

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MAHLE BEHR CHARLESTON INC.,

Petitioner,

v.

FRANK AMIDIO CATALANO,

Patent Owner,

Patent No. RE47,494 to Catalano

Issue Date: July 9, 2019

Title: ELECTROLYSIS PREVENTION DEVICE AND METHOD OF USE

Inter Partes Review No.: IPR2023-00861

Declaration of Dr. Dana J. Medlin

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	QUALIFICATIONS.....	2
III.	MATERIALS AND OTHER INFORMATION CONSIDERED	4
IV.	SUMMARY OF MY OPINIONS.....	6
V.	LEGAL PRINCIPLES	7
	A. Claim Construction	7
	B. Anticipation	9
	C. Obviousness.....	10
VI.	OVERVIEW OF THE '494 PATENT	13
	A. Specification.....	23
	B. Summary of the Prosecution History	34
	C. Person of Ordinary Skill in the Art	50
VII.	OVERVIEW OF THE REFERENCES RELIED UPON BY PETITIONER	52
	A. Tomosada	52
	1. Overview	52
	B. The Tomosada-Hanazaki-069 Combination	71
	1. Overview of Hanazaki-069	71
	2. The Combination of Tomosada and Hanazaki-069 was Predictable.....	74
	C. Hanazaki-196.....	78
	1. Overview	78
	D. The Hanazaki-196-Hanazaki-069 Combination	90

1.	The Combination of Hanazaki-196 and Hanazaki-069 was Predictable.....	90
E.	Godefroy.....	94
1.	Overview	94
F.	The Godefroy-Hanazaki-069 Combination.....	100
1.	The Combination of Godefroy and Hanazaki-069 was Predictable.....	100

VIII. ANALYSIS OF THE REFERENCES RELIED UPON BY PETITIONER 103

A.	Claims 12, 15, 16, 19–21, 24–26, 29, 31–34, 37, 40, 42, 43, and 45 Are Anticipated by and/or Obvious Over Tomosada	103
1.	Claim 12	103
i.	“A method of preventing corrosion of a radiator, the method comprising:”	103
ii.	“installing a sacrificial anode assembly including a sacrificial anode within the radiator,”	104
iii.	“wherein the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.”	107
2.	Claim 15 – “wherein the sacrificial anode consists essentially of an active metal.”	113
3.	Claim 16 – “wherein the sacrificial anode consists essentially of aluminum, magnesium, or zinc”	115
4.	Claim 19 – “wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly within the fluid flow of the radiator”	115
5.	Claim 20 – “wherein the radiator comprises aluminum”	116
6.	Claim 21 – “wherein the hot liquid is coolant”	117
7.	Claim 24 – “further comprising installing a second sacrificial anode assembly within the radiator.”	117
8.	Claim 25	121
i.	“A radiator for use in a motor vehicle, the radiator further comprising:”	121
ii.	“a hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine; and”	122

iii.	“a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.”	123
9.	Claim 26 – “wherein the sacrificial anode consists essentially of an active metal.”	125
10.	Claim 29 – “wherein the sacrificial anode is installed onto a surface of the radiator”	125
11.	Claim 31 – “wherein the radiator comprises aluminum”	127
12.	Claim 32 – “wherein the radiator enables air-cooling of the hot liquid”	127
13.	Claim 33 – “further comprising a second sacrificial anode.”	127
14.	Claim 34 – “wherein the hot liquid is coolant”	128
15.	Claim 37	129
i.	“An electrolysis prevention device for preventing corrosion, the electrolysis prevention device comprising:”	129
ii.	“a sacrificial anode made of an active metal; and”	129
iii.	“an anode holder supporting the sacrificial anode, the anode holder adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.”	129
16.	Claim 40 – “wherein the sacrificial anode comprises zinc” ...	131
17.	Claim 42 – “wherein the engine radiator comprises aluminum”	132
18.	Claim 43 – “wherein the anode holder enables the sacrificial anode to be located within fluid flow of the hot coolant inlet”	132
19.	Claim 45 – “wherein the hot liquid is coolant”	133
B.	Claims 22, 23, 27, 35, 36, 38, 39, 46, and 47 Are Obvious Over by Tomosada and Hanazaki-069	133
1.	Claim 22 – “wherein the hot liquid is water”	133
2.	Claim 23 – “wherein the hot liquid is antifreeze”	134
3.	Claim 27 – “wherein the active metal is at least one of aluminum, magnesium, and zinc”	134
4.	Claim 35 – “wherein the hot liquid is water”	135
5.	Claim 36 – “wherein the hot liquid is antifreeze”	135
6.	Claim 38 – “wherein the sacrificial anode comprises aluminum”	136
7.	Claim 39 – “wherein the sacrificial anode comprises magnesium”	136

8.	Claim 46 – “wherein the hot liquid is water”	137
9.	Claim 47 – “wherein the hot liquid is antifreeze”	137
C.	Claims 12, 15–17, 19–21, and 24 Are Anticipated by and/or Obvious Over Hanazaki-196	138
1.	Claim 12	138
i.	“A method of preventing corrosion of a radiator, the method comprising:”	138
ii.	“installing a sacrificial anode assembly including a sacrificial anode within the radiator,”	139
iii.	“wherein the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.”	142
2.	Claim 15 – wherein the sacrificial anode consists essentially of an active metal.	145
3.	Claim 16 – wherein the sacrificial anode consists essentially of aluminum, magnesium, or zinc.	146
4.	Claim 17 – “wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly in a fitting hole in the radiator.”	147
5.	Claim 19 – wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly within the fluid flow of the radiator.	148
6.	Claim 20 – wherein the radiator comprises aluminum.	149
7.	Claim 21 – wherein the hot liquid is coolant.	150
8.	Claim 24 – further comprising installing a second sacrificial anode assembly within the radiator.	151
D.	Claims 22, 23, 25–29, 31–40, and 42–47 Are Obvious Over Hanazaki-196 and Hanazaki-069	152
1.	Claim 22 – wherein the hot liquid is water.	152
2.	Claim 23 – wherein the hot liquid is antifreeze.	153
3.	Claim 25	153
i.	A radiator for use in a motor vehicle, the radiator further comprising:	153
ii.	a hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine; and	154
iii.	a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.	155

4.	Claim 26 – wherein the sacrificial anode consists essentially of an active metal.	156
5.	Claim 27 – wherein the active metal is at least one of aluminum, magnesium, and zinc.	157
6.	Claim 28 – “wherein the sacrificial anode is installed in a fitting hole penetrating the radiator.”	157
7.	Claim 29 – wherein the sacrificial anode is installed onto a surface of the radiator.	158
8.	Claim 31 – wherein the radiator comprises aluminum.	159
9.	Claim 32 – wherein the radiator enables air-cooling of the hot liquid.	160
10.	Claim 33 – further comprising a second sacrificial anode.	160
11.	Claim 34 – wherein the hot liquid is coolant.	161
12.	Claim 35 – wherein the hot liquid is water.	162
13.	Claim 36 – wherein the hot liquid is antifreeze.	162
14.	Claim 37 i. An electrolysis prevention device for preventing corrosion, the electrolysis prevention device comprising: ii. a sacrificial anode made of an active metal; and iii. an anode holder supporting the sacrificial anode, the anode holder adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.	162 162 163 164
15.	Claim 38 – wherein the sacrificial anode comprises aluminum.	166
16.	Claim 39 – wherein the sacrificial anode comprises magnesium.	167
17.	Claim 40 – wherein the sacrificial anode comprises zinc.	168
18.	Claim 42 – wherein the engine radiator comprises aluminum.	168
19.	Claim 43 – wherein the anode holder enables the sacrificial anode to be located within fluid flow of the hot coolant inlet.	168
20.	Claim 44 – “wherein the anode holder is installed in a fitting hole penetrating the engine radiator”	169
21.	Claim 45 – wherein the hot liquid is coolant.	170
22.	Claim 46 – wherein the hot liquid is water.	171
23.	Claim 47 – wherein the hot liquid is antifreeze.	171

E.	Claims 12, 15–17, 19–21, 24–29, 31–34, 37–40, and 42–45 Are Anticipated by and/or Obvious Over Godefroy.....	172
1.	Claim 12	172
	i. A method of preventing corrosion of a radiator, the method comprising:	172
	ii. installing a sacrificial anode assembly including a sacrificial anode within the radiator, ...	173
	iii. wherein the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.	175
2.	Claim 15 – wherein the sacrificial anode consists essentially of an active metal.	176
3.	Claim 16 – wherein the sacrificial anode consists essentially of aluminum, magnesium, or zinc.	177
4.	Claim 17 – wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly in a fitting hole in the radiator.	177
5.	Claim 19 – wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly within the fluid flow of the radiator.	178
6.	Claim 20 – wherein the radiator comprises aluminum.	179
7.	Claim 21 – wherein the hot liquid is coolant.	179
8.	Claim 24 – further comprising installing a second sacrificial anode assembly within the radiator.	180
9.	Claim 25	181
	i. A radiator for use in a motor vehicle, the radiator further comprising:	181
	ii. a hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine; and	181
	iii. a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.	182
10.	Claim 26 – wherein the sacrificial anode consists essentially of an active metal.	183
11.	Claim 27 – wherein the active metal is at least one of aluminum, magnesium, and zinc.	183
12.	Claim 28 – wherein the sacrificial anode is installed in a fitting hole penetrating the radiator.	184
13.	Claim 29 – wherein the sacrificial anode is installed onto a surface of the radiator.	184

14.	Claim 31 – wherein the radiator comprises aluminum.....	185
15.	Claim 32 – wherein the radiator enables air-cooling of the hot liquid.	186
16.	Claim 33 – further comprising a second sacrificial anode.	186
17.	Claim 34 – wherein the hot liquid is coolant.	187
18.	Claim 37	187
	i. An electrolysis prevention device for preventing corrosion, the electrolysis prevention device comprising:	187
	ii. a sacrificial anode made of an active metal; and.....	188
	iii. an anode holder supporting the sacrificial anode, the anode holder adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.....	188
19.	Claim 38 – wherein the sacrificial anode comprises aluminum.	190
20.	Claim 39 – wherein the sacrificial anode comprises magnesium.	190
21.	Claim 40 – wherein the sacrificial anode comprises zinc.....	191
22.	Claim 42 – wherein the engine radiator comprises aluminum.	192
23.	Claim 43 – wherein the anode holder enables the sacrificial anode to be located within fluid flow of the hot coolant inlet.	192
24.	Claim 44 – wherein the anode holder is installed in a fitting hole penetrating the engine radiator.....	192
25.	Claim 45 – wherein the hot liquid is coolant.	192
F.	Claims 22, 23, 35, 36, 46, and 47 Are Obvious Over Godefroy and Hanazaki-069	193
1.	Claim 22 – wherein the hot liquid is water.....	193
2.	Claim 23 – wherein the hot liquid is antifreeze.....	194
3.	Claim 35 – wherein the hot liquid is water.....	194
4.	Claim 36 – wherein the hot liquid is antifreeze.....	194
5.	Claim 46 – wherein the hot liquid is water.....	194
6.	Claim 47 – wherein the hot liquid is antifreeze.....	195
IX.	CONCLUSION	196

1. I, Dana J. Medlin Ph.D., P.E., FASM, of Anaheim, California, declare that:

I. INTRODUCTION

2. I have been retained as a technical expert by counsel on behalf of MAHLE Behr Charleston Inc. (“Petitioner”). I understand that Petitioner is requesting that the Patent Trial and Appeal Board institute an *Inter Partes* review (“IPR”) proceeding of U.S. Patent No. RE47,494 (“the ’494 Patent,” EX1001).

3. I have been asked by Petitioner’s counsel (“Counsel”) to provide my independent analysis and consideration of whether certain references teach or suggest the features recited in claims 12, 15–17, 19–29, 31–40, and 42–47 (the “challenged claims”) of the ’494 Patent. My opinions and the bases for my opinions are set forth below. My opinions are based on my education and experience.

4. In writing this Declaration, I have considered the following: my own knowledge and experience, including my teaching and work experience in the fields of mechanical system design, corrosion prevention systems, corrosion failure analysis, and metallurgical engineering; and my experience of working with others involved in those fields.

5. I am not, and never have been, an employee of Petitioner. I have no financial interest in either party or in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis, for all tasks involved. My

compensation is not dependent on the outcome of these proceedings or on the content of my opinions. I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the '494 Patent.

II. QUALIFICATIONS

6. My qualifications for forming the opinions in this report are summarized here and explained in more detail in my curriculum vitae ("CV"), which is provided as Appendix A appended hereto.

7. As detailed in my CV, I have extensive experience in the design, development, and manufacture of corrosion prevention systems, with a career spanning over 30 years in this field. I have specific expertise in the design and development of sacrificial anodes and have a sound understanding of the relevant electromechanical principles and constraints associated with the implantation of such devices into a radiator. I have also engaged in extensive consulting work, as Vice President of Metallurgical Engineering for Eurofins EAG Laboratories LLC, in the design and development of these types of systems.

8. I earned my Bachelors and Masters of Science degrees in Mechanical Engineering (Metallurgy Option) from the University of Nebraska in 1988 and 1990, respectively. I also earned my Ph.D. in Material Science Engineering from the University of Nebraska in 1993.

9. I am a Fellow of ASM-International, a distinguished honor in the field of metallurgical and materials science engineering. I was previously the Kielhorn Professor of Materials Joining & Welding Engineering at LeTourneau University, and also the NUCOR Professor of Metallurgy at the South Dakota School of Mines & Technology. I am also a Technical Advisor Member of the Association of Firearm and Tool Mark Examiners (AFTE). Additionally, I have published and presented over 120 technical papers, presentations, and books, and have been a named inventor on 11 patents.

10. In addition to designing new technologies, I have, throughout my career, mentored, trained, and supervised young engineers and can easily appreciate how a less experienced engineer or designer would perceive the prior art and approach the technical problems disclosed in the prior art.

11. I also have extensive consulting experience in the design and development of corrosion prevention systems. My consulting experience has involved corrosion evaluations and testing, failure analysis & remedial action, mechanical testing, heat treatment issues, plumbing failures, welding metallurgy, metallurgical related fire investigations, polymer/plastic failure investigations, medical device design and validation, and bearing and gear investigations.

12. I am currently employed as the Vice President of Metallurgical Engineering for Eurofins EAG Laboratories. I also teach metallurgical and materials engineering courses for industry and professional societies.

13. I have previously served as an expert in two IPR cases involving galvanic corrosion in drilling components. I also served as an expert in two IPR cases involving electric discharge machining. I also served as an expert in a patent infringement case involving dissolvable magnesium materials used to manufacture frac balls and frac plugs.

14. Based on my experience and education, I believe that I am qualified to opine as to the knowledge and level of skill of one of ordinary skill in the art at the time of the alleged invention of the '494 Patent ("POSITA"; refer to Section VI.C, below) and what such a person would have understood at that time, and the state of the art during that time. Based on my experiences, I understand and know of the capabilities of persons of ordinary skill in this field during the late 1990s to mid 2010s and specifically during the time before the time of the alleged invention of the '494 Patent. Indeed, I worked closely with many such persons in the field during that time frame.

III. MATERIALS AND OTHER INFORMATION CONSIDERED

15. All of the opinions contained in this declaration are based on the documents I have reviewed and my professional judgment, as well as my education,

experience, and professional knowledge. I am not an attorney and I am not offering any legal opinions in this declaration.

16. In forming the opinions expressed in this declaration, I relied upon my education, knowledge, and experience in the relevant field of the art, and have considered the viewpoint of a POSITA as of December 5, 2008, which I understand to be the earliest effective filing date of the claims. I have considered the materials referenced herein, including the '494 Patent (EX1001), excerpts of the prosecution history (EX1010) of the '494 Patent, excerpts of the prosecution history of U.S. Patent No. 8,236,145 ("the '145 patent) (EX1009), and the following materials:

- Certified translation of Japanese Patent Application Publication No. S55-68595 to Tomosada ("Tomosada," EX1005);
- Certified translation of Japanese Patent Application Publication No. A-6-272069 to Hanazaki, *et al.* ("Hanazaki-069," EX1006);
- Certified translation of Japanese Patent Application Publication No. H1-217196 to Hanazaki, *et al.* ("Hanazaki-196," EX1007);
- Certified translation of International Patent Application Publication No. 03/100337 to Godefroy, *et al.* ("Godefroy," EX1008);
- U.S. Patent No. 5,649,591 to Green ("Green," EX1011);
- U.S. Patent No. 1,514,903 to Gush ("Gush," EX1012);
- U.S. Patent No. 6,109,987 to Watanabe, *et al.* ("Watanabe," EX1013);

- Chinese Patent No. 1225998A to Guo (“Guo,” EX1014);
- Ford Care and Home Repair, How to Enjoy Your Ford Car, *Radiator Repairs*, 1922 Ed. to Murray Fahnestock (“Fahnestock,” EX1015); and
- U.S. Patent No. 4,776,392 to Loyd (“Loyd,” EX1017).
- Other materials which I understand are attached to the Petition.

17. I have considered these materials through the lens of a POSITA, which is discussed further in Section VI.C below) related to the '494 Patent as of the effective filing date, and I have done so during my review of these materials.

IV. SUMMARY OF MY OPINIONS

18. This Declaration explains the conclusions that I have formed based on my knowledge and experience and my review of the references (prior art) listed above. To summarize, I have concluded that:

- Claims 12, 15, 16, 19–21, 24–26, 29, 31–34, 37, 40, 42, 43, and 45 are anticipated by and/or obvious over Tomosada;
- Claims 22, 23, 27, 35, 36, 38, 39, 46, and 47 are obvious over Tomosada and Hanazaki-069;
- Claims 12, 15–17, 19–21, and 24 are anticipated by and/or obvious over Hanazaki-196;
- Claims 22, 23, 25–29, 31–40, and 42–47 are obvious over Hanazaki-196 and Hanazaki-069;

- Claims 12, 15–17, 19–21, 24–29, 31–34, 37–40, and 42–45 are anticipated by and/or obvious over Godefroy; and
- Claims 22, 23, 35, 36, 46, and 47 are obvious over Godefroy and Hanazaki-069.

V. LEGAL PRINCIPLES

19. In forming my analysis and conclusions expressed in this declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by Counsel.

A. Claim Construction

20. I understand that a claim must be construed under the *Phillips* standard. Under that standard, words of a claim are given their plain and ordinary meaning as understood by person of ordinary skill in the art (also “POSITA”) at the time of invention, in light of the specification and prosecution history, unless those sources show an intent to depart from such meaning, as well as pertinent evidence extrinsic to the patent. For purposes of this declaration, I applied the plain and ordinary meaning of each term as would have been understood by a person of ordinary skill in art at the time of the alleged invention unless explicitly stated otherwise. I understand that the following constructions have been adopted by Petitioner:

Claim(s)	Term(s)	Construction
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25, 26, 29, 33, 37	“sacrificial anode”	“piece of metal used to protect another piece of metal by preferentially corroding”
25, 37	“within 10 inches of the hot liquid inlet” / “within 10 inches of a hot liquid inlet”	“within 10 inches of the center axis of [the hot liquid inlet / a hot liquid inlet]”
25, 29, and 37	“installed” / “installation”	plain and ordinary meaning with no clarifying statement
26, 27, and 37	“active metal”	“metal that reacts with oxygen”
37	“an anode holder” / “the anode holder”	plain and ordinary meaning
12	“sacrificial anode assembly”	“sacrificial anode and at least one other connected part that forms one unit”

I also understand that “consists essentially of” X is to be interpreted as “includes

only X” or “includes essentially only X.” In this regard, I also understand that claim 27 is to be construed to require that the sacrificial anode includes only or essentially only a *combination* of aluminum, magnesium, *and* zinc.

B. Anticipation

21. I understand that a patent claim is invalid if it is anticipated by a single item of prior art. I understand that an anticipation analysis involves two steps. First, the patent claims are construed to ascertain their scope. Second, each construed asserted claim is compared to the prior art reference on an element-by-element basis. If the prior art reference discloses or contains each and every element of the claimed invention, either expressly or inherently, then it anticipates the claim.

22. I understand that anticipation by inherent disclosure is appropriate only when a prior art reference necessarily includes or discloses the unstated claim element. I also understand that the discovery of a new or previously unreported or unappreciated property of a prior art composition, or of a scientific explanation for how a prior art composition operates, does not make the prior art composition patentably new to the entity or person that discovered the new property or mode of operation. I further understand that there is no requirement that a POSITA would have recognized the inherent disclosure at the time of the invention.

23. For anticipation by a prior art publication or document, I understand that the reference’s description must enable a POSITA to practice the claimed

invention without undue experimentation. I further understand that the following factors may be considered to determine whether any experimentation would have been undue:

- a) The quantity of experimentation necessary;
- b) The amount of direction or guidance presented;
- c) The presence or absence of working examples;
- d) The nature of the claimed invention;
- e) The state of the prior art;
- f) The relative skill of those in the art;
- g) The predictability or unpredictability of the art; and
- h) The breadth of the claims.

C. Obviousness

24. I understand that a patent claim can be considered to have been obvious to person of ordinary skill in the art at the time the application was filed. This means that, even if all of the elements of a claim are not found in a single prior art reference, the claim is not patentable if the differences between the subject matter in the prior art and the subject matter in the claim would have been obvious to a person of ordinary skill in the art at the time the application was filed.

25. I further understand that a determination of whether a claim would have been obvious must consider several factors, including, among others:

- a) the level of ordinary skill in the art at the time the application was filed;
- b) the scope and content of the prior art; and
- c) what differences, if any, existed between the claimed invention and the prior art.

26. I understand that the teachings of two or more references may be combined in the same way as disclosed in the claims, if such a combination would have been obvious to a person of ordinary skill in the art. In determining whether a combination based on either a single reference or multiple references would have been obvious, it is appropriate to consider at least the following factors:

- a) whether the teachings of the prior art references disclose known concepts combined in familiar ways, which, when combined, would yield predictable results;
- b) whether a person of ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;
- c) whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by a person of ordinary skill in the art;
- d) whether a person of ordinary skill in the art would have recognized a reason to combine known elements in the manner described in the claim;
- e) whether there is some teaching or suggestion in the prior art to make

the modification or combination of elements claimed in the patent; and

f) whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way.

27. I understand that a person of ordinary skill in the art has ordinary creativity, and is not an automaton.

28. I understand that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered, and I have not done that in regards to my opinions expressed herein.

29. I understand that certain factors—often called “secondary considerations”—may support or rebut an assertion of obviousness of a claim. I understand that such secondary considerations include, among other things, commercial success of the alleged invention, skepticism of those having ordinary skill in the art at the time of the alleged invention, unexpected results of the alleged invention, any long-felt but unsolved need in the art that was satisfied by the alleged invention, the failure of others to make the alleged invention, praise of the alleged invention by those having ordinary skill in the art, and copying of the alleged invention by others in the field. I further understand that there must be a nexus—a connection—between any such secondary considerations and the alleged invention. I also understand that contemporaneous and independent invention by others is a secondary consideration tending to show obviousness.

VI. OVERVIEW OF THE '494 PATENT

30. I understand that the '494 Patent is a reissue of the '145 patent. When reading the '494 Patent, I understand that “[m]atter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.” EX1001, 1:4–10 (emphasis omitted). In the quotes below, I have deleted text in heavy brackets and removed italics.

31. The '494 Patent includes 47 claims, of which claims 1, 12, 13, 25, and 37 are independent. *Id.*, 11:25–13:28. The claims recite as follows (bold brackets and Roman numerals added for consistency with references in Section VIII):

1. An electrolysis prevention device, for preventing corrosion caused by electrolysis, comprising:
 - a sacrificial anode made of an active metal; and
 - an anode holder supporting the sacrificial anode;wherein the holder is adapted to fit around the inlet connection of an engine heat exchange component in such a way as to allow for a hose to be attached overtop the device.

2. The electrolysis prevention device of claim 1
wherein the sacrificial anode is made of aluminum.

3. The electrolysis prevention device of claim 1
wherein the sacrificial anode is made of magnesium.

4. The electrolysis prevention device of claim 1
wherein the sacrificial anode is made of zinc.

5. The electrolysis prevention device of claim 1
wherein the anode holder is grounded to a vehicle.

6. The electrolysis prevention device of claim 1
wherein an end of the anode holder is attached to an
additional wire positioning the sacrificial anode further
down into the flow of liquid coolant within the engine heat
exchange component.

7. The electrolysis prevention device of claim 1 wherein the anode holder is connected to the engine heat exchange component by a clamp.

8. The electrolysis prevention device of claim 1 wherein the engine heat exchange component is a radiator.

9. The electrolysis prevention device of claim 1 wherein the engine heat exchange component is a heater core.

10. A radiator with the electrolysis prevention device of claim 1 in proximity to an inlet connection thereof.

11. A heater core with the electrolysis prevention device of claim 1 in proximity to an inlet connection thereof.

12. [i] A method of preventing corrosion of a radiator, the method comprising:

[ii] installing a sacrificial anode assembly including a sacrificial anode within the radiator, [iii] wherein the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.

13. An electrolysis prevention device, for preventing corrosion caused by electrolysis, comprising:

a sacrificial anode made of an active metal; and

an anode holder supporting the sacrificial anode;

wherein the holder is adapted to fit through and around the inlet connection of an engine heat exchange component in such a way as to allow for a hose to be attached to and around the inlet connection without dislodging the holder.

14. A engine heat exchange component with the electrolysis prevention device of claim 13 installed such that the holder of the device extends through, and is doubled back around, the inlet connection and the

sacrificial anode is disposed in proximity to the inlet connection.

15. The method of claim 12, wherein the sacrificial anode consists essentially of an active metal.

16. The method of claim 15, wherein the sacrificial anode consists essentially of aluminum, magnesium, or zinc.

17. The method of claim 12, wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly in a fitting hole in the radiator.

18. The method of claim 12, wherein the sacrificial anode is grounded.

19. The method of claim 12, wherein installing the sacrificial anode assembly further comprises: installing

the sacrificial anode assembly within the fluid flow of the radiator.

20. The method of claim 12, wherein the radiator comprises aluminum.

21. The method of claim 12, wherein the hot liquid is coolant.

22. The method of claim 12, wherein the hot liquid is water.

23. The method of claim 12, wherein the hot liquid is antifreeze.

24. The method of claim 12, further comprising installing a second sacrificial anode assembly within the radiator.

25. [i] A radiator for use in a motor vehicle, the radiator further comprising:

[ii] a hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine; and

[iii] a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.

26. The radiator of claim 25, wherein the sacrificial anode consists essentially of an active metal.

27. The radiator of claim 26, wherein the active metal is at least one of aluminum, magnesium, and zinc.

28. The radiator of claim 25 wherein the sacrificial anode is installed in a fitting hole penetrating the radiator.

29. The radiator of claim 25 wherein the sacrificial anode is installed onto a surface of the radiator.

30. The radiator of claim 25 wherein the sacrificial anode is grounded to the motor vehicle.

31. The radiator of claim 25 wherein the radiator comprises aluminum.

32. The radiator of claim 25 wherein the radiator enables air-cooling of the hot liquid.

33. The radiator of claim 25, further comprising a second sacrificial anode.

34. The radiator of claim 25, wherein the hot liquid is coolant.

35. The radiator of claim 25, wherein the hot liquid is water.

36. The radiator of claim 25, wherein the hot liquid is antifreeze.

37. [i] An electrolysis prevention device for preventing corrosion, the electrolysis prevention device comprising:

[ii] a sacrificial anode made of an active metal; and

[iii] an anode holder supporting the sacrificial anode, the anode holder adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.

38. The electrolysis prevention device of claim 37, wherein the sacrificial anode comprises aluminum.

39. The electrolysis prevention device of claim 37, wherein the sacrificial anode comprises magnesium.

40. The electrolysis prevention device of claim 37, wherein the sacrificial anode comprises zinc.

41. The electrolysis prevention device of claim 37, wherein the engine radiator is used in a motor vehicle, and wherein the sacrificial anode is grounded to the motor vehicle.

42. The electrolysis prevention device of claim 37, wherein the engine radiator comprises aluminum.

43. The electrolysis prevention device of claim 37, wherein the anode holder enables the sacrificial anode to be located within fluid flow of the hot coolant inlet.

44. The electrolysis prevention device of claim 37, wherein the anode holder is installed in a fitting hole penetrating the engine radiator.

45. The electrolysis prevention device of claim 37, wherein the hot liquid is coolant.

46. The electrolysis prevention device of claim 37,
wherein the hot liquid is water.

47. The electrolysis prevention device of claim 37,
wherein the hot liquid is antifreeze.

A. Specification

32. The '494 Patent states that "[t]his application relates generally to motor vehicles...and in particular to radiators and engines and preventing corrosion in the cooling system of said vehicles, especially those with components of dissimilar metal construction which present most cooling system corrosion problems." *Id.*, 1:35–41. The '494 Patent explains that "[a]utomobile cooling systems circulate water and coolant liquids through an engine's water jacket, head, and water pump to facilitate heat transfer" and that "[a]fter absorbing the heat, the hot liquid is piped back to the radiator/storage tank which is a liquid to air heat exchanger." *Id.*, 1:43–47. The '494 Patent also explains a "typical radiator is made up of a storage tank either above or to the side of the cooling tubes and exchanged cooling fins" and that "[t]his storage tank has an opening to the interior of the storage tank part, a core of cooling tubes, which is where the coolant liquid flows, and fins, connected to these cooling tubes, which transfer heat to the air that is pulled or pushed through the fins

and around the tubes for heat transfer from the coolant to the air passing through.”

Id., 1:47–55.

33. According to the '494 Patent, “[o]ver time..., aluminum parts have been incorporated into engine thermal control devices, such as radiators and heater cores” and “[w]hile the use of aluminum offers several advantages an unfortunate side effect of using dissimilar metals is an increase in electrolytic activity, leading to increased vulnerability to corrosion.” *Id.*, 1:58–64. The '494 Patent states that “[i]n response to the electrolytic activity, also known as electrolysis, aluminum components corrode and become porous and may begin to leak in as little as two weeks.” *Id.*, 1:64–67.

34. The '494 Patent states that “[d]uring electrolysis, one of the metals in the system acts as an anode and corrodes” and “[t]he other metal acts as a cathode and does not corrode.” *Id.*, 2:1–3. The '494 Patent recognizes that “sacrificial anodes, constructed of active metals, that is metals that react with oxygen, such as magnesium, aluminum, zinc or combinations thereof, *have also been used* as corrosion inhibitors.” *Id.*, 2:6–9. Thus, the '494 Patent recognizes that use of sacrificial anodes (including those made of magnesium, aluminum, zinc or combinations thereof) in radiators was nothing new. Indeed, as I explain in Sections VII and VIII, below, Tomosada (EX1005), Hanazaki-069 (EX1006), Hanazaki-196 (EX1007), and Godefroy (EX1008) all taught use of such sacrificial anodes in

radiators years (indeed, in most cases, decades) before the effective filing date of the '494 Patent.

35. The '494 Patent also states that “[a] need exists for a corrosion-inhibiting sacrificial anode which is easily accessible” and that “[s]ince a sacrificial anode is designed to be consumed, easy accessibility would allow verification of its effective working status and efficient replacement when depleted.” EX1001, 2:19–23. The '494 Patent states that “prior attempts at preventing corrosion in heat exchangers have failed due to the sacrificial anode being installed in undesirable locations.” *Id.*, 2:24–26. The '494 Patent also states that “a need continues to exist to prevent corrosion in radiators and other engine thermal control devices” and that “[c]urrent sacrificial anode devices are deficient in that they fail to position the anode optimally to allow for maximal corrosion resistance and easy monitoring, removal, and replacement.” *Id.*, 2:32–36.

36. The '494 Patent describes several embodiments. However, the embodiments of Figures 1A–8B appear to be most pertinent to independent claims 12, 25, and 37. I discuss these embodiments in more detail below.

37. According to the '494 Patent, “FIG. 1A is a left side cross-sectional view of a radiator 11 having an electrolysis prevention device 12 in accordance with a first preferred embodiment of the present invention.” *Id.*, 6:27–29. The '494 Patent explains that “an electrolysis prevention device 12 includes a sacrificial anode 13

supported at the end of a sleeve wire, metal slide, clip 15 or the like such that the anode is disposed adjacent the radiator inlet 17.” *Id.*, 6:30–33. The ’494 Patent states that the “anode 13 should be composed of a metal that reacts strongly with oxygen, also known as an active metal, such as magnesium, aluminum, zinc or combinations thereof.” *Id.*, 6:33–36.

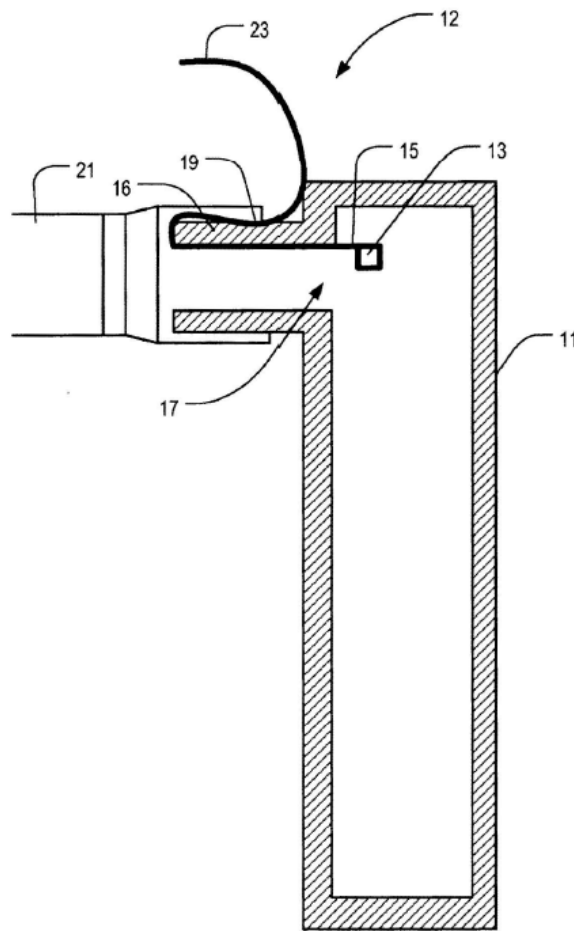


FIG. 1A

38. The ’494 Patent explains that “[t]he radiator hose 21 slides over the inlet [fitting] connection 16 and is clamped in place.” *Id.*, 6:39–40. The ’494 Patent

also states that “[s]uch an assembly 12 can be installed very quickly and can be used in radiators having plastic tanks as well as in radiators having aluminum tanks.” *Id.*, 6:47–49. The ’494 Patent teaches that a “typical radiator includes an aluminum core 31 and either plastic or all-aluminum tanks 33” and that “[t]he specific inlet connection 16 varies by vehicle make, model and model year, but the inlet 17 is generally understood to refer to the vicinity of where hot water coming directly from the engine enters into the radiator 11.” *Id.*, 7:2–8.

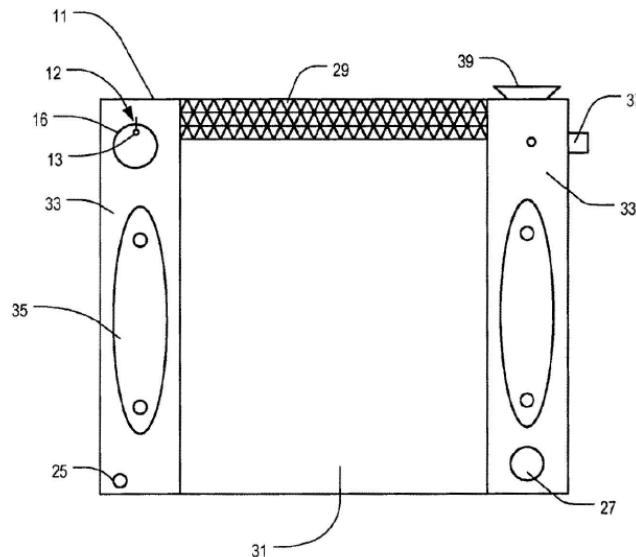


FIG. 1B

39. The ’494 Patent states that “FIG. 2A is a left side cross-sectional view of a radiator 11 having an electrolysis prevention device 112 in accordance with a second preferred embodiment of the present invention.” *Id.*, 7:17–20. The ’494

Patent explains that the “electrolysis prevention device 112 in this embodiment is generally similar to that of FIG. 1A, but the anode 13 itself hangs further down below the center axis of the radiator inlet 17 so as to be placed slightly lower into the flow of the water, coolant, or antifreeze.” *Id.*, 7:20–24.

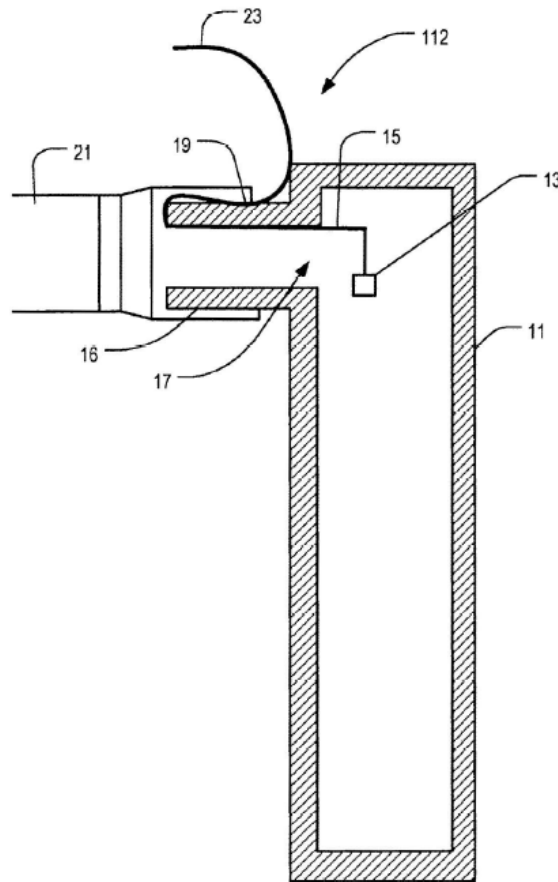


FIG. 2A

40. The '494 Patent also states that “FIG. 3A is a left side cross-sectional view of a radiator 11 having an electrolysis prevention device 212 in accordance with a third preferred embodiment of the present invention....” *Id.*, 7:34–41. The '494 Patent explains that “[i]n this preferred embodiment, the sacrificial anode 13

and support 19 are held in place with a clamp 41.” *Id.*, 7:43–45.

