BUYER'S GUIDE TO THE BEST OF PHOTOGRAPHY

# DARKROOM & CREATIVE CAMERA TECHNIQUES

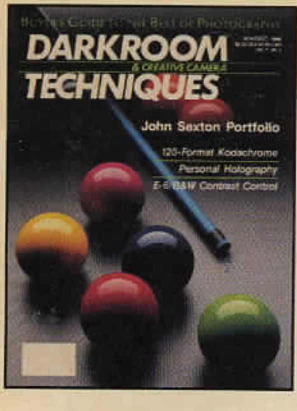
NOV/DEC 1986
$2.50 USA/$3.50 CAN
VOL 7, NO 6

## John Sexton Portfolio

120-Format Kodachrome

Personal Holography

E-6/B&W Contrast Control




Cover photographer Dave Jordano made this photograph using the same props and setup he had used in making an advertising photo earlier in the day. It has become one of his most successful images.

Jordano used a single 4 × 5-foot custom built soft box positioned above the table at a 45-degree angle. The softbox held four modified strobe heads with a total output of 20,000ws. Jordano used an 8 × 10 Sinar-P camera, 240mm Nikkor-W lens, and Ektachrome 100 film.

Jordano is one of Chicago's most successful advertising photographers. His client list includes some of the most prestigious names in American business.

Member

**DARKROOM & CREATIVE CAMERA TECHNIQUES (ISSN 0195-3850)** is published bimonthly (Jan/Feb, Mar/Apr, May/Jun, Jul/Aug, Sep/Oct & Nov/Dec).  Newsstand Distribution: U.S.—Harvey Wasserman & Associates, 3420 Dundee Rd., Northbrook, IL 60062; Canada—Master Media Inc., P.O. Box 610, Oakville, Ontario L6J 5B4; Australia—Gordon and Gotch, Ltd., P.O. Box 767G, Melbourne 3001; other countries—Worldwide Media Service, Inc., 386 Park Ave. So., New York, NY 10016. Camera-store distribution: Information available from publisher. Subscription rates: U.S.—1 yr./$12, 2 yr./$22, 3 yr./$31; outside U.S.—1 yr./$15, 2 yr./$28, 3 yr./$40 (U.S. funds/U.S. bank or branch). Single copy—U.S./$2.50; back issues available. Subscription orders/inquiries to: Circulation Service Center, P.O. Box 1079, Skokie, IL 60077. Second-class postage paid at Chicago and additional mailing offices. **Postmaster: Send change-of-address notice to DARKROOM & CREATIVE CAMERA TECHNIQUES, Circulation Service Center, P.O. Box 1079, Skokie, IL 60077.**

# DARKROOM & CREATIVE CAMERA TECHNIQUES

**Nov/Dec 1986**

**Vol. 7, No. 6**



## DEPARTMENTS

## BUILD THE BIG BEAM FROM COMMON MATERIALS

# Exploring Personal

By Ed Wesly

I am a professional holographer, which means that in addition to being handy with a rotary saw and drill press, I'm part artist, part photographer, and part scientist. You don't need to be a scientist to start making holograms. In fact, you don't even need to understand how they work. In this article, I explain how to build a versatile, personal holographic setup for under $1,000, including the cost of the laser, and how to use it to produce eight of the most common types of holograms. You will find very little theory in this article. Much of the information presented here will be familiar to an experienced photographer.

A hologram is usually a record of the interaction between laser light sent directly to a plate, and light following a different course—often reflected off an object. "Playing back" the hologram transforms the viewing light into the object light, reproducing the object's three-dimensional appearance. To master holography, eventually you will need to learn about coherence, interference, and diffraction, but this is best saved for a time after you begin making holograms. Without practical experience, theory is dull and meaningless. For those of you desiring further reading, I provide a list of books at the end of this article.

The lasers used in personal holography are Class IIIb products. This means that they are the big brothers of the common supermarket, scanning lasers. You should always respect a Class IIIb laser, but you do not need to fear it. You will feel no heat when a Class IIIb beam touches your skin, even with prolonged exposure. If you look into the beam of a Class IIIb laser, your blink reflex will protect your eyes. Even so: *Never look directly into the beam of any laser.* Common sense dictates that all lasers be treated with respect. Besides, you never know when your blink reflex will go on the fritz.

