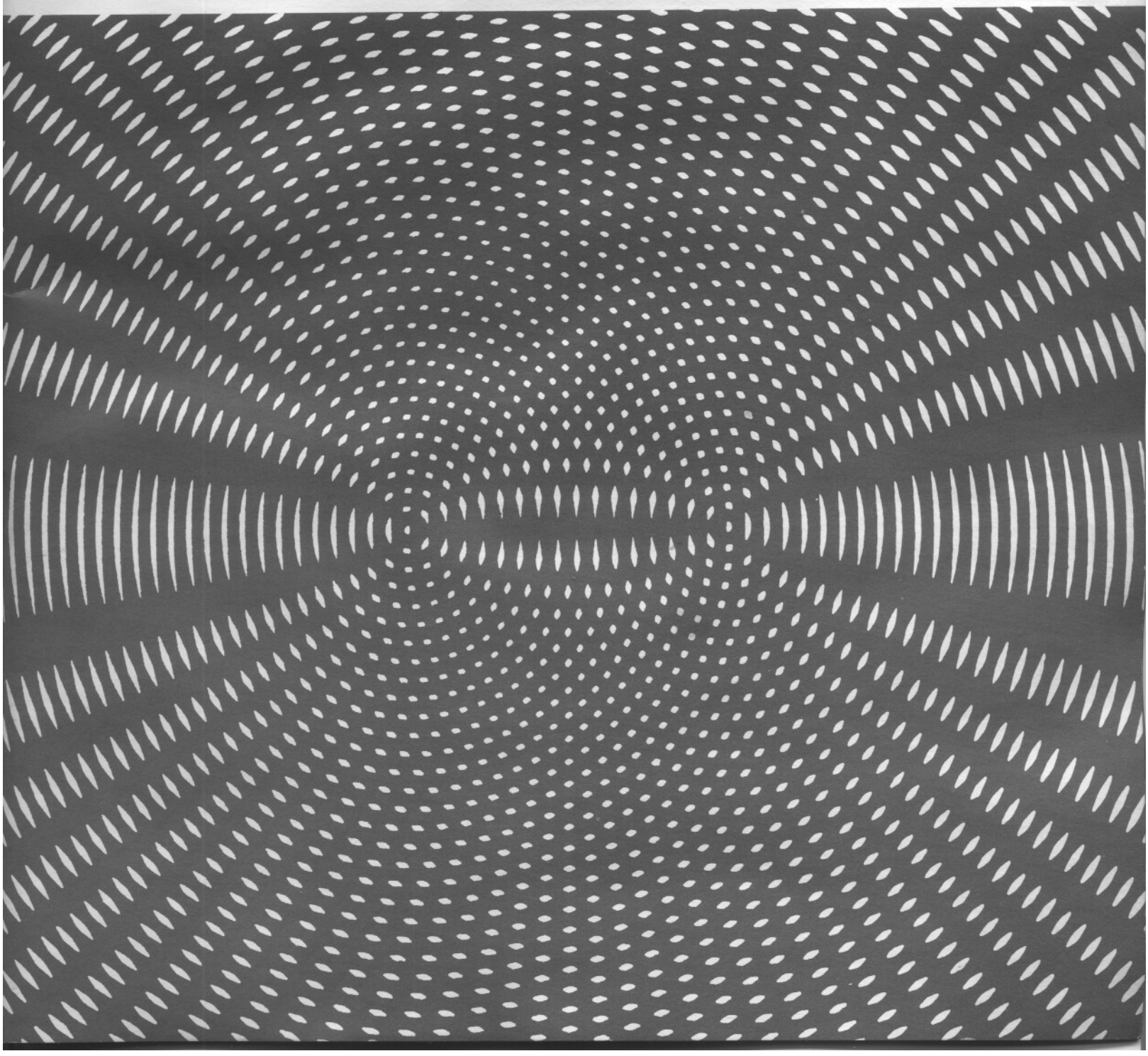
Summer Communique
1978

HOLOGRAPHY



HOLOGRAPHY

– from the Greek words holos "the whole," and graphein "to record." The term "holography" designates both the science and the process.

Hologram – is the ***product*** of holography from holos "the whole" and grammos "message" – "the whole message." A hologram is something like a photographic image – made on photographic film and can be projected into space. It ***must*** be made by the light of a laser.

The technical definition is –
A hologram is a record of the patterns made by interfering wavelengths from a coherent light source (a laser).

Laser is an acronym
Light **A**mplification by **S**timulated **E**mission of **R**adiation.