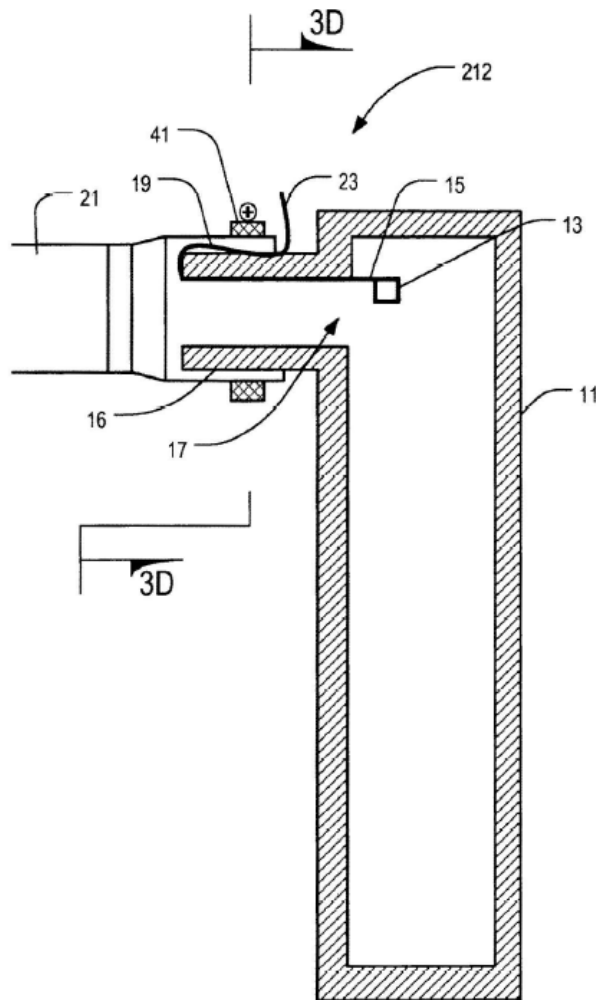


FIG. 3A

41. The '494 Patent also states that “FIG. 4A is a left side cross-sectional view of a radiator having an electrolysis prevention device 312 in accordance with a fourth preferred embodiment of the present invention....” *Id.*, 7:50–57. The '494 Patent states that “[i]n this embodiment, the electrolysis prevention device 312 is built into the radiator 11 when the radiator 11 is manufactured.” *Id.*, 7:57–59.

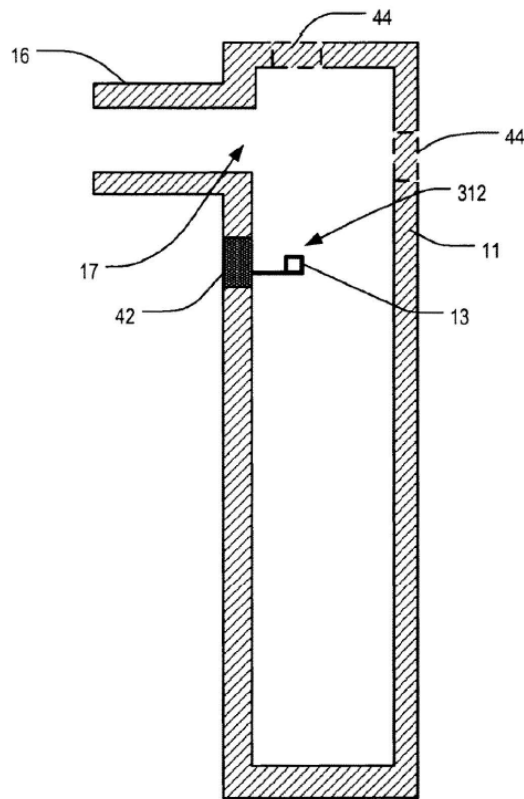


FIG. 4A

42. The '494 Patent also states that “FIG. 5A is a left side cross-sectional view of a radiator illustrating various locations for a removable plug 43 that may be replaced with an electrolysis prevention device 412 in accordance with a fifth preferred embodiment of the present invention....” *Id.*, 8:5–15.

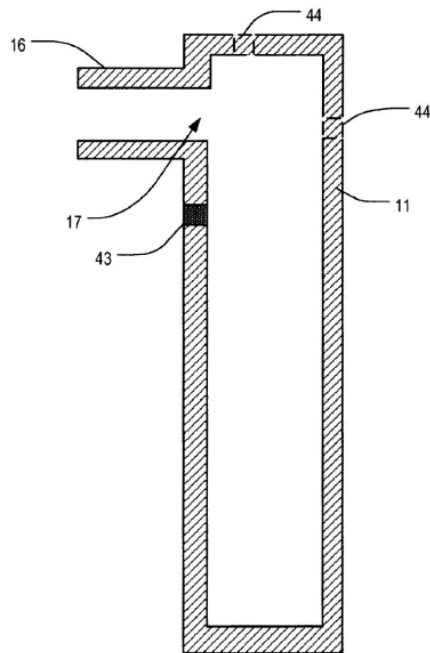


FIG. 5A

43. The '494 Patent provides that "FIG. 6A is a left side cross-sectional view of the radiator of FIG. 5A, shown with an electrolysis prevention device 412 installed in place of the removable plug 43...." *Id.*, 8:24–33.

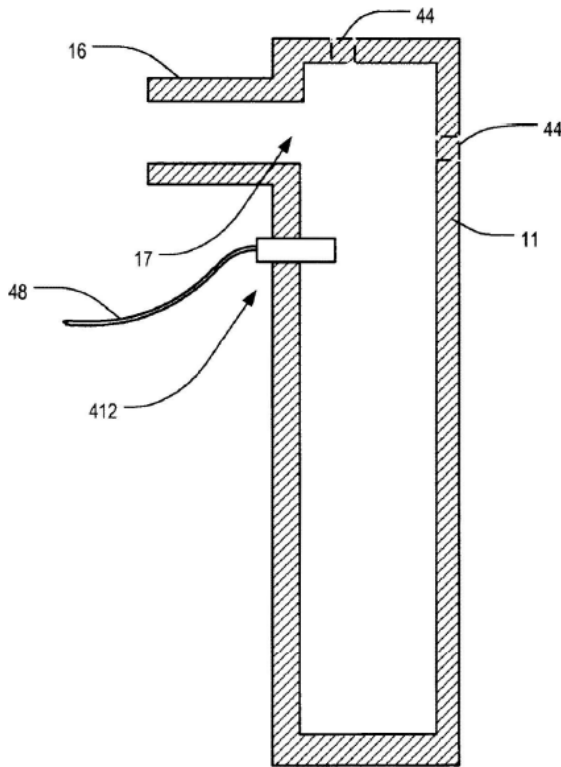


FIG. 6A

44. With reference to FIG. 7B, the '494 Patent states that the “sacrificial anode 13 and an anode holder 45 with a ‘pigtail’ connector 47 into which the anode attaches.” *Id.*, 8:40–51.

412

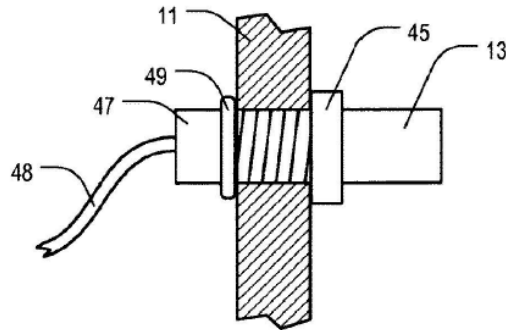


FIG. 7B

45. The '494 Patent also states that "FIGS. 8A and 8B are side schematic views of two electrolysis prevention devices arranged at different angles to promote easy access." *Id.*, 9:23–25. A POSITA would have understood that use of the term "electrolysis" in the '494 Patent means the same thing as electrochemical corrosion for purposes of the teachings '494 Patent.

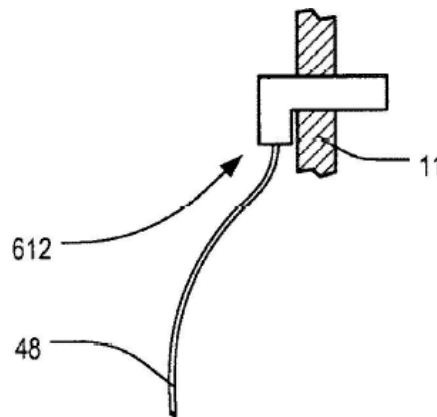


FIG. 8A

46. As I explain below, the combinations of features that the '494 Patent recited in the challenged claims were not innovative as of the effective filing date, as demonstrated at least by the prior art teachings in Tomosada (EX1005), Hanazaki-069 (EX1006), Hanazaki-196 (EX1007), and Godefroy (EX1008).

B. Summary of the Prosecution History

47. I understand that the '145 patent was examined before the '494 Patent. When examination of the '145 patent began, the Examiner initially rejected many claims under 35 U.S.C. § 102 as being anticipated by U.S. Patent No. 4,776,392 to Loyd ("Loyd," EX1017). EX1009, 51. In the same Office Action, the Examiner also rejected several claims under 35 U.S.C. § 102 as being anticipated by U.S. Patent No. 5,649,591 to Green ("Green," EX1011), and rejected several claims under 35 U.S.C. § 103 as being obvious in view of Loyd and Green. EX1009, 54–59.

48. In response, the applicant largely argued against the Examiner's rejections. Specifically, the applicant stated that "the Examiner makes no mention of what element of the Loyd device, if anything, he considers to be an anode holder" and that "the Applicant directs the Examiner's attention to, for example, FIG. 1A, wherein a radiator hose (reference numeral 21) is shown installed around an inlet fitting (16)." *Id.*, 36. The Examiner then allowed the application. *Id.*, 22.

49. A reissue application was then filed requesting that new claims be added to the '145 patent. EX1010, 40–45. Examination began by the Specialist

mailing an Office Action that raised multiple rejections including a rejection of several claims under 35 U.S.C. § 102 as being anticipated by Green (*id.*, 110) and several claims under 35 U.S.C. § 103 as being obvious in view of Green and U.S. Patent No. 1,514,903 to Gush (“Gush,” EX1012) (EX1010, 112).

50. Under a heading titled “Claim Construction,” the Specialist noted:

All of the independent claims 1, 12, 13, 20 and 23 require a heat exchange component having an inlet. The ’145 Patent notes in col. 5, lines 39-47 that the meaning of each term used therein should be given the meaning understood by the Ordinary Artisan. In col. 6, lines 1-3, “engine heat exchange component” is stated to refer to an engine radiator, heater core or other device for exchanging heat in an engine. In col. 6, lines 52-55, the ’145 Patent says: “The specific inlet connection 16 varies by vehicle make, model and model year, but the inlet 17 is generally understood to refer to the vicinity of where hot water coming directly from the engine enters into the radiator 11.” Therefore, the term “engine heat exchange component” will be considered synonymous with “radiator” and “inlet” will be interpreted **as the vicinity of the heat exchange**

component where hot water enters. “Inlet” and “Inlet connection” will be interpreted differently in that the connection is a specific structure while the inlet is the vicinity of the inlet connection.

Col. 6, lines 55-58 of the '145 Patent state: “The radiator 11 may include a fill cap 39 as shown in FIG. 1C but is understood to be optional and is not present on many radiators 39.” FIG. 1C shows an anode holder 12 directly adjacent to the inlet 17 but also shows a fill cap 39 in the vicinity of the inlet. The discussion of crossflow vs. downflow radiator types in col. 6, lines 10-45 lacks a mention of the fill cap 39, but the figures appear to illustrate that downflow radiators locate the inlet connection and the fill cap on the upper side of the radiator. The figures are inconsistent in the labeling of the inlet 17 or the inlet connection 16 or both. Therefore, “inlet connection” and “fill cap” will be interpreted as separate structures because a fill cap or the opening into which a fill cap enters would not permit hot water to enter

a radiator. Furthermore, the inlet connection and fill cap would have to be adjacent to each other for an anode holder or anode assembly located in the fill cap to be adjacent the inlet connection. However, since the inlet is not a structure but a vicinity, the fill cap would only need to be in the same vicinity as the inlet connection for the fill cap to be adjacent the inlet.

Id., 108–109 (emphasis in original).

51. Along with the Office Action, the Specialist included a Notice of References cited which listed 7 references, one of which is Hanazaki-196. *Id.*, 116. The image below includes the only English portion of Hanazaki-196 that was included with the Office Action. *Id.* 117., Hanazaki-196 is in Japanese.

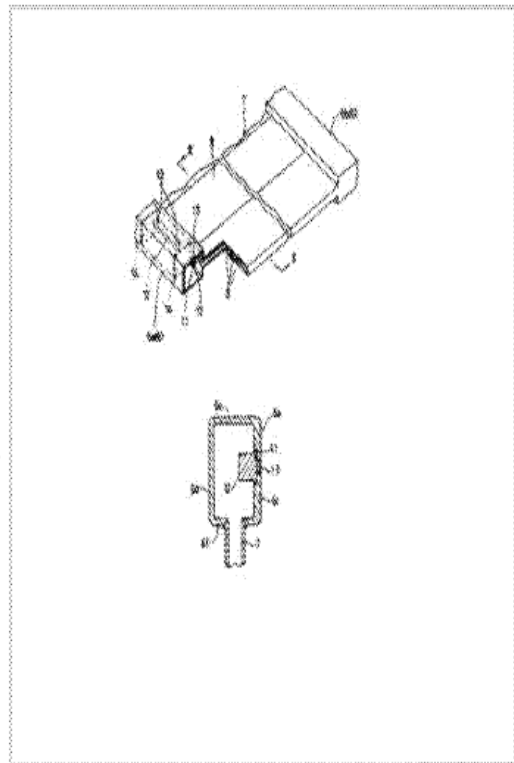
(11)Publication number : 01-217196
(43)Date of publication of application : 30.08.1989
(51)Int.Cl. : F28F 19/00
(21)Application number : 63-040880
(22)Date of filing : 25.02.1988
(71)Applicant : NIPPON LIGHT METAL CO LTD
(72)Inventor : HANAZAKI MASAYUKI
KAWAKITA KOJI

(54)HEAT EXCHANGER MADE OF ALUMINUM

(57)Abstract

PURPOSE: To solve problems of corrosion, and to improve durability of the title heat exchanger by providing a sacrifice anode made of a metal less noble than aluminum, which drops the electric potential of a pipe passage lower than the level of its pitting potential, on the inner wall of the pipe passage forming a brine flow path.

CONSTITUTION: On the inner wall of a pipe passage forming the brine flow path of a heat exchanger made of aluminum, which uses a brine consisting of an aqueous calcium chloride solution or an aqueous sodium chloride solution, is provided a sacrifice anode which is made of a metal less noble than aluminum and which drops the electric potential of the pipe passage by 50mV or more from the level of its pitting potential. Constituent substances for the anode electrode that meets such requirements may include zinc(Zn), magnesium(Mg) or an alloy of these metals, such as, for example, an alloy of Al-Zn-In-others. As for the amount of the sacrifice anode to be used, in the case where it is made of an aluminum alloy, an area ratio (anode/cathode area ratio) of the heat exchanger to the inner wall of the pipe passage is preferably 1:20W1:100.



Id.

52. In my opinion, it would have been very difficult for a POSITA to have comprehended the full teachings of Hanazaki-196 from only the image and text above. For example, this image and text does not fully explain where the sacrificial anode is located in Hanazaki-196 (it merely says “[o]n the inner wall of a pipe

passage forming the bring flow path”). While the figures from Hanazaki-196 are provided (*id.*, 124–126), it still would have been very difficult from a POSITA to have comprehended the full teachings of Hanazaki-196 from only the figures. For example, the teachings of Hanazaki-196 with respect to the header pipe 6a would have been beneficial to a POSITA in understanding where the inlet is located. *See* EX1007, 4 (disclosing header pipes 6a, 6b and stating that a “coolant supplying opening and coolant exhausting opening are provided at the two ends of the primary side header pipe 6a that is positioned on the upstream side....”). I explain these teachings in more detail in Sections VII and VIII, below.

53. In response, the patent owner largely argued against the Specialist’s rejections. With regard to Green, the patent owner stated that “Green describes a radiator cap that incorporates or has a sacrificial node attached to the cap” and that “Green is completely silent regarding where the cap is positioned on the radiator or any relationship to the position of the inlet that receives hot water from the engine.” *Id.*, 144. The patent owner also said that “[t]he current claims are based on the discovery by the inventor that in a radiator or heat exchanger core, a sacrificial anode oxidizes or corrodes and thus prevents electrolysis only when placed in proximity to the hot water inlet,” that “[t]his invention thus solves a problem that was unrecognized in the art,” and that “[a]dditionally, there is no evidence presented that

any sacrificial anode was placed near an inlet in any prior art radiator.” *Id.*, 145. However, the patent owner did not rebut the Specialist’s construction of “inlet.”

54. The Specialist then mailed another Office Action with numerous rejections. This second Office Action again raised multiple rejections including a rejection of several claims under 35 U.S.C. § 102 as being anticipated by Green. *Id.*, 169. In discussing these rejections, the Specialist said that “Green appears to illustrate a downflow type radiator in figure 3” and that “[b]ased on the claim construction outlined above, the ordinary artisan would understand that the radiator cap is adjacent an inlet and therefore the anode assembly is adjacent an inlet.” *Id.*, 170. The Specialist also stated: “Patent Owner argues only that Green cannot anticipate the claim because Green doesn't disclose an ‘inlet’ per se. These arguments dismiss the claim construction which is cited within the rejection over Green. Patent Owner has made no attempt to dispute the claim construction set forth.” *Id.*, 171.

55. The patent owner then filed a response without amending the independent claims. *Id.*, 197. With respect to the Specialist’s constructions, the patent owner stated that “[a]n inlet is more properly understood in the art as an opening that allows the inflow of liquid” and “[s]o, while Patent Owner agrees that inlet is not necessarily a structure, the inlet is formed by an opening in the wall of

the radiator or heater core that lets the water flow in.” *Id.*, 198. The patent owner also stated:

An inlet, designated by identifier 17, as shown in Figs. 1 A, 1 C, 2A, 2C, 3A, 3D, 4A, 4C, 5A, SC, 6A, 6C, and 10A, is illustrated as an opening in the wall that connects the interior of the connector to the fluid path in the heat exchange component. The inlet is, in every case, shown to be within the interior area of that opening when seen from the facing perspective and as at the opening in the wall of the heat exchange component when seen in cross-section.

Patent Owner urges, therefore, that the term inlet be construed to indicate an opening in the wall of the heat exchange component through which the hot water from the engine flows. For example, the specification at col 6, ln 10, describes the anode support as extending “through and out the radiator inlet.” This is another indication that the inlet is correctly construed as an opening in the wall between the connector and the interior of the heat exchange component.

Patent Owner agrees that the inlet connection and the fill cap are different structures, however, Patent Owner submits that in order for the fill cap to anticipate claim 12, for example, the fill cap would need to be adjacent the inlet opening in the wall, rather than adjacent some undefined vicinity of the opening.

Id.

56. With respect to Green, the patent owner argued that “Green is completely silent regarding where the cap is positioned on the radiator or any relationship to the position of the inlet that receives hot water from the engine.” *Id.*, 199.

57. The Specialist then mailed another Office Action with numerous rejections. The Specialist stated:

All of the independent claims 1, 12 and 13 require a “heat exchange component” having an inlet. The ’145 Patent notes in col. 5, lines 39-47 that the meaning of each term used therein should be given the meaning understood by the Ordinary Artisan. In col. 6, lines 1-3, “engine heat exchange component” is stated to refer to an engine

radiator, heater core or other device for exchanging heat in an engine. Patent Owner's remarks submitted May 24, 2016 pages 6 and 7 profess the intention for the term "engine heat exchange component" to be broader than a radiator and to include other devices to exchange heat in an engine. Therefore, "engine heat exchange component" will be considered to include any device exchanging heat in an engine.

In col. 6, lines 52-55, the '145 Patent says: "The specific inlet connection 16 varies by vehicle make, model and model year, but the inlet 17 is generally understood to refer to the vicinity of where hot water coming directly from the engine enters into the radiator 11." Patent Owner's remarks submitted May 24, 2016 on page 7 profess the intention for the term inlet to indicate an opening in the wall of the heat exchange component through which hot water from the engine flows. Therefore, the "inlet" will be considered to mean an opening in the wall of the heat

exchange component through which hot water from the
engine flows.

Id., 219–220.

58. This third Office Action again raised multiple rejections including a rejection of several claims under 35 U.S.C. § 102 as being anticipated by U.S. Patent No. 6,109,987 to Watanabe, *et al.* (“Watanabe,” EX1013), and several claims under 35 U.S.C. § 102 as being anticipated by Gush. *Id.*, 221–222. The Office Action also included a rejection of multiple claims under 35 U.S.C. § 102 as being obvious in view of Gush and Green. *Id.*, 223.

59. In response, the patent owner largely argued against the Specialist’s rejections. Specifically, the patent owner stated that “[t]he only inlet for coolant described in Watanabe is the inlet 75 in which uncooled water from the body of water in which the motor is operating enters the engine cylinder block.” *Id.*, 236.

60. The Specialist then mailed another Office Action with numerous rejections and reiterating its claim construction. This fourth Office Action again raised multiple rejections including a rejection of several claims under 35 U.S.C. § 102 as being anticipated by Chinese Patent No. 1225998A to Guo (“Guo,” EX1014) (EX10101, 249), a rejection of several claims under 35 U.S.C. § 102 as being anticipated by Watanabe (*id.*, 250), and a rejection of several claims under 35 U.S.C. § 102 as being anticipated by Gush (*id.*, 251). The Office Action also

included a rejection of a claim under 35 U.S.C. § 103 as being obvious in view of Guo and Green. *Id.*, 252.

61. In response, the patent owner incorporated the feature that the “sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator” into claim 12. *Id.*, 315. The patent owner argued that “Figure 1 in Gou (sic) does not explicitly or inherently teach that ‘the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator’ because in Gou, ‘sacrificial anode 3 mounted on a bleed valve 4’ does not explicitly or inherently anticipate ‘a hot liquid inlet to the radiator’, as recited in amended claim 12.” *Id.*, 320. With respect to Gush, the patent owner stated that the “cooling water manifold ‘O’ appears to be a component of ‘an internal combustion engine’ and not a part of a radiator (see *Gush*, pg 2, col 1, ln 20-29; Figs 4, 5)” and that “there is no explicit or inherent disclosure of any ‘inlet to the radiator’ in *Gush* and the depiction of radiator ‘L’ in *Gush* does not explicitly show or describe ‘a hot liquid inlet to the radiator’, as recited in amended claim 12.” *Id.*, 321.

62. The Specialist then mailed another Office Action with numerous rejections and stated:

In col. 6, lines 52-55, the ’145 Patent says: “The specific inlet connection 16 varies by vehicle make, model and model year, but the inlet 17 is generally understood to refer

to the vicinity of where hot water coming directly from the engine enters into the radiator 11.” Patent Owner’s remarks submitted May 24, 2016 on page 7 profess the intention for the term inlet to indicate an opening in the wall of the heat exchange component through which hot water from the engine flows. Therefore, the “inlet” will be considered to mean an opening in the wall of the heat exchange component through which hot water from the engine flows.

Id., 331–332.

63. This fifth Office Action again raised multiple rejections including a rejection of several claims under 35 U.S.C. § 103 as being obvious in view of Guo (*id.*, 333) and a rejection of several claims under 35 U.S.C. § 103 as being obvious in view of Gush (*id.*, 337). The Office Action also included a rejection of several claims under 35 U.S.C. § 103 as being obvious in view of Guo and Green. *Id.*, 338.

64. In response, the patent owner argued that “*Guo* is directed to ‘heating equipment’ of the type typically installed for indoor heating” and that “the assertion by the Office that ‘the ideal location would have depended on the actual size of the radiator and the Gou (sic) anode would not have performed differently from the claimed anode’ is also factually incorrect.” *Id.*, 356.

65. The Specialist then mailed an Advisory Action and stated “[f]urther consideration or search is required to review arguments concerning what, if any, differences exist between radiators for heating and radiators for cooling....” *Id.*, 364. The patent owner then filed another response similar to that filed before the Advisory Action. *Id.*, 382.

66. The Specialist then mailed another Office Action with numerous rejections and stated:

All of the claims require an “inlet” or “inlet connection”.

In col. 6, lines 52-55, the ’145 Patent says: “The specific inlet connection 16 varies by vehicle make, model and model year, but the inlet 17 is generally understood to refer to the vicinity of where hot water coming directly from the engine enters into the radiator 11.” Patent Owner’s remarks submitted May 24, 2016 on page 7 profess the intention for the term inlet to indicate an opening in the wall of the heat exchange component through which hot water from the engine flows. In the same submission, Patent Owner agrees that the fill cap is a different structure. Therefore, the “inlet” will be considered to mean

an opening in the wall of the claimed radiator through
which hot water from the engine flows.

Id., 395–396.

67. This sixth Office Action again raised multiple rejections including a rejection of several claims under 35 U.S.C. § 103 as being obvious in view of Gush and Ford Care and Home Repair, How to Enjoy Your Ford Car, *Radiator Repairs*, 1922 Ed. to Murray Fahnestock (“Fahnestock,” EX1015). *Id.*, 397. The Office Action also included a rejection of several claims under 35 U.S.C. § 103 as being obvious in view of Gush, Fahnestock, and Guo. *Id.*, 401. The Office Action also included a rejection of several claims under 35 U.S.C. § 103 as being obvious in view of Gush, Fahnestock, and Green. *Id.*, 404. The Office Action also included a rejection of a claim under 35 U.S.C. § 103 as being obvious in view of Gush, Fahnestock, Guo, and Green. *Id.*, 404.

68. An interview was then conducted and the Interview Summary states: “Mr Petrosino related the story of how a General Motors Technical Service Bulletin(TSB) and subsequent (sic) TSB led him to attempt the use of a grounded magnesium electrode near the hottest portion of a radiator interior and the successful protection of the radiator. This story was not of record previously and the examiner expressed that it presented the claims in a new light.” *Id.*, 448.

69. The patent owner then filed another response. The patent owner argued that “*Gush* instead discloses an electrode that is connected to a source of electricity and is used to introduce current into the water in a radiator.” *Id.*, 480. The patent owner also argued that “[n]othing in *Gush* describes the electrode it discloses as having any of these characteristics, e.g., being constructed of a relatively more active metal or being preferentially corroded or consumed.” *Id.*, 480–481. The patent owner also argued that “*Guo* is directed to an entirely different type of equipment from the automotive applications disclosed in *Gush* and *Fahnestock*.” *Id.*, 483.

70. The Specialist then mailed a Notice of Allowance. The Specialist stated:

The following is an examiner’s statement of reasons for allowance: The prior art, alone or in combination, fails to teach or fairly suggest radiators, electrolysis prevention devices installed in engine radiators, or methods of preventing corrosion of a radiator wherein a sacrificial anode is installed within ten inches of a hot liquid inlet of the radiator as claimed in claims 12, 25 or 37. Likewise, the prior art does not teach or fairly suggest electrolysis prevention devices supported by anode holders adapted to

fit around the inlet connection of an engine heat exchange component allowing for a hose to be attached over the device as claimed in claim 1. Also, the prior art does not teach or fairly suggest electrolysis prevention devices supported by anode holders adapted to fit through and around the inlet connection of an engine heat exchange component allowing for a hose to be attached to and around the inlet connection without dislodging the holder as claimed in claim 13. It would not have been obvious to modify the prior art radiators, devices and methods to arrive at the combinations embodied by claims 1, 12, 13, 25 or 37.

Id., 492.

71. It is my understanding that the Examiner did not consider Tomosada, Hanazaki-196, Hanazaki-069, and Godefroy during the prosecution of the '145 patent. It is also my understanding that the Specialist did not consider Tomosada, Hanazaki-069, and Godefroy during the prosecution of the '494 Patent.

C. Person of Ordinary Skill in the Art

72. I understand that there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including the educational level of active

workers in the field at the time of the alleged invention, the sophistication of the technology, the type of problems encountered in the art, and the prior art solutions to those problems.

73. In determining the characteristics of a hypothetical person of ordinary skill in the art of the '494 Patent at the time of the claimed invention, I considered several things, including the type of problems encountered in this field, and the rapidity with which innovations were made. I also considered the sophistication of the technology involved, the educational background and experience of those actively working in the field, and the level of education that would be necessary to understand the '494 Patent. Finally, I considered myself back in the relevant period of time and considered the state of the art and the level of skill of the persons working in this field at that time.

74. It is my opinion that the subject matter of the '494 Patent is a corrosion prevention system for a radiator. Based on the materials I have considered (including the prior art cited herein), my own knowledge and experience, and the level of skill required to design and build a corrosion prevention system for a radiator, I have come to the conclusion that the characteristics of a person of ordinary skill in the art of the '494 Patent would hold at least a bachelor's degree in mechanical engineering, metallurgical engineering, or materials science engineering, and have two or more years of experience in mechanical engineering, metallurgical engineering, or

materials science engineering and/or corrosion prevention system design. This hypothetical person would be capable of performing various design tasks and would understand the basic mechanical features and operation of a radiator; this hypothetical person would also have an appreciation for corrosion prevention and the mechanical and chemical issues and concerns associated with corrosion in a radiator. I believe these understandings are demonstrated, for example, by the prior art I discuss herein. A person could also have qualified as a person of ordinary skill in the art with some combination of (1) more formal education (e.g., an M.S. or Ph.D.) and less technical experience or (2) less formal education and more technical or professional experience in the fields listed above.

75. Although my qualifications and experience exceed those of the hypothetical person having an ordinary level of skill in the art, my analysis and conclusions herein are from the perspective of a person of ordinary skill in the art as in the 2000–2010 timeframe, unless otherwise noted.

VII. OVERVIEW OF THE REFERENCES RELIED UPON BY PETITIONER

A. Tomosada

1. Overview

76. Similar to the '494 Patent, Tomosada is directed to “improvements to an aluminum heat exchanger.” EX1005, 1. While Tomosada is not in English, I have

considered the certified translation of Tomosada which a POSITA would have understood as providing the teachings of Tomosada.

77. As an initial matter, and without regard to only Tomosada, a POSITA would have understood that a radiator is a heat exchanger. According to the '494 Patent, a "typical radiator is made up of a storage tank either above or to the side of the cooling tubes and exchanged cooling fins." EX1001, 1:47–49. Additionally, a POSITA would have understood that a common application for a radiator is use in an automobile to air-cool an engine of the automobile. For example, Godefroy discloses a "heat exchanger [that] can be constituted, for example, by a cooling radiator of a motor vehicle engine." EX1008, 5. A POSITA would have understood that the radiator provides this cooling by passing air across tubes, such as the heat exchanger tubes 1 of Tomosada, circulating the hot fluid within the radiator. Tomosada states that its radiator is "for an automobile." EX1005, 1.

78. Tomosada states that "[m]ost heat exchangers are made of copper or brass but in automobiles and other vehicles where there is demand for weight reduction, there is development of aluminum heat exchangers where heat exchanger tubes are formed using aluminum as a material" and that "since electrochemically, aluminum is a base metal relative to other structural metals typically used, anti-corrosion measures are required for heat exchanger tubes in an aluminum heat exchanger." *Id.* Tomosada is therefore directed to the same field as the '494 Patent

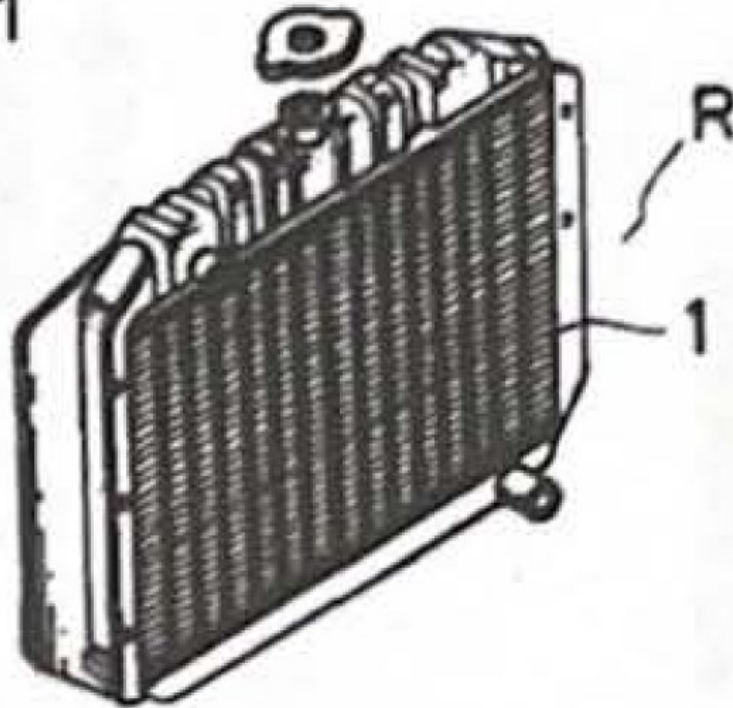
(corrosion prevention systems for radiators) and seeks to solve the same problem as the '494 Patent (how to prevent corrosion of a radiator due to dissimilar metals).

79. Tomosada first states that “conventionally, heat exchanger tubes are formed with anti-corrosion aluminum alloys with improved anti-corrosion characteristics such as aluminum-manganese and aluminum-magnesium” and that “heat exchanger tubes coated with zinc on the inner surface for the purpose of further improving anti-corrosion characteristics have been used.” *Id.* Tomosada explains that “this manner of anticorrosion method requires forming a zinc layer on the inner surface of small diameter heat exchanger tubes and so is expensive from a cost perspective.” *Id.*

80. Tomosada states that its “invention solves the problems associated with conventional aluminum heat exchangers, and provides an aluminum heat exchanger which is excellent in anti-corrosion characteristics, which can be manufactured at a low cost.” *Id.*

81. Tomosada then discusses its figures. First, Tomosada states that “[i]n FIG. 1 a radiator R for an automobile is illustrated.” *Id.* Figure 1 is provided below for reference.

FIG. 1



82. A POSITA would have understood that Figure 1 of Tomosada illustrates a hot liquid inlet, a liquid outlet, and a fill cap. I have provided an annotation of Figure 1 of Tomosada below highlighting the hot liquid inlet and the liquid outlet. Additionally provided below is Figure 1C of the '494 Patent, which shows a fill cap 39, a radiator inlet 17, and an outlet 27. *See* EX1001, 7:4–11. A POSITA would have understood that the connector on the same header as the fill cap is the hot liquid inlet (as is taught by the '494 Patent) and that the connector on the header opposite the fill cap is the liquid outlet.

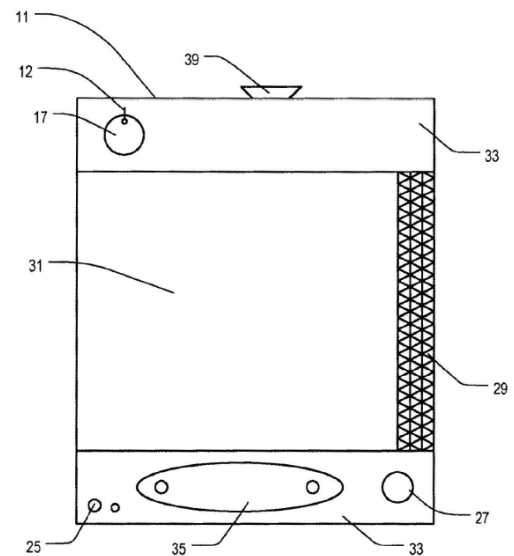
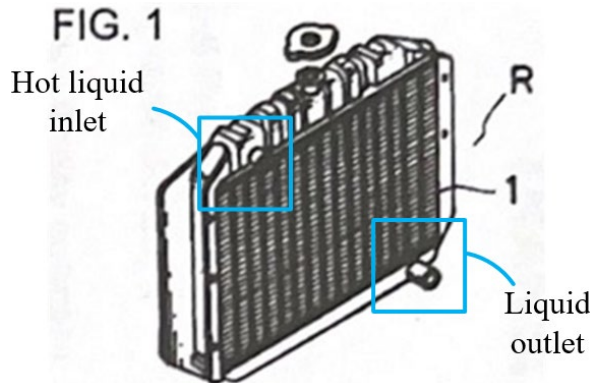
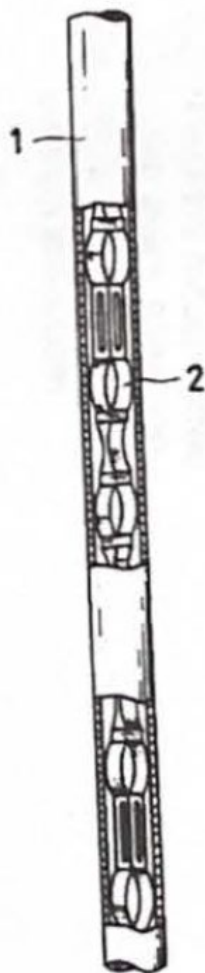


FIG. 1C

83. Tomosada then provides that “[a] heat exchanger tube 1 formed of anticorrosion aluminum alloy such as that illustrated in FIG. 2 is arranged inside the radiator R.” *Id.* Tomosada explains that a “turbulator 2 for improving heat exchange performance of the heat exchanger tube 1 is inserted into the heat exchanger tube 1.” *Id.* Figure 2 is provided below for reference. Tomosada does not state precisely when the turbulator 2 is inserted into the heat exchanger tube 1. Thus, a POSITA would have understood that either: (i) the turbulator 2 is inserted into the heat exchanger tube 1 prior to at least one of the headers being coupled to the heat exchanger tubes 1 or (ii) the turbulator 2 is inserted through the hot liquid inlet into the heat exchanger tubes 1 proximate the hot liquid inlet after the headers have been coupled to the heat exchanger tubes 1. A POSITA would have understood both (i) and (ii) to be

disclosed by Tomosada. In (i), the heat exchanger tubes 1 are coupled to one header (i.e., the lower header), the turbulators 2 are each inserted into one of the heat exchanger tubes 1, and then the second header (i.e., the upper header) is coupled to the heat exchanger tubes 1. In (ii), the heat exchanger tubes 1 are coupled to the headers without first inserting the turbulators 2, and then the turbulators 2 are fed through the hot water inlet into the heat exchanger tubes 1.

FIG. 2



84. Tomosada states that “[i]n this embodiment, the turbulator 2 is made using zinc or a zinc compound material that is an electrochemical base relative to aluminum” and that “[w]hen the heat exchanger tube 1 is filled with coolant, this turbulator 2 becomes a sacrificial anode relative to the heat exchanger tube 1 formed using an aluminum material with the heat exchanger tube 1 becoming the cathode and thus protected from corrosion.” *Id.*, 1–2. As an initial matter, a POSITA would have understood coolant a fluid that is circulated from a heat source to a radiator to provide cooling to the heat source. While water and antifreeze would not be understood to be coolant, water and antifreeze are fluids that are commonly circulated from a heat source to a radiator. *See, e.g.*, EX1006, ¶[0005]. A POSITA would have understood that use of water instead of coolant would have been advantageous and desirable in applications where, for example, coolant is not available but water is available. Similarly, a POSITA would have understood that use of antifreeze instead of coolant would have been advantageous and desirable in applications where, for example, the radiator is subjected to cold temperatures (e.g., to protect the radiator from damage).

85. Tomosada explains that “as the turbulator 2 formed of a zinc or zinc compound that acts as a sacrificial anode relative to the heat exchanger tube 1 is inserted into the heat exchanger tube 1 formed of an aluminum material, when the coolant filled in the heat exchanger tube 1 acts as an electrolyte solution, the

turbulator 2 becomes the anode and the heat exchanger tube 1 becomes the cathode.”

EX1005, 2. Tomosada teaches that “[a]s a result, the turbulator 2 is electrochemically corroded by battery action but on the other hand, similar to the case of forming a zinc layer by applying a zinc coating to the inner surface, the heat exchanger tube 1 becomes the cathode and is protected from corrosion.” *Id.*

86. As I explain in more detail below, A POSITA would have understood that the turbulator 2 is not configured such that the entire turbulator 2 is a sacrificial anode. As shown in Figure 2, the turbulator 2 is formed from a plurality of differently shaped components connected together. As shown, there are rectangular components, ring-shaped components, and bone-shaped components. Provided below is an annotation of Figure 2 of Tomosada annotating each of these components of the turbulator 2. The ring-shaped components taught by Tomosada are not sacrificial anodes and are rather intended to contact the heat exchanger tube 1 so as to support the sacrificial anodes (the rectangular components) within the heat exchanger tube 1 in the same way the wire 15 of the '494 Patent holds the sacrificial anode 13, as shown in Figure 1A, reproduced below. *See* EX1001, 6:30–33. As I explain below, a POSITA would have understood that the rectangular components are sacrificial anodes.

