston need not be coated with the iron, as the soft metal in contact with the hard is preferable to the co-acting surfaces of equal hardness. The piston is, however, provided with the usual sealing rings K.

In operation, the heat of combustion communicated to the piston and to the walls of the cylinder is rapidly dissipated by reason of the high thermal conductivity of the aluminum and the slight thickness of the iron film. There is no detrimental effect due to difference in co-efficients of expansion of the two metals, doubtless due to the limited thickness of the film. Also the heat which is imparted to the piston passes easily through the iron film and is dissipated by the radiating fins together with that which is imparted directly to the wall of the cylinder.

In the operation of internal combustion engines where the pistons or cylinders are formed of aluminum or aluminum alloy, it has been found that a certain amount of corrosion takes place, due to the chemical action of the products of combustion. This effect may be prevented by the coating of the exposed surface of the aluminum with a metal unaffected by the gaseous products, such for instance as iron. Therefore, a further important use of my invention is the protection of the parts from corrosion by the electrolytic surface deposit. This I have illustrated at L in Figure 2 which represents an electrolytic coating of iron or other protecting material on the head of the piston which is exposed to the action of the combustion gases.

Another application of my invention is the forming of a wearing surface upon a working part formed of soft steel. To facilitate machining, the working parts, such as the crank-shafts, etc., are usually formed of relatively soft steel and while these may be subsequently hardened by heat treatment it is extremely difficult to perform such operation without distortion. I can form an equally hard surface upon a soft steel element by an electrolytic deposit of iron or other metal and by originally machining the part with an excess clearance the deposit will bring the element to exact size. Furthermore there will be no distortion in shape so that no further finishing is required. Thus as shown in Figure 5, M is a portion of the crank-shaft, the outer surface of which is coated with an electrolytic deposit N which forms a hard wearing surface on the body of soft metal.

What I claim as my invention is:—

1. A machine element formed of aluminum and a film deposit of electrolytic iron forming a working surface thereon.

2. In an internal combustion engine, the combination of a cylinder and piston formed of relatively soft metal high in thermal conductivity and a film deposit of harder electrolytic metal on one of said members forming a bearing surface for the other member.

3. In an internal combustion engine, a member forming a portion of the wall of the explosion chamber and having a surface in working contact with the co-operating member, said first-mentioned member being formed of metal high in thermal conductivity and a film deposit of harder electrolytic metal on the working surface thereof.

4. In an internal combustion engine, the combination of a cylinder and piston formed of aluminum and a film deposit of harder electrolytic metal on the one forming a working surface for the other.

5. In an internal combustion engine, the combination with a cylinder and piston formed of aluminum, of a film deposit of electrolytic iron on the one forming a working surface for the other.

6. In an internal combustion engine, a cylinder formed of aluminum and a film of iron coating the inner working surface thereof.

7. In an internal combustion engine, a cylinder of aluminum having on integral portions thereof heat dissipating and work-

ing surfaces and a film deposit of electrolytic iron on the working surface.

8. In an internal combustion engine, a cylinder formed of aluminum and having integral heat dissipating fins, the inner surface of said cylinder being finished with an excess over the working clearance, and a film of harder metal electrolytically deposited on said surface and filling the excess clearance.

9. In an internal combustion engine, the combination with a piston, of a cylinder for receiving said piston formed of aluminum and finished to a size providing excess clearance, and an electrolytic deposit of iron on said finished surface occupying the excess clearance.

10. The method of forming internal combustion engine cylinders comprising the casting or otherwise forming the cylinder of aluminum, boring said cylinder with an excess clearance and electrolytically depositing a harder metal on the inner surface of the cylinder to take up said excess clearance.

In testimony whereof I affix my signature.

CHILD HAROLD WILLS.