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ELECTRICALLY CONDUCTIVE CERAMIC
THREAD GUIDE

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This invention relates to ceramic bodies of sufficient electrical conductivity to dissipate static charges and more particularly to the use of TiO_2 in the manufacture of thread guides and like bodies which not only are capable of preventing the accumulation of charges of static electricity but have many other desirable characteristics.

In Patent No. 2,214,703 I described a ceramic thread guide which is formed by vitrifying a mixture of materials comprising chiefly TiO_2 at a temperature of between $1350^\circ C.$ and $1400^\circ C.$ Such thread guides, while possessing many properties which particularly suit them for use in the textile industry, are electrical insulators, having a resistivity of around 1×10^9 megohms per cm^3 . Accordingly, the TiO_2 thread guides of my prior patent, 2,214,703, with guides of glass, porcelain and enameled metal, which likewise are electrical insulators, when used in a dry atmosphere, are likely to be charged with an electrical potential by the friction between the dry thread and the thread guide. This is due to the well known law of physics that whenever two non-conductors are rubbed together static electricity is developed, the charges on the non-conductors being equal but of opposite sign. If the accumulated charge on either the thread guide or the thread is discharged suddenly by coming into contact with or close to a conductor, such as a human being or a metallic object, it will cause shock to the operator of the machine or snapping of the thread due to sparking.

Various possible methods may be utilized to avoid the accumulation of static electricity. In some cases the surrounding atmosphere may be humidified to such an extent that the surfaces of the thread and the guide become sufficiently conductive to prevent the formation of static charges. While of some utility, this method is impractical when a dry and warm atmosphere is either required or desired to satisfactorily produce a yarn.

An alternative method is to use thread guides made of metal, such as steel and stainless steel. Such metal thread guides are good conductors for a resistivity of only $20-80 \times 10^{-6}$ ohms per cm^3 and therefore do not accumulate electrostatic charges but are objectionable because they wear rapidly and must be replaced at frequent intervals.

As a third possibility, the thread guides may be made from sintered carbides which are electrical conductors similar to metals, their resistivity being in the range of 20×10^{-6} ohms per cm^3 . However, as in the case of the other suggestions,

sintered carbides are not a complete solution of the problem since they are expensive and difficult to form the intricate shapes usually required for thread guides.

An ideal thread guide for use in a dry atmosphere must not only dissipate static charges but must also withstand abrasion, be smooth and not tear threads, and be economically formed into intricate shapes. Contrary to general belief, it has been found that it is not necessary to use highly conductive materials, such as metals or carbides, in order to dissipate static charges of electricity but that a material having a resistivity of 1 megohm or less per cm^3 will serve the same purpose. It is thus possible to manufacture thread guides of resistor materials rather than electrical conductors, and such materials, having in addition the characteristics required of the ideal thread guide, are the subject of this invention.

It is, therefore, the primary object of the invention to provide a ceramic thread guide or the like made chiefly from TiO_2 which has a resistance not greater than 1 megohm per cm^3 .

Another object of the invention is to provide a ceramic thread guide or the like made chiefly from TiO_2 which is capable of dissipating static charges of electricity, resistant to abrasion, is smooth and will not tear threads and can be economically formed into the varied and often intricate shapes necessary for this purpose.

A further object of the invention is to provide processes whereby TiO_2 , either alone or mixed with other ingredients, can be converted into a material sufficiently conductive to dissipate static charges of electricity.

An additional object of the invention is to provide processes for the utilization of TiO_2 , a non-conductor in the manufacture of ceramic thread guides having sufficient conductivity to prevent the accumulation of static charges of electricity on a guide or thread under all operating conditions.

Other objects will appear in the detailed description of the invention and, together with those previously mentioned, will be particularly pointed out in the appended claims.

In the process described in Patent No. 2,214,703, a body was formed from titanium dioxide (TiO_2) according to known ceramic methods and fired vitrification in a neutral oxidized atmosphere at a temperature of between $1350^\circ C.$ and $1400^\circ C.$ The resultant product, while eminently satisfactory in general use as a thread guide, was an insulating material and thus caused electrostatic charges to accumulate when used in a dry at-

mosphere with consequent ill effect upon either the operator or the thread. Were TiO_2 to be rendered conductive to such a degree as to dissipate static charges of electricity without loss of other desirable characteristics, its value as a component of thread guides and like bodies would be tremendously increased.

Since TiO_2 is an insulating material, the desired conductivity must be dependent upon other contents of the ultimate product. I have found that the presence of a relatively small percentage of a conductor material, such as titanium sesquioxide (Ti_2O_3) or a titanate of copper, vanadium or chromium, in the fired body is sufficient to reduce its resistivity below the optimum of 1 megohm per cm^3 . To produce a conductive body as opposed to the insulating body of my prior patent, it is necessary either to add the conducting material to TiO_2 or to so treat a TiO_2 mixture that the conducting material content will be obtained by chemical reaction during the firing.

