

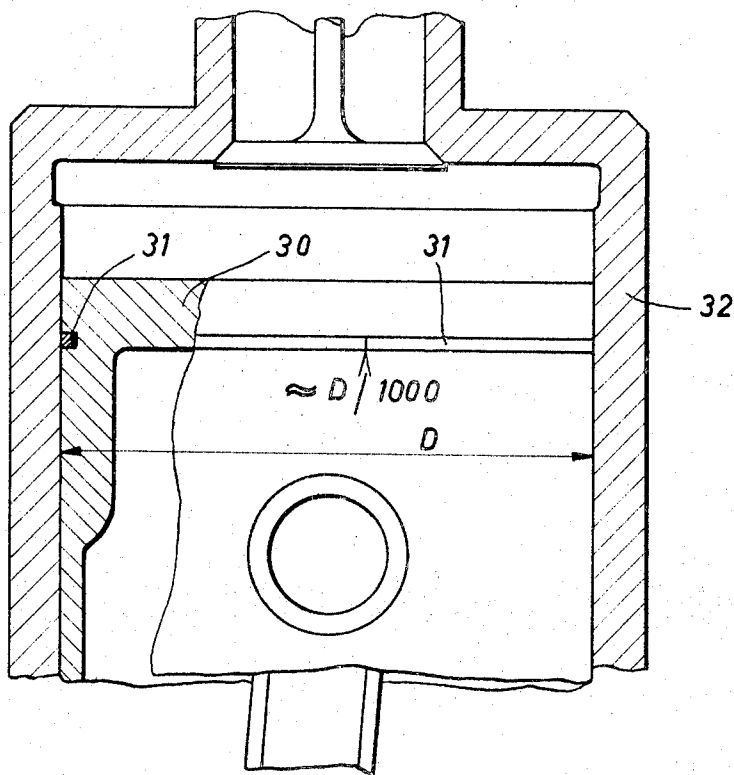
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PISTON RING FOR INTERNAL COMBUSTION ENGINES

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PISTON RING FOR INTERNAL COMBUSTION ENGINES

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P 26,853; Jan. 5, 1962, P 28,536
8 Claims. (Cl. 92-169)

ABSTRACT OF THE DISCLOSURE

A piston ring, for use between a piston and a cylinder, being composed entirely of at least one material selected from the group consisting of the metals molybdenum, tantalum and tungsten and alloys thereof containing at least 60% by weight of the respective metal.

The present application is a continuation-in-part of my copending application Ser. No. 181,556, filed Mar. 22, 1962, entitled: "Internal Combustion Engine" and now abandoned.

The invention is concerned with an internal combustion engine comprising a casing and one or several pistons each provided with at least one sealing member which frictionally engages a slideway situated on the interior of said casing.

One of the principal objects of the invention is to improve the sealing between piston and slideway.

It is another object of the invention to reduce the wear of said slideway.

It is a further object of the invention to provide improved sealing members so that the useful life of said engines is considerably extended.

The invention is especially important for internal combustion engines comprising a rotary piston with sealing strips. Hitherto, the useful life of said internal combustion engines with rotary pistons was practically limited to some 100 hours owing to the wear, especially owing to chatter marks appearing on the slideway on which the sealing strips slide. These chatter marks appear mainly in the neighborhood of the spark plug.

According to preferred embodiments, it is yet another object of the invention to overcome the aforesaid disadvantages by covering the slideway with especially selected materials.

Other objects and advantages of the present invention will become apparent from a further reading of the description and of the appended claims.

With the above and other objects in view, the present invention comprises in an internal combustion engine, in combination, a casing having an inner surface consisting of cast iron, steel or ceramic material, a piston movable therein, and at least one piston ring carried by the piston and slidably engaging the inner surface of the casing, the ring consisting entirely of at least one material selected from the group consisting of the metals molybdenum, tantalum and tungsten and alloys thereof containing at least 60% by weight of the metal, the piston ring, due to its composition, having a modulus of elasticity substantially higher than steel, a temperature of fusion higher than chromium and greater hardness, higher thermal conductivity and a coefficient of thermal expansion substantially smaller than steel, thus permitting construction of the piston ring with reduced radial thickness and consequent reduction in the required wall thickness of the piston, as well as enabling more rapid dissipation of friction-generated heat harmful to the engine, and construction of the piston ring to very close cold state tolerances without fear of binding upon heating-up

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of the engine, thus increasing the sealing efficiency of the ring.

The wear is remarkably reduced by making the sealing members of a high melting-point metal or substance of lower thermal expansion and better thermal conductivity than chromium, such as molybdenum, tungsten, tantalum or alloys thereof containing at least 60% of at least one of the elements molybdenum, tungsten and tantalum.

The wear which is due essentially to the so-called temperature flash resulting from friction and which tends to cause melting of the projecting molecular peaks of the surfaces, is appreciably reduced in this manner. The melting points of the materials mentioned are much higher than those of steel or chromium.

