Aug. 8, 1939. P. H. BRACE 2,169,020

PROCESS OF MAKING RESISTOR ELEMENTS

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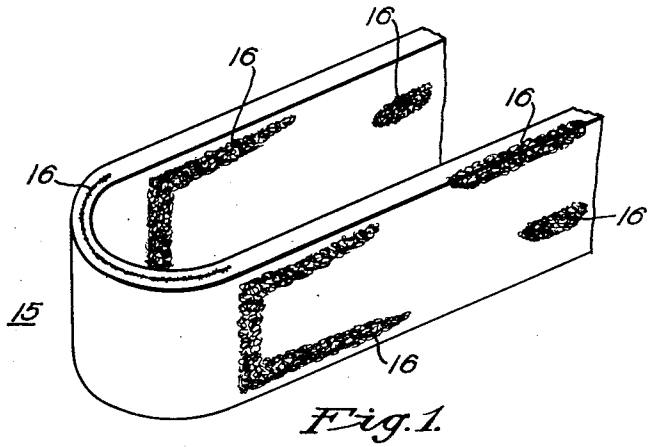


Fig. 1.

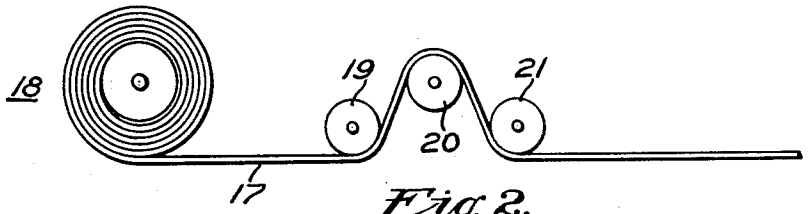


Fig. 2.

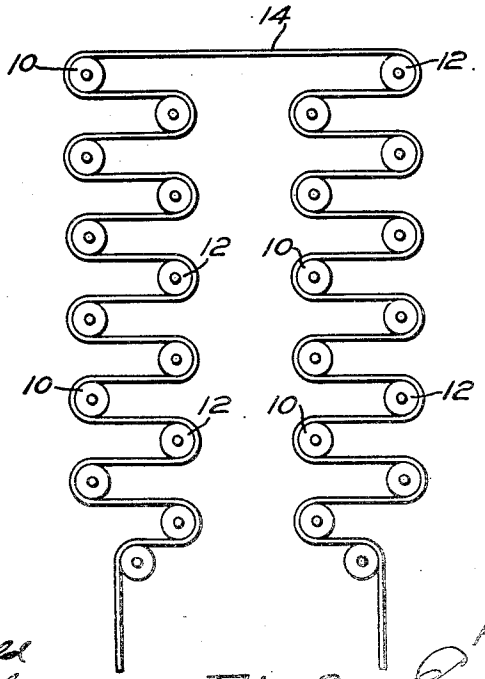


Fig. 3.

WITNESSES:

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PROCESS OF MAKING RESISTOR ELEMENTS

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2 Claims. (Cl. 29—155.5)

This invention relates generally to electric resistor elements, and particularly to a process of making metallic electric resistor elements.

In the electrical industry, the metallic resistor type of heating elements employed in electric furnaces are often exposed to the hot gases in the furnace. The metal of the elements exposed to the hot gases is so oxidized that serious damage is encountered and the operating efficiency of the furnace is greatly reduced.

An object of this invention is to provide for rendering metallic resistor elements resistant to hot gases.

Another object of this invention is to provide a process of making metallic resistor elements that are resistant to hot gases.

This invention may be better understood from the following description, when taken in conjunction with the accompanying drawing, in which:

Figure 1 is an isometrical elevational view of an end turn of the prior art metallic resistor element which has been exposed to hot gases.

Fig. 2 is a schematic view of a strip of metal and apparatus for treating it in accordance with the teachings of this invention, and

Fig. 3 is a schematic view of apparatus illustrating the shaping of the metallic resistor element.

In following the prior art processes for making resistor elements some suitable alloy such as the nickel chromium, chromium iron, nickel chromium iron or chromium aluminum iron alloys or alloys having similar electrical and physical characteristics is worked into strips of suitable width and thickness and subjected to a suitable annealing treatment after which, as illustrated in Fig. 3, the strips are wound around alternate spaced pins 10 and 12 to the predetermined convoluted shape of a resistor element 14.

When these elements are exposed to the hot gases of the furnace, serious oxidation of the metal is encountered. An end turn 15 of a resistor element made by the prior art processes is shown in Fig. 1 of the drawing. As illustrated in Fig. 1, the deterioration or oxidation of the metal of the elements, after exposure to the hot gases, is found along the side of the convolutions and along the top edge of the end turn 15 proper of the resistor element, as shown at 16. An examination of the elements reveals that the areas 16 are blistered and rough, the oxidation penetrating so deeply into the resistor element as to greatly impair its electrical properties.

In practicing this invention, the alloy is preformed into a strip 17 of a predetermined width and thickness of substantially the finished size of the element. In order to release the working strains set up in the strip by the working thereof, the preformed strip may be subjected to a suitable annealing treatment such as heating it at a temperature of between 800° C. and 1100° C. in a protective atmosphere of hydrogen or other suitable gas. The strip 17 may be wound into a roll 18 illustrated in Fig. 2 to facilitate the handling of the preformed strip.

In order to render the strip of metal resistant to the attack of hot gases, the annealed strip of metal may be subjected to a treatment suitable for causing a plastic deformation of the strip throughout its length. Through experiments, it is found that plastic deformation in an amount ranging from 2% to 25% is suitable for the purpose of this invention. By plastically deforming the entire strip of metal, the metal of the strip is placed in such condition that when later formed into the shape of the resistor element, each section of the resistor element will have substantially the same amount of plastic deformation.

The plastic deformation may be imparted to the annealed strip of metal in any suitable manner, as by cold working, drawing the strip under tension around a pin or, as illustrated in Fig. 2 by drawing the strip 17 from the roll 18 and passing it around a plurality of slighly staggered rolls. For the purpose of this invention the cold working or drawing herein described my be defined as plastically deforming the alloy strip at a temperature below its recrystallization temperature.

In the embodiment illustrated in Fig. 2, rolls 19, 20 and 21 are disposed in slightly staggered relation. These rolls may be adjusted to vary the staggered relation therebetween in order to vary the amount of plastic deformation imparted to the strip of metal as it is drawn therearound. In practice, the roll 20 is usually adjustable by some suitable means (not shown) to different positions with respect to positions of rolls 19 and 21.

After the strip of metal is plastically deformed, as hereinbefore described, it may be wound into a roll for storage for later use, or it may be cut into suitable lengths and as illustrated in Fig. 3 wound about the pins 10 and 12 to form the convoluted resistor elements. Usually the shaping of the metallic resistor element and particularly a resistor element comprising about 80% of nickel and 20% of chromium is accomplished at substantially room temperature in order to retain the effects of the plastic deformation imparted to the strip of metal. However where the metallic strip is brittle at room temperatures, as is the case of

the chromium aluminum iron alloys, and resistor element may be shaped at a temperature below its recrystallization temperature.

Although the upper limit of the plastic deformation imparted to the metallic strip is given hereinbefore as 25%, it is permissible for the upper limit of the plastic deformation to vary somewhat higher, depending upon the material employed, since the upper limit of the plastic deformation may be said to be determined by actual damage to the metal or the inconveniences encountered during the plastic deformation because of the work hardening effect the plastic deformation has upon the strip of metal.

Although this invention has been described with reference to a particular embodiment thereof, it is to be understood that it is not to be limited thereto, except insofar as is necessitated by the prior art and the scope of the appended claims.

I claim as my invention:

1. A process of making metallic resistor elements from an alloy comprising about 80% of nickel and about 20% of chromium for us in hot gaseous atmospheres, preforming the alloy into a strip of predetermined width and thickness, annealing the preformed strip, working the strip to plastically deform it throughout its length an amount ranging between about 2% and an amount necessary to damage the strip to render the alloy resistant to the hot gases, the plastically deformed strip being substantially of the same width and thickness as the preformed strip, and winding the plastically deformed alloy strip into a predetermined shape.

2. A process of making metallic resistor elements from an alloy comprising about 80% of nickel and about 20% of chromium for use in hot gaseous atmospheres comprising, preforming the alloy into a strip of predetermined width and thickness, annealing the preformed strip, working the strip throughout its length to plastically deform it between about 2% and an amount necessary to damage the strip to render the alloy resistant to the hot gases, the plastically deformed strip being substantially of the same width and thickness as the preformed strip, and winding the plastically deformed alloy strip at substantially room temperature into a predetermined shape.

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