25X1A

[redacted]

12 March 1965

25X1A

25X1A

[redacted]

Task Order No. 5

Have forwarded info copies to [redacted] T.M. (Formerly in N.P.I.C.) 3/17/65 AC

25X1A

[redacted]

In accordance with the requirements of the subject contract, forwarded herewith are three(3) copies of the final report of Inventions and Subcontracts, DD Form 882, two (2) copies of Record of Invention and three (3) copies of Invention Disclosure.

The description "Project Inspector" appearing in block No. 2 of the enclosed DD Form 882, is our internal code name for the subject task order.

Very truly yours,

25X1A

[redacted]

Senior Contract Administrator

LNL/gea

Enclosures
DD Form 882 - (3 Cys) Unclas.
Record of Inventions - (2 Cys) Unclas.
Invention Disclosure including attached Briefing Summary - (3 Cys) Unclas.

25X1A

[redacted]

E-2277

REPORT OF INVENTIONS AND SUBCONTRACTS
(Pursuant to "Patent Rights" Contract Clause)

Form Approved
Budget Bureau No. 22-R160

INSTRUCTIONS TO CONTRACTOR

This form may be used for INTERIM and FINAL reports, and when used shall be completed and forwarded to the Contracting Officer in triplicate.

An INTERIM report shall be submitted at least every twelve months, commencing with the date of the contract, and should include only those inventions and subcontracts for which complete information has not previously been reported.

A FINAL report shall be submitted as soon as practicable after the work under the contract is complete and shall include (a) a summary of all inventions required by the contract to be reported, including all inventions previously reported and any inventions since the last INTERIM report; and (b) any required information for subcontracts which has not previously been reported.

1. NAME AND ADDRESS OF CONTRACTOR

25X1A [redacted]

2. CONTRACT NUMBER

Project Inspector

3. TYPE OF REPORT *(check one)*

☐ a. INTERIM ☒ b. FINAL

SECTION I - INVENTIONS *("Subject Inventions" required to be reported by the "Patent Rights" clause)*

4. INVENTION DATA *(check one)*

☐ a. THERE WERE NO INVENTIONS WHICH REASONABLY APPEAR TO BE PATENTABLE

☒ b. LISTED BELOW ARE INVENTIONS WHICH REASONABLY APPEAR TO BE PATENTABLE. ANY INVENTION DISCLOSURES WHICH HAVE NOT BEEN PREVIOUSLY SUBMITTED TO THE CONTRACTING OFFICER ARE ATTACHED TO THIS REPORT.

(i) NAME OF INVENTOR	(ii) TITLE OF INVENTION	(iii) PATENT APPLICATION SERIAL NUMBER AND CONTRACTOR'S DOCKET NO.	(iv) CONTRACTOR HAS FILED OR WILL FILE U.S. PATENT APPLICATION		(v) CONFIRMATORY LICENSE OR ASSIGNMENT HAS BEEN FORWARDED TO CONTRACTING OFFICER	
			YES	NO	YES	NO
25X1A [redacted]	Improved Photo-Interpretation Apparatus	25X1A [redacted] Docket No. 360				x

Note: Contractor has not yet decided whether or not it desires to file a patent application on this invention.

SECTION II - SUBCONTRACTS *(Containing a "Patent Rights" clause)*

5. LISTED BELOW IS INFORMATION REQUIRED BUT NOT PREVIOUSLY REPORTED FOR SUBCONTRACTS. *(If not applicable, write "None".)*

(i) NAME AND ADDRESS OF SUBCONTRACTOR	(ii) SUBCONTRACT NUMBER	(iii) DATE CLAUSE FURNISHED TO CONTRACTING OFFICER	(iv) DATE SUBCONTRACT COMPLETED
NONE			

SECTION III - CERTIFICATE

CONTRACTOR CERTIFIES THAT THIS REPORT OF INVENTIONS AND SUBCONTRACTS, INCLUDING ANY ATTACHMENTS, IS CORRECT TO THE BEST OF THE CONTRACTOR'S KNOWLEDGE AND BELI[redacted]

DATE	NAME AND TITLE OF AUTHORIZED OFFICIAL *(Print or Type)*	SI[redacted]
3/9/65	25X1A [redacted] Patent Counsel	25X1A

[redacted] 25X1A CAS

DOCKET No.
360

TITLE OF INVENTION:	APPROXIMATE DATE CONCEIVED
25X1A Improved Photo-Interpretation Apparatus	August, 1964

INVENTOR	HOME ADDRESS	CITIZENSHIP
[redacted]		U. S.
		U. S.
		U. S.
		U. S.

ENTRIES IN R & D RECORD				WRITTEN REPORTS		
BOOK No.	PAGES	DATE	LOCATION	TITLE	DATE	LOCATION
A298	1-128	7/31/64 to 2/24/65	[redacted] 25X1A	Briefing Summary	Jan. 1965	[redacted] 25X1A

PUBLICATIONS				PAPERS PRESENTED	
NAME	TITLE OF ARTICLE	PAGES	DATE	WHERE	DATE
	None			None	

DRAWING/SKETCHES		
DRAWING No.	DATE	LOCATION
None		

DATE FIRST SUCCESSFULLY MADE	JOB NOS.
9/12/64 - 1/12/65	Government

TEST RESULTS:

Successful

HAS THIS INVENTION BEEN INCORPORATED INTO A PRODUCT OR EQUIPMENT SHIPPED OUTSIDE EG & G? ☐ YES ☒ NO — IF YES, WHEN?

REMARKS:

[redacted]

25X1

DOCKET NO.
360

TITLE OF INVENTION:	APPROXIMATE DATE CONCEIVED
Improved Photo-Interpretation Apparatus	August, 1964

25X1A

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		U. S.

