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ELECTRICAL BRUSH FOR HIGH ALTITUDE OPERATION

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The invention relates to electrical contact brushes, and more specifically to carbon brushes for use in electrical machinery required to operate under conditions such as exist in the atmosphere at high altitudes.

Well-made brushes composed of natural or artificial graphite, or other commercial forms of carbon, or of mixtures of carbon and one or more metals such as copper and silver, are very durable when operated in sliding contact against copper commutator bars or slip-rings at sea level or at altitudes up to about 15,000 feet. At higher altitudes brush wear is substantially accelerated, and under atmospheric conditions encountered at altitudes over 25,000 feet above sea level, the rate of wear of conventional brushes is extremely rapid. For example, a standard high-quality carbon brush, when operated against a copper commutator in air at 30,000 feet, wears almost as rapidly as if it were bearing against an abrasive wheel, and instances are known where brushes have worn out completely in less than an hour at these altitudes. The most suitable of the known brush compositions may in some instances last several hours; but at best the brushes can not be relied upon for long.

Modern aircraft use electrical motors, generators, and other electrical devices requiring contact brushes. Both military and civil aircraft are being designed to operate at great altitudes, and there is an urgent demand for electrical contact brushes that will operate dependably over a useful long life at such altitudes. The principal object of this invention is to meet this demand.

The reasons for the poor behavior of brushes at high altitudes are not altogether clear; but it seems certain that two important factors are the dryness and the low oxygen pressure of the air. A similar behavior has sometimes been observed, during periods of unusually dry winter weather, even at low altitudes in the cases of some brush compositions; but the problem has not been a serious one. By operating brushes in a test chamber in which the atmosphere can be controlled, it has been found that either a low moisture content or a low partial pressure of oxygen may cause rapid brush wear, and it has also been found that many expedients which overcome the trouble caused by dry air do not materially offset the ill effects of a low partial pressure of oxygen.

These observations suggest that an important factor in the satisfactory operation of a carbon brush at low altitudes is a film between the commutator or ring and the brush, which film is maintained by moisture and oxygen in the air.

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Further support for this hypothesis, and a suggestion that other film-forming materials might be substituted for moisture and oxygen, are found in the observation that new electrical apparatus, still containing traces of slightly volatile compounds in its insulation and paint, may not give trouble at high altitudes until after several weeks or months of use. This latter circumstance increases the hazard, because rapid brush wear may start without warning after a considerable period of satisfactory operation. In an airplane several hours from its base the brushes may suddenly start to wear at a rate which will destroy them in an hour.

One approach to the problem is to impregnate the brushes with one or more substances which will establish and maintain a suitable film between the commutator or slip-ring and the carbon brush. But the choice of an impregnant material is a difficult one, for much more is involved than the mere provision of a film-forming material. The material must be effective in small amounts, because the interstitial storage space in a brush body is not very great. It must be a liquid or liquefiable by melting or by solution to make impregnation possible, and it must have ability to penetrate thoroughly both inner and outer pores of the carbon. It must not evaporate rapidly. It must not exude, for exudation may result not only in undue depletion of the impregnant but also in the formation of a surface layer which tends to pick up dirt and to interfere with the smooth operation of the brush in its holder. Finally, the film which the impregnant supplies must have a low electrical resistance, must not pick up dirt nor decompose to deleterious products, and must be stable under a wide variety of conditions of atmosphere, temperature, and of mechanical and electrical stresses. Dozens of brush impregnants, including such materials as paraffin wax, beeswax, carnauba wax, linseed oil, ethylene glycol, greases, oleic acid or sodium oleate, and calcium chloride have been proposed for use at low altitudes, but for the problem here considered prior-known impregnants have given unreliable results. In many tests of old impregnants there were a few which improved brush life under some operating conditions, but none were found which increased the life to a commercially satisfactory level under the conditions existing at altitudes above 25,000 feet, and at the same time satisfied the other requirements indicated.

In accordance with this invention I propose to incorporate alkaline earth metal compounds in a carbonaceous brush, and have found that non-

deliquescent salts of barium, strontium and calcium, and the oxides of these metals, are adapted to establish a film of lubricating characteristics at the boundary between a brush surface and the sliding or rotating parts with which it contacts, said film being stable and wear resistant under operation in the absence of moisture or at low oxygen pressures. The metal compounds may be incorporated by impregnation of the brush with a solution of a salt or oxide, or they can be mechanically mixed, in proportions desired, with the brush stock before molding. Impregnated amounts of the added compounds may vary from about 1.0% to 10.0% by weight depending upon the porosity of the brush being treated. Usually at least 2% of the impregnant is desirable for best operation at high altitude conditions, and with mechanical mixing, as high as 25% of the film-forming material can be introduced, which may be desirable for some purposes.

Representative compositions which have been tested with very satisfactory results include barium perchlorate, barium chloride, barium, strontium and calcium fluoride, barium sulfide, and barium oxide. The more soluble compounds can be incorporated into brushes in suitable amount by impregnation with water solutions. For example, barium perchlorate in a water solution of 38.5% concentration was introduced into electrographitic and metal-containing brushes by vacuum-pressure impregnation. After thorough drying, the impregnated brushes were operated in dry air and under low oxygen pressures simulating those at very high altitudes. The brushes showed remarkable improvement in wear resistance and life under these conditions over untreated brushes made from similar stock. Copper-graphite brushes so treated showed in addition exceptionally low friction and low total contact drop, both of which properties further contribute to an excellent over-all performance. Similar tests on the same brush grades impregnated with a hot saturated aqueous solution of barium chloride (approximately 30 grams of barium chloride per 100 grams of solution) gave results equally advantageous.

