Dec. 21, 1948. W. W. RIGROD 2,456,891

IGNITOR

Filed Jan. 4, 1945

Fig. 2.

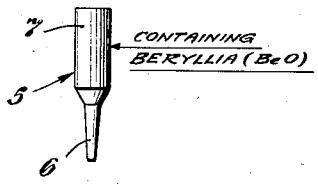


Fig. 3.

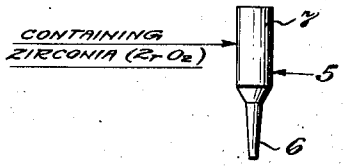


Fig. 1.

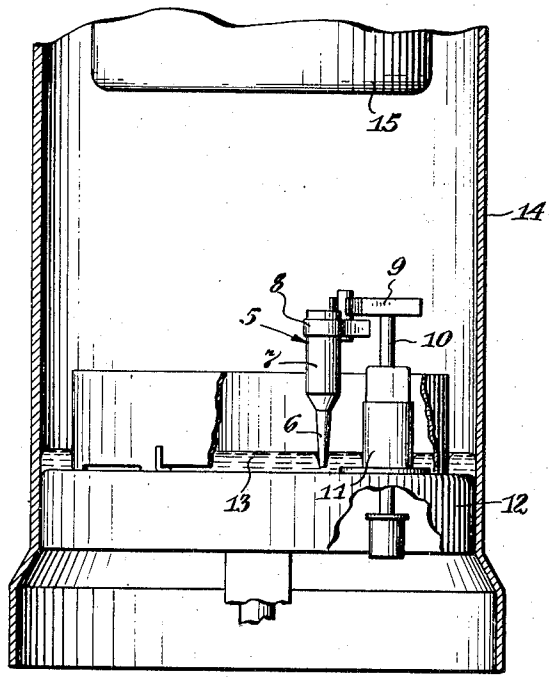
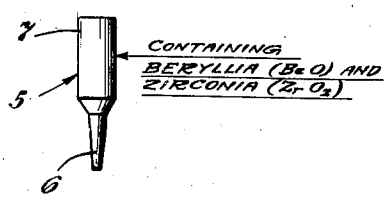


Fig. 4.



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IGNITOR

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10 Claims. (Cl. 250—27.5)

1

This invention relates to ignitors and more particularly to ignitors such as employed in ignitrons as a starting or keep-alive electrode.

The usual ignitors as heretofore made ordinarily contain boron carbide, boron nitride and carbon as their principal ingredients, having superseded the more ancient ignitors of silicon carbide and silica.

All of these prior art ignitors are characterized by a strong negative temperature coefficient of resistivity, that is to say, the ignitor resistance falls off as its temperature rises. A strong negative temperature coefficient of resistivity in an ignitor is undesirable, especially in welding service ignitrons, as such an ignitor tends to fire with lower voltage, and higher current when heated than when cold. Inasmuch as when a sinusoidal voltage wave is applied to an ignitor, the time of firing depends upon ignitor voltage, a strong dependency of ignitor voltage upon its temperature introduces wide variations in the firing instant. Thus a large negative temperature coefficient of resistivity reduces control of the welding "heat."

It would be an ideal condition to have the temperature coefficient of resistivity zero, but in practice such an ideal condition is not attained although it is closely approached by the present invention. There are numerous reasons why a strong negative temperature coefficient of resistivity is undesirable in ignitrons, some of the more important of which may be briefly reviewed as follows:

1. An ignitor having a strong negative temperature coefficient of resistivity, and hence a high firing voltage when cold, may prevent firing for the first few cycles of voltage application. In a system intended for low duty-cycle welding service, failure to fire for the first few cycles is disastrous. In rectifier ignitron installations, failure to fire for the first few cycles causes some tubes to fire sooner than others, and so carry an overload temporarily, resulting in possible damage to those tubes and to associated equipment.

2. An ignitor having a strong negative temperature coefficient of resistivity when used in welder-service ignitrons and when used with the firing angle phased back to a large degree in order to obtain a low root mean square welding current, is supplied with voltage so rapidly, and is heated so little by the arc current, that it fails to heat up appreciably and continues to run cold. This circumstance calls for a higher firing voltage than is available at the advanced phase-back angle, and hence definitely prevents firing.

2

Since a strong negative temperature coefficient of resistivity is an inherent property of boron carbide, present-day ignitors have the foregoing undesirable characteristics and disadvantages. Furthermore, it is a fact that the firing characteristics of an ignitor are critically dependent on the properties of the insulating material constituting an ingredient of the ignitor. Present day commonly employed insulating material for ignitors is boron nitride. Like the carbide, this nitride of boron has a strong negative coefficient of resistance, and thus the ignitors of common usage are definitely characterized by a strong negative temperature coefficient of resistance.

A further object of the invention is to provide an ignitor having less strong negative or more positive temperature coefficient of resistance.

Another object of the invention is to obtain a counteraction of strong negative temperature coefficients of resistance by introducing a material having a less strong negative or more positive temperature coefficient of resistance.

Still further objects of the invention will appear as the description progresses, both by direct recitation and by implication from the context.

Referring to the accompanying drawing exemplifying the invention:

Figure 1 is a vertical sectional view of an ignitron showing my improved ignitor mounted therein; and

Figures 2 to 4 are elevations of ignitors of the present invention indicating the novel ingredients incorporated therein.

