(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 018 855 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.07.2000 Bulletin 2000/28

(51) Int Cl.[7]: **H05B 3/78**

(21) Application number: **99310506.3**

(22) Date of filing: **23.12.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **30.12.1998 US 114135 P**

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(54) Gold-plated water heater element and method of making same

(57) A self-cleaning water heater element is provided. The water heater element is plated with a layer of gold such that the gold surface has a low surface roughness. The smooth gold surface inhibits scale formation on the water heater element. The gold-plated smooth-surfaced water heater element may be manufactured by coating a standard water heater element with an adhesion layer, electroplating a layer of bright nickel on the adhesion layer, and electroplating a gold layer on top of the bright nickel layer.

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Description

Background of the Invention

[0001] The present invention relates to heating elements utilized within water heaters.

[0002] Over time, electric water heater elements tend to develop scale (calcium carbonate). This scale is a poor heat conductor. The high heat flux at the heating element combined with the poor thermal conductivity of the scale film tends to cause the heating element to overheat, which can lead to failure. Also, the growth of scale on the element may physically deform the element and cause failure. Finally, as scale grows thick it tends to flake off the element and into the heated water.

[0003] A water heater element which minimizes or prevents scale growth or formation would be desirable.

Summary of the Invention

[0004] The present invention provides a self-cleaning water heater element. The water heater element is plated with a noble metal, such as gold, having low surface roughness. It has been found that plating a water heater element with gold having a low surface roughness dramatically effects the ability of the water heater element to inhibit scale formation. If the gold surface is too rough, the heating element will not adequately inhibit scale formation. However, if the gold surface is sufficiently smooth, scale formation is inhibited.

[0005] The existence of a gold-plated heating element has been documented, for example in an article indicating that Tefal has incorporated a gold-plated heating element into cordless kettles as a means of reducing scale. Generally, kettles have much smaller heating elements than water heaters. Also, kettles typically are not utilized as frequently as water heaters and are not exposed to continuous water contact. Further, kettles run on lower wattage than water heaters, and water heaters are capable of heating a much larger volume of water (that is, gallons rather than cups).

[0006] One embodiment of the present invention is a self-cleaning water heater element comprising a water heater element, and a layer of gold at least partially coating the water heater element.

[0007] The invention also provides a process for the preparation of a self-cleaning water heater element. The process comprises providing a water heater element, and electroplating a layer of gold onto the water heater element.

[0008] Other features and advantages of the invention will become apparent to those skilled in the art upon review of the following detailed description, claims and drawing.

Brief Description of the Drawing

[0009] The Figure shows a graph of weight gain (in grams of scale) versus total power (in watt hours) for water heater elements having various surface characteristics.

[0010] Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of construction, or to the steps or acts set forth in the following description. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting

Detailed Description of the Invention

[0011] In a preferred embodiment, the present invention is a self-cleaning water heater element which comprises a water heater element having a cross-sectional diameter of at least about 1/8 inch; a strike layer of nickel chloride disposed on the water heater element; a layer of bright nickel having a thickness of at least about 200 microinches disposed on the nickel chloride layer, and a gold layer having a thickness of at least about 10 microinches disposed on the layer of bright nickel. Applying a gold layer to a water heater element provides a method of inhibiting scale formation on the water heater element. Preferably, the gold layer has a surface roughness less than about 30 microinches Ra. Ra is the arithmetic mean of the departure of the roughness profile from the mean line.

[0012] The water heater element of the invention may be manufactured like a customary water heater element, except a layer of gold is electroplated on the surface. The gold layer is preferably hard 24 karat gold plate which may be electroplated using customary electroplating techniques. Gold electroplating baths and processes are well-known, for example, as described in U.S. Patents No. 4,168,214, 4,207,149 and 4,238,300, which are herein fully incorporated by reference. Preferably, the resulting gold layer is at least about 0.00001 inches (10 microinches) thick. To inhibit scale formation, the surface roughness of the gold layer is preferably less than about 30 microinches Ra; more preferably, less than about 20 microinches Ra; most preferably, less than about 15 microinches Ra. The roughness of the surface may be measured using a surface roughness tester such as a PROFILOMETER® (Trademark of the Warner

& Swasey Company).

[0013] The smoothness of the gold surface layer may be controlled by applying an adhesion layer to the water heater element before electroplating gold on top. The adhesion layer preferably contains a "strike" layer of nickel chloride followed by a layer of bright nickel finish. The nickel chloride may be applied using a Woods Nickel electroplating bath. The bright nickel plate may be applied using a Watts bath. Nickel plating and plating baths are well-known. See, for example, pages 199-206 of the Metals Handbook Ninth Edition, Volume 5, Surface Cleaning, Finishing, and Coating (1982), which is herein fully incorporated by reference. The bright nickel layer is preferably about 0.0002 to 0.0004 inches (200 to 400 microinches) thick. Bright nickel finish contains known additives which result in a smooth finish.