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Cover: The interference of continuous waves from two sources, at the same frequency, illustrated by the superposition of identical sets of concentric circles.

The history derives from the literature of the Museum of Holography in New York City. Writers for the museum are: Rosemary Jackson, Director, Edward A. Bush, Director of Information Services, and Susan Houde.

Other information comes in part from the teaching of Dr. Tung Jeong at his workshop at Lake Forest College, Illinois.

Among his other accomplishments in the development of the science of holography, Dr. Jeong is credited with the invention of the first 360° hologram in 1965.

Comparing a Photograph and a Hologram

Both are exposed by light onto a photographic emulsion (usually silver halide) on film or plate or emulsion on some other support.
Photography may be exposed by various light sources;
Holograms by the light of a LASER only –
A coherent monochromatic light Source.

Photo 3D (except by Cinerama and Stereo) can only be seen in 3 or more separate photos exposed by a camera from at least 3 separate positions (head on and both sides).
Holograms are 3D in one hologram and the VIEWER must change position (head on, side ways or up and down) to see a different perspective (parallax). Viewer does not move if hologram is moving.

Photos in color must be made from color film and expensively processed.
Holograms have a great range of color even though processed from black and white emulsion.

A light meter is used to measure exposure in both. **For a hologram, one measures each beam at the film plane.**

Resolution – Photo film emulsion is about 30 lines per millimeter.
Hologram film is as many as 3000 lines per millimeter (Agfa Gaevert 8E75 film).

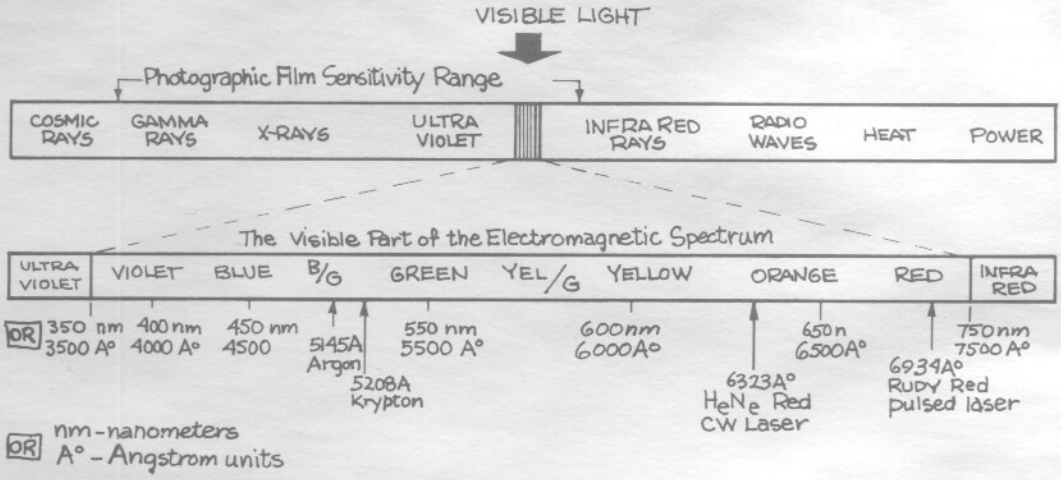
Viewing – Photographic image on paper/plastic is preferable or projection onto a surface.
Hologram – Reflection or transmission from film or projection into space (by white light or laser).

A photograph can be made of a photograph; **a hologram can be made of another hologram.**

History

Dr. Dennis Gabor invented the concept of holography in 1947 using only a mercury vapor lamp. The results, however, were dim, blurry images which Dr. Gabor found discouraging. Then, in 1960 at the Hughes Aircraft Company Research Laboratories in California, a man named Theodore Maiman invented the first laser – a pulsed ruby laser. Others had been working on the concepts of lasers and holography at about the same time. The first commercial laser was sold by TRION Instruments, Inc. to Texas Instruments, Inc., and white light *reflection* holography was developed in 1961 by Y. N. Denisyuk of the Soviet Union. Two men from the University of Michigan, Emmet Leith and Juris Upatnieks, developed *transmission* holograms, using the off-axis method to split the laser beam. (Dr. Gabor's technique is now called "The Classic In-Line" method.) The invention in 1960 of the continuous wave laser by Ali Javan of Bell Telephone Laboratories made holography easier. This steady, sharper and less dangerous beam, plus the new off-axis method of arranging the components, allowed the science of holography to jump forward immensely. The off-axis way is to split the beam, which is not difficult. With an ordinary piece of glass set at a 45° angle, half of the beam goes

The Electromagnetic Spectrum



through the glass, and half is deflected. One beam is directed to the film with original wavelengths; the other beam is directed to the object to be recorded, the wavelengths are somewhat altered, and the two beams meet at the film. The wavelengths form a pattern at this meeting. Both beams retain their coherency (the wavelengths are *in phase*).