25X1A

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		25X1A				

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None		

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REMARKS:

 [redacted]

DOCKET No. 360

TITLE OF INVENTION:

Improved Photo-Interpretation Apparatus

INVENTORS [redacted]

DESCRIPTION OF INVENTION: (PLEASE READ INSTRUCTIONS ON REVERSE SIDE)

See attached.

[redacted]

DATE 3/1/65

DATE 3/8/65

[redacted]

TE /65

TE 3/1/65

EXPLAINED TO, READ A[redacted]

WITNESS'S SIGNATURE DATE

WITNESS'S SIGNATURE DATE

Approved For Release 2002/09/03 : CIA-RDP78B04747A002500050021-7

PATENT DEPARTMENT

BRIEFING SUMMARY

JANUARY 1965

Method of Approach

The original concept calls for a modulated light table in which the modulation of the light source will compensate for gross differences in film exposure. In addition, techniques are to be applied to increase the contrast of detailed information in the photograph. Object of the study was to:

(1) Prove or disprove the validity of this approach.

(2) Determine to what extent the approach can be implemented with components and materials available according to the state of the art.

The first step taken was to develop a good background of information on photo interpretation in general and specifically on ideas and devices which have been suggested to solve the problems. An extensive literature search was made and the pertinent literature read and summarized. Discussions were held with various people who have had experience in photo interpretation. Field trips were made to Westover A. F. B., the Naval Photo Intelligence Laboratory in Washington, D. C., and Shaw A. F. B. The visits to the two Air Force installations were chiefly to view normal photo interpreter operation. The trip to the 25X1A Naval Laboratory was to inspect and discuss certain instruments made by [redacted]
25X1A [redacted] and others, for use in Photo interpretation.

The second step was to determine the state-of-the-art of the various components which would be required and from that determine the limitations which would be set on any practical device. This was done through specification sheets and direct contact with specific manufacturers who are in the forefront of their particular sections of the industry. Once the approximate state of the art was determined, a program of calculations and experiments was started to determine what the limitations would be for a practical device.

Numerous approaches for implementing the basic aims were discussed and investigated by calculation and by simple experiments, to confirm or point out errors in the calculated results. A large number of approaches were investigated. These were reduced to a comparatively small number which appear to be capable of implementation. Those approaches that appeared feasible were further tested by practical experiments and simulations.

On the basis of the above, an attempt was made to synthesize the best device, or devices, utilizing the tested approaches. Special effort was made to maintain simplicity of operation and maintenance. Basically, the design effort took two directions: 1). To design a universal unit, which would fulfill as many requirements as possible, and 2). To design smaller units, each of which would best fulfill a particular requirement or group of requirements at the expense of capability in other directions.

Limiting Problems

One limiting factor is the size of the photograph which the unit is required to handle. Certain approaches were eliminated because the lenses required would be impractically large; that would make them either impractical to manufacture or make the whole device too bulky.

The second limitation is the state-of-the-art in development of cathode ray tubes. Because of heating of the phosphor, there is a definite limitation on the light output that can be obtained from cathode ray tubes. Another problem is that high intensity cathode ray tubes operate at very high acceleration voltages and produce x-rays. Since the operator must be protected from x-ray exposure, this factor imposes further limitations on design. A check was made on the possibility of using a matrix of discreet incandescent lamps. This is impractical, inasmuch, as the inefficiency of the incandescent lamps creates a very large amount of heat. Some investigation was also made on the possibility of using a matrix of photo-emissive diodes as a light source. In the present state of development, these divices are orders of magnitude away from our requirements. The approach of using a modulated point light source and a mechanical scanning device was not investigated. It was judged that the scanning speed involved to produce a real-time device would present some very difficult mechanical problems. There are instances, in the literature examined, of devices which used mechanical scanners. However, these devices were for printing photographs and not for real-time viewing, therefore, much lower scanning frequencies were usable.

Television techniques will be used for scanning and for viewing the film. This introduces the limitations of rasters, spot size, and the gain-bandwidth of the video amplifiers to be used. We are in the process of conducting an investigation to determine the best television scan techniques available today, so that the television sections of the unit will have optimum scan rates and definition.

Another factor which placed definite limitations on the design is the limited light gathering ability of lens systems. A few approaches were discarded because the light gathering ability of practical lens systems was insufficient to attain sufficient illumination of the film.

<u>Results</u>

We feel that we have proven the validity of the basic principles. The principle of the modulated light table is being used in photographic printing by 25X1 [redacted] devices. In addition, we have, both with calculations and practical experiments, proven the feasibility of the principle for real-time viewing of photographic transparencies. One part of the demonstration prepared will illustrate this.

The enhancement techniques of increasing contrast ratios and outlining were investigated theoretically in our laboratory. Later, devices employing these techniques were examined at the Naval Laboratory in Washington. There remains no question as to whether these methods are feasible, inasmuch as they have been demonstrated.

None of the devices we have encountered in our reading or visits to installations combine the two basic ideas which we intend to combine in a single device. I refer to the idea of a modulated light table combined with a viewer which employs video processing of the signal to attain enhancement. Although 25X1A the [redacted] device in Washington is quite good for increasing contrast within small areas, it does this at the expense of loss of other areas of picture. In other words, by increasing the contrast in a given area, other areas are thrown into the whiter than white or blacker than black and are completely lost to view. An example of the advantage to be gained with the combinations of the two principles will illustrate our basic idea. If we take a transparency, with extremes of transmission of 5% and 50%, and place it on a light table with an intensity of 300 ft. lamberts, we obtain extremes of 15 and 150 ft. lamberts of intensity. That is, a difference from lightest to darkest areas of 135 ft. lamberts. By means of the modulated light table, we increase the 15 ft. lambert level to 30 and reduce the 150 ft. lambert level to 75 ft. lamberts. This gives us a maximum difference in light intensity of 45 ft. lamberts between extremes. Now, if we amplify our video signal so that we expand the range of 45 ft. lamberts back to 135, we obtain a 3 times increase in contrast. These figures are not necessarily typical, but were selected at random to illustrate the point. By selecting a smaller range of the gray level and expanding it to the full capability of the monitor, we can obtain more contrast expansion at the expense of throwing some portions of the view into whiter than white or blacker than black, as the [redacted] device does. By 25X1A combining both techniques, we get increase of contrast in all directions regardless of the direction of the scanning raster. Outlining techniques are good only for lines at right angles to the raster scan. However, a rotation of the camera or a special raster could solve this problem. Probably the better solution is rotation of the camera or film, since this is a very simple and uncomplicated solution. It is probably not worth going to great lengths to obtain outlining, inasmuch as, in the opinion of workers at the Naval Laboratory, the outlining is of limited usefulness.