There are many reasons why an experienced photographer would pursue holography. The first is the commercial

*There are many reasons why an experienced photographer would pursue holography. The first is the commercial imperative.*

imperative. A healthy young market for display holograms is beginning to grow in the United States. A common example of a commercial application would be a display in a building foyer of a company's headquarters. Often, a hologram is used as a centerpiece in a larger display that includes photographs and other materials. Second, technical and scientific photographers will find that holograms capture and explain many events in ways impossible for conventional photography. The most common example is industrial stress analysis, but recently I was involved in a project to make holograms in a bubble chamber to produce three-dimensional images showing the paths of subatomic particles. Finally, since holography is a natural extension of photography—not as alien as its results might lead you to believe—many photographers regard it as a valuable creative outlet and a useful addition to their photographic repertoire. Holography provides a whole new universe to explore.

All the projects I discuss are simple single-beam setups. You don't need to worry about beam splitting and other exotica, but the equipment is versatile enough to let you move on to these projects in the future. There are five areas you need to be concerned with to get started in holography: building the Big Beam; mounting the laser; mounting the beam spreader; mounting the subject and holoplate (film); and exposure and development.

**The Big Beam**

Vibration is the greatest enemy of holography. If any part of a holographic setup is vibrated during exposure, even an amount no greater than the width of a fraction of a wavelength of light, there will be no hologram. You can not simply mount a laser on your workbench and start making holograms. The Big Beam is my solution to vibration for the personal holographer.

I invented the Big Beam not because I needed access to holographic equipment—I work in a holographic lab—but because I wanted a portable setup I could use any time for my personal work. You can't buy something like this off the shelf. If you were to buy Big Beam components off the shelf, it would be an extremely expensive project, whereas you can build a Big Beam like mine for under $50.

Simply put, the Big Beam is a sturdy wooden cross mounted on three underinflated innertubes. Your laser, the beam spreader, the subject, and the holoplate are all mounted one way or another on the Big Beam. The innertubes provide isolation from vibrations that would otherwise make it impossible for you to produce excellent holograms. Note that I recommend *three* innertubes. Three-point suspension makes the Big Beam stable like a three-legged stool or tripod. Four-point suspension might introduce rocking motion, like a chair with one short leg. I also recommend adding ballast to the innertubes in the form of concrete blocks. You should also place blocks on the floor to support each tube.

Choose your innertubes carefully. I recommend small tubes (mine are from a VW Rabbit) to support the two cross arms and a larger one (a truck tube works well) for the foot. Inflate your innertubes to the consistency of the Pillsbury Dough Boy. As you can see from Figure 1, the subject and holoplate are mounted at the "T" end of the cross and the laser is mounted at the foot.

I recommend using 4 × 6-inch wooden beams (kiln-dried pine or hardwood) for constructing the cross. Do not use the greenish weather-treated lumber intended for landscaping, since it shrinks and swells considerably with changes in humidity, often with disasterous effects.

If you have enough room available, a 9-foot overall length is excellent for the cross, but 6 feet will do for most applications. The cross "T" is constructed out of a single 3 to 4-foot length of 4 × 6 and notched (1¾-inch depth) to fit the longer "I" beam. Position the "T" beam about 6 inches from the top end of the "I" and drill a hole through both boards. Use a ⅜-inch carriage bolt and wing nut to lock the two together.

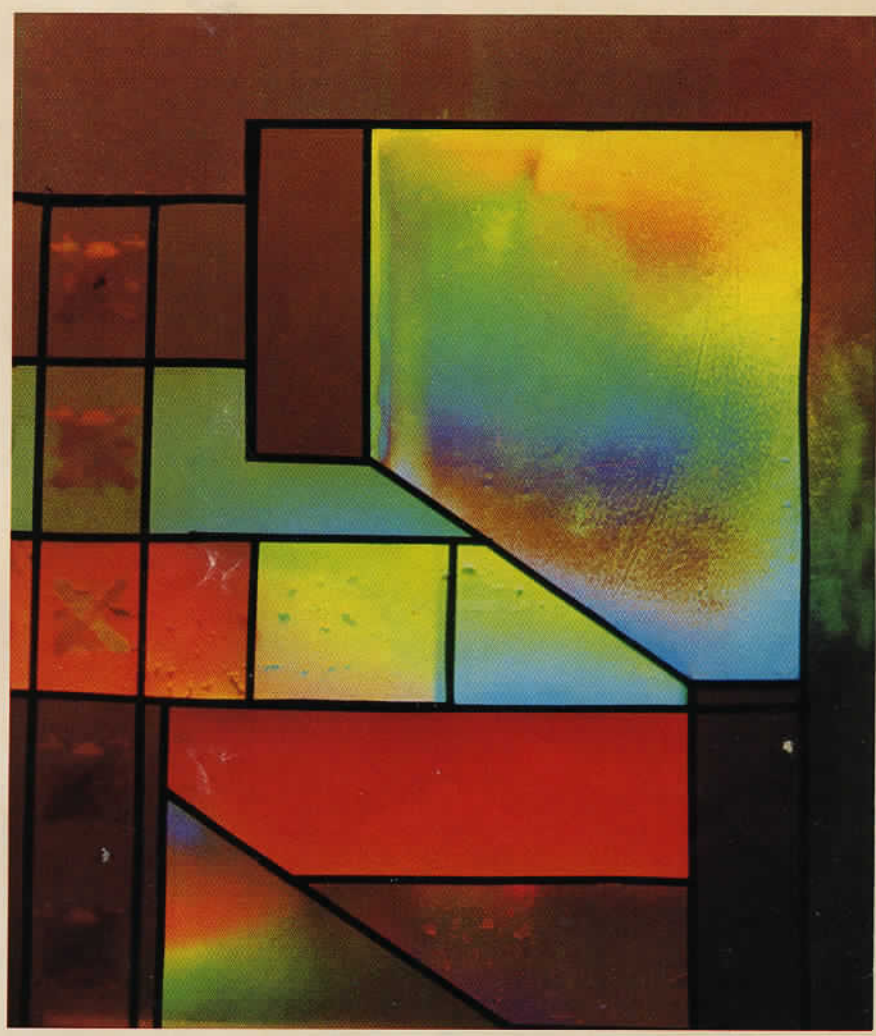
You will be drilling many holes in the Big Beam—for attaching the laser mount, the beam spreader, etc.—and you can easily mess this project up by making poorly drilled holes. Buy an inexpensive drill guide from your local hardware store. It will make a big difference.