In 1966, the first hologram of a human figure was made with a pulsed laser, by L. D. Siebert of Conductron Corporation. In 1968, Stephen Benton of Polaroid Corporation developed the *white light* transmission hologram (now a hologram could be seen by light other than laser light). And in that same year, artist Gerry Pethick invented the sandbox vibration isolation system, which enabled "ordinary" people to experiment with holography (the scientific way is more precise but is also much more expensive).

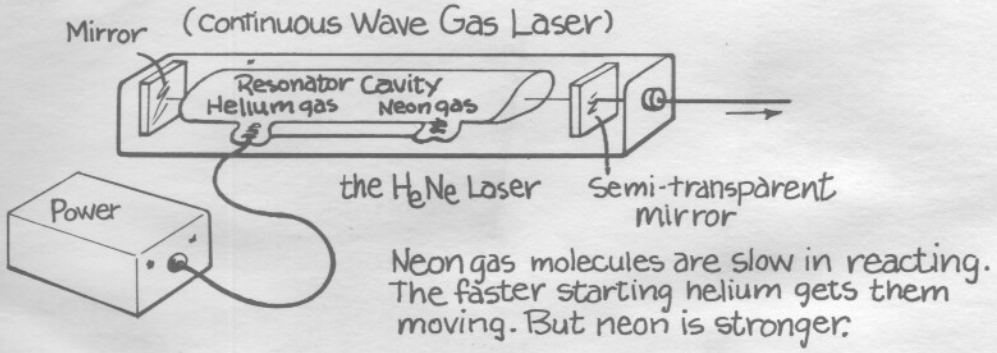
Why relate here all this history and all these obscure names? Well, soon you will be hearing more and more about the uses of holography as they affect things all around you. As with the growth of the movie industry, from scientific invention, passing into the hands of circus promoters, and arriving now at big-time artistic achievement, so will be the growth of holography. It has already moved, in a big way, from science and engineering into medicine, dentistry and industry.

Now holography has become a "new art form" and is in the process of revolutionizing the movie and television industries. Experiments have been conducted with holographic movies since 1967, by IBM, TRW and Bell Laboratories, as well as by the Soviet scientists. Why? Pretend you are a movie producer and could shoot your scenes on black and white film, transform them to a hologram by means of an inexpensive piece of plastic, and show your movie to an audience in color and 3rd dimension with no special viewing equipment – not even a screen. Think about saving those stupendous costs involved in color film and film processing. Isn't that quite an incentive?

In 1970, the first holographic art exhibition was held at Cranbrook Academy of Art in Michigan. In 1971, Dr. Dennis Gabor was awarded the Nobel Prize in Physics for his discovery of the principle of holography and Dr. Tung Jeong began his annual holography workshop at Lake Forest College Illinois. This same year, the first school of holography was started in San Francisco under the direction of Lloyd Cross. Another was opened in 1973, in New York City, directed by Joseph R. Burns, Jr. In 1974, at Columbia University, computer graphics and holography were combined in a holographic movie of a computer generated image. In 1975, the International Center for Photography in New York City held the exhibition "Holography '75: The First Decade," by Rosemary Jackson and Joseph Burns.[1] And in 1976, The Museum of Holography was granted a charter by the State of New York, with Rosemary Jackson as Director.

[1]Both Rosemary Jackson and Joseph Burns were alumni of Dr. Jeong's first Holography Workshop in 1971.

Inside a CW Laser



Holography

If the subject of this Communiqué intrigues you, please pay a visit to the Museum of Holography at 11 Mercer Street, south of Washington Square in the Soho District. Among the many exhibits you will see there is an Encyclopedia Britannica movie showing the theory and process of making a hologram. The demonstrator in that film is the man who will be the speaker for the Columbus Society of Communicating Arts on September 21, 1978. He is Dr. Tung H. Jeong, a nuclear physicist, and Chairman of the Department of Physics at Lake Forest College, Lake Forest, Illinois. Dr. Jeong has worked in many areas of holography and can well inform us of its applications. He is unique among physicists, in that he would like to see artists take up the medium of holography to see where it can go.

