N72-15414

NASA SP-5914 (02)

TECHNOLOGY UTILIZATION

SELECTED PHOTOGRAPHIC TECHNIQUES

A COMPILATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Foreword

The National Aeronautics and Space Administration and Atomic Energy Commission have established a Technology Utilization Program for the rapid dissemination of information on technological developments which have potential utility outside the aerospace and nuclear communities. By encouraging multiple application of the results of their research and development, NASA and AEC earn for the public an increased return on the investment in aerospace research and development programs.

This publication is part of a series intended to provide such technical information. A selection has been made of methods, devices, and techniques developed in the field of photography during implementation of space and nuclear research projects. These items include many adaptations, variations, and modifications to standard hardware and practice, and should prove interesting to both amateur and professional photographers and photographic technicians.

This compilation is divided into two sections. The first section presents techniques and devices that have been found useful in making photolab work simpler, more productive, and higher in quality. Section two deals with modifications to and special applications for existing photographic equipment.

Additional technical information on individual devices and techniques can be requested by circling the appropriate number on the Reader Service Card included in this compilation.

Unless otherwise stated, NASA and AEC contemplate no patent action on the technology described.

We appreciate comment by readers and welcome hearing about the relevance and utility of the information in this compilation.

Technology Utilization Office
National Aeronautics and Space Administration

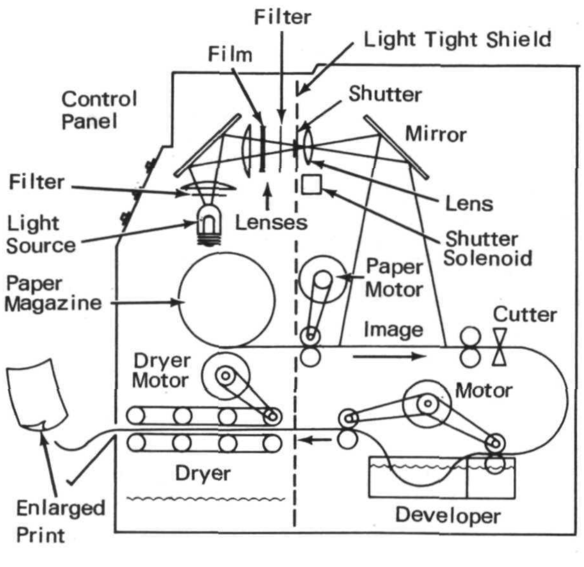
For sale by the National Technical Information Service, Springfield, Virginia 22151. **$1.00**

Contents

Section 1: Photolab Techniques and Devices

PHOTOGRAPHIC PRINT PROCESSOR

A photographic print processor converts negatives to enlarged, dry, positive prints with professional quality and high resolution (better than 100 lines per mm). The processor is capable of automatically producing multiple copies from a single negative at a rate of approximately three per minute. The gray tone range of the finished prints is adjustable to compensate for varying negative densities.



Optical elements (see fig.) direct the light from the source through the negative and onto the image plane. The photosensitive paper is stepped through the image plane to a cutter, developer, and dryer, and on to an external receiving tray. Those elements shown on the right side of the processor are separated from those on the left side by a light-tight shield, and the paper roll is contained within a separate light-tight housing. This permits the processor to be operated and serviced in a daylight environment.

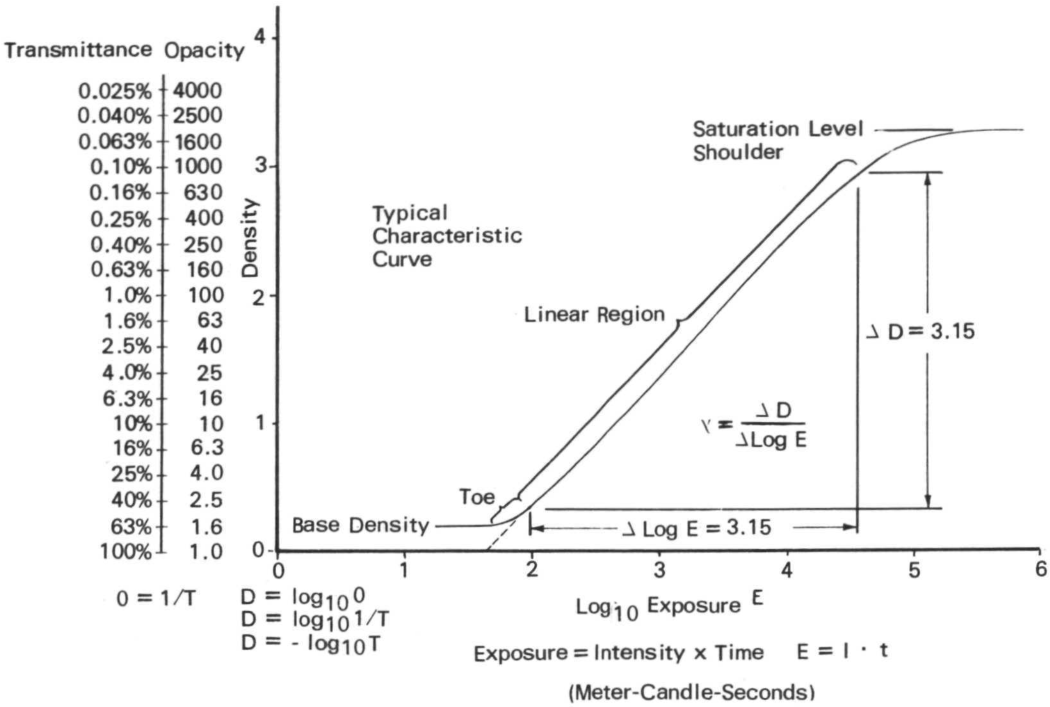
Source: P. Epstein and R. F. Santucci of
Electronic Image Systems Corp.
under contract to
Goddard Space Flight Center
(GSC-11073)

Circle 1 on Reader Service Card.

LINEAR RANGE OF FILM DEVELOPERS EXTENDED

A combination of developer chemicals has extended the linear range of recorded information on photographic film. The recorded brightness range of a Ronchi ruling on exposed film was used to conduct a controlled experiment that produced repeatable results. Initial experiments demonstrated a capability of recording subjects with a brightness range in excess of 15,000:1. Results indicated that a much greater brightness range could be accurately recorded, but that limitations in the equipment used prevented carrying the experiment further.

The brightness range (15,000:1) was encountered while recording the spatial frequency spectrum obtained by illuminating an optical square wave (Ronchi ruling) with laser light. Since standard methods were used to record the low-brightness orders, considerable "overexposure" was necessary, causing "burn in" of the high brightness orders. Conversely, an exposure set to record the high brightness orders resulted in the loss of the lower orders. Rather than use a multi-layer film or plate (such as X-ray which exhibits poor resolution, or extended-range film which requires color processing), a low-gamma developer was formulated for use with conventional, single-layer emulsion laboratory plates.



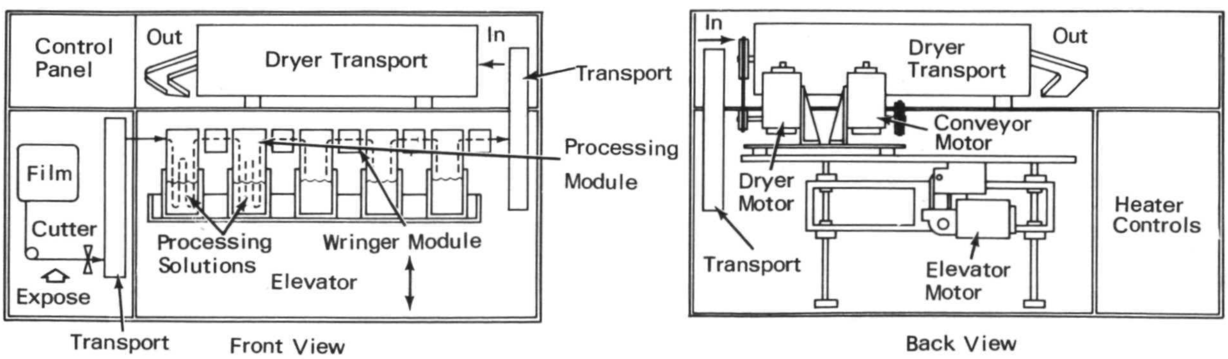
The maximum density of photographic emulsions is on the order of 2.5 to 3.5 (see fig.). In order to record a 1,000:1 exposure brightness range within an emulsion density range of from 0.3 to 2.3 (base fog level and top of linear portion of curve, respectively), the gamma must not be greater than 0.67. [2/3 = (density range)/(log10 exposure range)].

Source: O. G. Turner of
Lockheed Electronics Co.
under contract to
Goddard Space Flight Center
(GSC-10632)

Circle 2 on Reader Service Card.

PHOTOGRAPHIC FILM CHIP PROCESSOR

An automatic, self-contained, versatile processor separately develops and drys individual photographic negatives or film chips, and can be loaded, operated, and serviced in daylight. The processor (see fig.) includes four major subsystems: a film magazine and cutter assembly,



a processing bath, a film chip transport, and a dryer. The dryer subsystem is contained in an upper compartment, and the remaining subsystems in lower compartments that are light tight from one another and from the dryer.

During processor operation, film in the magazine is guided past an image plane where the desired exposure is made and the chip is separated by the cutter. The chip transport carries the chip up to the processing bath module where the chip is held between polyurethane belts which pass it through the processing and rinsing baths. Between the baths, the film is passed through wringers that remove any excess solution and isolate one process solution from the next. The last wringer in the line delivers the chip to a second transport that feeds it into the dryer. In the dryer, heated air is blown through nozzles and over the chip's emulsion surface at an angle that scrubs the moisture from the emulsion. The chip, suspended by its edges, passes through the dryer between O-rings that expose successive edge portions so that the chip emerges entirely dry and without curl as it falls into an output tray.

Source: P. Epstein, G. Donovan,
and E. LaWhite of
Electronic Image Systems Corp.
under contract to
Goddard Space Flight Center
(GSC-11074)

Circle 3 on Reader Service Card.

DIAGNOSTIC X-RAY FILM IDENTIFICATION SYSTEM: A CONCEPT

A proposed concept would have a small area of an X-ray film holder masked with an X-ray opaque substance, with several small computer-type alphameric readout modules mounted in the machine frame. These modules could be preset to any alphameric combination by a set of switches external to the equipment.

When the "dark-slide" is removed from the film holder, the modules are pulsed "on" long enough to expose the film with the appropriate identification. The ease of establishing the identification code by simply selecting switch positions is an advantage over previous practice in which it is necessary to remove a carrier, physically change the rather large lead numbers, and then replace the carrier. The proposed concept, in high production, multiple patient situations, relieves the operator of the need to enter and adjust the equipment for each patient.

Source: D. J. Winslow
Marshall Space Flight Center
(MFS-20291)

No further documentation is available.

HEAT WRITING IDENTIFIES PHOTOGRAPHS

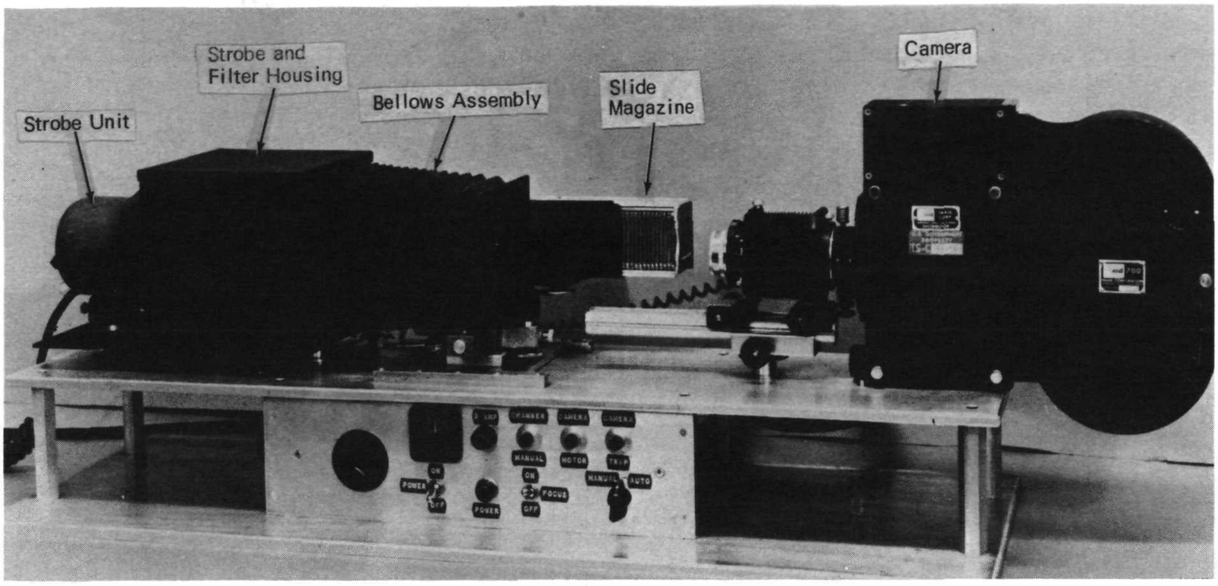
A pencil-tip soldering iron can be used to identify photographs by writing pertinent information on the emulsion side. The conventional method of writing such information on the reverse side places a special burden on the person using the photograph for reference. The new method avoids the necessity of looking on the reverse side, and is helpful in laboratory work involving the identification of oscilloscope trace photographs taken with a hand-held camera.

