United States Patent

[11] 3,607,242

[72] Inventors **Arnold J. Gottlieb**
Colonia;
Teh Po Wang, Cedar Grove, both of N.J.

[21] Appl. No. **827,027**
[22] Filed **May 22, 1969**
[45] Patented **Sept. 21, 1971**
[73] Assignee **Wilbur B. Driver Co.**

[54] **ELECTRICAL RESISTANCE ALLOY**
4 Claims, No Drawings

[52] **U.S. Cl.** **75/159**
[51] **Int. Cl.** **C22c 9/06**
[50] **Field of Search** 75/153, 159, 161; 148/32; 136/241; 200/166

[56] **References Cited**

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Primary Examiner—Charles N. Lovell
Attorneys—Theodore Jay, Jr. and Norman J. O'Malley

ABSTRACT: An electrical alloy which is essentially free of cobalt and carbon and comprising, as expressed in percent by weight:

nickel: 40–46%;

manganese: 2.5–3.5%;

iron: 0.5–0.6%

copper—balance

ELECTRICAL RESISTANCE ALLOY

BACKGROUND OF THE INVENTION

Constantan is the generic name for a known type of electrical resistance alloy containing nickel and copper as major constituents and small amounts of manganese, iron, cobalt and carbon. A typical nominal formulation can be:

nickel—44%
copper—1.5%
iron—0.5%
cobalt—0.2%
carbon—0.025%
copper—balance

This alloy is characterized by a resistivity in the fully annealed state of about 300 ohms per circular mil foot and a temperature coefficient of resistance (TCR) over the range −60° to 100° C. of about 20 parts per million per degree Centigrade (p.p.m./° C.). The value of TCR taken over the range −60° to 20° C., referred to as the cold range value, differs from the value of TCR taken over the range of 20° to 100° C., referred to as the hot range value. The difference in these values, defined as ΔTCR, is a measure of the linearity of the resistance versus temperature curve within the range of −60° to 100° C. The ΔTCR of this known alloy is about 20 p.p.m./° C.

The known alloy has two significant disadvantages. Firstly, its ΔTCR is too high for many applications. Secondly, this alloy, when placed in contact with glass or ceramic materials in a heated environment, can initiate a reaction in which gases are generated and are entrapped at the interface between the alloy and the glass of ceramic material or released therefrom. In either event, this gas generation is undesirable. For example, when wire formed of this alloy is used in the production of ceramic coated wire wound resistors, gas bubbles are formed and the resultant product is commercially unacceptable. We have developed a new electrical resistance alloy of the constantan type which overcomes these two disadvantages.

SUMMARY OF THE INVENTION

We have discovered that when the cobalt and carbon contents of the known alloy are effectively eliminated and, at the same time, the manganese content is substantially increased, the resultant new alloy is essentially gas free and its ΔTCR is substantially reduced (thus substantially increasing the linearity of the resistance versus temperature curve).

More particularly, our electrical resistance alloy is essentially cobalt and carbon free and comprises, as expressed in percent by weight:

40–46% nickel;
2.5–3.5% manganese;
0.1–0.6% iron;
balance—copper

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

One alloy composition, in accordance with our invention

and fabricated in accordance with conventional techniques for producing constantan-type alloys, is as follows:

43% nickel
3% manganese;
0.25% iron;
balance—copper

This alloy contained 0.03 percent or less of each of silicon, boron and magnesium which were added during melting as deoxidizers. Although great care was taken to eliminate cobalt and carbon, about 0.0003 percent of carbon and 0.03 percent cobalt were found to be present as tramp elements.

Ceramic coated wire wound resistors produced using the above alloy were found to be essentially free of gas bubbles. Typically, this alloy was found to have a ΔTCR of 11 p.p.m./° C. with a hot TCR range value of plus 6 **0**/Om/° C. and a cold TCR range value of −5 p.p.m./° C.

As a standard, a conventional constantan-type alloy was fabricated with the following composition:

44% nickel;
1.54% manganese;
0.45% iron;
0.21% cobalt;
0.025% carbon;
balance—copper

Ceramic coated wire wound resistors produced using the conventional alloy were found to be gassy and commercially unacceptable. The conventional alloy was found to have a TCR of 18 p.p.m./° C. and hot TCR range value of 25 p.p.m./° C. and a cold TCR range value of 7 p.p.m./° C.

Further experiments showed that our alloy could be maintained gas free with ΔTCR values maintained appreciably below that of the conventional alloy as long as the ranges set forth below were not appreciably exceeded:

nickel: 40–46%
manganese: 2.5–3.5%
iron: 0.1–0.6%
cobalt $\leq$ 0.03%
carbon $\leq$ 0.005%
copper–balance

What is claimed is:

1. An electrical resistance alloy which is essentially free of cobalt and carbon and comprising, as expressed in percent by weight:

40–46% nickel
2.5–3.5% manganese;
0.1–0.6percent iron;
balance—copper

2. An alloy as set forth in claim **1** wherein the carbon content $\leq$ 0.005 percent.

3. An alloy as set forth in claim **2** wherein the cobalt content $\leq$ 0.03 percent.

4. An alloy as set forth in claim **3** containing:

43% nickel;
3% manganese;
0.25% iron;
balance—copper

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,607,242 Dated September 21, 1971

Inventor(s) Arnold J. Gottlieb and Teh Po Wang

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 10 of the specification, please delete "copper" and insert--manganese--.

Signed and sealed this 7th day of March 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents