United States Patent [19]

Toshiki et al.

[11] **3,813,508**

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[54] **REED SWITCH**

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[52] **U.S. Cl.** **200/268**

[51] **Int. Cl.** **H01h 1/02**

[58] **Field of Search** ..... 29/195 J, 630 C; 200/166 C, 144 B

[56] **References Cited**

UNITED STATES PATENTS

3,222,489	12/1965	Chaikin	200/166 C
3,606,498	9/1971	Ohno	200/144 B X
3,663,777	5/1972	Steinmetz	200/166 C

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Attorney, Agent, or Firm—Chittick, Thompson & Pfund

[57] **ABSTRACT**

The cooperating contacts of a reed switch are made of rhodium oxide. Such contacts are prepared by plating rhodium on the reeds of reed switches and then oxidizing the surface layers of the plated rhodium contacts by heating them in an oxygen containing atmosphere at a temperature of from 380° to 580° C for 3 to 15 minutes.

2 Claims, 5 Drawing Figures

FIG. 1

FIG. 2

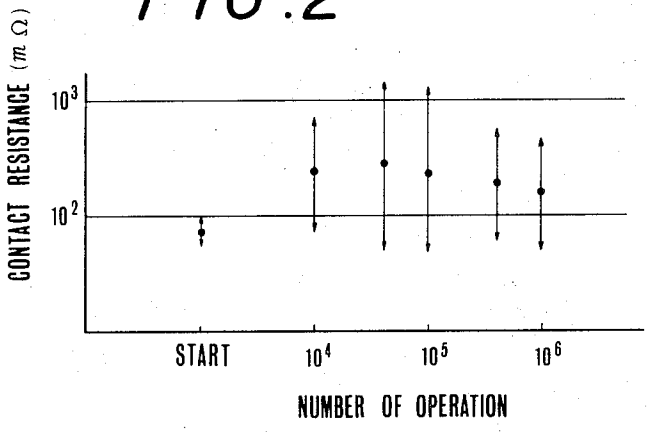


FIG. 3

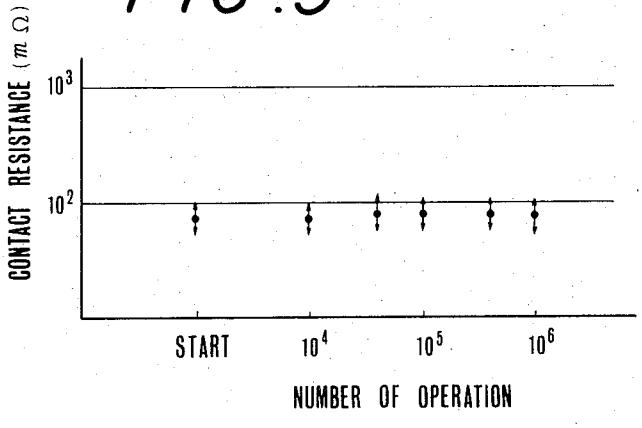


FIG. 4

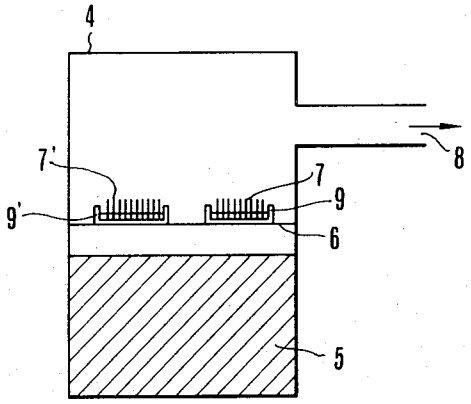
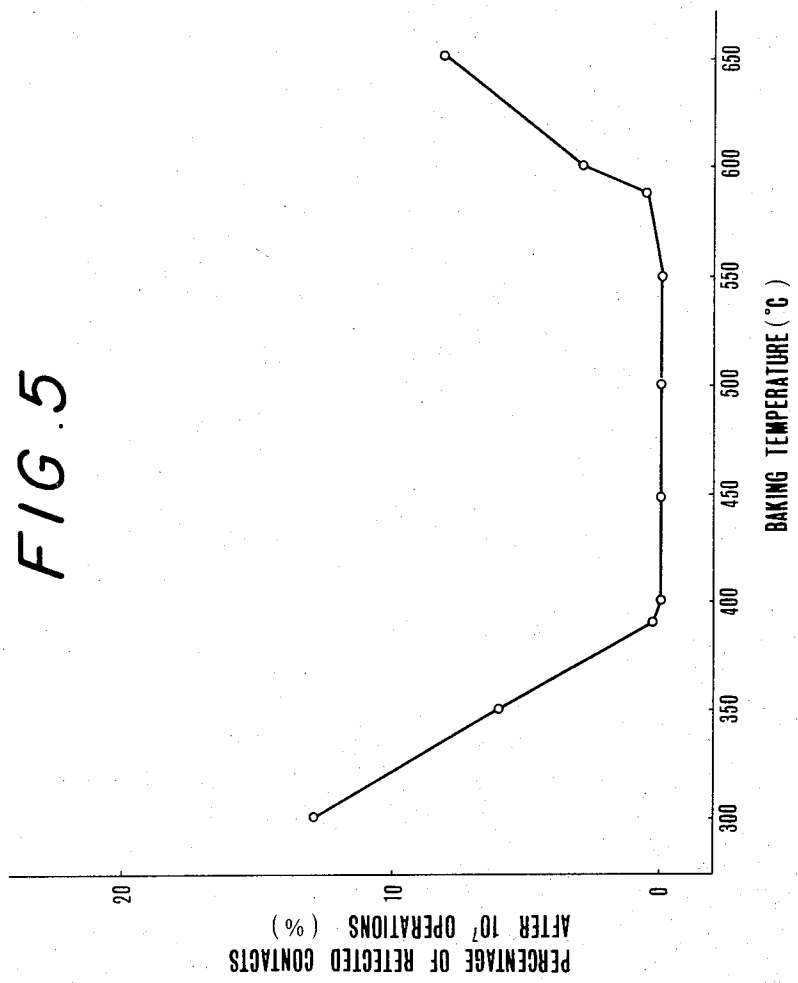