The cross indirectly makes contact with the three innertubes. Make wooden "Xs" out of 2-foot lengths of 2 × 4s (each one notched in its center) and bolt one to each of these three points on the cross (see Figure 1). The "Xs" make even contact with the innertubes and provide a place to put your ballast blocks.

After you have cut, drilled, and assembled your "I" and "T" beams, and the three "Xs," disassemble the Big Beam and give everything a healthy coat of polyurethane varnish followed by flat black enamel paint. This treatment seals the wood and minimizes the effects of humidity and reflections. Reassemble the cross and place it where you have room to work, because you've still got quite a few holes to drill.

### Mounting the Laser

Most beginning holographers make a fatal error in choosing a laser that ends up costing them dearly. They buy the least expensive laser possible. After a



***ABOVE: PHOTO 1, NEVADA.* This is an example of one of the most stunning effects that can be achieved with holography. In fact, it was my desire to experiment with diffraction gratings that prompted me to build the Big Beam in the first place. This work was made by attaching several diffraction gratings to a single display with each grating having unique spectral characteristics. The gratings were made using the Big Beam as described in the text. Figure 9 shows the setup and beam spread for making diffraction gratings.**

month or so, they realize that their laser is underpowered and they move up to a larger 7mw model. I am going to recommend only one laser for this project but with slight modifications in the laser mount, the Big Beam will work with almost any laser on the market. If you already own a laser, write to me care of this magazine for more details.

I recommend the Melles Griot cylindrical helium-neon laser Model No. 05-LHP-171. This model has 7mw of power and is polarized. Both these features make personal holography a little more versatile. A 7mw laser will provide enough power for you to be able to produce 8 x 10-inch holograms. Together, the head and its power supply will cost about $825. Check the end of this article for Melles Griot's address and telephone number.

The laser mount provides adjustable beam height and is constructed out of kiln-dried pine 2 x 4s. Figure 2 shows a diagram of the mount. It is attached to the Big Beam using two C-clamps as shown in Photo 2. The laser rests in holes cut into each of the two 2 x 4s.

Start by cutting two 15-inch lengths of 2 x 4. Be certain that the boards are exactly the same length and that *all four* end cuts are square. In the center of each board at 6 and 12 inches from the bottom, mark the wood and drill a small guide hole. Using a large hole cutter and drill guide, cut 1¾-inch (for the Melles Griot) holes at these four locations. Varnish and paint each board.

When constructed in this manner, the mount provides a choice of laser heights of 6 and 12 inches on one side. If the boards are flipped top-to-bottom, heights of 3 and 9 inches are possible. Please note that the C-clamps firmly attach each mount board to the foot of the "I" beam. You must cut two small sections of 1 x 2, which are bolted and glued onto the "I" about 1-foot apart. These too, must be varnished and painted black.

**The Beam Spreader**

The beam spreader is an inexpensive two-lens optical assembly that provides more beam control than many systems costing twenty times as much. In this arrangement, each lens is mounted independently in front of the laser beam.

*Most beginning holographers make a fatal error in choosing an underpowered, inexpensive laser that ends up costing them dearly.*

Since there are four possible beam heights, the two lenses must be adjustable vertically as well as horizontally.

