

PA 23,683

AP
9-15-66

AD

P. Townsend



TECHNICAL REPORT ECOM-2721

PHOTOPOLYMER PRINTER-PROCESSOR
(Exploratory Development)

BY PIERRE TOWNSEND

19961210 111

DISTRIBUTION STATEMENT A
Approved for public release
Distribution Unlimited

JUNE 1966

(Atch.)

DTIC QUALITY INSPECTED 4

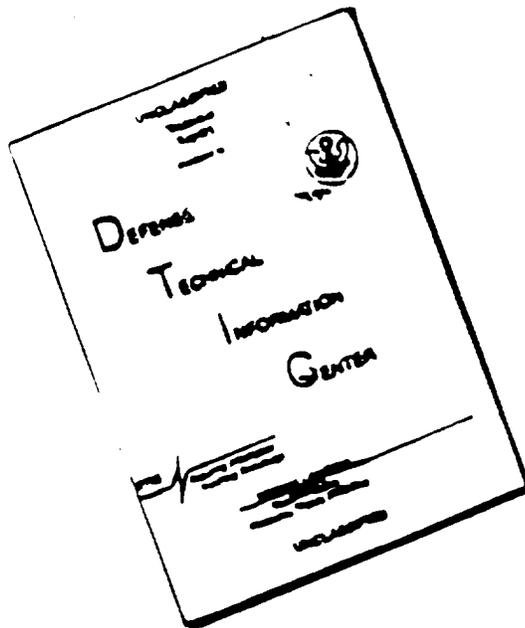
DD *wh*
SEP 9 1966

ECOM

UNITED STATES ARMY ELECTRONICS COMMAND · FORT MONMOUTH, N.J.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST
QUALITY AVAILABLE. THE COPY
FURNISHED TO DTIC CONTAINED
A SIGNIFICANT NUMBER OF
PAGES WHICH DO NOT
REPRODUCE LEGIBLY.

NOTICES

Disclaimers

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

The citation of trade names and names of manufacturers in this report is not to be construed as official Government indorsement or approval of commercial products or services referenced herein.

Disposition

Destroy this report when it is no longer needed. Do not return it to the originator.

TECHNICAL REPORT ECOM-2721

PHOTOPOLYMER PRINTER-PROCESSOR (EXPLORATORY DEVELOPMENT)

By

Pierre Townsend

PHOTO-OPTICS TECHNICAL AREA

COMBAT SURVEILLANCE AND TARGET ACQUISITION LABORATORY

JUNE 1966

DA TASK Nr. 1Z6 34401 D248 01

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

U. S. ARMY ELECTRONICS COMMAND, FORT MONMOUTH, NEW JERSEY 07703

ABSTRACT

An exploratory development model of a Photopolymer Printer-Processor, designed to make positive transparencies from 5-inch-wide aerial roll film by means of the photopolymer process, is evaluated. The equipment is contained in two separate units: a printer, viewer, and chopper in one unit; a processor and dryer in the second unit. The units weigh 80 pounds and 115 pounds, respectively.

The light source in the printer is a 100-watt mercury arc tube; about 40 seconds are required for printing. After printing and chopping, the print is manually fed into the processor where it is gripped at the edges by conveyor belts and carried, emulsion side up, down an incline under a stream of 1 percent hydrogen peroxide. Processing and drying require 72 seconds per print. As presently designed, the equipment requires an amount of hydrogen peroxide and water that is excessive.

Field film development

end

TABLE OF CONTENTS

ABSTRACT	ii
PURPOSE	1
FACTUAL DATA	1
CONCLUSIONS	13
RECOMMENDATIONS	13

FIGURES

1. Photopolymer Printer and Processor	2
2. Reaction Mechanism Chart	3
3. Formula for Photopolymer Coating	4
4. Photopolymer Printer	7
5. Photopolymer Processor	9
6. Processor Flow Chart	10

PHOTOPOLYMER PRINTER-PROCESSOR (EXPLORATORY DEVELOPMENT)

PURPOSE

The purpose of this report is to present the results of the evaluation of an exploratory development model of a Photopolymer Printer-Processor (Fig. 1) which was developed for making positive transparencies from 5-inch-wide aerial roll film by means of the photopolymer process.

