→ * The use of Model L725EE compression compensator for the quantitative estimation of stresses in glass.

I. EQUIPMENT: *The model L725EE compression compensator is designed as a production tool. The compensator is calibrated against a fixed standard such as a quartz wedge, a series of fixed retardation plates, or against another compensator which is kept as a secondary standard for the factory. The compensator is essentially a portable loading frame with a series of four glass plates all loaded in varying amounts of compression, by means of set screws along one edge. For general factory use the four plates are loaded in 25 millimicron intervals i.e. 25 50 75 and 100 mu. The loading at each plate is indicated with the retardation clearly lettered in white glass ink on the surface of the loaded glass. Each plate should show uniform retardation over its entire area. Variations in retardation over the surface may be corrected by regrinding to flatness the two edges upon which the load is applied, and by replacing the load distributing material (either blotting paper or thin kid leather). It is the uniform retardation over the entire area which makes this instrument more suitable for production glass strain measurement, than other commercially available devices.

II. METHOD OF USE

A. Direction of strain

1. In order to determine the direction of strain, the work is placed properly in the field of the polariscope: i.e. at 45% to plane of view in the case of deflection type polariscopes and horizontal or vertical in our projection type instruments. With the work in the field the compensator is then placed alongside, and a rotation made of whether the work is in the same color range as the compensator. Since the direction of loading in the compensator is known, that is compression along the axis of the loading screws, it will then be possible to say that when the work and the compensator are in the same color range the work is in compression along on axis parallel to the axis of the loading screws in the compensator. Conversely when the work and compensator differ in color ranges, the work may be said to have tension along an axis parallel to the axis at the loading screws in the compensator.

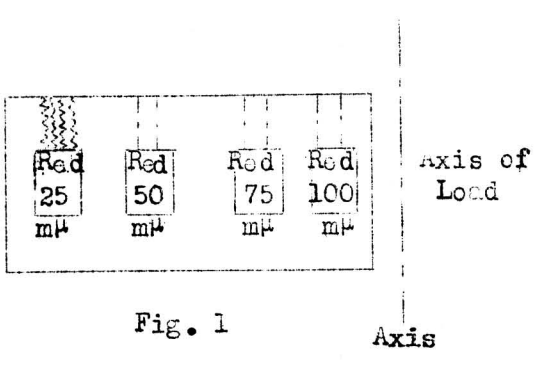
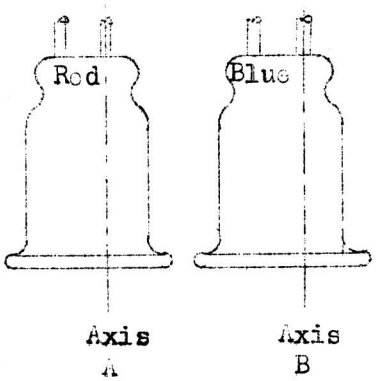


Fig. 1



Sample A has compression along axis of lead. Longitudinal compression

Sample B has tension along axis of lead Longitudinal Tension.

2. When observing circular shapes the strains will generally be radial and their strains will form a symetrical pattern as shown in Fig. 2.

