

# United States Patent Office

2,715,080

Patented Aug. 9, 1955

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2,715,080

## ELECTRICAL CONTACT BRUSH

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No Drawing. Application May 27, 1954,

Serial No. 432,943

6 Claims. (Cl. 117-223)

This invention relates to electrical current collecting contact devices and to carbon or graphite brushes operating in contact with rotating current collectors of dynamoelectric machinery, especially those operating under conditions of extreme dryness. This application is a continuation-in-part of my prior application Serial No. 293,005; filed June 11, 1952, and now abandoned.

The problem of rapid wear of electrical brushes at high altitudes has existed for many years. In the region of 30,000 feet altitude and above, the absence of water vapor in the atmosphere creates conditions under which brushes, deprived of the lubricating effect of water vapor, wear away very quickly. In a dry atmosphere the total usable length of a brush may be worn away in a matter of minutes.

Accordingly, it is an object of this invention to provide a brush which may be used in a dry atmosphere without experiencing undue wear and which has a longer useful life when used in normal atmospheres.

It is another object of the invention to provide an electrical contact brush having incorporated therein as an additive a compound including at least two atoms having high electronegativity coefficients.

It is a further object of the invention to provide an electrical contact brush containing as an additive a small quantity of sodium pyrophosphate.

Briefly stated, in accordance with one aspect of this invention, I provide a carbon brush for electrical purposes containing from about 1% to 5% by weight of a compound selected from the group consisting of chlorates, bromates, phosphates, borates, selenates, and fluosilicates of alkali metals.

I have discovered that there is a correlation between the ability of a particular compound to confer wear resistance qualities upon carbon brushes used in a dry atmosphere and the electronegativity coefficients of the individual elements entering into combination to form the compound. As reported by Pauling in his book *The Nature of the Chemical Bond*, the electronegativity coefficients of the elements are greatest for elements positioned to the right and toward the top of the periodic table and are least for elements positioned to the left and toward the bottom of the periodic table. Thus, alkali metals such as lithium, sodium, potassium, rubidium, and cesium have electronegativity coefficients of 1.0, 0.9, 0.8, 0.8, and 0.7, respectively. Among the elements positioned to the right on the periodic table, oxygen has an electronegativity coefficient of 3.5 and the halogen group of fluorine, chlorine, bromine, and iodine have electronegativity coefficients of 4.0, 3.0, 2.8, and 2.4, respectively. Among the halogens, I prefer to use fluorine but find chlorine and bromine also satisfactory for my purposes. Boron, silicon, phosphorus, and selenium have electronegativity coefficients of 2.0, 1.8, 2.1, and 2.4, respectively. While these coefficients are not as great as the coefficients of oxygen, fluorine, chlorine, and bromine, I have found that compounds containing these elements in

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combination with oxygen serve as efficient additives to prolong carbon brush life, especially in dry atmospheres.

It is desirable in accordance with my invention that the largest numerical value possible be obtained by subtracting the electronegativity coefficient of the metal portion of the molecule from the electronegativity coefficient of the non-metallic portion of the molecule of the compound used as an additive.

Other considerations enter into choosing the particular compound used as a brush additive. For instance, the electronegativity coefficient of cesium is slightly less (0.7) than the electronegativity coefficient of sodium (0.9). However, the difference is usually not sufficiently great to justify using cesium in preference to sodium in view of the greater availability and lower cost of sodium. Physical characteristics as well as economic factors also enter into choosing the best additive. The simplest way to impregnate a carbon brush with an additive is by immersing the brush in a solution containing the dissolved additive. Consequently, it is desirable that the additive be readily soluble in water, although other liquid solvents may be used.