This equipment was needed to fulfill a functional requirement in a projected mobile photographic laboratory (Darkroom Photographic, Portable, ES-35()). Development of the Photopolymer Printer-Processor was started in May 1963. Work on the photopolymer process, which culminated in the photopolymer film used in the present equipment, was begun in 1959. Efforts to improve the photopolymer film continued during the development of the present equipment.

One of the goals in the development of equipment for the ES-35() laboratory was to eliminate or minimize the need for water. This led to an investigation of non-silver halide photographic techniques, one of which was the photopolymer process.

FACTUAL DATA

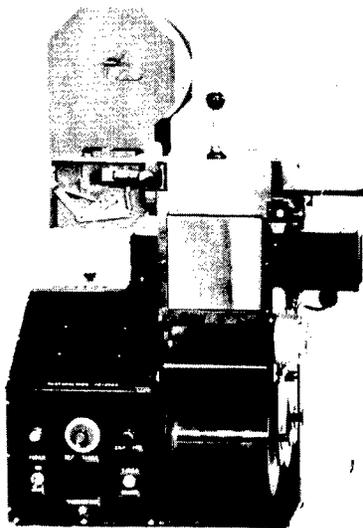
It was originally intended that the Photopolymer Printer-Processor would consist of a single unit comprising a viewer, printer, chopper and a dryer. Technical difficulties and administrative considerations during development resulted in the separation of the equipment into two units: a viewer, printer and chopper in one unit, and a processor and dryer in the other. The original concept of pushbutton, automatic operation to obtain a finished cut sheet positive transparency of a selected negative was changed. Advancement of the photopolymer film and chopping requires manual operation. Processing and drying in the second unit is entirely automatic following manual insertion of the photopolymer print bearing the latent image into the processor.

Twenty-five rolls (5" x 250') of photopolymer film were prepared by the contractor for use in the evaluation of the equipment. This film consisted of a thin layer (0.5 mil thick) of the photopolymer emulsion evenly spread on a standard film base material (Plestar).

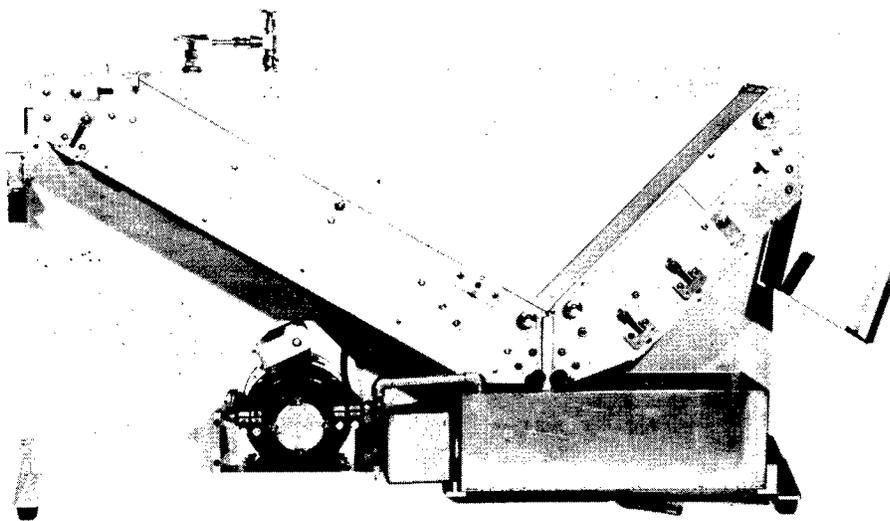
A graphic outline of the reaction mechanism involved in printing and developing photopolymer film is shown in Fig. 2.