Throughout the investigation, lack of sufficient light intensity has been a problem. There are electronic and semi-conductor type light amplifiers being made and developed, but they have not yet reached a stage where they can be of use to us in this project. In general, they are lacking in light level and resolution capability. One way of overcoming the difficulty is to change our light signal to an electrical signal, amplify it and then reconvert it to a light signal. Basically, this is closed circuit television monitoring. Any such system inherently contains a danger of loss of information and resolution. However, it is feasible, if the equipment is used properly, to attain the required number of line pairs per mm., and possibly more, without loss of information. There are numerous advantages to be obtained in the use of closed circuit television viewers. If we backlight a film with a compensated source, then change our information to a video signal, we can actually obtain an increase in contrast as noted above. The principle is simple. The compensation of the light source reduces the differences in average area density between various areas of film. This compresses the overall dynamic range, so as to allow us to amplify the remaining signal and increase the local differences in density without exceeding the dynamic range of the system. This allows for more enhancement on a film where the contrast is generally poor, than on one where there are both low and high contrast areas. However, a control can be provided so that when viewing, the P. I. could adjust according to the requirements of the particular area of interest. This principle, with the exception of the compensated light source, is already in use on devices that have been examined at the Naval Laboratory. Pick up of the video signal may be accomplished either by photomultiplier, using time sharing techniques, or by a vidicon camera. Other circuitry, such as aperture compensation circuits and gated differentiators may be added to give line enhancement and outlining. In a closed circuit TV viewing system, the vidicon becomes the limiting factor, as far as resolution is concerned. There are American commerical tubes available specified at 1500 TV lines for center of screen resolution. The problem of resolution is a question of how much magnification we can obtain and still have sufficient light intensity to activate the vidicon to its maximum capability. With a high performance vidicon 250 line pairs per mm should be obtainable with available state of the art light sources, on a film with 10% transmission and an f/1 lens system. The main objection to a TVmonitor system of viewing will perhaps be more psychological than other. As when viewing a scene through a microscope our field of view becomes more limited as we increase the magnification, the view also is limited as we go to greater resolution capabilities with a monitor. In addition, in order not to have the discernment capability of the eye exceed the true resolution of the monitor, the size of the monitor screen must be guaged properly to the distance at which it is going to be viewed. For example, a monitor which is to be viewed at a distance of 3 ft. with a 900 line system should not have more than 10'' screen height. A monitor viewed at 8 ft. would have a screen approximately 33 x 25 inches .. Higher resolution television systems will allow for larger monitors at the same distance. This factor does not impose a limitation on the ultimate resolution, it merely ties the field size to the resolution with which it is being viewed. In other words, with a 900 line system, to get 200 line pairs per mm resolution, the total field on the viewing monitor would correspond to 2 1/4 mm in height on the actual photo. Therefore, the problem of using closed circuit television techniques for viewing is not one so much of loss or likely loss of information, but acclimating the user to the new techniques. The following are some advantages to be obtained from closed circuit TV.

1. Since there is no problem interrupting the viewing by a direct examination of the film, the optics can be optimized, and there is no need for a magnetic memory.
2. A number of monitors can be operated simultaneously and a television projector can be connected to the same line if desired.
3. The general lighting conditions of the operations room need be much less rigorously controlled, inasmuch as the optical section of the unit is enclosed and the viewing monitors can be individually adjusted for the ambient conditions.

4. If desired, more than one film can be viewed simultaneously on different viewers, and a monitor switched between various pictures, at will. This system could be used for comparingg "before and after" photographs. A signal switching system would show the two photographs alternately on the same screen and any changes would appear as a flickering image at the point of change.

Specific Devices

A. Combined Unit

This unit will be a rather large desk type console. It will have a tilted modulated light table on the top surface, conveniently located for the viewer. The light table will have, as a light source, a 16" diameter cathode ray tube. Controll information for the light source will be obtained by a photomultiplier mounted above the viewing area combined with a magnetic memory or, by use of light pipe technique, the memory may be eliminated and the photomultiplier could be mounted at a lower level where it would not interfere with the viewer. The memory is used to provide capability for close viewing of the film with magnifiers or microscopes. To use this feature, the information obtained by the photomultiplier is recorded on a magnetic tape or disc. Then the photomultiplier is moved aside and, as long as the film is not moved, the information from the memory will maintain the proper modulation of the light table. The unit will have controls for shrinking the raster size to a small area and for positioning this area any place on the film. The general intensity of the light source and the degree of modulation will be controlled by the operator. Beside the actual light table will be mounted a closed circuit television monitor. The camera of the closed circuit television system will be mounted on a mechanical arm or boom, and, by remote control, can be brought to bear on the photograph which is on the light table. The TV system will be 1000 or 2000 line raster. The camera position controls will be synchronized with the raster position control. Contrast control, grey level control and brightness control will be available in the TV system. In addition, an outlining function and a positive or negative picture capability can be supplied. There may be difficulties in the mechanical design, but the device does provide direct access to the film, variable magnification, the full required resolution and a capability of using numerous monitors and/or a projector. Measurements can be made on a 1 to 1 basis on the film itself, or through the monitoring system by means of calibrated reticles. Disadvantages of this system are possible interference between camera, photomultiplier and viewer; control requirement on ambient lighting, so as not to interfere with the photomultiplier cell; and a possible x-ray hazard. With the levels of accelerator voltage used for the applicable tube, it will be necessary to have a sheet of leaded glass between the tube and the film to protect the viewer. Although most versatile, this is the largest and most expensive of the devices being suggested here as possible solutions.