Sodium pyrophosphate ( $\text{Na}_2\text{P}_2\text{O}_7$ ) is one of the preferred additives in accordance with my invention. This additive improves the dry atmosphere wear resistance of all types of carbon brushes commercially available. A preferred method of impregnating a carbon brush with sodium pyrophosphate is to immerse a brush in a solution of dibasic sodium phosphate ( $\text{Na}_2\text{HPO}_4$ ) in a closed container. The container is evacuated to a pressure of about 4 centimeters Hg in order to draw air out of the brush. The vacuum is then broken in order to enable atmospheric pressure to force the dibasic sodium phosphate solution through the brush. The brush is then removed from the solution and the water evaporated in a drying oven. The brush is then heated to a temperature of about 400° C. at which temperature it is maintained for about 3 hours. This treatment splits off water from the dibasic sodium phosphate to convert it to sodium pyrophosphate. Sodium pyrophosphate has a melting point of 988° C. Consequently, the treatment temperature could have been much higher than 400° C. without interfering with the conversion of the dibasic salt to sodium pyrophosphate. The treatment could also have been at a lower temperature but in this event a longer treatment period would have been necessary to compensate for the slower rate of conversion.

If too much additive is present in the carbon brush, it will overheat during operation. If too little is present, the brush has poor wear resistance. While there is some variation in the optimum proportion of additive, in general I have found that brush performance is improved if about 1% to 5% by weight of the additive is present, a preferred range being about 3.5% to 5%. The proportion of additive present may be controlled very closely by controlling the concentration of the aqueous additive solution. To some extent the strength of the solution must also be correlated with the porosity of the brush structure, the less porous structures requiring a more concentrated solution in order to have the same proportion of additive finally present. For a brush structure of about 25% porosity, I have found that a 200% solution of dibasic sodium phosphate results in a brush having about 4% sodium pyrophosphate after drying and conversion. A 100% solution produces about a 3% brush. In the case of dibasic sodium phosphate, I have found it desirable to regulate the proportion of additive by controlling the specific gravity of the aqueous solution. Thus, a solution having a specific gravity of 1.225 produces a final brush containing 2% sodium pyrophosphate. A solution having a specific gravity of 1.450 produces a brush having sodium pyrophosphate present to the extent

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of 5% while a solution having a specific gravity of 1.150 produces a brush containing about 1% by weight sodium pyrophosphate.

In addition to the sodium pyrophosphate previously discussed in detail, alkali metal borates, silicates, selenates, chlorates, bromates, fluosilicates, and alkali metal phosphates besides sodium phosphates are satisfactory additives. In the detailed example of sodium pyrophosphate previously given, the aqueous solution utilized was dibasic sodium phosphate. The excellent solubility of the dibasic phosphate makes it easy to use for introducing the additive to the brush. However, its use necessitates a subsequent heat treatment to convert the dibasic phosphate to the pyrophosphate. Actually the pyrophosphate itself may be used in an aqueous solution and the brush may then be placed in a drying oven to evaporate the water picked up in the aqueous treatment. The step of heating to 400° C. may then be omitted. This same process may be used to impregnate a brush with any of the other impregnating compounds mentioned herein. Since the method is exactly the same, the specific details for impregnating with each additive will not be repeated. In the case of certain of the compounds having low aqueous solubility, liquids in which the solubility is greater than water may be substituted for water.

While the present invention has been described with reference to particular embodiments thereof, it will be understood that numerous modifications may be made by those skilled in the art without actually departing from the invention. Therefore, I aim in the appended claims to cover all such equivalent variations as come within the true spirit and scope of the foregoing disclosure.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A carbon brush for electrical purposes containing from about 1% to 5% by weight of an alkali metal pyrophosphate.

2. A carbon brush as claimed in claim 1 wherein the pyrophosphate is present to the extent of about 3.5% to 5% by weight.

3. A carbon brush for electrical purposes containing about 1% to 5% by weight of sodium pyrophosphate.

4. A carbon brush for electrical purposes containing from about 3.5% to 5% by weight of sodium pyrophosphate.

5. The method of impregnating a current collecting carbon brush with an alkali metal pyrophosphate which comprises impregnating the carbon brush with an aqueous solution of dibasic alkali metal phosphate, drying the brush, and heating said brush to convert the dibasic phosphate to the pyrophosphate.

6. The method of impregnating a current collecting carbon brush with sodium pyrophosphate which comprises immersing the brush in an aqueous solution of dibasic sodium phosphate until the carbon brush has become impregnated with the phosphate, drying the carbon brush, and heating the carbon brush to convert the dibasic phosphate to pyrophosphate.

#### References Cited in the file of this patent

#### UNITED STATES PATENTS

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