Photopolymer emulsion consists of a uniform mixture of vinyl monomer, ferric salt, gray dye, and gelatin spread in a thin layer on a film base. The exact formula, provided by the contractor, is included as Figure 3 in this report. The preparation of a duplicate positive transparency by the photopolymer process is based on the formation of a relief image consisting of polymerized vinyl monomer; the unpolymerized portions of the emulsion are dissolved away in warm water at 100-110°F.

Printing requires exposure to a strong ultra-violet (3650 Å) light source which reduces the ferric salt, in the dry state, to ferrous ion which, during development, decomposes hydrogen peroxide to form the free radical HO. This free radical causes polymerization of the vinyl monomer.



Printer



Processor

Fig. 1 Photopolymer Printer and Processor

PHOTOPOLYMERIZATION PHOTOGRAPHY

(NEGATIVE TO POSITIVE TRANSPARENCY)

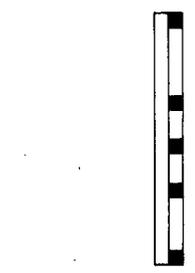
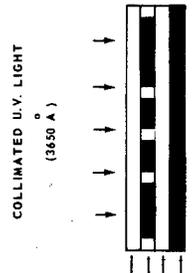
STEP 1 CONTACT PRINTING	STEP 2 POLYMERIZATION and MONOMER WASH OFF	STEP 3 DRYING
<p>COLLIMATED U.V. LIGHT (3650 Å)</p>  <p>BASE EMULSION NEGATIVE PHOTOPOLYMER MATERIAL</p> <p>BASE EMULSION</p> <p>COLLIMATED U.V. LIGHT (3650 Å)</p> <p>NECESSITY OF PRINTING THROUGH BASE OF PHOTOPOLYMER MATERIAL. POLYMER MUST FORM IN CONTACT WITH BASE FOR ADHERENCE TO OCCUR.</p>	 <p>POSITIVE TRANSPARENCY APPEARS AS EXPOSED AREAS ARE POLYMERIZED AND UNEXPOSED AREAS ARE WASHED AWAY SIMULTANEOUSLY BY WARM (104°) SOLUTION OF 1 PERCENT HYDROGEN PEROXIDE.</p>	 <p>DRY BY HOT AIR IMPINGEMENT.</p>
$\text{Fe}^{3+} \xrightarrow{h\nu} \text{Fe}^{2+}$ <p>PHOTOREDUCTION OF FERRIC SALT IN DRY STATE TO FERROUS ION.</p>	$\text{Fe}^{2+} + \text{HOOH} \longrightarrow \text{Fe}^{3+} + \text{HO}\cdot + \text{OH}^-$ <p>FERROUS ION DECOMPOSES HYDROGEN PEROXIDE TO FORM FREE RADICAL (HO·)</p> $\text{HO}\cdot + \text{(-C-CH}_2\text{)} \longrightarrow \left(\begin{array}{c} \text{CH-CH}_2 \\ \quad \\ \text{CH-CH}_2 \end{array} \right)_n$ <p>VINYL MONOMER VINYL POLYMER</p> <p>FREE RADICAL INITIATES POLYMERIZATION OF VINYL MONOMER</p>	<p>NOTE: PHOTOPOLYMER MATERIAL CONSISTS OF A UNIFORM MIXTURE OF VINYL MONOMER, FERRIC SALT, GRAY DYE AND GELATIN SPREAD IN A THIN LAYER (0.5 mil thick) ON A CELLULOSE ACETATE FILM BASE (5 mils thick).</p>

Fig. 2 Reaction Mechanism Chart

Fig. 3 FORMULA FOR PHOTOPOLYMER COATING

PART 1

N,N'- methylenebisacrylamide	0.83 Kg.
Gelatin, Kind and Knox No. 1757	3.00 Kg.
Water	10.40 Liters
Acrylated gelatin (4.2% solids)	35.70 Liters
Saponin 8% ag. solution	5.85 Liters

PART 2

Benzyl alcohol	2.925 Kg.
Tricresyl phosphate	2.925 Kg.
Nigrosine SSB (duPont)	1.800 Kg.