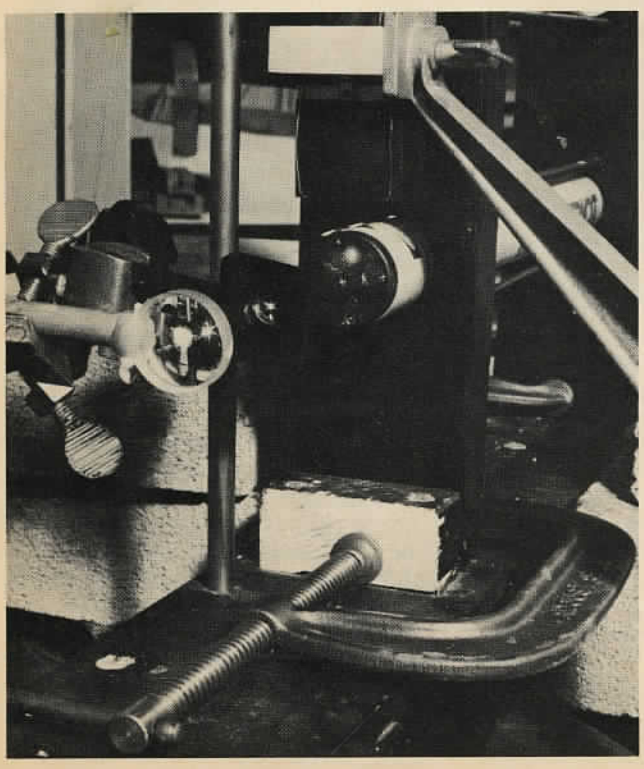
Notice from Photo 2 that in front of the laser, I have built a mount for the two lenses (familiar to those who took high school chemistry) using ½-inch steel rod and laboratory clamps. The one pictured is slightly more complex than you need.

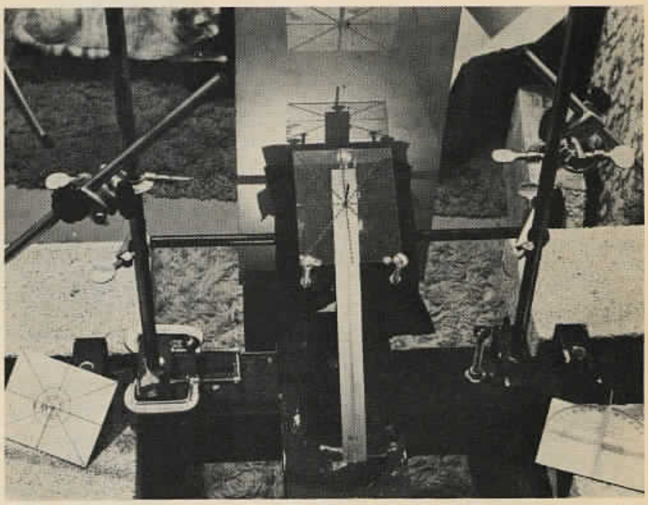
Cut three 18-inch lengths of ½-inch steel rod. Drill two ½-inch holes near the edge of the "I" beam at about a 3-inch depth. Drill one hole about 14 inches and the other about 2 inches from the centermost laser mount board. The holes should be in alignment with one another. Drive an 18-inch rod into each of these holes, and you are done making the mount.

The third steel rod is suspended horizontally from the two vertical rods using lab clamps. I buy mine used from the two sources given at the end of this article. The two spreading lenses must be attached to this horizontal rod also using lab clamps, so that the whole assembly can be adjusted with great accuracy. When this support structure is complete it looks like a set of football goalposts.

You can see from Photo 2 that one of the lenses I use has a factory-made mount with a ½-inch rod threaded to it. I was lucky to find this one. More than likely, you will need to hot glue or epoxy all your lenses to short lengths of ½-inch wooden dowel rods.

I suggest that you purchase a selection of lenses from one of the science supply stores listed at the end of this article. A $20 investment in lenses will give you enough possible combinations to vary your coverage for any project. Basically, the object is to adjust your lenses until the beam covers your subject, mirrors, and holoplate. Any single-element lenses will work but negative





AT LEFT: PHOTO 2. ***This foot end view of the Big Beam shows the laser, laser mount with C-clamps, beam spreader (left-center), and solenoid shutter (top-center). Note concrete blocks.***

ABOVE: PHOTO 3. ***This "T" end view of the Big Beam shows the goalposts, lab clamps, subject/plate holder (center), and reflection (top-center) used in adjusting the polarization vector.***

ones are preferred for this application, and they must be fairly short focal lengths in the range of 5 to 30mm.

My system requires that the lenses be kept exceptionally clean. The first time you turn on your laser and project it through the lenses you will note bullseye patterns on the beam. These diffraction patterns look like ripples on a pond and result from small specks of dust on your lenses. You must clean them before making a hologram.