FIG. 5


PERCENTAGE OF REJECTED CONTACTS
AFTER 10⁷ OPERATIONS (%)
0
10
20
300
350
400
450
500
550
600
650
BAKING TEMPERATURE (°C)

REED SWITCH

BACKGROUND OF THE INVENTION

This invention relates to a reed switch having contacts whose contact resistance does not increase after a number of operations and to a method of preparing such contacts.

A conventional reed switch comprises a sealed glass envelope **1**, a pair of reeds **2** usually made of Fe-Ni Permalloy, and contacts **3** on the inner ends of reeds **2** said contacts being usually formed by plating a nobel metal.

Although rhodium has generally been used as the nobel metal because it is suitable for use as the contact material for reed switches, has a disadvantage in that the contact resistance between contacts of rhodium increases abnormally after a relatively small number of operations. Although a number of reasons for this may be considered, surface adsorption and catalytic action inherent to rhodium are considered to be the major reasons. When contacts of rhodium whose surfaces have adsorbed various organic substances or other impurities are opened and closed many times polymers are formed by the energy of collision of the contacts any by the catalytic action of rhodium and such polymers cause an increase in the contact resistance.

Accordingly, it is desirable to develop a novel method of surface treatment of the contact which can eliminate the catalytic action of rhodium thereby providing reliable contacts free from any abnormal increase in the contact resistance.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an improved reed switch provided with rhodium contacts which do not increase their contact resistance during use.

Another object of this invention is to provide a novel method of surface treatment of the rhodium contacts of reed switches.

According to this invention, these and other objects can be accomplished by oxidizing the rhodium contacts of a reed switch so as to form extremely thin films of rhodium oxide. To this end, the contacts plated with thin films of rhodium are heated to a temperature of $480° \pm 100°C$ for 3 to 15 minutes in an oxygen containing atmosphere. The resulting thin films of rhodium oxide greatly reduce the adsorption of impurities and catalytic action of metallic rhodium.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** is a diagrammatic representation of a conventional reed switch;

FIG. **2** is a graph showing the variation in the contact resistance of a prior art reed switch having rhodium contacts;

FIG. **3** is a graph showing the variation in the contact resistance of the rhodium contacts prepared in accordance with this invention;

FIG. **4** is a diagrammatic representation of a test device used to demonstrate the advantage of this invention; and

FIG. **5** is a graph showing the relationship between the deterioration of the contact resistance and baking temperature.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As above described, according to this invention, contacts of reed switches are prepared by plating rhodium on the reeds of reed switches and then oxidizing the plated rhodium in an oxygen containing atmosphere under conditions described above. To compare the variation in the contact resistance of the prior art rhodium contacts and rhodium contacts having thin layers of rhodium oxide which are prepared by the method of this invention, the following experiment was made. More particularly, as shown in FIG. **4**, a dish shaped container **9** containing leads **7** for reed switches having contacts prepared by the method of this invention and another container **9'** containing reeds having prior art rhodium plated contacts were placed on a perforated shelf **6** of a sealed vessel **4**. A quantity of benzol **5** was placed in the bottom of vessel **4** which was exhausted by means of a vacuum pump (not shown) connected to an exhaust pipe **8**. After 24 hours, the reeds **7** and **7'** were taken out from the vessel **4** and were respectively used to fabricate reed switches and life tests were carried out for these reed switches. As shown in FIG. **2**, the contact resistance of conventional contacts increased greatly after a relatively small number of operations, whereas the contact resistance of the contacts treated in accordance with this invention varied only a little after many operations (that is 10^6) as shown in FIG. **3**.

When inspected with a microscope, the prior art contacts were observed to have formed polymers because they have adsorbed benzol which was converted into polymers by the energy of the collision of contacts and the catalytic action of rhodium. On the other hand no polymer was noted on the contacts of reeds of this invention.

FIG. **5** shows a preferred range of oxidation temperature, wherein the ordinate shows the percentage of rejected contacts due to excessive increase in the contact resistance after 10^7 operations (which is a typical number of cycles for the life test) and the abscissa represents the baking or oxidation temperature of plated rhodium contacts. As can be noted from FIG. **5** with a baking temperature of from about 380°C to about 580°C, the percentage of the rejected contacts is approximately zero but increases rapidly at temperatures below 380°C and above 580°C. This is because at temperatures below 380°C the reaction is not sufficient whereas at temperatures above 580°C the surface layer of rhodium undergoes recrystallization due to heat or the diffusion of the plated metal occurs.

What is claimed is:

1. In a reed switch comprising a sealed envelope, a pair of reeds sealed to the wall of said envelope and a pair of cooperating contacts, the improvement wherein said contacts comprise thin surface layers of rhodium oxide operative to prevent surface contamination and without substantial increase in contact resistance.

2. The reed switch according to claim **1** wherein each of said contacts comprises a plated layer of rhodium and a thin layer of rhodium oxide thereon.

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