Source: J. Craft of
Chrysler Corp.
under contract to
Marshall Space Flight Center
(MSF-14362)

No further documentation is available.

SLIDE-TO-STRIP FILM COPYING DEVICE

This semiautomatic copying device reproduces 35 mm slides onto continuous 35 mm film for use with continuous display projectors. The unit is made from commercially available photographic equipment (see fig.) consisting of a 35 mm camera, a slide changer, a strobelight, and a housing for the strobe unit and filters. Electrical circuitry controls the sequential activation of the components.



The strobe unit provides the light for film exposure and a bellows assembly permits discrete focusing through the use of a secondary light source built into the filter housing. When focusing has been completed, a cartridge with as many as 36 slides is inserted and the slides are sequentially recorded on the roll of 35 mm film. A potentiometer on the control panel permits cycle (exposure) time selection during the automatic mode.

Source: L. Shapiro and J. Byrne of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-02483)

Circle 4 on Reader Service Card.

PLASTIC FILM ELIMINATES SILK SCREENING OF EQUIPMENT PANELS

A new technique makes it possible to apply or revise equipment panel designs and nomenclature quickly and inexpensively. Prior art used the silk screen process that requires appreciable surface preparation plus considerable drying time following application.

The equipment panel design layout is shot on regular photographic film. After film development, the emulsion side of the film is opaqued with a colored material that sharply contrasts with the panel surface. The opaque backing is then coated with an appropriate adhesive, and the film is trimmed to size and impressed on the equipment panel.

Source: D. R. Conger of
North American Aviation, Inc.
under contract to
Manned Spacecraft Center
(MSC-798)

Circle 5 on Reader Service Card.

"TUFF" COATING APPLICATOR

This simple, inexpensive device automatically applies a constant, preselected, protective coating to photographic film while simultaneously removing all foreign matter from the film surface. Figures 1 and 2 illustrate the improvement provided by this device over the old method of wiping the film with a hand-held cloth that has been dipped in the coating solution.

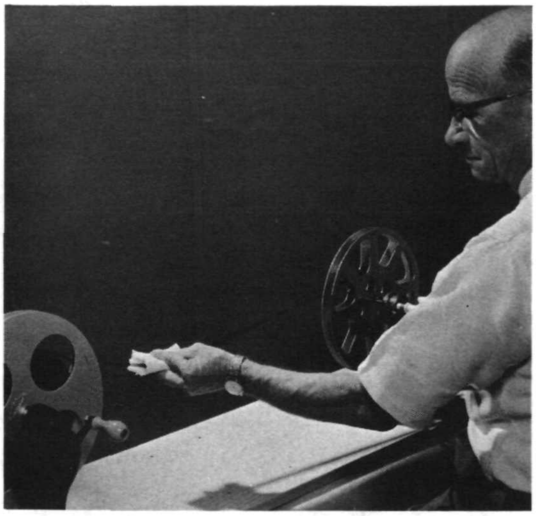


Figure 1.

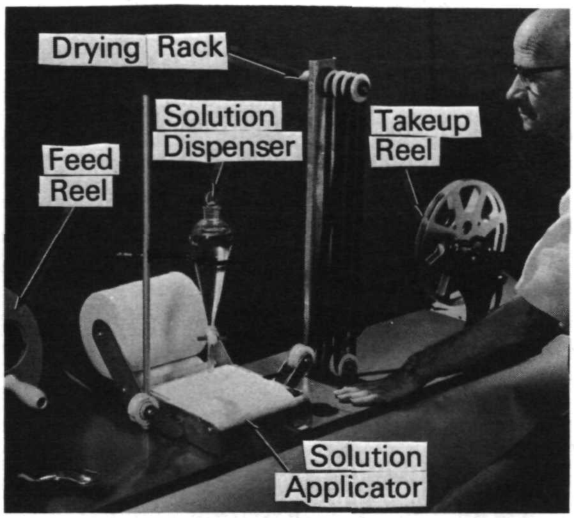


Figure 2.

Rotating the takeup reel (see Fig. 2) draws the film off the feed reel, through the solution applicator, and over the drying rack for storage on the takeup reel. The solution dispenser outlet permits the coating solution to be metered to the volume required by the film travel speed. The drying rack permits much greater film travel speed than was possible in the old method (see Fig. 1).

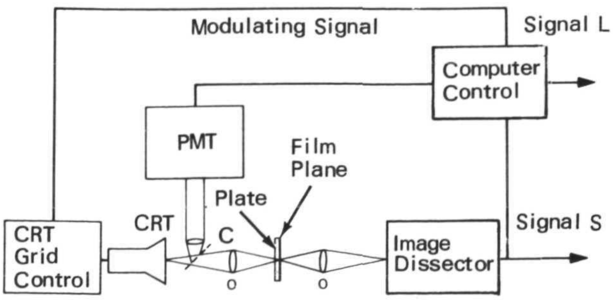
Source: F. E. Griffith of
General Electric Co.
under contract to
Marshall Space Flight Center
(MFS-13755)

No further documentation is available.

ELECTRO-OPTICAL SCANNING OF FILM

This method obtains an acceptable signal-to-noise ratio from the camera of a flying-spot scanning system when there is a wide range of transmissivities within a given frame of film. In areas of low transmissivity, more light is required in order to effect a camera-tube output of sufficiently high signal-to-noise ratio. Illumination of the whole frame with a light of higher intensity could cause a "flare" effect, especially from the areas of high transmissivity.

The new method produces the operation of a scan-in/scan-out flying-spot scanning system that recognizes three different ranges of transmissivity within a frame. Selectively, it acts on these levels either to intensify the illumination or to extend the duration of the illuminating spot at any picture element. Thus, it



improves the ratio of signal to tube noise in the camera's output.

The increase in illumination at a picture element, necessary to raise the camera-tube output signal to a usable level, is effected by means of a closed-loop modulated illumination system that senses the level of the tube's output signal. If the level is low, the system increases the intensity of spot illumination; if it is very low, the spot dwells on the picture element for a sufficient length of time to allow integrating the output to a usable level. Confining the illumination to a spot decreases the system aperture, and so, greatly reduces the flare effect.

By separating the required illumination and defining the system apertures, the technique provides for the production and control of the light brightness, but minimizes the effects of phosphor decay, halo, astigmatism, scanning-spot size, etc. With the use of a controlled brightness of light, a high signal-to-noise ratio can be achieved for each scanned element of the image.

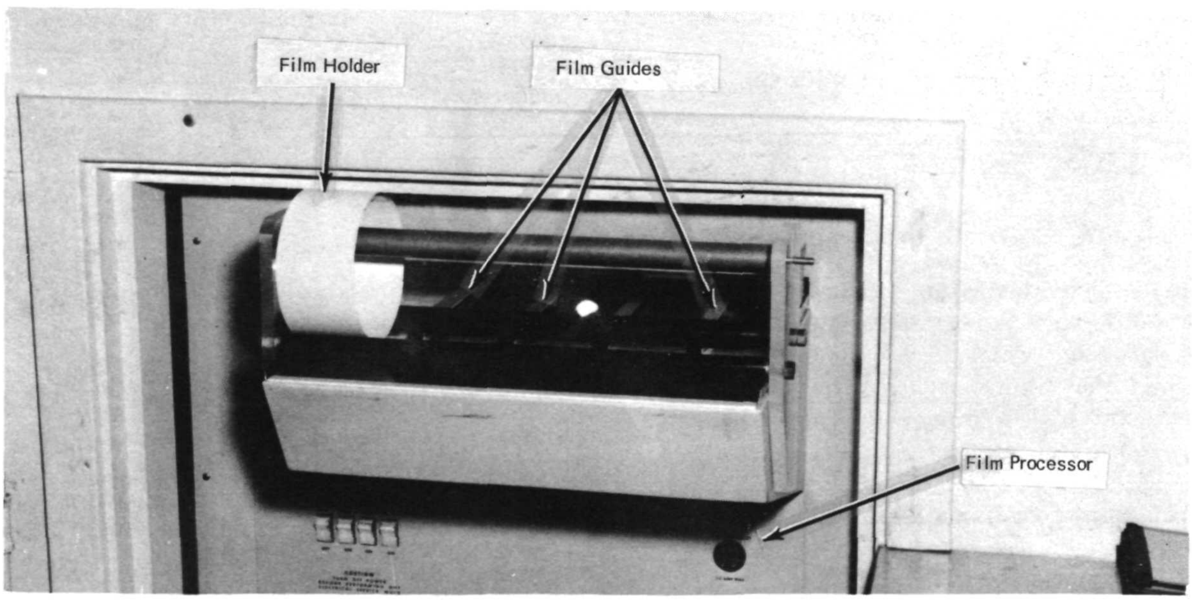
The illuminator (scan-in component) is not limited to any particular source of light; sources may include cathode-ray tubes, incandescent lamps, arc lamps, and lasers. For scanning an extended dynamic range, the scan-out component may be a nonstorage type of camera tube such as a scanned photomultiplier tube or an image-dissector tube. Storage types of camera tubes, such as vidicons, image orthicons, isocons, or emitrons, may be used within their respective dynamic range capabilities.

This invention may interest those concerned with the storage or computer correction of photographic images.

Source: F. C. Billingley and J. J. Volkoff of Caltech/JPL under contract to NASA Pasadena Office (NPO-11106)

Circle 6 on Reader Service Card.

FILM FEED AND GUIDE FOR AUTOMATIC X-RAY FILM PROCESSORS



A film rack roller (see fig.) provides automatic, unattended feed and guide for processing X-ray film. Up to 5 reels of X-ray film can be fed into the processor, and the film can be suspended in a manner that prevents the inclusion of extraneous matter (artifacts) normally encountered through dark room handling procedures.

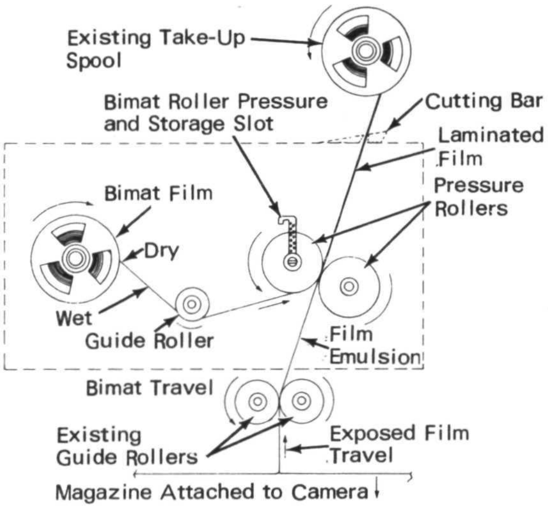
The rack roller assembly is placed on top of the film processor feed tray, and the exposed X-ray film is stripped of its wrapping, rolled in a loose coil, and placed on a drop-in roller at the rear of the rack assembly. The assembly feeds the film into the processor without further operator handling, thus preventing possible film contamination. This feed and guide assembly can handle five rolls of 70 mm film simultaneously.

Source: F. E. Sugg of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-16931)

Circle 7 on Reader Service Card.

MAGAZINE BIMAT PROCESSOR: A CONCEPT

A proposed method would permit rapid, on-site processing of photographic film by using existing film magazines to complete the processing as the film is exposed. The present method of exposing the film, delivering it to a photolab for processing, and returning it to the user is costly and time consuming when early analysis of the film is desired.



A standard magazine is converted to a Bimat processor by adding three stainless steel rollers (one guide and two pressure). The exposed negative and Bimat film are laminated by the pressure rollers and wound on the take-up spool (see fig.). The Bimat transfer film consists of a 4-MIL polyester film with a hydrophilic gelatin layer containing physical development nuclei. All chemicals required for processing and fixing the negative are contained in the Bimat film.

