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PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2018/046104	09.08.2018	09.08.2017

International Patent Classification (IPC) or both national classification and IPC
INV. F16J9/26 F16J1/08 F02F3/00 F02F5/00

Applicant
ETAGEN, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Fax: +31 70 340 - 3016	see form PCT/ISA/210	Regaud, Christian Telephone No. +31 70 340-0

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2018/046104

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1-30
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-30
Industrial applicability (IA)	Yes:	Claims	1-30
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

1. Reference is made to the following documents:

D1 JP H02 78752 A (RIKEN KK) 19 March 1990 (1990-03-19)

D2 US 5 598 763 A (RAO V DURGA N [US] ET AL) 4 February 1997 (1997-02-04)

2. The present application does not meet the criteria of Article 33(2) PCT, because the subject-matter of claim 1 is not new.

D1 discloses (references signs in parentheses refer to D1, figure 1):

A sealing ringset (3; 3') configured to seal against a bore of a cylinder (4) without liquid lubricant, the sealing ringset comprising:
- at least one sealing ring (3) comprising metal (paragraph 1, "aluminum") configured to be arranged on a piston (1) to seal against the bore; and
- an applicator (5) comprising a solid lubricant (see D1, claim 1, "solid lubricant") configured to be arranged on the piston and to provide lubrication between the at least one sealing ring and the bore.

The features of claim 1 are also known from D2 (see D2, figure 3).

3. Dependent claims 2-10 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (see D1, figure 1; see D2, figure 3).

- claims 2-5 : see D1, figure 1; see D2, figure 3.

- claim 6 : see D1, claim 1 : "lubricant"; see D2, , claims 1, 8 : "lubricant".

- claim 7 : see D1, paragraph 1 : "anodic oxide coating"; see D2, claim 1 c).

- claim 8 : see D1, figure 1; see D2, figure 3.

- claims 9-10 : see D1, claim 1, figure 1; see D2, claims 1, 8, figure 3.

4. The present application does not meet the criteria of Article 33(2) PCT, because the subject-matter of claim 11 is not new.

D1 discloses (references signs in parentheses refer to D1, figure 1):

A piston (1) assembly comprising:
- a piston comprising at least one circumferential groove (2; 2'); and
- a sealing ringset (3; 3') comprising:
- at least one sealing ring (3) comprising metal (paragraph 1, "aluminum") configured to be arranged in the at least one circumferential groove and configured to seal against a bore without liquid lubricant, and
- an applicator (5) comprising a solid lubricant (see D1, claim 1, "solid lubricant") configured to be arranged in the at least one circumferential groove and configured to provide lubrication between the at least one sealing ring and the bore.

The features of claim 11 are also known from D2 (see D2, figure 3).

5. Dependent claims 12-20 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (see D1, figure 1; see D2, figure 3).

- claims 12-15 : see D1, figure 1; see D2, figure 3.

- claim 16 : see D1, claim 1 : "lubricant"; see D2, , claims 1, 8 : "lubricant".

- claim 17 : see D1, paragraph 1 : "anodic oxide coating"; see D2, claim 1 c).

- claim 18 : see D1, figure 1; see D2, figure 3.

- claims 19-20 : see D1, claim 1, figure 1; see D2, claims 1, 8, figure 3.

6. The present application does not meet the criteria of Article 33(2) PCT, because the subject-matter of claim 21 is not new.

D1 discloses (references signs in parentheses refer to D1):

A device (figure 1) comprising:
- a cylinder (4) comprising a bore;
- a piston (1) comprising at least one circumferential groove (2; 2') and configured to move axially within the bore; and
- a sealing ringset (3; 3') comprising:
- at least one sealing ring (3) comprising metal (paragraph 1, "aluminum") configured

to be arranged in the at least one circumferential groove and configured to seal against the bore without liquid lubricant, and
- an applicator (5) comprising a solid lubricant (see D1, claim 1, "solid lubricant") configured to be arranged in the at least one circumferential groove and configured to provide lubrication between the at least one sealing ring and the bore.

The features of claim 1 are also known from D2 (see D2, figure 3).

7. Dependent claims 22-30 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step (see D1, figure 1; see D2, figure 3).

- claims 22-25 : see D1, figure 1; see D2, figure 3.

- claim 26 : see D1, claim 1 : "lubricant"; see D2, , claims 1, 8 : "lubricant".

- claim 27 : see D1, paragraph 1 : "anodic oxide coating"; see D2, claim 1 c).

- claim 28 : see D1, figure 1; see D2, figure 3.

- claims 29-30 : see D1, claim 1, figure 1; see D2, claims 1, 8, figure 3.

