



(11)

EP 3 950 985 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.02.2022 Bulletin 2022/06

(21) Application number: **19921526.0**

(22) Date of filing: **12.12.2019**

(51) International Patent Classification (IPC):
C22C 21/00 ^(2006.01) **C22F 1/04** ^(2006.01)
F04C 18/02 ^(2006.01) **C22F 1/00** ^(2006.01)

(52) Cooperative Patent Classification (CPC):
C22C 21/00; C22C 21/02; C22F 1/04; F04C 18/02;
C22F 1/00

(86) International application number:
PCT/JP2019/048674

(87) International publication number:
WO 2020/194906 (01.10.2020 Gazette 2020/40)

(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

(30) Priority: **27.03.2019 JP 2019060327**

(71) Applicant: **Showa Denko K.K.**
Tokyo 105-8518 (JP)

(72) Inventor: **KITAMURA, Keizo**
Kitakata-shi, Fukushima 966-0845 (JP)

(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

(54) **SCROLL MEMBER AND METHOD FOR PRODUCING SCROLL FORGED ARTICLE**

(57) Provided is a scroll member excellent in mechanical strength at a root portion of a blade where the largest load is applied, the scroll member being provided with an alumite film having sufficient hardness. An alumite film having a Vickers hardness of 400 or more is formed on a surface of a scroll forged article made of an aluminum alloy, the aluminum alloy containing: Si: 8.0

mass% to 12.0 mass%; Fe: 0.1 mass% to 0.5 mass%; Cu: 0.6 mass% to 1.1 mass%; Mg: 0.2 mass% to 0.8 mass%; and the balance being Al and inevitable impurities. A tensile strength of a bottom plate of the scroll forged article in a plane direction is 350 MPa or more and less than 400 MPa.

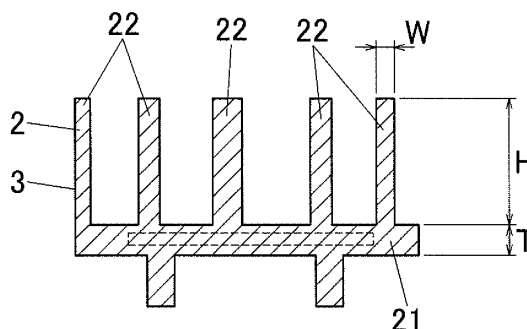


FIG. 2

Description**Technical Field**

[0001] The present invention relates to a scroll member for use in an air-conditioning compressor, etc., for an automobile, such as, e.g., an electric vehicle and a hybrid vehicle, and also relates to a method for producing a scroll forged article.

Background Art

[0002] In recent years, a compressor adopted as an automotive electric compressor for use in an automobile, such as, e.g., an electric vehicle and a hybrid vehicle, is mostly of a scroll-type. This scroll type is characterized in that it is high in efficiency and excellent in quietness. A scroll-type compressor is composed of, as shown in FIG. 3, a fixed scroll 50 and a swing scroll. The fixed scroll 50 is provided with a bottom plate (flange) 52 and a spiral blade portion 51 provided on the bottom plate. The swing scroll is provided with a spiral blade portion having the same shape as the spiral blade portion of the fixed scroll and a bottom plate. The spiral blade portion of the swing scroll is arranged to face the blade portion 51 of the fixed scroll in a substantially engaged manner and is configured to swing.

[0003] The swing scroll is made of an aluminum alloy for weight reduction. As the production method, there are production methods, such as, e.g., casting, die casting, and forging. However, a production method by forging is advantageous from the viewpoint of strength as a component, reliability, shaping into a complex spiral shape, and the like.

[0004] On the other hand, the swing scroll adopted in an automotive electric compressor is required to be superior in abrasion resistance. The abrasion resistance is secured by imparting hardness to the film by applying an alumite treatment or a plating treatment to the surface. In order to achieve the weight reduction by reducing the thickness, it is also required that the mechanical strength of the root portion of the blade that is the most burdensome (specifically, it is required to be superior in the tensile strength of the bottom plate of the scroll in the plane direction). That is, it is required to be excellent in both the surface processability and the mechanical strength.

[0005] In Patent Document 1, as a high strength abrasion resistance aluminum alloy extruded material, an extruded material having the following configuration is described. This extruded material contains Si: 6 to 12% (weight%, hereinafter "%" denotes weight%), Fe: 0.1 to 1.0%, Cu: 1.0 to 5.0%, Mn: 0.1 to 1.0%, Mg: 0.4 to 2.0%, Ti: 0.01 to 0.3%, and Sr: 0.005 to 0.2%. Nickel as an impurity is limited to be less than 0.05%. The balance is Al and impurities. The average particle diameter of the eutectic Si particles dispersed in the matrix is 1.5 to 5.0 μm . The eutectic Si particles of the average particle diameter are present at 5,000 pieces/ mm^2 or more and less than 10,000 pieces/ mm^2 .

[0006] Further, Patent Document 2 describes the following configuration. It contains Si: 5 to 12% (mass%, hereinafter "%" denotes mass%), Fe: 0.1 to 1%, Cu: less than 1%, Mg: 0.3 to 1.5%, and the balance being Al and impurities. The particle diameters of the eutectic Si particles dispersed in the matrix are present in the range of 0.4 to 5.5 μm . Among them, the particle diameters of the eutectic silicon particles account for 60% or more in the size of 0.8 to 2.4 μm . Further, the eutectic Si particles are present at 4,000 pieces/ mm^2 or more and less than 40,000 pieces/ mm^2 . The film hardness Hv after the alumite treatment is 400 or more.

Prior Art Document**Patent Document**

[0007]

Patent Document 1: Japanese Patent No. 3,261,056

Patent Document 2: Japanese Patent No. 4,511,156

SUMMARY OF THE INVENTION**Problems to be Solved by the Invention**

[0008] In Patent Document 1, the content rate of Cu or Mg is adjusted to improve the abrasion resistance and the strength of the aluminum alloy. However, the film hardness Hv after the alumite treatment is about 310 to 370, and therefore there was a problem that sufficient film hardness could not be obtained.

[0009] In Patent Document 2, the film hardness Hv after the alumite treatment is 400 or more. However, with respect to the mechanical strength, in the extruded material described in examples, the tensile test is performed in the same direction as the extrusion direction, and the assessment is made only in the direction favorable to the tensile test result.

However, as noted above, the mechanical strength of the root portion of the blade to which the load is most applied is the most important factor. In particular, it is essential that the tensile strength of the bottom plate of the scroll in the plane direction is excellent. In the case of an extruded material, the plane direction of the bottom plate of the scroll is a direction perpendicular to the extrusion direction. For this reason, in Patent Document 2, there is a possibility that it may not be

enough in terms of such mechanical properties.
[0010] The present invention has been made in view of such technical background. It is an object of the present invention to provide a scroll member which is excellent in mechanical strength of a root portion of a blade to which a load is most applied and is provided with an alumite film having a sufficient hardness, and also to provide a production method of a scroll forged article.

Means for Solving the Problem

[0011] In order to achieve the above-described objects, the present invention provides the following means.

[1] A scroll member in which an alumite film having a Vickers hardness of 400 or more is formed on a surface of a scroll forged article made of an aluminum alloy, the aluminum alloy containing: Si: 8.0 mass% to 12.0 mass%; Fe: 0.1 mass% to 0.5 mass%; Cu: 0.6 mass% to 1.1 mass%; Mg: 0.2 mass% to 0.8 mass%; and the balance being Al and inevitable impurities,

wherein a tensile strength of a bottom plate of the scroll forged article in a plane direction is 350 MPa or more and less than 400 MPa.

[2] The scroll member as recited in the above-described Item 1, wherein the aluminum alloy further contains one or more metals selected from the group consisting of: Ti: 0.01 mass% to 0.3 mass%; B: 0.0001 mass% to 0.05 mass%; and Sr: 0.001 mass% to 0.1 mass% at a content rate.

[3] The scroll member as recited in above-described Item 1 or 2, wherein the aluminum alloy further contains one or more metals selected from the group consisting of: Mn: 0.01 mass% to 0.3 mass%; Cr: 0.01 mass% to 0.3 mass%; Ni: 0.01 mass% to 0.3 mass%; Zr: 0.01 mass% to 0.3 mass%, and V: 0.01 mass% to 0.1 mass% at a content rate.

[4] A method of producing a scroll forged article, comprising: forging an aluminum alloy continuously cast material without performing extrusion to obtain a scroll forged article in which a tensile strength of a bottom plate in a plane direction is 350 MPa or more and less than 400 MPa, the aluminum alloy continuously cast material containing: Si: 8.0 mass% to 12.0 mass%; Fe: 0.1 mass% to 0.5 mass%; Cu: 0.6 mass% to 1.1 mass%; Mg: 0.2 mass% to 0.8 mass%; and the balance being Al and inevitable impurities.

Effects of the Invention

[0012] In the invention recited in the above-described Item [1], it is possible to provide a scroll member which is excellent in the mechanical strength of the root portion of the blade to which a load is most applied and has an alumite film sufficient in the hardness.

[0013] In the invention recited in the above-described Item [2], it is possible to miniaturize the metallic structure of the aluminum alloy to further improve the mechanical strength.

[0014] In the invention recited in the above-described Item [3], when Mn, Cr, or Zr is contained, it is possible to miniaturize the structure of the aluminum alloy to further improve the mechanical strength. Further, when Ni or V is contained, it is possible to improve the mechanical strength in a high-temperature region.

