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United States Patent [19]

Erskine

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[54] **SINGLE AND DOUBLE SUPERIMPOSING INTERFEROMETER SYSTEMS**

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[*] Notice: This patent is subject to a terminal disclaimer.

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[51] **Int. Cl.**[7] **G01B 9/02**

[52] **U.S. Cl.** **356/345**; 356/28.5; 356/352

[58] **Field of Search** 356/345, 346, 356/351, 352, 357, 359, 28.5

[56] **References Cited**

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[57] **ABSTRACT**

Interferometers which can imprint a coherent delay on a broadband uncollimated beam are described. The delay value can be independent of incident ray angle, allowing interferometry using uncollimated beams from common extended sources such as lamps and fiber bundles, and facilitating Fourier Transform spectroscopy of wide angle sources. Pairs of such interferometers matched in delay and dispersion can measure velocity and communicate using ordinary lamps, wide diameter optical fibers and arbitrary non-imaging paths, and not requiring a laser.

32 Claims, 34 Drawing Sheets

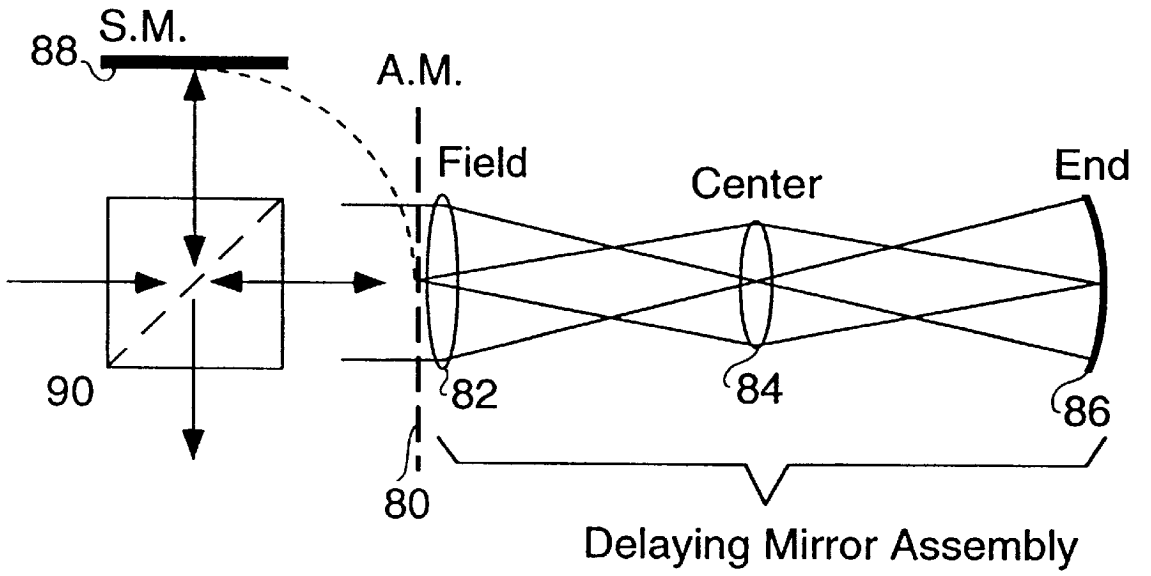


Fig. 28A

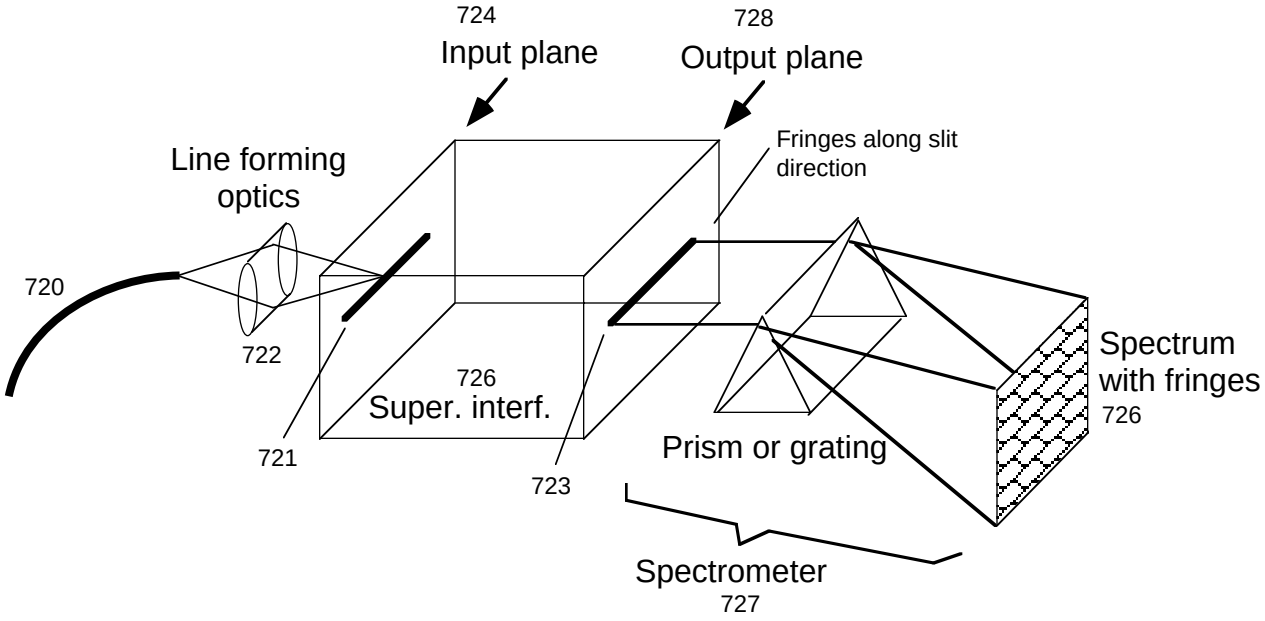
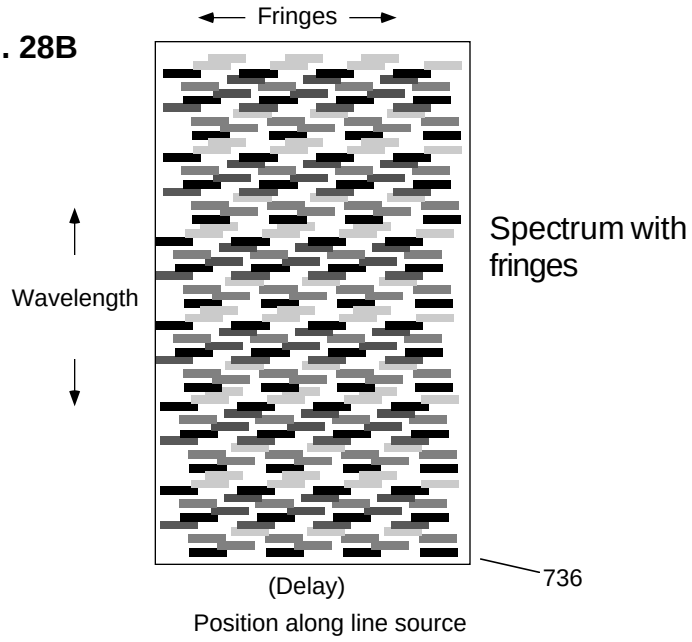


Fig. 28B



Excerpt from Patent US6,115,121

17. Superimposing interferometer in series with spectrometer

It is useful to combine a superimposing interferometer in series with a chromatically dispersive spectrometer (such as prism or grating). This can enhance fringe visibility in spectroscopic and velocimetry applications because it prevents crosstalk between fringes of different wavelengths having different phases. The interferometer 726 can precede (Fig. 28A) or follow (Fig. 28C) the spectrometer 727. The advantage of using a superimposing interferometer instead of a non-superimposing interferometer, when combined with the spectrometer, is the ability to imprint a constant delay or a uniformly inclined delay with adjustable inclination across the spectrum.