Source: C. E. Park of
The Boeing Co.
under contract to
Kennedy Space Center
(KSC-06786)

Circle 8 on Reader Service Card.

HEAT-SHRINKABLE TUBING PREVENTS CORROSION OF RACK BARS IN X-RAY FILM PROCESSOR

A recently developed technique uses heat-shrinkable polyvinylchloride tubing around the rack bars in X-ray film processors to prevent corrosion of the bars. In the past, this corrosion resulted in contamination of the processing solution and impingement of undesirable artifacts on the X-ray film. The stainless steel bars required frequent polishing to retard corrosion due to the reactive quality of the processing solution.

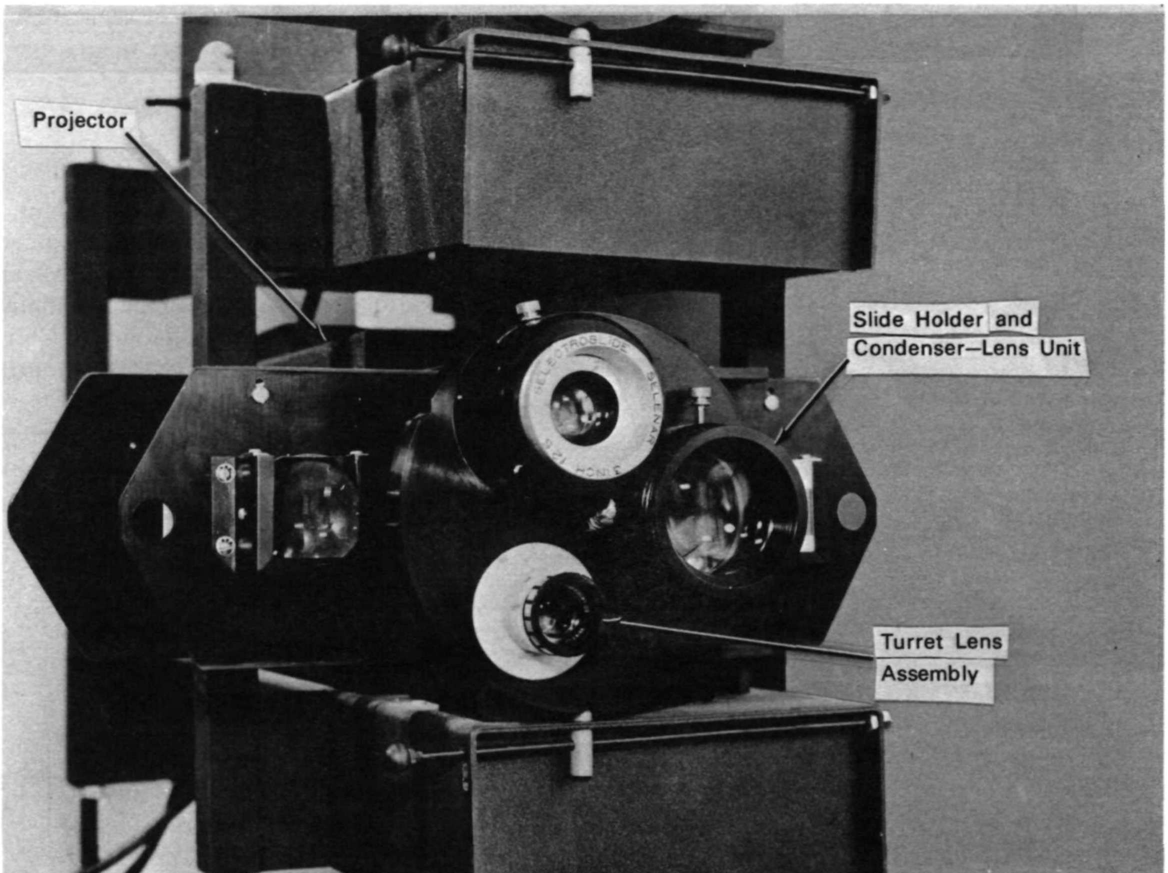
In one application, a total of 18 stainless steel rack bar assemblies, in a standard, commercially-available X-ray film processor, were improved by the installation of polyvinylchloride heat-shrinkable tubing that eliminated solution contamination by corrosive particles. This technique improved film quality and eliminated daily rack cleaning since the processing solution was nonreactive with the polyvinylchloride tubing.

Source: G. W. McClelland and J. W. White of North American Rockwell Corp. under contract to Manned Spacecraft Center (MSC-15781)

No further documentation is available.

SINGLE PROJECTOR ACCOMMODATES SLIDES OF DIFFERENT SIZE AND FORMAT

A new slide projector will accommodate 35 mm double-frame slides on a horizontal or vertical format without requiring the internal condenser-lens assemblies to be changed or substituted.



The projector has two adjustable external units. One, the holder for different size slides, includes a means for mounting appropriate condensing lenses and heat filters. The other unit is a turret lens assembly.

The projector uses a standard light source. The slide holder condensing lens unit is mounted between the light source and the turret lens. All lenses are prefocused, requiring only occasional adjustment. These units allow a desired slide and the corresponding objective lens to be rapidly selected. With this machine, the slides can be rapidly changed in any sequence.

For special effects, two projector assemblies could be mounted, one above the other. A separate power supply and control panel provide unusual flexibility, permitting smooth transitions and dissolves from one display to the next without a break on the screen, as well as the superimposition of the displays from the slides in the two projectors.

For normal operation, one machine projects a slide on the screen while the second machine is being loaded with the next slide. When there is a cue for a slide change, a relay rapidly switches the light from one projector to the other, thus eliminating annoying movements of the display across the screen, brilliant light flashes, and blank screens. The control unit provides single-button operation of one or more projectors in conjunction with one or more screens.

Flexible operation, effective visual display, and relatively low cost are the main advantages of the system.

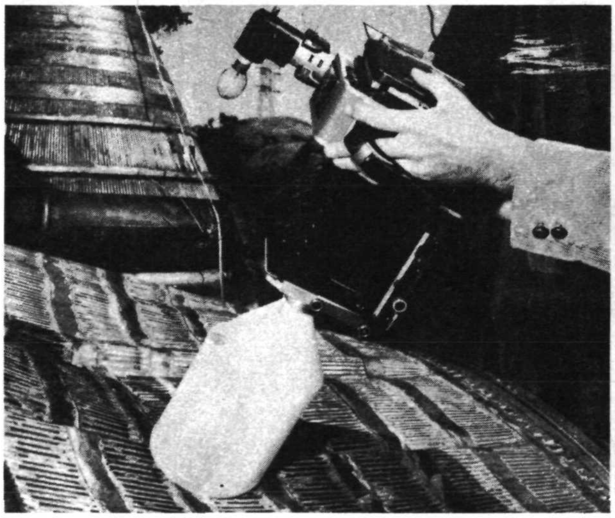
Source: G. M. Gates
Goddard Space Flight Center
(GSC-439)

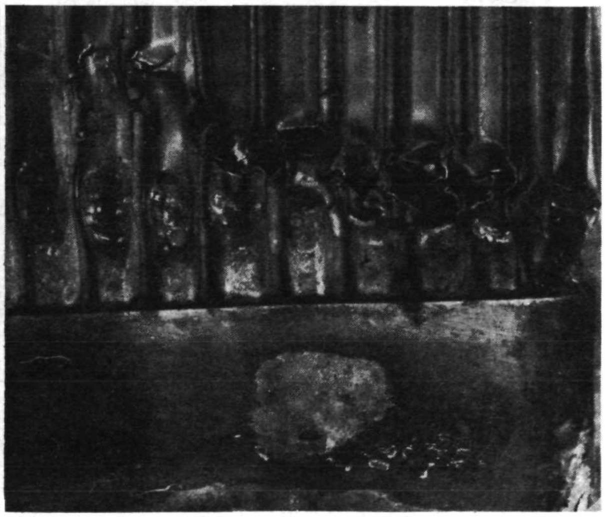
Circle 9 on Reader Service Card.

Section 2. Modifications and Special Purpose Applications

INSTANT FOCUSING AND FRAMING DEVICE

Instant focusing and framing of small objects or areas for macrophotography is possible using a throw-away plastic chemical bottle. The empty, translucent plastic bottle (see fig.)





is adapted to fit the camera lens housing. The bottom of the bottle is cut away, the camera lens and bottle neck are fastened together, and the lens board is positioned to permit accurate focusing to the location of the bottle's opposite end. Once set, the new lens board position is scribed on the camera bed, permitting the operator to quickly find the approximate point at which the camera would be in focus with the attachment in place. Critical focus is then accomplished with the standard rank focus knob.

With the attachment in place and the lens board reset to the scribed mark on the camera bed, the camera is placed over the small area to be photographed, which is framed exactly within the limits defined by the outer edge of the plastic bottle. The image is then focused critically using the camera's ground glass, and the camera bed is locked to that distance. The reflector on the flash attachment is removed and a bare flashbulb is used, providing soft diffused light for even illumination of the subject.

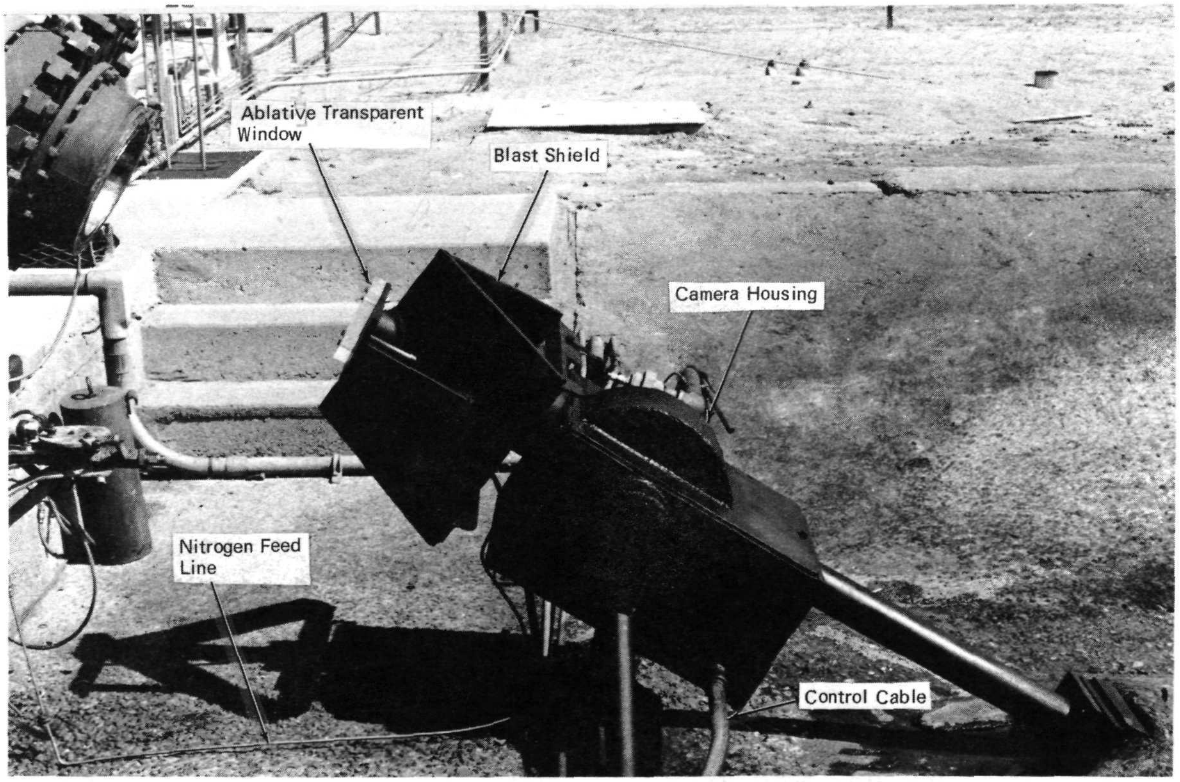
This technique may be employed during the in-field filming of close-up subjects, without the necessity for the bulky equipment required for normal techniques.

Source: D. H. Reese of North American Rockwell Corp. under contract to Marshall Space Flight Center (MFS-14161)

Circle 10 on Reader Service Card.

ENGINE COMBUSTION PHOTOGRAPHIC DEVICE

A protective device permits photographing the combustion process within a liquid propellant engine. A previous process involved a periscope attachment for the camera in a rather sophisticated arrangement that was considerably more expensive than the new device.