FIG. 2

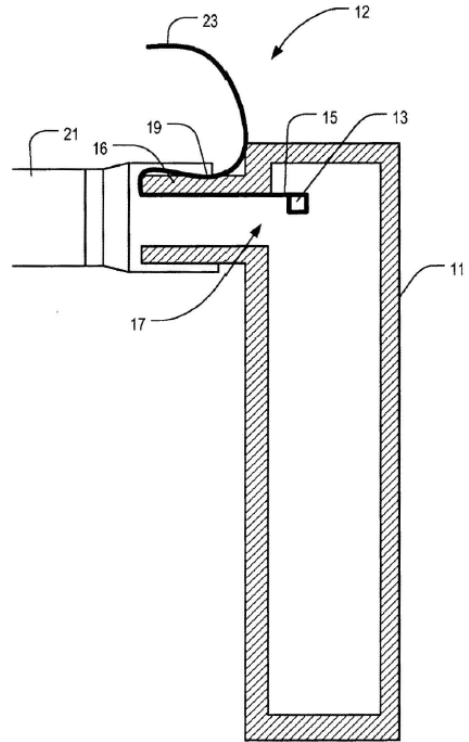
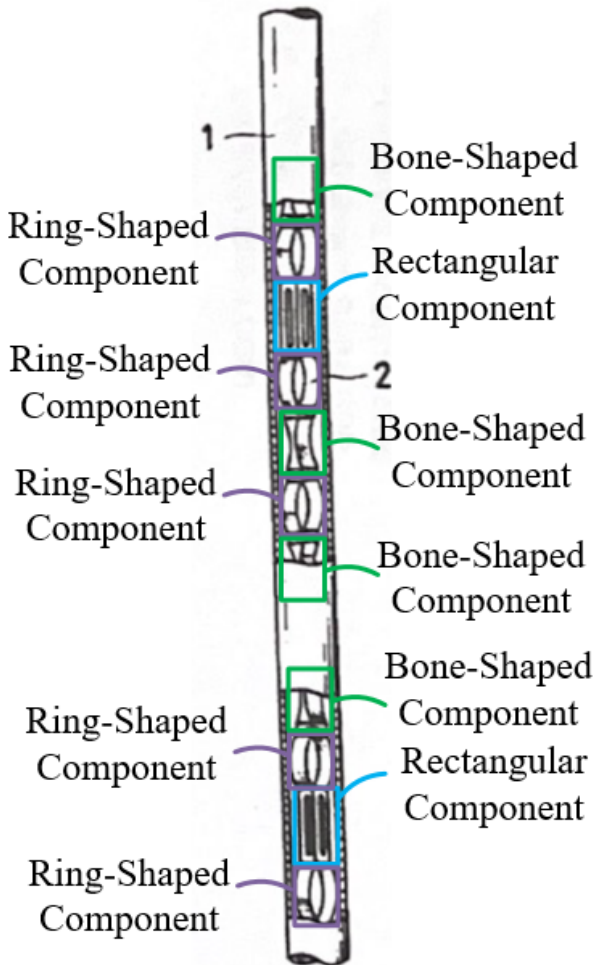


FIG. 1A

87. A POSITA would have understood that if these components were all electrochemically corroded, these components would be electrochemically corroded at different rates due to their different shapes and sizes. For example, a POSITA would have understood that the ring-shaped components and the bone-shaped components would be electrochemically corroded more quickly than the rectangular components due to the minimum cross-sectional area of the rectangular components

being greater than the minimum cross-sectional areas of the ring-shaped components and the bone-shaped components. Such a construction of the turbulator 2 (i.e., where the entire turbulator 2 is a sacrificial anode) would lead to mechanical failure, thereby causing the turbulator 2 to break apart during operation. For example, the ring-shaped components would be electrochemically corroded more quickly than the rectangular components, and the turbulator 2 may break apart at each ring-shaped component. The pieces of the turbulator 2 may then flow within the heat exchanger tube 1 and may damage downstream components of the radiator system (e.g., pumps, tanks, filters, hoses, etc.). The rectangular components are therefore preferentially corroded and are a piece of metal that are used to protect other pieces of metal. For at least these reasons, a POSITA would have understood that the rectangular components of the turbulator 2 are sacrificial anodes.

88. Similarly, a POSITA would have understood that the ring-shaped components are not sacrificial anodes. Rather, a POSITA would have understood that the ring-shaped components function to position the rectangular components within the heat exchanger tube 1 and provide an electrical contact with the heat exchanger tube 1. This electrical contact is necessary for the sacrificial anodes (the rectangular components) to function as anodes. For example, Figure 2 (detailed view below) depicts the ring-shaped components in contact with the heat exchanger tube 1 while also depicting a space between the rectangular components and the heat

exchanger tube 1. A POSITA would have understood that this contact between the ring-shaped components and the heat exchanger tube 1 is utilized in Tomosada to position the rectangular component within the heat exchanger tube 1 by limiting movement of the rectangular component relative to the heat exchanger tube 1 due to contact between the ring-shaped component and the heat exchanger tube 1.



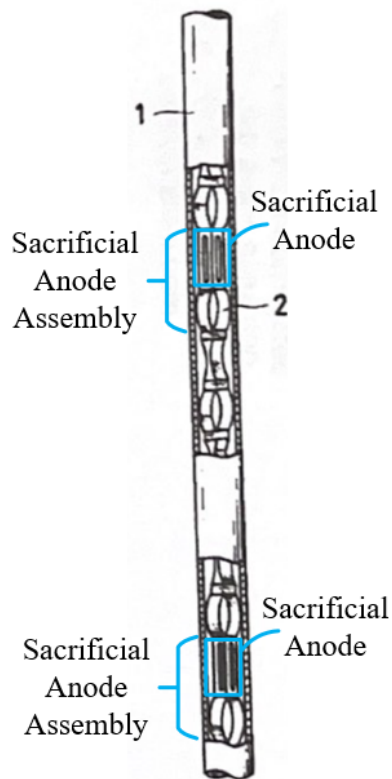
89. A POSITA would have understood that these various components (bone-shaped component, rectangular component, ring-shaped component) are assembled to form the turbulator 2. Additionally, as shown by the repetition of these components, a POSITA would have understood that this modularity would enable

the turbulator 2 to be tailored to a target application. For example, the repetition of components would enable the turbulator 2 to exhibit enhanced flexibility. Moreover, a POSITA would have also found it obvious to arrange the components in any order such that the turbulator 2 is tailored for a target application.

90. For at least these reasons, a POSITA would have understood that when Tomosada states that the “turbulator 2 becomes a sacrificial anode relative to the heat exchanger tube 1” (EX1005, 1–2), Tomosada means that at least one component, but *not all components*, of the turbulator 2 become a sacrificial anode relative to the heat exchanger tube 1. Accordingly, a POSITA would have understood that the turbulator 2 is necessarily a “sacrificial anode assembly including a sacrificial anode.” The assembly includes the rectangular component (the sacrificial anode) and multiple other components (the ring-shaped component and the bone-shaped component) that do not become sacrificial anodes.

91. A POSITA would have understood that the turbulator 2 includes multiple sacrificial anode assemblies, each of which includes one of the sacrificial anodes (the rectangular components) and at least one other component. Below I have provided an annotation of Figure 2 showing two sacrificial anode assemblies, each including one sacrificial anode (rectangular component) and one anode holder (ring-shaped component).

FIG. 2



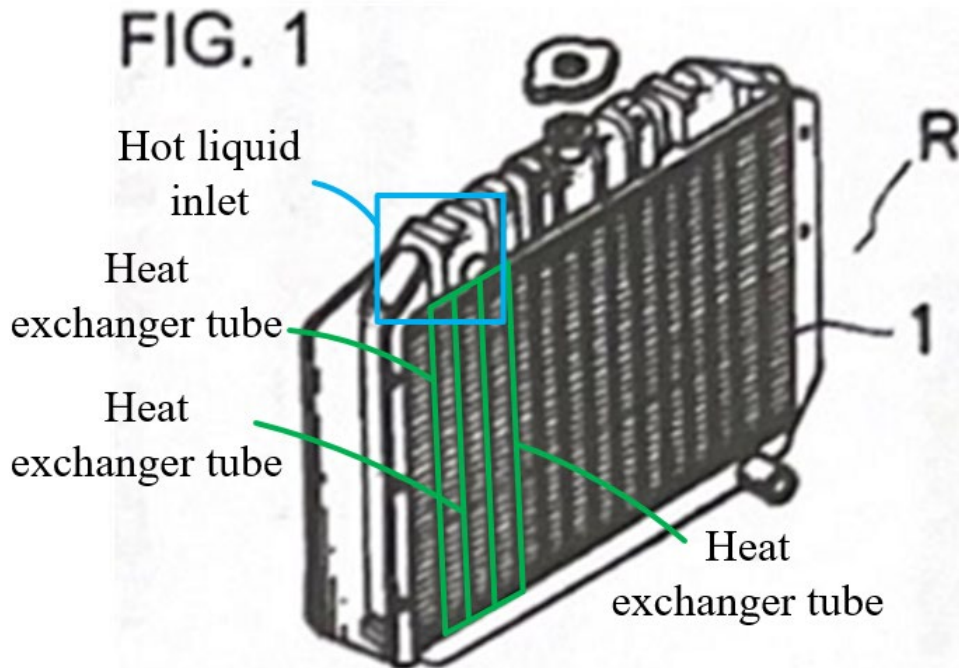
92. For the sake of argument only, a POSITA would have also found it obvious in view of Tomosada to have constructed the turbulator 2 as I have described above, to the extent such a construction is not already utilized in Tomosada. Namely, a POSITA would have found it obvious to construct the turbulator 2 out of multiple different components, where only some of the components (the rectangular components) are sacrificial anodes, and other components (at least the ring-shaped components) are not sacrificial anodes. Such a construction would provide the benefits of being modular so as to enable tailoring of the turbulator 2 to a target application, while also mitigating undesirable separation of the turbulator 2 due to

corrosion of components with relatively small cross-sectional areas. In this regard, Tomosada explains that while “in the embodiment described above, the case of forming the turbulator 2 using a zinc or zinc compound material was described but the turbulator 2 need only act as a sacrificial anode relative to the heat exchanger tube 1 formed using an aluminum material” and that “the shape of the turbulator 2 is not in particular limited to the shape illustrated in FIG. 2.” EX1005, 2.

93. Additionally, such a construction of the turbulator 2 would have provided cost savings relative to a turbulator 2 that is entirely a sacrificial anode. For example, such a construction of the turbulator 2 would have enabled a majority of the turbulator to be formed from aluminum, which often is less expensive, while only requiring a small portion of the turbulator to be formed from an aluminum alloy, zinc (or a zinc alloy), or magnesium (or a magnesium alloy), which often is more expensive. These cost savings would have been an important motivator to a POSITA because the turbulator 2 is replaceable and providing these cost savings would make the turbulator 2 more desirable. In this regard, Tomosada also teaches that a “corroded turbulator that was the sacrificial anode can easily be replaced with a new turbulator so an inexpensive aluminum heat exchanger with favorable corrosion resistance can be provided.” *Id.*

94. A POSITA would have understood that Tomosada teaches that the radiator R includes a plurality of heat exchanger tubes 1 extending between its top

header and its bottom header. As shown in the annotation of Figure 1, reproduced below, some of these heat exchanger tubes 1 are directly under the hot liquid inlet. Regardless of whether or not the turbulators 2 are inserted into the heat exchanger tubes 1 before or after the headers are coupled to the heat exchanger tubes 1, a POSITA would have understood that the turbulators 2 are inserted within heat exchanger tubes 1 that are directly under the hot liquid inlet.



95. Assuming the turbulators 2 are inserted prior to at least one of the headers being coupled to the heat exchanger tubes 1, a POSITA would have understood that the turbulator 2 would be located within each of the heat exchanger tubes 1. Such an understanding is consistent with, for example, Hanazaki-069 which explains that “it is preferable to provide a sacrificial anode over the entire length of

the radiator tube, so that the radiator tube receives corrosion protection uniformly in the longitudinal direction.” EX1006, ¶[0014]. By including at least one turbulator 2 for each heat exchanger tube 1, corrosion can be prevented throughout the radiator R.

96. Therefore, the turbulators 2 would be located within the heat exchanger tubes 1 underneath the hot liquid inlet. A POSITA would have understood that as a result of the turbulators 2 being located underneath the hot liquid inlet, the sacrificial anodes contained in each of the turbulators 2 would be placed within 10 inches of a center axis of a hot liquid inlet to the radiator of Tomosada. Moreover, if the turbulators 2 are inserted through the hot liquid inlet (i.e., after the headers have been coupled to the heat exchanger tubes 1), the sacrificial anodes contained in each of the turbulators 2 would be placed within 10 inches of a center axis of a hot liquid inlet to the radiator of Tomosada.

97. For the sake of argument only, a POSITA would have also found it obvious in view of Tomosada to have located the turbulators 2 within 10 inches of a center axis of the hot liquid inlet so as to prevent corrosion near the hot liquid inlet. A POSITA would have understood that corrosion prevention systems provide anodic protection over a certain distance upstream of a sacrificial anode and over a certain distance downstream of the sacrificial anode. This distance is significantly greater in the downstream direction due to the flow of the fluid through the radiator. Thus,

a POSITA would have been motivated to locate a sacrificial anode as close to a hot liquid inlet as possible because this would provide protection of portions of a radiator near the hot liquid inlet while still providing protection of portions of the radiator downstream of the hot liquid inlet. Thus, locating the sacrificial anode at the hot liquid inlet would provide the radiator with its maximum protection and easy replacement (i.e., through the hot liquid inlet without removal of the header).

98. A POSITA also would have understood that corrosion is greater at the hot liquid inlet than at the outlet. This difference is driven by not only the temperature of the fluid and more turbulent flow, which are each far greater at the hot liquid inlet, but also the fact that immediately upstream of the hot liquid inlet is the engine, which can itself provide ions into the fluid. Therefore, a POSITA would have found it obvious and beneficial to locate the sacrificial anode as close to the hot liquid inlet as possible. Hanazaki-069 explains that “water quality, temperature, flow velocity, pH, dissolved oxygen, etc.” impact the potential difference between a sacrificial anode and a tube. *Id.*, [0010]. A POSITA would have found it obvious to variously locate the sacrificial anode, such as within 10 inches of a center axis of the hot liquid inlet, in order to optimize these variables for a target application because such variations are merely a design choice that would have been well within the skill of a POSITA.

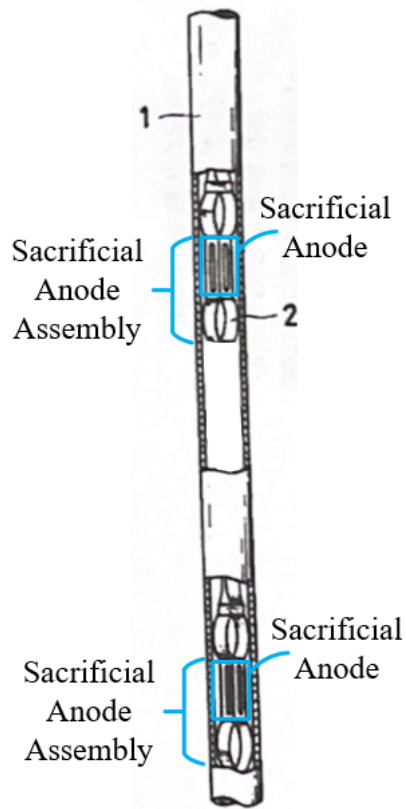
99. The '494 Patent does not include any teachings as to the importance of 10 inches. Instead, the '494 Patent merely states that the “device 12 may be attached to the interior of the radiator 11 at any of a variety of locations 44 in the vicinity of the inlet 17” and that “[i]n particular, this allows for an anode 13 to be attached by any way imaginable within 10 inches in any direction of the center axis of the inlet connection 16.” EX1001, 7:59–64. A POSITA would not have understood the '494 Patent as providing any discussion with regard to distinguishing this distance (10 inches) from the prior art. A POSITA would have understood that design of corrosion prevent systems often involves routine optimization of various variables and dimensions. For example, it was commonplace for a POSITA to vary distances between sacrificial anodes and inlets in order to determine which distance provided optimal corrosion protection.

100. Additionally, a POSITA would have found it obvious to incorporate one or more additional sacrificial anodes, such as a sacrificial anode at the outlet, for radiators that have relatively long flow paths. Such additional sacrificial anodes would be used to prevent corrosion when the flow path of the radiator exceeds the length of protection provided by the sacrificial anode at the hot liquid inlet. In this way, corrosion near the outlet would be prevented.

101. One way to provide additional sacrificial anodes that would have been obvious to a POSITA is to divide the turbulator 2 into multiple turbulators 2. As a

result of this division, each of the turbulators 2 includes its own sacrificial anode. Thus, when one of the sacrificial anodes becomes corroded and replacement is desired, one turbulator 2 is replaceable without replacing the other turbulator 2. This would decrease maintenance costs associated with the radiator because a shorter turbulator 2 would cost less than a larger turbulator 2 (e.g., due to material cost, etc.). Additionally, this would simplify replacement because the difficulty associated with removal of the turbulator 2 would increase proportionately to the length of the turbulator 2 due to contact between the ring-shaped components and the heat exchanger tube 1 and due to space claim constraints of components (e.g., the engine, etc.) surrounding the radiator. Below I provide a modification of Figure 2 showing two turbulators 2, each having its own sacrificial anode assembly.

FIG. 2



B. The Tomosada-Hanazaki-069 Combination

1. Overview of Hanazaki-069

102. Hanazaki-069, similar to Tomosada and the '494 Patent, is directed to “an aluminum alloy radiator having improved corrosion resistance by attaching a sacrificial anode to the inner surface of a tube.” Hanazaki-069, ¶[0001]. Hanazaki-069 states that “there is a limit to the weight reduction and thinning of radiators with conventional cladding materials that use the sacrificial anode action of Zn.” *Id.*, ¶[0004].

103. While Hanazaki-069 is not in English, I have considered the certified translation of Hanazaki-069 which a POSITA would have understood as providing the teachings of Hanazaki-069.

104. Hanazaki-069 explains that “it is conceivable to use aluminum, which has excellent strength, to give the radiator tube the necessary strength, and to prevent corrosion by another means” and that “[c]athodic protection, in which a sacrificial anode is placed near the metallic structural material and is preferentially corroded, is known as a method of preventing corrosion of metallic structural materials that come into contact with aqueous solutions.” *Id.* Hanazaki-069 teaches that “[a]n example of the use of this cathodic protection for heat exchangers such as radiators is also introduced in JP-A-55-68595.” *Id.* It is my understanding that “JP-A-55-68595” is Tomosada. Thus, Hanazaki-069 explicitly builds on Tomosada. A POSITA would have found it obvious to look to Hanazaki-069 to modify Tomosada when Hanazaki-069 explicitly teaches improvements relative to Tomosada.

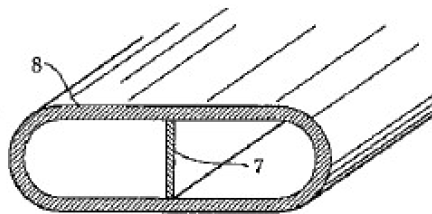
105. Hanazaki-069 states that “the corrosive environment inside the radiator fluctuates in a complex manner, and simply placing a sacrificial anode in the radiator tube does not provide sufficient corrosion protection” and that “[f]or example, radiators are not always supplied with the ideal liquid, and sometimes tap water is supplied instead of the antifreeze liquid.” *Id.*, ¶[0005]. Therefore, a POSITA would

have understood Hanazaki-069 as teaching that radiators, such as that of Tomosada, are often supplied water and are often supplied antifreeze.

106. Hanazaki-069 explains that “[t]he present invention was devised to solve such problems, and by specifying the material combination of the tube material and the sacrificial anode material and attaching the sacrificial anode having a specified surface area to the inner surface of the radiator tube, the radiator tube is always kept below the pitting corrosion potential, and the purpose is to reliably prevent the radiator from corrosion even if there is a fluctuation in the corrosive environment.” *Id.*, ¶[0005].

107. Hanazaki-069 states that “[a]s shown in Figs. 4~12, sacrificial anode 7 was placed on the inner surface of tube 8 in various forms.” *Id.*, ¶[0017].

【図4】



108. Hanazaki-069 states that the “material of the sacrificial anode is not subject to the present invention, and Al, Zn, Mg, or these alloys can be used as long as the Al alloy tube is maintained at a noble potential with a potential difference of ΔE of 20 mV or more within the range that does not inhibit brazeability.” *Id.*, ¶[0015]. Hanazaki-069 explains that “when the Al alloy is used as a sacrificial

anode, the anti-corrosion effect increases with increasing Zn content.” *Id.* Hanazaki-069 explicitly provides an example where the sacrificial anode includes only a combination of aluminum, zinc, and magnesium. *Id.*, Table 7.

2. The Combination of Tomosada and Hanazaki-069 was Predictable

109. Counsel has informed me that the teachings of a reference may only be used to establish unpatentability where the reference is analogous art to the patent application (or, as here, a claim of the '494 Patent where the reference is analogous art to the '494 Patent). Counsel has informed me that the reference and the patent application (here the '494 Patent) are analogous art where the reference and the patent application (here the '494 Patent) are directed to the same field of endeavor and to solving the same problem.

110. The field of endeavor of the '494 Patent is corrosion prevention systems for radiators. For example, the '494 Patent states that “[t]his application relates generally to motor vehicles, whether powered by gas, diesel, electric battery, propane, natural gas, or any other like material, and in particular to radiators and engines and preventing corrosion in the cooling system of said vehicles, especially those with components of dissimilar metal construction which present most cooling system corrosion problems.” EX1001, 1:35–41. Tomosada and Hanazaki-069 are analogous art directed to the same field of endeavor as the '494 Patent. For example,

Tomosada states that “present invention solves the problems associated with conventional aluminum heat exchangers, and provides an aluminum heat exchanger which is excellent in anti-corrosion characteristics, which can be manufactured at a low cost.” EX1005, 1. Hanazaki-069 states that the “present invention relates to an aluminum alloy radiator having improved corrosion resistance by attaching a sacrificial anode to the inner surface of a tube.” EX1006, ¶[0001].

111. The '494 Patent is directed to the problem of how to prevent corrosion of a radiator due to dissimilar metals. For example, the '494 Patent states that “[i]n response to the electrolytic activity, also known as electrolysis, aluminum components corrode and become porous and may begin to leak in as little as two weeks.” EX1001, 1:61–67. Tomosada and Hanazaki-069 are directed to the same problem as the '494 Patent. Specifically, Tomosada states that “since electrochemically, aluminum is a base metal relative to other structural metals typically used, anti-corrosion measures are required for heat exchanger tubes in an aluminum heat exchanger.” EX1005, 1. Hanazaki-069 states that “simply placing a sacrificial anode in the radiator tube does not provide sufficient corrosion protection.” EX1006, ¶[0005].

112. When seeking to solve the problem of the '494 Patent, a POSITA would have predictably considered Tomosada and Hanazaki-069 because they extensively describe existing solutions to the same problem and are within the same field of

endeavor as the '494 Patent. Additionally, Hanazaki-069 explains that it builds on Tomosada. Thus, a POSITA would have found it obvious to look to Hanazaki-069 to modify Tomosada when Hanazaki-069 explicitly teaches improvements relative to Tomosada.

113. A POSITA would have found it obvious to use water or antifreeze, as taught by Hanazaki-069, instead of coolant described by Tomosada. First, water and antifreeze are used for the same purpose – circulation and heat transfer within a radiator. Second, a POSITA would have understood that the radiator of Tomosada does not include any structure that would preclude use of other types of fluid such as water and antifreeze. As a result, a POSITA would have understood that the radiator of Tomosada is capable of being used with other types of fluid (including the water and antifreeze taught by Hanazaki-069) and enables selection and use of a fluid that is more appropriate for a particular type of application. A POSITA would have understood that there are certain types of applications where water is preferred, such as applications where the amount of cooling that the fluid is required to provide is relatively small (i.e., when the radiator is used with an engine that is relatively small). Similarly, a POSITA would have understood that there are certain types of applications where antifreeze is preferred, such as applications where the radiator is exposed to relatively cold temperatures.

114. In view of the similarities between the coolant described in Tomosada and the water and antifreeze described by Hanazaki-069, the lack of Tomosada to describe any structure which would prohibit use of another type of fluid (such as water or antifreeze), and the lack of Hanazaki-069 to describe the water and antifreeze as requiring a sacrificial anode with any particular structure, a POSITA would have had a reasonable expectation of success in making such a modification of Tomosada.

115. Similarly, a POSITA would have found it obvious to use a sacrificial anode that is made from aluminum, magnesium, and zinc, as taught by Hanazaki-069, instead of the zinc compound material described by Tomosada. First, a combination of aluminum, magnesium, and zinc is a zinc compound material. Second, the composition taught by Hanazaki-069 and the composition taught by Tomosada are used for the same purpose – a sacrificial anode. Third, a POSITA would have understood that the sacrificial anode of Tomosada does not include any structure that would preclude use of other types of compositions such as the composition taught by Hanazaki-069. As a result, the sacrificial anode of Tomosada is capable of being made using other compositions (including the combination of aluminum, zinc, and magnesium taught by Hanazaki-069) and enables selection and use of a composition that is more appropriate for a particular type of application. A POSITA would have understood that there are certain types of applications where

an aluminum, zinc, and magnesium composition is preferred. As explained by Hanazaki-069 and shown in its testing, the composition changes the potential difference, and it is desirable to control the potential difference so as to desirably prevent corrosion. EX1006, ¶¶[0014]–[0015]. For example, greater turbulent flow rates may require greater corrosion protection, and it may be desirable to change the potential difference to provide additional corrosion protection.

116. In view of the similarities between the zinc alloy described in Tomosada and the combination of aluminum, zinc, and magnesium taught by Hanazaki-069, the lack of Tomosada to describe any structure which would prohibit use of another composition (such as the combination of aluminum, zinc, and magnesium), and the lack of Hanazaki-069 to describe the combination of aluminum, zinc, and magnesium as requiring a sacrificial anode with any particular structure, a POSITA would have had a reasonable expectation of success in making such a modification of Tomosada.

C. Hanazaki-196

1. Overview

117. Similar to the '494 Patent, Tomosada, and Hanazaki-069, Hanazaki-196 is directed to a “heat exchanger made from aluminum, that uses a brine made from an aqueous solution of calcium chloride or sodium chloride, wherein a sacrificial anode, formed from a metal that is less noble than aluminum, and that

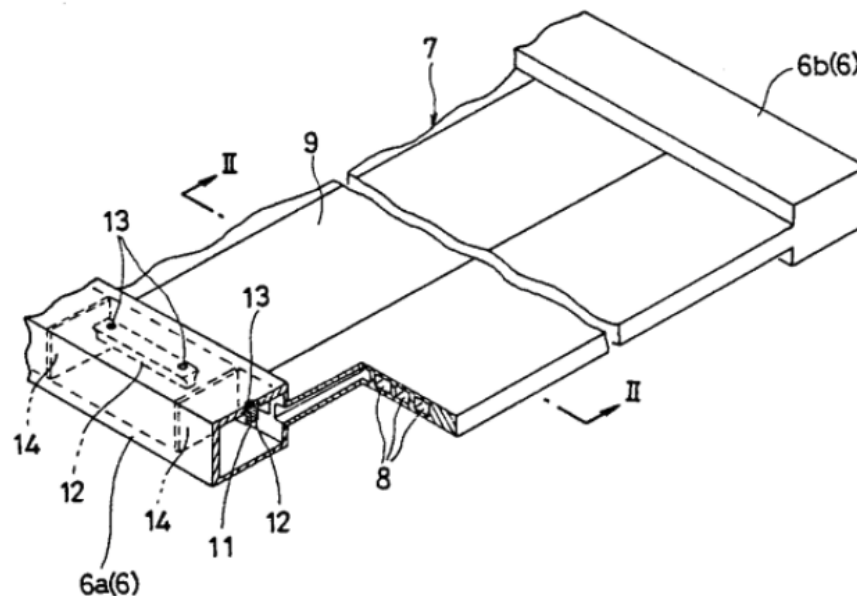
reduces the electropotential of the pipeline to 50 mv, at least, less than the pitting electropotential, is formed on an inner wall of a pipeline that forms a brine flow path.” EX1007, 2. Hanazaki-196 explains that “that which is termed ‘brine,’ such as, for example, an aqueous solution of calcium chloride or an aqueous solution of sodium chloride, is known as a coolant.” *Id.*, 1. As I explained in Section VII.A.1, above, a POSITA would have understood that a radiator is a heat exchanger. Therefore, a POSITA would have understood the teachings of Hanazaki-196 as to its heat exchanger as applying to a radiator. While Hanazaki-196 is not in English, I have considered the certified translation of Hanazaki-196 which a POSITA would have understood as providing the teachings of Hanazaki-196.

118. Hanazaki-196 explains that “in various cooling devices in which such heat exchangers are used, and particularly in those that are mobile, such as, for example, refrigeration equipment or refrigerated trucks for shipping, or the like, reducing weight through making the heat exchanger from aluminum or an aluminum alloy is extremely important in not just enabling more freight to be loaded, commensurate with the weight reduction, but in improving fuel consumption as well.” *Id.*, 2.

119. With regard to Figures 2A and 2B, reproduced below, Hanazaki-196 states that “[t]his heat exchanger is structured from a pair of header pipes 6 (6a and 6b) that have a relatively large diameter, arranged in parallel with a space

therebetween, and heat exchanging pipe units 7, connecting between the header pipes 6a and 6b, where a coolant supplying opening and coolant exhausting opening are provided at the two ends of the primary side header pipe 6a that is positioned on the upstream side, where heat is exchanged in the heat exchange region during the time until the coolant that is introduced from the supplying opening arrives at the exhaust opening 10 after traveling serpentine through each of the brine flow paths 8 of each of the header pipes 6 and the heat exchanging pipe units 7.” *Id.*, 4.

FIG. 2A

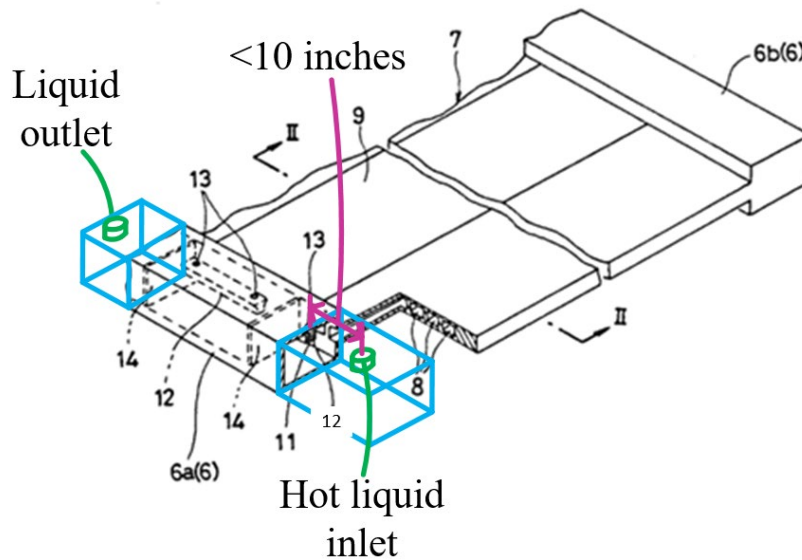


120. A POSITA would have understood that the coolant exhausting opening and the supplying opening described by Hanazaki-196 are a liquid outlet and a hot liquid inlet, respectively. Hanazaki-196 teaches that the liquid outlet and the hot liquid inlet are on the header pipe 6a. A POSITA would have understood that the hot

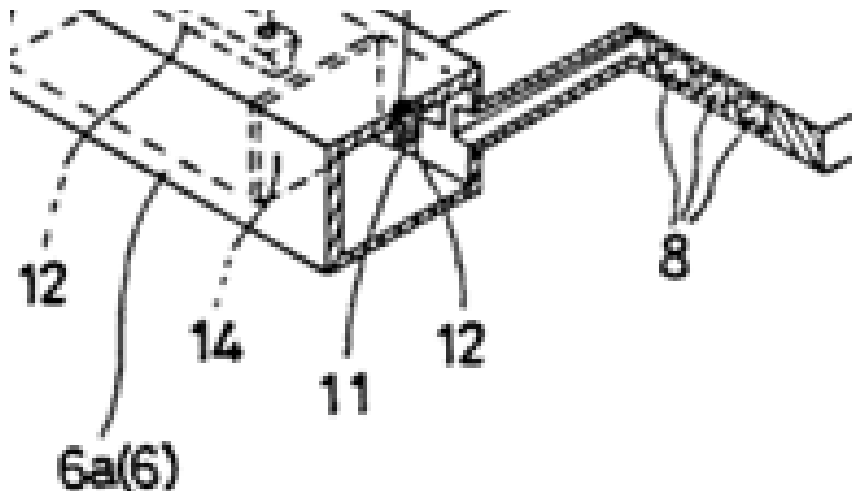
liquid inlet is on one side of the header pipe 6a and the liquid outlet is on the other side of the header pipe 6a. A POSITA would have understood that this understanding of the hot liquid inlet is consistent with the definition of an inlet provided by the '494 Patent which states that the "specific inlet connection 16 varies by vehicle make, model and model year, but the *inlet 17 is generally understood to refer to the vicinity of where hot water coming directly from the engine enters into the radiator 11.*" EX1010, 7:4–8.

121. Below I provide an annotation of Figure 2A of Hanazaki-196 showing the hot liquid inlet and the liquid outlet. *Id.*, 4. The blue lines indicate portions of the header pipe 6a that are hidden in the original figure, the green lines indicate the hot liquid inlet and the liquid outlet, and the purple lines illustrate the distance of the center of the hot liquid inlet to one of the sacrificial anodes 12 that is shown in Figure 2A.

FIG. 2A

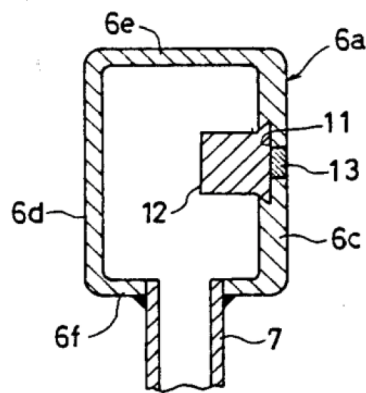


122. A POSITA would understand from Figure 2A that at least one of the sacrificial anodes 12 is within 10 inches of a center axis of the hot liquid inlet. When viewed in detail, Figure 2A (detailed view below) illustrates a second sacrificial anode 12 that a POSITA would have understood as being within 10 inches of the hot liquid inlet (as shown in the annotation above).



123. With reference to Figure 3, Hanazaki-196 teaches that a “sacrificial anode 12, made from an essentially rectangular rod-shaped body, extrusion molded to a prescribed dimension, from an alloy of Al-Zn-In-another metal...is fitted into this attaching groove 11 [in the header pipe 6a], followed by plug welding at welding points 13....” *Id.*, 4. These welding points 13 are necessarily connected to the sacrificial anode 12. As a result, each sacrificial anode 12 and its welding points 13 form one unit.

FIG. 3



124. Hanazaki-196 states that “FIG. 4A and FIG. 4B depict a modified example of the cross-sectional shape of the attaching groove 11 that is formed in each header pipe 6 and of the sacrificial anode 12 that is attached in the attaching groove 11, where in the case of FIG. 4A the attaching groove 11 is formed in a wide helical groove shape and the sacrificial anode 12 that is attached within the attaching groove 11 is formed with a cross-sectional shape that is substantially trapezoidal, where in the case of FIG. 4B, an attaching groove 11 is formed into a helical groove

shape by ribs 15 that each protrude from the back wall 6c, the front wall 6d, and the top wall 6e, where the sacrificial anode 12 that is attached within the attaching groove 11 is formed so as to have a cross-sectional shape that is substantially rectangular.” *Id.*

125. Hanazaki-196 also states:

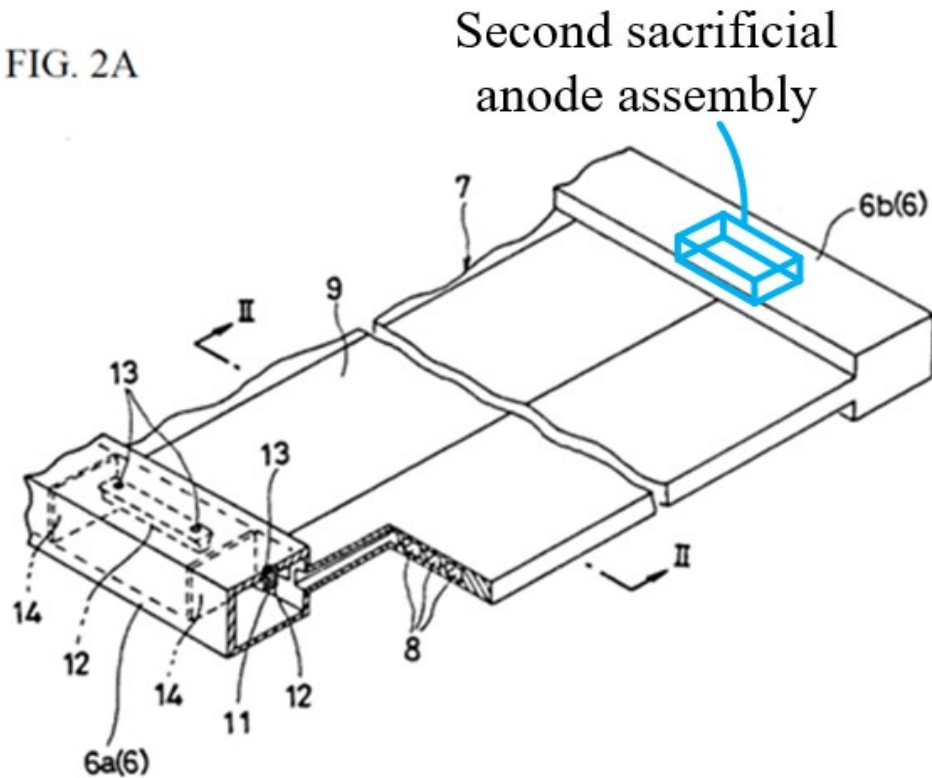
For the method for attaching the sacrificial anode to the inner wall of the pipeline of the heat exchanger, at least a portion of the sacrificial anode and pipeline inner wall should be welded or secured, and, preferably, the heat exchanger may be formed from a pair of header pipes and a large number of heat exchanging pipes that form a heat exchange region bridging between these header pipes, where the header pipes and/or heat exchanging pipes for forming the flow path for the brine are formed from aluminum molded members, and attaching grooves that extend along the axial direction may be formed in the pipe inner walls of one or both of the above, and the sacrificial anode may be arranged along these attaching grooves can at least a portion between the sacrificial anode and the header pipes and/or between the heat exchanging pipes

and the pipeline inner walls, may be welded or secured. In this way, *through arranging sacrificial anodes within the attaching grooves in the header pipes* and/or heat exchanging pipes that are formed from aluminum molded members in this way and welding and securing, the provision of the sacrificial *anodes* will be accurate, and the cross-sectional area of the brine flow path will not be too large or too small locally, and thus there will be no concerns about producing erosion or about turbulent flow causing bubbles that would reduce the efficiency of heat exchange.