Salvador Dali is one artist who has made several holograms. Another artist, a woman by the name of Anait, has made a multiplex hologram (a moving drum) which is on display at the Salvador Dali Museum in Cleveland, Ohio.[1]

What do you experience when you see a hologram? Have you ever viewed a roomful of paintings by Monet? That's excitement! But compare the pigments of a painting, no matter how brilliant, to the pure colors of light itself. Think of the rainbow or the opalescence of oil on water, and *that* is what a hologram is like (although there are, also, achromatic holograms). Holograms do not always require a flat support, as do most traditional art forms. They can exist in space. They can be created with a computer to show things that do not exist. For example, from mathematical numbers, a building can be built with no blue prints necessary.

The following list of some of the uses of holography are from NASA publication SP 5118:

- Law Enforcement and Crime Prevention
- Banking and Economic Control
- Food Production, Processing, and Distribution
- Wearing Apparel and Household Furnishings
- Communications, Data Processing, and Transfer
- Education and Welfare
- Transportation
- Entertainment, Recreation, and Advertising
- Building and Construction
- Manufacturing and Instrumentation
- Business and Services
- Medicine and Public Health
- Chemical Industry, Drugs and Plastics
- Resource Maintenance and Management
- Aerospace Exploration and Utilization
- Defense

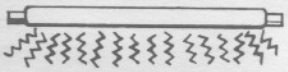
[1]24050 Commerce Park Road in the Beechwood area east of Cleveland. (Phone before arrival, 216-464-0372.)

Non-Coherent Light

Tungsten Bulb

A mixture of single rays of light makes "white light".

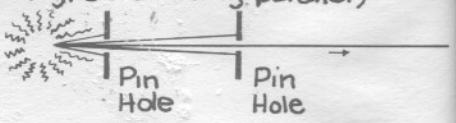
Fluorescent Tube



Gives off intermittent not steady, mixed rays

Point Light Source

Collimated Light
(Rays forced into some degree of being parallel)



Elaboration

Data•Holographic techniques make it possible to store a large amount of information in a small space, 200 times as much as microfilm or microfiche, and to read it back at higher rates of speed.[2] Holograms can be stored on different planes within the emulsion. Retrieval is in 3D.

Art•Museums are making holograms of their treasures a) as replicas to be sent on loan instead of the original; b) in case of loss due to decay, damage or theft. The statues of Venice, Italy have been recorded by holography to preserve the image of their present state, in view of future erosion. Art objects damaged by accident or vandalism can be reconstructed or restored.

Law•Document clarification and object reconstruction for evidence.

Analysis•Plastics, drugs, chemicals, plasma.

Liquids•Measurement of sprays and pollutants.

Mapping•Aerial, oceanographic, oil exploration.

Transportation•Traffic flow, aircraft landing in low visibility conditions.

NDT•Non-destructive testing in manufacturing and maintenance – stress, weak points; measurements of deviations from standards.

Interferometry•Horticulture, medicine, cancer, bones, tumors, tissues, disease, pregnancy – measurement of growth, decay, change or rate of change.

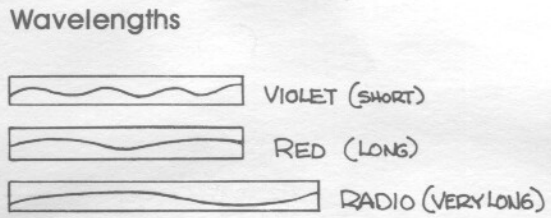
Metal•Small parts working (watch parts), welding, drilling small holes (needles).

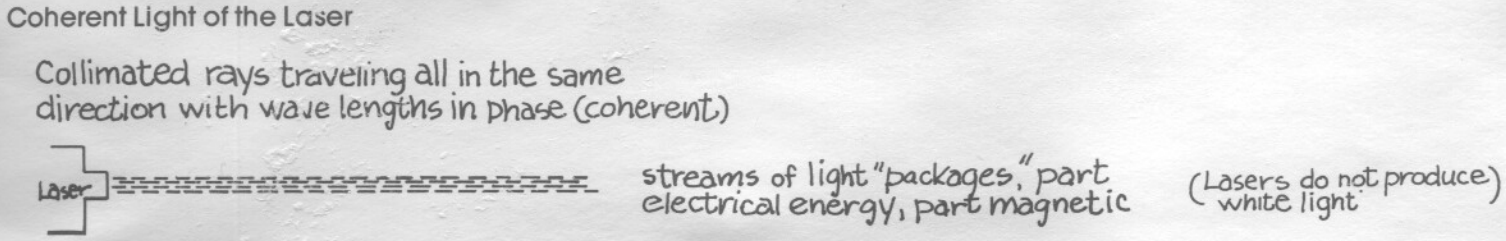
Supermarkets•The laser reads the symbols on the packages. Holography tells the computer what to charge the customer.

