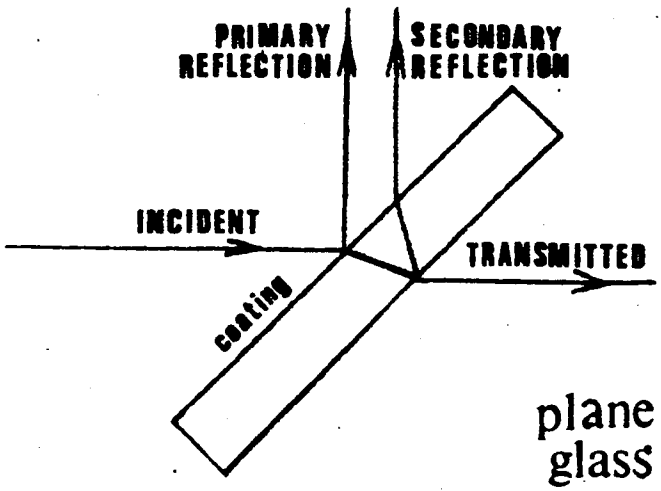
BEAMSPLITTERS

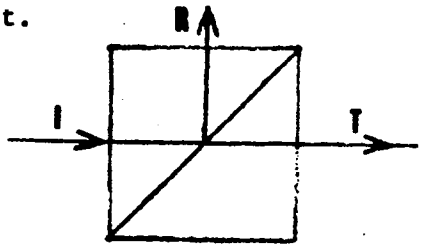
Beamsplitters divide the beam that hits them into parts, a reflected beam and a transmitted beam. They are necessary in holography for separating the laser beam into a reference beam and an object beam, and also for splitting the object beam to provide lighting of a scene from different angles.

There are two types of beamsplitters--fixed and variable. The simplest one is just a flat piece of glass where some light incident on it is reflected, with the rest passing through except for a secondary reflection of negligible intensity from the back surface. This secondary reflection may have to be blocked off, depending upon the application. With this beamsplitter about 10% of the light is reflected, with the rest (about 90%) being transmitted. But there are other fixed ratio plane glass beamsplitters that provide different ratios of reflected to transmitted light by having a semi-reflective metallic coating on one side. The more reflective the coating, the less light gets transmitted. Also, some light gets absorbed by the coating. Again, watch out for the secondary reflection, and set the splitter in a position where the beam hits the coated side first.



plane glass

Another type of fixed ratio beamsplitter consists of two prisms cemented together. The reflected beam is the product of frustrated internal reflection. This beamsplitter is wasteful of the light, as 30% is reflected, 30% is transmitted, and the rest is absorbed. They do not work well with linearly polarized lasers because the direction of polarization is changed due to the internal reflections.



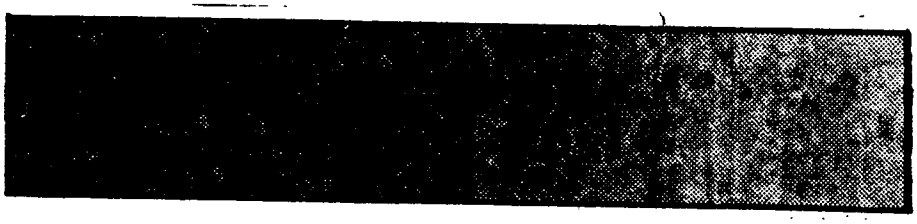
prism type

When using any of these fixed ratio beamsplitters in a holographic set up, you must control the ratio of reference to object beams by the amount of spread of the beams to control their intensities. However, this is sometimes inconvenient, if not downright frustrating. A variable beamsplitter gives a wide range of ratios by having a coating whose density varies along the length of the beamsplitter. By adjusting the beamsplitter to let the beam hit different sections of it, you can dial in whatever ratio is necessary for the set up.