B. Field Light Table

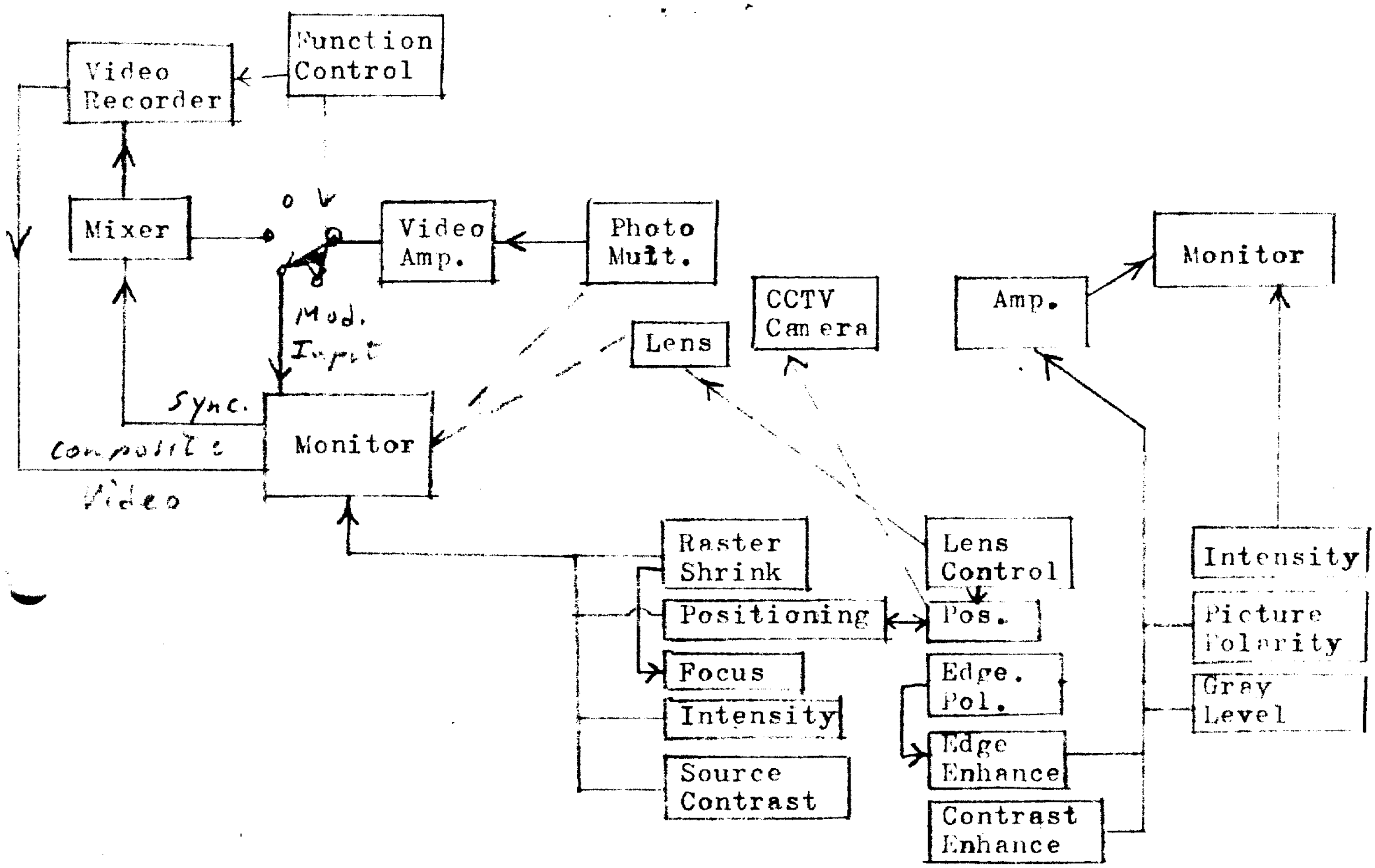
This unit will be a small desk type console, with the light table itself at a sloping angle in front of the operator, or it could be in a slope-front unit which may be placed on a desk. It is basically a modulated light table. The source of light is a 16" or 10" diameter cathode ray tube. Information for controlling the light source will be obtained by a photomultiplier mounted above the lighted surface. A provision will be included, with a magnetic memory, to allow for recording the necessary control information and then moving the photomultiplier aside, so that the film maybe closely examined and measured, without interfering with the modulation. While the film is being lighted through the control of the memory, the film must not be moved. This device may also be constructed using light pipes, in which case the memory may be eliminated, or there may be a combination of light pipes and memory. Modulation control for the light table, intensity control, a raster shrinking control and a positioning control will be provided. When the raster is shrunk down, the general compensation will be included in a small area. This unit is smallest, most simple and least expensive of those being suggested. It will be suitable for field use. It could be used with the tube magnifiers, magnifying glasses, or microscopes that are presently being used on normal light tables. This unit will be suitable for stereo viewing, inasmuch as the stereo pair will be lit up and compensated simultaneously and a normal stereo viewer could be used above it. The unit allows direct access to the film and direct measurement on the film. The only enhancement provided by this device is that which is gained by allowing the eye to operate at optimum light level. In other words, we eliminate excess glare and flare from highly transmissive areas, so that the eye of the viewer is not required to operate and discern details in a relatively dark area of the film while being disturbed by the excess light coming through more highly exposed areas of film. The ambient light in the room should be controlled as not to interfere with the viewer or with the photomultiplier itself. As in the first device mentioned, the x-ray hazard must be guarded against. This will probably mean a sheet of leaded glass between the cathode ray tube and the viewer.

