Dec. 7, 1937. G. H. BLETTNER 2,101,045

INTERNAL COMBUSTION ENGINE

Filed June 6, 1936

Fig. 1.

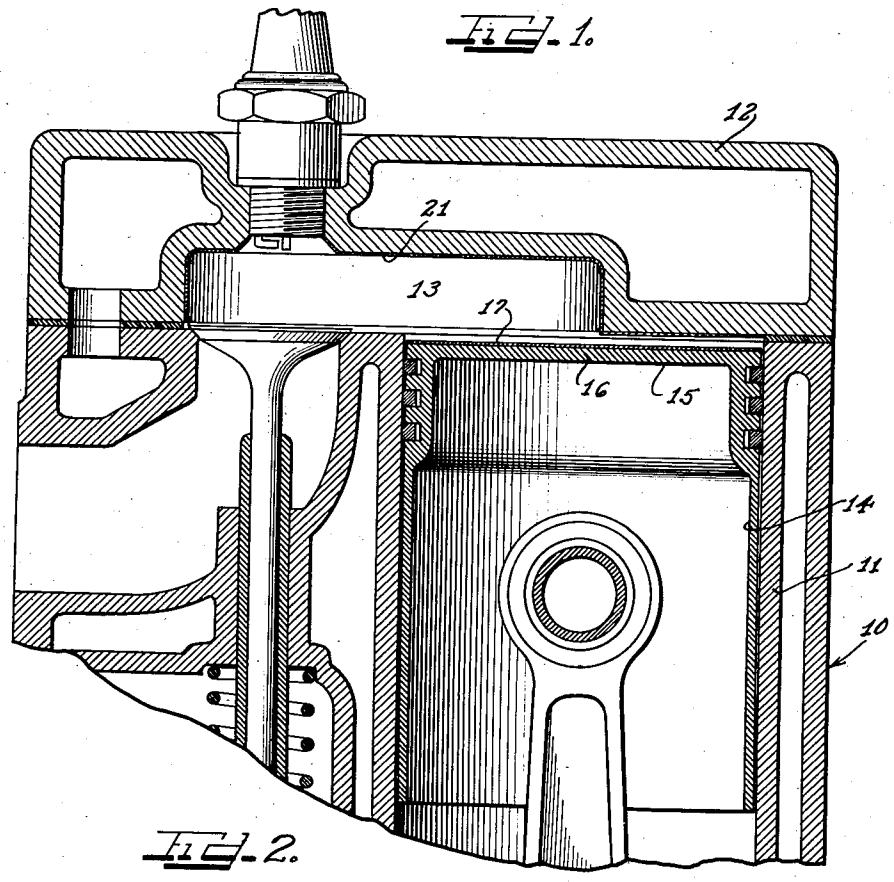
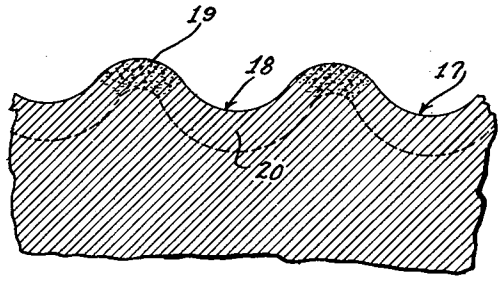


Fig. 2.



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by Charles A. Hill Attys.

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INTERNAL COMBUSTION ENGINE

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3 Claims. (Cl. 123—191)

This invention relates to an internal combustion engine and more particularly to elements thereof, such as a piston having a steel surface for that portion exposed to the gases of combustion in an internal combustion engine.

It has heretofore been proposed to manufacture pistons having steel heads, but to the best of my knowledge, steel head pistons have not proved satisfactory commercially on account of overheating and resultant "hot spots", chiefly in the center of the head, caused by insufficient heat conductivity of the material itself and because the heat absorbed by the piston head does not flow rapidly enough to the ring belt through the thin section at high engine speeds.

I have found, however, that if the surface of a piston head, or of that part of the head which is exposed to combustion, is formed of steel of suitable analysis, and the thickness of the piston head is properly proportioned, with due regard to the characteristics of the particular steel selected for such head, in relation to the heat available in the engine, such a piston will operate satisfactorily. In its use in an internal combustion engine, such a piston will be subjected to conditions that will cause certain chemical changes on or in the surface exposed to combustion, resulting in the formation of a thermal insulating composition consisting of a lacey film of iron oxides and carbides of iron. According to my observations, a piston having such a composition formed on a steel surface exposed to combustion will operate satisfactorily. The composition of matter, thus integrated in the surface of the piston exposed to combustion, prevents the head from becoming as hot as it otherwise would and accomplishes the elimination of "hot spots" and detonation. It also results in holding more heat in the working chamber and in lowering the transmission of heat through the piston head to the lubricating oil.