Id., 3.

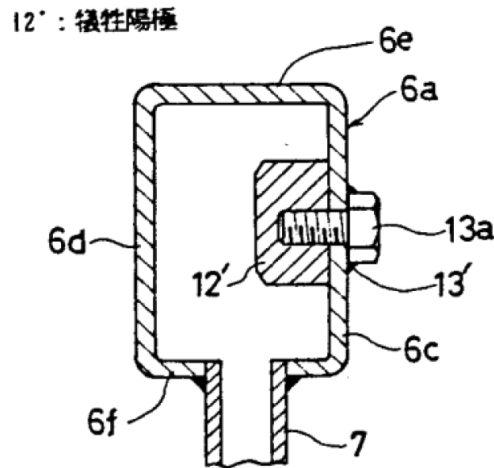
126. Accordingly, Hanazaki-196 teaches including multiple sacrificial anodes 12 (and their welding points or bolts 13) in the first header pipe 6a and including at least another sacrificial anode 12 (and its welding points or bolts 13) in the second header pipe 6b. Below I provide an annotation of Figure 2A of Hanazaki-196 illustrating this “second sacrificial anode assembly” in the second header pipe 6b.

FIG. 2A



127. Hanazaki-196 states that "FIG. 5 depicts a modified example of an attaching structure for a case of a sacrificial anode 12' that is made from zinc (Zn) or magnesium (Mg), where a bolt 13a that is screwed through the back wall 6c of the header pipe 6 is welded tightly 13' from the outside, and the threaded portion thereof screws together with the sacrificial anode 12'." *Id.*, 2.

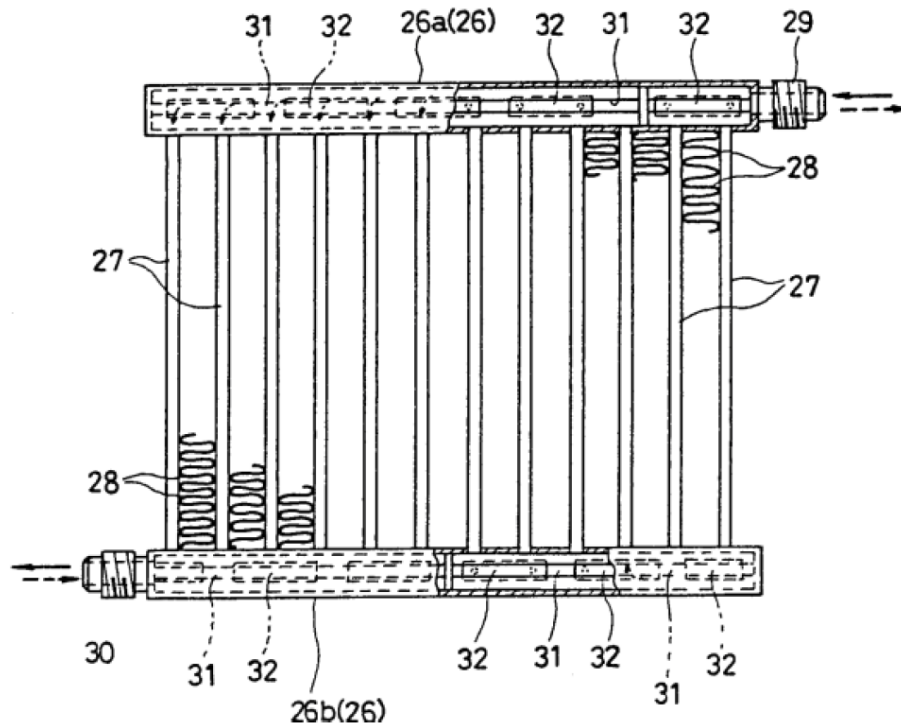
FIG. 5



12': Sacrificial Anode

128. With reference to an embodiment shown in Figure 11, reproduced below, Hanazaki-196 discloses a “heat exchanger [that] comprises: a pair of header pipes 26a and 26b that have a relatively large diameter, provided in parallel with a space therebetween; 12 heat exchanging pipes 27 that connect between these header pipes 26a and 26b; and a corrugated heat exchanging fin 28 that is provided, substantially perpendicularly with respect to the heat exchanging pipes 27, between mutually adjacent heat exchanging pipes 27, wherein: a coolant supplying opening 29 is provided at one end of the primary side header pipe 26a that is positioned at the top and a coolant exhausting outlet 30 is provided at one end of the secondary side header pipe 26b, positioned toward the bottom, where the coolant that is introduced from the supplying opening 29 is subjected to heat exchange in a heat exchanging region, prior to arriving at the exhausting outlet 30.” *Id.*, 5.

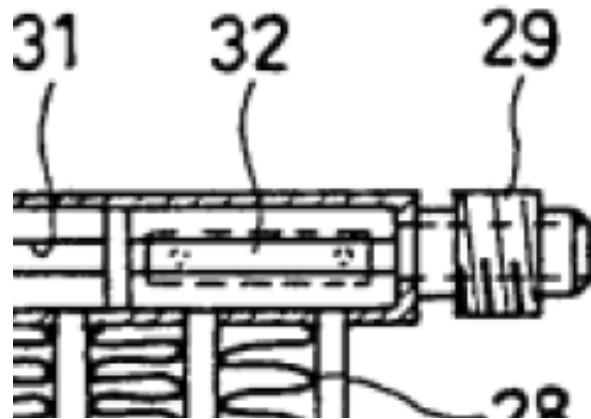
FIG. 11



129. Hanazaki-196 explains that “the header pipes 26a and 26b are formed, through aluminum extrusion molding, with the cross-sectional shapes thereof being circular, and an attaching groove 31 is formed in a helical groove shape along the total length thereof on the inner surface side, where the sacrificial anode 32 that is formed with prescribed dimensions, in the same manner as in the first embodiment set forth above, is fitted into the attaching groove 31, and is plug welded, at at least two welding points for each individual sacrificial anode 32, at prescribed intervals such as, for example, with a spacing of 30 cm.” *Id.*

130. As shown in Figure 11 (detailed view below), Hanazaki-196 depicts a sacrificial anode 32 at the supplying opening 29. A POSITA would have understood

that this sacrificial anode 32 is within 10 inches of the center axis of the hot liquid inlet inlet.



131. Additionally, a POSITA would have understood that the teaching provided by Hanazaki-196 of locating the sacrificial anode 32 within 10 inches of the center axis of the hot liquid inlet in the embodiment of Figure 11 likewise informs where the sacrificial anode 12 is located in the embodiment of Figure 2A. Specifically, a POSITA would have understood that the Hanazaki-196 teaches locating the sacrificial anode 12 at the hot liquid inlet in the embodiment of Figure 2A because Hanazaki-196 teaches locating the sacrificial anode 32 at the supplying opening 29 in Figure 11. At the very least, the teachings of Hanazaki-196 with respect to the sacrificial anode 32 in Figure 11 would have made it obvious to a POSITA to likewise locate the sacrificial anode 12 at the hot liquid inlet.

D. The Hanazaki-196-Hanazaki-069 Combination

1. The Combination of Hanazaki-196 and Hanazaki-069 was Predictable

132. As I discussed in Section VII.B.2, above, the field of endeavor of the '494 Patent is corrosion prevention systems for radiators. *See* EX1001, 1:35–41. Hanazaki-196 and Hanazaki-069 are analogous art directed to the same field of endeavor as the '494 Patent. For example, Hanazaki-196 states that “the present inventors arrived at the present invention through solving this problem of corrosion in a heat exchanger made from aluminum that uses brine that is made from an aqueous solution of calcium chloride or sodium chloride.” EX1007, 2. Hanazaki-069 states that the “present invention relates to an aluminum alloy radiator having improved corrosion resistance by attaching a sacrificial anode to the inner surface of a tube.” EX1006, ¶[0001].

133. As I also discussed in Section VII.B.2, above, the '494 Patent is directed to the problem of how to prevent corrosion of a radiator due to dissimilar metals. *See* EX1001, 1:61–67. Hanazaki-196 and Hanazaki-069 are directed to the same problem as the '494 Patent. Specifically, Hanazaki-196 states that “when these brine coolants are used, the corrosiveness in relation metal is extremely high, due to the electrolytes, and thus there is a major problem with durability of heat exchangers that use brine, such as having a service life that is no greater than five years, at the

longest, even with a steel heat exchanger.” EX1007, 2. Hanazaki-069 states that “simply placing a sacrificial anode in the radiator tube does not provide sufficient corrosion protection.” EX1006, ¶[0005].

134. When seeking to solve the problem of the '494 Patent, a POSITA would have predictably considered Hanazaki-196 and Hanazaki-069 because they extensively describe existing solutions to the same problem and are within the same field of endeavor as the '494 Patent.

135. A POSITA would have found it obvious to use water or antifreeze, as taught by Hanazaki-069, instead of coolant described by Hanazaki-196. First, water and antifreeze are used for the same purpose –circulation and heat transfer within a radiator. Second, a POSITA would have understood that the heat exchanger of Hanazaki-196 does not include any structure that would preclude use of other types of fluid, such as water and antifreeze. As a result, a POSITA would have understood that the heat exchanger of Hanazaki-196 is capable of being used with other types of fluid (including the water and antifreeze taught by Hanazaki-069) and enables selection and use of a fluid that is more appropriate for a particular type of application. A POSITA would have understood that there are certain types of applications where water is preferred, such as applications where the amount of cooling that the fluid is required to provide is relatively small (i.e., when the radiator is used with an engine that is relatively small). Similarly, a POSITA would have

understood that there are certain types of applications where antifreeze is preferred, such as applications where the radiator is exposed to relatively cold temperatures.

136. In view of the similarities between the coolant described in Hanazaki-196 and the water and antifreeze described by Hanazaki-069, the lack of Hanazaki-196 to describe any structure which would prohibit use of another type of fluid (such as water or antifreeze), and the lack of Hanazaki-069 to describe the water and antifreeze as requiring a sacrificial anode with any particular structure, a POSITA would have had a reasonable expectation of success in making such a modification of Hanazaki-196.

137. Similarly, a POSITA would have found it obvious to use the heat exchanger of Hanazaki-196 in a motor vehicle, as taught by Hanazaki-069. First, a POSITA would have recognized that a common use for a heat exchanger, such as that described by Hanazaki-196, is as a radiator of a motor vehicle. Indeed, Hanazaki-196 states that the “heat exchanger made from aluminum in the present invention may be used in heat exchanging *in any field*, such as, for example, air cleaning, air conditioning, bookbinding, dry ice, refrigeration for shipping, cooling water towers, refrigerators, refrigerated trucks, and the like.” EX1007, 3. Thus, Hanazaki-196 teaches that the heat exchanger can be used in *any field*. Hanazaki-069 describes “heat exchangers [that are] mounted on vehicles such as automobiles.” EX1006, 2. Second, a POSITA would have understood that Hanazaki-069 does not

describe any structure of its radiator that is required due to use with a motor vehicle. Third, a POSITA would have understood that Hanazaki-196 does not describe any structure of its heat exchanger which precludes use with a motor vehicle.

138. In view of the similarities between the heat exchanger described in Hanazaki-196 and the radiator taught by Hanazaki-069, the lack of Hanazaki-196 to describe any structure which would prohibit use as a radiator of a motor vehicle, and the lack of Hanazaki-069 to describe a motor vehicle as requiring a radiator with any particular structure, a POSITA would have found it obvious to utilize the heat exchanger taught by Hanazaki-196 as a radiator in a motor vehicle, as taught by Hanazaki-069, because doing so would have provided the benefits of the heat exchanger taught by Hanazaki-196 to the vehicle.

139. Similarly, a POSITA would have found it obvious to use a sacrificial anode that is made from aluminum, magnesium, and zinc, as taught by Hanazaki-069. First, the composition taught by Hanazaki-069 and the various alloys taught by Hanazaki-196 are used for the same purpose – a sacrificial anode. Second, a POSITA would have understood that the sacrificial anode 12 of Hanazaki-196 does not include any structure that would preclude use of other types of compositions such as the composition taught by Hanazaki-069. As a result, the sacrificial anode of Hanazaki-196 is capable of being made using other compositions (including the combination of aluminum, zinc, and magnesium taught by Hanazaki-069) and

enables selection and use of a composition that is more appropriate for a particular type of application. A POSITA would have understood that there are certain types of applications where an aluminum, zinc, and magnesium composition is preferred. As explained by Hanazaki-069 and shown in its testing, the composition changes the potential difference, and it is desirable to control the potential difference so as to desirably prevent corrosion. EX1006, ¶¶[0014]–[0015]. For example, greater turbulent flow rates may require greater corrosion protection, and it may be desirable to change the potential difference to provide additional corrosion protection.

140. In view of the similarities between the alloys described in Hanazaki-196 and the combination of aluminum, zinc, and magnesium taught by Hanazaki-069, the lack of Hanazaki-196 to describe any structure which would prohibit use of another composition (such as the combination of aluminum, zinc, and magnesium), and the lack of Hanazaki-069 to describe the combination of aluminum, zinc, and magnesium as requiring a sacrificial anode with any particular structure, a POSITA would have had a reasonable expectation of success in making such a modification of Hanazaki-196.

E. Godefroy

1. Overview

141. Similar to the '494 Patent, Godefroy is directed to “a device for protecting the aluminum walls of a heat exchanger against corrosion by an

aggressive medium to which these walls are exposed.” EX1008, 2. Godefroy explains that “heat exchangers are usually composed of a bundle of tubes connected to one or more manifolds defining a volume intended to be traversed by a heat transfer fluid, most often a liquid, which can be or may potentially become corrosive.” *Id.* Godefroy explains that these heat exchangers include “light alloy heat exchangers used in motor vehicles” and “engine cooling radiators.” *Id.* Godefroy states that “protection [of aluminum tubes against corrosion] is made possible by modifying the electrochemical potential of the protective strip below the electrochemical potential of the aluminum, so as to confer cathodic protection.” *Id.*, 3. Godefroy teaches that “[t]his is generally done by adding zinc or zinc-aluminum or magnesium-aluminum or zinc-aluminum-magnesium alloys which lower (i.e. make them more electronegative) the potential of the protective strip aluminum alloy” but that “[t]his known solution requires co-laminating, which complicates the manufacturing processes and increases the thickness of the walls of the tubes.” *Id.* Godefroy is therefore directed to the same field as the ’494 Patent (corrosion prevention systems for radiators) and seeks to solve the same problem as the ’494 Patent (how to prevent corrosion of a radiator due to dissimilar metals). While Godefroy is not in English, I have considered the certified translation of Godefroy which a POSITA would have understood as providing the teachings of Godefroy.

142. Godefroy explains that its “invention proposes a protection device of the type defined above for this purpose, which comprises at least one renewable sacrificial resist formed of elements capable of lowering at least locally the electrochemical potential of the aluminum of the walls of the heat exchanger.” *Id.*, 5. Godefroy teaches that “[i]n one design, the sacrificial resist is contained within the heat exchanger” and that “[t]his heat exchanger can be constituted, for example, by a cooling radiator of a motor vehicle engine.” *Id.* As an initial matter, I note that a POSITA would have understood based on the teachings of Godefroy the term “sacrificial resist” to mean “sacrificial anode.” For example, the discussion in Godefroy of cathodic protection, sacrificial components, and electrochemical potential indicates that the “sacrificial resist” is a “sacrificial anode.” Accordingly, for purposes of my analysis, I refer to the sacrificial resist of Godefroy as a sacrificial anode.

143. Godefroy states that “Fig. 1...shows a manifold 10 of a heat exchanger, in particular of a motor vehicle, to which a pipe 12 is connected, intended for the inlet or the outlet of a heat transfer liquid.” *Id.*, 8. Godefroy explains that “the manifold 10 can be part of a cooling radiator of a motor vehicle engine, which is traversed by the engine coolant.” *Id.*

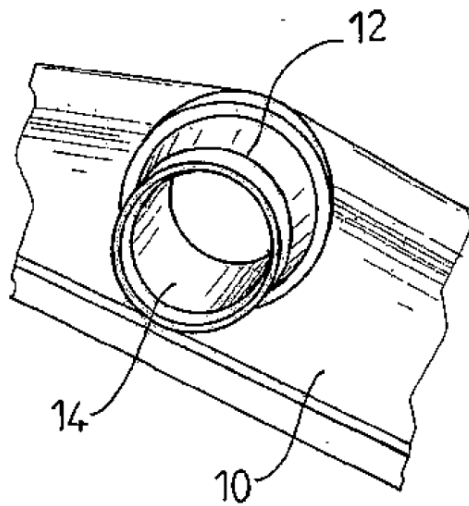


FIG.1

144. Godefroy explains that “[t]o prevent any risk of corrosion, inside the pipe 12, there is a sacrificial resist 14 made here in the form of a tubular insert applied against the internal wall of the pipe 12” and that “[g]iven its location, the insert is completely bathed in the cooling fluid.” *Id.* Godefroy states that “[t]his insert is formed from a renewable sacrificial resist consisting of elements capable of lowering at least locally the electrochemical potential of the aluminum contained in the walls of the heat exchanger,” that “[b]y way of example, this insert can be formed from zinc and/or magnesium,” and that “[i]t may be in particular a zinc alloy, a magnesium alloy or even an alloy of zinc and magnesium.” *Id.*, 8–9. Godefroy teaches that “the sacrificial resist can be placed in any other spot on the heat exchanger, for example in reservoirs, protrusions or other housings that a heat exchanger may contain.” *Id.*, 10. A POSITA would understand from Figure 1 that the sacrificial anode 14 is within 10 inches of a

center axis of a hot liquid inlet because the sacrificial anode 14 is disposed on the inside of the connector 12, which Godefroy teaches is “intended for the inlet...of a heat transfer liquid.” EX1008, 8. Below I provide an annotation of Figure 1 showing the sacrificial anode taught by Godefroy and annotating the inlet. While Godefroy does not provide exact dimensions with Figure 1, a POSITA would have understood Figure 1 as showing that an entirety of the sacrificial anode 14, or at least a significant portion of the sacrificial anode 14, is within 10 inches of a center axis of the inlet. At least an upstream edge of the sacrificial anode 14 is explicitly shown at the inlet, for example.

Sacrificial anode

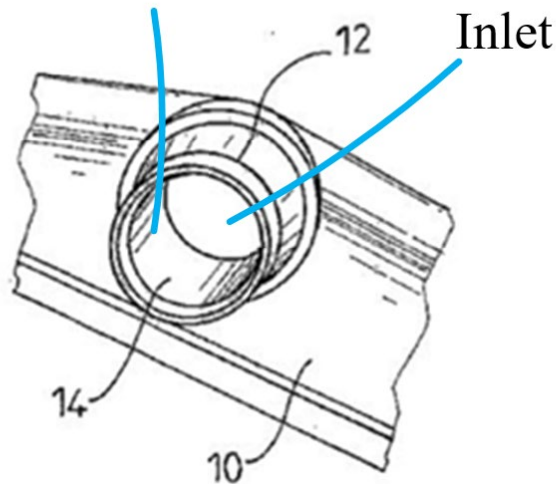


FIG.1

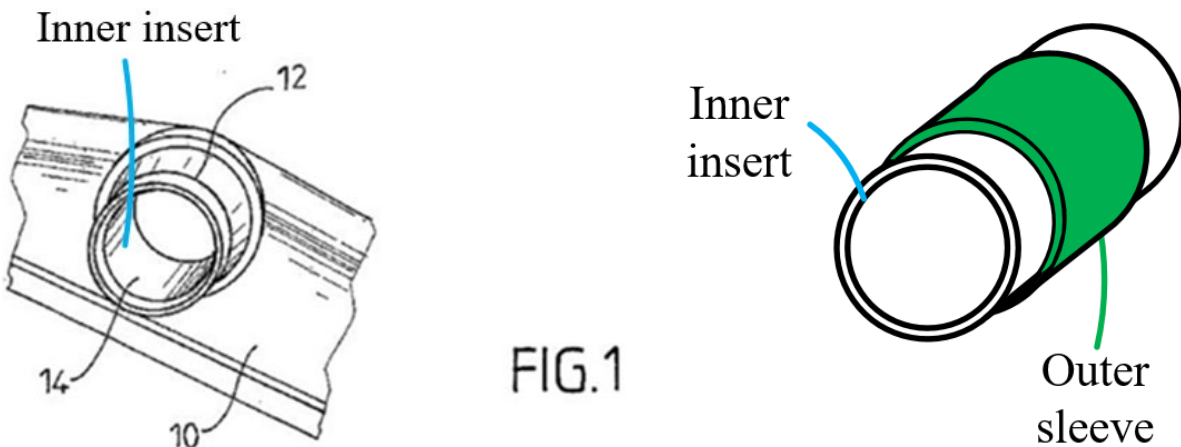
145. A POSITA would have understood that a radiator, such as that taught by Godefroy, includes an inlet and an outlet, as discussed by Godefroy with respect to the pipe 12. *Id.*, 8. Thus, a POSITA would have understood Godefroy as teaching that the sacrificial anode 14 would be applied in some arrangements at the inlet *and*

the outlet, as opposed to only the inlet or the outlet. Nothing in Godefroy suggests that only one sacrificial anode 14 is required. Indeed, Godefroy discusses the drawbacks associated with insufficiently preventing corrosion, and a POSITA would have found it obvious to incorporate the sacrificial anode 14 at the inlet and the outlet in order to increase protection of the radiator. Thus, Godefroy teaches use of two sacrificial anodes 14, one at the inlet and one at the outlet. To the extent not explicitly disclosed by Godefroy, such a modification of Godefroy would have been obvious to a POSITA because it would have provided these benefits, was contemplated by Godefroy, and would have been well within the skill of a POSITA.

146. A POSITA would have understood the sacrificial anode 14 of Godefroy to be an assembly that includes not only the “elements capable of lowering at least locally the electrochemical potential of the aluminum,” but also at least one part that enables the “tubular insert [to be] applied against the internal wall of the pipe 12,” as taught by Godefroy.

147. From Figure 1, a POSITA would have understood Godefroy as showing that the sacrificial anode 14 (formed as an insert) includes an inner insert that is a sacrificial anode, or that includes sacrificial anodes, and an outer sleeve within which the inner insert is placed. The outer sleeve facilitates application of the inner insert to the pipe 12. While Godefroy does not depict the outer sleeve in Figure 1, a POSITA would have understood that there are numerous feasible configurations for

the outer sleeve. Below I have provided an annotation of Figure 1 showing the inner insert and an example of one of the numerous configurations that would have been obvious to a POSITA in view of the teachings of Godefroy that shows the sacrificial anode 14 (formed as an insert) utilized by Godefroy.



F. The Godefroy-Hanazaki-069 Combination

1. The Combination of Godefroy and Hanazaki-069 was Predictable

148. As I discussed in Section VII.B.2, above, the field of endeavor of the '494 Patent is corrosion prevention systems for radiators. *See* EX1001, 1:35–41. Godefroy and Hanazaki-069 are analogous art directed to the same field of endeavor as the '494 Patent. For example, Godefroy states that its invention “relates...to a device for protecting the aluminum walls of a heat exchanger against corrosion by an aggressive medium to which these walls are exposed.” EX1008, 2. Hanazaki-069 states that the “present invention relates to an aluminum alloy radiator having

improved corrosion resistance by attaching a sacrificial anode to the inner surface of a tube.” EX1006, ¶[0001].

149. As I also discussed in Section VII.B.2, above, the ’494 Patent is directed to the problem of how to prevent corrosion of a radiator due to dissimilar metals. *See* EX1001, 1:61–67. Godefroy and Hanazaki-069 are directed to the same problem as the ’494 Patent. Specifically, Godefroy states that “[s]uch protection is made possible by modifying the electrochemical potential of the protective strip below the electrochemical potential of the aluminum, so as to confer cathodic protection.” EX1008, 2. Hanazaki-069 states that “simply placing a sacrificial anode in the radiator tube does not provide sufficient corrosion protection.” EX1006, ¶[0005].

150. When seeking to solve the problem of the ’494 Patent, a POSITA would have predictably considered Godefroy and Hanazaki-069 because they extensively describe existing solutions to the same problem and are within the same field of endeavor as the ’494 Patent.

151. A POSITA would have found it obvious to use water or antifreeze, as taught by Hanazaki-069, instead of coolant described by Godefroy. First, water and antifreeze are used for the same purpose – circulation and heat transfer within a radiator. Second, a POSITA would have understood that the radiator of Godefroy does not include any structure that would preclude use of other types of fluid such

as water and antifreeze. As a result, a POSITA would have understood that the radiator of Godefroy is capable of being used with other types of fluid (including the water and antifreeze taught by Hanazaki-069) and enables selection and use of a fluid that is more appropriate for a particular type of application. A POSITA would have understood that there are certain types of applications where water is preferred, such as applications where the amount of cooling that the fluid is required to provide is relatively small (i.e., when the radiator is used with an engine that is relatively small). Similarly, a POSITA would have understood that there are certain types of applications where antifreeze is preferred, such as applications where the radiator is exposed to relatively cold temperatures.

152. In view of the similarities between the coolant described in Godefroy and the water and antifreeze described by Hanazaki-069, the lack of Godefroy to describe any structure which would prohibit use of another type of fluid (such as water or antifreeze), and the lack of Hanazaki-069 to describe the water and antifreeze as requiring a sacrificial anode with any particular structure, a POSITA would have had a reasonable expectation of success in making such a modification of Godefroy.

VIII. ANALYSIS OF THE REFERENCES RELIED UPON BY PETITIONER

A. Claims 12, 15, 16, 19–21, 24–26, 29, 31–34, 37, 40, 42, 43, and 45 Are Anticipated by and/or Obvious Over Tomosada

1. Claim 12

153. Claim 12 recites:

12. [i] A method of preventing corrosion of a radiator,
the method comprising:

[ii] installing a sacrificial anode assembly including a
sacrificial anode within the radiator, [iii] wherein the
sacrificial anode is placed within 10 inches of a hot liquid
inlet to the radiator.

i. “A method of preventing corrosion of a radiator, the method comprising:”

154. As I have explained in Section VII.A.1, Tomosada discloses a method of preventing corrosion of a radiator. Tomosada states that its invention “solves the problems associated with conventional aluminum heat exchangers, and provides an aluminum heat exchanger which is excellent in anti-corrosion characteristics, which can be manufactured at a low cost.” EX1005, 1. These “anti-corrosion characteristics” are provided by a method of preventing corrosion. Tomosada describes this method as providing a sacrificial anode (via the turbulator 2) in the radiator R. *Id.*, 1–2. A POSITA would have understood that providing the

sacrificial anode, as taught by Tomosada, is a method of preventing corrosion of a radiator, as required in claim 1.

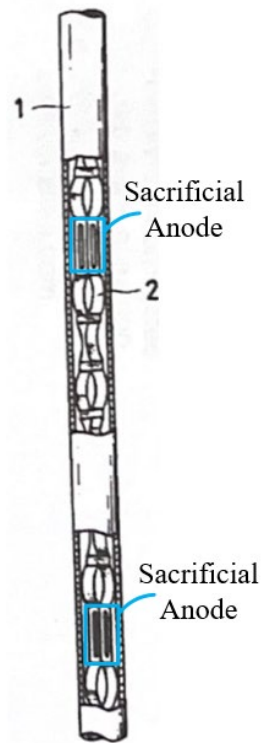
ii. “installing a sacrificial anode assembly including a sacrificial anode within the radiator,”

155. The turbulator 2 is “inserted into the heat exchanger tube 1.” *Id.*, 1. This “insert[ion]” is an installation within the radiator. As I have explained in Section VII.A.1, the turbulator 2 of Tomosada is a sacrificial anode assembly that includes a sacrificial anode. First, Tomosada depicts the turbulator 2 as including multiple different components (rectangular components, ring-shaped components, bone-shaped components) that are connected together. Second, the entirety of the turbulator 2 would not have been understood to be a sacrificial anode. Instead, a POSITA would have understood that only certain components (the rectangular components) of the turbulator 2 are sacrificial anodes. Otherwise, the turbulator 2 would have been prone to failure which would have caused the radiator to become undesirable.

156. Again, as I explained in Section VII.A.1, a POSITA would have understood the rectangular components to be sacrificial anodes. A POSITA would have understood the other components (the ring-shaped components, the bone-shaped components) as not being sacrificial anodes. Below is an annotation of Figure 2 of Tomosada highlighting the sacrificial anodes taught by Tomosada. These

sacrificial anodes are connected to other components (the ring-shaped components, the bone-shaped components) in an assembly.

FIG. 2



157. Tomosada explains that the “turbulator 2 becomes a sacrificial anode relative to the heat exchanger tube 1 formed using an aluminum material with the heat exchanger tube 1 becoming the cathode and thus protected from corrosion.” *Id.*, 1–2. Therefore, when Tomosada teaches that the turbulator 2 is installed within the radiator R, Tomosada likewise teaches installation of a sacrificial anode assembly including a sacrificial anode (one of the rectangular components) within the radiator.

158. As I have described in Section VII.A.1, a POSITA would have understood the turbulator 2 of Tomosada as necessarily being “sacrificial anode and at least one other connected part that forms one unit.” A POSITA would have also understood the turbulator 2 as including a “piece of metal used to protect another piece of metal by preferentially corroding.” This piece of metal is the rectangular component taught by Tomosada. Accordingly, Tomosada teaches “installing a sacrificial anode assembly including a sacrificial anode within the radiator.”

159. Regardless of whether Tomosada explicitly teaches that the rectangular components are sacrificial anodes, a POSITA would have found it obvious to construct the turbulator 2 such that only the rectangular components are sacrificial anodes. For example, a POSITA would have found it obvious to construct the rectangular components from a sacrificial anode material (such as those taught by Tomosada) and to construct the other components (the ring-shaped components, the bone-shaped components) out of material that is not sacrificial anode material.

160. This construction would have provided the radiator with the benefits described by Tomosada (i.e., corrosion prevention). Additionally, as I have discussed in Section VII.A.1, this construction would have decreased a cost of the turbulator 2 because sacrificial anode material is generally more expensive than non-sacrificial anode material. Therefore, by decreasing the overall amount of sacrificial anode material in the turbulator 2 by only forming the rectangular components from

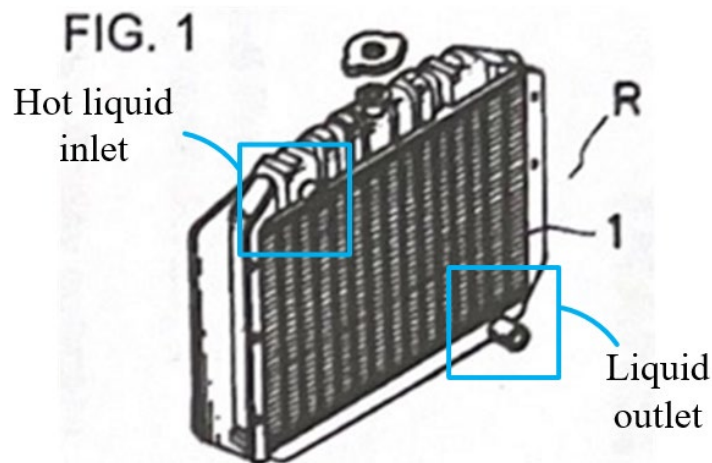
sacrificial anode material would have decreased the cost of the turbulator 2 and therefore made the turbulator 2 more desirable. Reducing the cost of the turbulator 2 would have been desirable to a POSITA because the turbulator 2 is intended to be replaced (i.e., after being sufficiently corroded). Thus, the cost of replacing the turbulator 2 would be decreased which would have made the radiator R more desirable than other radiators which require more expensive replacement of sacrificial anodes (or yet other radiators which do not have sacrificial anodes or do not enable replacement of sacrificial anodes).

161. Thus, a POSITA would have found it obvious to construct the turbulator 2 to include a “sacrificial anode and at least one other connected part that forms one unit,” where the sacrificial anode is a “piece of metal used to protect another piece of metal by preferentially corroding.” Accordingly, a POSITA would have understood Tomosada as teaching “installing a sacrificial anode assembly including a sacrificial anode within the radiator” through its teaching of inserting the turbulator 2 in the heat exchanger tube 1.

iii. “wherein the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.”

162. As I have explained in Section VII.A.1, Figure 1 of Tomosada depicts a hot liquid inlet and a liquid outlet. Below is an annotation of Figure 1 of Tomosada highlighting the hot liquid inlet and the liquid outlet. These structures are

conventional with radiators, such as that described by Tomosada. The hot liquid inlet receives the liquid/fluid from the heat source (engine), and the liquid outlet provides the liquid/fluid to a downstream component (such as a pump) in the cooling circuit/loop.



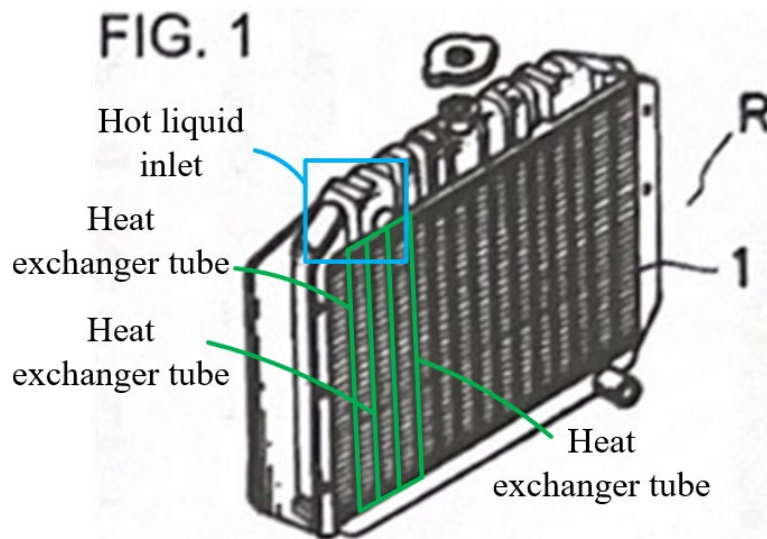
163. The radiator R includes multiple heat exchanger tubes 1. In this regard, Tomosada states that a “heat exchanger tube 1 formed of anticorrosion aluminum alloy such as that illustrated in FIG. 2 is arranged inside the radiator R.” *Id.*, 1.

164. From Figure 1 alone, I estimate that the radiator R includes at least 15 of the heat exchanger tubes 1. A POSITA would have understood that the radiator R would include different numbers of the heat exchanger tubes 1 (e.g., based on a cooling capability of the radiator R).

165. A POSITA would have understood that the radiator R also includes a first header (e.g., tank, etc.) and a second header (e.g., tank, etc.). The hot liquid inlet is disposed on the first header and the liquid outlet is disposed on the second header.

The heat exchanger tubes 1 extend from the first header to the second header. An analogous structure is described in Hanazaki-196 which teaches a header 6a, a header 6b, and flow paths 8 therebetween (see Figure 2A). Use of headers and heat exchanger tubes in the fashion described above was conventional.

166. Some of these heat exchanger tubes 1 are disposed directly underneath the hot liquid inlet. I have annotated a few of these heat exchanger tubes 1 in Figure 1 of Tomosada below. At least one turbulator 2 is located within each of these heat exchanger tubes 1.

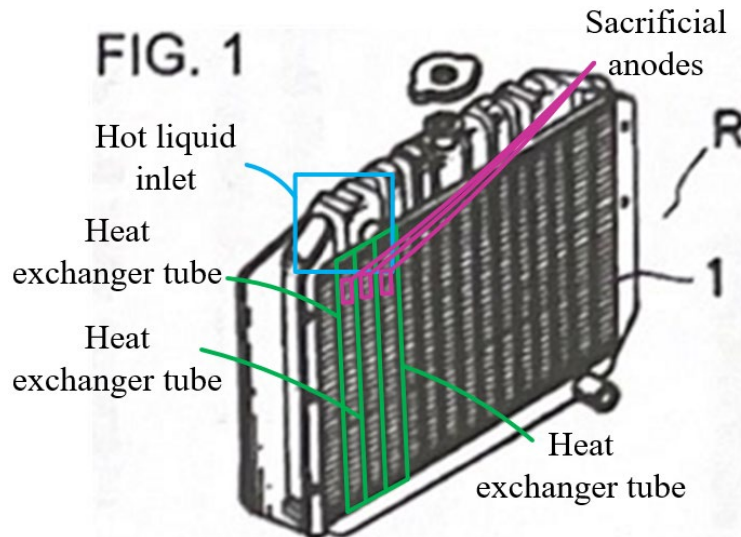


167. A significant portion of each of these heat exchanger tubes 1 is within 10 inches of a center axis of the hot liquid inlet. For example, where the heat exchanger tubes are 20 inches long, a POSITA would have understood that almost half of each of the heat exchanger tubes 1 are located within 10 inches of a center axis of the hot liquid inlet.

168. A POSITA would have understood that Tomosada provides for various positioning of the turbulator 2 within the heat exchanger tube 1 such that the radiator is tailored for a target application. Indeed, as depicted in Figure 2, Tomosada teaches that the turbulator 2 extends at least almost an entire length of the heat exchanger tube 1. Thus, a POSITA would have understood that the turbulator 2 extends at least almost an entire length of the heat exchanger tube 1 between the first header and the second header. Such an understanding is consistent with, for example, Hanazaki-069 which explains that “it is preferable to provide a sacrificial anode over the *entire length of the radiator tube*, so that the radiator tube receives corrosion protection uniformly in the longitudinal direction.” EX1006, ¶[0014].

169. As also depicted in Figure 2 of Tomosada, Tomosada teaches that each of the turbulators 2 includes multiple sacrificial anodes (the rectangular components), each pair of the sacrificial anodes separated from one another by a number of the other components (the ring-shaped components and the bone-shaped components). In view of the teaching that each turbulator 2 extends at least almost an entire length of the heat exchanger tube 1 between the first header and the second header, a POSITA would have understood that at least one of the sacrificial anodes (the rectangular components) taught by Tomosada is placed within 10 inches of the center axis of the hot liquid inlet. I have annotated Figure 1 of Tomosada below to highlight what a POSITA would have understood as example locations for the

sacrificial anodes, each of these example locations is within 10 inches of the center axis of the hot liquid inlet.



170. For at least these reasons, a POSITA would have understood the turbulator 2 of Tomosada as including a sacrificial anode (the rectangular component) that is placed “within 10 inches of the center axis of a hot liquid inlet.”

171. For the sake of argument, a POSITA would have also found it obvious to locate at least one of the sacrificial anodes of at least one of the turbulators 2 within 10 inches of a center axis of the hot liquid inlet. As I have explained in Section VII.A.1, a flow path has a significant impact on the protection provided by a sacrificial anode. Specifically, a sacrificial anode placed in a flow path provides anodic protection over a significantly smaller distance upstream of the sacrificial anode than the anodic protection it provides downstream of the sacrificial anode. For at least this reason, a POSITA would have been motivated to locate the sacrificial

anode of the turbulator 2 as far upstream as possible (i.e., as close to a hot liquid inlet as possible, etc.) in order to provide protection to as much of the heat exchanger tube 1 as possible.

172. In addition to maximizing the protection due to the flow, a POSITA would also have understood that corrosion is generally greater proximate a hot liquid inlet than it is proximate an outlet. This is due to both greater temperature of the fluid at the hot liquid inlet and greater turbulence of the fluid at the hot liquid inlet. Therefore, a POSITA would have found it obvious to locate the turbulator 2 within 10 inches of a center axis of the hot liquid inlet because a POSITA would have understood that the hot liquid inlet is a location that is associated with increased corrosion for the reasons I have described above.