Figure 28A shows the interferometer 726 preceding the spectrometer 727. Since the spectrometer has a slit-like entrance pupil 723, the light passing through the interferometer should be line-like in cross-section. If the source is an optical fiber 720, the light is formed into a line 721 by cylindrical optics 722, or by use of a fiber bundle where individual fibers are rearranged into a line. This line-like beam 721 is sent into the input plane 724 of the interferometer, leaves the interferometer at the output plane 728 and enters the spectrometer system slit 721 as a line-like beam having fringes. The spectrometer is represented by the prism symbol 732. The actual details internal to the interferometer and spectrometer are omitted. The spectrometer disperses the incident light perpendicular to the direction of the slit to form a rectangular spectrum 726. This spectrum could have fringes, as suggested by Fig. 28B.

The interferometer can imprint either a constant delay or a delay that varies rapidly across the slit-like length, so that periodicity of the fringes can be arbitrarily adjusted, and could be infinitely wide. In spectroscopy of sources that have a non-smooth spectrum, such as the absorption lines in sunlight or starlight, the fringes may vary in phase and amplitude from wavelength channel to channel. In velocimeter applications, where light from the detecting interferometer is dispersed by a spectrometer, then the fringes could form a systematically varying pattern versus wavelength and delay (position along the slit).

Figure 28C shows the spectrometer 725 preceding the interferometer 729. In this case the spectrometer presents a rectangular spectrum as an input 731 to the interferometer. The interferometer passes this spectrum to its output image plane 733 while imprinting a fringe pattern on the spectrum. The orientation of the fringes could be in any direction relative to the wavelength axis, depending on which direction the inclined delay is made.