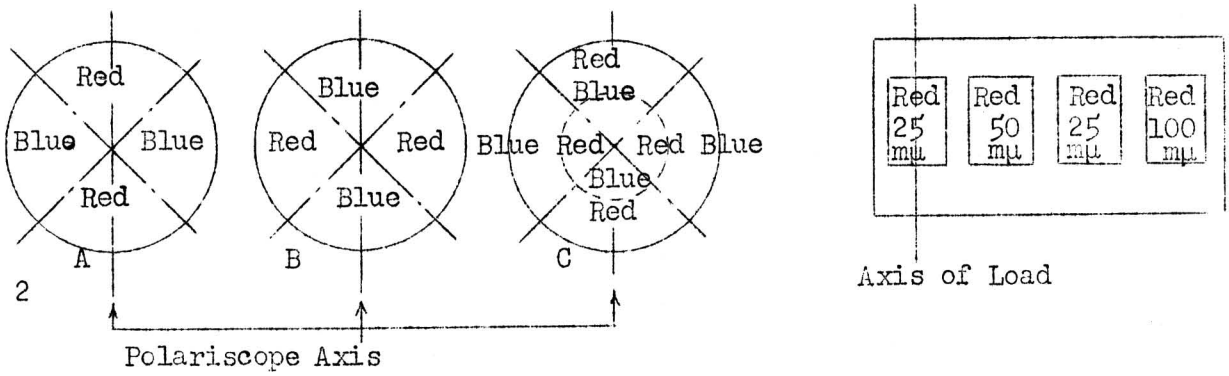


Fig. 2

The same rules will apply in the case of radial strain that applied previously in the case of forces all in the same direction. Thus in Fig. 2A. The red range is along the axis which is parallel to the axis of loading in the compensator. Since the colors are alike the strain in the work is the same as that in the compensator i.e. compression thus this seal would be in radial compression. Fig. 2B shows unlike colors along the same axis and would therefore be in radial tension. Fig. 2C shows a combination of radial tension near the center and radial compression in the outer zone.

B. Determination of Quantity of Strain.

1. After the direction of the stresses in the glass has been determined it is then necessary to determine the amount of stress. The amount can be estimated in two ways. The first is to compare the colors in the work with the various colors given by the different plates of the compensator. Thus 25mμ will be blue or red, 50mμ will be blue green or red with some orange, 75mμ will be green or red-orange, and 100mμ will show to green with a yellowish tint or orange. Work which has a blue color can then be said to have a strain corresponding to approx. 25mμ, etc. It is always more accurate to compare colors in the blue range than in the red range. This can be done by placing the axis of loading in the compensator perpendicular to the axis of the polariscope.
2. The second method is to orient the compensator so as to have an unlike color range as compared to the range present in the work. The object is to subtract reds from blues until the color at the background (sensitive violet) is reached, by placing first the 25mμ plate, then the 50mμ plate, etc., until the color in the work, has diminished to sensitive violet. If the work is so oriented as to show a green color, the compensator is oriented to show the red range. The 25mμ plate when placed in the light path will drop the color to blue green, the 50mμ plate will drop the color to blue and the 75mμ plate will show the same color as the background. This sample will then be said to have an estimated strain corresponding to 75mμ retardation.
3. It should be understood that the maximum unit shearing stresses in the work cannot be determined in the manner indicated above, but requires methods of photoelastic stress analysis beyond the scope of manufacturing process control.

III. CALCULATIONS

A. Birefringence Constants

Various glasses will show different retardations for a given stress as shown below.

G1	273	G705AJ	337	G726MX	343
G8	239	G705BA	372		
G12	248	G705FN	346	The units are millimicron	
G371BN	341	G705R	353	retardation per cm of light path	
G702P	340	G707DG	436	through sample loaded at	
				1 kilogram/mm^2(1426 #/in^2.	

B. Maximum Allowable Stress

1. The maximum safe working stress in glass to metal seals should not exceed 1 kilogram/mm^2 (1426 #/in^2)

2. Commercial annealing practice is to not exceed 250#/in^2. Shape, however, has a decided effect on the allowable strain.

3. The engineer should establish the maximum allowable unit stress for a given product.

Example: To find unit stress. (approximate)
Cathode Ray face plate
Thickness .120" = .3 cm.
Retardation as estimated by compression compensator 50mu
Kind of Glass G12.

From table of Birefringence Constants G12 glass is found to have a retardation at 248mu in a plate one centimeter thick with a load of 1kg/mm^2 (1426#/in^2) to find stress in glass "S".

$$S \text{ kg/mm}^2 = \frac{\text{Retardation in mu}}{\text{Thickness cm} \times \text{Birefringence Const.}} = \frac{R}{T \times C}$$

$$S = \frac{50}{.3 \times 248} = .67 \text{ kg/mm}^2 \text{ or S in\#/in}^2 = .67 \times 1426 = 955\#/\text{in}^2.$$

*Correction