173. As I also discussed above in Section VII.A.1, a POSITA would have routinely optimized various variables and dimensions, such as a distance between a sacrificial anode and a hot liquid inlet, during design and testing of a corrosion prevention system for a radiator. The '494 Patent does not include any teachings that a POSITA would recognize as proclaiming the critical nature of 10 inches. A POSITA would have found it obvious to design and test a corrosion prevention system such that at least one sacrificial anode is within 10 inches of a center axis of a hot liquid inlet. For example, Hanazaki-196 teaches a sacrificial anode in the same header pipe as the hot liquid inlet (see Figure 2A of Hanazaki-196, for example),

and Godefroy teaches a sacrificial anode on a connector for the hot liquid inlet (see Figure 1 of Godefroy).

174. For at least these reasons, a POSITA would have found it obvious to locate the sacrificial anode (the rectangular component) of the turbulator 2 “within 10 inches of the center axis of a hot liquid inlet.” Accordingly, Tomosada teaches “wherein the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.”

2. Claim 15 – “wherein the sacrificial anode consists essentially of an active metal.”

175. A POSITA would have found it obvious to select a construction of the sacrificial anode that enables the corrosion prevention system to be tailored for a target application. One aspect of this tailoring is selecting a metal for the sacrificial anode. A POSITA would have found it obvious to utilize any of a multitude of metals, and various combinations of metals, depending on the application. A POSITA would have understood that these metals and combinations thereof “react[] with oxygen” in that they provide corrosion protection.

176. A POSITA would have understood that one such active metal is zinc because zinc reacts with oxygen. Indeed, the '494 Patent itself states in its “[b]ackground” section that “sacrificial anodes, constructed of active metals, that is metals that react with oxygen, such as magnesium, aluminum, zinc or combinations

thereof, have also been used as corrosion inhibitors.” EX1001, 2:6–9. Similar to what is described in the “[b]ackground” section of the ’494 Patent, Tomosada states that “the turbulator 2 is *made using zinc* or a zinc compound material that is an electrochemical base relative to aluminum” and that “when the coolant filled in the heat exchanger tube 1 acts as an electrolyte solution, the turbulator 2 becomes the anode and the heat exchanger tube 1 becomes the cathode.” EX1005, 1, 2.

177. As I discussed in Section V.A, I understand that “consists essentially of” X is to be interpreted as “includes only X” or “includes essentially only X.” Thus, I understand that claim 15, which recites that the “sacrificial anode consists essentially of an active metal,” means that the sacrificial anode includes only an active metal or includes essentially only an active metal. Tomosada teaches such a sacrificial anode. As I discussed above, Tomosada states that the turbulator 2 is “made using zinc” so as to “become[] the anode.” Thus, Tomosada teaches that the sacrificial anodes (the rectangular components) of the turbulator 2 are made using zinc. A POSITA would have understood “made using” as meaning “including only” or “including essentially only,” and therefore would have understood Tomosada as teaching that its sacrificial anodes consist essentially of an active metal. This understanding is informed by Tomosada stating “made using zinc or a zinc compound material.” A POSITA would have understood that “made using zinc” is necessarily different from “made using...a zinc compound material.” Thus, a

POSITA would have understood that “made using zinc” means including only zinc or including essentially only zinc. Accordingly, Tomosada discloses “wherein the sacrificial anode consists essentially of an active metal.”

3. Claim 16 – “wherein the sacrificial anode consists essentially of aluminum, magnesium, or zinc”

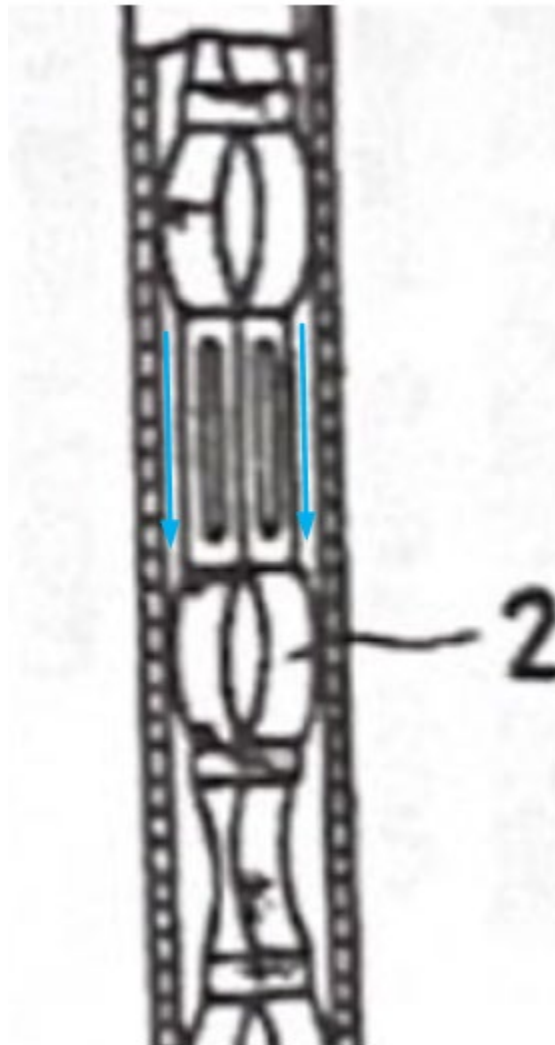
178. *See* Section VIII.A.2.

179. As I have explained in Section VIII.A.2, Tomosada discloses that its sacrificial anodes (the rectangular components) consist essentially of zinc. Therefore, Tomosada discloses that “the sacrificial anode consists essentially of aluminum, magnesium, or zinc.”

4. Claim 19 – “wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly within the fluid flow of the radiator”

180. *See* Section VIII.A.1.ii.

181. As I have explained in Section VIII.A.1.ii, Tomosada provides its sacrificial anodes (the rectangular components) in a fluid flow through the heat exchanger tube 1 when the turbulator 2 is inserted within the heat exchanger tube 1. Below is an annotation of a detailed view of Figure 2 of Tomosada showing the fluid flow around one of the sacrificial anodes taught by Tomosada.



182. Therefore, Tomosada discloses that “installing the sacrificial anode assembly” includes “installing the sacrificial anode assembly within the fluid flow of the radiator.”

5. Claim 20 – “wherein the radiator comprises aluminum”

183. Tomosada extensively describes its radiator as including aluminum. First, the title of Tomosada is “ALUMINUM HEAT EXCHANGER.” EX1005, 1. Tomosada then states that its “invention relates to improvements to an aluminum

heat exchanger.” *Id.* Tomosada then explains that its “heat exchanger tube 1 [is] formed of anticorrosion aluminum alloy....” *Id.* Therefore, Tomosada discloses that “the radiator comprises aluminum.”

6. Claim 21 – “wherein the hot liquid is coolant”

184. Tomosada states that “[w]hen the *heat exchanger tube 1 is filled with coolant*, this turbulator 2 becomes a sacrificial anode relative to the heat exchanger tube 1 formed using an aluminum material with the heat exchanger tube 1 becoming the cathode and thus protected from corrosion.” *Id.*, 1–2. Tomosada also states that “as the turbulator 2 formed of a zinc or zinc compound that acts as a sacrificial anode relative to the heat exchanger tube 1 is inserted into the heat exchanger tube 1 formed of an aluminum material, when *the coolant filled in the heat exchanger tube 1 acts as an electrolyte solution*, the turbulator 2 becomes the anode and the heat exchanger tube 1 becomes the cathode.” *Id.*, 2.

185. Therefore, Tomosada discloses that “the hot liquid is coolant.”

7. Claim 24 – “further comprising installing a second sacrificial anode assembly within the radiator.”

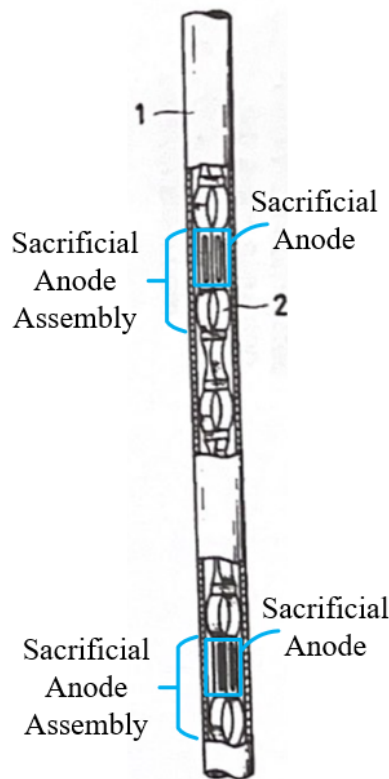
186. *See* Section VIII.A.1.ii.

187. Claim 24 recites “installing a second sacrificial anode assembly within the radiator.” Claim 24 does not recite any details regarding a sacrificial anode of the second sacrificial anode assembly. Accordingly, a POSITA would not have

understood claim 24 as requiring two sacrificial anodes to be installed within 10 inches of a center axis of a hot liquid inlet, or as requiring the second sacrificial anode assembly be on a different turbulator 2. Rather, claim 24 merely requires an additional sacrificial anode assembly “within the radiator.” This mere duplication of parts was well known and conventional in radiator design.

188. As I have discussed in Section VIII.A.1.ii, Tomosada discloses that each of its turbulators 2 includes multiple sacrificial anodes and multiple other components. Therefore, a POSITA would have understood the turbulator 2 of Tomosada as including a “second sacrificial anode assembly” in addition to the “sacrificial anode assembly” discussed above with reference to claim 12. This “second sacrificial anode assembly” includes a sacrificial anode (the rectangular component) and at least one of the other components. I have provided below an annotation of Figure 2 of Tomosada highlighting these sacrificial anode assemblies.

FIG. 2



189. Therefore, a POSITA would have understood the turbulator 2 of Tomosada as including a second “sacrificial anode and at least one other connected part that forms one unit” that is installed within the radiator. Accordingly, Tomosada discloses “installing a second sacrificial anode assembly within the radiator.”

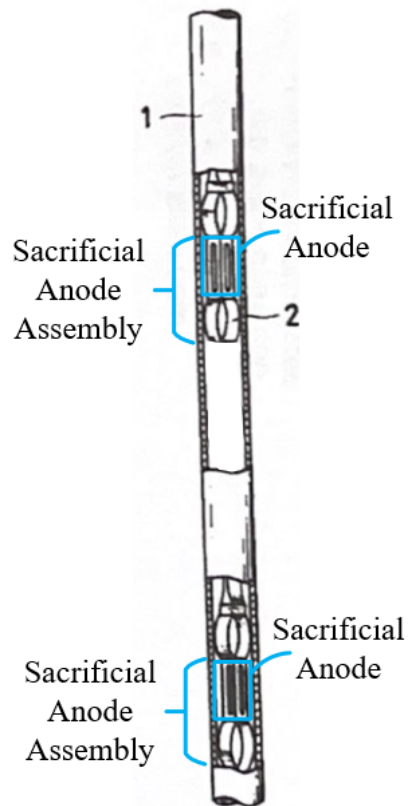
190. Moreover, as I have discussed in Section VIII.A.1.iii, Tomosada discloses that the radiator includes multiple turbulators 2, each within one of the heat exchanger tubes 1 and including its own sacrificial anodes (the rectangular components). Thus, in addition to Tomosada disclosing that one turbulator 2 includes both the “sacrificial anode assembly” of claim 12 and the “second sacrificial

anode assembly,” Tomosada also discloses two turbulators 2 where one includes the “sacrificial anode assembly” of claim 12 and the other includes the “second sacrificial anode assembly.”

191. Therefore, a POSITA would have understood Tomosada as disclosing a second “sacrificial anode and at least one other connected part that forms one unit” that is installed within the radiator. Accordingly, Tomosada discloses “installing a second sacrificial anode assembly within the radiator.”

192. Even further, a POSITA would have found it obvious to divide the turbulator 2 taught by Tomosada into two pieces, with each piece having at least one of the sacrificial anodes. This would enable replacement of a shorter turbulator 2 (the upstream turbulator 2), which would have reduced maintenance costs. *See* EX1005, 2 (“a corroded turbulator that was the sacrificial anode can easily be replaced with a new turbulator...”). In this regard, Tomosada states that the “shape of the turbulator 2 is not in particular limited to the shape illustrated in FIG. 2.” *Id.*, 2. Below I provided a modification of Figure 2 of Tomosada illustrating these two separate sacrificial anode assemblies.

FIG. 2



193. Therefore, a POSITA would have found it obvious to modify the turbulator 2 of Tomosada so that a “second sacrificial anode assembly [is installed] within the radiator.” Accordingly, Tomosada teaches “installing a second sacrificial anode assembly within the radiator.”

8. Claim 25

- i. “A radiator for use in a motor vehicle, the radiator further comprising:”

194. *See* Section VIII.A.1.i.

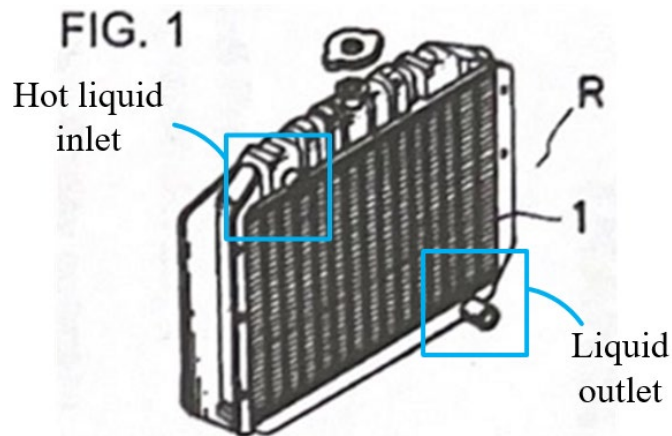
195. As I have discussed in Section VIII.A.1.i, Tomosada discloses a radiator R. Tomosada explicitly states that “[i]n FIG. I a radiator R for an automobile is illustrated.” EX1005, 1. Tomosada also states that “[n]ote that in the embodiment described above, the description used a radiator for an automobile as an example, but the present invention is not limited to this and can be applied to a heater core for an automobile, a radiator for cargo handling vehicles, and the like as well as other aluminum heat exchangers.” *Id.*, 2. Tomosada also provides that “FIG. I is a perspective view of a radiator for an automobile according to the embodiment of the present invention.”

196. Therefore, Tomosada discloses a “radiator for use in a motor vehicle.”

ii. “a hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine; and”

197. *See* Sections VIII.A.1.i, VIII.A.1.iii, and VIII.A.8.i.

198. As I have discussed in Section VIII.A.1.iii, the radiator R of Tomosada is utilized in a cooling loop/circuit that circulates fluid from an engine to the radiator R. The radiator R receives the fluid through the hot liquid inlet that I have discussed in Section VIII.A.1.iii. Reproduced below for quick reference is my previous annotation of Figure 1 of Tomosada highlighting the hot liquid inlet and liquid outlet.



199. Thus, a POSITA would have understood that the hot liquid inlet of the radiator of Tomosada is necessarily from an engine of a motor vehicle. Additionally, a POSITA would have understood that the hot liquid inlet provides fluid communication for fluid flow of hot liquid from the engine.

200. Therefore, Tomosada discloses a “hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine.”

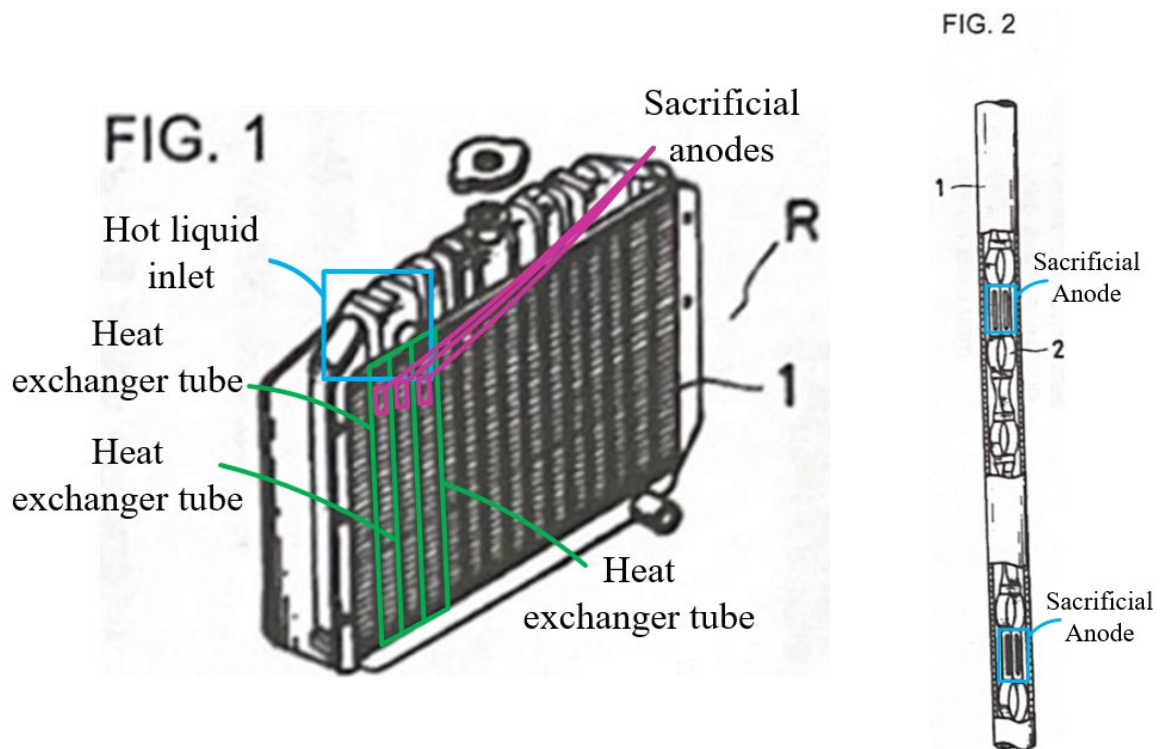
iii. “a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.”

201. See Sections VIII.A.1.ii–VIII.A.1.iii.

202. First, I note that unlike claim 12, claim 25 does not recite a “sacrificial anode *assembly*.”

203. As I discussed above with respect to claim 12, Tomosada teaches that the turbulator 2 includes a sacrificial anode. As I also discussed above, Tomosada teaches that the radiator R is constructed such that this sacrificial anode is “installed

within 10 inches of the hot liquid inlet of the radiator.” For quick reference, I again provide below my annotation of Figure 1 of Tomosada highlighting what a POSITA would have understood as example locations for the sacrificial anodes. Each of these example locations is within 10 inches of the center axis of the hot liquid inlet. I also provide below my annotation of Figure 2 highlighting the sacrificial anodes of the turbulator 2.



204. As I also explained above, a POSITA would have found it obvious to construct the radiator R such that at least one of the sacrificial anodes of the turbulator 2 is “installed within 10 inches of the hot liquid inlet of the radiator,” to the extent that the radiator R is not already described by Tomosada as including such a sacrificial anode.

9. Claim 26 – “wherein the sacrificial anode consists essentially of an active metal.”

205. *See* Section VIII.A.2.

206. As I have discussed above in Section VIII.A.2, Tomosada states that “the turbulator 2 is *made using zinc* or a zinc compound material that is an electrochemical base relative to aluminum” and that “when the coolant filled in the heat exchanger tube 1 acts as an electrolyte solution, the turbulator 2 becomes the anode and the heat exchanger tube 1 becomes the cathode.” EX1005, 1, 2. A POSITA would have understood that “made using zinc” means including only zinc or including essentially only zinc. Accordingly, Tomosada discloses “wherein the sacrificial anode consists essentially of an active metal.”

10.Claim 29 – “wherein the sacrificial anode is installed onto a surface of the radiator”

207. *See* Section VIII.A.1.ii.

208. As I have discussed above in Section VIII.A.1.ii, Tomosada depicts the turbulator 2 as including multiple different components (rectangular components, ring-shaped components, bone-shaped components) that are connected together. Tomosada teaches that the ring-shaped components contact the heat exchanger tube 1, as shown in the detailed view of Figure 2 of Tomosada shown below. This contact occurs as a result of the turbulator 2 being inserted (installed) in the heat exchanger

tube 1. This contact provides an electrical contact with the heat exchanger tube 1 which enables the sacrificial anode (rectangular component) to prevent corrosion.



209. A POSITA would not have understood claim 29 as requiring the sacrificial anode itself to contact the surface of the radiator. Rather, a POSITA would have understood that a component can, and often is, installed onto a surface via another component. Here, with respect to the turbulator 2 of Tomosada, the sacrificial anode (rectangular component) is installed onto the surface of the heat exchanger tube 1 via the ring-shaped component (which contacts the heat exchanger tube 1). Such an understanding of “installed onto the surface” is consistent with the

discussion provided in the '494 Patent regarding the wire 15 and the anode 13. *See* EX1001, 6:30–33 and Figure 1A.

210. Therefore, Tomosada discloses that “the sacrificial anode is installed onto a surface of the radiator.”

11.Claim 31 – “wherein the radiator comprises aluminum”

211. *See* Section VIII.A.5.

212. As I discussed in Section VIII.A.5, Tomosada extensively describes its radiator as including aluminum. *See* EX1001, 1. Therefore, Tomosada discloses that “the radiator comprises aluminum.”

12.Claim 32 – “wherein the radiator enables air-cooling of the hot liquid”

213. As I discussed in Section VII.A.1, a POSITA would have understood that the radiator R is used for air-cooling the hot liquid within the heat exchanger tube 1 because a common application for a radiator is use in an automobile to air-cool an engine of the automobile and the radiator provides this cooling by passing air across tubes, such as the heat exchanger tubes 1 of Tomosada, circulating the hot fluid within the radiator. Therefore, Tomosada discloses that “the radiator enables air-cooling of the hot liquid.”

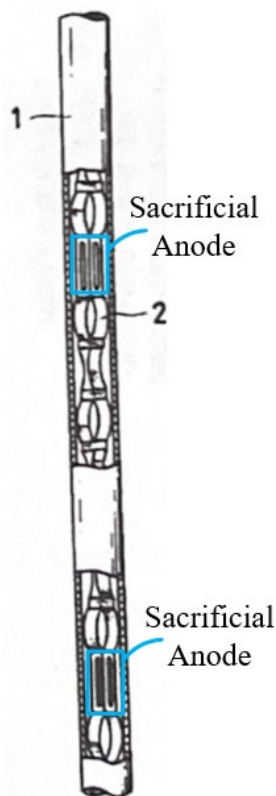
13.Claim 33 – “further comprising a second sacrificial anode.”

214. *See* Sections VIII.A.1.ii and VIII.A.7.

215. I understand that claim 33 does not recite a “sacrificial anode assembly,” but rather only recites a “second sacrificial anode.”

216. As I have discussed in Sections VIII.A.1.ii and VIII.A.7, Tomosada discloses that the turbulator 2 includes several sacrificial anodes (the rectangular shaped components). Below is an annotation of Figure 2 of Tomosada highlighting the sacrificial anodes taught by Tomosada.

FIG. 2



217. Therefore, Tomosada discloses a “second sacrificial anode.”

14.Claim 34 – “wherein the hot liquid is coolant”

218. *See* Section VIII.A.6.

219. As I have discussed in Section VIII.A.6, Tomosada discusses filling the heat exchanger tube 1 with “coolant.” *See* EX1005, 1–2. Therefore, Tomosada discloses that “the hot liquid is coolant.”

15.Claim 37

i. “An electrolysis prevention device for preventing corrosion, the electrolysis prevention device comprising:”

220. *See* Section VIII.A.1.i.

221. As I have discussed in Section VIII.A.1.i, the turbulator 2 prevents corrosion by its sacrificial anodes (the rectangular components) being preferentially corroded. As explained by Tomosada, this corrosion occurs due to electrochemical action, which is known by a POSITA as electrolysis. *See* EX1005, 1–2. Therefore, Tomosada discloses an “electrolysis prevention device for preventing corrosion.”

ii. “a sacrificial anode made of an active metal; and”

222. *See* Sections VIII.A.1.ii and VIII.A.2.

223. As I have explained in Section VIII.A.2, Tomosada teaches that its sacrificial anodes (the rectangular components) include zinc. According to the “[b]ackground” section of the ’494 Patent, zinc is an active metal. EX1001, 2:6–9. Therefore, Tomosada discloses “a sacrificial anode made of an active metal.”

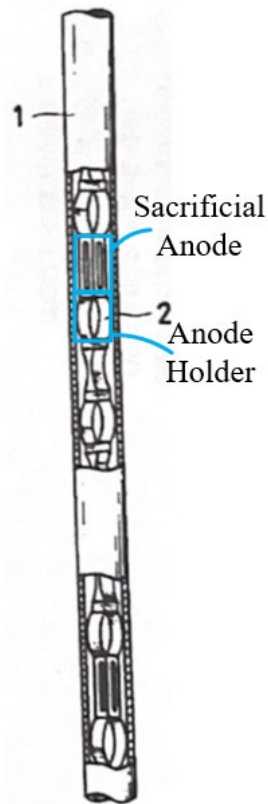
iii. “an anode holder supporting the sacrificial anode, the anode holder adapted for installation

in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.”

224. *See* Sections VIII.A.1.ii–VIII.A.1.iii and VIII.A.10.

225. As I explained in Section VIII.A.10, the ring-shaped components function to position the rectangular components within the heat exchanger tube 1 and provide an electrical contact with the heat exchanger tube 1. The ring-shaped components support the sacrificial anodes (the rectangular components), and the ring-shaped components are adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator, as discussed with respect to claim 12 and the sacrificial anode. Therefore, the ring-shaped components are anode holders. I have annotated Figure 2 of Tomosada below to highlight the anode and anode holder.

FIG. 2



226. As I have explained above with respect to claim 12, the anode holder of Tomosada is adapted for installation in the radiator within 10 inches of a center axis of a hot liquid inlet to the radiator. Therefore, Tomosada discloses “an anode holder supporting the sacrificial anode, the anode holder adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.”

16.Claim 40 – “wherein the sacrificial anode comprises zinc”

227. *See* Section VIII.A.2.

228. As I have explained in Section VIII.A.2, Tomosada teaches that its sacrificial anodes (the rectangular components) include zinc. Therefore, Tomosada discloses that “the sacrificial anode comprises zinc.”

17.Claim 42 – “wherein the engine radiator comprises aluminum”

229. *See* Section VIII.A.5.

230. As I have explained in Section VIII.A.5, Tomosada teaches that its radiator includes aluminum. Therefore, Tomosada discloses that “the engine radiator comprises aluminum.”

18.Claim 43 – “wherein the anode holder enables the sacrificial anode to be located within fluid flow of the hot coolant inlet”

231. *See* Sections VIII.A.1.ii–VIII.A.1.iii, VIII.A.4, and VIII.A.15.iii.

232. As I have explained in Section VIII.A.4, Tomosada teaches that the turbulator 2 is installed such that the sacrificial anodes are located within fluid flow of the radiator. A POSITA would have understood that this fluid flow is also “fluid flow of the hot coolant inlet.” Moreover, claim 43 does not require a particular location of the anode holder, but merely that the anode holder “enables” location of the sacrificial anode within fluid flow of the hot coolant inlet. A POSITA would have understood that the ring-shaped elements of the turbulator 2 of Tomosada meet this requirement.

233. As I have explained in Section VIII.A.15.iii, the ring-shaped component of the turbulator 2 is an anode holder that holds the sacrificial anodes (the rectangular components). Therefore, Tomosada discloses that “the anode holder enables the sacrificial anode to be located within fluid flow of the hot coolant inlet.”

19.Claim 45 – “wherein the hot liquid is coolant”

234. *See* Section VIII.A.6.

235. As I have discussed in Section VIII.A.6, Tomosada discusses filling the heat exchanger tube 1 with “coolant.” *See* EX1005, 1–2. Therefore, Tomosada discloses that “the hot liquid is coolant.”

B. Claims 22, 23, 27, 35, 36, 38, 39, 46, and 47 Are Obvious Over by Tomosada and Hanazaki-069

1. Claim 22 – “wherein the hot liquid is water”

236. *See* Sections VII.B.1–VII.B.2.

237. As I have explained in Section VII.B.1, Hanazaki-069 teaches use of radiators with water and with antifreeze. Specifically, Hanazaki-069 states that “the corrosive environment inside the radiator fluctuates in a complex manner, and simply placing a sacrificial anode in the radiator tube does not provide sufficient corrosion protection” and that “[f]or example, radiators are not always supplied with the ideal liquid, and sometimes tap water is supplied instead of the antifreeze liquid.” EX1006, ¶[0005].

238. As I have explained in Section VII.B.2, a POSITA would have found it obvious to utilize the radiator R of Tomosada with other fluids, such as water, as taught by Hanazaki-069. Therefore, the combination of Tomosada and Hanazaki-069 teaches that “the hot liquid is water.”

2. Claim 23 – “wherein the hot liquid is antifreeze”

239. *See* Sections VII.B.1–VII.B.2 and VIII.B.1.

240. A POSITA would have understood from the statement in Hanazaki-069 that “sometimes tap water is supplied instead of the antifreeze liquid” means that antifreeze is used as the hot liquid in some situations (i.e., those situations where tap water is not used). Furthermore, as I have explained in Section VIII.B.1, a POSITA would have found it obvious to utilize the radiator R of Tomosada with other fluids, such as antifreeze, as taught by Hanazaki-069. Therefore, the combination of Tomosada and Hanazaki-069 teaches that “the hot liquid is antifreeze.”

3. Claim 27 – “wherein the active metal is at least one of aluminum, magnesium, and zinc”

241. As I discussed in Section VIII.A.2, Tomosada teaches making the turbulator 2 using a “zinc compound material,” as an alternative “zinc.” A POSITA would have understood that this “compound material” is a zinc alloy and includes more than zinc.

242. Hanazaki-069 teaches an example of a zinc alloy. Specifically, Hanazaki-069 discusses alloys of aluminum, zinc, and magnesium (EX1006, ¶[0015]) and provides an example where the sacrificial anode includes only a combination of aluminum, zinc, and magnesium (*id.*, Table 7).

243. As I discussed in Section VII.B.2, a POSITA would have found it obvious to utilize an alloy of aluminum, zinc, and magnesium for the sacrificial anode, as taught by Hanazaki-069 and contemplated by Tomosada. Therefore, the combination of Tomosada and Hanazaki-069 teaches that “the active metal is at least one of aluminum, magnesium, and zinc.”

4. Claim 35 – “wherein the hot liquid is water”

244. *See* Sections VII.B.1–VII.B.2 and VIII.B.1.

245. As I have explained in Section VIII.B.1, a POSITA would have found it obvious to utilize the radiator R of Tomosada with other fluids, such as water, as taught by Hanazaki-069. Therefore, the combination of Tomosada and Hanazaki-069 teaches that “the hot liquid is water.”

5. Claim 36 – “wherein the hot liquid is antifreeze”

246. *See* Sections VII.B.1–VII.B.2 and VIII.B.1.

247. As I have explained in Section VIII.B.1, a POSITA would have understood from the statement in Hanazaki-069 that “sometimes tap water is supplied instead of the antifreeze liquid” means that antifreeze is used as the hot

liquid in some situations (i.e., those situations where tap water is not used). Furthermore, a POSITA would have found it obvious to utilize the radiator R of Tomosada with other fluids, such as antifreeze, as taught by Hanazaki-069. Therefore, the combination of Tomosada and Hanazaki-069 teaches that “the hot liquid is antifreeze.”

6. Claim 38 – “wherein the sacrificial anode comprises aluminum”

248. *See* Section VIII.B.3.

249. As I discussed in Section VIII.B.3, Hanazaki-069 teaches using an alloy that includes aluminum for the sacrificial anode, and a POSITA would have found it obvious to utilize such an alloy for the sacrificial anode. Therefore, the combination of Tomosada and Hanazaki-069 teaches that “the sacrificial anode comprises aluminum.”

7. Claim 39 – “wherein the sacrificial anode comprises magnesium”

250. *See* Section VIII.B.3.

251. As I discussed in Section VIII.B.3, Hanazaki-069 teaches using an alloy that includes magnesium for the sacrificial anode, and a POSITA would have found it obvious to utilize such an alloy for the sacrificial anode. Therefore, the combination of Tomosada and Hanazaki-069 teaches that “the sacrificial anode comprises magnesium.”

8. Claim 46 – “wherein the hot liquid is water”

252. *See* Sections VII.B.1–VII.B.2 and VIII.B.1.

253. As I have explained in Section VIII.B.1, a POSITA would have found it obvious to utilize the radiator R of Tomosada with other fluids, such as water, as taught by Hanazaki-069. Therefore, the combination of Tomosada and Hanazaki-069 teaches that “the hot liquid is water.”

9. Claim 47 – “wherein the hot liquid is antifreeze”

254. *See* Sections VII.B.1–VII.B.2 and VIII.B.1.

255. As I have explained in Section VIII.B.1, a POSITA would have understood from the statement in Hanazaki-069 that “sometimes tap water is supplied instead of the antifreeze liquid” means that antifreeze is used as the hot liquid in some situations (i.e., those situations where tap water is not used). Furthermore, a POSITA would have found it obvious to utilize the radiator R of Tomosada with other fluids, such as antifreeze, as taught by Hanazaki-069. Therefore, the combination of Tomosada and Hanazaki-069 teaches that “the hot liquid is antifreeze.”

C. Claims 12, 15–17, 19–21, and 24 Are Anticipated by and/or Obvious Over Hanazaki-196

1. Claim 12

i. “A method of preventing corrosion of a radiator, the method comprising:”

256. Under the heading “Problem Solved by the Present Invention,” Hanazaki-196 states that “[a]s the result of diligent research in contemplation of the perspective described above, the present inventors arrived at the present invention through solving this problem of corrosion in a heat exchanger made from aluminum that uses brine that is made from an aqueous solution of calcium chloride or sodium chloride.” EX1007, 2. Hazanki-196 explains that “[w]hile in the aluminum heat exchanger according to the present invention a pitting electropotential is produced in the pipeline that forms the flow path for the brine through the use, as a coolant, of a brine that is made from an aqueous solution of calcium chloride or sodium chloride, an anticorrosion electric current flows from the sacrificial electrode that is attached to the inner wall of the pipeline, thereby bringing the pipeline to less than the critical pitting electropotential, thereby preventing corrosion of the aluminum pipeline, that is, of the heat exchanger.” *Id.*, 3.

257. As I discussed in Section VII.A.1, a POSITA would have understood that a radiator is a heat exchanger. Therefore, a POSITA would have understood the heat exchanger of Hanazaki-196 as a radiator. In this regard, Hanazaki-196 states

that the “heat exchanger made from aluminum in the present invention may be used in heat exchanging *in any field*, such as, for example, air cleaning, air conditioning, bookbinding, dry ice, refrigeration for shipping, cooling water towers, refrigerators, refrigerated trucks, and the like.” *Id.*, 3. A POSITA would have understood that “any field” includes a radiator of a motor vehicle.

258. Therefore, Hanazaki-196 discloses a “method of preventing corrosion of a radiator.”

ii. “installing a sacrificial anode assembly including a sacrificial anode within the radiator,”

259. Hanazaki-196 states that “FIG. 2A and FIG. 2B show an aluminum heat exchanger according to a first embodiment according to the present invention.” *Id.*, 4. Hanazaki-196 explains that “[t]his heat exchanger is structured from a pair of header pipes 6 (6a and 6b) that have a relatively large diameter, arranged in parallel with a space therebetween, and heat exchanging pipe units 7, connecting between the header pipes 6a and 6b, where a coolant supplying opening and coolant exhausting opening are provided at the two ends of the primary side header pipe 6a that is positioned on the upstream side, where heat is exchanged in the heat exchange region during the time until the coolant that is introduced from the supplying opening arrives at the exhaust opening 10 after traveling serpentine through each of the brine flow paths 8 of each of the header pipes 6 and the heat exchanging pipe units 7.” *Id.*

260. According to Hanazaki-196, “as depicted in FIG. 3, which shows the primary side header pipe 6a enlarged...an attaching groove 11...is formed, spanning the total length, on the inner surface side thereof, and a sacrificial anode 12...is fitted into this attaching groove 11, followed by plug welding at welding points 13 at at least five locations for a single sacrificial anode 12 is fitted into this attaching groove 11....” *Id.* I provide Figures 2A and 3 of Hanazaki-196 below.

FIG. 2A

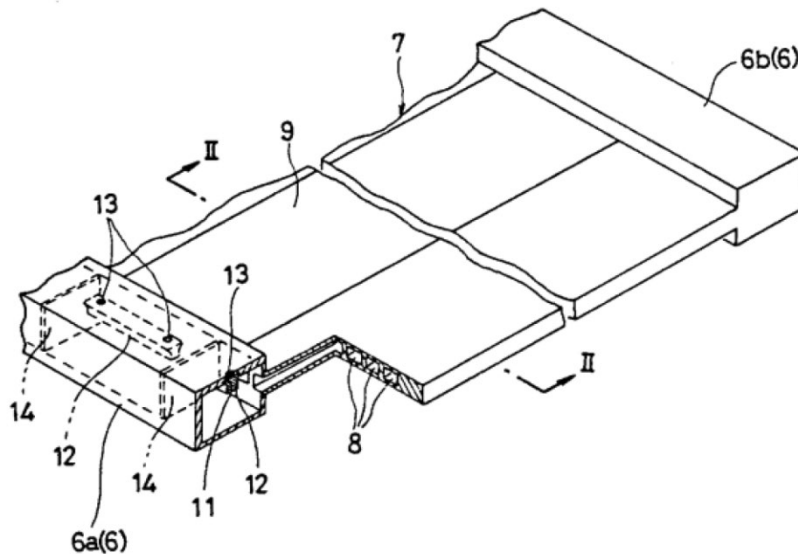
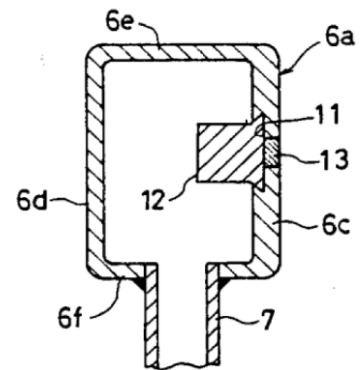


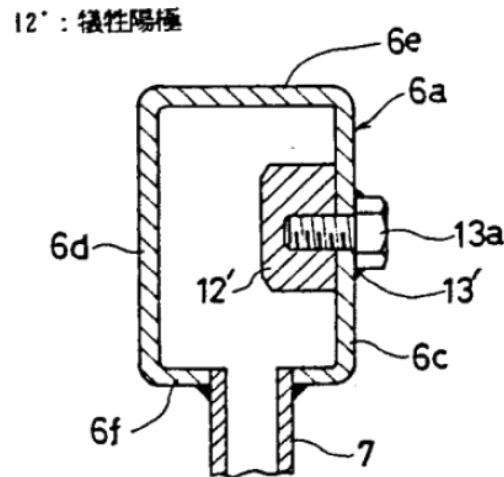
FIG. 3



261. As I have discussed in Section VII.C.1 above, Hanazaki-196 teaches that the sacrificial anode 12 is part of an assembly that includes at least one other connected part. Specifically, Hanazaki-196 teaches that the welding points 13 are connected to the sacrificial anode 12 and together form one unit, as shown in Figure 3 of Hanazaki-196.

