DUAL PROJECTOR LAMPS

[0001] This is a continuation-in-part of our pending Provisional Application Serial No. 60/348,023, filed Jan. 10, 2002, from which application priority is claimed.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention is in the field of information display systems, and more particularly, in the field of projection displays.

[0004] 2. Description of the Related Art

[0005] Liquid crystal projectors are widely used as information display devices because of their compactness, light weight, high resolution and brightness. The light source for most of these projectors is an arc lamp, which may be either metal halide, high pressure mercury vapor or xenon. Desired arc lamp characteristics are compact size, high efficiency, high (lumen) light output, broad (full-color) spectral gamut and short arc gap for efficient light utilization. Such lamps are available from a number of commercial sources, including N. V. Philips Gloeilampenfabriken, Osram, Ushio and Welch-Allyn, among others.

[0006] Less desirable characteristics of arc lamps are the lack of all but a nominal dimming capability and life expectancy of only a few hundred hours to a few thousand hours. Arc lamp failure modes are often catastrophic (i.e. zero light output), so that when a lamp fails the entire projector becomes unusable until the lamp is replaced.

[0007] There are instances where these limitations are very significant shortcomings. In outdoor applications, for example, projector light output might need to be adjusted over a very wide range to accommodate viewing ambient illumination levels, ranging from full sunlight to moonless night. The need for wide dimming is particularly important in military and defense applications, such as aircraft cockpits. Projector failure is always unwanted, but in critical applications such as in aircraft, or in other situations where access to the lamp for replacement might be difficult or especially time consuming, improved operating lifetime is a necessity.

[0008] In the prior art, dealing primarily with film projection systems in which the images to be projected were on a slide or other permanent photographic record, space and weight were not substantial considerations and therefore, projectors were provided with extra light sources which could be physically moved into the location of the primary light source.

[0009] In some instances, the second lamp was physically exchanged with the failed primary lamp as in the patents to P. M. Field et al, U.S. Pat. No. 3,294,966; Li Donnici, U.S. Pat. Nos. 3,914,645 and 4,518,233; Gehly et al., U.S. Pat. No. 5,032,962; Dreyer, Jr. et al, U.S. Pat. No. 5,135,301; and Rodriguez, Jr. et al, U.S. Pat. No. 5,241,333. A similar approach was used with an LCD projector in the patent to Park et al, U.S. Pat. No. 5,296,883, in which a plurality of arc tubes are mounted on a rotatable plate and each can be automatically brought into position as the primary light source when the arc tube in use experiences a failure.

[0010] An alternative approach to the replacing of a failed lamp is disclosed in the patent to Krasin, U.S. Pat. No. 4,061,911. Here a primary lamp and a spare are fixedly mounted in the projector. The primary lamp is on the optical axis while the replacement lamp is off axis. A movable mirror is deployed to direct the light from the replacement lamp to the optical axis when the primary lamp fails.

[0011] In overhead projectors, limited lamp life is sometimes compensated by using dual lamps which are mounted in movable cassettes, so that upon the failure of one lamp, a second is physically moved into its place. This approach is not desirable since such cassettes are bulky and susceptible to jamming, and require operator interaction to effect a lamp change. Additionally it is difficult if not impossible to precisely align the replacement lamp with such a scheme. Misalignment between the arc lamp and the condenser optics results in poorer uniformity and reduced efficiency.

[0012] Similarly, the conventional way to dim arc lamp projectors is via the mechanical insertion or adjustment of neutral density filters or mechanical irises. These approaches are bulky and relatively unreliable.

SUMMARY OF THE INVENTION

[0013] The current invention provides an all-electronic means of selection between two lamps for a projection system, and also provides a wide dimming range for arc lamp projectors. It offers the potential for automatic lamp substitution in the event of a lamp failure.

[0014] According to the present invention, a pair of lamps are arranged along the side and the rear of a polarizing beam splitter. The p-polarized component ("P") of the first lamp output is transmitted through the beam splitter while the second ("S") component is reflected. The s-polarized component of the second lamp output is reflected by the beam splitter while the ("P") component is transmitted. The output path of the beam splitter thus comprises the "P" component of the first lamp and the "S" component of the second lamp.

[0015] A liquid crystal polarization rotator is interposed in the output path of the beam splitter and at 0° passes the "P" polarized output beam through an output polarizer which is transparent for "P" polarized light. To dim the p-polarized light, the rotator is oriented toward a 90° rotation, progressively attenuating the light passing through until, at 90°, the "P" polarized light is blocked. In the case where the first lamp is off (or failed), the "S" polarized second lamp light component is reflected in the beam splitter and is now the light in the output path while the "P" component is transmitted in a direction orthogonal to the light path. However, the rotator at 0° will block the "S" polarized light. Rotating the polarization to 90° will pass the "S" polarized light and an intermediate setting will dim the light. Accordingly, dimming takes place as the rotator goes from 90° to 0°.

[0016] In one embodiment, the rotator can be a one half wave plate which is mechanically rotated through 90°. In an alternative embodiment, an untwisted nematic LCD with its director axis at 45° to the "S" and "P" polarization states could be a half-wave retarder (90° rotation) when a first voltage is applied, and a zero-wave retarder (0° rotation) when a second voltage is applied.

[0017] In another alternative embodiment, a twisted nematic (TN) LCD can serve the same function. When constructed with a 90° twist and its director axis aligned with the