GLY 4200C

## THE LEVER RULE

The Lever Rule (or Law of Moments) can be used to estimate the relative percentage of solid or liquid in a mixture of solid plus melt. The principle of the lever rule is quite simple, as Figure 1 illustrates:

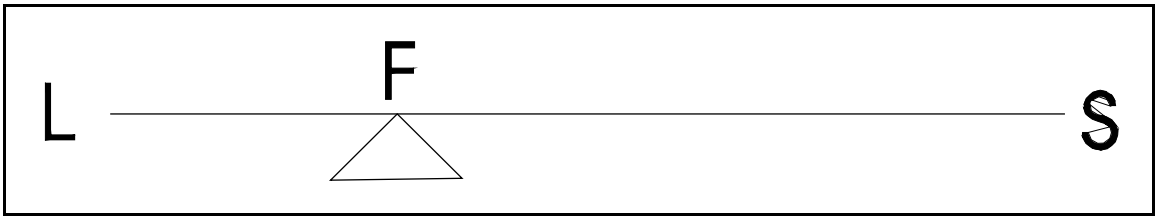


**Figure 1**

The distance LF is 33 mm, while SF is 89mm. The letters L and S can be assumed to represent liquid and solid, respectively. F represents the fulcrum. LF + SF = 122mm, and represents the entire composition. The percentage of liquid and solid are therefore:

$$\%LIQUID = 100(LF)/(LF+SF) = 100(33)/(122) = 27\% \quad (1)$$

$$\%SOLID = 100(SF)/(LF+SF) = 100(89)/(122) = 73\% \quad (2)$$

The computation is quite easy. Two difficulties remain. The first is where to place the fulcrum. The second is which side of the fulcrum represents liquid and which side represents solid? To find the answers to these questions examine Figure 2, which might be taken from a phase diagram.

Assume a melt of composition A cools. At 800°C the first crystals should just begin to appear. The composition is essentially 100% liquid. Therefore the fulcrum must be at point B. Point S is also at point B and point L is on the temperature axis at 800°C.

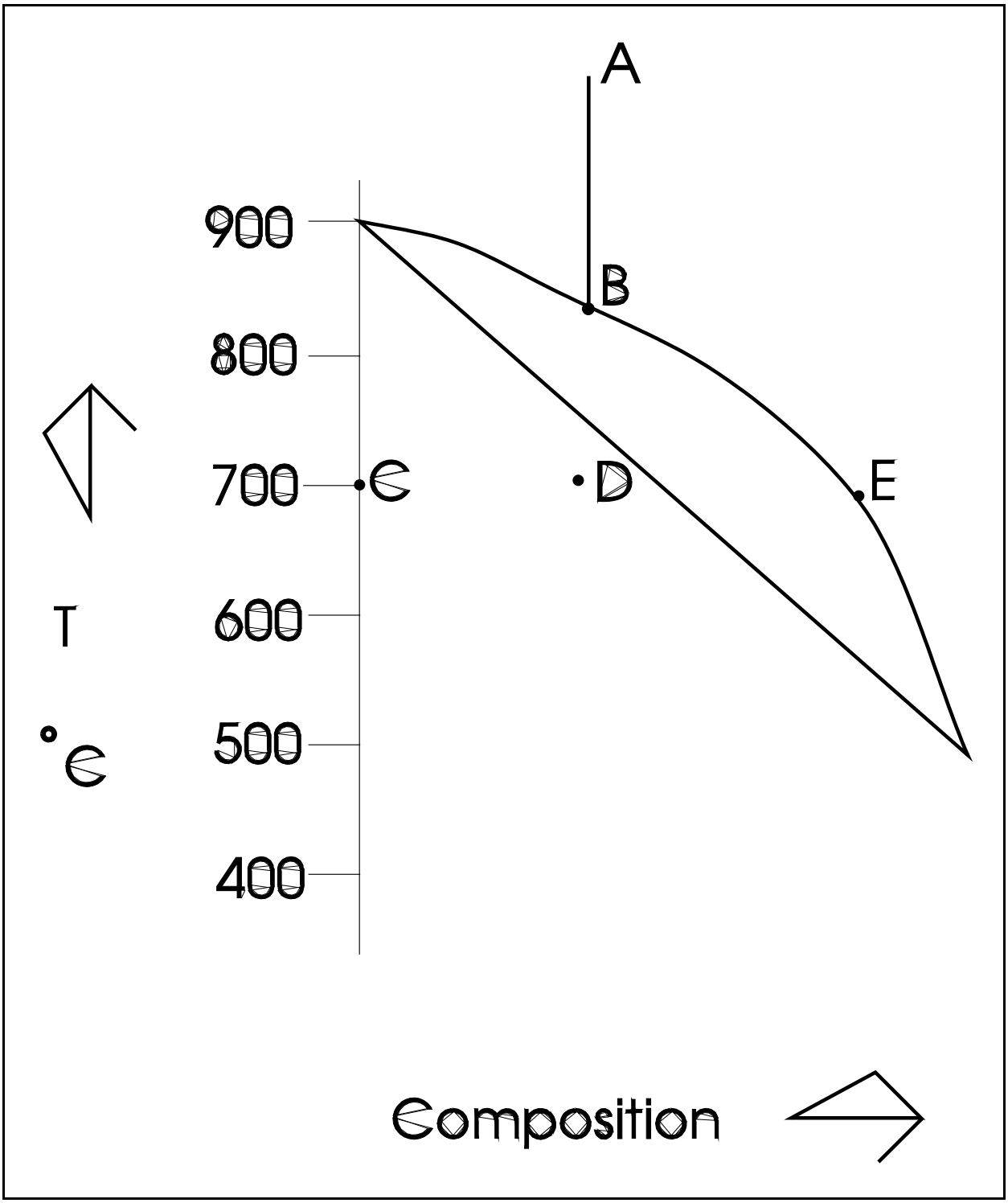


**Figure 2**

$$SF = SB = 0 \quad \textbf{(3)}$$

$$\%LIQUID = 100(LB)/(LB + SB) = 100\% \quad \textbf{(4)}$$

$$\%SOLID = 100(SB)/(LB + SB) = 0\% \quad \textbf{(5)}$$

What happens at 700°C? The liquid has composition represented by E, the solid is represented by C. The fulcrum is at D (directly under the original composition). Therefore LF corresponds to CD = 35 mm, and SF = ED = 45mm.

$$\%LIQUID = 100(35)/(35 + 45) = 44\% \quad \textbf{(6)}$$

$$\%SOLID = 100(45)/(35 + 45) = 56\% \quad \textbf{(7)}$$

The liquid side of the lever is always on the side of the fulcrum away from the liquidus, and the solid side is on the side away from the solidus. The same law can be applied to similar situations in other phase diagrams, e.g. liquid-vapor, solid-vapor, etc.

The Lever Rule is generally good only for semiquantitative estimates. The reproductions of phase diagrams in books are generally too small, and the printing too imprecise, to allow calculation to better than two significant figures. Replotting on a larger scale from original data may allow quantitative work to be done.

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February 19, 2004