Such thermal insulation membrane as described may be produced not only upon the face of the piston head but also upon all exposed surfaces of the combustion chamber of an internal combustion engine, with the exception of the cylinder walls themselves. This may be done by subjecting the piston head or cylinder head, when such exposed surfaces are formed of suitable steel containing not more than 2% of carbon and substantially free from graphitic carbon, to proper heat conditions and the alternate actions of reducing and oxidizing gases. The reactions which take place on or in the surface of the heated piston head or cylinder head under such conditions result in the formation of an integral membrane composed largely of oxides of iron and carbides of iron having a low rate of heat conductivity.

The present invention, however, is directed primarily to a piston having its surface which is exposed to combustion of a suitable steel, and of such proportions or mass underlying the surface, that its temperature may be elevated sufficiently, so that a permanent surface layer or membrane of the type described will be formed on or in that surface during the normal operation of the piston in an internal combustion engine. This result may be accomplished by selecting a steel having a carbon content of 2% or less and substantially free from graphitic carbon, preferably of low "kindling temperature", and constructing the piston head of a proper wall thickness having due regard to the analysis of the steel selected to be exposed to combustion and to its physical characteristics, and also to the operating conditions of the particular engine with which that piston is to be associated.

It is therefore an important object of this invention to provide a piston or other elements of an internal combustion engine, having that portion exposed to combustion formed of a steel having a carbon content of 2% or less and substantially free from graphitic carbon, said piston head being provided on its exposed surface with a permanent membrane or film having thermal insulation properties and consisting essentially of iron oxides and carbides of iron.

It is a further important object of this invention to provide a piston having that surface exposed to combustion, of a suitable steel which is susceptible to the acquisition and retention of a thermal insulation membrane consisting of oxides and carbides of iron on or in the surface of the head thereof, whereby the efficiency of an engine employing such piston is increased and detonation reduced.

Other and further important objects of this invention will become apparent from the following description and appended claims.

This invention (in a preferred form) is illustrated in the drawing and hereinafter more fully described.

On the drawing:

Figure 1 is a fragmentary sectional view of a combustion chamber of an internal combustion engine showing a piston of my invention installed therein.

Figure 2 is a fragmentary enlarged sectional view of the end wall of a piston head.

As shown on the drawing:

The reference numeral 10 indicates a conven-

tional internal combustion engine having a cylinder 11, cylinder head 12 and combustion chamber 13. A piston 14 is mounted for reciprocation within the cylinder 11.

In accordance with the principles of this invention, the piston 14, and more particularly the surface of the head 15, thereof is formed of a steel having a carbon content of 2% or less and substantially free from graphitic carbon. Preferably a steel having a low "kindling point" is used in the manufacture of the surface of the head 15, but high carbon steels may be used, as may also alloy steels containing chromium, nickel or other elements in such limited amounts as will, upon the temperature of the surface being elevated to the "kindling point", allow the desired reactions to take place in the presence of proper gases, provided the thickness is adjusted. For the purposes of my invention, however, cast iron is not satisfactory since it contains uncombined or graphitic carbon which inhibits the desired reactions.

Depending upon the particular analysis and characteristics of the steel selected for use in the manufacture of the surface of the piston head 15, and also depending upon the size of the engine and the conditions under which the engine will be operated, the thickness of the end wall 16 of the head should be so proportioned as to result, during the operation of the engine, in a rise in the surface temperature to the "kindling point" of the material selected. At such temperature the exposed surface of the heated piston head, in the presence of the gases of supply and combustion, will have formed thereon a permanent film or membrane 17 consisting essentially of iron oxides and carbides of iron.

A proper thickness of end wall 16 is secured by calculation. The use of that thickness, taking into consideration the analysis and characteristics of the steel of the piston head and of the exposed surface to be insulated, and also the operating conditions and size of engine, will result, during normal operation of the engine, in a temperature rise of that surface such as will cause the formation of a thermal insulation layer or membrane 17.

The formation of the membrane 17 is due to the raising of the temperature of the exposed surface of the end wall 16, during the operation of the engine, to the "kindling point" of the steel used on the surface of the head. By the term "kindling temperature" or "kindling point" is meant that temperature below the melting point of any steel at which such steel when properly heated will rapidly unite at its surface with oxygen. When the exposed surface 16 of the piston head reaches the kindling point in the operation of the engine, reactions occur in the presence of the gases of supply and combustion which result in the formation of oxides and carbides of iron.

By way of example, and not as a limitation upon the scope of the present invention, I prefer to use for a 3¼" piston, a head sectional thickness including that surface exposed to combustion, formed from steel of S. A. E. #X 1112 specification, of a thickness of approximately 0.120 of an inch, subject to usual manufacturing variations and limitations. The section of the surface exposed to combustion together with underlying mass should not, however, be so thin as to allow vibrations to be set up in it during the operation of the engine that would rupture the insulating membrane or flake off such insulating medium.