PART 3

Graphol Yellow, 20% solids (GAF)	4.680 Kg.
Polyvinylpyrrolidone, K-30 (GAF)	0.936 Kg.
Water	8.425 Liters
Saponin 8% ag. solution	14.700 Liters
Wetsit* 10% ag. solution	6.300 Liters

PART 4

Ferric ammonium citrate, brown	4.32 Kg.
Water	45.00 Liters

* Jacques-Wolfe

Mixing and Coating Procedure

The N,N'-methylenebisacrylamide is dissolved in 10.4 liters of water. The dry gelatin is then added and allowed to swell at room temperature for 30 minutes. The mixture is then heated with stirring to a temperature of about 50°C, and stirring is continued to effect complete solution of the monomer and gelatin. The acrylated gelatin is next melted and added to the monomer:gelatin solution with agitation. The saponin solution is then added and the mix is pumped through a RAPISONIC* homogenizer for thorough mixing.

Fig. 3 FORMULA FOR PHOTOPOLYMER COATING (Cont)

The nigrosine dye is dissolved in the mixture of benzyl alcohol and tricresyl phosphate at a temperature of 90°C, and this dye solution is then added to the homogenizer. The mixture is blended for 10 minutes.

In a separate container, the polyvinylpyrrolidone is dissolved in 8.425 liters of water, the graphtol yellow is added with stirring, and the mixture is then added to the homogenizer. The container is then rinsed with the saponin and wetsit solutions. This liquid is added to the homogenizer. After a 10-minute blending period, the mixture is transferred to a container of adequate volume. The ferric ammonium citrate is dissolved in the quantity of water specified in Part 4. This solution is then added, with stirring, to the blended mixture consisting of Parts 1, 2 and 3. Stirring is continued for 15 minutes. The temperature of the mix should be 40°C.

Prior to coating, the mixture is filtered to remove any agglomerates.

The photopolymer composition is applied to subbed Plestar filmbase on a conventional coating machine by a transfer roll technique. Coating speed is 28 ft./min. The thickness of the dry coating is 12.7 microns.

NOTE: The quantity of mix specified was found to yield approximately 1300 linear feet of coated film, 44 inches wide.

Development immediately follows printing because the latent image retention of photopolymer film is poor. The steps in the process are:

1. Printing by ultraviolet light,
2. Development (polymerization) by immersion in warm (100-110°F), hydrogen peroxide solution (1% H₂O₂),
3. Wash-off by warm water (100-110°F).

