Jan. 2, 1945. P. G. CHACE 2,366,178

CORROSION-RESISTING COMPOSITE METAL

Filed June 23, 1941

FIG. 1.

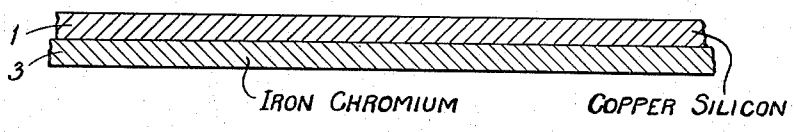


FIG. 2.

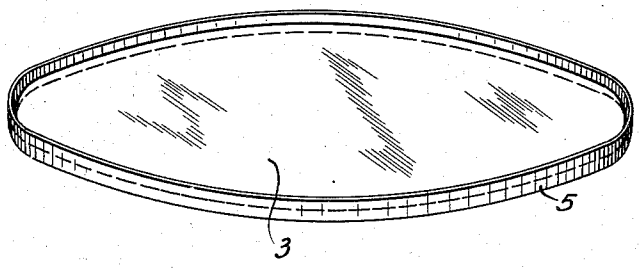


FIG. 3.

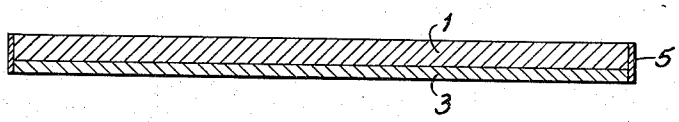


FIG. 4.

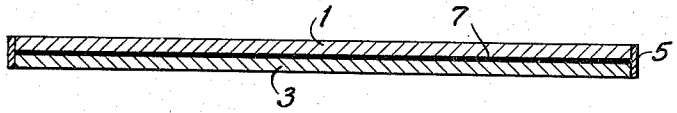


FIG. 5.

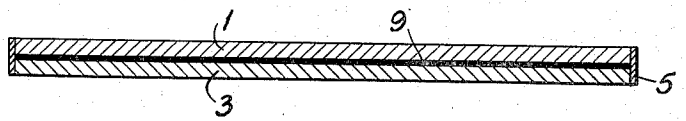
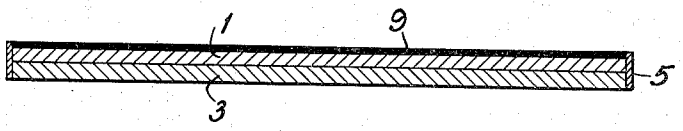


FIG. 6.



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Patented Jan. 2, 1945

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UNITED STATES PATENT OFFICE

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CORROSION-RESISTING COMPOSITE METAL

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Application June 23, 1941, Serial No. 399,398

6 Claims. (Cl. 297—15)

This invention relates to composite metal elements and particularly to bimetallic elements which are corrosion resisting.

Among the several objects of the present invention are the provision of a composite thermostatic metal which is corrosion resisting, which has an improved bond, and which has a long life when operating in corrosion-promoting atmospheres and mediums; the provision of composite thermostatic metal of the class described which has both good hot-rolling and good cold-rolling properties; and the provision of composite thermostatic metal of the type indicated which is relatively simple and economical to manufacture. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the ingredients and combinations of ingredients, the proportions thereof, and features of composition, which will be exemplified in the products hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing, in which are illustrated several of various possible embodiments of the invention,

Fig. 1 is a representation of a bimetallic element showing a strip of iron chromium alloy fused throughout its length to a similar strip of copper silicon alloy;

Fig. 2 is a conventionalized ingot of an iron chromium alloy with an upstanding skirt around the edges, all shown in perspective;

Fig. 3 is a representation of the Fig. 2 embodiment after the copper silicon alloy has been fused thereon;

Fig. 4 is a representation of an alternative bimetallic element;

Fig. 5 is a representation of a still further embodiment; and,

Fig. 6 is an illustration of the Fig. 5 embodiment during a subsequent stage of manufacture.

Similar reference characters indicate corresponding parts throughout the several views of the drawing.

Many of the thermostatic elements commonly in use are subject to corrosion when used in the presence of moisture in places such as steam radiators, or water mixing valves, or in other installations where corrosion-promoting fluids or atmospheres come in contact with the thermostatic metal. As a result, such elements frequently need replacing, and inasmuch as corrosion tends to reduce their activity and life, such corrosion may set up, unknown to the user, dangerous conditions which might result in loss of life or injury. To avoid this corrosion of the composite metal element, it has sometimes been customary in the past to treat the thermostatic metal surface to make it less subject to corrosion, as by plating it with a corrosion-resisting material, such as cadmium, tin, zinc, lead, or chromium. This, however, has the disadvantage that the plating increases the cost materially and does not assure satisfactory life for the thermostatic element. Furthermore, such plating is not entirely satisfactory since an electro-voltaic potential may be set up which produces pitting and eating away of the protective metal.