The camera housing, made from relatively thick steel plate, contains a cylindrical member in front of the lens to hold a flange which supports a thick, ablative, transparent window of polymethyl methacrylate and a wedge-shaped blast shield. Leading into the camera housing is a nitrogen feed that maintains an overpressure in the housing to prevent the entry of combustion gases during engine firing. The total device protects the camera from blast and, since the shield is not directly attached to the camera housing, post-run heat conduction to the camera is minimized.

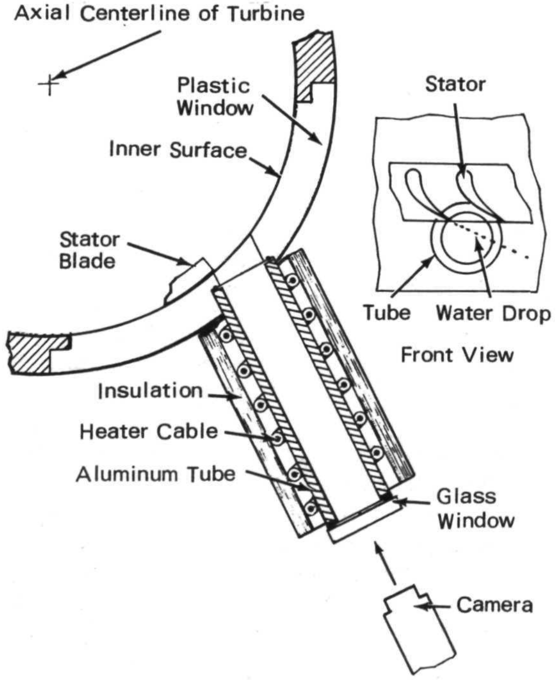
This device is placed a short distance downstream of the nozzle exit along the centerline of the exhaust jet. The window is located upstream of the point where the first shock would normally occur in the free jet. The presence of the shock caused by the window is not obvious as viewed by the camera from within the housing.

Source: R. M. Clayton and J. G. Sotter of
Caltech/JPL
under contract to
NASA Pasadena Office
(XNP-10840)

Circle 11 on Reader Service Card.

HEATED PHOTOGRAPHIC WINDOW PREVENTS CONDENSATION

A heated tube leading to a photographic flat glass window mounted in the casing of a steam turbine permits clear pictures to be taken of the flow of droplets within the turbine. Without this heat application, condensation on the window inner surface makes the gathering of useful photographic data relatively impossible. The flat glass window also eliminates possible distortion, which might be encountered from curved windows normally used without this heating device.



Axial View of Erosion Test Turbine

The photographic glass window is mounted outboard of the duct wall in an aluminum extension tube heated to a temperature slightly above that of the bulk steam. This assures evaporation of any condensation that may stream off the duct walls into the tube, and prevents condensation on the window. Both tube and heating coil are insulated to reduce heat loss and power requirements.

Source: J. R. Baughman and R. Spies of
North American Rockwell Corp.
and L. Hays of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-10890)

No further documentation is available.

ELECTROLUMINESCENT DIODES AS TIMING SIGNAL RECORDERS IN HIGH FRAME-RATE CAMERAS

A technique for replacing neon bulbs in high frame-rate cameras with solid state electroluminescent diodes has been developed.

Line source electroluminescent diodes of the silicon carbide type were successfully used to record pulse-width modulated timing code signals on 16 mm motion picture films at frame rates from 2 to 500 frames/sec, and at pulse rates from 10 to 10,000/sec. The reserve density and the sharp definition of timing marks indicate the capability for recording up to 1500 frames/sec. Tests and timing-signal recording-block design were for the Milliken DBM-5 camera with a maximum frame rate of 500 frames/sec. Type EF color film (ASA 160) was used for the maximum frame-rate tests. Two diodes were used to make duplicate recordings on each film edge, and diode electrical and optical characteristics and timing block optical-mechanical considerations were determined. The construction and use of six-channel diodes to record full digital data "words" across the soundtrack channel width, or to produce expanded digital data records along the length of the film and in fixed spacing relative to a corresponding pictorial record, are additional possibilities for future research.

Source: M. A. Kerr of
General Electric Co.
under contract to
NASA Headquarters
(HQN-10489)

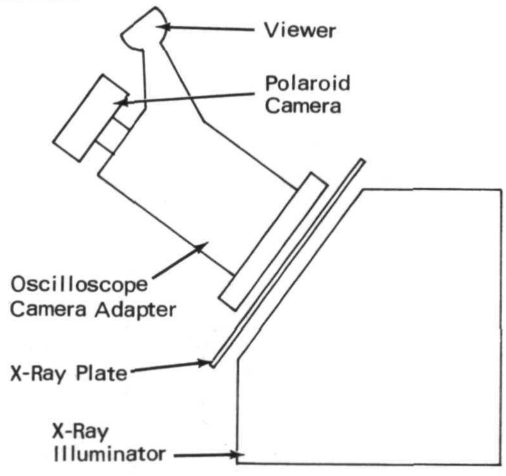
Circle 12 on Reader Service Card.

INSTANT COPY OSCILLOSCOPE CAMERA MAKES QUICK, QUALITY PHOTOGRAPHS OF X-RAYS

The adapter of this oscilloscope camera (see fig.) is positioned flush against the developed X-ray, and the X-ray is illuminated from the back with a standard X-ray reader. This arrangement allows the intensity of the illumination to be varied in order to emphasize certain areas of interest on the X-ray. Film exposure depends on the darkness of the X-ray image.

High-quality photos taken with this method show almost as much detail as the original X-ray and can be repeated inexpensively and rapidly. There is no focusing adjustment necessary. Photographing only the areas of interest on inspection-type radiographs allows the X-ray plates themselves to be put into permanent storage after photographs are taken, saving space in working files. In most cases, the area of interest involves only a small percentage of the total area of the X-ray. Quality photographs of this type may be taken by a technician or engineer familiar with the X-ray.

Use of this technique assumes the availability of an oscilloscope camera which, because of cost, would not be purchased specially for this application. Various copy cameras can be purchased at lower cost, are particularly suited for X-ray work, and possess degrees of flexibility beyond those contained in oscilloscope cameras.

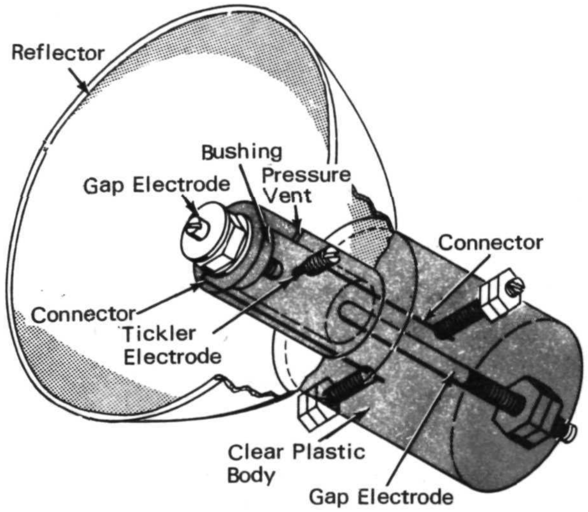


Source: G. J. Zillner of
Westinghouse Astronuclear Laboratory
under contract to
AEC-NASA Space Nuclear Systems Office
(NUC-10071)

Circle 13 on Reader Service Card.

SMALL HIGH-INTENSITY FLASHER PERMITS CONTINUOUS CLOSE-IN PHOTOGRAPHY

A compact, high-intensity spark-flash unit can be used as a light source for continuous rapid photography. The unit is a spark-breakdown flash source, enclosed in polymethyl-



methacrylate, and incorporating a parabolic reflector. Commercially available flashers are bulky, require collimation, and deliver more light energy than may be required. In some commercial designs, the units are subject to rupture or explosion.

The body of the flasher is machined in one piece from polymethylmethacrylate plastic. This material is highly transparent and has high rupture strength. All electrodes are made of stainless steel. The flasher operates at 8 to 10 kV which is discharged across the gap electrodes through an RC network. The discharge is triggered by a tickler electrode extending through the body into the gap. This electrode is powered by a standard 6 V ignition coil. A conventional parabolic reflector is used for beam collimation. The light pulses delivered by this unit have a duration of 1 to 5 μsec.

One unit of this design is still in operation and has been flashed more than 400 times without failure. Gap-area fogging is removed with solvent after each 100 flashes. The use of molded rather than machined bodies would effect a considerable savings in unit cost.

Source: C. Pascale of
the Guggenheim Laboratories,
Department of Aeronautical Engineering,
Princeton University
under contract to
AEC-NASA Space Nuclear Systems Office
(NUC-0043)

Circle 14 on Reader Service Card.

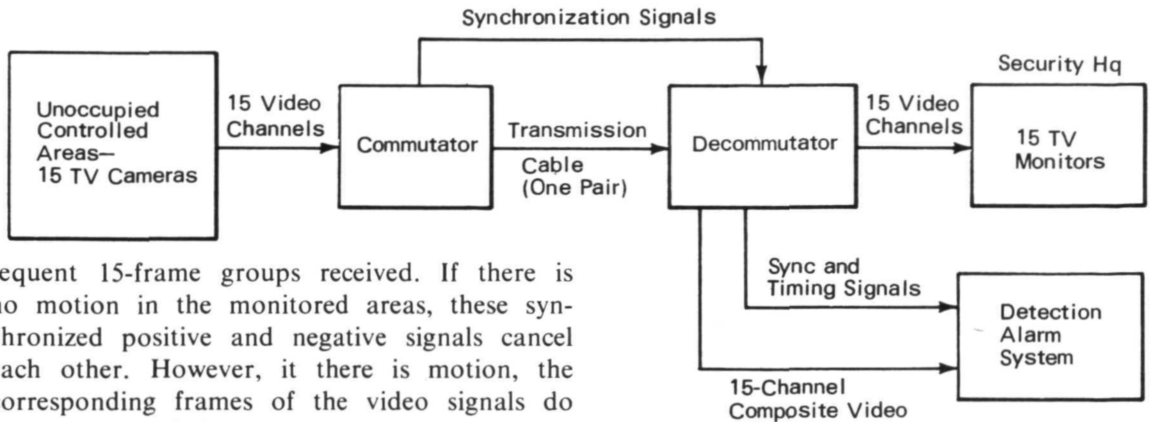
SECURITY WARNING SYSTEM SIMULTANEOUSLY MONITORS UP TO FIFTEEN REMOTE AREAS

A security warning system is capable of monitoring several remote or unoccupied areas simultaneously, and permits visual surveillance of each area. No such system is presently available commercially. One company designed a prototype, but it works with only one television camera and monitor.

The video motion detection system, consisting of 15 television cameras, monitors, and associated circuitry, utilizes a commutator and decommutator, allowing time-multiplexed video transmission. The television cameras are located in remote or unoccupied areas. When motion is detected by a camera, the system alarm sounds at the headquarters location, and an appropriate warning indicator lights up.

Video signal frames from 15 television cameras are sequentially combined within the commutator and transmitted along one cable pair to the decommutator. The decommutator reconverts the composite signal to the original video signal frames and channels them in proper sequence to 15 television monitors. The composite signal to the decommutator is also fed from the decommutator receiver to the detection alarm rack. The detection alarm system and the television monitors are housed in an equipment rack at the headquarters location.

The detection alarm system inverts the first 15 frames (1 from each camera) of the composite signal and records them on a video magnetic tape loop. The inverted frames are then played back and compared with the subsequent 15-frame groups received. If there is no motion in the monitored areas, these synchronized positive and negative signals cancel each other. However, it there is motion, the corresponding frames of the video signals do not match, and the system generates an output to the proper warning indicator and the system alarm.



The initial record phase requires only 1/2 sec. One complete scan of 15 frames of channels (1/30 sec. per frame) is fed through an isolation amplifier to an inverting amplifier and recorded on a video magnetic tape loop. A flip-flop circuit, controlled by a gate signal from a tape control switch, allows only one complete scan of the 15 channels to be inverted and recorded. The second gate signal of the decommutator resets the flip-flop, which in turn disables the recording circuit.

During the operating phase of the detection alarm system, a video tape recorder plays back the inverted 15 frames of video through an adjustable delay line (to insure proper synchronization) to an adder circuit. The adder circuit receives both a positive-going waveform (the composite video signal from the isolation amplifier) and a negative-going waveform (the recorded video signal from the tape loop). The signals are algebraically added in the adder circuit and an output voltage is produced only if there is a difference. A difference occurs if any motion is detected. Regardless of the adder output polarity, one of two Schmitt trigger circuits is triggered at a preset detecting level. The Schmitt trigger pulses are gated, and a simultaneous trigger pulse from the Schmitt trigger circuit produces an output from a one-shot multivibrator circuit. The output of the one-shot multivibrator is amplified, energizing a monitor indicator light, the equipment-rack indicator light and the system alarm.