C. Remote Viewer

This unit will be a desk type console, containing the complete device, or the major part of the device may be rack mounted with remote controls on a monitor that may be placed anywhere convenient. The unit will use a 16" diameter cathode ray tube as a modulated light source. The information for control of the light source will be gathered by a photomultiplier. Video information will be obtained by a vidicon which will view the backlighted film simultaneously with the photomultiplier. The unit will be totally enclosed with no direct access to the film. All the enhancement features provided in the combination unit, described in A, will be available in this unit. The unit will be simpler mechanically and much less expensive to design and build, because there will be no need for synchronized systems for moving spot location and camera. On this unit, the camera and light source will be held stationary and the film carriage will be moved to obtain relative positioning of the camera and film. Measurements will be made by means of calibrated reticles which will be inserted at the film plane. Since these reticles will be viewed simultaneously with the film, any dimensional distortions would occur in the reticle together with the film, and there will be no error in comparison of reticle and film. Inasmuch as the unit is enclosed, there are no restrictions on the ambient light. The unit will require no magnetic memory since the photomultiplier and vidicon would always be viewing the film together. This unit promises the best results and yet is not the most expensive, or the most complicated of the group. The most likely objection to this unit is the fact that there is no direct access to the film. Devices that were built for the Navy, and which we examined in Washington, also do not give direct access to the film. They do not feel that this is a disadvantage. In fact, it may be an advantage since there is much less likelihood of the original film being damaged. Even if this is not immediately acceptable to interpretors today, it may be the type of device which will eventually be used. It promises the most in possibilities of future development with reasonable cost and operability.

D. High Magnification Viewer

This unit is specifically designed to obtain the highest possible magnification to allow for even higher resolution than the 200 line pairs per mm required. The unit will be constructed in either a desk type console, with the viewing screen before the interpretor, or in a rack with a remote monitor including the controls for the equipment in the rack. The light source will be a very high intensity small diameter projection cathode ray tube. An image of the cathode ray tube will be projected on the film by means of a variable optic. The illuminated film will be viewed by a photomultiplier which supplies the control information for the intensity modulation of the light source. Video information will be obtained by viewing the illuminated film with a vidicon. As the magnification of viewing is increased, the image of the cathode ray tube source on the film will be reduced in size. This will allow the same lighting compensation within the smaller area being viewed, as is normally used over the whole film area. This unit is completely enclosed and there will be no direct access to the film. It is very similar in its characteristics to the remote viewer of part C, with the exception that the maximum area which can be viewed will be on the order of a 2" square of film. This limitation is imposed by the practical size of the optics which are required. The advantage over the remote viewer of C is that higher magnification will be available. This unit could be used for viewing 35 mm or other small film sizes, or for viewing small areas on larger film. It should be capable of providing resolution better than the present requirement.



Block Diagram

Device # A. Combined Unit

4/08/65

25X1A

TITLE OF INVENTION:

Improved Photo-Interpretation Apparatus

25X1A

INVENTORS [redacted]

DESCRIPTION OF INVENTION: (PLEASE READ INSTRUCTIONS ON REVERSE SIDE)

See attached.

ILLEGIB

[redacted]

25X1A

[redacted]

EXPLAINED TO, READ AND UNDERSTOOD BY:

WITNESS'S SIGNATURE	DATE	WITNESS'S SIGNATURE	DATE

Approved For Release 2002/09/03 : CIA-RDP78B04747A002500050021-7

PATENT DEPARTMENT

HOW TO PREPARE AN INVENTION DISCLOSURE

1. Disclose only ONE INVENTION — Prepare a separate Invention Disclosure for each invention.

2. **Make your Invention Disclosure COMPLETE** — It is complete if, after reading it, a person skilled in the art can understand and build it.

3. **In writing your Invention Disclosure discuss:**
   - (a) THE PURPOSE, OBJECT and PROBLEM SOLVED BY your invention,
   - (b) OLD METHODS, if any, and their disadvantages,
   - (c) Related PRIOR ART publications, patents, devices and related research or engineering activities, if known,
   - (d) Attached SKETCHES, PRINTS, or PHOTOS that help describe your invention,
   - (e) The OPERATION and DESCRIPTION of your invention. This is the most important part of your Invention Disclosure,
   - (f) ADVANTAGES of your invention,
   - (g) ALTERNATIVE METHODS of doing what you have done,
   - (h) EQUIVALENTS of components of your invention,
   - (i) FEATURES of your invention which you believe to be NEW and INGENIOUS,
   - (j) How your invention can contribute to EG&G's future progress and growth.

4. Use more than one Invention Disclosure form if necessary to completely describe your invention.

5. WITNESSES — At least two witnesses should sign and date each sheet of your Invention Disclosure and each drawing, separate sketch and photo. They should sign only after (1) you have explained your invention to them, (2) they have read your Invention Disclosure, and (3) you are satisfied that each witness thoroughly understands your invention. Do not use a person as a witness if he does not understand your invention.

6. The Invention Disclosure form is a three-copy snap-out form. Retain your copy and send the original and carbon copies together with drawings, separate sketches, and photos to the Patent Department.

7. In the future, refer to your invention by the EG&G Docket Number that will appear on an acknowledgment sent you by the Patent Department.

BRIEFING SUMMARY

JANUARY 1965

Method of Approach

The original concept calls for a modulated light table in which the modulation of the light source will compensate for gross differences in film exposure. In addition, techniques are to be applied to increase the contrast of detailed information in the photograph. Object of the study was to:

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Limiting Problems

One limiting factor is the size of the photograph which the unit is required to handle. Certain approaches were eliminated because the lenses required would be impractically large; that would make them either impractical to manufacture or make the whole device too bulky.