### Subject and Plate Holders

I will describe two general purpose holders (subject/plate and frame plate) here and discuss variations later in the article. The support structure for the holders is identical to the beam spreader's. You will probably end up building several similar devices and using them for holding plates, mirrors, and subjects, after drilling more holes in your Big Beam in the appropriate locations.

The support structure is the same goalpost arrangement used with the beam spreader. You will need three 18-inch pieces of ½-inch steel rod. Drill two ½-inch holes about a foot apart into the "T," spanning the "I" beam. Drive two of the rods into these holes and attach the horizontal rod using lab clamps.

In many of your experiments, you will wish to place goalposts in a variety of places on the Big Beam. It pays to have a reserve of ½-inch steel rod and lab clamps on hand.

The subject/plate holder can be used for simultaneously holding plates and subjects, and it is usually attached to the goalpost I just described. This holder is constructed from a 6-inch piece of 2 × 6-inch pine, three ¼ × 20 carriage bolts four inches long, three 20d nails, several ¼ × 20 hexnuts, two short sections of ½-inch steel rod, several ¼ × 20 T-nuts, a small piece of black felt or velour, and epoxy glue. See Photo 3. The T-nuts are small pieces of metal with holes tapped with ¼-inch threads. After you drive a T-nut into wood with a small hammer, you have an excellent base for a threaded bolt.

First drill three 5/16-inch holes in the 2 × 6 for the carriage bolts in approximately the positions shown in Photo 3. Drive a T-nut into each of these holes and glue black felt over the wood, completely covering the T-nuts. Thread a hexnut onto each carriage bolt about halfway to its head, punch a hole through the felt covering a T-nut, and screw the bolt/hexnut into the T-nut. Repeat this operation for the other two T-nuts. These carriage bolts provide three-point support for the holoplate during exposure. The distance from the head of each carriage bolt to the felt can be adjusted by manipulating the hexnuts. Place a 4 × 5-inch glass plate on top of the carriage bolts, and drive a nail into the 2 × 6 next to each carriage bolt. As shown in Photo 3, the nails help hold the holoplates in position.

To complete this project, drill a ½-inch hole centered in each of the two vertical sides of the subject/plate holder. Insert a small section of ½-inch steel rod into each hole. Use these two rods to attach the subject/plate holder to the goalpost with lab clamps.

The frame plate holder is used for transmission holograms. It is constructed out of an old-fashioned 4 × 5 contact printing frame and is very useful for many projects. Simply glue a section of 2 × 4 to the bottom of the printing frame. Drill a ½-inch hole into the bottom of the 2 × 4 and install a section of ½-inch steel rod. Use this rod to attach the frame plate holder to the goalpost.

### Holoplates, Exposure, Development

The holographic plate I recommend is Agfa Holotest 8E75HD, which has a sensitivity of 100 microjoules per square centimeter. Since most people do not have lightmeters calibrated in microwatts, exposure tests are required.

Never mount an exposure control mechanism directly on the Big Beam. Since all exposures will be of long duration, you can hold a card in front of the laser to block the beam and draw it away to expose, counting out seconds to yourself. The main drawback of this method is that if the card makes contact with the Big Beam, vibrations will result.

You can modify a camera shutter and operate it with a cable release, but you must still be wary of any vibrations. I have a 12-volt DC solenoid mounted vertically on the floor next to the Big Beam. I attached cardboard to the solenoid's arm in front of the laser and plugged a stepdown transformer into an enlarger timer to control it. Photo 2 shows this shutter configuration.

To make an exposure test, cut a corner out of a 4 × 5-inch piece of cardboard and cover your holoplate with it. Make a 5-second exposure. Rotate the card and make a 10-second exposure. Repeat this procedure for 20 and 40-second exposures. Process the test plate and evaluate the results. An experienced photographer will have no trouble discerning which exposure is correct after the plate is dry.

I recommend pyrochrome processing for holographic plates, which involves development in a pyro developer followed by one of two bleaches and *no fixation*. I also suggest using distilled water for compounding the developer and bleach, since this eliminates one more processing variable.

**Pyrochrome Processing at 68°F**

1. Develop 1 to 6 minutes.
2. Wash 3 minutes.
3. Bleach (see formulas).
4. Wash 3 minutes.
5. Wetting agent 2 minutes.
6. Dry standing upright.

**Pyrochrome Developer**

**Part A**

| | |
|---|---|
| Water | 750ml |
| Pyrogallic acid | 10g |
| Water to make | 1 liter |

**Part B**

| | |
|---|---|
| Water | 750ml |
| Sodium carbonate (monohydrate) | 60g |
| Water to make | 1 liter |

Add equal parts A and B just before use and process with continuous agitation.