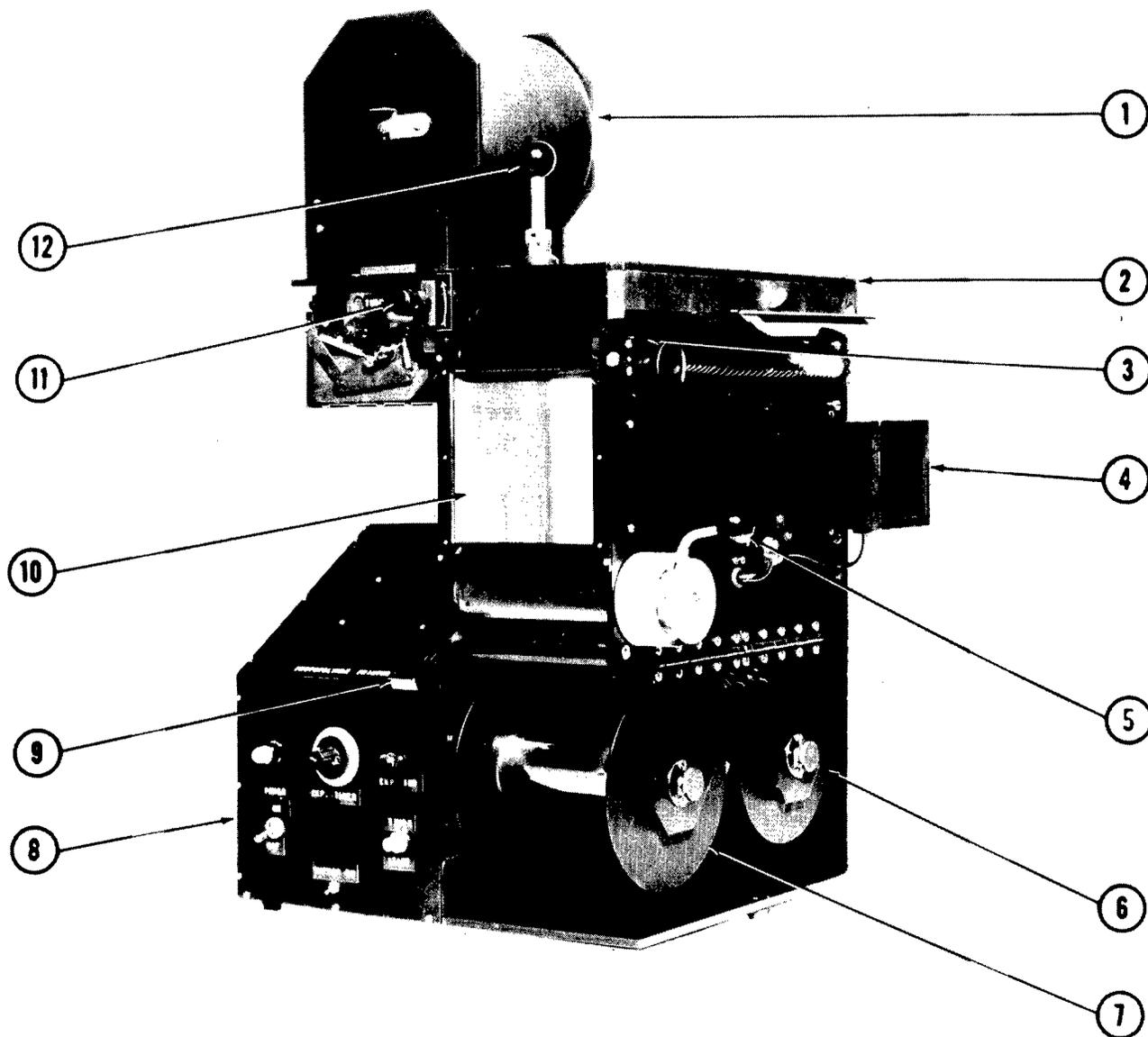
In the equipment which will be discussed, the last two steps are combined in the final model so that the print underwent polymerization and wash-off simultaneously. However, it was found necessary to add a final fresh water rinse to prevent staining from redeposited monomer and other residues. The process remained, therefore, a two-step or two-solution process.

The printer (Fig. 4) is a step and repeat type. It measures 25.4" h x 18" w x 14" d and weighs about 80 pounds. The printing lamp is a mercury arc tube, G. E. H100A 4/T, 100 watt, removed from its T-10 envelope and mounted in a reflector from a Sylvania Professional Sun Gun Photo Light. The lamp remains on while the printer is in operation. Exposure time is controlled by a rotary shutter which is actuated by a pushbutton control. The exposure time is set on a rotary dial which is calibrated up to 70 seconds. Pilot lights indicate whether power is on and whether an exposure is underway. The aerial roll film being printed is held by feed and takeup spools (capacity: 5" x 250'), which are connected to constant torque motors designed to rotate in opposite directions. Thus, a constant tension is maintained on the film, causing it to lie flat and ensuring that it will transfer from the feed to the takeup spool without slack. An integral viewer on the front of the printer permits viewing and selection of negatives prior to printing.

To print a selected negative, it is necessary to reverse-wind a manual crank one revolution. This moves the selected negative back from the viewer into the print exposure area. The photopolymer material is also advanced manually, one frame at a time, by means of a detented crank. The path of the photopolymer material is at right angles to the negative to facilitate chopping of the exposed print. The chopper employs a sliding knife edge and is manually operated.