The second limitation is the state-of-the-art in development of cathode ray tubes. Because of heating of the phosphor, there is a definite limitation on the light output that can be obtained from cathode ray tubes. Another problem is that high intensity cathode ray tubes operate at very high acceleration voltages and produce x-rays. Since the operator must be protected from x-ray exposure, this factor imposes further limitations on design. A check was made on the possibility of using a matrix of discreet incandescent lamps. This is impractical, inasmuch, as the inefficiency of the incandescent lamps creates a very large amount of heat. Some investigation was also made on the possibility of using a matrix of photo-emissive diodes as a light source. In the present state of development, these divices are orders of magnitude away from our requirements. The approach of using a modulated point light source and a mechanical scanning device was not investigated. It was judged that the scanning speed involved to produce a real-time device would present some very difficult mechanical problems. There are instances, in the literature examined, of devices which used mechanical scanners. However, these devices were for printing photographs and not for real-time viewing, therefore, much lower scanning frequencies were usable.

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Another factor which placed definite limitations on the design is the limited light gathering ability of lens systems. A few approaches were discarded because the light gathering ability of practical lens systems was insufficient to attain sufficient illumination of the film.

Results

We feel that we have proven the validity of the basic principles. The principle of the modulated light table is being used in photographic printing by 25X1 [redacted] devices. In addition, we have, both with calculations and practical experiments, proven the feasibility of the principle for real-time viewing of photographic transparencies. One part of the demonstration prepared will illustrate this.

The enhancement techniques of increasing contrast ratios and outlining were investigated theoretically in our laboratory. Later, devices employing these techniques were examined at the Naval Laboratory in Washington. There remains no question as to whether these methods are feasible, inasmuch as they have been demonstrated.

None of the devices we have encountered in our reading or visits to installations combine the two basic ideas which we intend to combine in a single device. I refer to the idea of a modulated light table combined with a viewer which employs video processing of the signal to attain enhancement. Although 25X1A the [redacted] device in Washington is quite good for increasing contrast within small areas, it does this at the expense of loss of other areas of picture. In other words, by increasing the contrast in a given area, other areas are thrown into the whiter than white or blacker than black and are completely lost to view. An example of the advantage to be gained with the combinations of the two principles will illustrate our basic idea. If we take a transparency, with extremes of transmission of 5% and 50%, and place it on a light table with an intensity of 300 ft. lamberts, we obtain extremes of 15 and 150 ft. lamberts of intensity. That is, a difference from lightest to darkest areas of 135 ft. lamberts. By means of the modulated light table, we increase the 15 ft. lambert level to 30 and reduce the 150 ft. lambert level to 75 ft. lamberts. This gives us a maximum difference in light intensity of 45 ft. lamberts between extremes. Now, if we amplify our video signal so that we expand the range of 45 ft. lamberts back to 135, we obtain a 3 times increase in contrast. These figures are not necessarily typical, but were selected at random to illustrate the point. By selecting a smaller range of the gray level and expanding it to the full capability of the monitor, we can obtain more contrast expansion at the expense of throwing some portions of the view into whiter than white or blacker than black, as the [redacted] device does. By 25X1A combining both techniques, we get increase of contrast in all directions regardless of the direction of the scanning raster. Outlining techniques are good only for lines at right angles to the raster scan. However, a rotation of the camera or a special raster could solve this problem. Probably the better solution is rotation of the camera or film, since this is a very simple and uncomplicated solution. It is probably not worth going to great lengths to obtain outlining, inasmuch as, in the opinion of workers at the Naval Laboratory, the outlining is of limited usefulness.

Throughout the investigation, lack of sufficient light intensity has been a problem. There are electronic and semi-conductor type light amplifiers being made and developed, but they have not yet reached a stage where they can be of use to us in this project. In general, they are lacking in light level and resolution capability. One way of overcoming the difficulty is to change our light signal to an electrical signal, amplify it and then reconvert it to a light signal. Basically, this is closed circuit television monitoring. Any such system inherently contains a danger of loss of information and resolution. However, it is feasible, if the equipment is used properly, to attain the required number of line pairs per mm., and possibly more, without loss of information. There are numerous advantages to be obtained in the use of closed circuit television viewers. If we backlight a film with a compensated source, then change our information to a video signal, we can actually obtain an increase in contrast as noted above. The principle is simple. The compensation of the light source reduces the differences in average area density between various areas of film. This compresses the overall dynamic range, so as to allow us to amplify the remaining signal and increase the local differences in density without exceeding the dynamic range of the system. This allows for more enhancement on a film where the contrast is generally poor, than on one where there are both low and high contrast areas. However, a control can be provided so that when viewing, the P.I. could adjust according to the requirements of the particular area of interest. This principle, with the exception of the compensated light source, is already in use on devices that have been examined at the Naval Laboratory. Pick up of the video signal may be accomplished either by photomultiplier, using time sharing techniques, or by a vidicon camera. Other circuitry, such as aperture compensation circuits and gated differentiators may be added to give line enhancement and outlining. In a closed circuit TV viewing system, the vidicon becomes the limiting factor, as far as resolution is concerned. There are American commerical tubes available specified at 1500 TV lines for center of screen resolution. The problem of resolution is a question of how much magnification we can obtain and still have sufficient light intensity to activate the vidicon to its maximum capability. With a high performance vidicon 250 line pairs per mm should be obtainable with available state of the art light sources, on a film with 10% transmission and an f/1 lens system. The main objection to a TVmonitor system of viewing will perhaps be more psychological than other. As when viewing a scene through a microscope our field of view becomes more limited as we increase the magnification, the view also is limited as we go to greater resolution capabilities with a monitor. In addition, in order not to have the discernment capability of the eye exceed the true resolution of the monitor, the size of the monitor screen must be guaged properly to the distance at which it is going to be viewed. For example, a monitor which is to be viewed at a distance of 3 ft. with a 900 line system should not have more than 10" screen height. A monitor viewed at 8 ft. would have a screen approximately 33 x 25 inches .. Higher resolution television systems will allow for larger monitors at the same distance. This factor does not impose a limitation on the ultimate resolution, it merely ties the field size to the resolution with which it is being viewed. In other words, with a 900 line system, to get 200 line pairs per mm resolution, the total field on the viewing monitor would correspond to 2 1/4 mm in height on the actual photo. Therefore, the problem of using closed circuit television techniques for viewing is not one so much of loss or likely loss of information, but acclimating the user to the new techniques. The following are some advantages to be obtained from closed circuit TV.