In each of the several processes by which the requisite conductivity can be given to a TiO_2 body, TiO_2 is the chief raw material. The TiO_2 may be in precipitated form, calcined at a temperature of between 1000 and 1400° C., or powdered rutile material, preferably air floated, or a mixture of these forms, in which event the materials are carefully mixed either wet or dry according to known ceramic methods. While TiO_2 has sufficient inherent plasticity for simple shapes, it is desirable to add plasticizers, such as dextrin, goulac or wax, to the original mixture, when more intricate or complex forms or shapes are required. Fluxes, such as clay, kaolin, feldspar or aluminum oxide, may also be added to the mixture to both decrease the firing temperature and increase the hardness of the fired body, the maximum amount of fluxes which can be added without injury to the properties of the body being 20 percent.

The TiO_2 , after being mixed with such plasticizers and fluxes as may be required, is then made into a vitrified body having the desired characteristics by any one of the following processes:

1. A body is formed in the desired shape from TiO_2 and fired to vitrification in a kiln in a reducing atmosphere. The reducing atmosphere may be either CO or H_2 or a mixture of these gases. Above 1000° C. TiO_2 is reduced to Ti_2O_3 and the vitrified body is thus given the requisite conductivity.

2. A body is formed in the desired shape from TiO_2 and fired to vitrification in a neutral or oxidizing atmosphere. The vitrified body is then refired above 1000° C. in a reducing atmosphere of CO or H_2 or a mixture of these gases to partially or completely reduce the TiO_2 to Ti_2O_3 . This process has the advantage over the first that it is possible to control the extent of the reduction and, therefore, the resistivity of the ultimate product more closely.

3. Ti_2O_3 as such is mixed with TiO_2 and the mixture formed into a body or article of the desired shape. The article is then fired to vitrification in a reducing atmosphere to prevent oxidation of the Ti_2O_3 , sufficient of the Ti_2O_3 being

introduced to lower the resistivity of the ultimate product to at least 1 megohm per cm^3 .

4. An oxide of copper, vanadium or chromium or a compound of one of these oxides is added to and mixed with TiO_2 . The mixture, after being formed into the desired shapes, is fired to vitrification in a neutral or oxidizing atmosphere, the metallic oxide reacting with the TiO_2 during the firing to form the titanate of the metal. Of these titanates, that of vanadium is most effective in reducing the resistivity of the TiO_2 , 10 percent of vanadium titanate in the fired body being sufficient to reduce its resistivity to less than 1×10^{-6} megohms per cm^3 . In each case a sufficient amount of the metallic oxide or compound of the metallic oxide is mixed with the TiO_2 to reduce the resistivity of the ultimate product to at least 1 megohm per cm^3 .

5. A titanate of copper, vanadium or chromium as such is added to and mixed with TiO_2 , the resultant mixture, after being formed into the desired shapes, being fired to vitrification in a neutral or oxidizing atmosphere. This process is preferable to the fourth because closer control can be exercised on the final resistivity of the fired article.

Whether one or another of the above processes is utilized the ultimate product is a vitrified crystalline body in which are combined the physical characteristics of the vitrified TiO_2 bodies described in Patent 2,214,703 and sufficient conductivity to dissipate electrostatic charges. It is thus apparent that there has been provided a product of wide utility and several processes by which this product can be produced expeditiously and inexpensively.

Having now described the invention, I claim:

1. A ceramic thread guide body comprising a vitrified mixture of titanium oxide and a metallic oxide, said vitrified body having a resistivity not greater than 1 megohm per cm^3 .

2. A ceramic thread guide body comprising a vitrified compound containing both titanium dioxide and titanium sesquioxide, said vitrified body having a resistivity not greater than 1 megohm per cm^3 .

3. A ceramic thread guide body comprising a mixture of titanium dioxide and an oxide of a metal of the class consisting of copper, vanadium and chromium, said thread guide after vitrification having a resistivity not greater than 1 megohm per cm^3 .

4. A thread guide body comprising a vitrified ceramic material composed of titanium dioxide and a titanate of a metal of the class consisting of copper, vanadium and chromium, said thread guide having a resistivity not greater than 1 megohm per cm^3 .

5. A ceramic thread guide body comprising a vitrified mixture of titanium dioxide and a titanium sesquioxide, said titanium sesquioxide forming a sufficient percentage of said mixture to reduce the resistivity of said thread guide to at least 1 megohm per cm^3 .

6. A thread guide body of vitrified ceramic material containing titanium sesquioxide as a reaction product of titanium dioxide and having a resistivity not greater than 1 megohm per cm^3 .

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