In addition, for metals such as tungsten and molybdenum, the thermal conductivity is about twice as high as for steel, which again reduces the wear produced by the temperature flash for a given dissipation of energy between the rubbing surfaces.

The wear may be still further reduced by coating at least the critical portions of the slideways upon which sealing elements slide on the cylinder walls with a layer of a substance having a temperature of fusion higher than that of chromium and having a thermal conductivity greater and/or a coefficient of thermal expansion smaller than those of iron. Substances suitable for this purpose are molybdenum, tungsten-tantalate, molybdenum silicide, aluminum oxide, or other appropriate hard materials formed for example of carbides, borides or nitrides, either pure or mixed with binding agents.

According to one embodiment of the invention the sealing element for a combustion engine with rotary piston is formed as a thin cylinder of tungsten or similar hard material. Such a cylinder performs sliding and rolling movements. The heat is therefore uniformly distributed and the rectilinear form is thus better maintained in all operating conditions of the engine. The sealing effect is thus greatly assisted. The rolling action considerably reduces the heat of friction and thus the wear on the sealing member. The production of so-called chatter marks is thus substantially reduced if not definitely prevented. The sealing elements may thus be formed in a simple manner from round wire, preferably of tungsten or molybdenum.

The slideway can easily be improved by coating it by the well-known metal spraying process, using molybdenum wire in a spray pistol.

Molybdenum oxides form vapors already at some 600° Celsius (equal to 1112° F.) so that the molten drops of molybdenum impinge in a completely clean form upon the slideway and form a very firmly adhesive, melted-on layer on the internal surface of the iron casing.

According to another modification of the manufacturing process, materials with very high melting-points are melted by means of plasma-arc flames on to components of normally used materials, such as steel or cast iron so that a smooth surface is formed.

According to a further modification of the manufacturing process the thin layers of the very high melting-point metals, such as tungsten and molybdenum, are deposited by surface exchange reactions or by thermal decomposition from the vapor phase, using especially the halides of the appropriate metals.

The surface of the slideway may consist of a hard compound having a high melting point, with sealing elements of a high melting-point hard metal of lower coefficient of thermal expansion and higher thermal conductivity than steel sliding or rolling thereon. There may likewise be recommended a combination of a slideway surface of a high melting-point metal as set out above and a sealing

element of a hard material formed of chemically saturated compounds of high binding energy, such as microcrystalline aluminum oxide.

Owing to its high specific gravity, the use of tungsten for the sealing member would produce a higher centrifugal thrust on the slideway. This improves the operation of rotary piston engines at low speeds of rotation.

On the other hand the effect of the increased specific gravity may be offset by the use of sealing elements in the form of tubes, in order to reduce the proportion of the wear due to inertial forces at very high speeds of rotation. An accurately ground sealing element of sintered alumina or other suitable ceramic material would be particularly suitable for this purpose. Rods or tubes of sintered alumina are relatively simple to make by normal ceramic processes.

Small tubes have the advantage that the sealing element may be withdrawn from and replaced in the engine without stripping of the same. After the removal of a screw plug having an inner end ground flush with the internal side wall of the engine casing or cylinder the sealing members may be withdrawn by the use of a taper pin or a wire and readily replaced.

With two such access openings in the opposite side-walls of the encompassing engine casing, the sealing elements and any associated grooved packing pieces can be replaced by pushing them through from one side to the other.

In a preferred embodiment of the invention the sealing members of conventional internal combustion engines with oscillating pistons include piston rings made of molybdenum, tantalum or tungsten, but preferably of molybdenum. This applies both to pressure-seal and to oil-seal or scraper rings. These metals are particularly suitable for this purpose, since they possess a very much smaller coefficient of thermal expansion than cast iron and a very much higher modulus of elasticity. The resilience of such rings is thus sufficiently high for the radial thickness to be reduced as compared with that of normal cast iron rings while maintaining a satisfactory seal. The resistance to wear of these metals is very good owing to the hardening produced by forming them into profiled wires; the hard chromium plating, often employed when the rings are made of cast iron or spring steel, may thus be dispensed with. The substantially higher thermal conductivity of tungsten is particularly advantageous in this application, as it assists in the transfer of heat from the piston to the cylinder wall. Finally, such piston rings have the special advantage of providing an intrinsically better seal, because its thermal expansion is about one-third of that of cast iron or steel rings. The piston rings can therefore be made so as to form an almost perfect seal when cold, without the fear of their seizing when hot. Satisfactory sealing may thus be obtained with only a single ring. Despite the higher cost of the material, substantial advantages in operating economy are produced by the reduction in indirect frictional losses due to ring friction and inertial effects which largely counterbalance the higher cost due to the expensive material. Such rings may be made of very stable materials and because of the wire profile also much cheaper and also more easily. The cost of the material is then acceptable especially in applications where efficiency is important.

