B.S.T.J. BRIEFS

The Use of Wollaston Prisms for a High-Capacity Digital Light Deflector

By W. J. TABOR

Manuscript received March 23, 1964

A digital light deflector was recently proposed by T. J. Nelson[1] in which n optical modulators and n uniaxial crystals were used to provide 2^n positions of the beam. Each uniaxial crystal was used to deflect a beam of light into either of two beams, with the light at the output remaining parallel to the input but displaced by an amount proportional to the thickness of the crystal. For a large number of positions it was found that a lens had to be employed in order to focus the beam into a small spot. The use of the lens requires that converging or diverging light must pass through the uniaxial crystal. In this brief we point out that this converging beam, when passing through the crystal as an extraordinary ray, is subjected to an index of refraction which varies rapidly with angle. The digital light deflector using this type of deflection therefore has appreciable image distortion, and the limiting spot densities that can be achieved are less than would be predicted if only diffraction were important.

A system which has less image distortion than the above can be constructed by using Wollaston prisms[2] (similarly Rochon or Senarmont prisms) and parallel light. (See Fig. 1.) Only the first two prisms are shown in Fig. 1. A Wollaston prism has the property that a collimated beam incident to its first face will be deviated, depending on its polarization, into either of two collimated beams. In this case the output beams will have an angular separation, whereas in the Nelson proposal the two output beams were laterally displaced without a change in angle. In general, n prisms will be used to provide 2^n resolvable angles, and these angles can be displayed as 2^n focused spots of light by means of a lens. This system has several advantages: (1) the parallel bundles of light contain only the angular variation implied by diffraction theory, which can be made small; (2) the light rays are always either nearly parallel or perpendicular to the optic axis where the index varies only slowly with angle and (3) the Wollaston prism contains much less material than the equivalent blocks of uniaxial crystal.

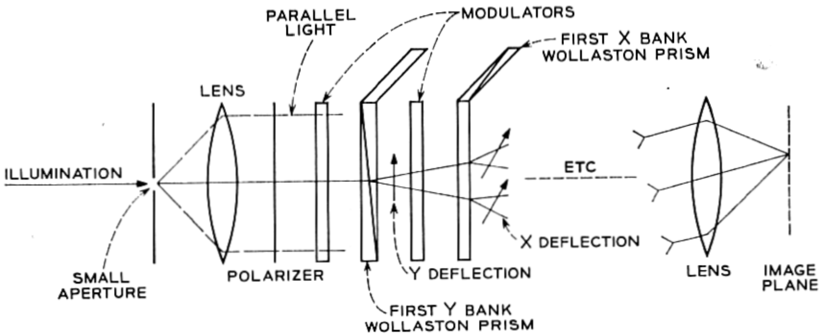

Fig. 1 — Use of Wollaston prisms in a digital light deflector.

One disadvantage of the Wollaston prism is that the deviation angle is not constant as the incident angle of the parallel bundle of light is varied from the perpendicular direction. This may necessitate placing the Wollaston with the smallest deviation first, the next largest second, etc. With this arrangement no Wollaston prism will have an incident angle differing from the perpendicular direction by amounts as large as the deviation angle of that prism. In this way the problem of the varying deviation angle should be minimized.

REFERENCES

1. T. J. Nelson, Digital Light Deflection, B.S.T.J., this issue, p. 821.
2. Jenkins, F. A., and White, H. E., *Fundamentals of Optics*, third ed., McGraw-Hill, New York, 1957, p. 504.