[0015] In the invention as recited in the above-described Item [4], the tensile strength of the bottom plate of the scroll forged article in the plane direction can be sufficiently ensured by performing forging processing or the like without performing extrusion processing. It also ensures the adequate strength of the root portion of the blade to which a load is most applied.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a plan view showing an example of a scroll member according to the present invention.

FIG. 2 is a cross-sectional view taken along the line A-A in FIG. 1 (the dotted line indicates the tensile test piece sampling position).

FIG. 3 is a perspective view showing an example of a fixed scroll.

EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0017] A scroll member 1 according to the present invention is a scroll member in which an alumite film 3 is formed on a surface of a scroll forged article 2 made of an aluminum alloy (see FIG. 2). The aluminum alloy consists of Si: 8.0 mass% to 12.0 mass%, Fe: 0.1 mass% to 0.5 mass%, Cu: 0.6 mass% to 1.1 mass%, Mg: 0.2 mass% to 0.8 mass%, and the balance being Al and inevitable impurities. The tensile strength of the bottom plate 21 of the scroll forged article 2 in the plane direction is 350 MPa or more and less than 400 MPa. With such a configuration, it is possible to provide a scroll member 1 which is excellent in the mechanical strength of the root portion of the blade portion 22 to which a load is most applied and is provided with a sufficiently hard alumite film 3 (see FIG. 1 and FIG. 2). Note that when the tensile strength in the plane direction becomes 400 MPa or more, there is a possibility that forging becomes difficult.

[0018] FIG. 1 and FIG. 2 show an embodiment of the scroll member 1 according to the present invention. The scroll member 1 is composed of a substantially disc-shaped bottom plate 21 and a spiral blade portion 22 upwardly provided thereon. This scroll member 1 is formed by a forging process.

[0019] Preferably, the aluminum alloy further contains one or more metals selected from the group consisting of Ti: 0.01 mass% to 0.3 mass%, B: 0.0001 mass% to 0.05 mass%, and Sr: 0.001 mass% to 0.1 mass% at a content rate.

[0020] In this case, the structure of the aluminum alloy can be miniaturized to further improve the mechanical strength.

[0021] Preferably, the aluminum alloy further contains one or more metals selected from the group consisting of: Mn: 0.01 mass% to 0.3 mass%; Cr: 0.01 mass% to 0.3 mass%; Ni: 0.01 mass% to 0.3 mass%; Zr: 0.01 mass% to 0.3 mass%; and V: 0.01 ~ 0.1 mass%, at a content rate.

[0022] When Mn, Cr, or Zr is contained, it is possible to miniaturize the structure of the aluminum alloy to further improve the mechanical strength. When Ni or V is contained, it is possible to improve the mechanical strength in a high-temperature region.

[0023] Next, the production method of the scroll forged article according to the present invention will be described. This production method is characterized in that a scroll forged article in which the tensile strength of the bottom plate 21 in the plane direction is 350 MPa or more and less than 400 MPa is obtained by subjecting an aluminum alloy continuously cast material to a forging process without performing extrusion processing, the aluminum alloy continuously cast material containing: Si: 8.0 to 12.0 mass%; Fe: 0.1 mass% to 0.5 mass%; Cu: 0.6 mass% to 1.1 mass%; Mg: 0.2 mass% to 0.8 mass%; and the balance being Al and inevitable impurities. According to this production method, the tensile strength of the bottom plate 21 of the scroll forged article in the plane direction is sufficiently ensured, which in turn can sufficiently ensure the strength of the root portion of the blade to which a load is most applied.

[0024] Next, the composition of the "aluminum alloy" in the scroll member according to the present invention and the production method of the scroll forged article according to the present invention will be described in detail.

[0025] The Si (component) can improve the strength of the aluminum alloy by precipitation Mg_2Si particles in coexistence with Mg and improve the strength and the abrasion resistance by the presence of eutectic Si. If the Si content rate is less than 8.0 mass%, it is less effective in increasing the strength and the abrasion resistance. On the other hand, if the Si content rate exceeds 12.0 mass%, a primary crystal Si crystallizes, deteriorating the surface processability (alumite property). Therefore, Si content rate is set to fall within the range from 8.0 mass% to 12.0 mass%. Among them, the Si content rate is preferably set to fall within the range from 9.0 mass% to 11.0 mass%.

[0026] The Fe (component) precipitates Al-Fe based particles or Al-Fe-Si based particles to suppress recrystallization at the heat treatment after the forging forming to improve the ductility and the toughness of the scroll member. If the Fe content rate is less than 0.1 mass%, the effects of ductility improvement and toughness improvement are poor. On the other hand, if the Fe content rate exceeds 0.5 mass%, coarse crystallized substances of an Al-Fe system and an Al-Fe-Si system increase to deteriorate the surface processability (alumite performance). Therefore, the Fe content rate is set within the range of 0.1 mass% to 0.5 mass%. Among these, the Fe content rate is preferably set within the range from 0.15 mass% to 0.30 mass%.

