

1972

B72-10083

NASA TECH BRIEF

NASA Pasadena Office

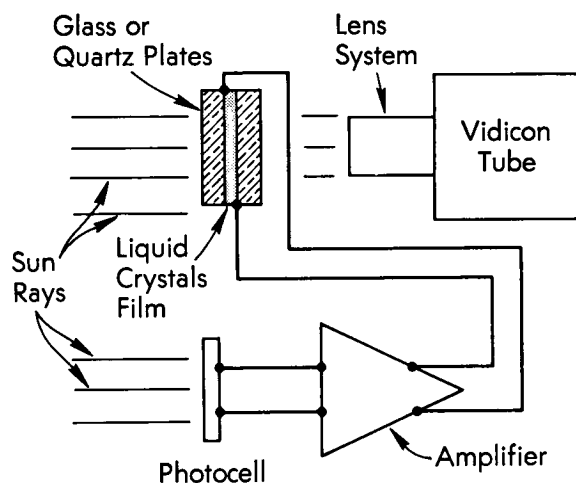


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Nematic Liquid Crystals for Optical Shutters — A Concept

The problem:

To protect light-sensitive devices such as Vidicon or Image Orthicon tubes and phototubes from high intensities of illumination. Ordinarily, such devices are protected by magnetically operated shutters that



are activated by phototubes which monitor luminous intensity, but mechanical devices of this sort in space vehicles may be subject to malfunctions.

The solution:

A nonmechanical shutter that utilizes nematic liquid crystals to attenuate illumination; the opacity of the liquid crystals is controlled by a photosensor.

How it's done:

Liquid crystals are organic compounds with molecular structures that can form large, orderly arrays such as those which make up solid crystals (mica,

quartz, diamond, etc.). As a result, certain types of liquid crystals can exhibit the optical properties of solids. Liquid crystals in the random-oriented state are normally transparent, but because of their so-called nematic quality they have the unusual property of becoming translucent and almost opaque on application of electrical current. A typical available commercial formulation has a resistivity of 10^{10} ohms/cm, and thus only an extremely small current is consumed during operation. The threshold voltage is 8 volts (AC or DC) and optimum voltage for maximum opacity is 22 volts; this voltage range produces a contrast ratio of 20:1.

A system utilizing nematic liquid crystals as a shutter for protection of optical devices is shown in the diagram. The shutter consists of two optically transparent glass or quartz plates with an interposed thin film of nematic liquid crystals. Electrodes for applying potential to the film may be provided by coating the inner face of the plates with a transparent conductive coating, such as tin oxide.

The shutter is positioned in front of the lens system that provides the input to the pickup tube. A photocell which also receives illumination from the same source as the pickup tube controls the amplifier output. The amplifier is adjusted so that whenever the intensity of illumination falling on the photocell exceeds a certain value, the voltage applied to the nematic crystal shutter will induce maximum attenuation; in this way, the pickup tube is protected from intense illumination. Intermediate values of illumination will lead to a partial attenuation of the light falling on the pickup tube; thus, the shutter also acts as a diaphragm.

(continued overleaf)

Typical liquid crystals formulations are somewhat yellow. For use with a color TV camera, compensation for this color could be provided either by the electronic circuitry associated with the camera or by suitable light filters. The risetime and relaxation times of available nematic liquid crystal formulations are of the order of 50 and 300 microseconds, respectively, and operating temperatures are from 18° to 80°C.

Notes:

1. Another potential utilization of nematic liquid crystals might be as a light chopper, which can be achieved by applying an alternating potential to the liquid crystals film.

2. Requests for further information may be directed to:

Technology Utilization Officer
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4800 Oak Grove Drive
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Reference: B72-10083

Patent status:

No patent action is contemplated by NASA.

Source: Robert E. Imus of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11367)