variable beamsplitters

more reflective

less reflective



less transmissive

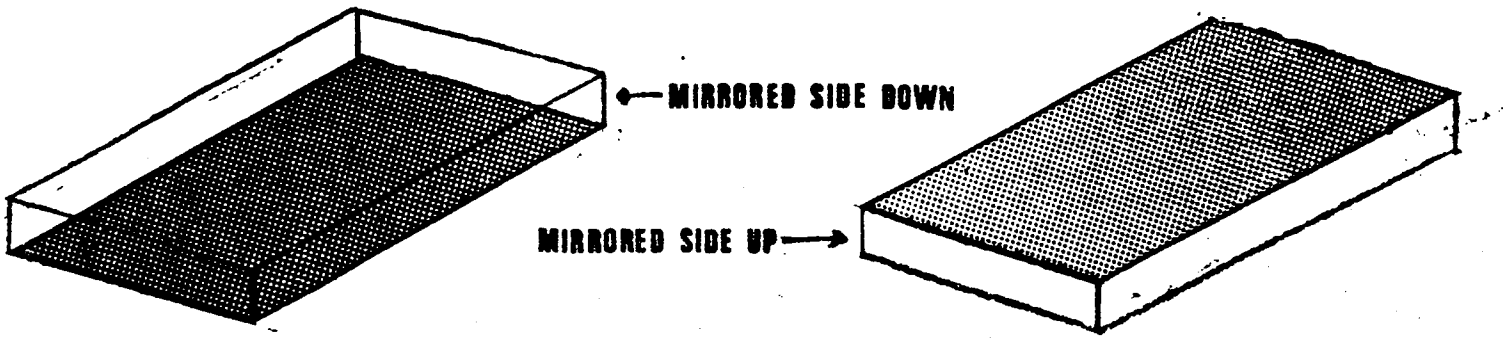
more transmissive

linear

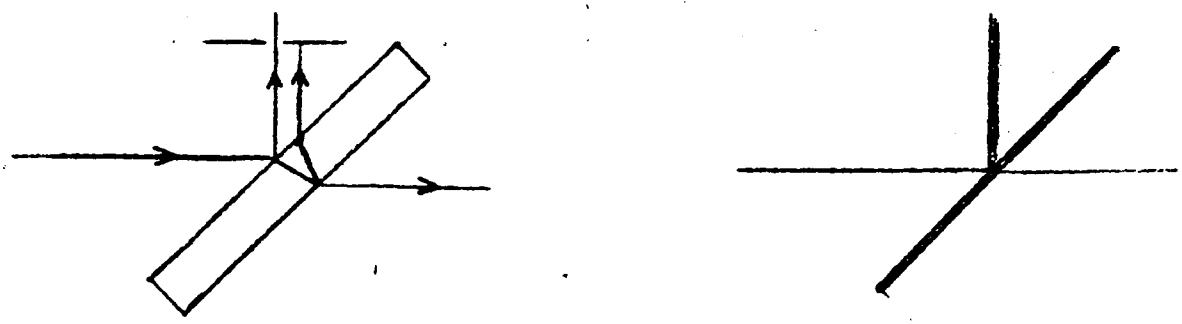
rotary

BEAMSPLITTING TIPS

Any type of beamsplitter absorbs some of the light passing through it, depending on the angle of incidence. This is unavoidable, but to minimize this loss, always place the mirrored side toward the laser. It's easy to tell which is the coated side on an unmounted beamsplitter; the thickness of the glass will be visible through the unmirrored side and the mirrored side's edge seems to end abruptly.

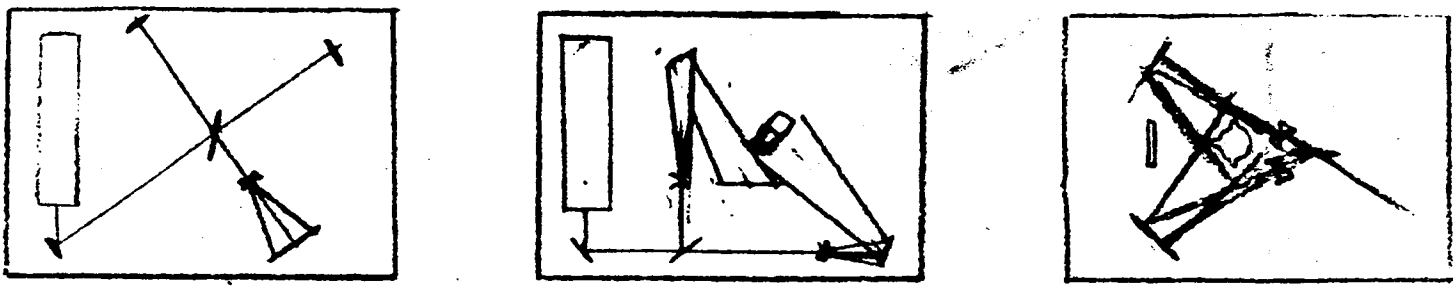


On thick beamsplitters it is easy to block off the secondary with a piece of metal with a hole drilled in it, as the distance between the two beams is determined by the thickness of the glass. But with very thin beamsplitters, the first and second reflections will be almost on top of each other and cannot be separated. This



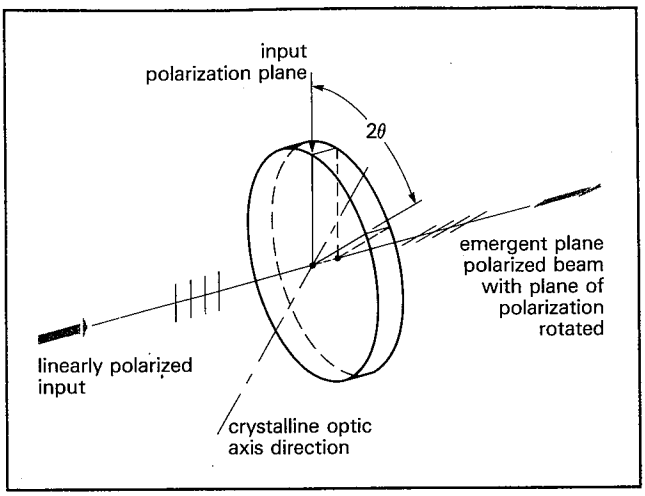
is fine for object beams, but these two reflected beams cannot be used as a reference beam because the hologram would require those same two beams for playback.