If any motion is deıected by a television camera, one of the Schmitt trigger circuits produces an output simultaneously with a gate signal, and the appropriate monitor indicator lamp is lighted. A reset button, located on the equipment rack, restores any trigger circuit to an operational state when desired.

This security system could be used in industrial and retail establishments such as banks, large retail stores, warehouses, and factories.

Source: R. C. Fusco of
Radio Corporation of America
under contract to
Kennedy Space Center
(KSC-66-39)

Circle 15 on Reader Service Card.

VIBRATION ACCURATELY MEASURED BY PHOTOGRAPHY

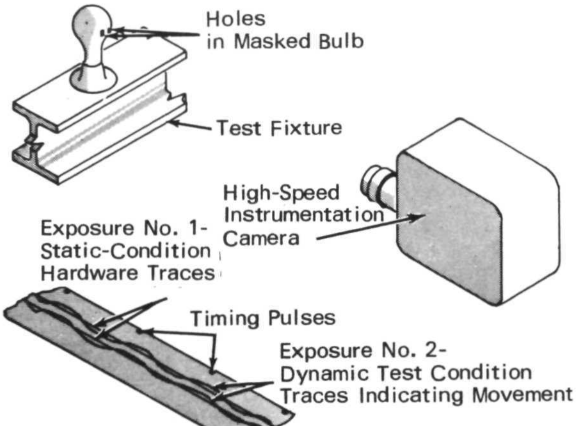
A photographic technique can provide an accurate, simple, and inexpensive means of measuring engine vibration when conventional electronic vibration instrumentation is unavailable. The method measures all established engine performance parameters.

The test setup includes a high speed instrumentation camera focused on a partially masked light bulb which is securely mounted to the test fixture. Two small holes are cut into the masking.

With the test hardware in a static condition, the light bulb is energized and the prefocused camera photographs the light rays emitted from the two small holes in the mask. The film is then rewound and used to photograph the same bulb during a dynamic test, with a timing trace added to the film edge. Any movement of the test fixture during the test is recorded on the film as a light trace deviating from the light rays photographed in the static hardware condition.

The amplitudes of the excursions are then computed by knowing the distance between the holes in the mask. The vibration frequency is determined using the timing trace added to the film on the second exposure.

The technique may be utilized to measure the lateral excursions of rotation shafts by backlighting the shaft and photographing its relative position under static conditions, rewinding the film, and reexposing with the shaft in the dynamic mode.



Source: K. A. Craig of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-1916)

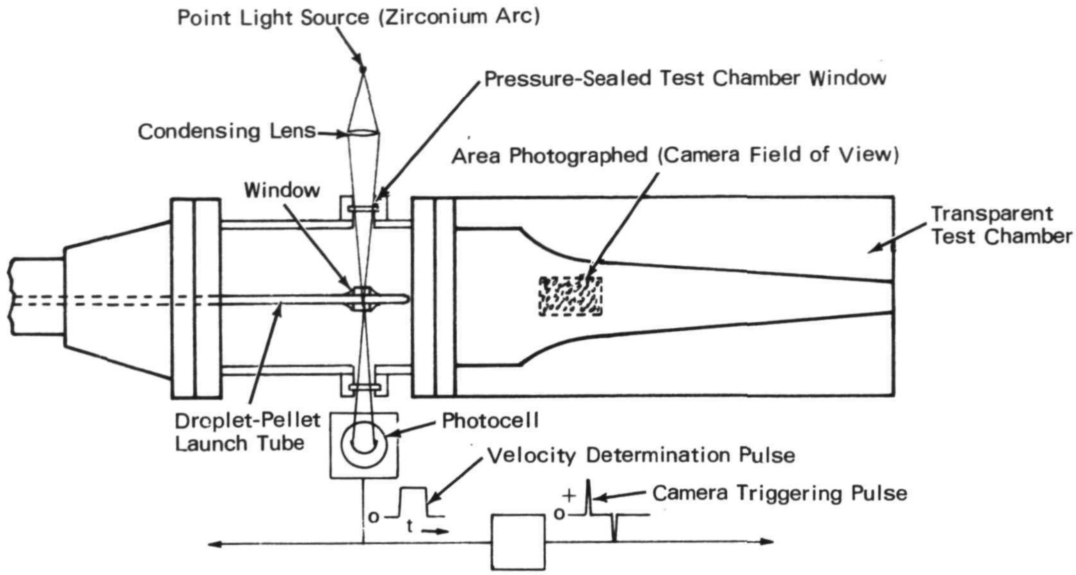
No further documentation is available.

HIGH-SPEED CAMERA SYNCHRONIZATION

The rotating mirror in a high-speed framing camera has been synchronized with the passage of a very-high-veloicity droplet to obtain direct photographic data on droplet breakup. Framing speed exceeded 250,000 frames per second. In this application, a photoelectric sensor was located upstream of the camera's field of view to detect the transit of the accelerating particle across a high-intensity light beam and to generate a signal which was subsequently conditioned to provide a timing pulse for controlling the rotating mirror.

Droplets are launched into a high-velocity air stream by a pneumatically driven pellet gun. Opposing windows are provided in the pellet gun barrel (launch tube) and in the outer walls of the test chamber. A point light source (zirconium arc) provides a high-intensity light beam through the windows to an external photoelectric sensor (photocell). Transit of the pellet during the droplet launching cycle interrupts this light beam, modifying the output signal of the sensor.

Conditioning of this modified signal provides a high-amplitude pulse which is used for camera triggering. The camera produces a gating pulse during operation, and electronic matching of these two pulses is adjusted to the flight velocity of the droplet, ensuring that the camera mirror (shutter) is in the correct position when the droplet enters the field of view. The camera must be operating prior



to the initiation of the triggering pulse, as at least one rotation of the mirror assembly is required to accomplish the matching of the two pulses.

This technique should be a useful tool for investigations of high-velocity interactions, where an optically discrete element can be isolated to provide the camera triggering pulse. Atomization, mixing, impact, deflection, and shock interaction phenomena can be readily recorded by this technique, for visual evaluation.

Source: E. A. Rojec of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-18062)

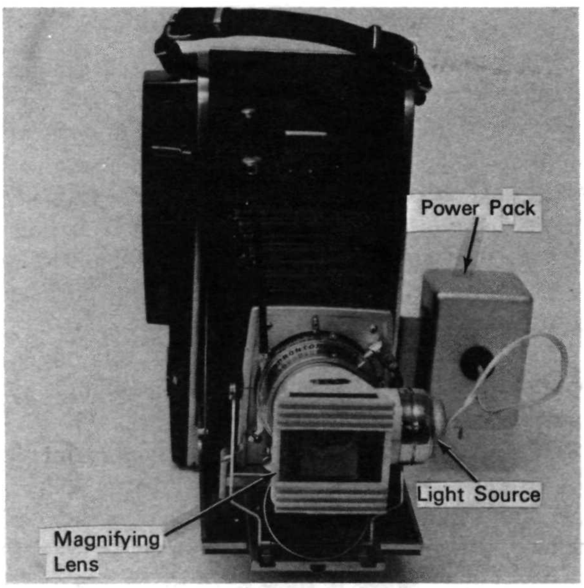
Circle 16 on Reader Service Card.

CAMERA LENS ADAPTER MAGNIFIES IMAGE

In the inspection of welds for possible flaws such as cracks or discontinuities, those that are not visible to the naked eye must be photographed in close-up and the negative must then be enlarged to bring out the required detail. All of this involves time and expense and adds delay to corrective procedures.

An illuminated 7-power magnifier adapted to the lens of a standard Polaroid Land camera can be used to produce enlarged photographs of the area under inspection.

The camera is modified by the addition of a magnifying lens and light source mounted in a depth-adjustable support bracket. The light source is diffused to eliminate hot spots or reflection. Power for the light source is supplied by two C-size dry batteries contained in a pack that is mounted on the camera case.



Weld flaws are first located by inspection with a 10-power magnifying glass and then photographed with this device, providing immediate pictorial data for use in remedial procedures.

Source: F. L. Moffitt
Marshall Space Flight Center
(MFS-11955)

Circle 17 on Reader Service Card.

HIGH-SPEED PULSE CAMERA

A miniaturized, 16 mm high-speed (up to 100 frames per second) pulse camera provides very uniform, controlled-duration exposures. The camera is designed to take a large number of accurate spectral photometric photographs upon instantaneous command, with a minimum of film-transport time between exposures. The design combines several high-performance features into a simple, reliable, compact, rugged, low-power package. The package includes a low-friction, low-inertia film transport; a very thin beryllium shutter driven by a low-inertia stepper motor for minimum actuation time after a pulse command; a binary data encoder for identifying each frame, recording the time, and recording the exposure conditions; and control electronics.

The camera contains a minimum of moving parts. There are no gears in the drive mechanisms, and most of the moving parts are simple rotating elements on reliable ball bearings. The rotor of the stepper motor drives the shutter directly, and the film drive claws are machined on the solenoid plunger. The camera is built to withstand severe vibration, shock, and temperature environments. Up to 2500 frames of thin-base 16 mm film can be accommodated within the transport section. This camera should have application in the synchronous operation of multiple-camera installations and in recording aperiodic as well as periodic events.

Source: J. R. Lawson of
Massachusetts Institute of Technology
under contract to
Manned Spacecraft Center
(MSC-11353)

Circle 18 on Reader Service Card.

COLOR VALUES IN TECHNICAL PHOTOGRAPHY

Proper color focusing can be obtained, even though the subject does not have a readily identifiable color or color scheme, by providing a reference color or color spectrum.

Color values in cine and still photography are significantly influenced by a large number of variables, such as lighting, film characteristics, and film processing techniques. When the color of the finished film forms a portion of the data from a physical test of some sort, it is necessary to establish the actual colors in spite of the listed sources of distortion.

In a new technique, one or more standard colors are applied to a coupon which is then secured in an unobtrusive portion in the camera field of view of the scene to be photographed. Where artificial lighting is used, the coupon is helpful in judging light balance and color balance, particularly when the subject to be photographed is largely monochromatic. In the finished film, any color shift can be readily detected by comparing the projected film image against the actual coupon that was used during the testing. Appropriate corrections can then be made in interpreting the colors shown by the finished film.

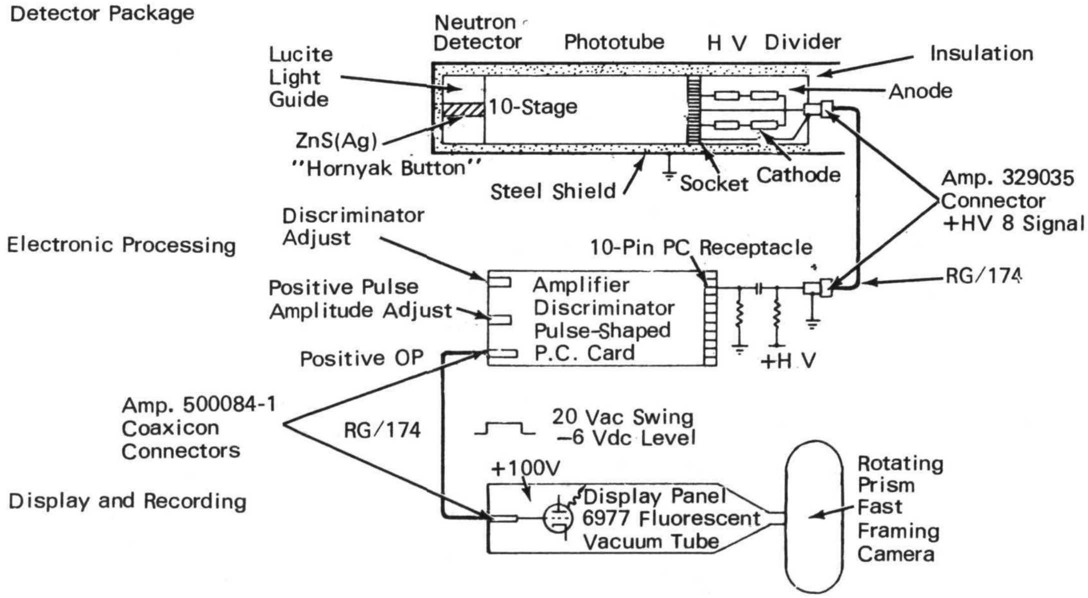
This technique has particular value in wind tunnel testing at supersonic or hypersonic speeds, when the models under test are monochromatic and the Schlieren photography employed tends to distort the film image. It is also useful when very-high-speed films are required, as these are extremely sensitive to processing variables and exposure limits. Marginal film results can yield useful data when a reference point for color correction is available.

