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TRIP REPORT

Place: G. E. Research Laboratory, Ceramics Division
Schenectady, New York
Persons Present: Dr. L. Navias; S. T. Jutila
Purpose: Discussion on properties of ceramics to be used for P. A. color tube screen assembly.
Date: December 1, 1954
Report By: S. T. Jutila, Color Design Engineering

Introduction:

The ceramic supports in the P.A. screen assembly serve a twofold purpose. First, they act as a mechanical support in order to keep the phosphor plate in secured alignment with respect to the grille assembly. Secondly, they act as insulators between the grille assembly and the phosphor plate.

Required Mechanical Properties:

1. Supports must be mechanically strong to stand shocks due to handling. They should stand handling and shipping without breaking.

2. Supports must be strong enough to withstand pressures caused by springs, clamps and alignment screws under severe vibrations and shocks so that no misalignment result.

3. Supports must have thermal expansion properties to match the frame and glass structures to which they are connected.

4. The properties of giving out gases must meet the conditions of maintaining good vacuum in a hard tube under the normal temperature conditions. Water absorbtion, etc. must be of such nature that all water escapes during exhaust cycle.

5. Supports must be economically producible.

Required Electrical Properties:

1. Supports have to be very poor conductors, i.e., good insulators under normal temperature conditions.

2. Supports must have a good dielectric strength to withstand high gradients.

The presently used African lava has a fairly reasonable mechanical properties although perhaps not sufficient for production models. The temperature expansion

agrees fairly well with that of the frame, this is very important in attaching these supports to the frame. The dielectric properties could be better. In any case, an investigation is needed for possibly better ceramics that possess better qualities than lava for supports.

New Possible Ceramics for P. A. Supports:

Mechanically strong materials with excellent dielectric properties are fine-grain aluminum silicate ceramics. These are suitable for vacuum use in many cases. The American Lava Company has one ALSIMAG 211-S ceramic especially made for vacuum use. According to Dr. L. Navias, such American Lava Company ceramics as ALSIMAG 491 and 513, which are much stronger than 211-S, are suitable in vacuum use up to the required temperatures for ordinary use (100° - 200°C).

However, these ceramics shrink during firing, and dies must be properly designed to take such shrinkage into account. The shrinkage depends on how the ceramic is pressed to the dies on their geometric form and on the firing schedule. Such linear shrinkage as 10 - 17% were observed.

Another fact is that during firing ceramics must be supported very carefully so that undesirable distortions are avoided.

An objectionable property of ALSIMAGS is their low thermal expansion coefficient that may cause severe trouble during exhaust cycle since the iron frame has about twice as high thermal expansion coefficient. This means that one cannot attach such supports by any ordinary manner to an iron frame without danger of breaking. However, if chromium or high nickel (42-44%) irons are used, their expansion coefficient is lowered so that a sufficient match may be possible.

Comparasion of Linear Thermal Coefficients:
Temperature greater than 25°C

Material	Linear Thermal Coefficient
Steel, annealed	10.95×10^{-6}
Ni-Iron (40% Ni)	6×10^{-6}
Lava, 1136, Alco	11.9×10^{-6}
Alsimag 491	7.7×10^{-6}
Alsimag 513	7.5×10^{-6}
Alsimag 211-S	8.5×10^{-6}
G.E. Research Lab Ceramic No. 2548	7.6×10^{-6}
Lava, 1137, Alco	11.5×10^{-6}

According to Dr. Navias, American Lava Company ALSIMAG 491 is a better ceramic at higher temperatures than ALSIMAG 513 for vacuum use. The shock resistivity of ALSIMAGS is about twice that of lavas, also the flexural, compressive and tensile strengths are much higher.

Coors Company, Golden, Colorado has some good ceramics with fine-grade aluminum silicate body. Such ceramics are:

Type AI - 200
AB - 2

Of these, AI-200 is stronger and better for high vacuum use.

The following table gives a comparasion of mechanical and electrical strengths of some American Lava ceramics.

Material	Compressive Strength lbs/in^2	Tensile Strength lbs/in^2	Flexural Strength lbs/in^2	Dielectric Strength volts/mil Step 60 CPS	Resistance to Impact ½" Rod, in/lbs.
Alsimag 491	10^5		45,000	250	6
Alsimag 513	10^5		45,000	250	7
Alsimag 211-S	6.5×10^4			240	4
Lava, Grade A	2×10^4	2500	9,000	80	3.3
Lava 1136	2.5×10^4		9,000	100	

For given ceramics to be fired, one has to determine shrinkage or expansion, the support for the piece to be fired, and the schedule of firing. Many factors are involved and only a few can be readily seen. The final results are experimental ones.

A possible safe combination of supports and frames are ALSIMAG supports and nickel-iron frames.

Dr. Navias pointed out that it seems to him the glass plate is the weakest member in the assembly. He also strongly objected to the use of ball pointed alignment screws directly against the glass plate. The pin loading, in such case, may be tons per square inch. For these alignment pins, one may use a shim that takes pin loading and distributes it over a sufficient area of the glass plate.

Dr. Navias also suggested that all inside corners should have a smooth radius in order to prevent cracking of the glass. Dr. Navias' remarks may point out that the glass plate breaks, first, under shock and then breaks the ceramic supports by twisting on the clamping springs or mechanisms.

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