Printing of photopolymer material must necessarily be through the base material; otherwise, the image will not adhere to the base. This, of course, adversely affects resolution unless the ultraviolet light is collimated. No collimating devices other than the parabolic reflector previously mentioned are used in the present design. The distance from the light source to the photopolymer material is 9.5 inches. A first surface mirror is used to effect a right angle upward change of direction.

Resolution measurements averaged about 23 lines per millimeter. This value was obtained by printing a USAF resolution target (contrast ratio = 85:1) on evenly divided areas of nine different prints. The readings were averaged to obtain the value given above. The time required for printing



- | | |
|------------------------------------|----------------------------------|
| 1. Print Material Cassette | 7. Negative Take-up Spool |
| 2. Exposure Platen | 8. Control Panel |
| 3. Print Cut-off Knife | 9. Negative Pinch Roll Release |
| 4. Light Source Cooling Air Intake | 10. Negative Viewer |
| 5. Negative Advance Crank | 11. Print Material Advance Crank |
| 6. Negative Supply Spool | 12. Platen Release Lever |

Figure 4 Photopolymer Printer

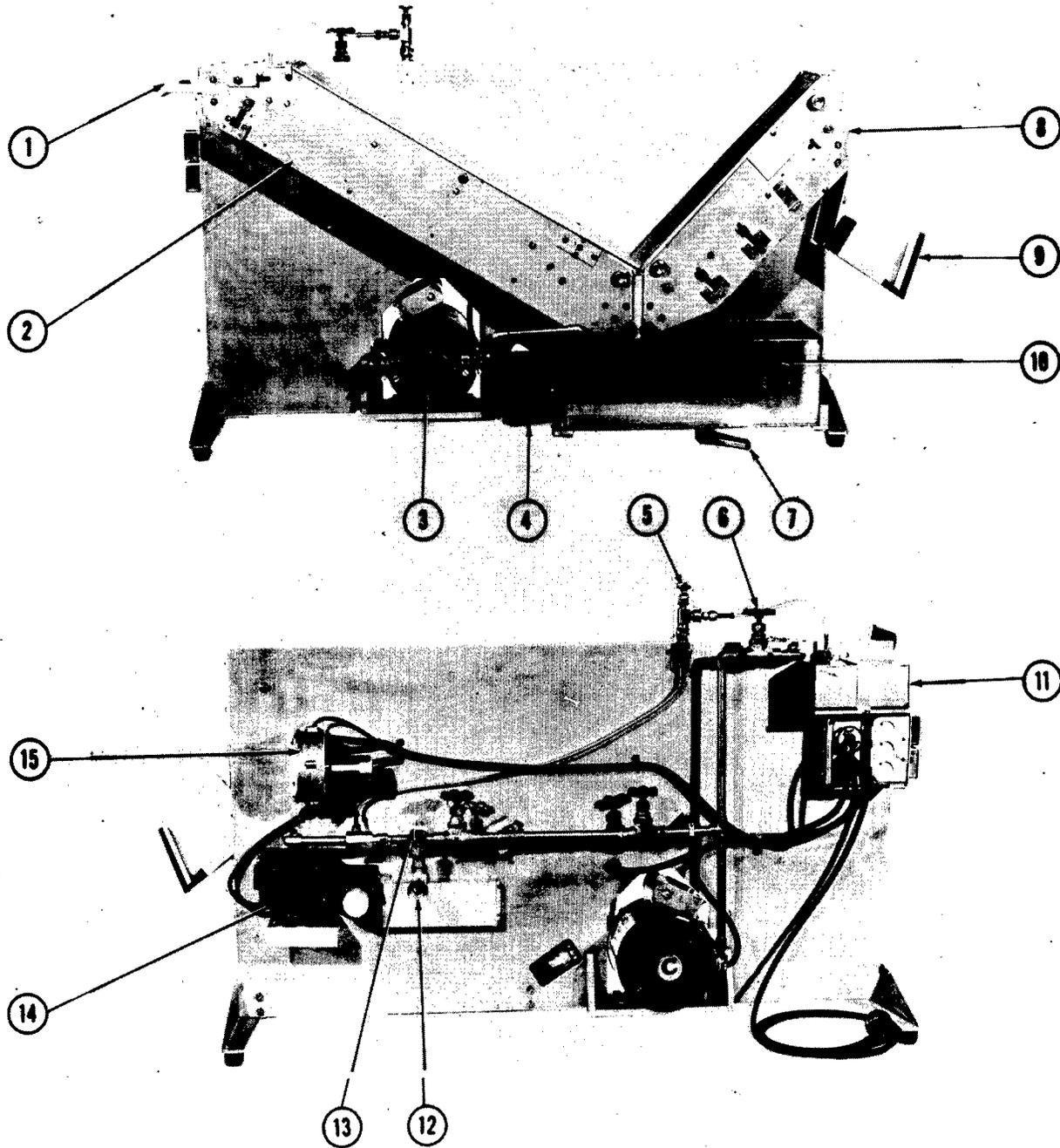
an average aerial negative is about 40 seconds, which is too slow.