Re Item VII

8. Independent claims are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art D1 being placed in the preamble (Rule 6.3(b)(i) PCT) and the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

9. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

10. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in D1-D2 are not mentioned in the description, nor are these documents identified therein.

Re Item VIII

11. Although claims 1, 11, 21 have been drafted as separate independent claims, claim 21 appears to contain all features of claim 11, and claim 11 appears to contain all features of claim 1. Therefore the aforementioned claims lack conciseness and as such do not meet the requirements of Article 6 PCT. Thus claims 1 and 11 should be deleted.

12. Annex : Automatic English translation of D1

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Machine Translated by EPO

Title : Aluminium alloy piston for internal combustion engine - has double structure layer comprising hard anodised aluminium layer coated with heat resistant resin coating layer.

Abstract : A double structure layer consists of a hard anodised aluminium layer and a heat resistant resin coating layer formed on the anodised aluminium layer. The double structure is set on ring grooves on a piston. The heat resistant resin coating layer is formed by spraying or applying a solid lubricant particle-contg. a thermosetting organic resin, ethylene tetrafluoride lubricating heat resistant organic resin, or heat resistant coating material resin on the layer. The layer is then burned.
The **solid lubricant** particle-contg. thermosetting organic resin pref. comprises molybdenum disulphide, graphite or boron nitride particle-contg. polyimide polyimide amide, or polyether imi imide resin. The ethylene tetrafluoride lubricating heat resistant organic resin comprises polytetrafluoroethylene, or a tetrafluoroethylene-exafluoropropylene copolymer resin. The heat resistant coating material resin comprises polycarbonate, polyether, or ether ketone resin.

USE/ADVANTAGE :
The aluminium alloy piston is used for internal combustion engines. Formation of the double structure layer prevents aluminium coagulation from the piston ring grooves to the piston ring. The use of the aluminium alloy piston prevents a decrease in internal combustion engine horse power caused by blow by.

[0001] BACKGROUND OF THE INVENTION 1. Field of the Invention The present invention relates to an aluminum alloy piston used in an internal combustion engine, and more particularly to an aluminum alloy piston for an internal combustion engine which prevents adhesion of an aluminum alloy from the surface of a ring groove of a piston to the surface of a piston ring . [Conventional Technology and Problems to be Solved by the Invention] Internal combustion engines of automobiles and the like tend to increase in output and high-speed rotation in recent years, so that the thermal load of the internal combustion engine increases and the oil temperature also rises . When an aluminum alloy piston is operated under such severe conditions, a phenomenon occurs in which the aluminum alloy adheres to the piston ring surface from the surface of the ring groove of the piston.This adhesion phenomenon causes local wear of the ring groove of the piston, seizure and breakage of the piston ring, which causes engine troubles such as reduction of horsepower of the internal combustion engine due to increase of blowpip. Then, a heat resisting and wear resistant layer is formed by applying molybdenum disulfide-thermosetting organic resin to the surface of the piston ring and then baking it, thereby preventing the adhesion phenomenon of the aluminum alloy, which causes engine trouble (Japanese Patent Laid-Open No. 60-8255 '2). Such piston rings having a fired film of molybdenum disulfide-thermosetting organic resin have certain results in eliminating engine troubles, but under severe usage conditions such as high thermal load and high temperature of oil, It was still insufficient in view of wear resistance and life span.In addition, in order to improve the wear resistance, it is partly performed to form a high hardness aluminum oxide film on the surface of the ring groove of the piston by a hard alumite treatment, but the aluminum oxide film has a surface roughness of When such a piston is used for an internal combustion engine of an automobile or the like, there is a problem such as an increase in initial oil consumption and an output reduction of the internal combustion engine due to an increase in blowpies, and thus it is widely adopted Not. SUMMARY OF THE INVENTION It is therefore an object of the present invention to provide an aluminum alloy piston for an internal combustion engine which can prevent adhesion of an aluminum alloy from the surface of a piston ring groove to the piston ring surface.Means for Solving the Problems As a result of intensive research in view of the above object, the present inventors have found that a hard alumite layer is

