

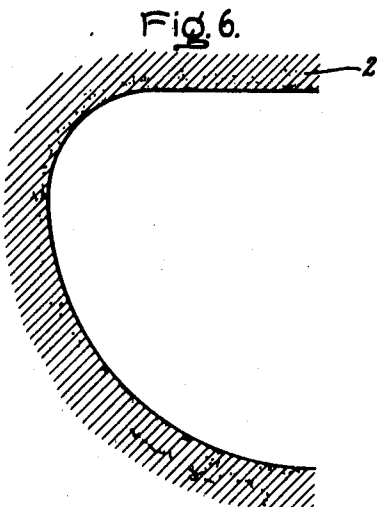
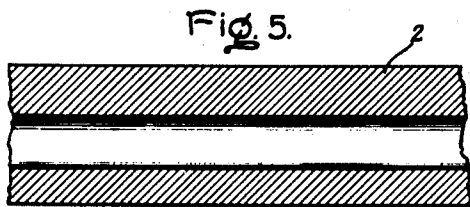
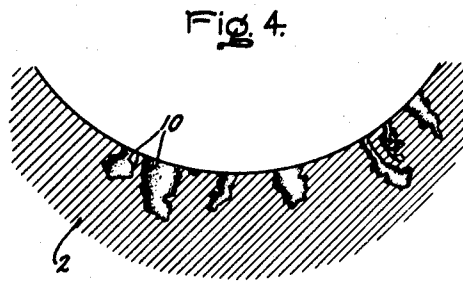
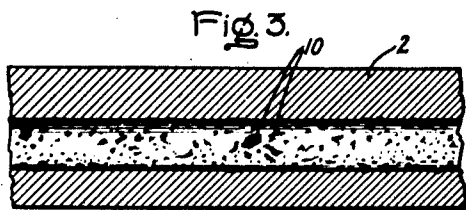
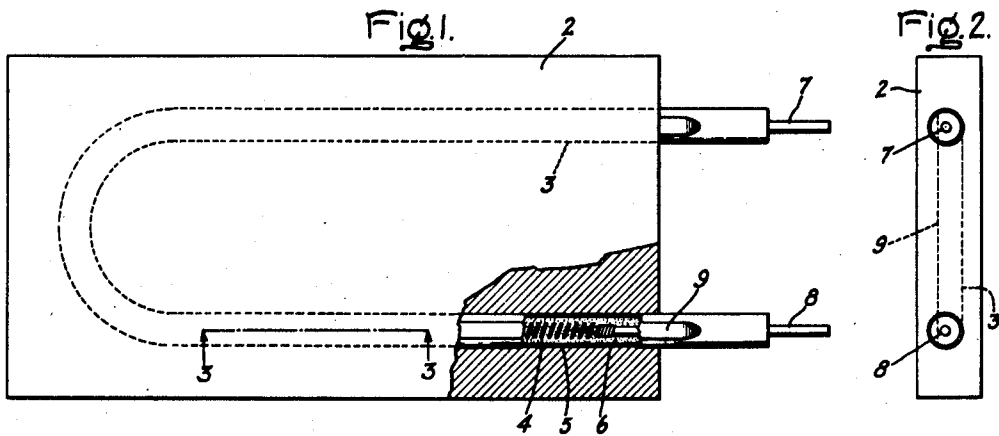
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O. G. VOGEL

2,469,800

ELECTRIC HEATER

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UNITED STATES PATENT OFFICE

2,469,800

ELECTRIC HEATER

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5 Claims. (Cl. 201—67)

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This invention relates to electric heaters, more particularly to electric heaters of the sheathed type wherein the sheathed heating element is cast in a metal body, and it has for its object improvements in heaters of this character.

In such heaters, a resistance heating conductor is housed within a metallic sheath, and is embedded in and supported in spaced relation with the sheath by a compacted mass of electrically insulating and heat conducting material, such as magnesium oxide, and the assembly of the sheath with the resistance conductor and compacted mass in it is cast into the metal body.