1. Since there is no problem interrupting the viewing by a direct examination of the film, the optics can be optimized, and there is no need for a magnetic memory.
2. A number of monitors can be operated simultaneously and a television projector can be connected to the same line if desired.
3. The general lighting conditions of the operations room need be much less rigorously controlled, inasmuch as the optical section of the unit is enclosed and the viewing monitors can be individually adjusted for the ambient conditions.

4. If desired, more than one film can be viewed simultaneously on different viewers, and a monitor switched between various pictures, at will. This system could be used for comparingg "before and after" photographs. A signal switching system would show the two photographs alternately on the same screen and any changes would appear as a flickering image at the point of change.

Specific Devices

A. Combined Unit

This unit will be a rather large desk type console. It will have a tilted modulated light table on the top surface, conveniently located for the viewer. The light table will have, as a light source, a 16" diameter cathode ray tube. Controll information for the light source will be obtained by a photomultiplier mounted above the viewing area combined with a magnetic memory or, by use of light pipe technique, the memory may be eliminated and the photomultiplier could be mounted at a lower level where it would not interfere with the viewer. The memory is used to provide capability for close viewing of the film with magnifiers or microscopes. To use this feature, the information obtained by the photomultiplier is recorded on a magnetic tape or disc. Then the photomultiplier is moved aside and, as long as the film is not moved, the information from the memory will maintain the proper modulation of the light table. The unit will have controls for shrinking the raster size to a small area and for positioning this area any place on the film. The general intensity of the light source and the degree of modulation will be controlled by the operator. Beside the actual light table will be mounted a closed circuit television monitor. The camera of the closed circuit television system will be mounted on a mechanical arm or boom, and, by remote control, can be brought to bear on the photograph which is on the light table. The TV system will be 1000 or 2000 line raster. The camera position controls will be synchronized with the raster position control. Contrast control, grey level control and brightness control will be available in the TV system. In addition, an outlining function and a positive or negative picture capability can be supplied. There may be difficulties in the mechanical design, but the device does provide direct access to the film, variable magnification, the full required resolution and a capability of using numerous monitors and/or a projector. Measurements can be made on a 1 to 1 basis on the film itself, or through the monitoring system by means of calibrated reticles. Disadvantages of this system are possible interference between camera, photomultiplier and viewer; control requirement on ambient lighting, so as not to interfere with the photomultiplier cell; and a possible x-ray hazard. With the levels of accelerator voltage used for the applicable tube, it will be necessary to have a sheet of leaded glass between the tube and the film to protect the viewer. Although most versatile, this is the largest and most expensive of the devices being suggested here as possible solutions.