The molybdenum or tungsten may also be replaced by tantalum. Generally, molybdenum is preferred, since tungsten is about twice as heavy, and tantalum about four times as expensive. Alloys of these three elements may also be used as the material of the piston ring, provided that such alloys have the desired characteristics. This generally requires a content of more than 60% of either molybdenum or tungsten or tantalum, or mixtures thereof in the alloy.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as

to its construction and its method of operation together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing, in which the figure is a fragmentary, schematic, cross-sectional view showing portions of a cylinder, piston and sealing element of an internal combustion engine.

Referring now to the drawing, the head of the piston of a reciprocating internal combustion engine according to the invention is shown in its cylinder. The left-hand side of the drawing shows a section through both piston and cylinder, the right-hand side shows the cylinder only in section. The piston 30 carries in a suitable groove a piston ring 31 which is so dimensioned as to spring out against the wall of the cylinder 32.

The cylinder 32 may consist of ferrous material, such as cast iron or steel, or cylinder 32 may include an inner surface layer consisting of ceramic material such as hard-fired aluminum oxide (not shown), supported by an outer sheet of, for instance, cast iron.

Piston ring 31, in accordance with the present invention, will consist in its entirety of either molybdenum, tungsten or tantalum, or mixtures thereof, or of alloys which consist to more than 60% by weight of one or more of the above-mentioned three elements.

The figure shows the head of the piston of an internal combustion engine according to the invention, in its cylinder. The left-hand side of the drawing shows a section through both piston and cylinder, the right-hand side shows the cylinder only in section. The piston 30 carries in a suitable groove a piston ring 31 of tungsten, which is so dimensioned as to spring out against the wall of the cylinder 32. The gap between the two adjacent ends of the piston ring 31 is about equal to one thousandth of the diameter of said piston. Thus a proper seal is guaranteed within the whole range between -60° Celsius and $+260^{\circ}$ Celsius and a clamping of the piston ring within said temperature range is avoided.

The piston ring can consist entirely of molybdenum, tungsten or tantalum, but might consist also of an alloy composed either nearly of the above-named materials or at least 60% by weight of said materials. Below a table of alloys for piston rings according to the invention:

	Percent				
Molybdenum.....	90	70	70	70	70
Tungsten.....	10	30			
Tantalum.....					10
Iron.....			20	20	20
Nickel.....			10		
Titanium.....				10	
	100	100	100	100	100

Experiments have shown that piston rings made of an alloy consisting of 90% molybdenum and 10% tungsten have a good performance and therefore should be generally preferred.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an internal combustion engine, an arrangement comprising, in combination, a casing having an inner surface; a piston movable therein; and at least one piston ring carried by said piston and slidably engaging said inner surface of said casing, said piston ring consisting of a strip having two opposite adjacent ends forming a narrow gap extending in axial direction of said ring, said ring consisting entirely of at least one material selected from the group consisting of the metals molybdenum, tantalum, and tungsten and alloys thereof containing at least 60% by weight of said metal, said piston ring, due to its composition, having a coefficient of thermal expansion substantially smaller than steel, thus permitting construction of said piston ring with a very narrow gap while eliminating excessive circumferential expansion resulting in closing of said gap and in consequent radial expansion of said ring leading to binding upon heating-up of said

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engine, thus increasing the sealing efficiency of said ring.

2. An arrangement as defined in claim 1, wherein said piston ring consists entirely of molybdenum, tantalum or tungsten.

3. An arrangement as defined in claim 1, wherein the inner surface of said casing consists of cast iron or steel.

4. An arrangement as defined in claim 3, wherein said piston ring consists entirely of molybdenum, tantalum or tungsten.

5. An arrangement as defined in claim 1, wherein said piston ring consists essentially of molybdenum.

6. An arrangement as defined in claim 1, wherein the gap between the adjacent ends of said strip is about one thousandth of the diameter of said piston.

7. In an internal combustion engine, in combination, a casing having an inner surface; a piston movable therein; and at least one piston ring carried by said casing and consisting of a ring-shaped strip having two opposite ends defining between themselves a narrow gap extending in axial direction of said piston ring, said strip being composed entirely of at least one material selected from the group consisting of the metals molybdenum, tantalum and tungsten and alloys thereof containing at least 60% by weight of the respective metal, and said piston ring due to its composition having a coefficient of thermal expansion so small that heating of the engine and consequent circumferential thermal expansion of said strip will not result in closing of said narrow gap and subsequent radial buckling of said piston ring, so that binding of said piston ring is avoided.

8. In an internal combustion engine, in combination, casing means having an inner surface; piston means movable in said casing means and having an outer surface

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juxtaposed with said inner surface; and at least one piston ring carried by one of said means and consisting of a ring-shaped strip having two opposite ends defining between themselves a narrow gap extending in axial direction of said piston ring, said strip being composed entirely of at least one material selected from the group consisting of the metals molybdenum, tantalum and tungsten and alloys thereof containing at least 60% by weight of the respective metal, and said piston ring due to its composition having a coefficient of thermal expansion so small that heating of the engine and consequent circumferential thermal expansion of said strip will not result in closing of said narrow gap and subsequent radial buckling of said piston ring so that binding of said piston ring is avoided.

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