Acoustical holography, liquid surface•Here, there is no photo processing; instead, sound waves cause ripples on the surface which can be read by light waves. This information appears on a cathode ray tube. This method is useful in medicine, oceanography or wherever there is interference from vibration. Acoustical holography and computers make a great combination.

Education•Training films, displays, exhibits.

[2]Also from NASA SP 5118.





Technical

A nutshell version only will be included in this article. There are many different "set-ups" used in holography, according to the purpose. Different kinds and sizes of lasers are used. *Creative* holography, as distinguished from industrial and medical holography, has *two basic forms;* reflection, and transmission. Lasers used for creative holoraphy are ususally ga[illegible] (helium, neon and argon and/or krypton). Holograms of moving subjects must be made with pulsed light lasers, as in strobe flash (stop action) photography. Pulsed light lasers contain a solid rather than a gas, a rod of imitation "ruby." Energy is applied to the molecules of the material contained in the laser. These molecules becom[illegible] "excited" and some are relea[illegible] a *coherent* stream. It is this quality that distinguishes the l[illegible] wavelengths from white light, which is a mixture of non-coheren[illegible] wavelengths (out-of-phase).

Creative Uses for Advertising, Promotion and Public Relations

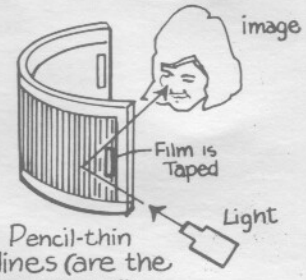
Display is the biggest use, and the most practical at present. Some who have used holography for these purposes are:

- General Motors International Building in New York City used an octagonal case with 4 windows showing alternating holograms of an automobile and a Napoleonic coach.
- A jeweler's display at Cartiers on [illegible] Avenue had a female hand [illegible]ng a diamond bracelet [illegible] appeared to dangle out over the sidewalk.
- Fisherman's Wharf, San Francisco – The New Museum of Witchcraft and Magic had a witch holding a ball which contains a second hologram. (It may be the one that was at Disneyland.)
- The Disneyland "Ghosts."
- McDonnell-Douglass at a trade show in Detroit had impressive 3' high holograms of a DC jet and scuba divers.
- The Quaker Oats Company used finger rings with holograms as premiums in cereal boxes.
- Japan's large-scale projections of television.
- Typesetting and communication.

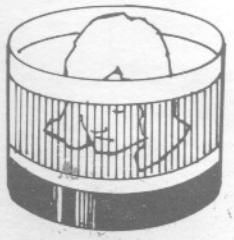
What can you imagine here for your client, your product or your service facility?

Consider trade shows, lobby and window or showcase displays, film strips, light shows. Once you have felt the magic of holograms, your imagination should expand.

Viewing a Multiplex Hologram

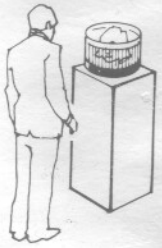


Pencil-thin lines (are the "negative") actually are mirrors which reflect the light.



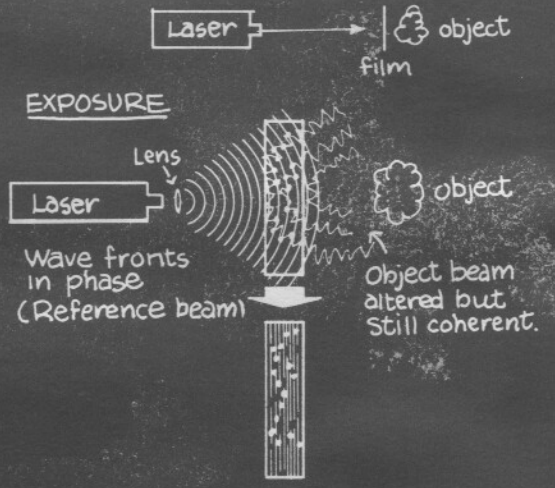
Mounted on a drum which may be motorized.