[0027] The Cu (component) contributes to the improvement of strength and hardness of the aluminum alloy by precipitating $CuAl_2$ particles. If the Cu content rate is less than 0.6 mass%, the effects of strength improvement and hardness improvement are poor. On the other hand, if the Cu content rate exceeds 1.1 mass%, the hardness of the alumite film decreases. Therefore, the Cu content rate is preferably set within the range of 0.6 mass% to 1.1 mass%. Among them, the Cu content rate is preferably set within the range of 0.7 mass% to 1.0 mass%. Note that Cu is dissolved during the alumite treatment. The dissolved Cu ion is a noble metal ion, and therefore Cu is precipitated on the surface of the aluminum alloy base material again, making it difficult to form an alumite film, which results in the deteriorated densification of the film. However, by controlling the Cu content rate within the above-described range, the formability and the denseness of the alumite film can be improved, and the hardness of the alumite film can be improved.

[0028] The Mg (component) may coexist with Si to improve the strength of the aluminum alloy by precipitating Mg_2Si particles. If the Mg content rate is less than 0.2 mass%, the strength improving effect is poor. On the other hand, if the Mg content rate exceeds 0.8 mass%, the processability decreases. Therefore, the Mg content rate is set within the range of 0.2 mass% to 0.8 mass%. Among them, the Mg content rate is preferably set within the range of 0.3 mass% to 0.7

mass%.

[0029] Further, in the above-described aluminum alloy, it is preferable to contain the following metals at the above-described content rate for the following reasons. The metal is one or more metals selected from the group consisting of: Ti: 0.01 mass% to 0.3 mass%; B: 0.0001 mass% to 0.05 mass%; and Sr: 0.001 mass% to 0.1 mass%. That is, the content of Ti or the content of B miniaturizes the structure of the ingot to prevent cracking of a casting at the time of casting and improve the workability of the casting. Therefore, it can be molded into a complex shape at the time of the forging process. If the Ti content rate is less than 0.01 mass%, the above-described effect is poor. On the other hand, if the Ti content rate exceeds 0.3 mass%, a giant intermetallic compound crystallizes, adversely affecting the processability and the alumite processability. Further, the content of Sr miniaturizes the eutectic Si to improve the workability and the alumite properties. If the Sr content rate is less than 0.001 mass%, the above-described effect is poor. On the other hand, even if the Sr content rate exceeds 0.1 mass%, the above-described effect is poor.

[0030] In the above-described aluminum alloy, it is preferable to contain metals at the above-described content rate for the following reasons. The above-described metal is one or more metals selected from the group consisting of: Mn: 0.01 mass% to 0.3 mass%; Cr: 0.01 mass% to 0.3 mass%; Ni: 0.01 mass% to 0.3 mass%; Zr: 0.01 mass% to 0.3 mass%; and V: 0.01 mass% to 0.1 mass%. By containing them, Al-Mn based particles, Al-Mn-Fe-Si based particles, Al-Cr based particles, Al-Cr-Fe-Si based particles, Al-Ni based particles, Al-Zr based particles, and Al-V based particles are recrystallized to inhibit the recrystallization during the heat treatment after the forging, which in turn can improve the ductility and the toughness. If Mn is less than 0.01 mass%, Cr is less than 0.01 mass%, Ni is less than 0.01, Zr is less than 0.01 mass%, and V is less than 0.01 mass%, the ductility improvement effects and the toughness improvement effects are poor. If the Mn content exceeds 0.3 mass%, the Cr content exceeds 0.3 mass%, the Ni content exceeds 0.3 mass%, the Zr content exceeds 0.3 mass%, and the V content exceeds 0.1 mass%, the following problems arise. That is, coarse crystallized products increase to adversely affect the alumite property or lower the ductility and the toughness of the aluminum alloy.

Examples

[0031] Next, specific examples of the present invention will be described. It should be noted, however, that the present invention is not particularly limited to these examples.

<Example 1>

[0032] The following aluminum alloy molten metal was hot-top continuous casting machined to produce a cast material with an outer diameter of 117 mm and a length of 1,000 mm. The aluminum alloy molten metal consists of: Si: 8.0 mass%; Fe: 0.25 mass%; Cu: 0.9 mass%; Mg: 0.5 mass%; and the balance being Al and inevitable impurities. The resulting cast material was subjected to a homogenization heat treatment for heating at 490°C for 7 hours, and then surface cutting was performed to an outer diameter of 104 mm. Then, the cast material was cut to a thickness of 25 mm, heated to 200°C in a heating furnace, immersed in a graphitic water-soluble lubricating oil for several seconds, and then taken out to form a lubrication film. Next, the cast material having a thickness of 25 mm was forged in a state in which it is being heated to 400°C. Thus, the scroll forged article shown in FIG. 1 and FIG. 2 was obtained. In the scroll forged article, the height (H) of the blade portion 22 was 40 mm, the thickness (W) of the blade portion 22 was 5 mm, the thickness (T) of the bottom plate 21 was 10 mm.