Source: J. Wilson of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-14471)

No further documentation is available.

FAST FRAMING CAMERAS PROVIDE HIGH-SPEED, MULTICHANNEL DATA RECORDING

Fast-framing cameras can provide high rates of data acquisition and can obtain and record rapidly changing data from nuclear reactor physics experiments, with relatively inexpensive equipment. Nuclear fission fuel elements are tested under transient conditions, resulting in intentional meltdown of the test element. A multichannel hodoscope (see fig.), with detectors sensitive to high energy fission neutrons emanating from the fuel pin, is used to observe this meltdown while it occurs. There are 334 channels, each focused at a small spot surrounding the location of the fuel pin. These channels are monitored, and the rapidly changing data is presented to a display-panel which in turn is photographed. A 16 mm fast-framing camera views the hodoscope's entire array of 334 lamps.



Every fission neutron detected by the hodoscope is translated by electronic processing to representation as a digital pulse. The neutron radiation absorbed in the "Harnyak button" scintillator is converted to a linear electrical pulse in the photomultiplier tube and then evaluated in the printed circuit card. A pulse meeting preset conditions is reissued as a positive-going gating signal which turns a 6977 fluorescent vacuum triode into conduction.

Depending on the camera optical system, the fluorescent vacuum tube provides sufficient light on recording film to yield an image above fog with exposure duration ranging from a few to some tens of microseconds. This step provides the analog record of the digital data.

In one experiment, a fast-framing camera was mounted to view the entire display panel of 334 lamps. The experiment was a transient test consuming a few seconds from start to finish. Film running at 1000 frames per second was sufficient to cover all aspects of a single meltdown. A neutron burst was initiated in the reactor at the same time that the high-speed camera was started. The resulting display pattern reflected the fuel position at any given instant. There was a high flashing rate along the fuel pin and somewhat less in adjacent lamps. As the pin bent or melted, the flashes promptly followed the changes.

With a shutterless fast-framing camera that provides 98% open time, there is essentially a series of 1 msec. exposures of the lamp array. At positions corresponding to the fuel location, the film image density is composed of a large number of exposures corresponding to an analog representation of the experimental data. When the film is run through a projector after development, a detailed space/time history of the movement of the fuel is obtained. A clock drives a Nixie numerical display giving the time in fractions of a millisecond after the entire sequence is initiated.

Source: A. DeVolpi
Reaction Physics Division
Argonne National Laboratory
(ARG-10252)

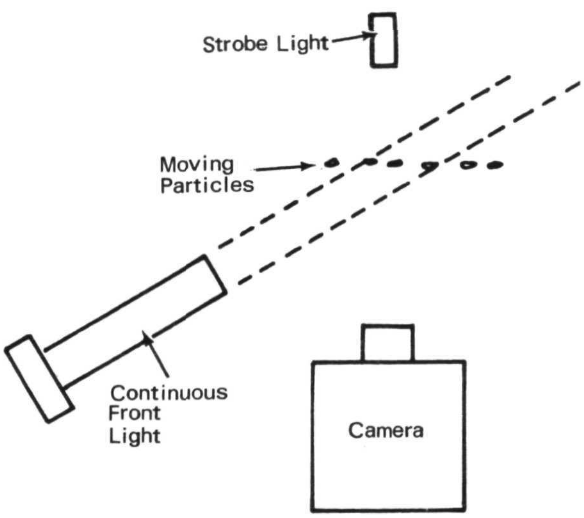
Circle 19 on Reader Service Card.

PHOTOGRAPHIC METHOD MEASURES PARTICLE SIZE AND VELOCITY IN FLUID STREAM

A method employing a nonframing motion picture camera, a continuous front light source, and a strobe light determines the size and velocity (in the range from Mach 0.5 to 1.0) of small particles in nonturbulent fluid streams.

The optical axis of the camera is positioned at right angles to the stream flow. A continuous light source is placed to illuminate the front of the stream, and a strobe light is placed on the opposite side of the stream.

When a particle illuminated by the continuous light source moves across the camera lens, a light streak or velocity trace is produced on the moving film. The strobe light produces an image or shadow of the particle at regular time intervals on the velocity trace on the film. The velocity of the particle is calculated from the known film travel speed and the slope of the trace on the developed film. The size and shape of the particle at the calculated velocity are determined by measuring the particle image produced by the strobe light, taking into account the geometrical relationships of the system.



Source: R. A. Dickerson of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-1536)

Circle 20 on Reader Service Card.

SURFACE TEMPERATURE MAPPING WITH INFRARED PHOTOGRAPHIC PYROMETRY

A new method uses infrared photographic pyrometry to measure and map the temperature distribution on a heated surface, with a high degree of accuracy and precision. The method involves the collection, detection and measurement of a narrow bandwidth of emitted infrared radiation. Standard, commercially available equipment is used, together with systematic procedures. These procedures, compared to conventional methods, can produce higher accuracy, extend the range of temperatures measured, and simplify data handling.

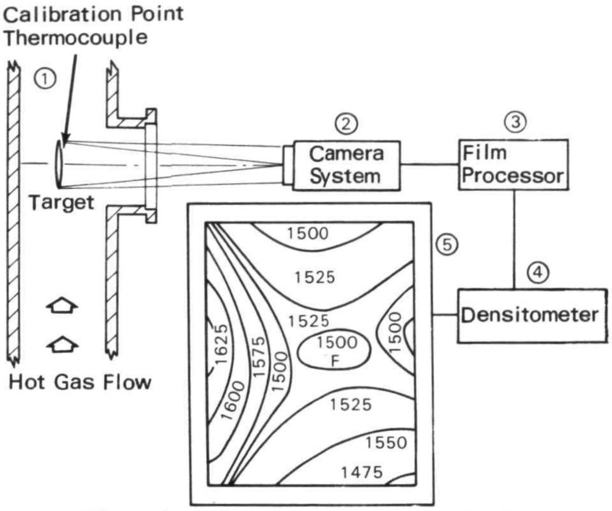


Figure 1. Surface Temperature Distribution Map of Airfoil

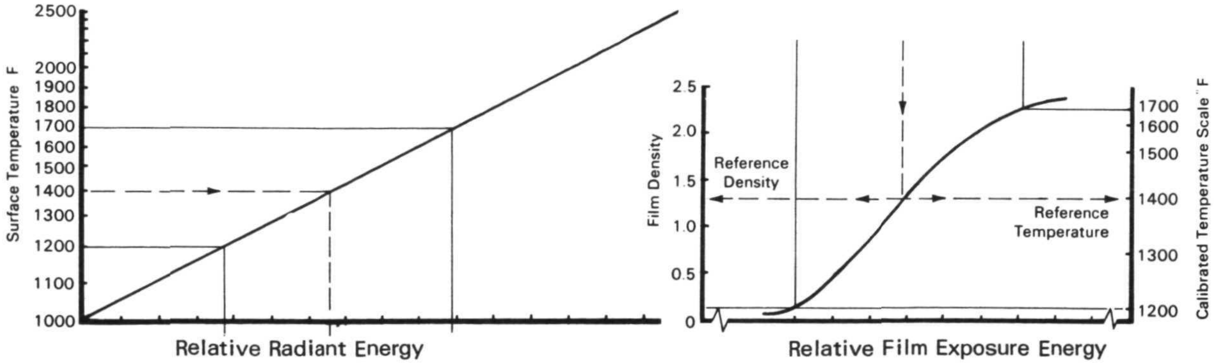


Figure 2.

The system is shown schematically in Figure 1. Major components include: (1) the heated surface or "target," to which at least one reference thermocouple is attached in the area to be photographed; (2) an optical viewpath and camera for recording the thermal radiation on infrared-sensitive film; (3) a closely-controlled film developing system; (4) a densitometer for measuring and recording the densities of the photographic image and for plotting contours of equal density; and (5) a method for converting the image densities to corresponding temperatures.

The relationship between image densities and corresponding temperatures is established and calibrated in three steps:

1. The relationship between relative radiant energy and surface temperature is computed using Planck's fundamental black body law. (Note: Although the emissivity of the heated surface is less than for a black body, actual values of emissivity are not needed since calibration depends only on the change of radiation with change of temperature. This relationship is the same for any value of surface emissivity. Hence, the use of black body emissivity is for convenience.) A typical plot of relative radiant energy versus surface temperature is shown in Figure 2, lower left.
2. The relationship between photographic image density and relative film exposure energy is obtained by photographing a conventional, calibrated, stepped exposure scale illuminated with a constant amount of energy. A calibration is obtained from the step densities of the resulting image. (Note: For accuracy, each film strip used is in-

dividually calibrated.) A typical plot of relative film exposure energy versus film density is shown in Figure 2, lower right.

3. The two plots are aligned using a temperature measured by a reference thermocouple on the target surface. The temperature measured by the thermocouple is located on the upper plot; the film density at the thermocouple location, as measured by the densitometer, is located on the lower plot. Both plots are drawn with the same abscissa scale. The plots are aligned by matching vertical lines drawn from these two points, as shown by the dashed lines in Figure 2. With the two plots aligned, density values can be related directly to the corrsponding temperatures.

Infrared photographic pyrometry has several major advantages over the more conventional surface thermocouple arrays or radiation pyrometers. These advantages are significantly enhanced by the use of the method described. A thermal photograph of an entire heated surface can be taken in one second or less. Complete temperature distribution data can be obtained without physically contacting or interfering with the heated surface, except by the reference thermocouple. The thermal photograph provides a permanent record for immediate or subsequent analysis.

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.95)
Reference:
NASA-TN-D-5179(N69-23895), Surface Temperature Mapping with Infrared Photographic Pyrometry for Turbine Cooling Investigations

Source: F. G. Pollock and R. O. Hickel
Lewis Research Center
(LEW-10763)

MODIFIED CATHODE RAY TUBE PLOTTER PRODUCES MULTIPLE PLOTS

A cathode ray tube plotter originally designed for single X-Y plots has been modified to produce multiple plots.

In the experimental testing of complicated equipment, it is necessary to report the measured parameters in a conventional X-Y plot form. When there is a large volume of data, and a single plot is placed on each form, as a conventional cathode ray tube plotter normally operates, the process requires considerable plotter time and produces huge volumes of paper. Placing multiple plots on one form would reduce the paper volume and the real plotter time. Also, placing certain similar plots on one form would be useful for comparison purposes.

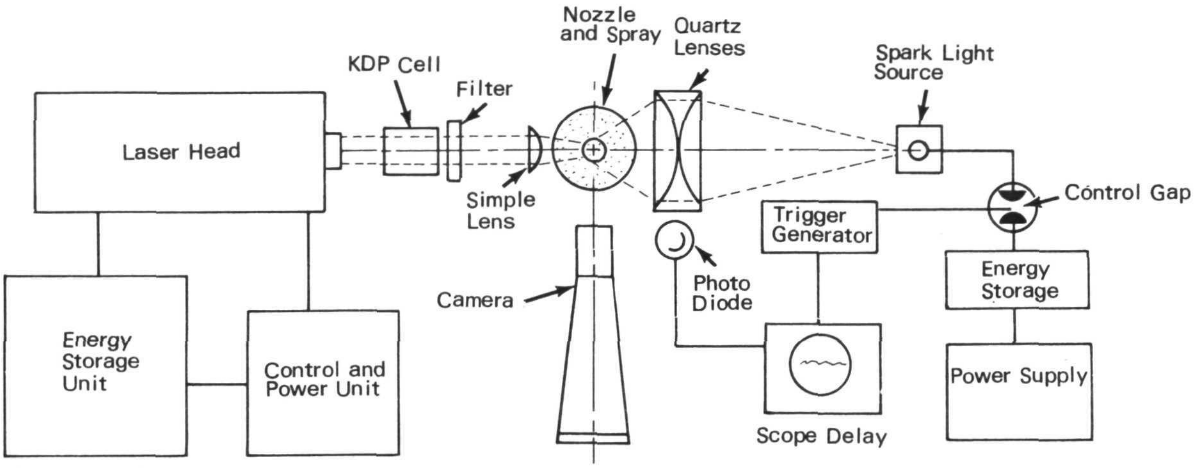
In this technique, four or more data tapes are compressed into one data tape, which is used as the primary computer program input (multi-tape input could be used). A card input is also fed to the computer, which defines the horizontal and vertical annotations on each plot, along with the channels to be plotted from those available. The computer produces the plotting tape input to the cathode ray tube plotter, and this input is used off-line to drive the plotter. The desired output is in the form of microfilm and standard size, reproducible hard copy.