**Pyrochrome Bleach**

| | |
|---|---|
| Water | 750ml |
| Potassium dichromate | 4g |
| Sulfuric acid (conc.) | 4ml |
| Water to make | 1 liter |

Note: Always add acid to water. Bleach for 2 minutes or less.

**Alternate Pyrochrome Bleach**

| | |
|---|---|
| Water | 750ml |
| Potassium ferricyanide | 10g |
| Potassium bromide | 10g |
| Water to make | 1 liter |

Bleach for 5 to 10 minutes.

For transmission holograms, develop 4 to 6 minutes. Reflection holograms require a 1 to 2-minute development time.

The alternate bleach formula will reconstruct the subject in the red color by which it was holographed. This will be necessary if you plan to make copies of your reflection holograms.

### Setting Up the System

Each project will produce unique setup procedures due to differences in subjects and positioning of the holoplate. However, a common logic runs through each of the eight projects.

*Adjust laser.* Very small adjustments in beam position should be made by inserting toothpicks into the laser mount holes. This may not look very glamorous but it works great.

*Adjust beam spread.* Using the lenses, adjust the beam spread correctly for the chosen project as shown in Figure 3 through Figure 10. The distance between the lenses can be manipulated to create a zoom effect. If you project the spread beam onto a piece of cardboard, you will see a bright inner circle of light surrounded by a darker outer ring. Generally speaking, applications requiring mirrors (bouncing the beam around) use both the inner and outer portions of the beam. Other projects should be exposed using only the brighter, inner portion of the beam. Clean the lenses until the beam is free of bullseyes.

*Adjust plate holder.* With the exception of in-line holograms, plate holders should never be positioned directly on axis with the laser beam. In all other cases, the plate holder should be in the range of 30 to 45-degrees off axis. In many cases, you may wish to tilt the plate top-to-bottom instead of from left-to-right.

*Adjust polarization vector.* Put a piece of scrap glass in your plate holder in exactly the same location where your holoplate will be placed. Mount a piece of white foamboard at the top of the Big Beam, on axis with the laser beam so that laser light bounces off the glass and onto the foamboard. Rotate the laser in its mount until the reflected image is as dim as possible. If your laser does not need to be adjusted again, remove the foamboard and you are ready to go to work.

**The Setups**

*Figure 3. In-line Transmission Hologram.* The figure shows the setup and beam spread for this earliest of all holograms. An in-line hologram is made by placing a high contrast transparency between the laser and holoplate. You must view the hologram with laser light to reconstruct the image. In this case, as with all holograms, it is most easily viewed by putting it back into the holder in which it was made. At arm's length, the high contrast image appears to float in space on both sides of the holoplate.

*Figure 4. Deep Scene Transmission Hologram.* Very large objects can be holographed using the setup and coverage shown in Figure 4. The laser light diffusely reflects off the subject and onto the holoplate. The remainder of the beam goes directly to the plate. Deep-scene holograms must be viewed with laser light and show a 3-D effect with the object floating in space.

*Figure 5. Transmission With Mirror.* The workhorse setup shown in Figure 5 is the preferred approach to many holographic assignments. Laser light bounces directly from the front-surface mirror and indirectly from the subject to the holoplate. A resulting hologram must be viewed in laser light and shows the subject in three dimensions and often reproduces the mirror as well.

*Figure 6. Transmission Transfer.* The setup shown in Figure 6 will create a copy from an existing transmission hologram. This copy can be viewed under normal white light using a high-intensity light or flashlight. Laser light travels through the master hologram projecting an image that is focused onto the copy holoplate. Light from the beam also illuminates the plate directly. The final hologram shows the subject in three dimensions hanging in space as if it were sticking through the hologram.

*Figure 7. Denisyuk Reflection Hologram.* This type of hologram is one of the most difficult to understand and one of the easiest to make. The setup in Figure 7 is the project the subject/plate holder was originally designed for. A small subject (dice, toy, etc.) is placed behind the holoplate and in contact with it. The carriage bolts on the subject/plate holder are adjusted to make a snug fit. Laser light passes through the holoplate during exposure and bounces off the subject and back onto the plate. The subject must be highly reflective and may need a coat of silver paint. A resulting Denisyuk hologram may be viewed under white light and shows the 3-D subject hanging in space behind the plate.

*Figure 8. Reflection Transfer* shows the setup and beam spread for making copies of reflection holograms. The positioning of the master hologram is critical in this scheme. You must place the master so that when viewed its image appears on the laser side of the plate. You must use the Alternate Pyrochrome Bleach discussed earlier when processing the master, otherwise this technique will not work. Copies may be viewed under white light and appear to straddle the plate.