[0033] Next, the resulting scroll forged article was subjected to an alumite treatment. The alumite treatment was carried out using 15 mass% of a sulfuric acid as the electrolytic bath in a current density of 3 A/dm² at a bath temperature of 5°C. With this, a scroll member 1 with an alumite film 3 having a thickness of about 40 μm formed on a surface of the scroll forged article 2 was obtained.

<Examples 2 to 16>

[0034] Scroll members 1 were obtained in the same manner as in Example 1 except that aluminum alloy molten metals having alloy compositions (including inevitable impurities) shown in Table 1 were used.

Table 1

Production method		Composition of aluminum alloy (mass%)												
		Si	Fe	Cu	Mg	Mn	Cr	Ti	B	Sr	Zr	V	Ni	Al
Ex. 1	Cont. casting → Forging	8.0	0.25	0.9	0.5	-	-	-	-	-	-	-	-	Balance
Ex. 2	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	-	-	-	-	-	-	Balance
Ex. 3	Cont. casting → Forging	12.0	0.25	0.9	0.5	-	-	-	-	-	-	-	-	Balance
Ex. 4	Cont. casting → Forging	10.5	0.10	0.9	0.5	-	-	-	-	-	-	-	-	Balance
Ex. 5	Cont. casting → Forging	10.5	0.50	0.9	0.5	-	-	-	-	-	-	-	-	Balance
Ex. 6	Cont. casting → Forging	10.5	0.25	0.6	0.5	-	-	-	-	-	-	-	-	Balance
Ex. 7	Cont. casting → Forging	10.5	0.25	1.1	0.5	-	-	-	-	-	-	-	-	Balance
Ex. 8	Cont. casting → Forging	10.5	0.25	0.9	0.2	-	-	-	-	-	-	-	-	Balance
Ex. 9	Cont. casting → Forging	10.5	0.25	0.9	0.8	-	-	-	-	-	-	-	-	Balance
Ex. 10	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	0.05	0.001	-	-	-	-	Balance
Ex. 11	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	-	-	0.05	-	-	-	Balance
Ex. 12	Cont. casting → Forging	10.5	0.25	0.9	0.5	0.15	-	-	-	-	-	-	-	Balance
Ex. 13	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	0.15	-	-	-	-	-	-	Balance
Ex. 14	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	-	-	-	0.15	-	-	Balance
Ex. 15	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	-	-	-	-	0.05	-	Balance
Ex. 16	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	-	-	-	-	-	0.15	Balance

Table 2

	Tensile strength		Strength		Alumite film hardness		Overall evaluation
	(MPa)	Evaluation	(MPa)	Evaluation	(HV)	Evaluation	
Ex. 1	352	○	251	○	401	○	Passed
Ex. 2	364	○	263	○	406	○	Passed
Ex. 3	371	○	277	○	402	○	Passed
Ex. 4	360	○	260	○	407	○	Passed
Ex. 5	366	○	267	○	408	○	Passed
Ex. 6	355	○	252	○	403	○	Passed
Ex. 7	372	○	276	○	406	○	Passed
Ex. 8	351	○	253	○	401	○	Passed
Ex. 9	386	○	291	○	404	○	Passed
Ex. 10	369	○	282	○	403	○	Passed
Ex. 11	365	○	278	○	405	○	Passed
Ex. 12	381	○	283	○	405	○	Passed
Ex. 13	373	○	276	○	400	○	Passed
Ex. 14	374	○	280	○	404	○	Passed
Ex. 15	367	○	264	○	402	○	Passed
Ex. 16	359	○	261	○	406	○	Passed

<Comparative Examples 1 to 13>

[0035] Scroll members were obtained in the same manner as in Example 1 except that aluminum alloy molten metals having alloy compositions (including inevitable impurities) shown in Table 1 were used.

<Comparative Example 14>

[0036] An aluminum alloy molten metal of the same composition as in Example 2 was subjected to hot-top continuous casting. With this, a cast material with an outer diameter of 203 mm and a length of 1,000 mm was obtained. The resulting cast material was subjected to a homogenization heat treatment for heating at 490°C for 7 hours and then extruded with an outer diameter of 104 mm. Then, the extruded material was cut to a thickness of 25 mm. The cut extruded material was heated to 200°C in a heating furnace and then immersed in a graphitic based water-soluble lubricating oil for several seconds and taken out therefrom. Thus, a lubrication film was formed. Next, a scroll member was obtained in the same manner as in Example 1 except that a scroll forged article was obtained by subjecting an extruded material having a thickness of 25 mm to forming in a state in which it was being heated to 400°C.

