4.4 Constructing a Slide Projector

Components Required: white light source S, condensing lens L_1 (f'=50 mm), lens holder, transparent slide P, plate holder, projection lens L_2 (f'=190 mm), 2-axis tiltable holder, white screen.

Principle

As shown in Figure 4.4-1, L_1 is a condenser, and L_2 is a projection lens. A slide is just behind L_1 (we can assume $v_1 = u_2$). If the magnification of a slide projector is M, the length of slide projector is D, and the focal length of L_1 and L_2 are f_1 and f_2, respectively.

By taking $M = v_2 / u_2$, $1/f_2 = 1/u_2 + 1/v_2$, we can get

$$f_2 = \frac{1}{M+1} v_2 \tag{4.4-1}$$

By taking $D = u_1 + v_1$, $v_1 = u_2$, $1/f_1 = 1/u_1 + 1/v_1$, we can get

$$f_1 = \frac{v_2}{M} - \frac{1}{D}\left(\frac{v_2}{M}\right)^2 \tag{4.4-2}$$

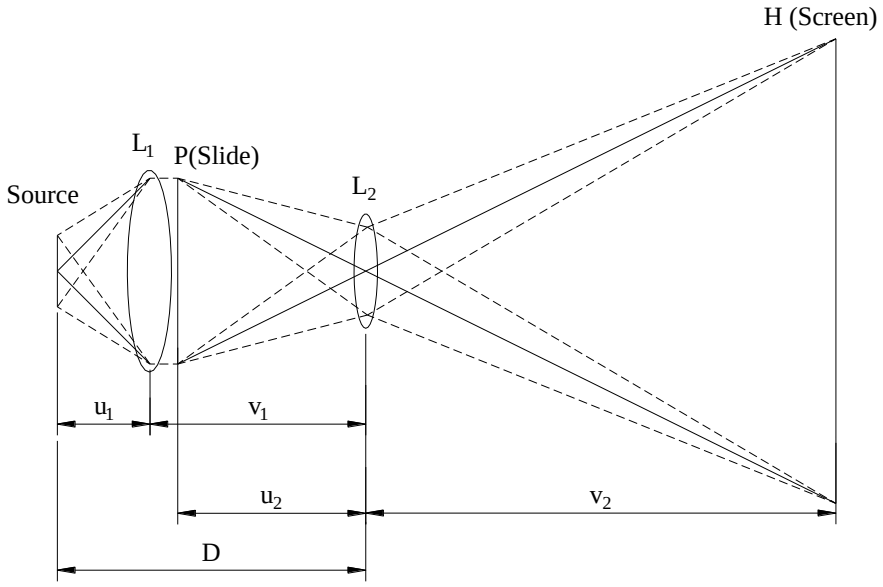

Figure 4.4-1 Schematic of slide projector imaging

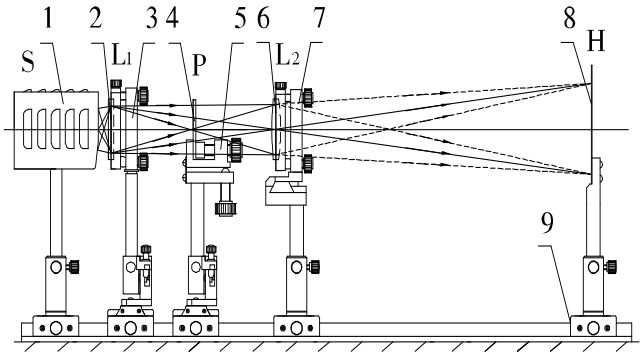

Figure 4.4-2 Configuration of components

1: Bromine Tungsten Lamp S (LLC-3)
2: Condenser Lens L_1 ($f_1^{'}$ =50 mm)
3: Lens Holder (SZ-08)
4: Projector Slide *P*
5: Plate Holder A (SZ-12)
6: Projection Lens L_2 ($f_2^{'}$ =190 mm)
7: 2-axis Tiltable Holder (SZ-07)
8: White Screen (SZ-13)
9: Optical Rail (LEPO-54)
* Ground glass on LLC-3 is not used and Adaptor Piece (SZ-09) can be used

Experimental Procedures:

1) Refer to Figure 4.4-2, align all components in same height on the optical rail, set the distance between L_2 and screen *H* about 0.8 m (if space available, it should be better to set a larger distance);
2) Move slide *P* back and forth, till a clear image (imaged by L_2) is observed on *H*;
3) Fix condenser L_1 as close as possible to *P* (may use the adapter piece SZ-09), remove *P*, move light source *S* back and forth, till the image of *S* formed by L_1 is clear on L_2 aperture plane;
4) Put back slide *P* at its pervious location, observe the brightness and uniformity of the projected image on the screen;
5) Remove L_1, observe the brightness and uniformity of the projected image again, and recognize the function of L_1.
6) Through the experiment, understand the principle of a slide projector and the function of its condenser, learn how to adjust a projection optical system, and understand illuminating condition for achieving a uniform light field on the screen (Kohler illumination).