*Figure 9. Diffraction Gratings.* It was my desire to experiment with diffraction gratings that prompted me to build the Big Beam in the first place. Photo 1 shows an example of my work with what I believe is one of the most stunning effects that can be achieved with holography. When viewed under white light a diffraction grating displays a beautiful spectral rainbow effect having incredible color saturation. Figure 9 shows the setup for making diffraction gratings. Notice

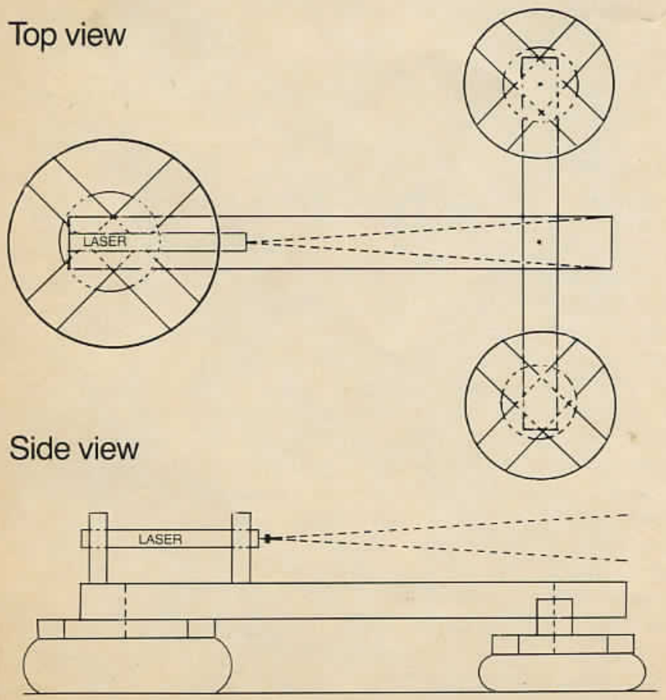



***Figure 1. The Big Beam.***

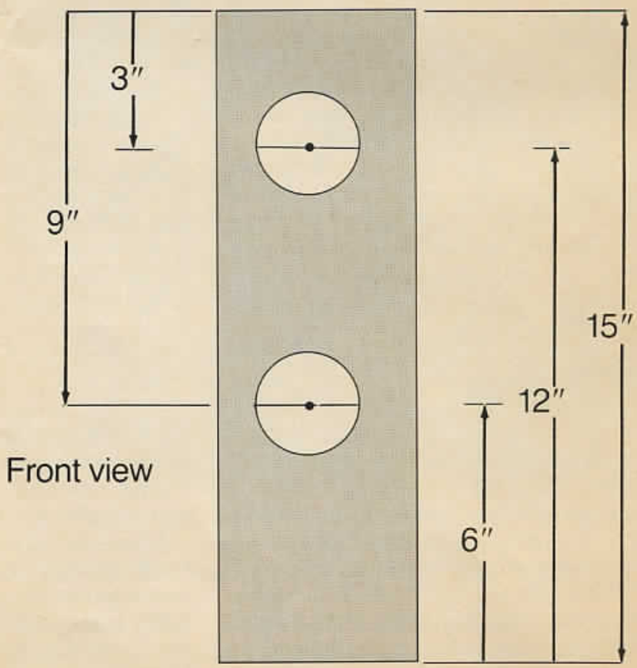



***Figure 2. Laser holder for 3, 6, 9 and 12-inch beam heights.***

that the laser beam must illuminate both the front-surface mirror and holoplate. The mirror-to-plate angle will affect the way the spectrum is reproduced.

*Figure 10. Cylindrical Transmission Hologram.* I included the project shown in Figure 10 because such holograms are very challenging and their final effect is a real show-stopper. The subject to be holographed is suspended in the center of a black plastic cylinder. A piece of holographic film, corresponding in length to the circumference of the cylinder's interior, is placed (emulsion out) into the cylinder. During exposure, the laser beam illuminates all sides of the subject. If the resulting hologram is placed in a clear plastic cylinder and viewed with a strong white light source, the 3-D image floats in space. By rotating the cylinder or walking around it, you can watch all sides of the subject reconstruct. The image is not only three dimensional but rendered in 360 degrees! If you remove the film from the clear cylinder and view it flat, the front of the subject is at one end of the film and the rear at the other. In the middle, the subject bends and turns with comic and impossible convolutions. I suggest you start with a project requiring film no larger than 3 by 9 inches.

**Resources and Parting Words**

The Big Beam offers a variety of alternatives in construction and design. In fact, versatility is one of the most important design criteria I set for the Big Beam from the start. Listed below are some resources I have used in working on this project.