Table 3

Production method		Composition of aluminum alloy (mass%)												
		Si	Fe	Cu	Mg	Mn	Cr	Ti	B	Sr	Zr	V	Ni	Al
Comp. Ex. 1	Cont. casting → Forging	6.0	0.25	0.9	0.5	-	-	-	-	-	-	-	-	Balance
Comp. Ex. 2	Cont. casting → Forging	14.0	0.25	0.9	0.5	-	-	-	-	-	-	-	-	Balance
Comp. Ex. 3	Cont. casting → Forging	10.5	0.25	0.3	0.5	-	-	-	-	-	-	-	-	Balance
Comp. Ex. 4	Cont. casting → Forging	10.5	0.25	1.5	0.5	-	-	-	-	-	-	-	-	Balance
Comp. Ex. 5	Cont. casting → Forging	10.5	1.0	0.9	0.5	-	-	-	-	-	-	-	-	Balance
Comp. Ex. 6	Cont. casting → Forging	10.5	0.25	0.9	1.5	-	-	-	-	-	-	-	-	Balance
Comp. Ex. 7	Cont. casting → Forging	10.5	0.25	0.9	0.5	0.5	-	-	-	-	-	-	-	Balance
Comp. Ex. 8	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	0.5	-	-	-	-	-	-	Balance
Comp. Ex. 9	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	0.5	0.1	-	-	-	-	Balance
Comp. Ex. 10	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	-	-	0.3	-	-	-	Balance
Comp. Ex. 11	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	-	-	-	0.5	-	-	Balance
Comp. Ex. 12	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	-	-	-	-	0.3	-	Balance
Comp. Ex. 13	Cont. casting → Forging	10.5	0.25	0.9	0.5	-	-	-	-	-	-	-	0.5	Balance
Comp. Ex. 14	*1)	10.5	0.25	0.9	0.5	-	-	-	-	-	-	-	-	Balance
*1) Cont. casting → Extruding → Forging														

Table 4

	Tensile strength		Strength		Alumite film hardness		Overall evaluation
	(MPa)	Evaluation	(MPa)	Evaluation	(HV)	Evaluation	
Comp. Ex. 1	342	×	243	×	418	○	Failed
Comp. Ex. 2	358	○	281	○	384	×	Failed
Comp. Ex. 3	335	×	239	×	409	○	Failed
Comp. Ex. 4	384	○	285	○	375	×	Failed
Comp. Ex. 5	361	○	267	○	369	×	Failed
Comp. Ex. 6	376	○	277	○	382	×	Failed
Comp. Ex. 7	392	○	297	○	381	×	Failed
Comp. Ex. 8	390	○	301	○	374	×	Failed
Comp. Ex. 9	373	○	284	○	383	×	Failed
Comp. Ex. 10	363	○	265	○	387	×	Failed
Comp. Ex. 11	391	○	297	○	382	×	Failed
Comp. Ex. 12	364	○	262	○	374	×	Failed
Comp. Ex. 13	362	○	267	○	373	×	Failed
Comp. Ex. 14	335	×	238	×	405	○	Failed

[0037] Scroll members obtained as described above were evaluated according to the evaluation method described below.

<Tensile Strength Test>

[0038] To perform a tensile test, an ASTM-R3 test piece was taken from a 10 mm thick bottom plate of the scroll member from a position as indicated by the dotted line in FIG. 2. The resulting test piece was subjected to a tensile test of the bottom plate in the plane direction using AG100kNXplus manufactured by Shimadzu Corporation to measure the tensile strength (MPa) at 25°C. The measurement results are shown in Tables 2 and 4. The n number was set to 3. Three averages were taken as the tensile strength. In Table 2, those having a tensile strength of 350 MPa or more and less than 400 MPa are evaluated as "○". On the other hand, those having a tensile strength deviating from the above-mentioned ranges, it is indicated as "X".

<Strength Measurement Method>

[0039] From the above-described tensile test results, 0.2% proof stress at 25°C was determined. The measurement results are shown in Tables 2 and 4. The number n was set to 3. The average value of the three pieces was defined as a 0.2% proof strength. In Tables 2 and 4, those in which a 0.2% proof stress is 250 MPa or more and 300 MPa or less are evaluated as "○". On the other hand, those in which the 0.2% proof strength deviates from the above-described range are evaluated as "X".

