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ELECTRIC MAKE AND BREAK CONTACT

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This invention relates to an electrical make and break contact and particularly to tungsten contacts employed in automobile ignition and similar systems.

The general object of the invention is to provide an improved tungsten contact suitable for such work.

In an automobile ignition system, the contacts are called upon to make and break at tremendously high speeds, such as three thousand times a minute. The most suitable contacts developed for this exacting surface have been very hard dense discs of tungsten, cut from a dense hard non-porous tungsten rod or sheet. The tungsten discs are of very small diameter, for instance about $\frac{3}{16}$ of an inch, and very thin, for instance $\frac{1}{16}$ of an inch thick.

In the operation of a tungsten contact, the major factors contributing to breakdown are the heat developed due to contact resistance, especially resulting from the pressure contact resistance coefficient of tungsten, and the oxidation of the grain boundaries which progresses from these boundaries to the entire contact surface. The production of this oxide further raises the contact resistance of the tungsten, thereby bringing about localized contact effects with resultant overheating, fusing and pitting of the surface. While for a great many applications in which tungsten contacts are used the effects of the contact resistance coefficient of tungsten are not unduly detrimental, they become quite serious when encountered in the rapid make and break action taking place in automobile ignition and similar systems.

I have found that the addition of a very small quantity of boron reduces the pressure resistance coefficient and limits the oxidation of the tungsten contact, especially at the grain boundaries.

The amount of boron added must be held to very low limits, especially since the addition of boron makes it quite difficult to swage tungsten rod down to the size from which the discs must be cut. Beneficial results are obtained from the addition of fractional percentages of boron, for instance from the least useful amount, such as 0.1% or lower up to approximately 1%. For a contact having a diameter not substantially greater than 150 mils, about $\frac{1}{2}\%$ boron can be added; for larger diameters, the percentage of boron may be increased up to about 1%.

In the manufacture of the contact of this invention, finely divided boron in the desired percentage, for instance $\frac{1}{2}\%$, may be ball milled

with the tungsten powder for a period sufficient to insure a thorough intermixing of the elements. The powder mixture is then pressed into slugs by considerable pressure, approximately about ten tons per square inch. The pressed slug is then baked in a non-oxidizing atmosphere at a temperature of about 1200° C. for a short period of time, preferably about fifteen minutes, and is then heat treated in a non-oxidizing atmosphere, preferably hydrogen, by passing an electric current through it, the current being increased gradually until the slug is heated to about between 3000° C. and 3200° C., the heat being maintained at the maximum temperature for a short period of time, such as for about ten minutes, after which the flow of current is discontinued and the slug allowed to cool rapidly.

The treated slugs are then hot swaged into rods of the desired diameter, such as 150 mils, the rods then being heated in a non-oxidizing atmosphere, preferably of hydrogen, by passing an electric current therethrough, the metal being quickly heated to a temperature of about 2400° C., the temperature being held at the maximum value for a short period of time, approximately two minutes, after which the rod is cooled rapidly. The resultant material has a hard, dense, non-porous structure, from which discs of the desired thickness may be cut.

Another method of introducing boron into the tungsten contact is to prepare tungsten discs in the same manner as hereinabove described but without the inclusion of the boron and thereafter heat the contacts to a temperature of about 1200° C. to 1500° C. in an atmosphere of boron hydride. The depth and extent of the reaction of the boron hydride with the tungsten and the penetration of the boron into the tungsten disc is determined by the temperature, time of treatment and concentration of the boron hydride.

The boron hydride may be made by heating 2.25 parts of magnesium powder with one part of B_2O_3 in a current of hydrogen, Mg_3B_2 being produced. This is decomposed with HCl diluted with a stream of hydrogen at 50° C., the resultant boron hydride and hydrogen gas being passed over the contacts.

The improvement brought about by the addition of a small percentage of the boron to the hard, dense, non-porous tungsten contact body has been checked in a series of comparative tests in automobile ignition test systems. For instance, tungsten contacts containing $\frac{1}{2}\%$ boron showed a P. A. R. rating of 89% as compared with a P. A. R. rating of 68.2% for tungsten con-

tacts of the type at present used as standard equipment in automobile ignition systems. The comparative ratings were arrived at by obtaining the area of a curve of percent satisfactory operation plotted against duration of test in hours and dividing this area by an area which would have been obtained if all units had operated satisfactorily for three hundred hours. The characteristic tungsten transfer noted with the standard contacts brought about by oxidation and pitting was noticeably reduced and in some cases absent with the tungsten boron contacts.

While this invention primarily has to do with the addition of a small percentage of boron to tungsten electrical make and break contacts for automobile ignition systems, the addition of similarly small percentages of boron to molybdenum make and break contacts brings about a marked improvement in such contacts and reduces the amount of molybdenum oxide which would ordinarily be produced in operation. Likewise the invention is also applicable to tungsten make and break ignition type contacts containing very small quantities of other elements such as 1% molybdenum, where such other elements are not present in an amount sufficient to substantially change the characteristics of the tungsten.

What is claimed is:

1. An electrical make and break contact for automobile ignition systems and the like comprising a hard, dense, non-porous disc of one of the elements tungsten and molybdenum, characterized by the addition of a relatively small quantity of boron up to approximately 1%.

2. Tungsten make and break contacts for automobile ignition systems and the like characterized by the addition of a relatively small quantity of boron not substantially exceeding $\frac{1}{2}\%$.

3. A hard, dense, non-porous tungsten make and break contact containing as an essential ingredient up to approximately 1% boron.

4. An electrical make and break contact for automobile ignition systems and the like containing from about .1% to about 1% boron and the balance tungsten.

5. A hard, dense, non-porous electrical make and break contact for automobile ignition systems and the like composed of about $\frac{1}{2}\%$ boron and the balance substantially tungsten.

6. A hard, dense, non-porous molybdenum approximately 1% boron.

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CERTIFICATE OF CORRECTION.

Patent No. 2,253,533.

August 26, 1941.

SAMUEL RUBEN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 24, claim 6, after "molybdenum" insert the words --make and break contact containing--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of October, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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