*Laser:* Melles Griot, 1770 Kettering Street, Irvine, CA 92714, 714-261-5600.

*Lenses, front-surface mirrors, laboratory clamps, and other accessories:* American Science Center, 5700 Northwest Highway, Chicago, IL 60646, 312-763-0313, and Edmund Scientific Company, 101 East Gloucester Pike, Barrington, NJ 08007.

*Books on holography: How to make Holograms,* by Don MacNair, TAB Books 1982, *Holography Handbook: Making Holograms the Easy Way,* by Fred Unterseher, Jeannene Hansen, and Bob Schlesinger, Ross Books 1982, *The Making and Evaluation of Holograms,* by Nils Abramson, Academic Press 1981.

*Holography workshops:* Lake Forest College Holography Workshops, Lake Forest, IL 60045.

*Holoplates and film:* Integraf, P.O. Box 745, Lake Forest, IL 60045, 312-234-3756.

*Photographic chemistry:* Aldrich Chemical Company, P.O. Box 355, Milwaukee, WI 53201; City Chemical, 132 West 22nd Street, New York, NY 10011; Fisher Scientific Company, 412-565-8300; Fluka Chemical, 255 Oser Avenue, Hauppauge, NY 11788; Lauder Photographic, 2650B Mercantile Drive, Rancho Cordova, CA 95670; Photographer's Formulary, P.O. Box 5105, Missoula, MT 59806; Sargent-Welch Scientific, 312-677-0600; Tech-Chem, P.O. Box 956, Westmont, IL 60559; Zone V, P.O. Box 218, Maynard, MA 10754.

My goal in writing this article has been to provide enough information for an experienced still photographer to expand into holography without spending a small fortune or exerting an inordinate amount of effort. In spite of the space limitations, I have left out no critical details. However, much subtle detail has been lost. I could easily write a complete article on each of the eight projects covered, plus a few more I had to leave out. If you wish to see more articles in this magazine on the subject of personal holography, I urge you to write to the editor and let him know. □

*Holographer/photographer Ed Wesly is a holographic engineer for Northwestern University in Evanston, Illinois. His holograms have been exhibited in many art galleries in the United States.*

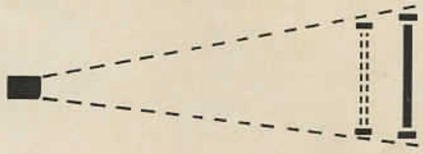


**Figure 3. In-line hologram**

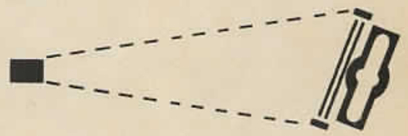


**Figure 7. Denisyuk hologram**

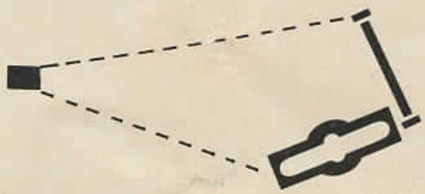


**Figure 4. Deep scene hologram**

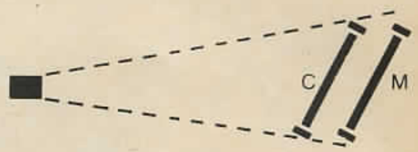



**Figure 8. Reflection transfer**

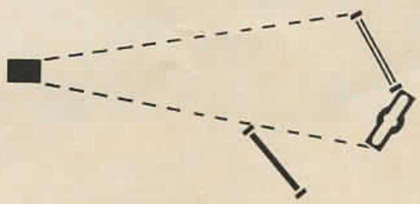


**Figure 5. Transmission with mirror**

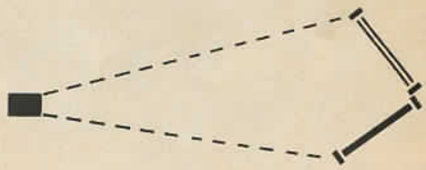


**Figure 9. Diffraction gratings**

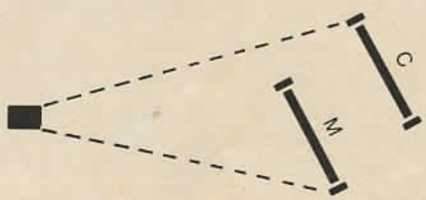



**Figure 6. Transmission transfer**

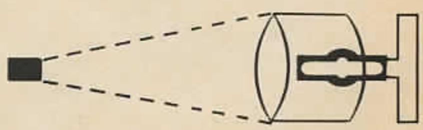


**Figure 10. Cylindrical hologram**

Key:
M = master hologram — Subject — Holoplate
C = copy hologram — Mirror — Transparency