<Vickers Hardness Evaluation Method of Alumite Film>

[0040] A scroll member on which an alumite film was formed was cut to a predetermined size, embedded in a resin frame, and subjected to surface micropolishing to the extent that the alumite film hardness was measurable. Thereafter, the Vickers hardness of the alumite film was measured. The n number was set to 3. The average value of these three was defined as the Vickers hardness. In Tables 2 and 4, the alumite film in which the Vickers hardness (HV) is 400 or more is evaluated as "○". On the other hand, in the alumite film in which the Vickers hardness (HV) is less than 400, it is evaluated as "X".

[0041] As can be seen from the tables, in the scroll members of Examples 1 to 16, the tensile strength of the bottom plate in the plane direction is 350 MPa or more and less than 400 MPa, and the mechanical strength of the root portion

of the blade to which a load is most applied was excellent. The Vickers hardness (HV) of the alumite film was 400 or more, and the hardness of the alumite film was high.

[0042] On the other hand, in Comparative Examples 1 to 14, which deviated from the specified ranges of the present invention, at least one of the tensile strength of the bottom plate in the plane direction and the alumite film hardness (alumite property) was inferior.

Industrial Applicability

[0043] A scroll member according to the present invention is suitably used as an in-vehicle electric scroll of an automobile, such as, e.g., an electric vehicle and a hybrid vehicle.

[0044] This application claims priority to Japanese Patent Application No. 2019-60327, filed on March 27, 2019, the contents of which are incorporated herein by reference in their entirety.

[0045] The terms and descriptions used herein have been used to describe embodiment according to the present invention, and the present invention is not limited thereto. The present invention is intended to allow any design changes within claims without departing from the spirit of the invention.

Description of Symbols

[0046]

- 1: Scroll member
- 2: Scroll forged article
- 3: Alumite film
- 21: Bottom plate
- 22: Blade portion

Claims

1. A scroll member in which an alumite film having a Vickers hardness of 400 or more is formed on a surface of a scroll forged article made of an aluminum alloy, the aluminum alloy containing: Si: 8.0 mass% to 12.0 mass%; Fe: 0.1 mass% to 0.5 mass%; Cu: 0.6 mass% to 1.1 mass%, Mg: 0.2 mass% to 0.8 mass%; and the balance being Al and inevitable impurities, wherein a tensile strength of a bottom plate of the scroll forged article in a plane direction is 350 MPa or more and less than 400 MPa.
2. The scroll member as recited in claim 1, wherein the aluminum alloy further contains one or more metals selected from the group consisting of: Ti: 0.01 mass% to 0.3 mass%; B: 0.0001 mass% to 0.05 mass%; and Sr: 0.001 mass% to 0.1 mass% at a content rate.
3. The scroll member as recited in claim 1 or 2, wherein the aluminum alloy further contains one or more metals selected from the group consisting of: Mn: 0.01 mass% to 0.3 mass%; Cr: 0.01 mass% to 0.3 mass%; Ni: 0.01 mass% to 0.3 mass%; Zr: 0.01 mass% to 0.3 mass%, and V: 0.01 mass% to 0.1 mass% at a content rate.
4. A method of producing a scroll forged article, comprising: forging an aluminum alloy continuously cast material without performing extrusion to obtain a scroll forged article in which a tensile strength of a bottom plate in a plane direction is 350 MPa or more and less than 400 MPa, the aluminum alloy continuously cast material containing: Si: 8.0 mass% to 12.0 mass%; Fe: 0.1 mass% to 0.5 mass%; Cu: 0.6 mass% to 1.1 mass%; Mg: 0.2 mass% to 0.8 mass%; and the balance being Al and inevitable impurities.