formed on the surface of a ring groove of an aluminum alloy piston for an internal combustion engine, and a heat-resistant resin coating It is possible to prevent adhesion of the aluminum alloy from the surface of the ring groove of the piston to the surface of the piston ring and conceived the present invention. That is, the piston made of an aluminum alloy for an internal combustion engine according to the present invention is characterized in that a hard alumite layer as a first layer and a heat-resistant resin coating layer as a second layer are formed in order on the surface of a piston outer circumferential gully groove . EXAMPLES The present invention will be described in detail with reference to the drawings in the following examples.FIG. 1 is a sectional view showing in detail the vicinity of a ring groove of an aluminum alloy piston for an internal combustion engine of the present invention. The aluminum alloy piston 1 has a plurality of ring grooves 2.2 'on the outer peripheral surface, and the piston ring 3.3' is accommodated in each ring groove 2.2 '. Each piston ring 3.3 'is in sliding contact with the inner wall of the cylinder 4. In the present embodiment, the hard alumite layer 5 (first layer) and the heat-resistant resin coating layer 6 (second layer) are formed as a two-layer structure on the surface of the piston 1 including the surface of the ring groove 2.2 ' There. The hard alumite layer 5 and the heat-resistant resin coating layer 6 are formed by the following steps. As a first step, a hard alumite layer 5 (first layer) is formed on the surface of the base material 11 of the piston by anodized alumite treatment.The anodized alumite treatment is carried out by direct electrolysis using a sulfuric acid-oxalic acid hard alumite treatment bath using the base material 11 of the piston as an anode and a lead plate or the like as a cathode. As the treatment bath, those commonly used for anodized alumite treatment can be appropriately used. In order to uniformly form the hard alumite layer 5 which is the anodic oxide coating, the anodized alumite treatment is carried out under low temperature conditions by cooling the treatment bath to around 0 ° C. to sufficiently cool the workpiece. The hard alumite layer 5 obtained in this manner is harder (HMV 400 to 500) and has a higher shear strength than the aluminum alloy of the base material. The hard alumite layer 5 preferably has a thickness of 10 to 20 μm. If the thickness is less than 10 μm, the durability is insufficient, and if it exceeds 20 μm, the surface roughness and cracks become large, and it is too thick and economical.

However, since the base material 11 of the piston is an aluminum alloy, the surface of the ring groove 2.2 'has no uniform composition. Therefore, during the anodic oxidation reaction, a part of the aluminum alloy base material elutes from the surface of the ring groove 2.2 ', or a part of the composition which is difficult to form an oxide film like eutectic Si protrudes . As a result, the surface roughness of the hard alumite layer 5 increases, making it difficult to form a smooth surface, and cracks are likely to occur in the hard alumite layer 5. Therefore, when a piston having only the hard

alumite layer 5 formed thereon is used for an internal combustion engine of an automobile or the like, problems such as an increase in the initial oil waste amount and a decrease in output of the engine due to the blowpip are caused.In order to compensate for the defect of the hard alumite layer 5, as a second step, a heat resistant resin coating layer 6 (second layer) having a further excellent lubricating effect and a large covering power is formed on the hard alfito layer 5. In order to form the heat-resistant resin coating layer 6 having the above characteristics, a thermosetting organic resin containing solid lubricant particles as a coaching material, a heat-resistant tetrafluoroethylene-based heat-resistant organic resin or a heat-resistant coating resin It is preferable to form a coating fired film.As the thermosetting organic resin containing the solid lubricant particles, a resin such as polyimide containing particles such as molybdenum disulfide, graphite or boron nitride, polyimide amide, polyether imide, etc., a resin such as the tetrafluoroethylene lubricating heat resistant organic resin Resins such as polytetrafluoroethylene, polychlorotrifluoroethylene and tetrafluoroethylene-exluoroblobulene copolymer, and resins such as polycarbonate, polyether, and ether ketone as the heat resistant coating resin. The second step is carried out as follows. First, the piston on which the hard anodized layer 5 is formed is preheated to 150 to 200 ° C. in the atmosphere to enlarge the surface irregularities and cracks of the hard alumite layer 5.Thereafter, a solution of the resin coating material dissolved in a solvent such as toluene, xylene, N-methyl-2-pyrrolidone or the like is applied or sprayed and air dried to form the heat-resistant resin coating material on the hard alumite layer 5 Make it deep into cracks and irregularities. Thereafter, by baking and curing at 200 to 220 ° C., the heat-resistant resin coating layer 6 can be strongly adhered to the hard alumite layer 5 to form the heat-resistant resin coating layer 6. Since the heat-resistant resin coating layer 6 fills the irregularities and cracks of the hard alumite layer 5 to smooth the surface, it is possible to solve problems such as an increase in initial oil consumption and a decrease in output of the internal combustion engine due to a blowpie.The thickness of such a heat-resistant resin coating, -G is preferably 3 to 15 μm, which is less than 3 μm, has almost no effect of forming the heat-resistant resin coating layer 8, and when it exceeds 15 μm, the adhesion of the coating layer decreases . More preferably 5 to 20 μm. In the above description, the example in which the coating film is formed also on the surface of the piston 1 has been explained, but the object of the present invention is to accomplish if the coating of the double structure is present on the surface of the ring groove 2.2 ' You can do. [Action] In the coating of the double structure of the present invention, the hard alumite layer of the lower layer (first layer) is hard and has high shear strength, and its irregularities and cracks are caused by heat resistant resin coating of the upper layer (second layer) It is sealed by a layer.Therefore, the defect of the hard anodized layer is completely eliminated, and

