



(12) **EUROPEAN PATENT APPLICATION**

(88) Date of publication A3:
25.05.2022 Bulletin 2022/21

(51) International Patent Classification (IPC):
C25D 11/02 (2006.01) **C25D 11/30** (2006.01)
C25D 11/04 (2006.01)

(43) Date of publication A2:
06.04.2022 Bulletin 2022/14

(52) Cooperative Patent Classification (CPC):
C25D 11/024; C25D 11/04; C25D 11/30

(21) Application number: **21200000.4**

(22) Date of filing: **29.09.2021**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **MASUHARA, Shinya**
Hamamatsu-shi, 432-8611 (JP)
• **KAWANAKA, Shimpei**
Hamamatsu-shi, 432-8611 (JP)
• **FUJITA, Masahiro**
Hamamatsu-shi, 432-8611 (JP)

(30) Priority: **02.10.2020 JP 2020167803**

(74) Representative: **Henkel & Partner mbB**
Patentanwaltskanzlei, Rechtsanwaltskanzlei
Maximiliansplatz 21
80333 München (DE)

(71) Applicant: **Suzuki Motor Corporation**
Shizuoka 432-8611 (JP)

(54) **METHOD FOR PRODUCING LAYERED FILM STRUCTURE AND PISTON FOR INTERNAL COMBUSTION ENGINE**

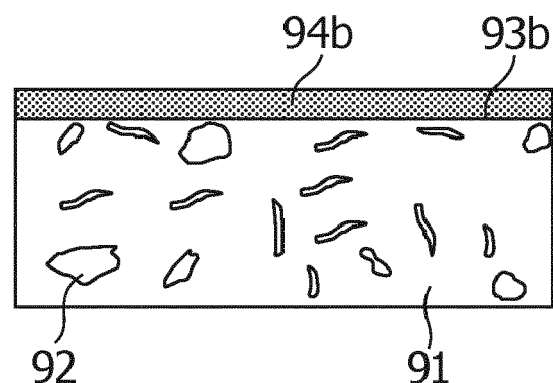
(57) [Problem to be Solved]

To provide a method for producing a layered film structure wherein a smooth anodized film or chemical conversion film is formed on a surface of an alloy member without being affected by a precipitated phase contained in the alloy member, and a piston for an internal combustion engine.

[Solution]

The production method of the present invention includes the steps of: forming a pure metal layer on a surface of an alloy member; and conducting an anodizing treatment or a chemical conversion treatment on the pure metal layer to obtain a layered film structure having the alloy member and a film formed on the surface thereof. The piston for an internal combustion engine of the present invention has this layered film structure, wherein an interface between the alloy member and the film is linear at a cross section of the layered film structure or a precipitated phase is present in the interface and the interface is linear at the cross-section of the layered film structure except a portion where the precipitated phase is present.

FIG.13B





EUROPEAN SEARCH REPORT

Application Number

EP 21 20 0000

5

10

15

20

25

30

35

40

45

50

55

3

EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2008 081839 A (AISAN IND) 10 April 2008 (2008-04-10) * abstract * * paragraphs [0006], [0022], [0025], [0039] *	1-5	INV. C25D11/02 C25D11/30 C25D11/04
X	----- CN 106 435 673 A (RIZHAO KINKONG PISTON CO LTD) 22 February 2017 (2017-02-22) * abstract * * embodiments *	1, 3, 5, 6	
X	----- JP 2007 231340 A (FUJIFILM CORP) 13 September 2007 (2007-09-13) * abstract * * examples 1-15 * * paragraph [0021] *	1, 2, 4, 5	
X	----- CH 576 006 A5 (SIEMENS AG) 31 May 1976 (1976-05-31) * examples 4-6 *	1-3, 5	
X	----- WO 2015/147164 A1 (SUZUKI MOTOR CORP [JP]) 1 October 2015 (2015-10-01) * abstract * * paragraph [0027] * * examples 1-3 *	6, 7	TECHNICAL FIELDS SEARCHED (IPC) C25D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 13 April 2022	Examiner Lange, Ronny
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	



Application Number

EP 21 20 0000

5

10

15

20

25

30

35

40

45

50

55

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



LACK OF UNITY OF INVENTION SHEET B

Application Number

EP 21 20 0000

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 2, 3(completely); 1(partially)

Inventive concept I regards a method for producing a layered film structure, comprising the steps of: forming a pure metal layer on a surface of an alloy member; and conducting an anodizing treatment on the pure metal layer to obtain a layered film structure comprising the alloy member and a film formed on a surface thereof, wherein the alloy member is an aluminum alloy or a magnesium alloy and/or wherein the anodizing treatment is conducted by direct current electrolysis, a flow of current is kept constant, and the anodizing treatment is terminated at the time when, or after, a voltage increase rate relative to a reaction time increases.

2. claims: 4, 5(completely); 1(partially)

Inventive concept II regards a method for producing a layered film structure, comprising the steps of: forming a pure metal layer on a surface of an alloy member; and conducting an anodizing treatment or a chemical conversion treatment on the pure metal layer to obtain a layered film structure comprising the alloy member and a film formed on a surface thereof, wherein the anodizing treatment is conducted by alternating current-direct current superimposition electrolysis, a voltage is kept constant, and the anodizing treatment is terminated at the time when, or after, a current decrease rate relative to a reaction time is greater or wherein the chemical conversion treatment is terminated at the time when, or after, a time to end the reaction with the pure metal layer by the chemical conversion treatment has passed.

3. claims: 6, 7

Inventive concept III regards a piston for an internal combustion engine comprising a layered film structure having an alloy member and a film formed on a surface thereof, wherein (a) an interface between the alloy member and the film in the layered film structure is linear at a cross section of the layered film structure or (b) a precipitated phase contained in the alloy member is present in the interface between the alloy member and the film in the layered film structure, and the interface is linear at the cross-section of the layered film structure except at a portion where the precipitated phase is present.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 20 0000

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

13-04-2022

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2008081839 A	10-04-2008	NONE	
CN 106435673 A	22-02-2017	NONE	
JP 2007231340 A	13-09-2007	CN 101074486 A	21-11-2007
		JP 4824430 B2	30-11-2011
		JP 2007231340 A	13-09-2007
		US 2008029399 A1	07-02-2008
CH 576006 A5	31-05-1976	AT 314927 B	25-04-1974
		BE 783082 A	01-09-1972
		CH 576006 A5	31-05-1976
		FR 2137582 A1	29-12-1972
		GB 1365009 A	29-08-1974
		IT 955228 B	29-09-1973
		JP S5632398 B1	27-07-1981
		LU 65300 A1	23-08-1972
		NL 7205056 A	09-11-1972
		SE 400317 B	20-03-1978
		ZA 722607 B	31-01-1973
WO 2015147164 A1	01-10-2015	JP 6418498 B2	07-11-2018
		JP 2015193915 A	05-11-2015
		US 2016138179 A1	19-05-2016
		WO 2015147164 A1	01-10-2015