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INSULATOR

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The invention, generally considered, relates to insulators and more particularly to new and improved means for forming the roughened surfaces thereon by which the cement used as a bond between multi-part insulators is caused to adhere to or grip the underlying surface to which it is applied.

The primary object of our invention is to provide a sand for the purpose named which, when applied to a surface of an insulator will add to and not detract from the strength of the assembled unit.

A still further object of the invention is to provide a ground ceramic substance which may be applied to an insulator body prior to the firing of the same and which, when fired with the insulator body, will so unite with the body as to be an integral part thereof rather than something added to or attached to the insulator body as has been the custom in the past.

There are other objects as will hereinafter be pointed out in connection with the detailed description of the manner in which and the substances from which the new composition of matter is produced.

Before describing the invention in detail it is believed it will lead to a better understanding of the invention to refer briefly to the conditions as they now exist.

Sand for forming the sanded surfaces in connection with insulators and by which the cement used to connect either the parts of a suspension insulator unit or the parts of a multi-part insulator, such as is commonly employed for bus bar supports, for lead in bushings or multi-part pin type, so as to hold the cement to the insulator, has long been used in the insulator art. An example of this use is to be found in the patent to Austin No. 1,284,975. It has also been long recognized that while a sanded surface secured to the insulator body by the glaze coating during the firing of the insulator is less expensive to apply and in a great many respects forms a better gripping surface for the cement than can be produced by roughening the surface of the porcelain or by forming ridges and grooves therein, it has also been recognized that neither sand nor the other methods used up to the present time have been able to utilize effectively either the strength of the porcelain or the strength of the interposed cement.

As pointed out in the Austin patent, the glaze by which the sand is caused to adhere to the insulator during the firing of the insulator tends to shrink from the extreme projecting points of the sand particles and to be concentrated at the bases of these particles so that, after the firing operation, certain portions of the sand remain uncoated. It has been found, however, that the strength of the bond between the parts of the insulator is increased if the entire surface of the sand particles is coated with the glaze. In this connection see Patent No. 1,784,392.

Since in suspension insulators the transmission line depends upon its support for the bond between the parts of each suspension unit, it is a common provision in purchase contracts that each suspension unit to be supplied thereunder shall have been subjected to a definite mechanical load. The contract specifications usually also require the insulator unit to be under electrical stress at the time of the test. In carrying out the mechanical portion of this test the insulator is subjected to a direct pull, and the amount of the pull accurately determined. The result of the combined test gives therefrom the strength of the unit under load. The average strength of a standard suspension insulator under the M and E test, using the best grade of the old type porcelain sand secured to the insulator body by the reglazing process, is about thirteen thousand pounds. Certain insulators of any selected group may, for reasons which are unknown, slightly exceed this value.

It has been discovered by one of the joint inventors, Davidge H. Rowland, as pointed out in his Patent No. 2,157,100, that the strength of an insulator body can be materially increased by applying to such body a glaze having a coefficient of expansion between five and twelve percent less than the coefficient of expansion of the insulator body. This disclosure led us to investigate the effect of different coefficients of expansion of various types of sand and the effects thereof when used in connection with insulator bodies.

As a result of our researches we have discovered, first, that the failure of the ordinary porcelain sand to give a higher bond value is in all probability due to the fact that the sand does not fuse to the body of the insulator but is dependent entirely for its connection to the insulator upon the fusion of the glaze with the insulator body and with the sand. Strains which are therefore imposed upon the sand particles tend to disrupt the continuity of the glaze and thus cause incipient cracks which immediately lead to failure of the connection. This detrimental effect is materially increased where the coefficient of expansion of the sand is greater than the coefficient of the body of the insulator and of the glaze.

We have discovered that an exceedingly satisfactory sand for use with insulators may be formed by mixing Hanover ball clay with some of the ingredients used in the production of glazes. In the formation of this new type of sand we make a complete mixture of Hanover ball clay and other substances as hereinafter pointed out. The mixture is then allowed to dry to the "bone-dry" state and is then broken up to

form a series of particles having the usual form of the acceptable type of sand grains.

The coefficient of expansion of Hanover ball clay through the range of temperatures from twenty-five (25) to five hundred (500) degrees centigrade is in the nature of 6.31×10^{-6} per degree centigrade, whereas the coefficient of expansion of either the mass or the sand formed by mixing approximately 98.36% of Hanover ball clay with 1.64% of iron oxide of the formula Fe_2O_3 is in the nature of 5.00×10^{-6} per degree centigrade. We have been unable to determine the reason for the reduction in the coefficient of expansion of the mixture since the coefficients of expansion per degree centigrade of both iron oxide and Hanover ball clay are higher than the coefficient of expansion of the mixture. This phenomenon is also observed when a certain percentage of Hanover ball clay is mixed with manganese dioxide and is also present when a certain percentage of Hanover ball clay is mixed with calcium carbonate to form the sand particles.