the ring grooves with no aluminum adhesion phenomenon are formed. The present invention will be described in more detail by the following examples. Example 1 As a first step, a piston made of an aluminum alloy (ACgA material) having a ring groove on the outer periphery was used and a sulfuric acid-oxalic acid anodizing bath having 20% by weight of sulfuric acid and 20 g / i of oxalic acid cooled to around 0 ° C. , Immersing the piston, using this as an anode and a lead plate as a cathode, current density 3A / cII! , Anodic oxidation was performed by flowing a direct current of 30 V for 30 minutes. The hard alfito layer formed on the surface of the ring groove of the piston had a thickness of 10 μm 1 hardness (IMV) of 450 and a surface roughness of 8 μm.Next, as a second step, the piston on which the hard alumite layer formed in the first step was formed was preheated in air at 180 ° C. for 30 minutes, and then a thermosetting organic resin containing molybdenum disulfide particles (Molykote A solution consisting of 30% by weight of mouth 5-7409, manufactured by Dow Corning @ Ltd.) and N-methyl-2-pyrrolidone as a solvent was sprayed with a spray gun, air-dried for 30 minutes, and sintered at 200 ° C. for 1 hour. The thickness of the obtained heat-resistant resin coating layer was 8 μm, and the surface of the film was smooth. By the first step and the second step, a smooth surface layer having a double structure was formed on the surface of the ring groove of the piston.

The piston thus obtained was assembled in a water-cooled 4-cycle, 4-cylinder (1600 cc) engine and subjected to a 10 hour and 100 hour durability test under operating conditions of 560 Orpm revolution and 4/4 load, and after 10 hours and The presence or absence of adhesion of aluminum alloy from the surface of the piston ring groove to the piston ring surface after 100 hours was investigated. The results are shown in Table 1. As shown in Table 1, adhesion of aluminum alloy from the surface of the ring groove to the piston ring surface was not observed after 10 hours and 100 hours. The oil consumption was also measured, and as shown in FIG. 2, the oil consumption during the 100 hour test was stably low. Comparative Example 1 The same test as in Example 1 was carried out using the piston obtained in the same manner except that the second step was not performed using the example. The results are shown in Table 1 and FIG.As is apparent from Table 1 and Table 2, the piston of the present invention prevents agglomeration of the aluminum alloy from the surface of the ring groove to the surface of the piston ring, the oil consumption is also stably low . As described above in detail, since the piston of the present invention has a layer having a double structure composed of a hard alumite layer and a heat-resistant resin coating layer on the surface of the ring groove, It is possible to prevent agglomeration of the aluminum alloy from the surface of the ring groove to the piston ring surface. Therefore, by incorporating the piston of the present invention in an internal

combustion engine of an automobile or the like, it is possible to prevent engine troubles such as reduction in horsepower of the internal combustion engine due to an increase in blowby-by.

[0002] Brief Description of the Drawings

[0003] FIG. 1 is a sectional view showing the vicinity of the ring groove of the piston of the present invention in detail, and FIG. 2 is a graph showing the relationship between the test time and the oil consumption in the tests of Example 1 and Comparative Example 1 . ■ Aluminum alloy piston 2.2 '· Ring groove 3.3' · Piston ring 4 · · · Cylinder 5 · · · hard alumite layer (first layer) 6 ... heat resistant resin coating Layer (Second Layer) Applicant Shareholder Company Riken Agent Representative Takahashi Bridge Ma 1 Figure 1 No.2, Figure 2, Eyelid B Correction Threshold Procedure Amendment (Ship Okayama Showa era, 1984 October 12 Yoshihiro Takeshi, Director General of the Patent Office November 1, 1999 Showing the Case of Showa 63 1988 2 Invention Name of the invention Aluminum alloy piston for internal combustion engines Relationship with the case Correcting applicant .Name, Name Riken 4 Agent's Address Address Iidabashi 1-chome Chiyoda-ku, Chiyoda-ku, Tokyo No. 8, No. 10 No. 5 of the amendment order 3th page 2nd line "JSR J" .

[Claims]

1. A piston made of an aluminum alloy for an internal combustion engine, characterized in that it has a layer of a double structure comprising a hard alumite layer and a heat-resistant resin coating layer formed on the hard alumite layer . (2) The piston made of aluminum alloy for an internal combustion engine according to claim 1, wherein the heat-resistant resin coating layer is composed of a thermosetting organic resin containing solid lubricant particles, a tetrafluoroethylene lubricating heat-resistant organic resin or a heat- The piston made of an aluminum alloy for an internal combustion engine, characterized in that it is formed by spraying or applying a resin and then firing.