Source: D. B. Glaeser of
Aerojet-General Corp.
under contract to
AEC-NASA Space Nuclear Systems Office
(NUC-10074)

Circle 21 on Reader Service Card.

FLUORESCENT PHOTOGRAPHY OF SPRAY DROPLETS USING A LASER LIGHT SOURCE

The problem of obtaining adequate time resolution to "stop" droplet motion is common to many photographic spray studies. For example, if the minimum droplet size of interest is 10 microns and droplet velocities lie in the range of 10 to 100 m/sec, the droplets move 10^6 to 10^7 diam/sec. If the criterion that the droplet moves no more than 0.1 diameter during film exposure is chosen for "stopping" the motion, time resolutions of 10^{-7} to 10^{-8} sec are required. For such short exposure times, high light intensities are needed. Intensity-time characteristics of flash tubes and spark gaps do not meet the short duration and high energy requirements.



Lasers having pulse powers on the order of 10 to 100 MW (0.1 to 1.0 J out in 20 to 40 nsec) offer a solution to the problem of getting enough light to the film in a short enough time. However, the coherent nature of laser light makes direct shadow photography of particles in the micron range impracticable. An alternate method of utilizing a laser as a light source for droplet photography is the fluorescent dye technique. With this method, the monochromatic laser emission is transformed by the fluorescent process into droplet emission over a wavelength band; it is this light which is used to record the droplet image. In this fluorescent technique, a selected region of a spray is irradiated with ultraviolet light which causes dye in the spray liquid to fluoresce, and the droplets are photographed as self-luminous sources of visible light. In order to obtain a laser wavelength falling within the dye absorption band, the second harmonic of ruby at 3471 Å is generated using a potassium dihydrogen phosphate (KDP) crystal.

Experiments show that the Q-switched laser-optical harmonic generator combination produces sharp, well-exposed droplet images. Direct comparison of images produced by both the spark gap and laser source methods shows that drop sizes can be accurately determined from the laser source-produced images.

Spray photographs were obtained with two dyes which fluoresce at different wavelengths, suggesting the possibility of stream and droplet differentiation using color photography.

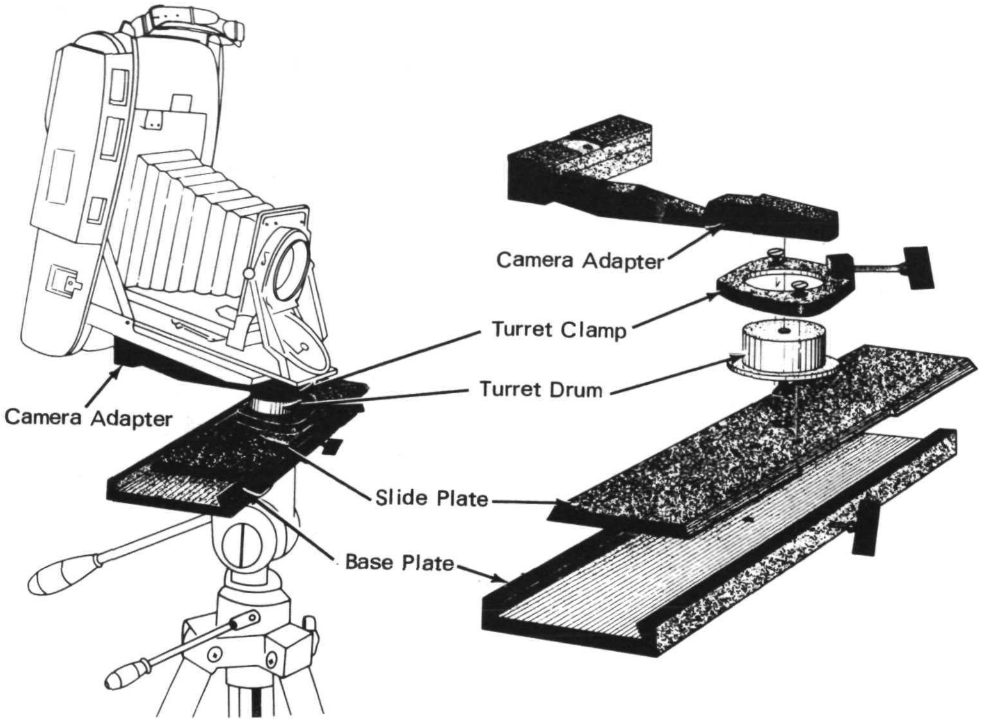
The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.95)
Reference:
NASA-CR-72251 (N67-32277), Fluorescent Photography of Droplets in a Spray Using a Q-Switched Laser as a Light Source

Source: J. Groeneweg, H. Hiroyasu, and R. Sowls of
The University of Wisconsin
under contract to
Lewis Research Center
(LEW-10777)

CAMERA MOUNT FOR CLOSE-UP STEREO PHOTOGRAPHS

A camera mount adaptable to any camera facilitates obtaining close-up stereo (3D) pairs of photographs. These photographs provide an accurate record of surfaces having small defects which may be apparent in relief but not in two dimensions. Stereo photographs have their greatest value in work with precisely designed and produced models which, in testing, may be destroyed or become unavailable.



A mount was developed with camera positioning capabilities to take close-up stereo pairs of photographs of irregular rocket propellent surfaces. In addition, the photographs were to assist quality control personnel in assessing the condition of materials, flight hardware, etc., having possible small defects in skins or castings.

The construction of the camera mount is illustrated in the figure. The basic mount can be used with any standard camera, or with a stereo camera should controlled "toe in" be required. The design of the camera adapter can be varied to meet the mounting requirements of the particular camera used.

With the camera mounted on the adapter, the slide plate is inserted to the left of center approximately 35 mm and the turret drum is rotated so that the camera is aimed at the subject to be photographed. After the first exposure is made, the slide plate is shifted to the right 70 mm (35 mm to the right of center) and the turret drum is rotated so that the camera can again view the subject to be photographed. The two photographs can be mounted side by side and viewed with the naked eye or with prisms or optical aids so that the viewer may see 3D relief.

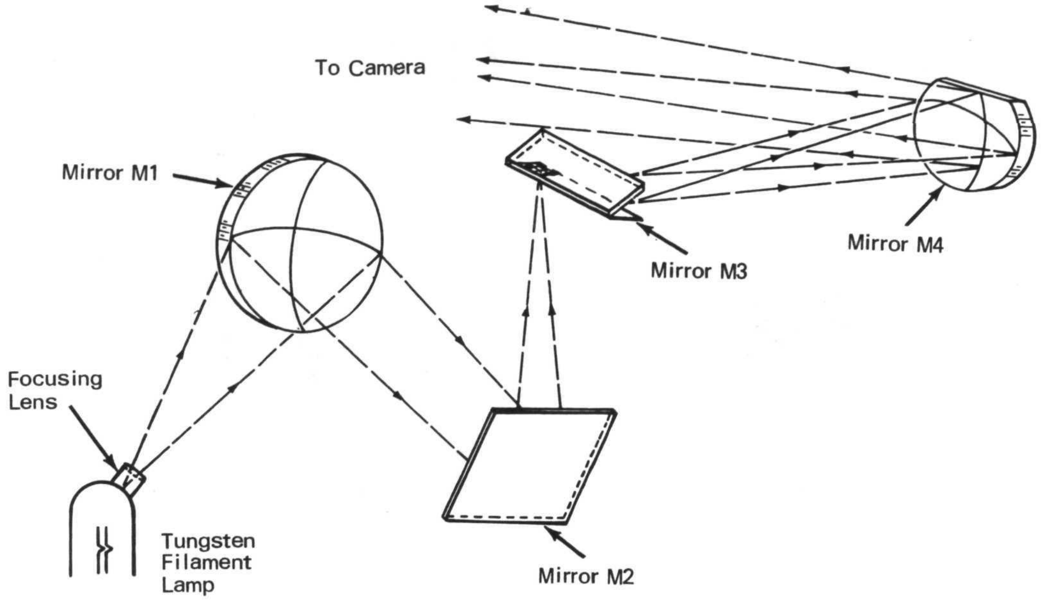
The slide plate and base plate may be indexed in any fashion; mm were chosen for the prototype. The turret clamp and turret drum allow the camera to toe in as normal eyes do to view a particular point from two camera positions. Angular degree graduation of the turret drum and turret clamp assures toe in duplication from one set of stereo pairs to another.

Source: P. H. Glaude
Langley Research Center
(LAR-10442)

Circle 22 on Reader Service Card.

ULTRAVIOLET PHOTOGRAPHIC PYROMETER USED IN COMBUSTION ANALYSIS

Photographic pyrometry has been used to investigate the role of carbon as a thermal radiator and to determine the geometry, location, and progress of afterburning phenomena in the exhaust plume of a liquid-propellant engine.



Photographic pyrometry is used with instrumentation capable of producing a photographic image of the afterburning region as indicated by the ultraviolet emission from the OH molecule. An optical system with adequate transmission in the 2500 to 3500 Å spectral region is employed. Calibrated intensity standards are photographed simultaneously with the object field, so that a quantitative reduction of the radiometric data can be performed. This results in a spatial mapping of the apparent color temperature of the object field.

A tungsten filament lamp serves as the primary image to develop the calibrated intensity standards. Light from the tungsten filament lamp is projected onto mirror M1 and reflected to flat mirror M2. Flat mirror M2 rotates the primary image and reflects it to M3 where the image is spatially divided into five zones of differing intensity by step attenuators.

Mirror M3 serves as the object for mirror M4, which collimates the light diverging from the primary image and sends it to the camera. Mirror M4 thereby forms, at the plane of the exhaust plume, a virtually erect image of the step-attenuated primary image (the calibrated intensity standard); the standard is photographed along with the exhaust plume.

This technique is applicable to any process requiring quantitative measurement of ultraviolet transmission.

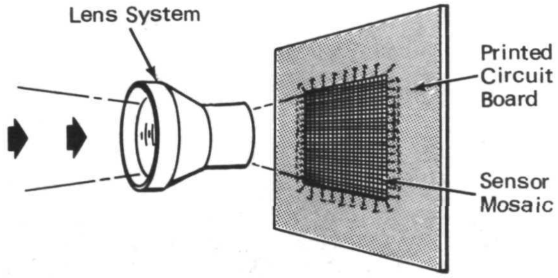
The calibration source is a tungsten ribbon filament lamp equipped with a quartz window; the lamp has been successfully used as an ultraviolet radiation intensity standard.

Source: B. P. Levin of
North American Rockwell Corp.
under contract to
Marshall Space Flight Center
(MFS-499)

Circle 23 on Reader Service Card.

TELEVISION CAMERA ELIMINATES VIDICON TUBE

This camera system uses a solid state imaging device in the form of a phototransistor mosaic sensor, instead of a vidicon tube, for light sensing and image conversion.



The sensor is a square mosaic made up of 2,500 phototransistors with 50 light-sensitive semiconductor elements on a side. Each element is composed of a 3-layer phototransistor controlling its own current, which is modulated by the light striking it. Each phototransistor has an independent base region, with the emitters interconnected by evaporated aluminum strips in 50 isolated columns. Readout is accomplished by applying voltage to a 50-element collector strip and sequentially commutating the rows of emitter elements so that one element at a time is read, with all other elements cut off. Fifty emitter follower amplifiers in the emitter element readout circuitry enhance camera sensitivity by providing high input impedance to each element and low output impedance for the switching circuit.

Flip-flop binary logic provides the pulse sequence for mosaic multiplexing by pulsing the emitter readout switches, applying voltage pulses to the collector strips, and synchronizing the horizontal and vertical sawtooth generators for the monitor.

The digital logic circuits scan the sensor mosaic at 60 frames per second to produce pictures composed of a series of dots rather than lines. The 5 MHz video bandwidth signal can be transmitted over commercial telephone lines.

Source: Westinghouse Electric Corporation
under contract to
Marshall Space Flight Center
(MFS-472)

Circle 24 on Reader Service Card.