B. Field Light Table

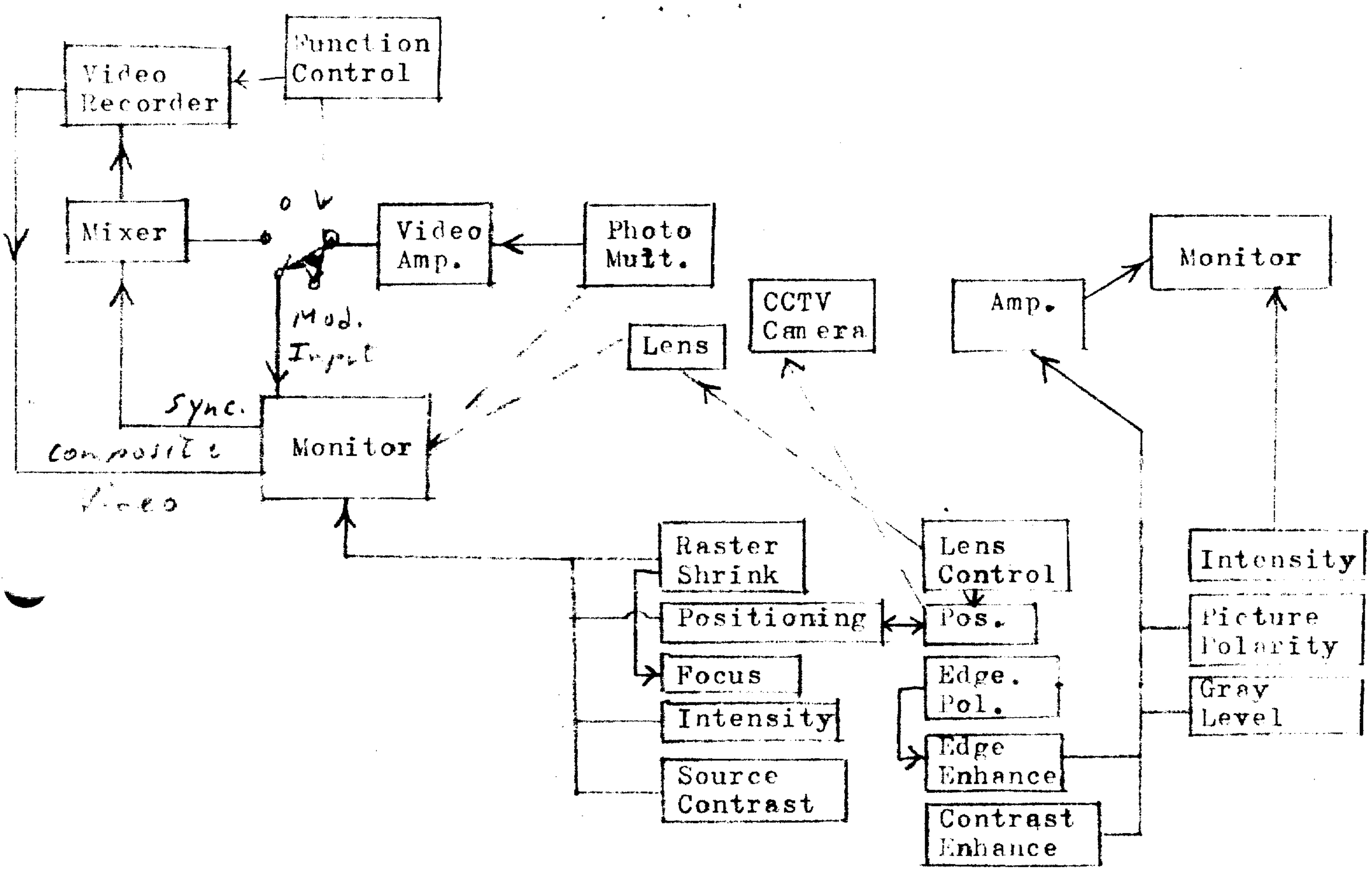
This unit will be a small desk type console, with the light table itself at a sloping angle in front of the operator, or it could be in a slope-front unit which may be placed on a desk. It is basically a modulated light table. The source of light is a 16" or 10" diameter cathode ray tube. Information for controlling the light source will be obtained by a photomultiplier mounted above the lighted surface. A provision will be included, with a magnetic memory, to allow for recording the necessary control information and then moving the photomultiplier aside, so that the film maybe closely examined and measured, without interfering with the modulation. While the film is being lighted through the control of the memory, the film must not be moved. This device may also be constructed using light pipes, in which case the memory may be eliminated, or there may be a combination of light pipes and memory. Modulation control for the light table, intensity control, a raster shrinking control and a positioning control will be provided. When the raster is shrunk down, the general compensation will be included in a small area. This unit is smallest, most simple and least expensive of those being suggested. It will be suitable for field use. It could be used with the tube magnifiers, magnifying glasses, or microscopes that are presently being used on normal light tables. This unit will be suitable for stereo viewing, inasmuch as the stereo pair will be lit up and compensated simultaneously and a normal stereo viewer could be used above it. The unit allows direct access to the film and direct measurement on the film. The only enhancement provided by this device is that which is gained by allowing the eye to operate at optimum light level. In other words, we eliminate excess glare and flare from highly transmissive areas, so that the eye of the viewer is not required to operate and discern details in a relatively dark area of the film while being disturbed by the excess light coming through more highly exposed areas of film. The ambient light in the room should be controlled as not to interfere with the viewer or with the photomultiplier itself. As in the first device mentioned, the x-ray hazard must be guarded against. This will probably mean a sheet of leaded glass between the cathode ray tube and the viewer.

C. Remote Viewer

This unit will be a desk type console, containing the complete device, or the major part of the device may be rack mounted with remote controls on a monitor that may be placed anywhere convenient. The unit will use a 16" diameter cathode ray tube as a modulated light source. The information for control of the light source will be gathered by a photomultiplier. Video information will be obtained by a vidicon which will view the backlighted film simultaneously with the photomultiplier. The unit will be totally enclosed with no direct access to the film. All the enhancement features provided in the combination unit, described in A, will be available in this unit. The unit will be simpler mechanically and much less expensive to design and build, because there will be no need for synchronized systems for moving spot location and camera. On this unit, the camera and light source will be held stationary and the film carriage will be moved to obtain relative positioning of the camera and film. Measurements will be made by means of calibrated reticles which will be inserted at the film plane. Since these reticles will be viewed simultaneously with the film, any dimensional distortions would occur in the reticle together with the film, and there will be no error in comparison of reticle and film. Inasmuch as the unit is enclosed, there are no restrictions on the ambient light. The unit will require no magnetic memory since the photomultiplier and vidicon would always be viewing the film together. This unit promises the best results and yet is not the most expensive, or the most complicated of the group. The most likely objection to this unit is the fact that there is no direct access to the film. Devices that were built for the Navy, and which we examined in Washington, also do not give direct access to the film. They do not feel that this is a disadvantage. In fact, it may be an advantage since there is much less likelihood of the original film being damaged. Even if this is not immediately acceptable to interpretors today, it may be the type of device which will eventually be used. It promises the most in possibilities of future development with reasonable cost and operability,

D. High Magnification Viewer

This unit is specifically designed to obtain the highest possible magnification to allow for even higher resolution than the 200 line pairs per mm required. The unit will be constructed in either a desk type console, with the viewing screen before the interpretor, or in a rack with a remote monitor including the controls for the equipment in the rack. The light source will be a very high intensity small diameter projection cathode ray tube. An image of the cathode ray tube will be projected on the film by means of a variable optic. The illuminated film will be viewed by a photomultiplier which supplies the control information for the intensity modulation of the light source. Video information will be obtained by viewing the illuminated film with a vidicon. As the magnification of viewing is increased, the image of the cathode ray tube source on the film will be reduced in size. This will allow the same lighting compensation within the smaller area being viewed, as is normally used over the whole film area. This unit is completely enclosed and there will be no direct access to the film. It is very similar in its characteristics to the remote viewer of part C, with the exception that the maximum area which can be viewed will be on the order of a 2" square of film. This limitation is imposed by the practical size of the optics which are required. The advantage over the remote viewer of C is that higher magnification will be available. This unit could be used for viewing 35 mm or other small film sizes, or for viewing small areas on larger film. It should be capable of providing resolution better than the present requirement.



Block Diagram

Device # A. Combined Unit

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