[0014] Prior to electroplating, the water heater element may be lightly blasted (for example with glass beads) in order to remove oxides and scale which could inhibit adhesion of the electroplated layers to the element.

[0015] Standard water heater elements have a cross-sectional diameter of approximately 1/4 to 1/2 inches. Preferably, the cross-sectional diameter of the water heater element is at least about 1/8 or 1/4 inches.

[0016] In practice, the element is disposed in a water heater. Typically, water heaters have an anode attached thereto which helps to decrease corrosion of the water heater tank. Isolating the heating element from the anode may decrease scale formation on the element. The element may be suitably isolated, for example, through the use of a resistor as described in U.S. Patent No. 4,848,616 to Nozaki which is herein fully incorporated by reference.

EXAMPLE 1

[0017] The Figure shows data from element scale tests in which the quantity of scale formed on various water heater elements is measured as a function of total power. The tests were carried out by inserting each element individually into a 20 gallon open top water heater filled with a saturated calcium carbonate solution, running the water heater, and periodically measuring the total power expended and the weight of the element. Five water heater elements were tested, each having different surface characteristics. Gold-52 and Gold-22 represent gold-plated water heater elements in which the surface roughness is 52 microinches Ra (rough gold) and 22 microinches Ra (smooth gold), respectively. Water heater elements are customarily made of incoloy. On the Figure, Incoloy 20, Smooth Incoloy, and Rough Incoloy represent incoloy elements having surface roughnesses of 20, 13, and 40 microinches Ra, respectively. Data for the incoloy elements are shown for purposes of comparison.

[0018] The Figure shows that a standard incoloy water heater element (which contains approximately 50% nickel) has approximately the same scale formation in weight gain whether the incoloy surface is rough (40 microinches Ra surface roughness) or smooth (13 microinches Ra surface roughness). In contrast, a gold-plated element has approximately the same weight gain as the incoloy elements when the surface is rough (shown as Gold-52 with a surface roughness of 52 microinches Ra). However, the scale formation in weight gain is dramatically reduced when the gold surface is smooth (shown as Gold-22 with a surface roughness of 22 microinches Ra).

[0019] The Gold-22 gold-plated water heater element is prepared as follows. A 0.375 inch diameter tubular element made of incoloy is coated with an adhesion layer of nickel chloride using a Woods nickel electroplating bath. A bright nickel layer having a thickness of 0.0002 to 0.0004 inches is electroplated on the nickel chloride layer using a bright Watts nickel electroplating bath. Finally, a layer of hard 24 karat gold having a minimum thickness of 0.00001 inches is electroplated onto the bright nickel layer.

EXAMPLE 2

[0020] Additional Testing was run to evaluate the effect of an anode on the scale performance of a gold plated element. The testing was run in a 20-gallon open top water heater filled with saturated calcium carbonate solution. Gold plated electric elements with 4.5 Kilowatt (KW) rating were run both with and without connection to an anode in the tank. Both elements were smooth surface elements (21 microinches Ra). The elements were left in the tanks until the elements had operated from 11 to 17 hours. Afterwards the elements were removed, dried and weighed. Results show that isolation of the gold element improves anti-scale performance. This is thought to be due to limiting scale formed as a result of cathodic protection.

Element	Anode Protection	Energy Use (Kilowatt-Hrs)	Wt. Gain(gms)	Wt. Gain vs. Energy use (mg/Kw)
Smooth Gold	Yes	77	1.6	21
Smooth Gold	No	51	0.02	0.4

[0021] The reader's attention is directed to all papers and documents which are filed concurrently with or previous

to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0022] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0023] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0024] The invention is not restricted to the details of the foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A self-cleaning water heater element comprising:

a water heater element; and
a gold layer at least partially coating the water heater element.

2. The self-cleaning water heater element of claim 1 wherein the gold layer has a surface roughness less than about 30 microinches Ra.

3. The self-cleaning water heater element of claim 1 further comprising an adhesion layer disposed between the water heater element and the gold layer.

4. The self-cleaning water heater element of claim 3 wherein the adhesion layer comprises a nickel.

5. The self-cleaning water heater element of claim 1 further comprising a layer of bright nickel disposed between the water heater element and the gold layer.

6. The self-cleaning water heater element of claim 1 wherein the water heater element has a diameter of at least about 1/8 inch.

7. The self-cleaning water heater element of claim 1 wherein the self-cleaning water heater element is disposed in a water heater.

8. The self-cleaning water heater element of claim 1 wherein the self-cleaning water heater has an anode attached thereto, and wherein the self-cleaning water heater element is electrically isolated from the anode.

9. A process for the preparation of a self-cleaning water heater element, the process comprising:

providing a water heater element; and
electroplating a layer of gold onto the water heater element.

10. The process of claim 9 further comprising the step of applying an adhesion layer to the water heater element prior to electroplating the gold layer.

11. The process of claim 9 further comprising applying a layer of bright nickel to the water heater element before electroplating the gold layer.