In the specific embodiment of the invention, and describing the exemplifications of the drawing in detail, the ignitor is designated therein by reference numeral 5, and is shown as having a tapered lower end or tip portion 6 and a larger or more sturdy upper end or body portion 7 integrally formed with the tip portion. A supporting metallic band 8 is shown gripping the said body portion, the band being supported by a bracket 9 in turn carried by a lead-in wire 10 which is sealed through a nipple 11 welded on a header 12, said nipple projecting above the surface level of mercury or other cathode material 13 carried upon the said header and within the cylindrical side wall 14 of the ignitron. Above the cathode and starter electrode or ignitor is an anode 15. The various parts mentioned have usual or any desired relation, it being understood that the cylindrical side wall 14 is sealed at top and bottom enabling the interior to be evacuated.

The ignitor 5 of the present invention consists of sintered or otherwised unified mixture of in-

gredients of which boron carbide and carbon are utilized substantially in proportions as employed in ignitors of the prior art. In addition to boron carbide and carbon, I use a ceramic selected from the group consisting of beryllia (BeO), zirconia (ZrO_2), separately or together. This ceramic replaces boron nitride (BN) heretofore used in manufacture of ignitors.

Use of beryllia as an ingredient, as indicated by Figure 2, gives several beneficial results, of which slight rise in firing voltage in "cold firing" over voltage when hot, is an important advantage derived. Moreover, beryllia is found to produce an ignitor which is far stronger mechanically than prior art ignitors made with boron nitride. Furthermore, boron nitride is soluble in water, whereas beryllia is insoluble and the ignitor made therewith will not decompose in the air nor even in water or steam, thereby assuring longer life and presenting less storage difficulties prior to sealing into the ignitron. It has also been determined that a smaller proportion of beryllia than boron nitride is needed for an ignitor to obtain the same cold resistance and that ignitors as here proposed using beryllia require lower cold resistance than those using boron nitride to have the same firing currents. Addition of small quantities of beryllia to ignitors containing boron nitride, or other ceramics having the usual strong negative coefficient causes a pronounced increase in electrical resistance and mechanical strength.

Use of zirconia as an ingredient as indicated in the ignitor of Fig. 3 gives a pronounced less negative or more positive temperature coefficient of resistance. The firing voltage when the ignitor is hot is greater than when cold in an ignitor utilizing zirconia. This unusual property makes it possible to attain any desired temperature coefficient by mixing zirconia in suitable proportions with boron nitride or other ceramics having usual strong negative coefficient of resistivity.

The benefits of the more positive temperature coefficient of resistivity of zirconia may be attained with the mixture of zirconia and beryllia and thereby also have the benefits above recited of beryllia. An ignitor compounded with both beryllia and zirconia is indicated in Fig. 4. This ignitor using both zirconia and beryllia thus has increased benefits over a mixture of either one with the general ingredients, such as boron carbide and carbon mentioned above.

The proportions of ingredients employed for making my improved ignitor may be varied over a wide range, but by way of example, tabulation is given below of proportions in percentages by weight, which have proved successful.

No.	B_4C	B	C	BeO	ZrO_2
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1	77	9	8	6	
2	30	30	10		30
3	52	20	8		20
4	78	9	5	1.6	6.4

In adopting the proportions in the mixtures represented by the foregoing tabulation, the percentages of beryllia (BeO) and of zirconia (ZrO_2) were determined experimentally, and percentage of other ingredients calculated to give a total of 100%. Range of proportion of beryllia lies from maximum shown of 6% in the first example to the minimum of 1.6% in the fourth example. A low approximate average of substantially 3% beryllia is the preferred percentage in round figures. Several percent variation of each of the other ingredients appears relatively non-critical in comparison to the specific range for the beryllia.

I claim:

1. An ignitor comprising ingredients of boron and carbon, and an additional ingredient of a metallic compound inclusion whereof gives to the composition a less negative and more positive temperature coefficient of resistance.

2. An ignitor comprising ingredients of boron and carbon, and an additional ingredient inclusion whereof gives to the composition a less negative and more positive temperature coefficient of resistance, said additional ingredient being selected from the group of chemical compounds in which beryllium and zirconium are elements.

3. An ignitor comprising ingredients of boron and carbon, and an additional ingredient inclusion whereof gives to the composition a less negative and more positive temperature coefficient of resistance, said additional ingredient being selected from the group of chemical compounds consisting of beryllia and zirconia.

4. An ignitor comprising ingredients of boron and carbon, and an additional ingredient inclusion whereof gives to the composition a less negative and more positive temperature coefficient of resistance, said additional ingredient being an oxide of a group of elements represented by beryllium and zirconium.

5. An ignitor comprising ingredients of boron and carbon, and an additional ingredient inclusion whereof gives to the composition a less negative and more positive temperature coefficient of resistance, said additional ingredient being beryllia.

6. An ignitor comprising ingredients of boron and carbon, and an additional ingredient inclusion whereof gives to the composition a less negative and more positive temperature coefficient of resistance, said additional ingredient being zirconia.

7. An ignitor consisting of a mixture of boron carbide, boron, carbon and beryllia.

8. An ignitor consisting of a mixture of boron carbide, boron, carbon and zirconia.

9. An ignitor consisting of a mixture of boron carbide, boron, carbon, beryllia and zirconia.

10. An ignitor consisting of boron carbide, boron, carbon and a metallic compound of which the metal is selected from the group of beryllium and zirconium.

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