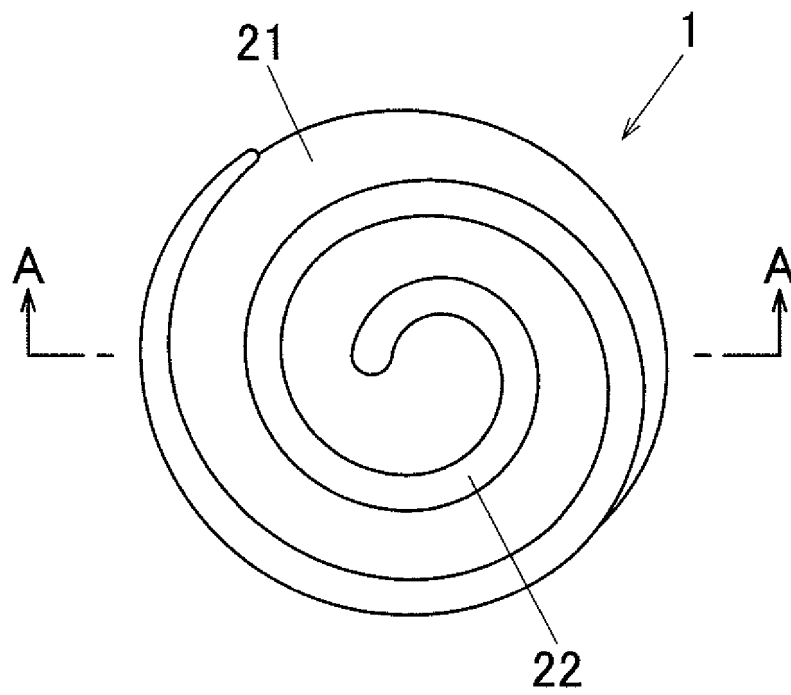


FIG. 1

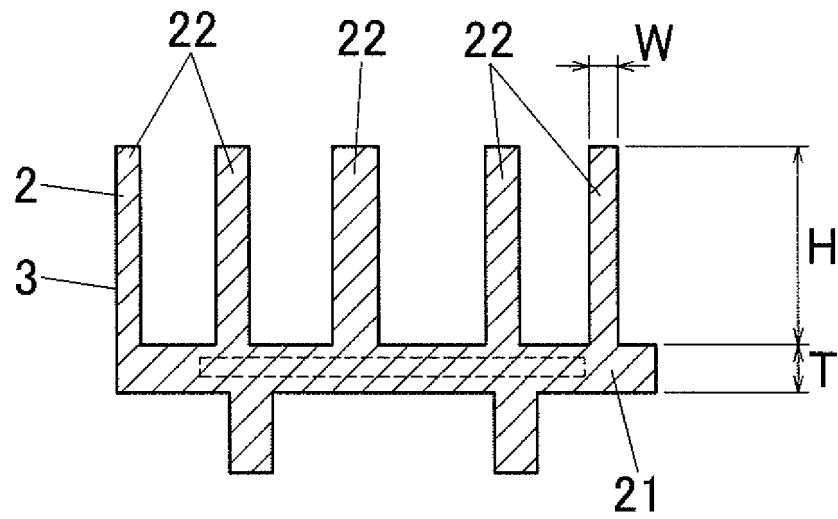


FIG. 2

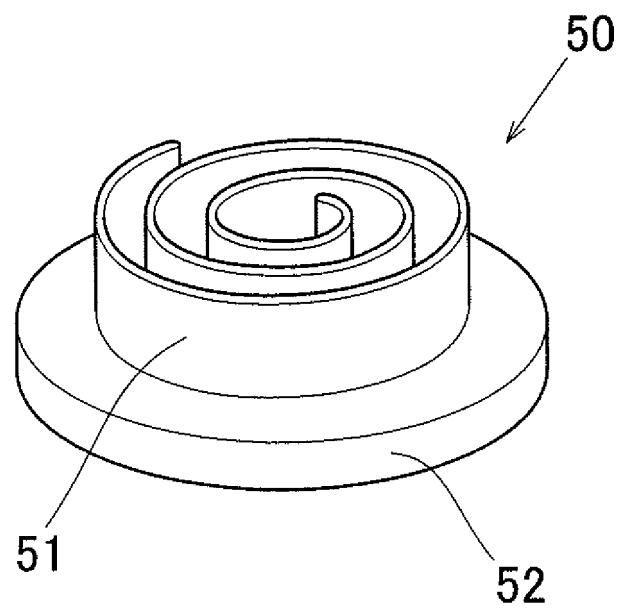


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/048674

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. C22C21/00 (2006.01)i, C22F1/04 (2006.01)i, F04C18/02 (2006.01)i, C22F1/00 (2006.01)n
 FI: C22C21/00 C, F04C18/02 311R, F04C18/02 311S, C22F1/04, C22F1/00 613, C22F1/00 624, C22F1/00 630A,
 C22F1/00 630C, C22F1/00 631A, C22F1/00 682, C22F1/00 683, C22F1/00 691B, C22F1/00 691C, C22F1/00 694B

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. C22C21/00-21/18, C22F1/04-1/057, F04C18/02, C22F1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-232087 A (SHOWA DENKO KABUSHIKI KAISHA) 19 August 2004, claims, paragraphs [0057], [0070], [0071], [0073], [0074], [0077], [0079]-[0081]	1-4
A	WO 01/77398 A1 (SHOWA DENKO KABUSHIKI KAISHA) 18 October 2001	1-4

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
02.03.2020Date of mailing of the international search report
17.03.2020Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2019/048674

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2004-232087 A	19.08.2004	US 2005/0109429 A1 claims, paragraphs [0093], [0094], [0139]-[0150], [0157]-[0166], [0177], [0178], [0181]-[0183]	
		WO 2005/049896 A1 EP 1715084 A1	
WO 01/77398 A1	18.10.2001	US 2003/0005983 A1 US 2002/0003012 A1 US 2004/0140018 A1 KR 2002-0022693 A	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3261056 B [0007]
- JP 4511156 B [0007]
- JP 2019060327 A [0044]