262. For the sake of argument, Hanazaki-196 also provides for the use of bolts as a substitute for the welding points 13. In this regard, Hanazaki-196 explains that “when welding or securing between the sacrificial anode and the pipeline inner wall of the header pipe and/or heat exchanging pipe, the welding or securing between some or all of the sacrificial anode that is provided within the attaching groove on the inside of the pipeline is carried out, from outside of the header pipe and/or heat exchanging pipe, through, for example, plug welding, spot welding, seam welding, *bolting*, or the like.” *Id.*, 3. Additionally, Hanazaki-196 states that “FIG. 5 depicts a modified example of an attaching structure for a case of a sacrificial anode 12’...where a bolt 13a that is screwed through the back wall 6c of the header pipe 6 is welded tightly 13’ from the outside, and *the threaded portion thereof screws together with the sacrificial anode 12’.*” *Id.*, 4. I have reproduced Figure 5 of Hanazaki-196 below. These bolts 13a are connected to the sacrificial anode 12’. Therefore, the sacrificial anode 12’ is part of an assembly that includes at least one other connected part (the bolts 13a).

FIG. 5

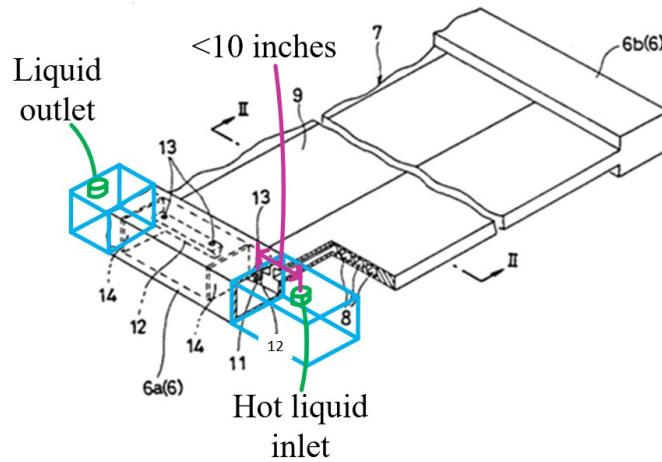


263. Accordingly, Hanazaki-196 discloses “installing a sacrificial anode assembly including a sacrificial anode within the radiator.”

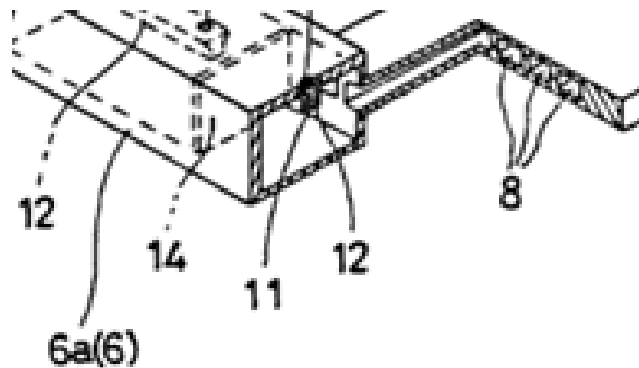
iii. “wherein the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.”

264. As I have discussed in Section VII.C.1, Hanazaki-196 discloses header pipes 6a, 6b and states that a “coolant supplying opening and coolant exhausting opening are provided at the two ends of the primary side header pipe 6a that is positioned on the upstream side....” EX1007, 4. Provided below is the annotation of Figure 2A of Hanazaki-196 that I discussed above illustrating the hot liquid inlet.

FIG. 2A



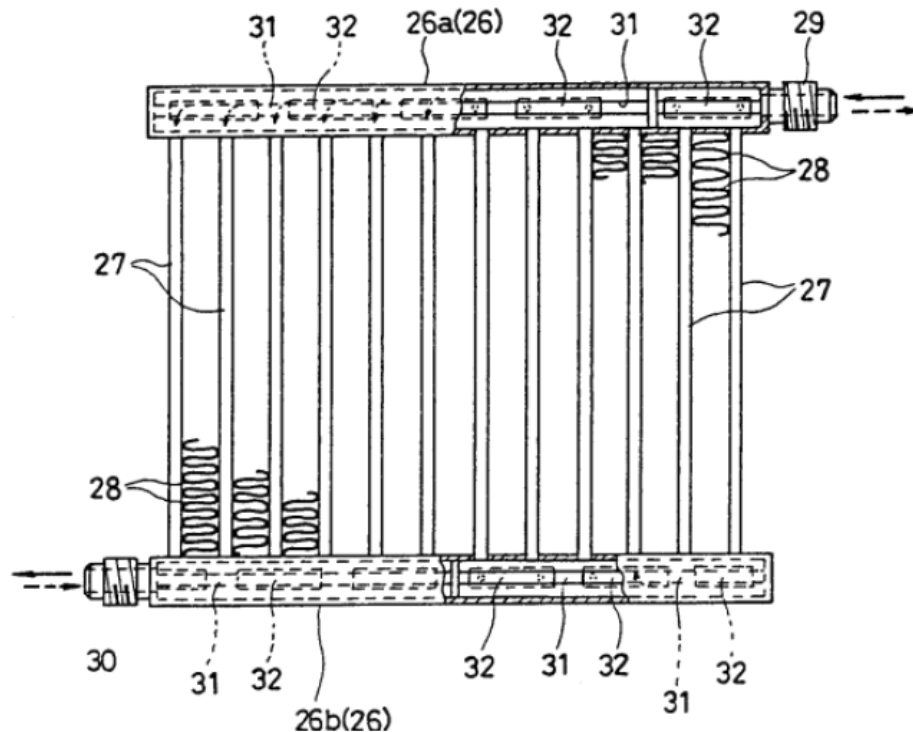
265. A POSITA would have understood at least one of the sacrificial anodes 12 depicted in Figure 2A to be within 10 inches of a center axis of the hot liquid inlet. As shown below, only a portion of one of the sacrificial anodes 12 is shown, with another portion cut away. This would indicate to a POSITA that this cut-away sacrificial anode 12 extends even closer to the hot liquid inlet.



266. Thus, a POSITA would have understood Figure 2A as depicting a sacrificial anode that is within 10 inches of a center axis of the hot liquid inlet. This understanding is buttressed by the discussion of Hanazaki-196 with regard to Figure

11, reproduced below. In Figure 11, Hanazaki-196 discloses locating a sacrificial anode 32 at a supplying opening 29. *Id.*, 5. Accordingly, Hanazaki-196 discloses that “the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.”

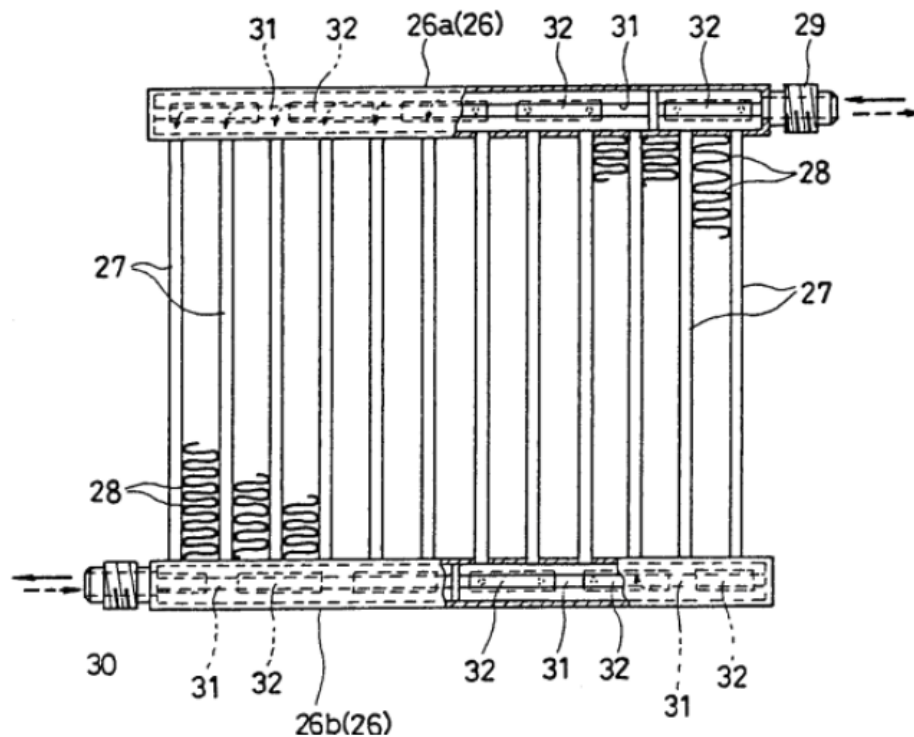
FIG. 11



267. For the sake of argument, it would have been obvious to a POSITA to have located one or more of the sacrificial anodes 12 within 10 inches of a center axis of the hot liquid inlet. As I discussed in Section VII.A.1, there are several reasons why a POSITA would have chosen such a location for the sacrificial anode. In addition to these reasons, Hanazaki-196 provides a yet further reason because Hanazaki-196 uses dividing plates 14 in the header pipe 6a to cause serpentine flow (in the embodiment of Figure 2A). EX1007, 4. A POSITA would have understood

that the sacrificial anode 12 must be located at the inlet so as to be upstream of the first dividing plate 14. Additionally, Hanazaki-196 discloses an embodiment (shown in Figure 11) where a sacrificial anode 32 is located at a supplying opening 29, which a POSITA would have understood as a hot liquid inlet. EX1007, 5. These teachings would further motivate a POSITA to locate the sacrificial anode 12 within 10 inches of a center axis of the hot liquid inlet. Accordingly, Hanazaki-196 teaches “wherein the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.”

FIG. 11



2. Claim 15 – wherein the sacrificial anode consists essentially of an active metal.

268. See Section VIII.A.2.

269. Hanazaki-196 teaches that “[a]node electrodes that satisfy such conditions include, specifically, zinc (Zn) or magnesium (Mg) or metal alloys equivalent thereto, such as, for example, an Al-Zn-In-(other metal) alloy..., or the like.” *Id.*, 2. With reference to Figure 5, Hanazaki-196 discloses that a “modified example of an attaching structure for a case of a sacrificial anode 12’ that is made from zinc (Zn) or magnesium (Mg)....” *Id.*, 4. Hanazaki-196 also discloses that “if the sacrificial anode is made from zinc, the amount used should be between 0.008 and 1.296 g/cm² with respect to the unit area of the pipeline inner wall, and if the sacrificial anode is made from magnesium, the amount used should be between 0.002 and 0.306 g/m² with respect to the unit area of the pipeline inner wall.” *Id.*, 1–2; *see id.*, 1. Thus, Hanazaki-196 discloses that its sacrificial anode is made from only zinc or essentially only zinc.

270. As I discussed above in Section VIII.A.2, zinc reacts with oxygen and is an active metal according to the ’494 Patent. *See*, EX1001, 2:6–9. As I also explained, a POSITA would have understood that “made from” includes “made from only” zinc and “made from essentially only” zinc. Therefore, Hanazaki-196 discloses that “the sacrificial anode consists essentially of an active metal.”

3. Claim 16 – wherein the sacrificial anode consists essentially of aluminum, magnesium, or zinc.

271. *See* Sections VIII.A.2 and VIII.C.2.

272. As I discussed in Section VIII.C.2, Hanazaki-196 discloses a sacrificial anode that consists essentially of zinc. Therefore, Hanazaki-196 discloses that “the sacrificial anode consists essentially of aluminum, magnesium, or zinc.”

4. Claim 17 – “wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly in a fitting hole in the radiator.”

273. See Section VIII.C.1.ii.

274. As shown in Figure 3, Hanazaki-196 teaches that a fitting hole is formed in the header pipe 6a and that the welding point 13 extends through this fitting hole. Figure 3 of Hanazaki-196 is reproduced below.

FIG. 3

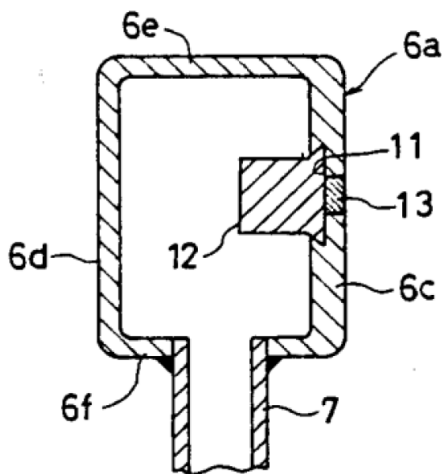
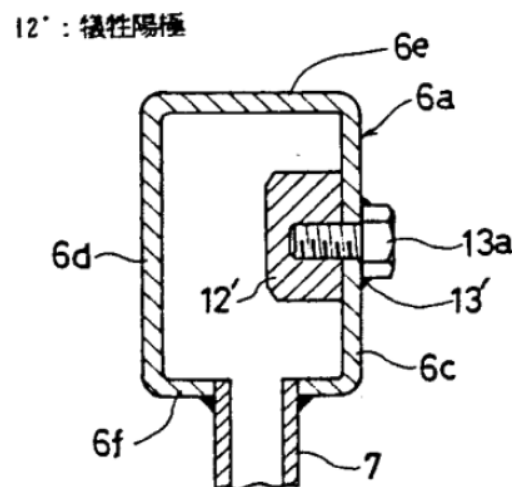


FIG. 5



275. As I have explained in Section VIII.C.1.ii, with regard to the welding points 13, Hanazaki-196 states that “when welding or securing between the sacrificial anode and the pipeline inner wall of the header pipe and/or heat exchanging pipe, the welding or securing between some or all of the sacrificial anode

that is provided within the attaching groove on the inside of the pipeline is carried out, *from outside of the header pipe and/or heat exchanging pipe*, through, for example, plug welding, spot welding, seam welding, bolting, or the like.” *Id.*, 3. As shown in Figure 5, reproduced above, Hanazaki-196 teaches that a hole is formed in the header pipe 6a through which the bolt 13a extends. In this regard, Hanazaki-196 teaches that the “bolt 13a...is *screwed through the back wall 6c* of the header pipe 6 is welded tightly 13’ from the outside, and the threaded portion thereof screws together with the sacrificial anode 12’.” *Id.*, 4.

276. Indeed, a POSITA would have understood this welding and bolting to require a fitting hole formed in the header pipe 6a. As a result, installing the sacrificial anode assembly would have been understood to necessarily include installing the sacrificial anode assembly in a fitting hole in the radiator (i.e., by welding the sacrificial anode 12 at the welding points 13, by bolting the sacrificial anode 12’ via the bolt 13a, etc.).

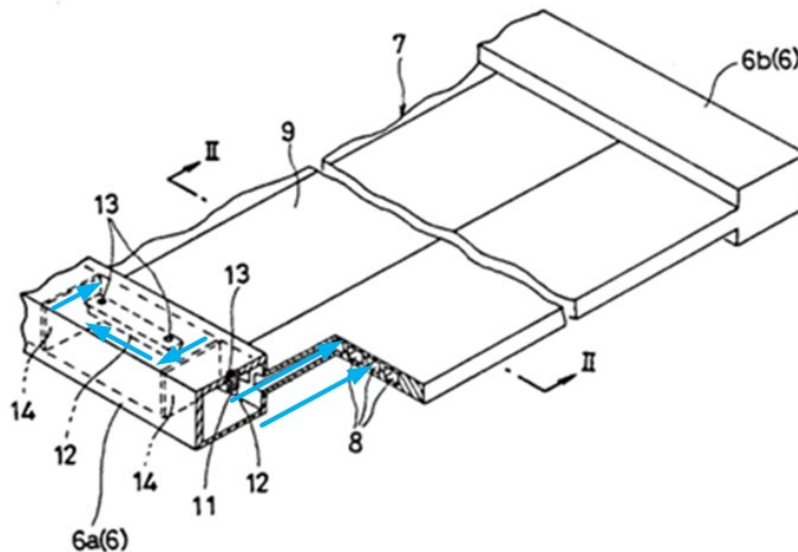
277. Thus, Hanazaki-196 discloses that “installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly in a fitting hole in the radiator.”

5. Claim 19 – wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly within the fluid flow of the radiator.

278. *See* Section VIII.C.1.ii.

279. As I have explained in Section VIII.C.1.ii, Hanazaki-196 provides its sacrificial anodes 12 in a fluid flow within the header pipe 6a. Below is an annotation of a detailed view of Figure 2A of Hanazaki-196 showing the fluid flow around the sacrificial anodes 12 taught by Hanazaki-196.

FIG. 2A



280. Therefore, Hanazaki-196 discloses that “installing the sacrificial anode assembly” includes “installing the sacrificial anode assembly within the fluid flow of the radiator.”

6. Claim 20 – wherein the radiator comprises aluminum.

281. The title of Hanazaki-196 is “Heat Exchanger Made from Aluminum.” *Id.*, 1. Hanazaki-196 states that “[t]he present invention relates to a heat exchanger that is made from aluminum...” *Id.* Hanazaki-196 also states that “the object of the present invention is to provide an aluminum heat exchanger, made from aluminum

or an aluminum alloy....” *Id.*, 2. Hanazaki-196 also provides that “FIG. 2A and FIG. 2B show an aluminum heat exchanger according to a first embodiment according to the present invention.” *Id.*, 4. Hanazaki-196 includes ample additional discussion of the radiator being aluminum. Therefore, Hanazaki-196 discloses that “the radiator comprises aluminum.”

7. Claim 21 – wherein the hot liquid is coolant.

282. Hanazaki-196 states that “[c]onventionally, aluminum heat exchangers made from aluminum or aluminum alloys have problems with pitting, so typically Freon gas, ammonia gas, or the like, has been used as the coolant, where the coolant is used recirculating, repetitively undergoing evaporation and condensation during the refrigerating cycle.” *Id.*, 1. Hanazaki-196 also teaches “that which is termed ‘brine,’ such as, for example, an aqueous solution of calcium chloride or an aqueous solution of sodium chloride, is known as a coolant that is used for this purpose, where, for example, for a calcium chloride aqueous solution the eutectic point of a 29.9 wt% aqueous solution (with a specific gravity of 1.286) is low, at -55°C, and is non-toxic and inexpensive, and thus is used broadly in industry.” *Id.*, 1–2.

283. With reference to Figures 2A and 2B, Hanazaki-196 states that “[t]his heat exchanger is structured from a pair of header pipes 6 (6a and 6b) that have a relatively large diameter, arranged in parallel with a space therebetween, and heat exchanging pipe units 7, connecting between the header pipes 6a and 6b, where a

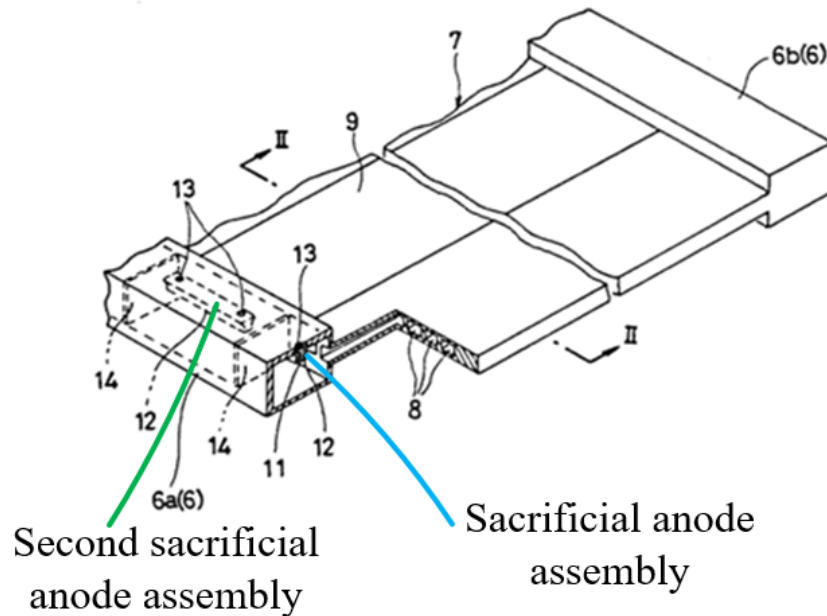
coolant supplying opening and coolant exhausting opening are provided at the two ends of the primary side header pipe 6a that is positioned on the upstream side, where heat is exchanged in the heat exchange region during the time until the coolant that is introduced from the supplying opening arrives at the exhaust opening 10 after traveling serpentine through each of the brine flow paths 8 of each of the header pipes 6 and the heat exchanging pipe units 7.” *Id.*, 4. Therefore, Hanazaki-196 discloses that “the hot liquid is coolant.”

8. Claim 24 – further comprising installing a second sacrificial anode assembly within the radiator.

284. *See* Section VIII.C.1.ii.

285. As shown in Figure 2A, Hanazaki-196 includes two of the sacrificial anodes 12, each with its own welding points 13. As I have explained in Section VIII.C.1.ii, a POSITA would have understood each of the sacrificial anodes 12, in combination with its welding points 13 or bolts 13a, to be a sacrificial anode assembly.

FIG. 2A



286. Therefore, Hanazaki-196 discloses “installing a second sacrificial anode assembly within the radiator.”

D. Claims 22, 23, 25–29, 31–40, and 42–47 Are Obvious Over Hanazaki-196 and Hanazaki-069

1. Claim 22 – wherein the hot liquid is water.

287. See Sections VII.B.1 and VII.D.1.

288. As I have explained in Section VII.B.1., Hanazaki-069 teaches use of radiators with water and with antifreeze. Specifically, Hanazaki-069 states that “the corrosive environment inside the radiator fluctuates in a complex manner, and simply placing a sacrificial anode in the radiator tube does not provide sufficient corrosion protection” and that “[f]or example, radiators are not always supplied with

the ideal liquid, and sometimes tap water is supplied instead of the antifreeze liquid.”
EX1006, ¶[0005].

289. As I have explained in Section VII.D.1, a POSITA would have found it obvious to utilize the heat exchanger of Hanazaki-196 with other fluids, such as water, as taught by Hanazaki-069. Therefore, the combination of Hanazaki-196 and Hanazaki-069 teaches that “the hot liquid is water.”

2. Claim 23 – wherein the hot liquid is antifreeze.

290. See Sections VII.B.1, VII.D.1, and VIII.D.1.

291. As I have explained in Section VII.D.1, a POSITA would have found it obvious to utilize the heat exchanger of Hanazaki-196 with other fluids, such as antifreeze, as taught by Hanazaki-069. EX1006, ¶[0005]. Therefore, the combination of Hanazaki-196 and Hanazaki-069 teaches that “the hot liquid is antifreeze.”

3. Claim 25

i. A radiator for use in a motor vehicle, the radiator further comprising:

292. See Sections VII.D.1 and VIII.C.1.i.

293. As I have explained in Sections VII.D.1 and VIII.C.1.i, Hanazaki-196 teaches use of its heat exchanger in *any* field. *Id.*, 3. A POSITA would have understood that *any field* includes use as a radiator in a motor vehicle. Accordingly, Hanazaki-196 discloses a “radiator for use in a motor vehicle.”

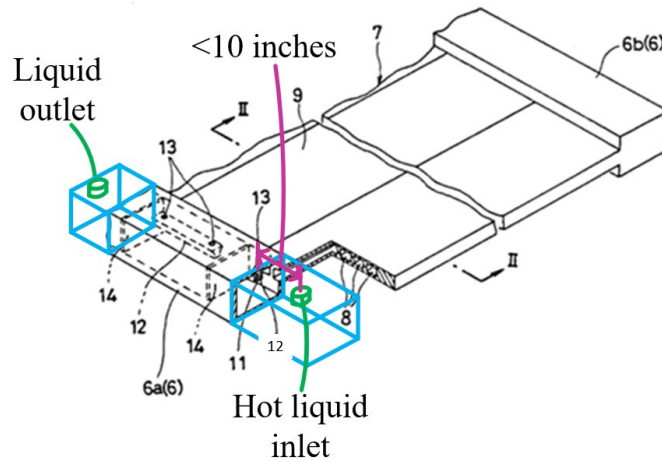
294. For the sake of argument, a POSITA would have found it obvious to utilize the heat exchanger of Hanazaki-196 as a radiator for use in a motor vehicle. Specifically, Hanazaki-069 discloses “heat exchangers mounted on vehicles such as automobiles...” EX1006, ¶[0002]. A POSITA would have understood that the heat exchanger of Hanazaki-196 would be beneficial in applications such as use in vehicles, as taught by Hanazaki-069. Moreover, a POSITA would have understood that it is conventional to utilize a heat exchanger as a radiator in a motor vehicle. Therefore, the combination of Hanazaki-196 and Hanazaki-069 teaches a “radiator for use in a motor vehicle.”

- ii. **a hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine; and**

295. *See* Sections VIII.C.1.i, VIII.C.1.iii, and VIII.D.3.i.

296. As I have explained in Section VIII.C.1.iii, Hanazaki-196 teaches that its heat exchanger includes a hot liquid inlet and a liquid outlet, as shown in the annotation of Figure 2A of Hanazaki-196 provided below. These structures are conventional with radiators, such as that described by Hanazaki-196. The hot liquid inlet receives the liquid/fluid from the heat source (engine), and the liquid outlet provides the liquid/fluid to a downstream component (such as a pump) in the cooling circuit/loop.

FIG. 2A



297. Thus, a POSITA would have understood that the hot liquid inlet of the radiator of Hanazaki-196 is necessarily from an engine of a motor vehicle. Additionally, a POSITA would have understood that the hot liquid inlet provides fluid communication for fluid flow of hot liquid from the engine.

298. Therefore, Hanazaki-196 discloses a “hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine.”

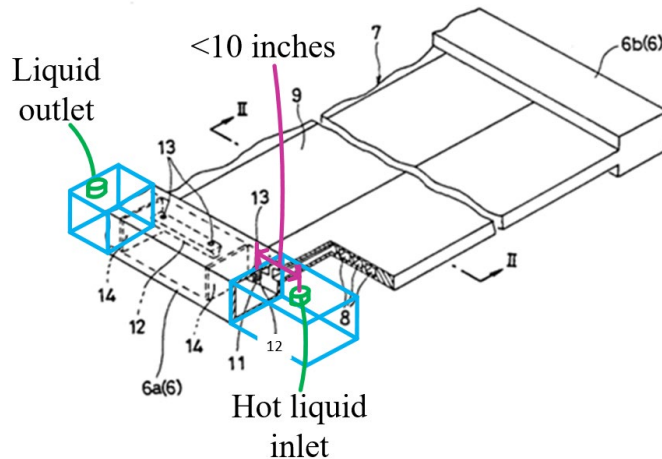
iii. a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.

299. See Sections VIII.C.1.ii–VIII.C.1.iii.

300. As I discussed above with respect to claim 12, Hanazaki-196 teaches that the sacrificial anode is “installed within 10 inches of the hot liquid inlet of the radiator.” For quick reference, I again provide below my annotation of Figure 2A of Hanazaki-196 highlighting the sacrificial anode 12 which is disposed near the hot

liquid inlet and extends even closer to the hot liquid inlet. Therefore, Hanazaki-196 discloses “a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.”

FIG. 2A



301. As I also explained above, a POSITA would have found it obvious to have located one or more of the sacrificial anodes 12 within 10 inches of a center axis of the hot liquid inlet. Therefore, Hanazaki-196 also teaches “a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.”

4. Claim 26 – wherein the sacrificial anode consists essentially of an active metal.

302. See Sections VIII.A.2 and VIII.C.2.

303. As I have discussed above in Section VIII.C.2, Hanazaki-196 discloses “[a]node electrodes that satisfy such conditions include, specifically, zinc (Zn) or magnesium (Mg) or metal alloys equivalent thereto, such as, for example, an Al-Zn-

In-(other metal) alloy..., or the like.” EX1007, 2. Accordingly, Hanazaki-196 discloses “wherein the sacrificial anode consists essentially of an active metal.”

5. Claim 27 – wherein the active metal is at least one of aluminum, magnesium, and zinc.

304. See Sections VII.D.1, VIII.A.2, and VIII.C.2.

305. As I have discussed in Section VIII.C.2, Hanazaki-069 discusses alloys of aluminum, zinc, and magnesium (EX1006, ¶[0015]) and provides an example where the sacrificial anode includes only a combination of aluminum, zinc, and magnesium (*id.*, Table 7).

306. As I discussed in Section VII.D.1, a POSITA would have found it obvious to utilize an alloy of aluminum, zinc, and magnesium for the sacrificial anode, as taught by Hanazaki-069. Therefore, the combination of Hanazaki-196 and Hanazaki-069 teaches that “the active metal is at least one of aluminum, magnesium, and zinc.”

6. Claim 28 – “wherein the sacrificial anode is installed in a fitting hole penetrating the radiator.”

307. See Sections VIII.C.1.ii and VIII.C.4.

308. As I have discussed in Section VIII.C.4, Hanazaki-196 teaches that a fitting hole is formed in the header pipe 6a and that the welding point 13 extends through this fitting hole. Similarly, the bolts 13a of Hanazaki-196 extend through

fitting holes in the header pipe 6a. Figures 3 and 5 of Hanazaki-196 are reproduced below.

FIG. 3

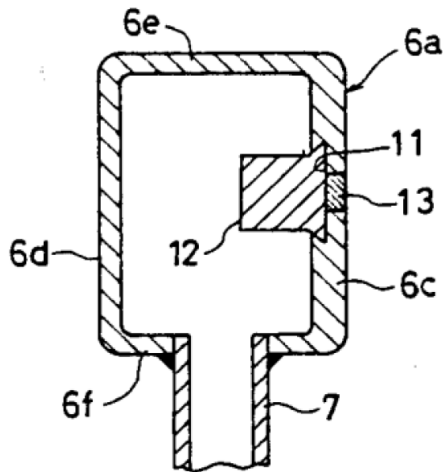
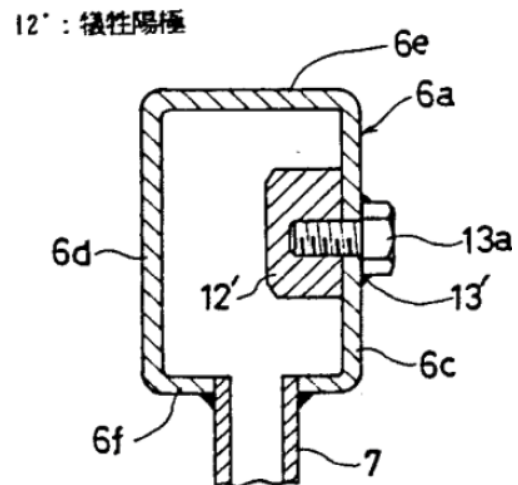


FIG. 5



309. Thus, Hanazaki-196 discloses that “the sacrificial anode is installed in a fitting hole penetrating the radiator.”

7. Claim 29 – wherein the sacrificial anode is installed onto a surface of the radiator.

310. See Section VIII.C.1.ii.

311. As I have discussed above in Section VIII.C.1.ii, Hanazaki-196 discloses that “the present invention is a heat exchanger...wherein a sacrificial anode...is formed on an inner wall of a pipeline that forms a brine flow path.” *Id.*, 2. Hanazaki-196 also states that “as depicted in FIG. 3, which shows the primary side header pipe 6a enlarged..., an attaching groove 11 of a helical groove shape is formed, spanning the total length, on the inner surface side thereof, and a sacrificial anode 12...is fitted into this attaching groove 11, followed by plug welding at

welding points 13 at at least five locations for a single sacrificial anode 12 with a prescribed spacing of, for example, 30 cm.” *Id.*, 4. Figures 2A and 3 of Hanazaki-196, which each show the sacrificial anode 12 installed on a surface of the radiator (within the header pipe 6a) are reproduced below.

FIG. 3

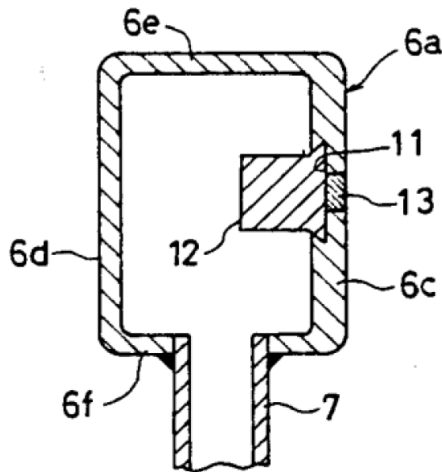
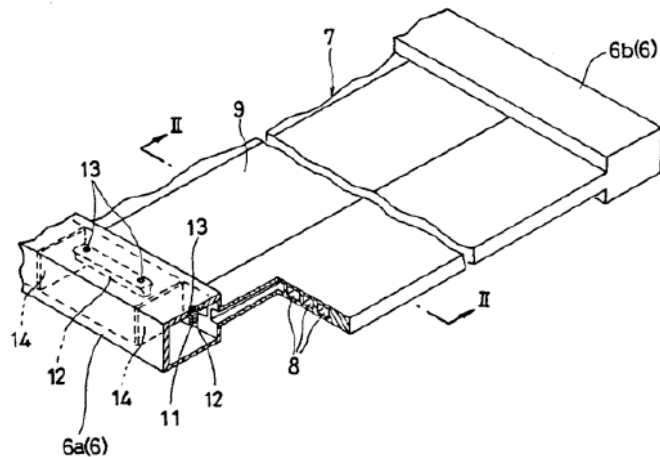


FIG. 2A



312. Therefore, Hanazaki-196 discloses that “the sacrificial anode is installed onto a surface of the radiator.”

8. Claim 31 – wherein the radiator comprises aluminum.

313. *See* Section VIII.C.6.

314. As I have discussed in Section VIII.C.6, Hanazaki-196 states that “[t]he present invention relates to a heat exchanger that is made from aluminum...” *Id.*, 1. Therefore, Hanazaki-196 discloses that “the radiator comprises aluminum.”

9. Claim 32 – wherein the radiator enables air-cooling of the hot liquid.

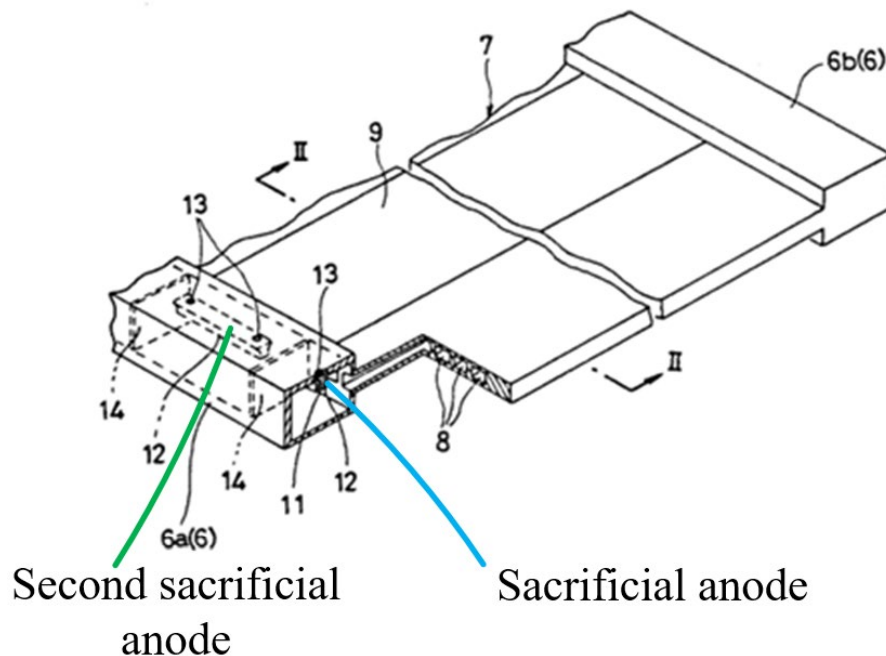
315. A POSITA would have understood that a common application for a radiator, such as that of Hanazaki-196, is use in an automobile to air-cool an engine of the automobile. A POSITA would have understood that the radiator provides this cooling by passing air across tubes, such as the flow paths 8 of Hanazaki-196, circulating the hot fluid within the radiator. As I discussed above, Hanazaki-196 states that its radiator is used in “any field” and discusses motor vehicles. A POSITA would have understood that using the radiator to air-cool the hot liquid would have been conventional. Therefore, Hanazaki-196 discloses that “the radiator enables air-cooling of the hot liquid.”

10.Claim 33 – further comprising a second sacrificial anode.

316. *See* Sections VIII.C.1.ii and VIII.C.8.

317. As I have discussed in Section VIII.C.8, Hanazaki-196 includes, in Figure 2A (annotated and reproduced below), two of the sacrificial anodes 12.

FIG. 2A



318. Therefore, Hanazaki-196 discloses a “second sacrificial anode.”

11.Claim 34 – wherein the hot liquid is coolant.

319. See Section VIII.C.7.

320. As I have discussed in Section VIII.C.7, Hanazaki-196 states that “[t]his heat exchanger is structured from a pair of header pipes 6 (6a and 6b) that have a relatively large diameter, arranged in parallel with a space therebetween, and heat exchanging pipe units 7, connecting between the header pipes 6a and 6b, where a *coolant* supplying opening and *coolant* exhausting opening are provided at the two ends of the primary side header pipe 6a that is positioned on the upstream side, where heat is exchanged in the heat exchange region during the time until the *coolant* that is introduced from the supplying opening arrives at the exhaust opening 10 after

traveling serpentine through each of the brine flow paths 8 of each of the header pipes 6 and the heat exchanging pipe units 7.” *Id.*, 4. Therefore, Hanazaki-196 discloses that “the hot liquid is coolant.”

12.Claim 35 – wherein the hot liquid is water.

321. *See* Sections VII.B.1, VII.D.1, and VIII.D.1.

322. As I have explained in Section VII.D.1, a POSITA would have found it obvious to utilize the heat exchanger of Hanazaki-196 with other fluids, such as water, as taught by Hanazaki-069. Therefore, the combination of Hanazaki-196 and Hanazaki-069 teaches that “the hot liquid is water.”

13.Claim 36 – wherein the hot liquid is antifreeze.

323. *See* Sections VII.B.1, VII.D.1, and VIII.D.1.

324. As I have explained in Section VII.D.1, a POSITA would have found it obvious to utilize the heat exchanger of Hanazaki-196 with other fluids, such as antifreeze, as taught by Hanazaki-069. EX1006, ¶[0005]. Therefore, the combination of Hanazaki-196 and Hanazaki-069 teaches that “the hot liquid is antifreeze.”

14.Claim 37

- i. An electrolysis prevention device for preventing corrosion, the electrolysis prevention device comprising:**

325. *See* Section VIII.C.1.i.

326. Hanazaki-196 discusses “pitting electropotential.” *See id.*, 2. For example, Hanazaki-196 states that “[w]hile in the aluminum heat exchanger according to the present invention a pitting electropotential is produced in the pipeline that forms the flow path for the brine through the use, as a coolant, of a brine that is made from an aqueous solution of calcium chloride or sodium chloride, an anticorrosion electric current flows from the sacrificial electrode that is attached to the inner wall of the pipeline, thereby bringing the pipeline to less than the critical pitting electropotential, thereby preventing corrosion of the aluminum pipeline, that is, of the heat exchanger.” *Id.*, 3. A POSITA would have understood that “pitting electropotential” is a measurement potential associated with electrolysis testing. In view of this discussion and the construction of the sacrificial anode 12 disclosed by Hanazaki-196, a POSITA would have understood that the sacrificial anode 12 is an “electrolysis prevention device” because the sacrificial anode 12 prevents corrosion due to electrolysis. Therefore, Hanazaki-196 discloses an “electrolysis prevention device for preventing corrosion.”

ii. a sacrificial anode made of an active metal; and

327. *See* Sections VIII.A.2, VIII.C.1.ii, and VIII.C.2.