TWO-COLOR HOLOGRAPHY

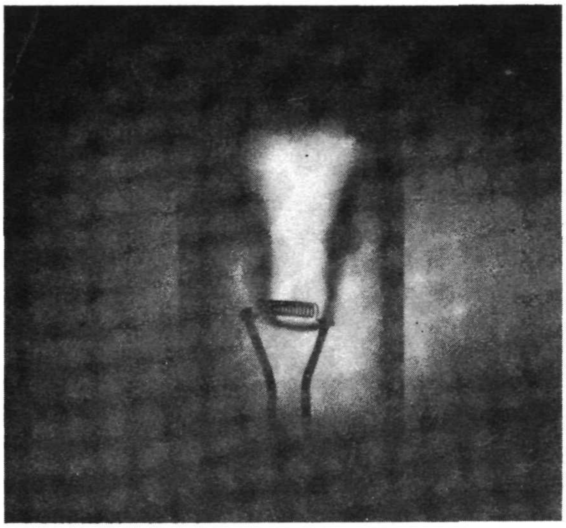
Holograms have been made with UV radiation obtained by second harmonic generation in a KDP crystal fed with red light from a Q-switched ruby laser.

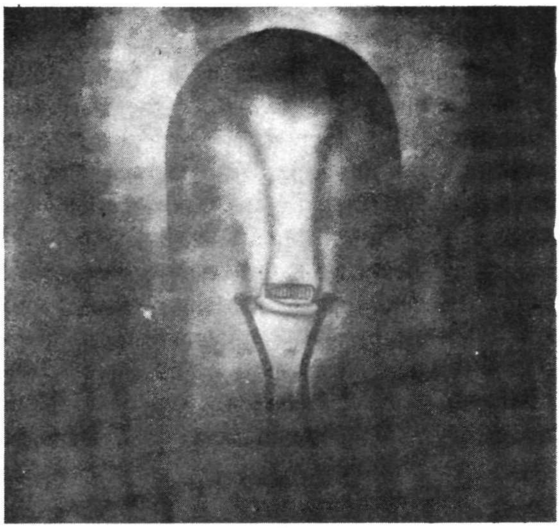
An important reason for the interest in holograms made with ultraviolet light is that smaller changes are visible because the shorter wavelength doubles the number of fringes in the holographic interferograms.

The figure shows an example of a double-exposed holographic interferogram, which was made by first exposing the plate with the lamp filament heated to a dull glow, causing density changes in the heated filling gas. The new aspect of this hologram is that two holograms are made simultaneously, one with the red light component (6943 Å) and one with the harmonic uv component (3471 Å). Two fringes are seen in the uv construction due to the shortened wavelength. Since both reconstructions were obtained with the 6328 Å beam from a He-Ne laser, the angle at which the uv construction occurs is approximately double that of the red construction. As a result, the two can be photographed separately.

The holographic arrangement consisted of a laser illuminator which included a ruby rod of high homogeneity, a nitrobenzene Kerr-cell Q-switch, an air-spaced Glan polarizer, and a 1-cm diameter intercavity aperture. The optical resonator consisted of a 99% reflectivity, dielectric-coated optical flat and an output sapphire resonant-reflector. The laser emitted a 0.75 J pulse of red radiation of 50 nsec duration; this was sufficient energy to record a hologram on a full plate. The output of the laser was passed through a KDP doubler, oriented to maximize the generation of uv radiation. Tests showed that the 5% conversion efficiency of the uv radiation was sufficient to expose the full plate area.

An interesting observation made while viewing the hologram was that the angular orientation sensitivity of the plate is less for the uv than it is for the red. This difference is apparently due to the absorption of the gelatin which rendered the effective thickness of the uv emulsion only 2.5 μ, in constrast to the 11μ thickness of emulsion utilized by the red.





Photographs of the two reconstructions from a single holographic interferogram of a projection lamp. The hologram was exposed simultaneously by the doubled and primary radiation from a Q-switched ruby laser. The filament of the lamp was heated between the two exposures, producing optical path length changes in the filling gas. Both images were reconstructed with a helium neon laser. The 0.6943 micron image is on the left. The other is the 0.347 micron or "doubled" image.

The combined beam from the laser was expanded by a simple lens and then divided into "scene" and "reference" beams by an elementary holocamera consisting of a glass beam splitter and three front-surface mirrors. A ground glass was placed 13.5 cm from the photographic plate in one beam; the light bulb scene was placed between the plate and the ground glass screen. Red holograms were made by placing a pair of filters before the output of the doubler. The filters absorbed 99% of the uv energy; uv-only holograms were made by using a pair of red absorbing filters. For red and uv holography, plates of partially absorbing uv glass were placed at the output of the doubler to balance the relative exposure.

The results demonstrate that doubling the ruby light is a practical method of gaining a factor of two in the sensitivity of holographic interferograms. Through the construction of a holocamera with uv grade optics, quality interferograms should be possible.

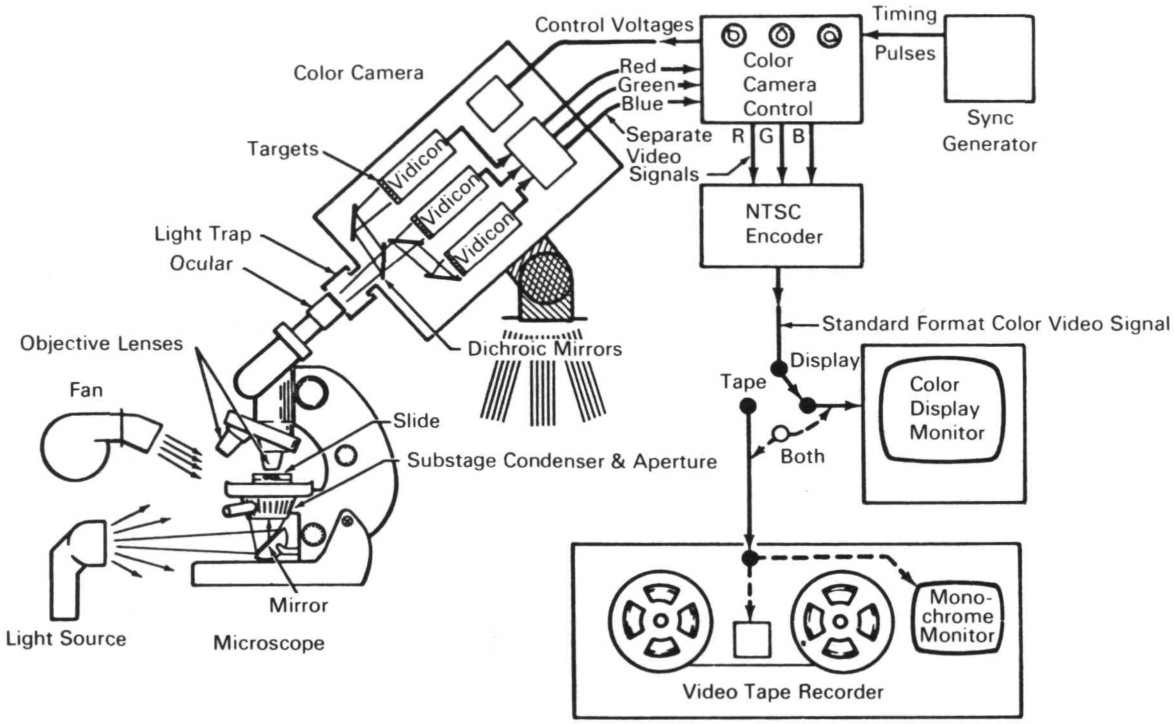
Source: L. O. Heflinger of
TRW Systems Group
under contract to
NASA Headquarters
(HQN-10349)

No further documentation is available.

COLOR-TELEVISED MEDICAL MICROSCOPY

An investigation has been made into the feasibility of color-television microscopy for use at laboratory-range magnifications to reproduce a slide image with sufficient fidelity for medical laboratory or instructional use.

After being processed by the color camera control unit, the three video signals are combined into a single color television signal in the standard National Television System Committee (NTSC) format by the NTSC encoder. From the



The arrangement of the system, as illustrated, uses an external light source and substage mirror to illuminate the slide, and a blower directed at the microscope stage to dissipate lamp-generated heat. The slide's real image, formed by the microscope optics, is projected through the lens opening into the color television camera with the camera lens removed. Dichroic mirrors at the camera's optical input separate the image into its red, green, and blue components and direct them to the photosensitive targets of three vidicon tubes, which act as optical-to-video transducers. Synchronous scanning of these targets produces three video signals corresponding to the optical image's red, green, and blue components.

NTSC encoder, the encoded video signal is routed either to the display monitor for real time viewing, or to the video tape recorder for storage, or to both.

There are many possible applications for the use of color-television microscopy. Medical education implementation, instant pathology reporting between operating room and remotely located pathologist viewing a biopsy through this medium, and computerized comparison of chromosome patterns from the digitized video signals with a pattern recognition program are only a few.

Source: J. C. Peck and M. A. Heath
Manned Spacecraft Center
(MSC-13086)

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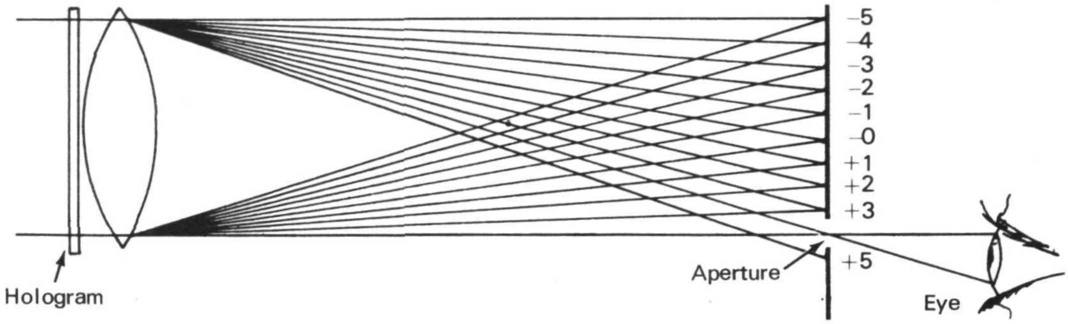
FINE-LINE SENSITIVITY FOR HOLOGRAPHIC INTERFEROGRAMS

Holography, the technique of lenless interferometry, has proven to be an extremely useful tool in an expanding number of scientific and engineering disciplines. As in most technologies, there are continual efforts to improve the sensitivity of the technique. It is intuitively apparent that, since holography is a light interference phenomenon, greater sensitivity can be obtained by enhancing the higher-order structure in the interferogram.



By the use of light diffracted into higher orders than the first, the phase sensitivity of holographic interferograms can be increased over the first order sensitivity by a factor equal to the order number used. In other words, if the fourth order is used, the sensitivity is increased by a factor of four.

The experimental arrangement for the information of the holograms consists of two beams from the same laser source impinging at a small angle on the hologram so that moderately coarse fringes are produced. The Michelson arrangement is convenient for this purpose since it permits the subject to be placed easily in one of the beams while avoiding long paths between subject and hologram. Interferometric accuracy is not required for the components nor the adjustment. The general procedure for constructing the holographic interferogram consists of the following operations. Step one: Make a heavily exposed hologram of the empty scene. Step two: On a second photographic plate, make a heavily exposed hologram with the phase subject in place in one of the beams. Step three: On a third photographic plate, make a double-exposed contact print of the holograms made in steps one and two, one exposure from the hologram of step one and the other exposure from the hologram of step two. Step four: Reconstruct the contact print of step three with a laser and view the light diffracted into the n^{th} order.

A lens and aperture near the focal point are useful in isolating the light of a particular order, as shown in the figure. The intensity variations viewed by the observer correspond to the intensity variations of conventional interferograms of the subject, except that the phase sensitivity is now "n" times as great.

A number of experimental tests of the two-exposure double-contact print process have been carried out with a He-Ne gas laser. The best performance thus far is a factor of four, obtained by readout in the fourth order. Since each fringe in the interferogram results from an average taken over a great many fringes on the contact print, the lines are straighter and more uniform. Also, the new technique makes small phase shifts evident by visual inspection.

Further enhancement can be obtained by displacing the original holograms during the contact printing step. For instance, if each original exposure is exposed n times during the contact printing step, with a displacement of one n^{th} the fringe spacing between each exposure, the resulting contact print will diffract n-squared times as much light as the singly exposed contact print. The one limitation is that the thickness of the line must not cause an overlap of lines during the multiple printing.

Source: L. O. Heflinger of
TRW Systems Group
under contract to
NASA Headquarters
(HQN-10348)

No further documentation is available.

NASA-Langley, 1971

"The aeronautical and space activities of the United States shall be conducted so as to contribute . . . to the expansion of human knowledge of phenomena in the atmosphere and space. The Administration shall provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

— NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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