Digital Computer Laboratory
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SUBJECT: VISIT TO RCA VICTOR IN CAMDEN, JANUARY 14, 1953

To: David R. Brown

From: Francis E. Vinal

Date: January 22, 1953

Abstract: The writer visited the RCA Victor Ferrite Plant and Development Laboratory in Camden, N. J., and was favorably impressed by their staff's feeling for the problem as well as the facilities available in the laboratory. They have quickly found a means for producing square loop ferrite material. An attempt has been made to observe domains in ferrites, which has been partially successful.

On January 14 I visited the RCA Victor plant in Camden for the purpose of discussing with their staff fabrication techniques for ferrites and magnetic effects in ferrites.

The morning was spent in discussion with Mr. Robert Hurley who has made some attempt to observe magnetic domains in ferrite materials. The work thus far has been limited to the manganese zinc ferrite which is their standard production body. Using a C frame for fly back transformer cores, he polished one crossectional face of the frame. The degree of polish which he was able to achieve was considerably superior to any other polished ferrite specimens that I have seen. This may be due in part to a rather unconventional polishing technique. As he received the frame from the production line it had received a preliminary rough polish on a diamond wheel. From there on he completed the polish using rouge alone. This was a very slow and tedious operation extending over a period of 8 hours but resulting in a surface from which no grains had been loosened and which had practically an optical finish. He did not make any attempt to etch this particular surface although he has etched some other specimens with 1 to 6 sulfuric acid. It is unfortunate that those that were etched were not polished well and those that were polished well were not etched. The highly polished specimen leaves considerable confusion as to where the grain boundaries occur. All this has lead Mr. Hurley to believe that in some cases he has observed very large crystals including many voids. I believe that the etching of the surface would show that actually the crystalline particles are much smaller and that many voids occur at grain junctions.

After polishing the specimens, he observed the surface through a cover glass under which a suspension of colloidal magnetite was placed. This is the same technique which has been used by the people of the Bell Laboratories and others to observe domain boundaries. With this technique, he observed two rather different phenomena. In one case, he observed convoluted lines which were

subject to rearrangements in the convolutions with the application of a magnetic field. This observation does not fit very well with any of our other knowledge of domains as all of that other information indicates that domains have primarily straight line boundaries with the possible exception of very fine grain materials where each grain is also a domain. It would seem possible that what Mr. Hurley observed was an alignment of colloidal magnetite along grain boundaries where the grains were single domain material. The other observation which he made may be more significant. In one portion of his polished specimen he observed diffuse dark lines running through what he would judge to be 4 or 5 crystal grains and that with the application of magnetic fields these lines would move left or right usually in opposing pairs, reversing their movement with the direction of the field.

Mr. Hurley very kindly loaned me his specimen on which he had made these observations and we are planning to have a look at it here.

The afternoon was spent primarily in the Ferrite Development Laboratory talking with Mr. J. O. Simpkiss. First of all, all the equipment in the laboratory paralleled to a large extent that which we are planning for installation here. The furnaces and some other pieces were home constructed but functionally they are the analogue of the material we have purchased ready made. We discussed raw materials and found they were starting with the following:

1. Iron oxide obtained from Binney and Smith which is pigment grade oxide designated Mapico Red No. ?. They find Mapico Reds are more consistant from batch to batch, and assay a little higher in iron than products of C. K. Williams Co. This is one of the same materials of which we have requested samples.
2. Magnesium oxide from technical grade magnesium carbonate.
3. Manganese from E. J. Lavino Company's Air-Floated African Manganese. This material analyzes to about 88% MnO_2. The remainder of this material is in question but apparently contains various impurity oxides, silica and so forth.

The E. J. Lavino Company also manufactures a synthetic grade of MnO_2 which is probably much higher in purity. This we should plan to look into and obtain for trial in our laboratory.

The principle point of process for magnetic memory cores which I observed there was the fact that the cores are quenched for a high temperature probably the top temperature of the firing cycle. The quenching was done by removing the setter slab from the furnace and scraping its contents into a shallow metal pan. This operation is carried out very rapidly and it is probable that the cores go from 1300 or more centigrade to room temperature within a matter of 3 minutes while the large portion of this quenching occurs in a matter of 15 seconds after removal from the furnace. The net effect of this operation, although apparently not too well understood by the RCA

people, is to freeze into the cores that $MnO \cdot Fe_2O_3$ structure which probably exists at the top temperature. During rapid cooling, oxidation of manganese or other changes may readily occur on the surface but it is probable that these changes do not pentrate the mass of the core (about General Ceramics F262 size).

They also have in operation a Stokes Press. Thus far they have not made square loop memory cores with it but have been practicing using their manganese zinc production body. They have had considerable success in obtaining uniform feed to the press despite the design of the feed hopper which they also feel is a discredit to Stokes Company. Their success has primarily resulted from rather elaborate process of preparing the granulated material fed to the press. A binder was first incorporated in the mix (Hercules Powder Company, trade name Flegatyn). This material was then separated to produce a fairly uniform grain size by passing through a 100 mesh sieve and keeping that portion retained by a 150 mesh sieve. This narrow size fraction is then treated with a little zinc stearate and tumbled in a mill jar without grinding. The purpose of this zinc stearate treatment is to glaze the surface of the grains, producing a very free flowing granulated solid. We do not want to introduce zinc into square loop material but probably some analagous substance can be found which will assist in obtaining a free flow of the ferrite without introducing new ions into the ferrite composition. It is my personal opinion that production of small memory cores on the Stokes Press will probably not be satisfactory by the quenching operation. Because of the small size it is probable that surface changes will pentrate far enough during cooling to upset the entire core. However, this remains to be seen.

I feel that the quality of the experimental work done in the RCA Laboratory is of a superior grade to that done at General Ceramics. First of all, the laboratories are kept extremely clean and dust free, with rubber tile floors and adequate containers for all materials. I saw no spillage and no open containers. Even the factory is vacuumed. I believe that this is definitely a favorable condition. Secondly, I believe that the staff at RCA including Mr. Harding, Mr. Hurley and Mr. Simpkiss, particularly Mr. Simpkiss, very definitely have the feel of the problem and that when they run into difficulties they know how to go about solving them. As time passes, I believe that our cooperation with this laboratory should be definitely continued as they may be in a position to perform some operation for which we are not equipped and vise versa.

Signed Francis E. Vinal
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Approved DRB
David R. Brown