328. As I discussed in Section VIII.C.2, Hanazaki-196 teaches that “[a]node electrodes that satisfy such conditions include, specifically, *zinc (Zn)* or magnesium (Mg) or metal alloys equivalent thereto, such as, for example, an Al-Zn-In-(other

metal) alloy..., or the like.” *Id.*, 2. Hanazaki-196 discloses that a “modified example of an attaching structure for a case of a sacrificial anode 12’ that is *made from zinc (Zn)* or magnesium (Mg)....” *Id.*, 4. According to the “[b]ackground” section of the ’494 Patent, zinc is an active metal. EX1001, 2:6–9. Therefore, Hanazaki-196 discloses “a sacrificial anode made of an active metal.”

iii. an anode holder supporting the sacrificial anode, the anode holder adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.

329. *See* Sections VIII.C.1.ii–VIII.C.1.iii.

330. As I explained in Section VIII.C.1.ii, Hanazaki-196 teaches coupling the sacrificial anode 12 to the header pipe 6a via the welding points 13. EX1007, 4. The welding points 13 are depicted in Figure 3, reproduced below. As shown in Figure 5, reproduced below, Hanazaki-196 teaches that a hole is formed in the header pipe 6a through which the bolt 13a extends. In this regard, Hanazaki-196 teaches that the “bolt 13a...is *screwed through the back wall 6c* of the header pipe 6 is welded tightly 13’ from the outside, and the threaded portion thereof screws together with the sacrificial anode 12’.” *Id.*, 4.

FIG. 3

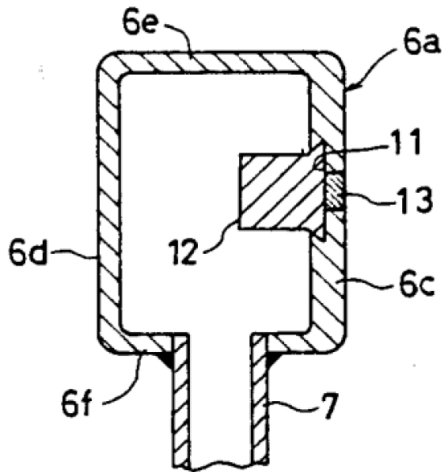
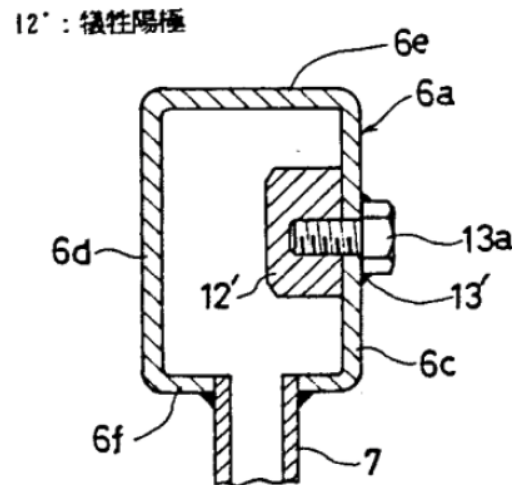


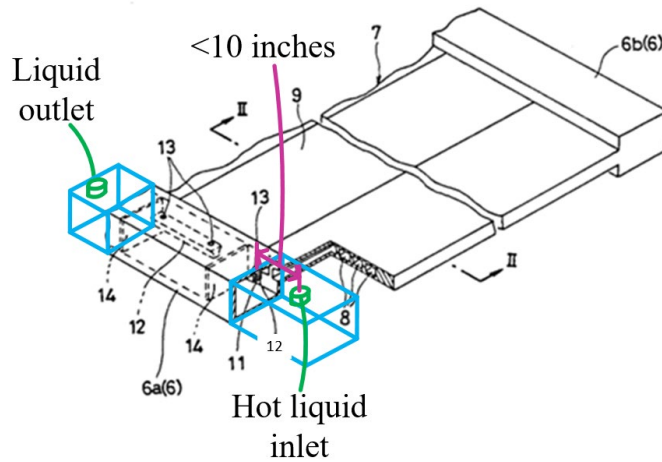
FIG. 5



331. The welding points 13 (or bolts 13a) are installed within (and through) the header pipe 6a and support the sacrificial anode 12, 12'.

332. As I discussed above with respect to claim 12, Hanazaki-196 teaches that the sacrificial anode is “installed within 10 inches of the hot liquid inlet of the radiator.” For quick reference, I again provide below my annotation of Figure 2A of Hanazaki-196 highlighting the sacrificial anode 12 which is disposed near the hot liquid inlet and extends even closer to the hot liquid inlet. A POSITA would have understood that the welding points 13 (or bolts 13a) are installed within (and through) the header pipe 6a so as to support the sacrificial anode 12, 12' at this location. Therefore, a POSITA would have understood that the welding points 13 (or bolts) support the sacrificial anode 12 and are “adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.”

FIG. 2A



333. Therefore, Hanazaki-196 discloses an “anode holder supporting the sacrificial anode, the anode holder adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.”

334. As I also explained above, a POSITA would have found it obvious to have located one or more of the sacrificial anodes 12 within 10 inches of a center axis of the hot liquid inlet. It would have also been obvious to a POSITA to have located the welding points 13 (or the bolts 13a) so as to locate the sacrificial anodes 12 in such a location. Accordingly, Hanazaki-196 teaches “an anode holder supporting the sacrificial anode, the anode holder adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.”

15.Claim 38 – wherein the sacrificial anode comprises aluminum.

335. Hanazaki-196 states that “in regard to the use of a sacrificial anode, although there will be differences depending on the material of the pipeline of the heat

exchanger, the type of brine used, and the like, if *the sacrificial anode is made from an aluminum alloy*, the area ratio thereof in respect to the inner wall area of the pipeline of the heat exchanger (the anode/cathode area ratio) should be between 1:10 and 1:140, and preferably between 1:20 and 1:100, and should be between 0.003 and 0.486 g/cm², and preferably between 0.006 and 0.147 g/cm², with respect to the unit area of the pipeline inner wall.” *Id.*, 2. Therefore, Hanazaki-196 discloses that “the sacrificial anode comprises aluminum.”

16.Claim 39 – wherein the sacrificial anode comprises magnesium.

336. Hanazaki-196 also states that “[n]ote that if the sacrificial anode is made from zinc, the amount used should be between 0.008 and 1.296 g/cm² with respect to the unit area of the pipeline inner wall, and *if the sacrificial anode is made from magnesium*, the amount used should be between 0.002 and 0.306 g.” *Id.*, 2–3. Hanazaki-196 also provides that “FIG. 5 depicts a modified example of an attaching structure for a case of a sacrificial anode 12' that is made from zinc (Zn) or magnesium (Mg), where a bolt 13a that is screwed through the back wall 6c of the header pipe 6 is welded tightly 13' from the outside, and the threaded portion thereof screws together with the sacrificial anode 12'.” *Id.*, 4. Therefore, Hanazaki-196 discloses that “the sacrificial anode comprises magnesium.”

17.Claim 40 – wherein the sacrificial anode comprises zinc.

337. See Section VIII.D.16.

338. As I have discussed in Section VIII.D.16, Hanazaki-196 also states that “[n]ote that if the sacrificial anode is *made from zinc*, the amount used should be between 0.008 and 1.296 g/cm² with respect to the unit area of the pipeline inner wall, and if the sacrificial anode is made from magnesium, the amount used should be between 0.002 and 0.306 g.” *Id.*, 2–3. Hanazaki-196 also provides that “FIG. 5 depicts a modified example of an attaching structure for a case of a sacrificial anode 12' that is *made from zinc (Zn)* or magnesium (Mg), where a bolt 13a that is screwed through the back wall 6c of the header pipe 6 is welded tightly 13' from the outside, and the threaded portion thereof screws together with the sacrificial anode 12'.” *Id.*, 4. Therefore, Hanazaki-196 discloses that “the sacrificial anode comprises zinc.”

18.Claim 42 – wherein the engine radiator comprises aluminum.

339. See Section VIII.C.6.

340. As I have discussed in Section VIII.C.6, Hanazaki-196 states that “[t]he present invention relates to a heat exchanger that is made from aluminum...” *Id.*, 1. Therefore, Hanazaki-196 discloses that “the engine radiator comprises aluminum.”

19.Claim 43 – wherein the anode holder enables the sacrificial anode to be located within fluid flow of the hot coolant inlet.

341. See Sections VIII.C.1.ii–VIII.C.1.iii, VIII.C.5, and VIII.D.14.iii.

342. As I have explained in Section VIII.C.5, Hanazaki-196 provides its sacrificial anodes 12 in a fluid flow within the header pipe 6a. A POSITA would have understood that this fluid flow is also “fluid flow of the hot coolant inlet.” Moreover, claim 43 does not require a particular location of the anode holder, but merely that the anode holder “enables” location of the sacrificial anode within fluid flow of the hot coolant inlet. A POSITA would have understood that the welding points 13 and/or the bolts 13a of Hanazaki-196 meet this requirement.

343. As I have explained in Section VIII.D.14.iii, the welding points 13 and the bolts 13a are anode holders that hold the sacrificial anodes 12/12’. Therefore, Hanazaki-196 discloses that “the anode holder enables the sacrificial anode to be located within fluid flow of the hot coolant inlet.”

20.Claim 44 – “wherein the anode holder is installed in a fitting hole penetrating the engine radiator”

344. *See* Sections VIII.C.1.ii–VIII.C.1.iii, VIII.C.4, and VIII.D.14.iii.

345. As I have discussed in Section VIII.C.4, Hanazaki-196 teaches that a fitting hole is formed in the header pipe 6a and that the welding point 13 extends through this fitting hole. Similarly, the bolts 13a of Hanazaki-196 extend through fitting holes in the header pipe 6a. Figures 3 and 5 of Hanazaki-196 are reproduced below.

FIG. 3

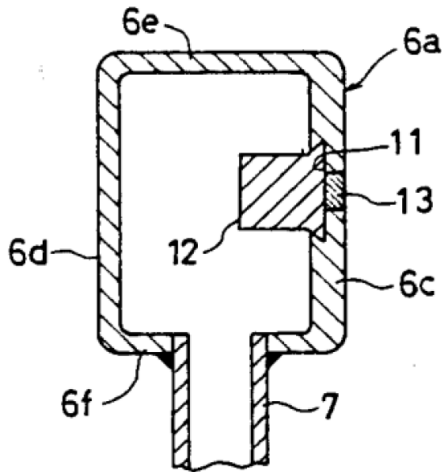
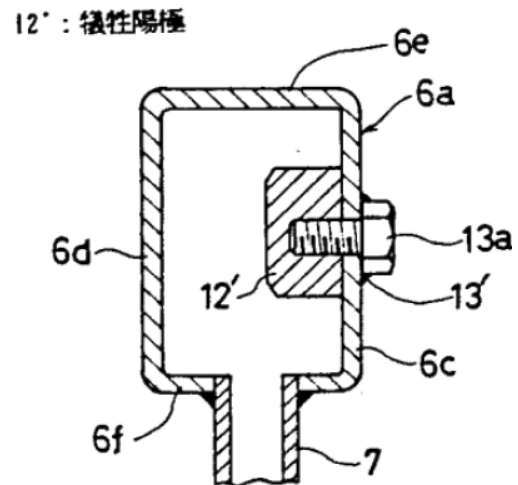


FIG. 5



346. Thus, Hanazaki-196 discloses that “the anode holder is installed in a fitting hole penetrating the engine radiator.”

21.Claim 45 – wherein the hot liquid is coolant.

347. See Section VIII.C.7.

348. As I have discussed in Section VIII.C.7, Hanazaki-196 states that “[t]his heat exchanger is structured from a pair of header pipes 6 (6a and 6b) that have a relatively large diameter, arranged in parallel with a space therebetween, and heat exchanging pipe units 7, connecting between the header pipes 6a and 6b, where a *coolant* supplying opening and *coolant* exhausting opening are provided at the two ends of the primary side header pipe 6a that is positioned on the upstream side, where heat is exchanged in the heat exchange region during the time until the *coolant* that is introduced from the supplying opening arrives at the exhaust opening 10 after traveling serpentine through each of the brine flow paths 8 of each of the header

pipes 6 and the heat exchanging pipe units 7.” *Id.*, 4. Therefore, Hanazaki-196 discloses that “the hot liquid is coolant.”

22.Claim 46 – wherein the hot liquid is water.

349. *See* Sections VII.B.1, VII.D.1, and VIII.D.1.

350. As I have explained in Section VII.D.1, a POSITA would have found it obvious to utilize the heat exchanger of Hanazaki-196 with other fluids, such as water, as taught by Hanazaki-069. Therefore, the combination of Hanazaki-196 and Hanazaki-069 teaches that “the hot liquid is water.”

23.Claim 47 – wherein the hot liquid is antifreeze.

351. *See* Sections VII.B.1, VII.D.1, and VIII.D.1.

352. As I have explained in Section VII.D.1, a POSITA would have found it obvious to utilize the heat exchanger of Hanazaki-196 with other fluids, such as antifreeze, as taught by Hanazaki-069. EX1006, ¶[0005]. Therefore, the combination of Hanazaki-196 and Hanazaki-069 teaches that “the hot liquid is antifreeze.”

E. Claims 12, 15–17, 19–21, 24–29, 31–34, 37–40, and 42–45 Are Anticipated by and/or Obvious Over Godefroy

1. Claim 12

i. A method of preventing corrosion of a radiator, the method comprising:

353. Godefroy states that “[t]he invention relates to the field of heat exchangers, in particular for motor vehicles” and that “[i]t relates, more specifically, to a device for protecting the aluminum walls of a heat exchanger against corrosion by an aggressive medium to which these walls are exposed.” EX1008, 2. Godefroy states that the “object of the invention is in particular to overcome the above drawbacks by proposing an effective device for protecting the aluminum walls of a heat exchanger against corrosion by an aggressive medium.” *Id.*, 5.

354. As I discussed in Section VII.A.1, a POSITA would have understood that a radiator is a heat exchanger. Additionally, Godefroy states that its “heat exchanger can be constituted, for example, by a cooling radiator of a motor vehicle engine.” *Id.*, 5. Therefore, a POSITA would have understood the heat exchanger of Godefroy as a radiator. In this regard, Godefroy states that its invention relates to heat exchangers for motor vehicles, and a POSITA would have understood such heat exchanges to be radiators. Accordingly, Godefroy discloses a “method of preventing corrosion of a radiator.”

ii. installing a sacrificial anode assembly including a sacrificial anode within the radiator,

355. Godefroy states that “[t]o prevent any risk of corrosion, inside the pipe 12, there is a sacrificial resist 14 made here in the form of a tubular insert applied against the internal wall of the pipe 12.” *Id.*, 8. Godefroy explains that “[t]his insert is formed from a renewable sacrificial resist consisting of elements capable of lowering at least locally the electrochemical potential of the aluminum contained in the walls of the heat exchanger.” *Id.* As I discussed in Section VII.E.1, above, a POSITA would have understood the “sacrificial resist” of Godefroy to be a sacrificial anode. The sacrificial anode 14 (formed as an insert) taught by Godefroy is shown in Figure 1, which I reproduce below.

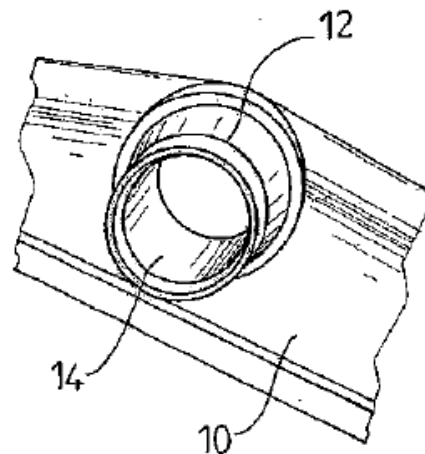


FIG.1

356. As I discussed in Section VII.E.1, above, a POSITA would have understood the sacrificial anode 14 (formed as an insert) of Godefroy to be an assembly that includes not only the “elements capable of lowering at least locally

the electrochemical potential of the aluminum,” but also at least one part that enables the “tubular insert [to be] applied against the internal wall of the pipe 12,” as taught by Godefroy.

357. From Figure 1, a POSITA would have understood Godefroy as showing that the sacrificial anode 14 (formed as an insert) includes an inner insert that is a sacrificial anode, or that includes sacrificial anodes, and an outer sleeve within which the inner insert is placed. The outer sleeve facilitates application of the inner insert to the pipe 12. While Godefroy does not depict the outer sleeve in Figure 1, a POSITA would have understood that there are numerous feasible configurations for the outer sleeve. Below I have provided an annotation of Figure 1 showing the inner insert and an example of one of the numerous configurations that would have been obvious to a POSITA in view of the teachings of Godefroy that shows the sacrificial anode 14 (formed as an insert) utilized by Godefroy.

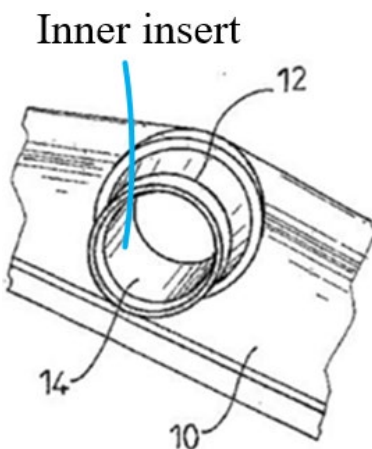
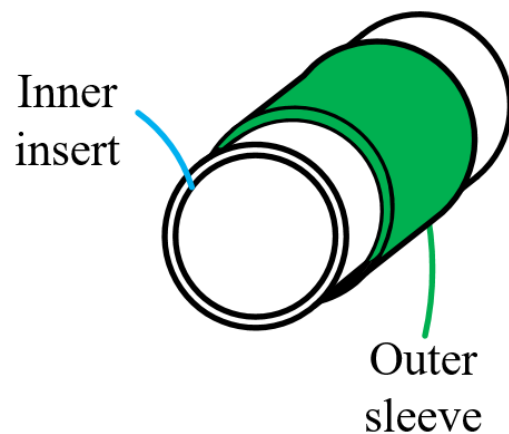


FIG.1



358. Therefore, a POSITA would have understood the sacrificial anode 14 (formed as an insert) as being “sacrificial anode and at least one other connected part that forms one unit.” Similarly, a POSITA would have understood the sacrificial anode 14 (formed as an insert) as including a “piece of metal used to protect another piece of metal by preferentially corroding.” Accordingly, Godefroy discloses “installing a sacrificial anode assembly including a sacrificial anode within the radiator.”

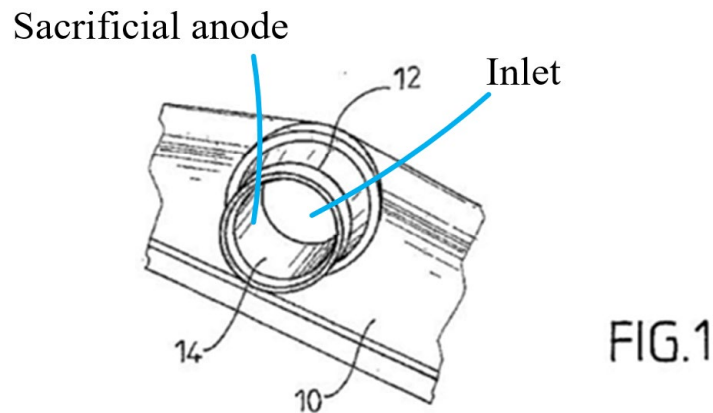
iii. wherein the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.

359. *See* Section VIII.E.1.ii.

360. Godefroy states that “Fig. 1...shows a manifold 10 of a heat exchanger, in particular of a motor vehicle, to which a pipe 12 is connected, intended for the *inlet* or the outlet of a heat transfer liquid.” *Id.*, 8. A POSITA would have understood that an inlet “of a heat transfer liquid” on a heat exchanger is a hot liquid inlet of a radiator. Such inlets are conventional on radiators.

361. As I have discussed in Section VIII.E.1.ii, the sacrificial anode 14 (formed as an insert) is applied to the pipe 12. A POSITA would have understood that the sacrificial anode 14 is therefore necessarily placed within 10 inches of a center axis of a hot liquid inlet to the radiator. Below I have provided an annotation of Figure 1 of Godefroy showing the sacrificial anode and the inlet, as disclosed by

Godefroy. Accordingly, Godefroy discloses that “the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.”



2. Claim 15 – wherein the sacrificial anode consists essentially of an active metal.

362. See Section VIII.A.2.

363. Godefroy discloses that its “invention proposes a protection device...which comprises at least one renewable sacrificial resist formed of elements capable of lowering at least locally the electrochemical potential of the aluminum of the walls of the heat exchanger” and that “these elements may include zinc and/or magnesium.” *Id.*, 5. Godefroy further provides that “[t]he elements in question advantageously comprise zinc and/or magnesium” and that “[i]n this case, it may be in particular zinc alloys, magnesium alloys or even zinc and magnesium alloys.” *Id.*, 6. Godefroy also explains that the “insert can be formed from zinc and/or magnesium” and that “[i]t may be in particular a zinc alloy, a magnesium alloy or

even an alloy of zinc and magnesium.” *Id.*, 7–8. Thus, Godefroy discloses that its sacrificial anode is made from only zinc or essentially only zinc.

364. As I discussed above in Section VIII.A.2, zinc reacts with oxygen and is an active metal according to the '494 Patent. *See*, EX1001, 2:6–9. As I also explained, a POSITA would have understood that “made from” includes “made from only” zinc and “made from essentially only” zinc. Therefore, Godefroy discloses that “the sacrificial anode consists essentially of an active metal.”

3. Claim 16 – wherein the sacrificial anode consists essentially of aluminum, magnesium, or zinc.

365. *See* Sections VIII.A.2 and VIII.E.2.

366. As I discussed in Section VIII.E.2, Godefroy discloses a sacrificial anode that consists essentially of zinc. Therefore, Godefroy discloses that “the sacrificial anode consists essentially of aluminum, magnesium, or zinc.”

4. Claim 17 – wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly in a fitting hole in the radiator.

367. *See* Sections VIII.E.1.ii–VIII.E.1.iii.

368. As I have discussed in Section VIII.E.1.ii, the sacrificial anode 14 (formed as an insert) is applied to the pipe 12. Also, I have discussed in Section VIII.E.1.iii. the pipe 12 is intended for the inlet or the outlet of a heat transfer liquid. A POSITA would have understood that the pipe therefore is a fitting hole in the radiator

of Godefroy. Therefore, Godefroy discloses that “installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly in a fitting hole in the radiator.”

5. Claim 19 – wherein installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly within the fluid flow of the radiator.

369. *See* Sections VIII.E.1.ii–VIII.E.1.iii.

370. As I have discussed in Section VIII.E.1.ii, the sacrificial anode 14 (formed as an insert) is applied to the pipe 12. Also, I have discussed in Section VIII.E.1.iii. the pipe 12 is intended for the inlet or the outlet of a heat transfer liquid. Godefroy provides that the “resist is preferably completely immersed in the aggressive medium, so that the entire resist can be consumed.” *Id.*, 5. Godefroy states that “[r]egardless of its location, the sacrificial resist is capable of being completely immersed in the aggressive environment.” *Id.*, 10. Godefroy also states that “[t]o prevent any risk of corrosion, inside the pipe 12, there is a sacrificial resist 14 made here in the form of a tubular insert applied against the internal wall of the pipe 12.” *Id.*, 8. Godefroy explains that “[g]iven its location, the insert is completely bathed in the cooling fluid.” *Id.* Therefore, Godefroy discloses that “installing the sacrificial anode assembly further comprises: installing the sacrificial anode assembly within the fluid flow of the radiator.”

6. Claim 20 – wherein the radiator comprises aluminum.

371. Godefroy states that its “[invention] relates...to a device for protecting the aluminum walls of a heat exchanger against corrosion by an aggressive medium to which these walls are exposed.” *Id.*, 2. Godefroy states that “[t]he object of the invention is in particular to overcome the above drawbacks by proposing an effective device for protecting the aluminum walls of a heat exchanger against corrosion by an aggressive medium.” *Id.*, 4. Godefroy explains that its “invention proposes a protection device of the type defined above for this purpose, which comprises at least one renewable sacrificial resist formed of elements capable of lowering at least locally the electrochemical potential of the aluminum of the walls of the heat exchanger.” *Id.* Godefroy also provides that the “insert is formed from a renewable sacrificial resist consisting of elements capable of lowering at least locally the electrochemical potential of the aluminum contained in the walls of the heat exchanger.” *Id.*, 7. Therefore, Godefroy discloses that “the radiator comprises aluminum.”

7. Claim 21 – wherein the hot liquid is coolant.

372. According to Godefroy, “[b]y way of example, the manifold 10 can be part of a cooling radiator of a motor vehicle engine, which is traversed by the engine coolant” and “[t]his radiator is part of a fluid circuit, here a cooling circuit, which is

traversed by the aforementioned cooling fluid.” *Id.*, 8. Therefore, Godefroy discloses that “the hot liquid is coolant.”

8. Claim 24 – further comprising installing a second sacrificial anode assembly within the radiator.

373. *See* Section VIII.E.1.ii.

374. Godefroy provides that the “invention proposes a protection device of the type defined above for this purpose, which comprises *at least one* renewable sacrificial resist formed of elements capable of lowering at least locally the electrochemical potential of the aluminum of the walls of the heat exchanger.” *Id.*, 5. Godefroy states that “Fig. 1...shows a manifold 10 of a heat exchanger, in particular of a motor vehicle, to which a pipe 12 is connected, intended for the inlet *or the outlet* of a heat transfer liquid.” *Id.*, 8. A POSITA would have understood the heat exchanger of Godefroy as including an inlet and an outlet, and that teachings of the pipe 12 as including a sacrificial anode assembly 14 (formed as an insert) apply to both the inlet and the outlet.

375. As I have discussed in Section VIII.E.1.ii, the sacrificial anode assembly 14 (formed as an insert) to be an assembly that includes not only the “elements capable of lowering at least locally the electrochemical potential of the aluminum,” but also at least one part that enables the “tubular insert [to be] applied against the

internal wall of the pipe 12,” as taught by Godefroy. Therefore, Godefroy discloses “installing a second sacrificial anode assembly within the radiator.”

9. Claim 25

i. A radiator for use in a motor vehicle, the radiator further comprising:

376. *See* Section VIII.E.1.i.

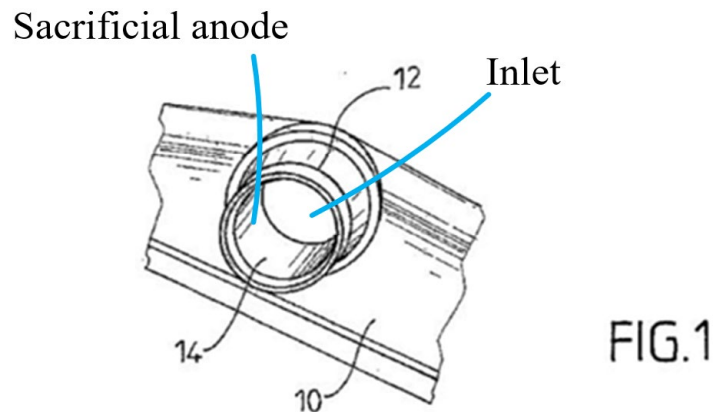
377. Godefroy discloses that its “invention relates to the field of heat exchangers, in particular for motor vehicles.” *Id.*, 2. Godefroy states that its “heat exchanger can be constituted, for example, by a cooling radiator of a motor vehicle engine.” *Id.*, 5. Godefroy discloses that “[b]y way of example, the manifold 10 can be part of a cooling radiator of a motor vehicle engine, which is traversed by the engine coolant” and that “[t]his radiator is part of a fluid circuit, here a cooling circuit, which is traversed by the aforementioned cooling fluid.” *Id.*, 8. Therefore, Godefroy discloses a “radiator for use in a motor vehicle.”

ii. a hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine; and

378. *See* Sections VIII.E.1.i–VIII.E.1.iii, and VIII.E.9.i.

379. As I have explained in Section VIII.E.1.iii, Godefroy teaches that its heat exchanger includes a hot liquid inlet (the inlet of the heat transfer liquid) and a liquid outlet (the outlet of the heat transfer liquid). As I explained in Section

VIII.E.9.i, Godefroy discloses a “radiator of a motor vehicle engine.” A POSITA would have understood that the inlet necessarily provides fluid communication for fluid flow of hot liquid from the engine.



380. Therefore, Godefroy discloses a “hot liquid inlet to the radiator from an engine of the motor vehicle, the hot liquid inlet providing fluid communication for fluid flow of hot liquid from the engine.”

iii. a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.

381. See Sections VIII.E.1.ii–VIII.E.1.iii.

382. As I discussed above with respect to claim 12, Godefroy teaches that the sacrificial anode 14 (formed as an insert) is applied to the pipe 12, and a POSITA would have understood that the sacrificial anode 14 is therefore necessarily placed within 10 inches of a center axis of a hot liquid inlet to the radiator. Therefore, Godefroy discloses “a sacrificial anode installed within 10 inches of the hot liquid inlet of the radiator.”

10.Claim 26 – wherein the sacrificial anode consists essentially of an active metal.

383. *See* Section VIII.E.2.

384. As I have discussed above in Section VIII.E.2, Godefroy discloses that the “insert can be formed from zinc and/or magnesium” and that “[i]t may be in particular a zinc alloy, a magnesium alloy or even an alloy of zinc and magnesium.” *Id.*, 7–8.

11.Claim 27 – wherein the active metal is at least one of aluminum, magnesium, and zinc.

385. According to Godefroy, corrosion “protection is made possible by modifying the electrochemical potential of the protective strip below the electrochemical potential of the aluminum, so as to confer cathodic protection” and that “[t]his is generally done by adding zinc or zinc-aluminum or magnesium-aluminum or *zinc-aluminum-magnesium* alloys which lower (i.e. make them more electronegative) the potential of the protective strip aluminum alloy by approximately 30 to 200 millivolts.” *Id.*, 3. Godefroy discloses that “[b]y way of example, this insert can be formed from zinc and/or magnesium” and “[i]t may be in particular a zinc alloy, a magnesium alloy or even an alloy of zinc and magnesium.” *Id.*, 7–8. Godefroy discloses that “[a]s in the case of Fig. 2, the insert may be based specifically on zinc and/or aluminum....” *Id.*, 9. Therefore, Godefroy discloses that the “active metal is at least one of aluminum, magnesium, and zinc.”

386. For the sake of argument, a POSITA would have also found it obvious to construct the sacrificial anode 14 (formed as an insert) out of an aluminum-magnesium-zinc alloy, as described in Godefroy, for reasons similar to those discussed in Section VII.B.2, above. Therefore, Godefroy teaches that the “active metal is at least one of aluminum, magnesium, and zinc.”

12.Claim 28 – wherein the sacrificial anode is installed in a fitting hole penetrating the radiator.

387. *See* Sections VIII.E.1.ii and VIII.E.4.

388. As I have discussed in Section VIII.E.4, the sacrificial anode 14 (formed as an insert) is applied to the pipe 12, and the pipe 12 is intended for the inlet or the outlet of a heat transfer liquid. A POSITA would have understood that the pipe 12 therefore is a fitting hole in the radiator of Godefroy. Thus, Godefroy discloses that “the sacrificial anode is installed in a fitting hole penetrating the radiator.”

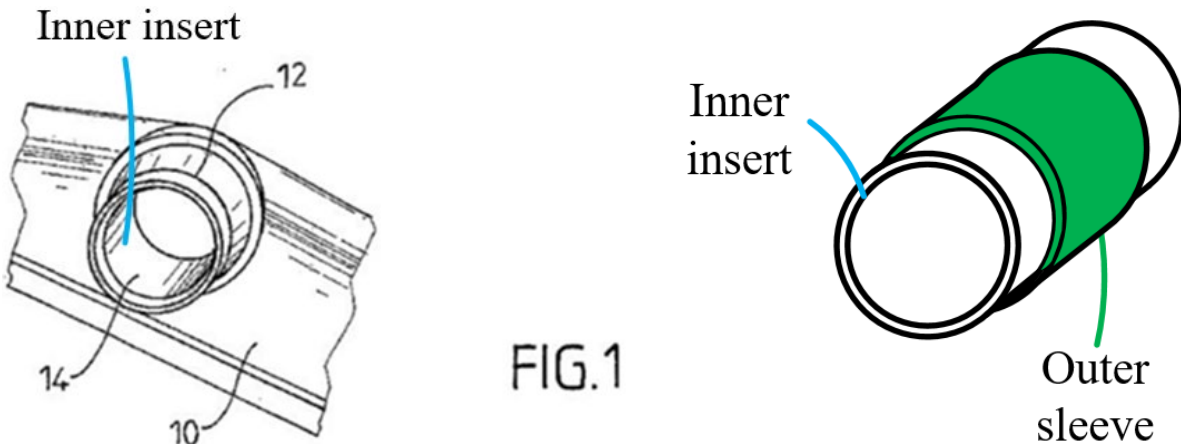
13.Claim 29 – wherein the sacrificial anode is installed onto a surface of the radiator.

389. *See* Section VIII.E.1.ii.

390. Godefroy states that “[t]o prevent any risk of corrosion, *inside* the pipe 12, there is a sacrificial resist 14 made here in the form of a tubular insert applied against the *internal* wall of the pipe 12.” EX1008, 8.

391. As I have discussed in Section VIII.E.1.ii, a POSITA would have understood that the sacrificial anode 14 (formed as an insert) includes an inner insert

that is a sacrificial anode, or that includes sacrificial anodes, and an outer sleeve within which the inner insert is placed. The outer sleeve facilitates application of the inner insert to the pipe 12. Below I have provided an annotation of Figure 1 showing the inner insert and an example of one of the numerous configurations that would have been obvious to a POSITA in view of the teachings of Godefroy that shows the sacrificial anode 14 (formed as an insert) utilized by Godefroy.



392. A POSITA would have understood that the outer sleeve is installed onto the pipe 12, which is a surface of the radiator. Therefore, Godefroy discloses that “the sacrificial anode is installed onto a surface of the radiator.”

14.Claim 31 – wherein the radiator comprises aluminum.

393. See Section VIII.E.6.

394. As I have discussed in Section VIII.E.6, Godefroy states its “[invention] relates...to a device for protecting the aluminum walls of a heat exchanger against

corrosion by an aggressive medium to which these walls are exposed.” *Id.*, 2. Therefore, Godefroy discloses that “the radiator comprises aluminum.”

15.Claim 32 – wherein the radiator enables air-cooling of the hot liquid.

395. Godefroy discloses that “[b]y way of example, the manifold 10 can be part of a cooling radiator of a motor vehicle engine, which is traversed by the engine coolant” and that “[t]his radiator is part of a fluid circuit, here a cooling circuit, which is traversed by the aforementioned cooling fluid.” *Id.*, 8. A POSITA would have understood that a common application for a radiator, such as that of Godefroy, is use in an automobile to air-cool an engine of the automobile.

396. A POSITA would have understood that the radiator provides this cooling by passing air across tubes circulating the hot fluid within the radiator, as taught by Godefroy. A POSITA would have understood that using the radiator to air-cool the hot liquid would have been conventional. Therefore, Godefroy discloses that “the radiator enables air-cooling of the hot liquid.”

16.Claim 33 – further comprising a second sacrificial anode.

397. *See* Sections VIII.E.1.ii and VIII.E.8.

398. As I discussed in Section VIII.E.8, Godefroy provides that the “invention proposes a protection device of the type defined above for this purpose, which comprises *at least one* renewable sacrificial resist formed of elements capable

of lowering at least locally the electrochemical potential of the aluminum of the walls of the heat exchanger.” *Id.*, 5. Godefroy states that “Fig. 1...shows a manifold 10 of a heat exchanger, in particular of a motor vehicle, to which a pipe 12 is connected, intended for the inlet *or the outlet* of a heat transfer liquid.” *Id.*, 8.

399. Godefroy therefore including one of the sacrificial anodes 14 (formed as an insert) at the inlet and one of the sacrificial anodes 14 (formed as an insert) at the outlet. Therefore, Godefroy discloses “a second sacrificial anode.”

17.Claim 34 – wherein the hot liquid is coolant.

400. *See* Section VIII.E.7.

401. As I discussed in Section VIII.E.7, Godefroy states that “[b]y way of example, the manifold 10 can be part of a cooling radiator of a motor vehicle engine, which is traversed by the engine coolant” and “[t]his radiator is part of a fluid circuit, here a cooling circuit, which is traversed by the aforementioned cooling fluid.” *Id.*, 8. Therefore, Godefroy discloses that “the hot liquid is coolant.”

18.Claim 37

i. An electrolysis prevention device for preventing corrosion, the electrolysis prevention device comprising:

402. *See* Section VIII.E.1.i.

403. Godefroy states that its “invention proposes a protection device of the type defined above for this purpose, which comprises at least one renewable

sacrificial resist formed of elements capable of lowering at least locally the electrochemical potential of the aluminum of the walls of the heat exchanger.” EX1008, 5. In view of this discussion and the construction of the sacrificial anode 14 disclosed by Godefroy, a POSITA would have understood that the sacrificial anode 14 is an “electrolysis prevention device” because the sacrificial anode 14 prevents corrosion due to electrolysis.

ii. a sacrificial anode made of an active metal; and

404. *See* Sections VIII.A.2, VIII.E.1.ii, and VIII.E.2.

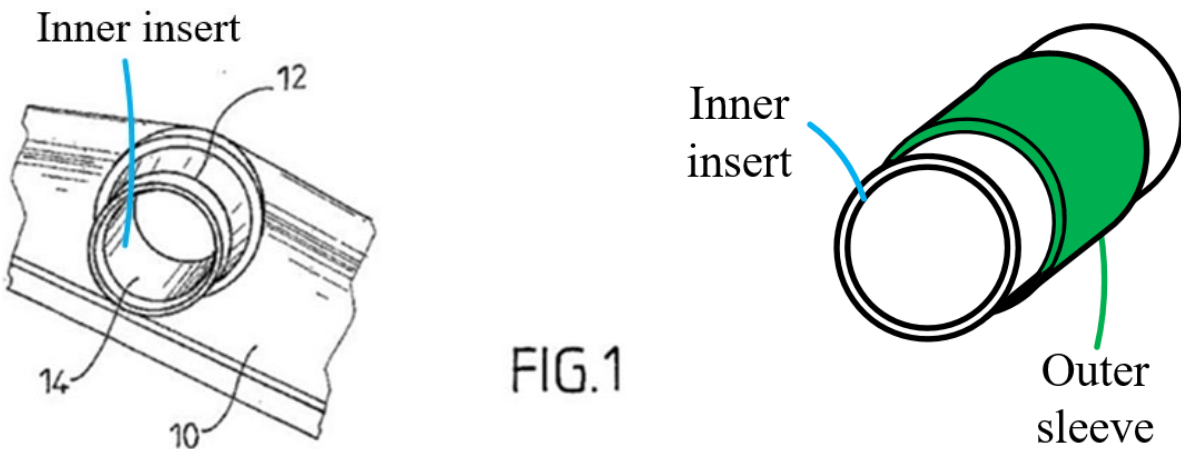
405. As I discussed in Section VIII.E.2, Godefroy discloses that the “insert can be formed from zinc and/or magnesium.” *Id.*, 7–8. Thus, Godefroy discloses that its sacrificial anode is made from zinc. According to the “[b]ackground” section of the ’494 Patent, zinc is an active metal. EX1001, 2:6–9. Therefore, Godefroy discloses “a sacrificial anode made of an active metal.”

iii. an anode holder supporting the sacrificial anode, the anode holder adapted for installation in an engine radiator within 10 inches of a hot liquid inlet to the engine radiator.