It has sometimes been the practice in the past to make a composite metallic element from an iron alloy having a high chromium content, and a metal alloy having a higher coefficient of expansion. The metal used for the high coefficient of expansion side has been one of the brasses. The mechanical properties of these brasses have presented manufacturing difficulties, which in many instances have prevented the manufacture of an adequate and satisfactory composite metal. For example, the cold-working properties of brass are so different from those of the chromium iron alloy that it has been difficult to satisfactorily cold-work the metal after it has been put together to form a thermostatic bimetal. Moreover, it is highly advantageous in the manufacture of bimetal to hot-roll the material down from its thick ingot size to an intermediate stage. The brasses are not adapted to this, since their hot-rolling temperatures differ too much from that of the chromium iron alloy. The manufacture of the brass-chrome iron bimetals has therefore been a relatively expensive process compared to the manufacture of bimetal in accordance with the present invention. The ingot size of the brass-chrome iron bimetals must be kept small because of the aforementioned difficulties and properties.

Where other constituents have been proposed for corrosion resisting bimetals, it has been found relatively impossible to directly bond the metals together. For this reason, an intermediate solder layer has been used which has led to two serious disadvantages. First, the use of the solder layer decreases the corrosion-resisting property of the thermostatic metal due to inferior bonding, and second, the solder layer decreases the strength of the metal at elevated temperatures, since the solder bond is relatively weak. Also, solder-bonded material is difficult to hot-roll satisfactorily.

By the present invention, it is possible to accomplish a direct bond between the metals, and they may be hot-rolled or cold-rolled in the desired manner. Their manufacture is accordingly economical, and a highly corrosion-resisting thermostatic metal is obtained.

According to the present invention a thermostatic element is provided which is corrosion resisting per se, particularly to air, water and water vapor, thus eliminating the need for surface plating. In addition, the present invention pro-

vides a thermostatic element made of composite thermostatic metal of the corrosion-resisting type which has a direct bond between the layers thereof.

The thermostatic metal of the present invention comprises layers of metal firmly secured together over their entire areas by a direct bond. One of the layers, in the present invention, comprises a corrosion-resisting metal having a low coefficient of expansion. The other layer comprises a second corrosion-resisting metal having a relatively high coefficient of expansion.

For the metal having a low coefficient of expansion a high chromium content stainless iron is employed. The composition of this alloy may be as follows:

	Per cent
Manganese	0.2–0.6
Carbon	0.01–0.2
Chromium	12–20
Silicon	0–1.5
Copper	0–1.5
Iron	Remainder

For the high expansion material an alloy of copper and silicon is employed. The composition of this alloy may be as follows:

	Per cent
Copper	96–99
Silicon	0.5–4
Manganese	0–1
Tin	0–2.5

The composite thermostatic metal of which bimetal will be described as an illustrative embodiment, may be formed from the two alloys in this preferred manner: Where the material is to be hot-rolled, to get a firm bond, the copper silicon alloy is melted directly onto the chrome-iron alloy, suitable means being provided to prevent the molten silicon copper alloy from running off the iron, such as, for example, welding an upstanding skirt around the edges of the iron to form a shallow pan. The composite metal so formed is then removed from the furnace, allowed to solidify and cool to about 1500° F., and is then rolled in a hot-rolling mill.

In instances in which it is found that the high chrome content of the chrome-iron alloy is responsible for the formation of chromium oxide on the surface of the alloy, which oxide will prevent a good bond, this oxide can be eliminated. For example, the chrome-iron alloy can be plated with a protective plate such as nickel before placing it in the furnace. This will prevent the formation of the chromium oxide. Alternatively, a flux can be coated over the chrome-iron alloy, such as one of the alkali fluorides. The presence of this flux will prevent the formation of chromium oxide, and when the copper silicon alloy is puddled onto the hot chrome-iron sheet, the flux being of lighter specific gravity rises to the surface, leaving a clean fresh chrome-iron surface for the copper silicon to weld to. The flux also protects the liquid surface of the copper silicon during puddling, solidifying and cooling to hot-rolling temperature, thus eliminating the necessity for cleaning the surface before rolling.

Referring now to the drawing, Fig. 1 illustrates a bimetallic element composed of the two alloys discussed above. Numeral 1 represent the copper silicon alloy, while 3 is the iron chromium alloy.

Fig. 2 illustrates one of the preferred methods of manufacture described. An upstanding skirt 5 has been welded onto the iron chromium alloy 3 preparatory to puddling on the copper silicon alloy. Fig. 3 illustrates a subsequent stage in the manufacture. The copper silicon alloy 1 has now been puddled onto the iron chromium alloy 3 to form the bimetal.

Fig. 4 illustrates an alternative method. Here the chrome iron alloy has been plated with nickel, as shown at 7, and the copper silicon alloy subsequently puddled on. This prevents the formation of chromium oxide on the surface of the chrome iron alloy.

