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# UNITED STATES PATENT OFFICE

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## CARBON BRUSH

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Rapid wear of carbon brushes has been known for sometime to occur at sea level in dry air. More recently, it has been found that brushes also wear rapidly at high altitudes due to the usually dry atmosphere up there. Laboratory tests have shown that many kinds of brushes wear rapidly at reduced pressures not only in dry air but even in moist air. This indicates that at high altitudes these brushes wear rapidly regardless of the atmospheric humidity. Such rapid wear has made direct current motors and generators hazardous at high altitudes under any conditions. Accordingly, for the last few years, many agencies and manufacturers have carried on work to determine the causes and remedy for this wear.

Numerous methods have been devised to overcome this wear by impregnating the brushes with various compounds in different ways. The present invention deals with one such method which has been found not only to increase the life of carbon brushes but also to improve their performance and to make it possible to control their voltage drop characteristic between brush and commutator to suit requirements.

One of the objects of this invention is, therefore, to treat carbon brushes in such manner as to increase their life by decreasing wear.

Another object is to provide a method of treatment of carbon brushes whereby their voltage drop between brush and commutator may be predetermined as desired.

Another object is to decrease brush wear and improve commutation level by introducing compounds such as silver sulfide.

Another object is to provide a method for impregnating carbon brushes with insoluble sulphide compounds by gradual precipitation from soluble compounds in which the brushes are first soaked, by immersing them in a solution containing a sulphureting agent which precipitates the sulphide.

Other and more specific objects will appear in the following description.

Impregnation of carbon brushes with $Ag_2S$ has been found to increase their life considerably and to alter the voltage drop across the brushes to the commutator. The $Ag_2S$ may be precipitated from $AgNO_3$, in which the brushes are first soaked, by submerging them then in water containing $H_2S$, or in $(NH_4)_2S$. The reaction of the ammonium sulfide is as follows:

$$2AgNO_3+(NH_4)_2S \rightarrow Ag_2S+2NH_4NO_3$$

If water containing $H_2S$ is used for the precipitation the voltage drop is lowered, whereas, if $(NH_4)_2S$ is used, the voltage drop is increased. Thus any desired drop within this range may be predetermined by using more or less of either

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precipitant to get the desired voltage drop to suit any particular requirements.

It has been further discovered that better results might be obtained for some purposes in the above method of precipitation of $Ag_2S$ by $(NH_4)_2S$ by preceding it by the introduction of bismuth iodide, which is soluble in alcohol, and of potassium iodide, by soaking them in a solution of the latter after drying out the alcohol of the bismuth iodide solution.

The iodides have a tendency to provide the necessary lubrication at the higher temperatures produced by the higher potential drop at the commutator by the $Ag_2S$ precipitated in this method.

Other comparatively insoluble compounds may be introduced in the brushes for the purpose of inhibiting brush wear in a similar manner, by first soaking the brushes in a solution of a soluble compound from which the insoluble compound may then be precipitated by immersing them in a solution of another soluble compound. For example, it has been found that lead iodide and bismuth acetate are good wear inhibitors and may be precipitated in the brushes by first soaking them in a solution of lead acetate and then submerging them in a solution of bismuth iodide, or vice versa. The precipitation is caused by the following reaction:

$$Pb(C_3H_3O_2)_3+BiI_2+H_2O \rightarrow PbI_2+Bi(C_3H_3O_2)_3+H_2O$$

The process of precipitation in the above reactions is sufficiently gradual to permit a practically homogeneous precipitation throughout the mass of the carbon brushes. To ensure a more homogeneous precipitation the brushes may be thoroughly dried after soaking in the first solution so as to permit better permeation of the second solution through all the pores of the brushes before the initial precipitation clogs the pores near the surface to prevent continuation of the process further inwardly of the carbon mass.

The time required for soaking the brushes in the solutions obviously depends on the porosity of the carbon, a more porous material requiring less time for thorough saturation. Saturation may also be hastened by first placing the carbon brush in a reduced pressure chamber to partially evacuate the pores therein, then soaking it in the solution under normal or superatmospheric pressure. Likewise, the evacuation step might be omitted and the soaking done under a higher pressure.

