Division 6 - Lincoln Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: BONDEZE MAGNETIC WIRE FOR MEMORY-PLANE CONSTRUCTION

To: N. H. Taylor

From: Andrew Bowen and E. A. Guditz

Date: August 27, 1954

Abstract: The possible eventual breakdown of the Quadruple Formex insulation in memory planes due to the abrasive action of vibrating memory cores could be prevented by wiring the planes with Bondeze #3 Magnetic wire. The resulting plane would have the windings bonded together, forming a strong grid with the memory cores firmly cemented at the intersections of the wires.

Abrasion, resulting from the constant vibration of cores in memory planes, could eventually cause inter-winding short-circuits. A satisfactory solution to this problem would involve creating a bond which could prevent the cores from moving with respect to the wires and which would not obstruct the circulation of conditioned air through the memory-stack. Since the latter requirement is not fulfilled when the planes are sprayed or embedded in plastic, an alternative solution was sought involving experiments with Bondeze #3 Magnetic wire, a product manufactured by the Phelps Dodge Copper Products Corporation, Fort Wayne, Indiana.

Bondeze wire which could be incorporated in the construction of memory planes has a triple layer of Formvar insulation coated with a transparent cement which can be activated by solvents or elevated temperatures, or a combination of both. The necessity for obtaining a strong bond without the application of pressure prompted the selection of the solvent-heat method. The type of solvent, denatured ethyl alcohol, and the heating temperature, 125°C., were recommended by the manufacturer.*

Preliminary tests with 4x4 memory planes, wound with the Bondeze wire and treated under the above conditions and at varying immersion and heating times, resulted in the following observations:

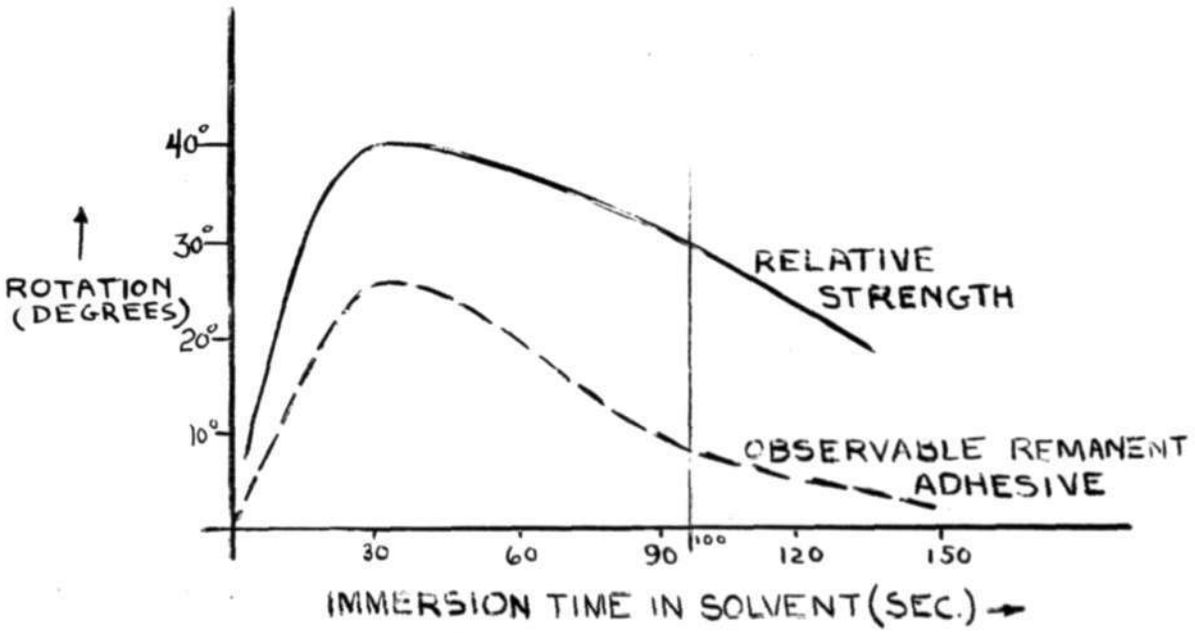
---

*Phelps Dodge Copper Products Corporation, Inca Manufacturing Division, Wire Engineering Report #330A.

1. The amount of adhesive remaining between wires and located in the center of the cores varied with different immersion and heating times. A minimum of this remanent adhesive would insure proper circulation of air through the planes of the memory-stack.

