The Use of the Polariscope in Testing High Tension Insulators.

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It has long been known that glass internally strained, when placed in a polariscope in the path of polarized light produces upon the screen a chromatic effect, and that the colors thus produced rotate across the field as the analyzer of the polariscope is rotated. If, however, this peculiarity of glass has ever been put to practical use along engineering lines, such usage has not been common and its results have not been made accessible.

Without going deeply into the theory of the action of polarized light upon crystalline bodies or the similar phenomenon produced by the action of polarized light upon the imaginary planes into which the molecules are forced to arrange themselves within glass subjected to internal stresses, the writer has found the above mentioned color rotation in glass which is internally strained of the utmost value in testing glass insulators. Any ordinary piece of glass which shows no color rotation in the polariscope, when compressed in a vise or clamp and subjected again to the polarized light test exhibits streaks of purple and brown radiating from the points where the pressure is applied. The greater the pressure the brighter and more far-reaching the color effects seem to be, and when the analyzer is turned each color field seems to rotate about the point of application of the compressing force as a center. Similarly if a piece of ordinary glass showing no such effect be heated to a molten state and allowed to cool suddenly, the internal stresses due to irregular and unequal cooling will produce similar color rotation upon the screen.

With these facts at hand, several high tension glass insulators of different makes designed for a 33,000 volt transmission line were subjected to the polarized light test. Those of the No. 1 type, manufactured by one company, showed no color rotation in any portion, while those of type No. 2, designed and manufactured by another company for the same service, showed very marked effects. Some of the latter showed results more marked than others. In some the principal peculiarity noticeable was the lack of uniform darkening and lighting of the entire field projected upon the screen as the analyzer was turned; while in others, especially in those that were whole, bright streaks of violet, purple and brown were seen, and found to rotate as the analyzer was rotated. In some cases these colored streaks were radial, and in still others they formed concentric rings about the knob of the insulator as a center. In order to prove more conclusively that these phenomena were caused by internal stresses, which were in turn produced by poor annealing, a portion of insulator No. 1, which showed no initial color rotation, was poorly annealed, and when tested again in the polariscope the color rotation effect was found to have been introduced. Conversely when a portion of insulator No. 2 was properly annealed the color rotation initially present was found to have disappeared.

The insulators which were first tested were those which had actually broken while in service upon the line, the parts of which were found on the ground near the poles where they were formerly installed. When later whole insulators of the same lot were tested it was found that in the latter the stresses were much more marked than in the broken parts. This fact caused the writer to suspect that some of the internal stresses produced by poor annealing were relieved by the breaking of the insulator, and to test this belief a whole insulator showing very marked color rotation was broken and the various parts placed in the polariscope for inspection. It was found that in spite of the fact that the same portion of the insulator which showed the most marked stresses was used when broken out, practically all the color rotation had been eliminated, although the stresses were still present to a less degree in the remainder of the insulator. In turn each quadrant of the umbrella of the insulator was broken out, and in each case the stresses were found to have been either reduced to a minimum or entirely eliminated. A further proof of the poor annealing was found in the fact that in insulators where the greatest stresses were present the umbrella shivered to bits when broken; while from insulators showing lesser stresses a whole quadrant could be broken out in a single piece.

Although it is very probable that insulators which are improperly annealed fail in service because of sudden temperature changes due to the weather and leakage of current over their surface, it seemed advisable to show, if possible, what effect, if any, the internal stresses had upon the mechanical strength of the insulator in order to determine whether the possible unequal strain from the line wire could be considered a cause for breakage. Only four whole insulators were available for this test, two of which had marked internal stresses, while in the other two the stresses were almost negligible. The insulators were broken by placing them upon an iron pin as in service and by exerting a strain upon them in the direction of the line wire. One insulator which was poorly annealed broke at 960 pounds, while the others failed at 1,890, 1,675 and 2,220 pounds respectively, the latter being one which was also poorly annealed. While this test did not show very conclusively that the poorly annealed insulators were weak mechanically, it is believed that if the pull in the latter case, could have been in such a direction as to cause the insulator to break along strained internal planes as was probably the case in the first test, the latter insulator as well would have been found to have been weak mechanically. For conclusive evidence of this fact, however, a much larger number of tests should be available.

It will be seen from the foregoing, therefore, that a very practical use has been made of the phenomenon which has so long been only an interesting physical experiment. With the aid of the polariscope it is not only possible to determine some of the causes for the unsatisfactory service given by certain glass insulators, but it is also possible to make preliminary acceptance tests upon new insulators and to eliminate all of those which show signs of improper annealing and which for this reason would be undesirable for installation where they must be subjected, not only to severe electrical and mechanical strains, but also to vibration and sudden temperature changes. Although porcelain is rapidly supplanting glass for high tension insulators, it is expected that this method of test will be used in the future to advantage and that it will prove of equal, if not greater value, than it has in this particular instance.