The advantages of this invention can thus be obtained by the selection for that surface exposed to combustion, in the manufacture of a piston, of any steel having a carbon content of 2% or less, provided it is substantially free from graphitic carbon and provided the surface "kindling point" of such steel and its other balanced characteristics of necessary strength at the required thickness will allow the surface temperature to be elevated sufficiently to reach its "kindling point" in the presence of the heat available in each particular installation, since the desired thermal insulation membrane will then be formed when subjected to proper heat conditions and proper gases, as in the operation of the engine.

Such membrane consists essentially of iron oxides and carbides of iron in the form of a lacey membrane, which in general, is of the order of thickness of less than 1/1000th of an inch. Such layer derived from the exposure of the surface to gases under proper heat conditions contains a proportion of oxides and carbides largely in excess of what might be present in the body of the steel itself. It is not to be confused with a deposit of carbon or other foreign material, such as is sometimes formed in a combustion chamber on exposed surfaces during the operation of an internal combustion engine.

A magnified cross section of the surface layer 17 (Fig. 2) exhibits a wavy contour 18, probably due to creepage or slip bands or perhaps marks formed in the machining of the piston head end wall 16. Under the microscope, the layer 17 shows a concentration of spongy iron oxides 19 in the crests of the surface layer and an excess of iron carbide 20 in the troughs of the layer. Said layer 17 assumes the form of a lacey membrane, which tends to have its greatest thickness at those points where the piston head is thinnest. The formation of the oxides and carbides of iron is believed to be due to the metal of the head being brought above the kindling temperature of the particular steel used, the affinity of oxygen to unite with that steel at that particular temperature and subsequent contact with the gases of supply and combustion of which free carbon is probably present in some of the gases in a very active state.

As shown in the drawing, the exposed surfaces of the steel cylinder head 12, as at 21, are also provided with a surface insulation layer of similar analysis and formation to that described. This layer, however, is not formed during the operation of the engine, since the temperature of the walls of the cylinder head due to the circulation of a cooling medium does not go above the kindling temperature of the metal at the exposed surface thereof. The layer 21 may, however, be formed by exposing the surface in properly heated condition, to the alternating effect of an oxidizing and reducing flame, such as may be produced by a welding torch.

The surface layers 17 and 21 may also be produced in an atmosphere controlled furnace by alternate application of oxidizing gases and carbonaceous gases upon a properly heated and selected steel.

Such insulation membrane functions as an intercepting barrier of low heat conductivity, retarding the rapid absorption of heat by the remainder of the underlying mass when exposed to combustion and subjected to heat applied intermittently, as in the operation of an internal combustion engine. Actual tests have shown that the power output is increased and the fuel

consumption of a given internal combustion engine is decreased when a piston having a piston head provided with a surface thermal insulation layer, such as described, is used.

One important effect of the thermal insulation layer described is to maintain a more uniform heat of lesser degree throughout that section exposed to combustion and keep the oil in the engine much cooler, thus increasing the useful life of the oil as well as that of the bearings. Such cooler running temperature of the head exposed to combustion also reduces detonation and loss of oil by vaporization and escape from the engine.

I am aware that many changes may be made and numerous details of construction may be varied through a wide range without departing from the principles of this invention, and I, therefore, do not purpose limiting the patent granted hereon otherwise than necessitated by the prior art.

I claim as my invention:

1. A piston for use in an internal combustion engine, said piston having that portion which is exposed to the gases of combustion formed of steel having a thermal insulating layer on its exposed surface consisting largely of a lacy membrane of oxides and carbides of iron, the thickness and kindling point of the steel being such that under the temperature and alternate oxidizing and carburizing conditions obtaining in the operation of an engine containing such piston said membrane of oxides and carbides of iron will persist by re-formation during continued engine operation.

2. A piston for use in an internal combustion engine, said piston having that portion which is exposed to combustion formed of steel of S. A. E. #X—1112 specification having a thermal insulating layer on its exposed surface consisting largely of a lacy membrane of oxides and carbides of iron, the thickness of the steel being such that under the temperature and alternate oxidizing and carburizing conditions obtaining in the operation of an engine containing such piston said membrane of oxides and carbides of iron will persist by re-formation during continued engine operation.

3. A piston for use in an internal combustion engine, said piston having a head end wall of a steel of not over 2% carbon content and free from graphitic carbon, said wall being of a thickness of about 0.12 inch for a diameter of three and one-fourth inches and correspondingly thicker for larger diameters, the surface of said wall exposed to combustion having an insulating film thereon of oxides and carbides of iron formed from the iron of said steel, the kindling point of said steel being such that under the alternate oxidizing and carburizing conditions obtaining in the operation of an engine using such piston said insulating film will persist by re-formation.

GEORGE H. BLETTNER.