406. *See* Sections VIII.E.1.ii–VIII.E.1.iii.

407. As I explained in Section VIII.E.1.ii, Godefroy discloses that the sacrificial anode 14 is formed as an insert. From Figure 1, a POSITA would have understood Godefroy as showing that the sacrificial anode 14 (formed as an insert)

includes an inner insert that is a sacrificial anode, or that includes sacrificial anodes, and an outer sleeve within which the inner insert is placed. The outer sleeve facilitates application of the inner insert to the pipe 12. While Godefroy does not depict the outer sleeve in Figure 1, a POSITA would have understood that there are numerous feasible configurations for the outer sleeve. Below I have provided an annotation of Figure 1 showing the inner insert and an example of one of the numerous configurations that would have been obvious to a POSITA in view of the teachings of Godefroy that shows the sacrificial anode 14 (formed as an insert) utilized by Godefroy.



408. The outer sleeve holds the inner insert, and therefore is an “anode holder supporting the sacrificial anode.” As I explained in Section VIII.E.1.iii, the sacrificial anode 14 (formed as an insert) is applied to the pipe 12, and a POSITA would have understood that the sacrificial anode 14 is therefore necessarily placed

within 10 inches of a center axis of a hot liquid inlet to the radiator. Accordingly, Godefroy discloses that “the sacrificial anode is placed within 10 inches of a hot liquid inlet to the radiator.”

19.Claim 38 – wherein the sacrificial anode comprises aluminum.

409. *See* Section VIII.E.11.

410. As I have discussed in Section VIII.E.11, Godefroy discloses that corrosion “protection is made possible by modifying the electrochemical potential of the protective strip below the electrochemical potential of the aluminum, so as to confer cathodic protection” and that “[t]his is generally done by adding zinc or *zinc-aluminum* or *magnesium-aluminum* or *zinc-aluminum-magnesium* alloys which lower (i.e. make them more electronegative) the potential of the protective strip aluminum alloy by approximately 30 to 200 millivolts.” *Id.*, 3. Godefroy discloses that “[a]s in the case of Fig. 2, the insert may be based specifically on zinc and/or *aluminum....*” *Id.*, 9. Therefore, Godefroy discloses that the “sacrificial anode comprises aluminum.”

20.Claim 39 – wherein the sacrificial anode comprises magnesium.

411. *See* Sections VIII.E.2 and VIII.E.11.

412. As I have discussed in Section VIII.E.11, Godefroy discloses that corrosion “protection is made possible by modifying the electrochemical potential

of the protective strip below the electrochemical potential of the aluminum, so as to confer cathodic protection” and that “[t]his is generally done by adding zinc or zinc-aluminum or *magnesium-aluminum* or *zinc-aluminum-magnesium* alloys which lower (i.e. make them more electronegative) the potential of the protective strip aluminum alloy by approximately 30 to 200 millivolts.” *Id.*, 3. Godefroy discloses that “[b]y way of example, this insert can be formed from zinc and/or magnesium” and “[i]t may be in particular a zinc alloy, a *magnesium* alloy or even an alloy of zinc and *magnesium*.” *Id.*, 7–8. Therefore, Godefroy discloses that “the sacrificial anode comprises magnesium.”

21.Claim 40 – wherein the sacrificial anode comprises zinc.

413. See Section VIII.E.2 and VIII.E.11.

414. As I have discussed in Section VIII.E.11, Godefroy discloses that corrosion “protection is made possible by modifying the electrochemical potential of the protective strip below the electrochemical potential of the aluminum, so as to confer cathodic protection” and that “[t]his is generally done by adding *zinc* or *zinc-aluminum* or *magnesium-aluminum* or *zinc-aluminum-magnesium* alloys which lower (i.e. make them more electronegative) the potential of the protective strip aluminum alloy by approximately 30 to 200 millivolts.” *Id.*, 3. Godefroy discloses that “[b]y way of example, this insert can be formed from zinc and/or magnesium” and “[i]t may be in particular a *zinc* alloy, a magnesium alloy or even an alloy of

zinc and magnesium.” *Id.*, 7–8. Therefore, Godefroy discloses that “the sacrificial anode comprises zinc.”

22.Claim 42 – wherein the engine radiator comprises aluminum.

415. *See* Section VIII.E.6.

416. As I have discussed in Section VIII.E.6, Godefroy states its “[invention] relates...to a device for protecting the aluminum walls of a heat exchanger against corrosion by an aggressive medium to which these walls are exposed.” *Id.*, 2. Therefore, Godefroy discloses that “the radiator comprises aluminum.”

23.Claim 43 – wherein the anode holder enables the sacrificial anode to be located within fluid flow of the hot coolant inlet.

417. *See* Sections VIII.E.1.ii and VIII.E.18.iii.

24.Claim 44 – wherein the anode holder is installed in a fitting hole penetrating the engine radiator.

418. *See* Sections VIII.E.1.ii–VIII.E.1.iii, VIII.E.4, and VIII.E.18.iii.

25.Claim 45 – wherein the hot liquid is coolant.

419. *See* Section VIII.E.7.

420. As I discussed in Section VIII.E.7, Godefroy states that “[b]y way of example, the manifold 10 can be part of a cooling radiator of a motor vehicle engine, which is traversed by the engine coolant” and “[t]his radiator is part of a fluid circuit,

here a cooling circuit, which is traversed by the aforementioned cooling fluid.” *Id.*,

8. Therefore, Godefroy discloses that “the hot liquid is coolant.”

F. Claims 22, 23, 35, 36, 46, and 47 Are Obvious Over Godefroy and Hanazaki-069

1. Claim 22 – wherein the hot liquid is water.

421. *See* Sections VII.B.2, VII.F.1, and VIII.B.1.

422. Godefroy states that “[b]y way of example, the manifold 10 can be part of a cooling radiator of a motor vehicle engine, which is traversed by the engine coolant” and “[t]his radiator is part of a fluid circuit, here a cooling circuit, which is traversed by the aforementioned cooling fluid.” *Id.*, 8.

423. Hanazaki-069 teaches use of radiators with water and with antifreeze. Specifically, Hanazaki-069 states that “the corrosive environment inside the radiator fluctuates in a complex manner, and simply placing a sacrificial anode in the radiator tube does not provide sufficient corrosion protection” and that “[f]or example, radiators are not always supplied with the ideal liquid, and sometimes tap water is supplied instead of the antifreeze liquid.” EX1006, ¶[0005].

424. As I have explained in Section VII.F.1, a POSITA would have found it obvious to utilize the radiator of Godefroy with other fluids, such as water, as taught by Hanazaki-069. Therefore, the combination of Godefroy and Hanazaki-069 teaches that “the hot liquid is water.”

2. Claim 23 – wherein the hot liquid is antifreeze.

425. *See* Sections VII.B.2, VII.F.1, VIII.B.1, and VIII.F.1.

426. As I have explained in Section VII.F.1, a POSITA would have found it obvious to utilize the radiator of Godefroy with other fluids, such as antifreeze, as taught by Hanazaki-069. EX1006, ¶[0005]. Therefore, the combination of Godefroy and Hanazaki-069 teaches that “the hot liquid is antifreeze.”

3. Claim 35 – wherein the hot liquid is water.

427. *See* Sections VII.B.2, VII.F.1, VIII.B.1, and VIII.F.1.

428. As I have explained in Section VII.F.1, a POSITA would have found it obvious to utilize the radiator of Godefroy with other fluids, such as water, as taught by Hanazaki-069. Therefore, the combination of Godefroy and Hanazaki-069 teaches that “the hot liquid is water.”

4. Claim 36 – wherein the hot liquid is antifreeze.

429. *See* Sections VII.B.2, VII.F.1, VIII.B.1, and VIII.F.1.

430. As I have explained in Section VII.F.1, a POSITA would have found it obvious to utilize the radiator of Godefroy with other fluids, such as antifreeze, as taught by Hanazaki-069. EX1006, ¶[0005]. Therefore, the combination of Godefroy and Hanazaki-069 teaches that “the hot liquid is antifreeze.”

5. Claim 46 – wherein the hot liquid is water.

431. *See* Sections VII.B.2, VII.F.1, VIII.B.1, and VIII.F.1.

432. As I have explained in Section VII.F.1, a POSITA would have found it obvious to utilize the radiator of Godefroy with other fluids, such as water, as taught by Hanazaki-069. Therefore, the combination of Godefroy and Hanazaki-069 teaches that “the hot liquid is water.”

6. Claim 47 – wherein the hot liquid is antifreeze.

433. *See* Sections VII.B.2, VII.F.1, VIII.B.1, and VIII.F.1.

434. As I have explained in Section VII.F.1, a POSITA would have found it obvious to utilize the radiator of Godefroy with other fluids, such as antifreeze, as taught by Hanazaki-069. EX1006, ¶[0005]. Therefore, the combination of Godefroy and Hanazaki-069 teaches that “the hot liquid is antifreeze.”

IX. CONCLUSION

I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code.

Dated: May 16, 2023

By: Dana J. Medlin

Dana J. Medlin Ph.D., P.E., FASM

APPENDIX A

Dana J. Medlin, Ph.D., P.E., FASM

Vice President – Metallurgical Engineering

Eurofins EAG Materials Science, LLC

250 North Nash Street

El Segundo, CA 90245

PH:310-322-2011

Cell: 402-661-4438

danamedlin@eurofinsEAG.com**Education**

Ph.D. Materials Science Engineering, University of Nebraska - Lincoln, NE

M.S. Mechanical Engineering (Metallurgy Option), University of Nebraska - Lincoln, NE

B.S. Mechanical Engineering (Metallurgy Option), University of Nebraska - Lincoln, NE

**Licensed
Professional
Engineer (P.E.)**

- Ohio (E63399)
- Nebraska (E-15403)
- Texas (137618)
- California (MT-2023)

Overview

Dr. Medlin has over 30 years of experience leading multidisciplinary failure analysis and design projects in metallurgical and materials science engineering, corrosion engineering, materials joining and welding, and biomedical engineering for a variety of companies and firms. He has testified internationally as an expert witness in cases involving medical device, automotive, aerospace, heavy equipment, fire investigations, firearms, ammunitions, plumbing, and marine applications. Specific areas of experience include: failure analysis & remedial action, medical device design and validation, bearing and gear investigations, welding metallurgy, corrosion evaluations and testing, mechanical testing, heat treatment issues, plumbing failures, metallurgical related fire investigations, and polymer/plastic failure investigations. He also teaches metallurgical and materials engineering courses for industry and professional societies. Dr. Medlin is a Fellow of ASM-International, a distinguished honor in the field of metallurgical and materials science engineering. He is also a Technical Advisor Member of the Association of Firearm and Tool Mark Examiners (AFTE) and was the Kielhorn Professor of Materials Joining & Welding Engineering at LeTourneau University. He is currently the VP – Metallurgical Engineering at EAG Laboratories.

Experience

**2021 – Current Vice President – Metallurgical Engineering
Eurofins EAG Materials Science, LLC (EAG Laboratories)
El Segundo, CA (Los Angeles Laboratory)**

- Managed the laboratory responsibilities for finance, invoicing, payroll, employees, certifications, facilities, equipment, and budgets. Interfaced with upper management with corporate business strategies, equipment procurement, acquisition due diligence, and employee retention.
- Conducts forensic engineering investigations, failure analysis, engineering design, expert testimony and maintenance metallurgical/polymer engineering problem solving. Dr. Medlin has been a technical expert in national and international litigation involving failure analysis, materials and metallurgical engineering, biomedical engineering, corrosion engineering, polymers, design and safety issues, and manufacturing problems. He has also been involved with research and development projects for numerous corporations.

2019 – 2021 Expert Consultant
Eurofins EAG Materials Science, LLC (EAG Laboratories)
El Segundo, CA and Longview, TX

- Conducted forensic engineering investigations, failure analysis, engineering design, expert testimony and maintenance materials engineering problem solving. Dr. Medlin has been a technical expert in national and international litigation involving failure analysis, materials and metallurgical engineering, biomedical engineering, corrosion engineering, polymers, design and safety issues, and manufacturing problems. He has also been involved with research and development projects for numerous corporations.

2019 – 2021 Kielhorn Professor
Department of Materials Joining & Welding Engineering
LeTourneau University
Longview, TX

- Responsible for teaching undergraduate and graduate courses in materials & metallurgical engineering, materials joining & welding engineering, as well as developing a research program in welding related metallurgy, undergraduate and graduate student advisor, student recruitment, regional consultant for industry, etc.

2015 – 2019 Senior Managing Consultant
EAG Laboratories
El Segundo, CA and Omaha, NE

- Conducted forensic engineering investigations, failure analysis, engineering design, expert testimony and maintenance metallurgical/polymer engineering problem solving. Dr. Medlin has been a technical expert in national and international litigation involving failure analysis, materials and metallurgical engineering, biomedical engineering, corrosion engineering, polymers, design and safety issues, and manufacturing problems. He has also been involved with research and development projects for numerous corporations.

2011 – 2015 Senior Managing Consultant
Engineering Systems Inc. (A consulting engineering & investigation company)
Omaha, NE

- Conducted forensic engineering investigations, failure analysis, engineering design, expert testimony and maintenance metallurgical/polymer engineering problem solving for a variety of companies and firms.

2011 – 2015 Adjunct Professor
South Dakota School of Mines and Technology
Department of Materials and Metallurgical Engineering
Biomedical Engineering Graduate Program
Rapid City, SD

- Graduate student guidance, graduate student committee member, Metallurgical Engineering and Biomedical Engineering program advisor, and research project consultant.

2005 – 2011 NUCOR Professor of Metallurgy
South Dakota School of Mines and Technology
Rapid City, SD

• **Department of Materials and Metallurgical Engineering (2005 – 2011)**

Responsible for teaching undergraduate and graduate courses in materials and metallurgical engineering, developing a research program in physical and mechanical metallurgy, undergraduate and graduate student advisor, student recruitment, regional consultant for industry, etc. Thesis Advisor for 12 graduate students and served on 25 thesis committees. Research involved with the

Arbegas Materials Processing & Joining Laboratory, Center for Friction Stir Processing and Corrosion Engineering Research. Awarded Tenure April 2011.

• **Director of the Biomedical Engineering Graduate Program (2010 - 2011)**

Responsible for managing the Biomedical Engineering graduate program at SDSM&T, managing graduate students, teaching courses, directing research projects, managing budgets, and coordinating research and teaching efforts with the University of South Dakota. Advisor for 5 graduate students in Biomaterials projects.

2005 – 2011 Private Engineering Consultant

Medlin Engineering Services

- Conducted forensic engineering investigations, failure analysis, engineering design, and maintenance metallurgical engineering problems for several companies and firms.

**2000 – 2005 Global Metallurgy & Materials Leader
and Principal Engineer**

Zimmer, Inc. (A major manufacturer of orthopedic, spinal and dental medical devices)

Metals Research Group

Warsaw, IN

- Coordinated materials research efforts between the different research organizations: Spinal - Minneapolis MN, Dental-Carlsbad CA, Orthopedic Europe – Switzerland, and Orthopedic US – Warsaw IN. Led efforts to eliminate research redundancies, reduce research outsourcing, unify corporate specifications and test procedures, resolve systemic manufacturing issues, prioritize research projects, develop “best practice” recommendations, etc.
- Team leader in the process development of metallurgically attaching Trabecular Metal (tantalum foam) to titanium substrates (three U.S. patents). Key member of project team responsible for metallurgically attaching the Trabecular Metal coating to new products including: modular acetabular cup, modular hip stem, and minimal invasive surgical hip stem. Instrumental in process validations and solving several production rollout problems. Modular acetabular cup project went from concept to full production.
- Managed the Corrosion Laboratory and doubled the testing capability in two years. Performed and directed corrosion tests and analysis including long-term immersion testing and potentiodynamic anodic polarization (PAP) testing. Designed corrosion test protocols for several new products.
- Project manager with the development of surface carburization heat treatment for austenitic stainless steel trauma products (plates and screws) and Co/Cr/Mo metal-on-metal hip and knee components. This process showed a 35% performance improvement and development work is being applied toward production components.
- Designed test protocols for new product static and dynamic mechanical testing including: bending fatigue, uniaxial fatigue, shear, tensile, fracture toughness, coating adhesion, corrosion testing, residual stress, chemical analysis, microstructural characterization, etc.
- Managed three projects evaluating new implant material evaluations and new process evaluations. Two of the new implant materials are being considered for future product application.
- Experience with Food and Drug Administration (FDA) medical implant regulations, 510k submissions, IDEs, testing requirements, process validations, test protocols, etc.
- Performed failure analysis on implants and reported failure source and possible corrective actions.
- Heat treat furnace and process equipment procurement and validation.
- Continuous involvement with solving production problems such as: machine tool and tool coating problems, laser welding problems, TIG welding issues, surface quality issues, machining scrap issues, casting defects, electro polishing problems, NDT issues, and heat treat issues.

**1998 – 2000 Specialist
and Principal Engineer**

The Timken Company (An alloy steel and bearing manufacturing company)

Bearing Metallurgy and Materials Department

Canton, OH

- Promoted to Specialist May 2000.
- Aerospace Division Plant Metallurgist February 2000 to April 2000. Managed 3 engineers and 6 technicians. Managed all metallurgical and heat treat quality issues. Supervised furnace validations and documentation for production deviations. Interfaced with customer design engineers concerning new product designs and made recommendations of potential design options.
- Principal Engineer September 1998 to May 2000.
- Team leader solving steel casting and hot/cold mill quality issues with a variety of steel plate and bar products. Involved with process equipment validations and optimizations.
- Instrumental in the microstructural design of “Debris Resistant Bearings” and the heat treatment processing. Interfaced with the customer to optimize the static and dynamic properties for this particular application. Team leader in resolving heat treatment and carburizing problems during initial rollout into production. This project went from concept to production rollout.
- Performed basic static and dynamic mechanical testing on standard test samples and prototype components.
- Involved with testing, evaluating, and reporting several production cost reduction and improvement projects including: machining tools and machining tool coatings, machining coolants-rates-surface quality, optimizing heat treatment times and temperatures, and induction hardening processes.
- One of two corporate experts with x-ray diffraction for phase identification, residual stress, and texture measurements. Procured and validated a new state-of-the-art XRD system.

**1997 – 1998 Materials Specialist
and Supervisor of Analytical Services Group**

LTV Steel Company (Producer of flat rolled and coated sheet steels)

- Supervised the personnel (2 engineers and 5 technicians) and analytical research equipment at the Customer Technical Center. Analytical equipment included: complete metallography laboratory, 2 scanning electron microscopes, FTIR, x-ray diffraction, laser surface profilometer, numerous hardness testers, and corrosion testing.
- Team Leader to determine methods to improved sheet steel quality by detecting and resolving melt shop casting defects and inconsistent heating/cooling practices with the rolling mill processes.
- Evaluated metallurgical quality problems with sheet steel and coatings, mechanical property and fatigue evaluations, corrosion testing, electrochemical plating and coatings, performed failure analysis and managed research and development projects.
- Wrote technical reports and communicated with customers about product defects, failures, and complaints.
- Assisted customer product development projects with potential new sheet steel design options with several companies including Ford, GM, Chrysler, Maytag, GCC, etc.
- Procured and validated glow discharge spectrometer for the laboratory. Led efforts to change carrier gas to Argon. This was the first LECO-GDS system to successfully do this.

**1993 – 1997 Research Assistant Professor
Metallurgical and Materials Engineering Department
Advanced Steel Processing and Products Research Center
Colorado School of Mines
Golden, CO**

- Managed 6-10 graduate student projects per semester. Graduate student and academic thesis advisor within the Advanced Steel Processing and Products Research Center (ASPPRC).
- Performed research projects for Chrysler Motors, GM Powertrain, Ford Research, Caterpillar, Timken Company, Torrington, and American Axle.
- Conducted research and supervised graduate and undergraduate research in the ASPPRC.
- Presented and published technical research results.
- Wrote and submitted research grant proposals.
- Performed static and dynamic mechanical testing and managed the fatigue laboratory.
- Taught undergraduate/graduate metallurgical and materials science engineering courses. Also taught short courses on metallurgical engineering to industry.
- Conducted failure analysis, engineering design and maintenance metallurgy for several companies

and firms.

1988 – 1993 Graduate Research & Teaching Assistant

**Mechanical Engineering Department
University of Nebraska-Lincoln
Lincoln, NE**

- Assisted with M.S., Ph.D. degrees and consulting on research projects.
- Advisor: Dr. W.N. Weins.

1987 - 1988 Undergraduate Research Assistant

**Mechanical Engineering Department
University of Nebraska, Lincoln, NE**

- NACE undergraduate research grant, corrosion and hydrogen permeation studies.
- Advisor: Dr. D. L. Johnson.

1986 (Summer) Engineering Associate

**Kawasaki Motors Inc.
Lincoln, NE**

**Publications/
Presentations**

- D.J. Medlin, "STEELS: Processing, Structure and Performance", 3-day (24 hours) Short Course, Taught at ASM-International, Materials Park, OH, June 13 – 15, 2022.
- Medlin, D.J., "Failures of Mechanical Springs", ASM Handbook, Volume 11A, *Analysis and Prevention of Component and Equipment Failures*, Edited by Miller, Shipley, Parrington, and Dennies, ASM International, October 2021.
- D.J. Medlin, "STEELS: Processing, Structure and Performance", 3-day (24 hours) Short Course, Taught virtual through ASM-International, Materials Park, OH, May 10 – 12, 2021.
- S. S. Tower, D.J. Medlin, R. L. Bridges, C.S. Cho., Corrosion of Polished Co-Cr Stems Presenting as Cobalt Encephalopathy, *Arthroplasty Today*, Vol 6, Issue 4, December 2, 2020, pp 1022-1027.
- D.J. Medlin, "STEELS: Processing, Structure and Performance", 3-day (24 hours) Short Course, Taught virtual through ASM-International, Materials Park, OH, August 3 – 5, 2020.
- D.J. Medlin, "STEELS: Processing, Structure and Performance", 3-day (24 hours) Short Course, Taught at ASM-International, Materials Park, OH, December 19 – 21, 2019.
- Justin D, Medlin DJ, Nguyen VB, Composite Joint Arthroplasty Systems and Methods, US Patent # 10,456,143, October 29, 2019.
- D.J. Medlin and J. Fuerst, *Failure Analysis of a SCUBA Tank*, Materials Science & Technology Conference 2019, Portland, OR, October 1, 2019.
- D.J. Medlin, *Corrosion and Rupture of a Municipal Water Piping System*, Materials Science & Technology Conference 2019, Portland, OR, October 1, 2019.
- D.J. Medlin, "STEELS: Processing, Structure and Performance", 3-day (24 hours) Short Course, Taught at ASM-International, Materials Park, OH, July 22 – 24, 2019.
- D.J. Medlin, "STEELS: Processing, Structure and Performance", 3-day (24 hours) Short Course, Taught at ASM-International, Materials Park, OH, March 18 – 20, 2019.
- D.J. Medlin, *Failure Analysis of Fracture Fixation Devices for Medical Implant Applications*, Materials Science & Technology Conference 2018, Columbus, OH, October 17, 2018.
- D.J. Medlin and D.L. Johnson, *Corrosion of 304 Stainless Steel Pneumatic Pressure Tubes*, Materials Science & Technology Conference 2018, Columbus, OH, October 17, 2018.
- J. Justin, D. Medlin, V. Nguyen, Composite Joint Arthroplasty Systems and Methods, European Patent Office, W02018160480A1, 09-07-2018.
- D.J. Medlin, *Failure Analysis of Artifacts for Litigation*, National Association of Corrosion Engineers Central Area Conference, August 8, 2018.
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- D.J. Medlin, "STEELS: Processing, Structure and Performance", 3-day (24 hours) Short Course, Taught at ASM-International, Materials Park, OH, July 23 – 25, 2018.
- D.J. Medlin, F. Schmidt, *Metallurgy for the Non-Metallurgist*, Association of Firearm and Tool Mark Examiners, Charleston, WV, 8-hour Seminar, June 3, 2018.
- D.L. Johnson, R. De Angelis, D.J. Medlin, J. E. Johnson, J. C. Carr, D. L. Conlin, *The Secant Rate of Corrosion: Correlating Observations of the USS Arizona Submerged in Pearl Harbor*, *Journal of Metals*, Vol 70, Issue 5, May 2018, pp 747-752.
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- D.J. Medlin, *Microbiological Influenced Corrosion of Engineering Components*, 46th Northern Plains Corrosion Control Course, National Association of Corrosion Engineers, Omaha, NE, January 17, 2018.
- D.J. Medlin and J. D. Fuerst, *Metallographic Preparation and Microstructural Characterization of Additive Manufactured Tantalum and Titanium Alloy Porous Coatings for Biomedical Applications*, ASTM Symposium Commemorating 100 Years of E04 Development of Metallographic Standards, ASTM E04 Committee, Atlanta, GA, November 16, 2017.
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- D.J. Medlin, "Professional Engineering Examination Review Course for Metallurgical Engineering", The Metallurgical Society, Professional Engineering Examination Committee, Warrendale, PA, 4-hour course, August 18, 2017.
- D.J. Medlin, "Metallurgy for the Non-Metallurgist", Association of Firearm and Tool Mark Examiners, Annual 2017 Meeting, Denver, CO, 8-hour Seminar, May 19, 2017.
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- D.J. Medlin, "The Basics of Corrosion", 47th Northern Plains Corrosion Control Course, National Association of Corrosion Engineers, Omaha, NE, January 17, 2017.
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- M. Helmus and D.J. Medlin, Volume Editors, *Medical Device Materials – II*, Proceedings of the Materials and Processes for Medical Devices Conference, August 25-27, 2004, St. Paul, MN, ASM-International.
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Patents

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- D. Medlin and S. Fromm, "Method of Coating Tissue to Promote Soft Tissue and Bone Healing, Involving Nanotechnology, and Photonic Curing System for Use in Repairing Tissue", US Patent # 9,211,114, December 15, 2015.
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- D. J. Medlin, "Case Hardened Orthopedic Implant", US Patent Application, in review, May 12, 2007.

University and Professional Teaching Experience

- Failure Analysis Engineering, undergraduate/graduate level, Materials Joining & Welding Engineering, LeTourneau University, [new course at LeTourneau University](#).
- Scanning Electron Microscopy Methods, Materials Joining & Welding Engineering, LeTourneau University, [new course at LeTourneau University](#).
- Welding Metallurgy 1, undergraduate level, Materials Joining & Welding Engineering, LeTourneau University.
- Thermodynamics and Kinetics of Materials Engineering, undergraduate level, Materials Joining & Welding Engineering, LeTourneau University.
- Materials Characterization Laboratory, undergraduate level, Materials Joining & Welding Engineering, LeTourneau University.

- D.J. Medlin, "STEELS: Processing, Structure and Performance", 3-day (24 hours) Short Course, Taught at ASM-International, Materials Park, OH, Taught 2 to 3 times a year since 2016.
- "Forensic Engineering", undergraduate/graduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 3 credits, new course at SDSM&T.
- "Corrosion Engineering", undergraduate/graduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 3 credits.
- "Introduction to Biomaterials Engineering", undergraduate/graduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 3 credits, new course at SDSM&T.
- "Metallurgical Engineering Junior Design", undergraduate/graduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 3 credits, Taught every year.
- "Professionalism in General Engineering", undergraduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 1 credits, Fall 2006.
- "Properties of Materials", undergraduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 3 credits, spring 2006, 65 students.
- "Mechanical Metallurgy", and laboratory, undergraduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 4 credits.
- "Physics of Metals", and laboratory, undergraduate/graduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 4 credits.
- "Processing and Joining Methods", undergraduate/graduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 3 credits.
- "Thermo-Mechanical Processing", undergraduate level, Materials and Metallurgical Engineering Department, South Dakota School of Mines and Technology, 3 credits.
- "Structure of Materials and X-Ray Diffraction", graduate level, Metallurgical and Materials Engineering Department, Colorado School of Mines, 3 credits.
- "Materials Science Engineering", undergraduate level, Metallurgical and Materials Engineering Department, Colorado School of Mines, 3 credits, substituted on as needed basis, Fall 1995 - Fall 1996.
- "Materials and Manufacturing Methods in Engineering", undergraduate level, Metallurgy and Materials Engineering Department, Colorado School of Mines, 3 credits, spring 1996, 28 students.
- "Dislocation Theory", graduate level, Metallurgical and Materials Engineering Department, Colorado School of Mines, 3 credits, fall 1995, 8 students.
- "Mechanical Metallurgy", graduate/undergraduate level, Metallurgical and Materials Engineering Department, Colorado School of Mines, 4 credits (with lab), taught 25% of the course, fall 1995.
- "Alloying and Phase Stability", graduate/undergraduate level, Metallurgical and Materials Engineering Department, Colorado School of Mines, 3 credits, substituted on as needed basis, spring 1995.
- "Structure of Materials", undergraduate level, Metallurgical and Materials Engineering Department, Colorado School of Mines, 4 credits (with lab), Substituted on as needed basis, fall 1994.
- "Selection of Metals: Aluminum and Aluminum Alloys", Short Course, Sponsored by ASM-Rocky Mountain Chapter and Colorado School of Mines, April 9, 1994.
- "Steel and Alloy Design", undergraduate/graduate, Mechanical Engineering Department, University of Nebraska-Lincoln, 3 credits, fall 1993, 14 students.
- "Corrosion Engineering", graduate/undergraduate, Mechanical Engineering Department, University of Nebraska-Lincoln, 3 credits, substituted on an as needed basis, fall 1992.
- "Materials Science Laboratory II", graduate/undergraduate, Mechanical Engineering Department, University of Nebraska-Lincoln, 2 (3 hour) laboratories per week, fall 1991.
- "Materials Science Laboratory I", undergraduate, Mechanical Engineering Department, University of Nebraska-Lincoln, 2 (3 hour) laboratory sections per week, spring and fall 1988-1990.

Professional Affiliations & Activities

- ASM Education Committee Chairman, ASM International, Materials Park, OH, 2017-present.
- ASM Technical Handbook Committee, 1997 - 2009, 2014 - Present.
- Association of Firearm and Tool Mark Examiners (AFTE) - Technical Advisor Member 2017 - Present
- ASM Nominating Committee for Board of Trustees and Vice President, ASM-International, Materials Park, OH, April 15, 2016.

- ASM Award Selection Committee, 2014 – 2015.
- “*Materials Characterization*”, Editorial Review Board, 2006 – 2010.
- Materials for Medical Devices Task Force, Original Committee Member, 2001 – Present.
- Conference Co-Chairman, *Materials and Processes for Medical Devices*, August 8-10, 2011, Minneapolis, MN.
- Conference Co-Organizer, *Materials, Medicine, and Nanotechnology Summit*, Cleveland Clinic, October 2-5, 2006, Cleveland, OH.
- Conference Co-Chairman, *Materials and Processes for Medical Devices*, August 25-27, St Paul, MN.
- Symposium Co-Organizer, *George Krauss Symposium on Ferrous Metallurgy*, ASM Materials Week, 1999, Cincinnati, OH.
- Subcommittee E04, Metallography, Voting Member Status, 1999 – Present.
- Subcommittee F04, Medical and Surgical Materials and Devices, Voting Member Status, 2001 – Present.
- Director of the Biomedical Engineering (BME) Graduate Program.
- BME Program Development Committee Member.
- Tenure and Promotion Committee.
- Materials Engineering & Science Graduate Committee.
- Biomedical Engineering Graduate Committee.
- SDSMT Scholarship Committee.
- Various Search Committees (VP Academics, MET, BME, Chemistry, and ME)
- Academic Advisor for SAE Super-Mileage Team.
- Advisor for Blacksmithing Club.
- Undergraduate and Graduate Student Advisor.
- “Professional Engineering Examination Review Course for Metallurgical Engineering”, The Metallurgical Society, Professional Engineering Examination Committee, Warrendale, PA, 4-hour course, August 20-21, 2015.
- “Metallurgy for the Non-Metallurgist”, Association of Firearm and Tool Mark Examiners, Dallas, TX, 8-hour seminar, May 28, 2015.
- Organizing Committee, First International Conference of Materials and Processes for Medical Devices, September 8-10, 2003, Anaheim, CA.
- Technical Programming Board, Annual ASM Materials Week Conference, 1998-2001.
- Co-Chair, ASM Heavy Equipment Committee, 1996-2001.
- Session Organizer and Chair – Heavy Equipment Sessions, *Carburizing and Heat Treatments for the Heavy Equipment Industry*, ASM Materials Week 2000, St. Louis, MO.
- Session Chair - Heavy Equipment Session, ASM Materials Week 1997, Indianapolis, IN.
- Session Chair, Microscopy and Microanalysis 2006, Chicago, IL, July 30 – August 3, 2006.
- Committee Judge, IMS Metallographic Contest, Microscopy and Microanalysis 2006, Chicago, IL, July 30 – August 3, 2006.
- Technical Session Organizer and Chairman, *Metallography and Microstructure of Ferrous Components*, 2001, IMS Materials, Week, 2001, Indianapolis, IN.
- Session Chair, 1999 IMS Materials Week, Cincinnati, OH.
- Program Director/Vice Chairman, Canton-Massillon Chapter, ASM-International, 1999-2000.
- Secretary, Canton-Massillon Chapter, ASM-International, 1998-1999.
- Executive Committee, Canton-Massillon Chapter, ASM-International, 1998-2000.
- Chairman, Rocky Mountain Chapter, ASM-International 1996-1997.
- Vice-Chair/Program Director, Rocky Mountain Chapter, ASM-International, 1996-1997.
- Secretary/Treasurer, Rocky Mountain Chapter, ASM-International, 1995-1996.
- Executive Committee, Rocky Mountain Chapter, ASM-International, 1995-1997.
- Membership Education, Rocky Mountain Chapter, ASM-International, 1994-1995.

Memberships

- American Society for Materials International, Member (1988 – Present)
- Failure Analysis Society, ASM International, Member, (2018 – Present)
- International Metallographic Society, Member (1990 – Present)
- American Society for Testing Materials, Member (1998 – Present)
 - F04 (Medical Materials Subcommittee)
 - E04 (Metallography Subcommittee)

- The Metallurgical Society, Member (1996 – Present)
- Professional Engineering Examination Board, Member (2008 – Present)
- Professional Engineering Examination Review Committee, Member (2014 – Present)
- Society for Biomaterials, Associate Member (2001 – Present)
- Society of Automotive Engineers, Member (1994 – 2001)
- The Iron & Steel Society, Member (1994 – 2001)
- National Association of Corrosion Engineers, Member (1998 – 1993, 2011 – Present)

Honors/Awards

- Honored as the Kielhorn Professor of Materials Joining & Welding Engineering at LeTourneau University.
- Honored as a Fellow of Alpha Sigma Mu, International Professional Honor Society for Materials Science and Engineering, October 4th, 2016, *“Having achieved and maintained throughout a distinguished career a seminal international standing in materials science and engineering profession”*.
- Awarded Tenure and Professor, South Dakota School of Mines & Technology, 2011.
- Honored as the NUCOR Professor of Metallurgy, South Dakota School of Mines & Technology, May 2009.
- Honored as a Fellow of ASM, July, 2007, for outstanding contributions to the field of metallurgical and materials engineering, as well as leadership and contributions to ASM.
- LTV Steel Special Achievement Award for Analysis of Surface Defects in Sheet Steel Technology, Customer Technical Center Award, September 1998.
- 1997 Lindburg Best Technical Paper, ASM Heat Treat Society, “Effects of Induction Hardening and Prior Cold Work on a Microalloyed Medium Carbon Steel”.
- Outstanding Graduate Teaching Assistant, College of Engineering and Technology, University of Nebraska-Lincoln, 1990.

Professional Service

- American Society for Materials International (ASM)
 - Member, 1988 – Present
 - Education Committee, 2017 - Present
 - ASM Nominating Committee 2016
 - ASM Award Selection Committee, 2014 – 2015
 - ASM Technical Handbook Committee, 1997-2009 and 2014 – present
 - Honored as a Fellow of ASM, July, 2007, for outstanding contributions to the field of metallurgical and materials engineering, as well as leadership and contributions to ASM.
 - *“Materials Characterization”*, Editorial Review Board, 2006 – 2010.
 - Materials for Medical Devices Task Force, Original Committee Member, 2001 – present
 - Conference Co-Chairman, *Materials and Processes for Medical Devices*, August 8-10, 2011, Minneapolis, MN.
 - Conference Co-Organizer, *Materials, Medicine, and Nanotechnology Summit*, Cleveland Clinic, October 2-5, 2006, Cleveland, OH.
 - Conference Co-Chairman, *Materials and Processes for Medical Devices*, August 25-27, St Paul, MN
 - Symposium Co-Organizer, *George Krauss Symposium on Ferrous Metallurgy*, ASM Materials Week, 1999, Cincinnati, OH.
- International Metallographic Society (IMS)
 - Member, 1990 – Present
- American Society for Testing Materials (ASTM)
 - Member, 1998 – Present
 - Subcommittee E04, Metallography, Voting Member Status, 1999 – Present

- Subcommittee F04, Medical and Surgical Materials and Devices, Voting Member Status, 2001 – Present
- The Metallurgical Society (TMS)
 - Member, 1996 – Present
- Association of Firearm and Tool Mark Examiners (AFTE) – Technical Advisor Member 2017 – Present
- Professional Engineering Examination Board (Metallurgical Engineering)
 - Member, 2008-Present
 - Professional Engineering Review Committee and Presenter, 2015 - Present
- Society for Biomaterials
 - Associate Member, 2001 – Present
- Society of Automotive Engineers (SAE)
 - Member, 1994 – 2001
- The Iron and Steel Society (ISS)
 - Member, 1994-2001
- National Association of Corrosion Engineers (NACE)
 - Member, 1988 – 1993, 2011- Present

Other Professional Activities

- “Professional Engineering Examination Review Course for Metallurgical Engineering”, The Metallurgical Society, Professional Engineering Examination Committee, Warrendale, PA, 4-hour course, 2015 – 2018.
- “Metallurgy for the Non-Metallurgist”, Association of Firearm and Tool Mark Examiners, Dallas, TX, 8-hour seminar, May 28, 2015 and June 2, 2018.
- Organizing Committee, First International Conference of Materials and Processes for Medical Devices, September 8-10, 2003, Anaheim, CA.
- Technical Programming Board, Annual ASM Materials Week Conference, 1998-2001.
- Co-Chair, ASM Heavy Equipment Committee, 1996-2001.
- Session Organizer and Chair – Heavy Equipment Sessions, *Carburizing and Heat Treatments for the Heavy Equipment Industry*, ASM Materials Week 2000, St. Louis, MO.
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- Technical Session Organizer and Chairman, *Metallography and Microstructure of Ferrous Components*, 2001, IMS Materials, Week, 2001, Indianapolis, IN.
- Session Chair, 1999 IMS Materials Week, Cincinnati, OH.
- Program Director/Vice Chairman, Canton-Massillon Chapter, ASM-International, 1999-2000
- Secretary, Canton-Massillon Chapter, ASM-International, 1998-1999
- Executive Committee, Canton-Massillon Chapter, ASM-International, 1998-2000
- Chairman, Rocky Mountain Chapter, ASM-International 1996-1997
- Vice-Chair/Program Director, Rocky Mountain Chapter, ASM-International, 1996-1997
- Secretary/Treasurer, Rocky Mountain Chapter, ASM-International, 1995-1996
- Executive Committee, Rocky Mountain Chapter, ASM-International, 1995-1997
- Membership Education, Rocky Mountain Chapter, ASM-International, 1994-1995