It is to be understood that normally the copper oxide formed on the commutator at ordinary operating temperatures acts as a smooth coating to reduce wear of the brushes which would otherwise wear much faster on a copper surface. The addition of $Ag_2S$ to the brushes adds to this normal lubrication to improve wear provided the

temperature is not increased too much. Since the temperature of operation at the commutator surface depends to some extent on the potential drop, i. e., the conductivity of the contact surface films, and since this drop is greater in the case of the $Ag_2S$ precipitated by $(NH_4)_2S$ than the carbon brush without the $Ag_2S$ would produce, a comparatively higher temperature of operation is obtained. Hence, in some cases of operation under conditions which might cause an excessive range of temperatures, it is necessary to provide more lubrication of a type which will maintain a good lubricating film at the higher temperatures where copper oxide and the $Ag_2S$ is not sufficient to keep the temperature below the range of boiling or decomposition of the lubricants. It is, therefore, a question of introducing the proper ingredients in the proper proportions and in a manner to get the desired results under the conditions of operation encountered. The methods herein outlined make it possible to provide a proper treatment of carbon brushes to give maximum wear for any given set or range of operating conditions.

Thus it is possible to:

1. Control the voltage drop between the brush and commutator.

2. Decrease brush wear for a range of operating brush temperatures by introducing a series of compounds which decompose over the same range of temperatures.

3. Decrease brush wear and improve the commutation level by introducing compounds such as silver sulfide.

Instead of immersing the brushes in another solution after they are soaked in the first solution, they may be merely exposed to a gaseous or vapor phase of the solvent which would otherwise be used to cause the precipitation of the insoluble compound.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. The method of treating carbon brushes to increase their life and improve the commutation level comprising subjecting them to a solution containing a suitable soluble compound of silver, then subjecting them to the action of a suitable compound of sulphur, whereby silver sulfide is precipitated within the pores of the brushes.

2. The method of claim 1 wherein the soluble compound of silver is silver nitrate.

3. The method of claim 1 wherein the compound of sulphur is hydrogen sulfide.

4. The method of claim 1 wherein the compound of sulphur is ammonium sulfide.

5. A method of treating carbon brushes, which comprises subjecting a brush to a water solution of silver nitrate, and then sulphureting the brush to precipitate silver sulphide.

6. A method of treating carbon brushes which comprises subjecting a brush to a water solution of silver nitrate, and then subjecting it to a fluid sulphureting compound to precipitate silver sulphide.

7. A method of treating carbon brushes, which comprises subjecting a brush to a water solution of silver nitrate, and then subjecting it to fluid hydrogen sulphide to precipitate silver sulphide.



8. A method of treating carbon brushes, comprising soaking them in a silver nitrate solution, then immersing them in water containing hydrogen sulfide to precipitate silver sulfide within the pores of the carbon.

9. The method of claim 8 in which the carbon brushes are dried prior to immersion in the water containing hydrogen sulfide.

10. A method of treating carbon brushes comprising soaking them in a solution of silver nitrate, then immersing them in a solution of ammonium sulfide so as to precipitate silver sulfide within the pores of the carbon.

11. The method of claim 10 in which the brushes are dried prior to their immersion in the ammonium sulfide solution.

12. A method of treating carbon brushes comprising soaking them in a solution of bismuth iodide in alcohol, then soaking them in a potassium iodide solution, and then precipitating silver sulfide in accordance with the method defined in claim 6.

13. The method of treating carbon brushes comprising subjecting them to a solution of bismuth and potassium iodides, subjecting them to a solution of a suitable soluble silver compound, and then subjecting them to the reaction of a suitable compound of sulphur to precipitate silver sulfide in the pores of the carbon.

14. The method of claim 13 wherein the soluble compound of silver is silver nitrate.

15. The method of claim 13 wherein the compound of sulphur is hydrogen sulfide.

16. The method of claim 13 wherein the compound of sulphur is ammonium sulfide.

17. The method of treating carbon brushes comprising subjecting them to a solution of bismuth iodide, then subjecting them to a solution of a suitable soluble compound of silver, and then subjecting the treated brushes to the reaction of a suitable compound of sulphur to precipitate silver sulfide in the pores of the carbon.

18. The method of treating carbon brushes comprising subjecting them to a solution of potassium iodide, subjecting them to a solution of suitable soluble compound of silver, and then subjecting them to the reaction of a suitable compound of sulphur to precipitate silver sulfide in the pores of the carbon.

19. A carbon brush impregnated with bismuth iodide and silver sulfide.

20. A carbon brush impregnated with potassium iodide, bismuth iodide and silver sulfide.

21. A carbon brush impregnated with potassium iodide and silver sulfide.

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