12. A self-cleaning water heater element comprising:

a water heater element having a cross-sectional diameter of at least about 1/8 inch;
a strike layer of nickel chloride disposed on the water heater element,
a layer of bright nickel having a thickness of at least about 200 microinches disposed on the nickel chloride

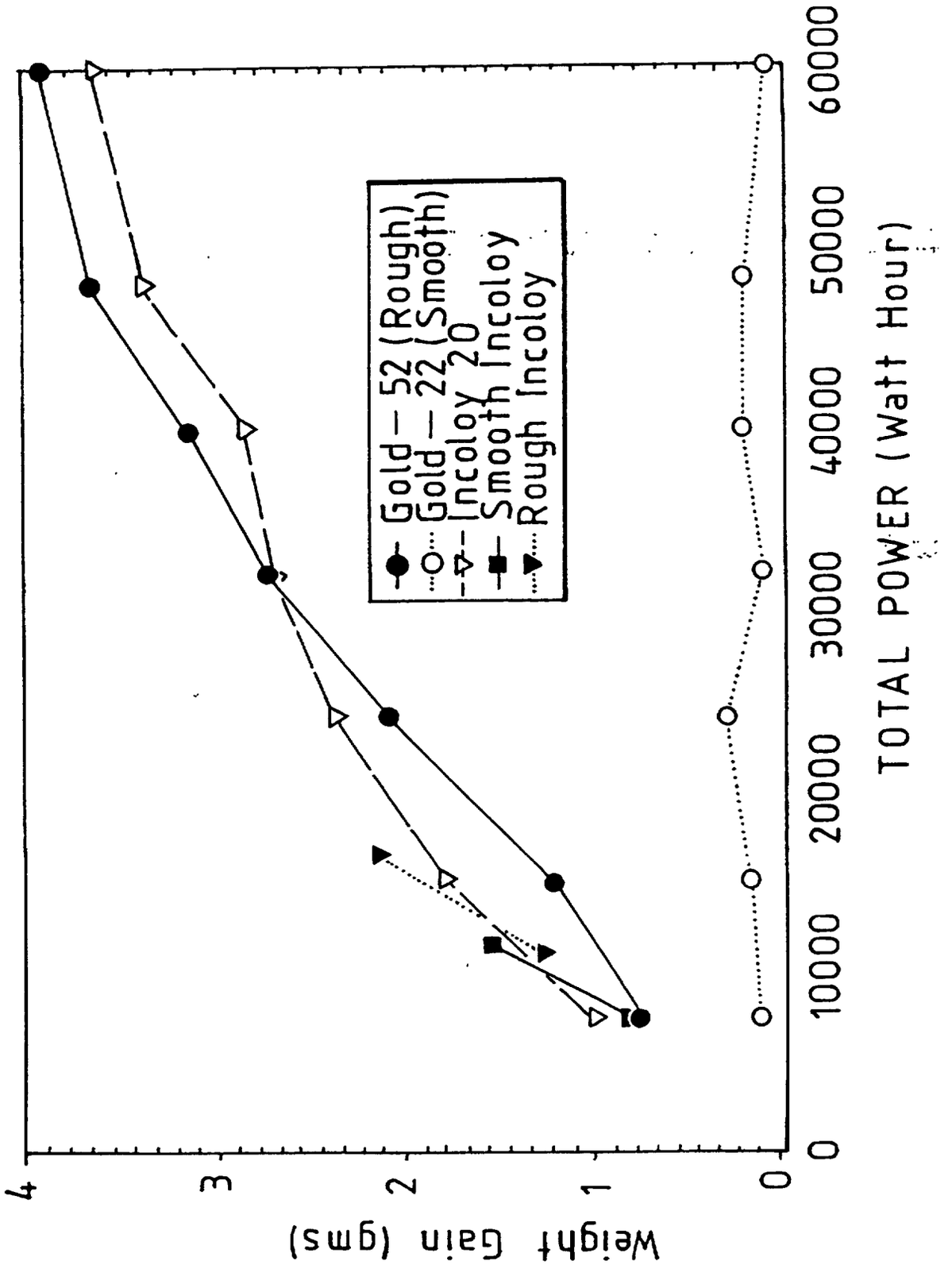
layer; and
a gold layer having a thickness of at least about 10 microinches disposed on the layer of bright nickel,

the gold layer having a surface roughness less than about 30 microinches Ra.

13. A method of inhibiting scale formation on a water heater element, the method comprising:
applying a gold layer to the element, the gold layer having a surface roughness less than about 30 microinches Ra.

14. The method of claim 13 further comprising providing a water heater having an anode attached thereto, the element being disposed in the water heater, the element being electrically isolated from the anode.

15. The method of claim 14 wherein the element is isolated from the anode with a resistor.


Weight Gain (gms)
0
1
2
3
4
0
10000
20000
30000
40000
50000
60000
TOTAL POWER (Watt Hour)
Gold — 52 (Rough)
Gold — 22 (Smooth)
Incoloy 20
Smooth Incoloy
Rough Incoloy