We have also found that there is a direct relation between the coefficient of expansion of the sand particles when applied to an insulator body to form the gripping surface for the cement bond and the strength of the assembled or bonded unit. When the coefficient of expansion of the sand particles is greater than the coefficient of expansion of either the porcelain body or the glaze body, as has been the custom in the past, the sanded surface so formed tends to weaken the insulator at the bonded point. When a sand having a coefficient of expansion less than the insulator body is connected to an insulator by a glaze also having a coefficient of expansion less than the body of the insulator the sand grip so formed, when bonded to form an assembled unit, increases the strength of the assembled unit. The reason ascribed for this unusual result is that upon the cooling of the insulator after the same has been fired, the sand particles, if formed from pulverized fired porcelain, expand at a greater rate than the insulator and crowd one another and produce or set up in the adjacent glaze and body incipient cracks and these incipient cracks form lines of weakness which result in the breaking of the insulator at less than its theoretical strength value. As examples of the increase in mechanical strength due to the use of a sand having a lower coefficient of expansion than that of the body of the insulator we have set forth below a table showing the strength values which have been obtained by a direct comparison between identical units bonded in the same manner and with the same cement and treated in an identical manner, the only difference between the units being in the coefficient of expansion of the sand used.

Sand body		Coeff. of expansion	Strength
Same as insulator		5.8×10^{-6}	13,190
Hanover ball clay	98.36	5.00×10^{-6}	15,660
Fe_2O_3	1.64		
Hanover ball clay	98.04	4.75×10^{-6}	17,900
MnO_2	1.96		
Hanover ball clay	95.08	3.93×10^{-6}	18,230
$CaCO_3$	4.92		

It will be understood that the percentages and the ingredients above given are merely examples and are not to be used in a limiting sense since we have found that the strength of the bond between the parts of insulators can be materially increased by utilizing from approximately 65% to approximately 99% of Hanover ball clay so long as there is mixed with such clay other ceramic substances and so long as the percentage of fluxes in the complete mixture does not exceed approximately 9%. We have found that where the fluxes exceed this percentage the sand particles upon the firing of the insulator soften to the flow point and simply fuse to form a band lacking the infinite number of sharp edges or projections so necessary to bond with the cement.

While, throughout the specification, we have referred to ball or Hanover ball clay, it is to be understood that the terms are used in their generic sense as indicating a hydrous aluminous silicate of the clay type which is plastic and fusible.

It is our belief, and microscopic examination of sections taken from insulators having the new form of sand applied thereto would seem to substantiate our belief, that the new form of sand is not dependent for its connection to the insulator body upon the associated glaze, that is to say, that upon the firing of the insulator body, the body and the adjacent sand particles, as well as the associated glaze, all fuse together and the sand therefore becomes an integral part of the insulator body and not an attachment thereto.

Having thus described our invention, what we claim is:

1. The improvement in multi-part insulators of the type including a body of vitrified ceramic material having a band of cement interposed between adjacent parts connecting the same and having a coating of fused sand underlying said cement band, said sand consisting of a mixture of ball clay and an oxide from the group including calcium and magnesium, said mixture having a coefficient of expansion less than the coefficient of expansion of either of said ingredients and of said body.

2. The improvement in multi-part insulators of the type including a body of vitrified ceramic material having a band of cement interposed between adjacent parts connecting the same and having a coating of fused sand underlying said cement band, said sand consisting of a mixture of ball clay and a flux the latter comprising an oxide from the group including calcium and magnesium of an amount less than nine percent of the mixture, said sand having a coefficient of expansion less than the coefficient of expansion of either of said ingredients and of said body.

3. The improvement in multi-part insulators of the type including a body of vitrified ceramic material having a band of cement interposed between adjacent parts connecting the same and having a coating of fused sand underlying said cement band, said sand consisting of a mixture of ball clay and an oxide from the group including calcium and magnesium; the coefficient of expansion of said sand being less than 5.01×10^{-6} per degree centigrade.

4. The improvement in multi-part insulators of the type including a body of vitrified ceramic material having a band of cement interposed between adjacent parts connecting the same and having a coating of fused sand underlying said cement band, said sand comprising a mixture of ball clay of an amount between 90% and 99% and a flux formed of an oxide of the group of oxides including calcium and magnesium, said flux being of an amount less than 9% of the said mixture, said sand having a coefficient of

expansion less than the coefficient of expansion of the ball clay.

5. The improvement in multi-part insulators of the type including a body of vitrified ceramic material having a band of cement interposed between adjacent parts connecting the same and having a coating of fused sand underlying said cement band, said sand comprising a mixture of ball clay of approximately 92% of the mixture, and a flux formed of an oxide of the group of oxides including calcium and magnesium, said oxide being of an amount less than 8% of the said mixture, said sand having a coefficient of expansion less than the coefficient of expansion of said oxide.

6. A method of forming a ceramic sand comprising mixing ball clay substantially free from impurities with a small percentage of oxide of the calcium magnesium group, firing said mixture and finally crushing the mixture to produce therefrom a granular mass of substantially uniform grain size.

7. A method of forming a ceramic sand comprising mixing ball clay substantially free from impurities with a small percentage of oxide of the calcium magnesium group, firing said mixture and finally crushing the mixture so fired to produce therefrom a granular mixture of which fifty percent (50%) will pass through a screen having a No. 60 mesh.

8. The improvement in multi-part insulators of the type including a body of vitrified ceramic material, a band of cement interposed between adjacent parts for connecting the same wherein said body is provided with a coating of fused sand underlying said cement band, said sand having a co-efficient of expansion less than the co-efficient of expansion of any of the elements forming the same and less than that of the said body.

9. The improvement in insulators of the multi-part type including a body of vitrified ceramic material whose co-efficient of expansion is in the nature of 5.8×10^{-6} per degree centigrade, a band of cement interposed between adjacent parts for connecting the same wherein a layer of sand fused to the said body underlies the cement band, said sand having a co-efficient of expansion in the nature of 3.8×10^{-6} per degree centigrade.

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