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INTENSIVE ELECTRIC ARC CARBON

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My invention relates to that class of arc carbons known as "intensive (or high-intensity) arc carbons" which are used for the production of a special type of gaseous arc known as an "intensive (or high-intensity) arc" which is characterized by phenomena commonly referred to as "the Beck effect", after the name of the inventor of this arc. The terms "intensive" and "high-intensity" arise from the fact that the carbons and arc are operated at high current densities.

The Beck effect involves the appearance of a relatively deep anode crater, in which resides a gaseous substance, the brilliance of which is extremely high.

As is known, certain requirements have to be observed in order to produce an intensive arc exhibiting the Beck effect. The carbon anode employed has necessarily to comprise two zones of different volatility, the inner zone or core being more volatile than the outer zone or shell. Also, the materials of the core must be volatile at high temperatures; if the materials of the core are volatile at too low a temperature, the Beck effect cannot be obtained whatever the current density used. These requirements therefore exclude, for example, arc carbons which are uniformly mineralized throughout their mass and also those which are cored if the shell is a metal or if the core contains substantial quantities of alkali or alkaline earth metals or their salts or other materials which volatilize at low temperatures or materials which fuse, but do not volatilize, at high temperatures. Furthermore, for obtaining the Beck effect, the anode is made thinner than a plain carbon electrode for the same current density. Again, there is a definite relation between the diameters of the core and shell of the carbon anode to be observed; this relation has to be between certain defined values which depend upon the diameter of the carbon and the current density to be used. The usual relationship is that the core diameter is substantially half the diameter of the shell. By properly observing these and other conditions, such as the diameter of cathode and the angle between the axes of the electrodes, a deep positive crater, as above-mentioned, will be caused to form in the end of the anode. The gases from the core are confined by the walls of this crater and thereby produce a stable gaseous arc.

The Beck effect may arise spontaneously or, on the other hand, may be excited. In the former case, it appears when the current density in the anode exceeds a certain minimum value, which is generally of the order to 0.5 amp. per square millimeter of cross-section, while at the same time the cathode emits a not very luminous, but very stable, pointed flame. There escapes from the anode crater, moreover, a large flame, which is violently repelled backwards, as if the cathode pointed flame possessed considerable kinetic energy.

The intensive arc has been in existence for about twenty to twenty-five years and during this time it has been commonly taught in literature relating to electric arcs, that the Beck effect can only be obtained with intensive arc carbon anodes of the class described whose cores are mineralized either with rare earths or thorium, or with mixtures of these different elements. Of course, not the free metals, but their compounds, are employed, which may be the oxides, fluorides, oxyfluorides or other insoluble compounds. For instance, such carbon anodes are known which, for a diameter of 16 mms., function very well between about 150 and 180 amperes (current densities of 0.75 to 0.90 ampere per sq. mm.). In these the core has a diameter equal to half that of the shell and contains about 50% by weight of fluorides, oxyfluorides or oxides of the rare earth metals, alone or mixed with thorium.

Further progress on the question was made in 1933 when it was established that the Beck effect can be obtained with intensive arc carbon anodes which contain only one other element besides carbon, namely, silicon, which may be combined with the carbon in the form of carborundum, as described in French Patent No. 770,345.

The invention hereinafter described relates to a new class of intensive arc carbon anodes, in which the rare earths and thorium are no longer necessary. I have found that intensive arc carbon anodes are obtained when the cores contain, in place of the rare earths and thorium, a suitable amount of one or more of the metals, iron, nickel, cobalt, manganese, chromium and vanadium, i. e., the metals having atomic numbers between 23 and 28 inclusive. The metals are incorporated in their metallic state and not as compounds, in contradistinction to prior practice employing rare earths. It is sufficient to incorporate between about 15 and about 70% by weight of any one or more of these elements in the core to obtain intensive arc carbon anodes which give a perfect Beck effect and the brilliance of which considerably surpasses that of pure carbon or of the silicon-containing intensive arc carbons described in French Patent 770,345. In particular, a Beck effect which is perfectly stable and of brilliance equal to about 60 to 80% of that given by

the rare earth intensive arc carbons is obtained when the cores contain 25% by weight of one of the above-mentioned elements, the remainder consisting of commercially pure carbon.