A still further embodiment is shown in Figs. 5 and 6. Here the chrome iron sheet has been coated with an alkali fluoride prior to the puddling on the copper silicon alloy. Fig. 5 illustrates the sheet just as the copper silicon alloy is puddled on. The alkali fluoride rises to the surface as shown in Fig. 6, leaving a clean chrome iron surface to which the copper silicon welds.

The tensile strength and other mechanical properties of the copper silicon alloys described are sufficiently near to the same properties of the chrome-iron alloys that the two metals work well together and may be easily cold-worked. This makes the manufacture thereof more economical. As a result of obtaining a direct bond between the metals comprising the present invention, a thermostatic metal having a higher strength, greater activity, wider usable temperature range, longer life and better corrosion-resisting properties than the corrosion-resisting bimetals hitherto known, is obtained. Former metals allegedly designed to have these desirable properties have instead been relatively weak, corrode relatively easily, are more difficult to manufacture, and in general are not satisfactory.

As specific examples of alloys which may be advantageously employed in the present invention, the following examples are given. They are illustrative only:

Chrome-iron alloy No. 1

	Percent
Manganese	0.2–0.6
Carbon	0.01–0.2
Chromium	12–20
Silicon	.2–1.5
Copper	.5–1.5
Iron	Remainder

Chrome-iron alloy No. 2

	Percent
Manganese	0.4
Carbon	0.05
Chromium	16
Silicon	1
Copper	1
Iron	Balance

Chrome-iron alloy No. 3

	Percent
Manganese	0.4
Carbon	0.05
Chromium	16–20
Iron	Balance

Chrome-iron alloy No. 4

	Percent
Manganese	0.4
Carbon	0.05
Chromium	12–16
Silicon	1
Copper	1
Iron	Balance

Copper-silicon alloy No. 1

	Percent
Copper	97–99
Silicon	0.75–1.75
Manganese	0.2–1.0

Copper-silicon alloy No. 2

	Percent
Copper	96–98
Silicon	0.5–1.5
Tin	0.75–2.5

Copper-silicon alloy No. 3

	Percent
Copper	96–98
Silicon	2–4

Copper-silicon alloy No. 4

	Percent
Copper	97–98.5
Silicon	1–2.5
Manganese	.15–.35

Copper-silicon alloy No. 5

	Percent
Copper	98
Silicon	1.25
Manganese	0.75

Copper-silicon alloy No. 6

	Percent
Copper	97
Silicon	3

Attention is directed to my copending application, S. N. 528,614, filed Mar. 29, 1944.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above alloys without departing from the scope of the invention, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A corrosion-resisting thermostatic metal composed of an alloy having substantially the following composition:

	Per cent
Manganese	0.2–0.6
Carbon	0.01–0.2
Chromium	12–20
Silicon	.2–1.5
Copper	.5–1.5
Iron	Remainder

and an alloy having substantially the following composition:

	Per cent
Copper	97–99
Silicon	0.75–1.75
Manganese	0.2–1.0

fused together.

2. A corrosion-resisting thermostatic metal composed of an alloy having substantially the following composition:

	Per cent
Manganese	0.4
Carbon	0.05
Chromium	16
Silicon	1
Copper	1
Iron	Balance

and an alloy having substantially the following composition:

	Per cent
Copper	98
Silicon	1.25
Manganese	0.75

fused together.

3. A corrosion-resisting thermostatic metal composed of an iron alloy containing: manganese approximately 0.2–0.6%, carbon approximately 0.01–0.2%, chromium approximately 12–20%, silicon approximately 0.2–1.5%, and copper approximately 0.5–1.5% and the balance iron; and a copper alloy containing: silicon approximately 0.5–4%, and manganese approximately 0.15–1% and the balance copper; fused together.

4. A corrosion-resisting thermostatic metal composed of an alloy having substantially the following composition:

	Per cent
Manganese	0.4
Carbon	0.05
Chromium	12–16
Silicon	1
Copper	1
Iron	Remainder

and an alloy having substantially the following composition:

	Per cent
Copper	97–99
Silicon	0.75–1.75
Manganese	0.2–1.0

fused together.

5. A corrosion-resisting thermostatic metal composed of an alloy having substantially the following composition:

	Per cent
Manganese	0.4
Carbon	0.05
Chromium	12–16
Silicon	1
Copper	1
Iron	Remainder

and an alloy having substantially the following composition:

	Per cent
Copper	97–98.5
Silicon	1–2.5
Manganese	.15–.35

fused together.

6. A corrosion-resisting thermostatic metal composed of an alloy having substantially the following composition:

	Per cent
Manganese	0.2–0.6
Carbon	0.01–0.2
Chromium	12–20
Silicon	.2–1.5
Copper	.5–1.5
Iron	Remainder

and an alloy having substantially the following composition:

	Per cent
Copper	97–98.5
Silicon	1–2.5
Manganese	.15–.35

fused together.

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