Here are some applications for beamsplitters:

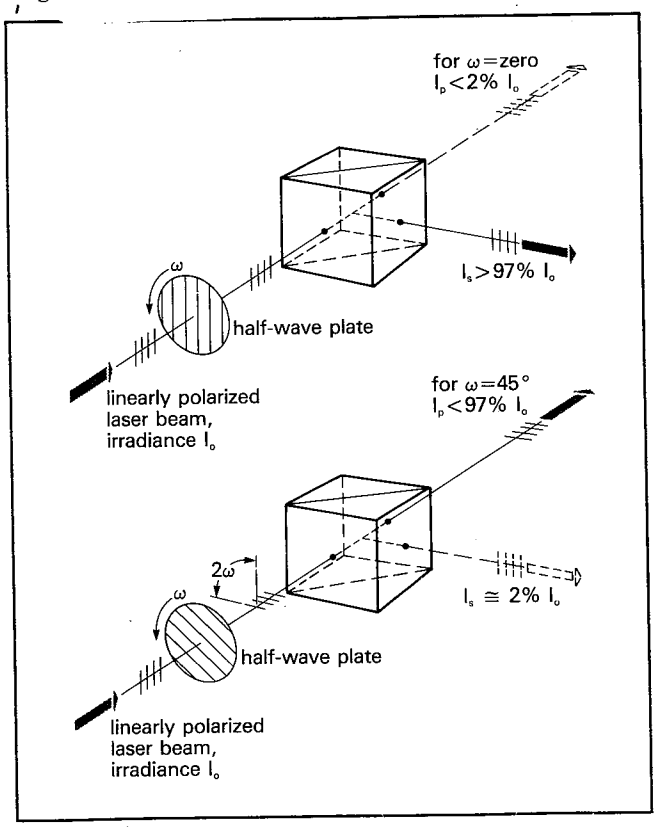


All beamsplitters should be handled with utmost care. Dust can be removed from the surfaces with a soft camel's hair brush, and uncoated plane glass ones can be cleaned with lens cleaning fluid and tissue. But all others that have the metallic coating CANNOT be cleaned for the same reason that a first surface mirror cannot be easily cleaned; the surface is too soft and is susceptible to scratches. KEEP FINGERS, SAND, ETC., OFF THE BEAMSPLITTERS!!!! DIRTY BEAMSPLITTERS AND MIRRORS END UP IN THE JUNKPILE!!!!

Although beamsplitting with a polarizing beamsplitting cube and half wave plates may seem more complicated and intimidating at first, the almost lossless nature of the optics compared with variable "reflective" coating which absorb beaucoup de photons make them invaluble for the low power He-Ne holographer. The low cost of cubes taken out of video disc machines on the surplus market makes them affordable, ($15-25) and good enough rotating stages from the hardware store for the half wave plates complete the set up with a minimum of cash outlay.



HALF-WAVE PLATE EFFECT ON LINEARLY POLARIZED LASER BEAM. The plane of polarization of the beam can be rotated at will without rotating the laser. The plane of polarization is essentially reflected in a plane containing the crystalline optic axis, and the output plane rotates at twice the angle rate of the retarder.



VARIABLE RATIO BEAMSPLITTER: The half-wave plate rotates with angular velocity ω while the permitted plane of output polarization (here suggested by lines on the highly transparent retarder) rotates at angular velocity 2ω. The polarized beams which finally emerge from the cube have the irradiances I_s I_p indicated. Intermediate irradiances are seen at intermediate times.

TRANSLATION

A polarized laser beam can come out of the half wave plate at any plane of polarization that you please.

By rotating the polarization plane the holographer can produce any ratio of relative intensities of the two beams.

As you would suspect, an incoming laser beam polarized in a plane 45 degrees from the normal will be split 50/50.

!!CAUTION!!

Notice that the two beams are polarized perpendicular to each other! A second and even third half wave plate might be necessary to align their vectors so that they can interfere!

The horizontally polarized beam could be used as is for a horizontally incident reference beam, while the vertically polarized one needs to be adjusted.

See the sheet, "ALIGNING POLARIZATION VECTORS"

The two output beams' polarization vectors are fixed, andindependent of the incoming polarization.

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