A particular heating application requires that the metal body be made of a copper-tin alloy having a high copper content. One such alloy which has found success in this application has a copper content of approximately 98.5% and a tin content of approximately 1.5%.

Much difficulty has been experienced in attempting to cast sheathed heaters having known sheath materials in such an alloy. In some cases the sheath became defective, in others the cast metal, and in still others both the sheath and casting became defective.

I have found that the heating element disclosed in the United States patent to J. C. Sharp No. 2,034,539, dated March 17, 1936, is satisfactory in so far as the heating element itself is concerned, but that the casting was rendered defective by the presence of a porous condition adjacent the sheath. Such porosity was found to be so extensive in most cases as to detrimentally affect the heat transfer between the heating element and the casting, and in certain applications it would permit corrosive liquids to permeate into the space surrounding the sheath in the casting.

I have overcome this difficulty by providing the exterior surfaces of the heating element sheath with a coating of chromium, which preferably will be formed by depositing the chromium on the sheath by means of a suitable plating process.

That is, in accordance with this invention, there is provided a cast alloy having a relatively high copper content in which is cast a sheathed heating element having a sheath with an important nickel component, such as the alloy of the aforementioned Sharp patent, the exterior walls of the sheath being coated with chromium.

I have further found that the beneficial results of this invention are obtained wherein a sheath made of pure nickel is used.

For a more complete understanding of this invention, reference should be had to the accompanying drawing in which Fig. 1 is a plan view of an electric heater embodying this invention, parts shown in section so as to illustrate certain details of construction; Fig. 2 is an end

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view of the heater shown in Fig. 1; Fig. 3 is a sectional view illustrating a part of the casting with the heating element removed and showing the condition or presence of interfacial porosity in the casting, that is, showing the porous sections in the casting which face the sheathed heating element which result when the sheath is not provided with the chromium coating in accordance with this invention, this figure being drawn to a larger scale than Figs. 1 and 2; Fig. 4 is a transverse sectional view taken through the casting shown in Fig. 3 and drawn to a much larger scale than Fig. 3; Fig. 5 is a view similar to Fig. 3 but illustrating a section through the casting showing the surface thereof which contacts the sheath wherein the sheath is provided with the chrome coating in accordance with this invention; and Fig. 6 is a transverse sectional view through the casting of Fig. 5, and drawn to a much larger scale.

Referring to the drawing, this invention has been shown in one form as applied to a heating unit comprising a casting 2 in which is cast a U-shaped heating element 3. The casting 2, as shown, is of rectangular form, and the heating element 3 is cast in it so that the two ends of the legs of the U-shaped element project from one end of the casting. The heating element 3 comprises a helical resistance conductor 4 mounted within a metallic sheath 5 and embedded in and supported in spaced relation with the sheath by a compacted mass 6 of electrically insulating and heat conducting material, such as magnesium oxide. Attached to the two ends of the resistance conductor 4 are terminals 7 and 8, the inner ends of which also are embedded in and supported by the mass 6 and the outer ends of which project from the ends of the sheath so that external connections can be made conveniently. Preferably and as shown, one side of the sheath will be flattened, as indicated by the numeral 9, in the manner described and claimed in the U. S. patent to O. G. Vogel No. 2,094,480 issued September 28, 1937.

The casting 2 is cast from a copper alloy wherein copper constitutes the major component. One copper alloy which has proved to be quite successful in one particular heating application has a copper content of 98.5% and a tin content of about 1.5%.

The sheath 5 of the heating element 3 is formed of the nickel-chrome-iron alloy of the aforesaid Sharp patent wherein the nickel is an important component. One specific alloy which has proved to be quite successful has approximately 14% chromium, 6% iron and the remainder consisting chiefly of nickel.

I have found that when the heating element 3 has a sheath 5 made in accordance with the Sharp patent the heating element itself stands

up well and has the characteristics that are desired, but that interfacial porosity occurs in the casting where it contacts the sheath. This interfacial porosity is indicated by the numeral 10 in Figs. 3 and 4. Figs. 3 and 4 are drawn from actual photographs made of the casting after the heating element 3 has been removed. The porous condition is evidenced by a series of relatively deep cavities, as shown, and it occurs to a material extent as shown in Fig. 3. These cavities in effect form heat insulating zones spaced about the sheath and thereby greatly inhibit the passage of heat from the heating element 3 to the casting; they also tend to form paths into which liquids may permeate into the space between the heating element and the casting; in addition to this they mechanically weaken the casting.