The latter salt has also been incorporated in brush compositions in amounts as high as 25% by weight, by mixing the salt with the brush stock before molding. In natural graphite brushes, and those composed of copper-graphite mixtures, barium chloride added in this manner, in amounts of 5% to 25% by weight, has produced a very good film-forming action, and such brushes gave satisfactory performance in dry air at a pressure of 19 cm. of mercury and at a temperature of -40°C . or below. These test conditions correspond to those encountered at an altitude of about 35,000 feet above sea level.

Other compounds which have given very good test results, when added directly to the brush molding mix in amounts of from 10% to 25% by weight, are barium, strontium and calcium fluoride, barium sulfide and barium oxide.

The many compounds mentioned have individual characteristics with regard to their influence on contact drop, coefficient of friction and brush life, but they all have in common the ability to form the wear-resistant lubricating film which is essential to prolong brush life during operation in dry atmosphere and under low oxygen pressure. In fact all alkaline earth metal salts and oxides appear to serve the purpose of the invention, with the exception of compounds like calcium chloride, which because of their

deliquescent character will absorb water too readily in normal atmospheres when incorporated into a brush in amounts sufficient to exert a film-forming action. Accordingly the broader claims are restricted to "non-deliquescent salts and oxides," which means to exclude compounds tending to melt or liquefy by absorption of moisture from the atmosphere.

What is claimed is:

1. Electrical contact brush comprising material selected from the group consisting of carbon and mixtures of carbon with metal, and minor proportions of a material acting to prolong the life of such brush in operation under atmospheric conditions low in moisture and oxygen pressure, said last-mentioned material being a member of the group consisting of non-deliquescent salts of and oxides of the alkaline earth metals.
2. Electrical contact brush as claimed in claim 1, wherein said alkaline earth metal compound is present in an amount of from about 1.0% to 25.0% by weight of the brush.
3. Electrical contact brush comprising material selected from the group consisting of carbon and mixtures of carbon with metal, and an impregnant material acting to prolong the life of such brush in operation under atmospheric conditions low in moisture and oxygen pressure, said impregnant material being a member of the group consisting of non-deliquescent salts of and oxides of the alkaline earth metals and present in an amount of about 2.0% to 10.0% by weight of the brush.
4. Electrical contact brush comprising material selected from the group consisting of carbon and mixtures of carbon with metal, and a material acting to prolong the life of such brush in operation under atmospheric conditions low in moisture and oxygen pressure, said last-mentioned material being incorporated by mixture with the brush stock before molding and being a member of the group consisting of non-deliquescent salts of and oxides of the alkaline earth metals and present in an amount of from about 5.0% to 25.0% by weight of the brush.
5. Electrical contact brush comprising material selected from the group consisting of carbon and mixtures of carbon with metal, and an impregnant material acting to prolong the life of such brush in operation under atmospheric conditions low in moisture and oxygen pressure, said impregnant material being a member of the group consisting of barium salts and barium oxide and present in an amount of about 2.0% to 10.0% by weight of the brush.
6. Electrical contact brush comprising material selected from the group consisting of carbon and mixtures of carbon with metal, and a material acting to prolong the life of such brush in operation under atmospheric conditions low in moisture and oxygen pressure, said last-mentioned material being incorporated by mixture with the brush stock before molding and being a member of the group consisting of barium salts and barium oxide and present in an amount of from about 5.0% to 25.0% by weight of the brush.
7. Electrical contact brush comprising material selected from the group consisting of carbon and mixtures of carbon with metal, and an impregnant material acting to prolong the life of such brush in operation under atmospheric conditions low in moisture and oxygen pressure, said impregnant material comprising barium per-

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chlorate in an amount of about 2.0% to 10.0% by weight of the brush.

8. Electrical contact brush comprising material selected from the group consisting of carbon and mixtures of carbon with metal, and an impregnant material acting to prolong the life of such brush in operation under atmospheric conditions low in moisture and oxygen pressure, said impregnant material comprising barium chloride in an amount of about 2.0% to 10.0% by weight of the brush.

9. Electrical contact brush comprising material selected from the group consisting of carbon and mixtures of carbon with metal, and a material acting to prolong the life of such brush in operation under atmospheric conditions low in moisture and oxygen pressure, said last-mentioned material being incorporated by mixture with the brush stock before molding and comprising barium chloride in an amount of about 5.0% to 25.0% by weight of the brush.

10. Electrical contact brush comprising material selected from the group consisting of carbon

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and mixtures of carbon with metal, and a material acting to prolong the life of such brush in operation under atmospheric conditions low in moisture and oxygen pressure, said last-mentioned material being incorporated by mixture with the brush stock before molding and comprising barium fluoride in an amount of about 5.0% to 25.0% by weight of the brush.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,867,524	Orne	July 12, 1932
1,895,756	Fuller	Jan. 21, 1933
2,361,220	Loftis	Oct. 24, 1944

FOREIGN PATENTS

Number	Country	Date
178,071	Great Britain	Apr. 10, 1923