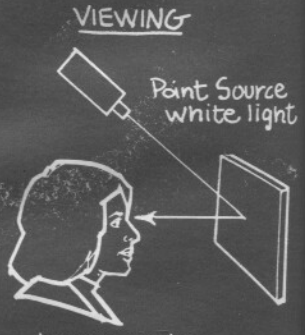
360° Hologram lit from above or below. Image is reflected into center space. Your portrait?



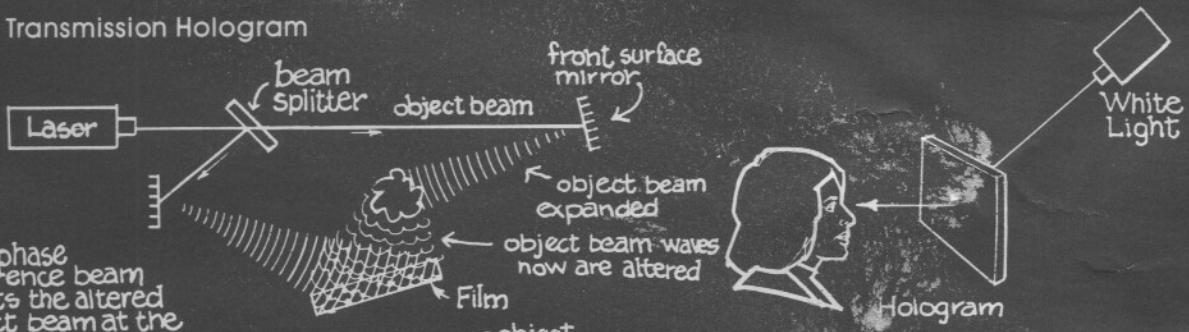
Two Basic Types of Creative Holograms

Reflection Hologram

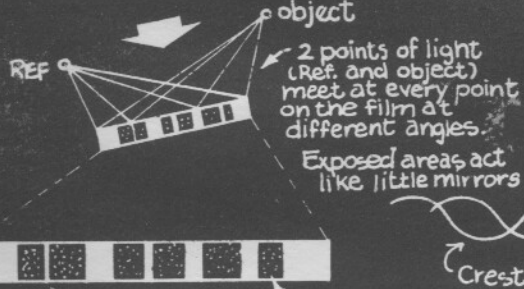




Transmission Hologram



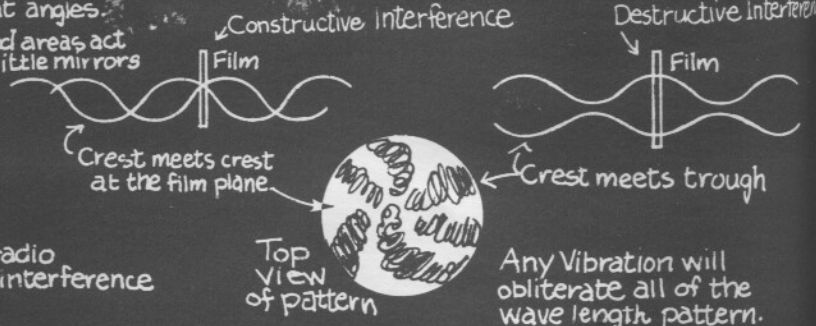
In phase reference beam meets the altered object beam at the Film plane to form a pattern.



The area of greatest intensity and of greatest exposure. Constructive interference.

area of less intensity (less exposure)

area of visual noise as static in radio destructive interference



Any Vibration will obliterate all of the wave length pattern.

8/14/78

Loren Billings
Director -

Hi,

Here is a copy of our quarterly "Communique". I told you I would send you. Reading the text so many times for corrections I missed a few on the spectrum. Now I hear that nano-meters are more often used than angstrom units. So 632.8nm is correct for Helium-Neon. I couldn't ask for all the changes - I wanted. The Design Studio was doing it for free, same as myself. (no type set for the diagrams (and I did not do the lettering). I also knew that argon + Krypton have other numbers also but I preferred to keep it simple.

The wave lengths DIAGRAM should have been with the spectrums and the viewing

of the transmission Holo should have been moved over.

I was asked to delete all the technical paragraphs in the beginning so I put a lot of that information into the Diagrams. That way we saved type costs. I deliberately left out the lenses etc. They (CSCA members) probably wouldn't be doing this any way. So by Bare theory they might get the gist of it better. If they want more, they can ask Dr. Jeong who can tell them better than I. Our quarterly goes to 500 people - top management officials throughout Calif area. Hope you get some visitors to your museum by it. you will surely be mentioned Sept 21. at meeting.

Hope to be your "student" one of these days.

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