2. The relative strength of the bond between the memory cores and the wires, determined by comparing the angle through which an average number of cores could be rotated before the adhesive bond failed, was also a function of these two variables.

Additional tests were conducted to determine the optimum values for variables. A constant heating time of five minutes was used while the immersion time in the solvent was varied from 0-180 seconds. The resulting data is plotted below:



The portion of the curve with the positive slope represents the increasing bond strength as progressively more of the adhesive is activated with longer immersion times until maximum strength is obtained. As the immersion time is increased beyond this 30 seconds, the adhesive diffuses into the solvent and the resulting solution which surrounds the memory cores produces a progressively weaker bond. Eventually an immersion time is reached where no effective union can be obtained. Similarly the amount of observable adhesive remaining within the core and between the wires increases, and then decreases for immersion times longer than 30 seconds. Unfortunately, the maximum amount of remanent adhesive is obtained for the strongest bond. However, if the immersion time is prolonged for an additional 70 seconds, the relative strength decreases approximately 25% while the amount of observable adhesive is reduced by a factor of nearly 70%.

Further tests were conducted using the optimum immersion time of 100 seconds while the heating time was varied from 1 to 7 minutes. The relative strength of the bond increased until a maximum value was obtained when the memory plane was heated for 3 minutes. Heating for longer time intervals had little effect on the resulting strength of the bond, while the amount of observable adhesive rapidly decreased with longer heating times until a minimum was obtained for values over four minutes. Consideration of these observations resulted in the selection of a 4 1/2 minute heating period for future testing purposes.

A 16x16 memory plane was immersed in denatured ethyl alcohol for 100 seconds and then subjected to a temperature of 125°C. for 4 1/2 minutes. After cooling to room temperature the 256 memory cores were found to be firmly adhered to the intersecting wires of the plane while a minimum of excess adhesive was observed.

Even after this stage of the process it is conceivable that a memory core may have to be replaced. To facilitate this operation the adhesive should be neutralized by immersing the plane in the solvent for five minutes and then vigorously shaking off the excess alcohol and dissolved adhesive. Since the z-winding has to be unwound to remove the damaged core it is recommended that this winding be replaced by untreated Bondeze wire so as to permit the bond to be reactivated.

Samples of Quadruple Formex wire and treated Bondeze (Formvar) wire were subjected to flame tests to determine the relative burning properties of the Formex insulation as compared to a similar material with a coating of adhesive. Results of these tests showed that the Bondeze wire burns at approximately the same rate as the Formex wire and for a shorter period of time.

Preliminary tests with Bondeze wire has resulted in the following conclusions:

A. Advantages:

1. The adhesive bond firmly cements wires together and bonds the memory cores to the windings of the planes, thus eliminating unnecessary abrasive action due to vibration.

2. A minimum of remanent adhesive allows the operating temperature of the memory-stack to be maintained since the circulation of conditioned air is not seriously obstructed.

3. The triple Formvar insulation of Bondeze wire exhibits the required abrasion resistive qualities necessary in memory-plane construction.

4. The memory cores which are bonded with Bondeze adhesive can be replaced with relative ease, as compared to the sprayed or embedded type of construction.

5. Memory-plane construction is not hampered since the diameter of the Bondeze wire is approximately that of the Quadruple Formex wire used in the existing memory planes.

B. Disadvantages:

1. Since the neutralizer for X-Var Stripper, used for removing the Formex insulation, and the activator for the Bondeze adhesive are both denatured ethyl alcohol, premature cementing occurs during the stripping process. However, if a mechanical stripping method is employed in the construction of memory planes a neutralizer would not be required.

2. If a memory core has to be replaced after the Bondeze wire has been activated, one of the windings would have to be replaced with untreated wire before the memory plane can again be made vibration-proof. The resulting bond would not be as strong as the original union.

It is concluded that the use of Bondeze #3 Magnetic wire in memory-plane construction appears to offer a practical solution to the problem involving the vibration of memory cores.

Signed: Andrew J. Bowen
Andrew Bowen

Signed: Elis A. Gudit
Elis A. Gudit

Approved: KHP
William N. Papian

AB:EAG:jd

CC: Group 62 Memory Section
Group 63 Leader and Section Chiefs
C. W. Watt
B. B. Paine
B. E. Morriss
W. Wittenburg (IBM)