It will be noted, moreover, that the different elements mentioned have relatively similar atomic weights, so that the percentages by weight mentioned correspond to substantially equal atomic percentages. Optical results which are also of the same order are thus obtained.

The maximum brilliance of these new intensive arc carbons is less than that of the rare earth intensive arc carbons. On the other hand, the surprising discovery has now been made that by mixing one or more of these same metals in suitable proportions with rare earth compounds usual in this industry, crater brilliances can be obtained which surpass those given by the pure rare earths. It will be found, for instance, that with a core comprising 11% iron and 41% fluorides of the cerium earths, the maximum brilliance exceeds by 10 to 20%, according to the current density, that which is obtained with the best carbon anodes containing pure rare earths. Thus, carbon anodes having a shell 9 mms. in diameter, with a core cavity of half the external diameter, enclosing a core of this same composition have given, (1) at 50 amperes, 57 volts at the terminals of the arc, 12% more light that the rare earths, (2) at 80 amperes, 68 volts, 16% more, and (3) at 85 amperes, 68 volts, 20% more.

It has also been found that nickel, cobalt, manganese, chromium and vanadium give similar increases in brilliance. In all cases, it has been found that there is an improvement in light and an improvement generally of the same order of magnitude.

Another advantage of these new carbon anodes is that the current density traversing them can be increased to a higher limit without reaching the zone where the arc becomes noisy and unstable. For instance, the ordinary (rare earth) intensive arc carbon anode of 9 mms. taken as reference above gives slight variations of light from 80 amperes, and the fluctuation of the light becomes troublesome at 85 amperes. With the iron composition mentioned above, the arc is still perfectly stable at 80 amperes and the variations are still only slight at 85 amperes. Finally, it has been found that the hourly wear of the new carbon anodes, under identical working conditions and with shells comprising carbon of identical quality, remains of the same order as it is with the usual intensive arc carbon anodes. .

In regard to the colour of the light, the latter appears to be less bluish and richer in radiation of lower frequencies. Consequently, it offers advantages in the power of penetration of the luminous beam of projectors, and for the projection of color films by means of intensive arcs. In the latter case, the fidelity of coloration is more exact with these new carbons, in which the rare earths and a metal such as iron are combined. On the other hand, when no rare earths are present, the coloration of the arc remains sufficiently white but has a greenish tint, particularly in the case of nickel.

It should be clearly understood that the invention stands independent of any scientific or technical theory which might be advanced in regard to the mechanism of the intensive arcs.

To conclude, it should be pointed out that the operation of the new carbon anodes is quite comparable with that of the known intensive carbon anodes and does not necessitate any modification of the adjustment or of the ventilation of the lamps. It is sufficient if this ventilation prevents the metallic oxides formed by the vaporization of the iron and other metals from settling on the mirrors or other optical apparatus with which the lamps are provided.

I claim:

1. An intensive arc carbon anode of the class described, comprising a shell of commercially pure carbon and a core which consists solely of carbon and at least one of the materials comprised in the group of free metals having atomic numbers between 23 and 28 inclusive and mixtures of such free metals with insoluble compounds of the rare earth metals.

2. An intensive arc carbon anode of the class described, comprising a carbon shell and a carbon core which contains a mixture of at least one of the metals in uncombined form having atomic numbers between 23 and 28 inclusive, and at least one insoluble compound of the rare earth metals, the remainder of the core consisting of carbon.

3. An intensive arc carbon anode of the class described, comprising a shell of commercially pure carbon enclosing a core of commercially pure carbon containing from about 15% to about 70% by weight of at least one of the metals having atomic numbers between 23 and 28 inclusive, the metals being in uncombined form, the remainder of the core consisting of carbon.

4. An intensive arc carbon anode of the class described, comprising a shell of commercially pure carbon enclosing a core of commercially pure carbon containing about 11% by weight of uncombined iron and about 41% by weight of commercial cerium fluoride, the remainder of the core consisting of carbon.

5. An intensive arc carbon anode of the class described, comprising a shell of commercially pure carbon enclosing a carbon core containing about 25% by weight of a metal in uncombined form having an atomic number between 23 and 28 inclusive, the remainder of the core consisting of commercially pure carbon.

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