I have obviated this difficulty by providing the exterior walls of the sheath 5 with a coating of chromium which is bonded to the sheath. This coating may be applied to the sheath in any suitable manner but I prefer to apply it by a suitable electroplating process. The thickness of this chromium layer is not critical; I have found, however, that the layer having a thickness of approximately .0001 inch or more is quite satisfactory, although good results have been obtained with layers of chromium .00002 to .00005 inch thick.

Figs. 5 and 6 illustrate the casting 2 with the heating element 3 removed but which element is provided with a chrome coating arranged in accordance with this invention. These drawings also were made from photographs of actual castings. It will be observed that the chrome layer has prevented the formation of any interfacial porosity.

It appears that the porous condition 10 is formed when the heating element 3 is cast into the metal mass 2 by the release of a gas from the heating element sheath. I am not certain what takes place but believe that the nickel in the nickel-chrome-iron alloy sheath absorbs surface oxygen either prior to or during the casting operation and that the oxygen unites with the nickel to form complex oxides; and that when the sheath is brought into contact with the copper alloy during the casting process the copper releases the oxygen by decomposing the complex oxides.

Whether or not this theory is correct, it is quite evident that gases do escape from the sheath which is not provided with the chromium coating and that these gases form the porous condition 10. It has been further demonstrated that the provision of the chromium coating prevents formation of this porous condition.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects and I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric heating unit comprising a sheathed heating element provided with a metallic sheath having a high nickel content and a resistance conductor housed in said sheath, a

coating of chromium covering said sheath, and a metallic mass having a high copper content cast into intimate contact with said coating and embedding said sheath, said coating preventing interfacial porosity in the adjacent contacting surfaces of said mass.

2. An electric heating unit comprising a heating unit having a resistance conductor and an outer metallic sheath housing said conductor formed of an alloy consisting chiefly of nickel, chromium and iron, the nickel content ranging between 50% and 80% of said alloy, a layer of chromium coating the exterior surfaces of said sheath, and a metal body the major component of which is copper cast into intimate contact with said coating and embedding said sheath, said coating preventing interfacial porosity in the adjacent contacting surfaces of said body.

3. An electric heating unit comprising an electric heating element having a resistance conductor and a metallic sheath encasing said conductor formed of a nickel-chrome-iron alloy where the nickel content ranges between 50% and 80%, said sheath being coated by a layer of chromium which is bonded thereto, and a metal body formed from a copper-tin alloy having about 98.5% copper and about 1.5% tin cast into intimate contact with said coating and embedding said sheath, said coating preventing interfacial porosity in the adjacent contacting surfaces of said body.

4. An electric heating unit comprising a cast metal body formed from a copper alloy wherein the copper is the major component, and a heating element cast in said body having a resistance conductor and an outer metallic sheath housing said conductor and formed of a nickel-chrome-iron alloy wherein the nickel is the major component, and an interposed layer of chromium arranged in intimate contact with the adjacent surfaces of said body and said sheath to prevent interfacial porosity in the adjacent surfaces of said body.

5. An electric heating unit comprising a cast metal body formed from a copper-tin alloy having about 98.5% copper and about 1.5% tin, and an electric heating element cast in said body having a resistance conductor and a metallic sheath enclosing said conductor formed of an alloy consisting of approximately 14% chromium, 6% iron and the remainder chiefly of nickel, and an interposed layer of chromium bonded to the adjacent surfaces of said body and said sheath to prevent interfacial porosity in the adjacent surfaces of said body.

OLIVER G. VOGEL.

REFERENCES CITED

The following references are of record in the file of this patent:

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2,181,484	Harris	Nov. 28, 1939
2,423,184	Greer	July 1, 1947

OTHER REFERENCES

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