The design of a successful processor was complicated during processing by the extreme softness of the photopolymer emulsion. Two unsuccessful processor prototypes are described below prior to discussing the equipment under evaluation.

The first processor prototype involved transport of the exposed 5-inch x 5-inch transparency print through the processing solution by means of edge gripping rollers. However, the vigorous agitation required to dissolve the unexposed monomer caused the prints to buckle, touch the roller surfaces, and become scratched. The second prototype sought to avoid buckling by having the print follow a curved path, thus imparting more rigidity to the print. However, buckling and scratching continued. Less agitation might have been required by going to a longer path length, but instead it was decided to try an entirely different approach.

The final model of the processor (Fig. 5) is designed to transport each print, emulsion side up, down an incline under a spray of 1 percent H_2O_2 (see Fig. 6). The prints are held by conveyer belts, one full width belt underneath and two elastomeric (urethane) edge gripping belts above. The incline (27" long) is slightly curved (convex). The H_2O_2 solution was first allowed to impinge directly on the photopolymer film until it was found to be the cause of streaking. To eliminate this, flat aluminum deflectors were attached to each of the four spray applicators to convert the spray into several light streams which run off the baffle and onto the photopolymer film. The function of each spray applicator, which is complex in design to assure even spraying, is therefore almost completely negated. A related modification, which was also required to minimize uneven development, involved the installation of two aluminum baffles, or shields, around the first spray applicator. This causes the formation of a pool of hydrogen peroxide solution which is necessary to coat the print evenly on first contact. The solution must be evenly applied at a uniform rate of speed; otherwise, marks will appear wherever spray droplets or eddies of solution momentarily touch the emulsion prior to application of the main body of solution. The method used in the present equipment is not satisfactory since the effects described above are not entirely eliminated. An optimum solution flow rate is required which involves a critical valve adjustment; furthermore, the valve requires frequent readjustment which is probably due to the vibration of the equipment in operation. Another undesirable design feature is the use of aluminum in the spray applicators; the amount and distribution of the effluent gradually changes owing to corrosion and clogging of the holes (0.025 and 0.047" dia.) in the spray tubes.

The run-off collects in an open processing solution tank at the base of the incline. This tank holds 1.8 gallons of 1 percent H_2O_2 solution which is constantly recirculated by a Jabsco No. 5795 centrifugal pump. The supply line (Fig. 5) from the pump branches into a by-pass back to the reservoir, and to another line which branches to two more lines. One of these lines connects with a single spray applicator at the point of print entry; the other connects with the four spray applicators previously discussed. The flow rates in the three lines are controlled



- | | |
|--|------------------------------------|
| 1. Print Material Acceptance Tray | 8. Print Drying Incline |
| 2. Processing Incline | 9. Print Material Discharge Tray |
| 3. Recirculating Pump | 10. Processing Solution Reservoir |
| 4. Solution Temperature Control Adjustment | 11. Replenishment Tank |
| 5. Replenishment Control Valve | 12. Print Wash Water Inlet |
| 6. Processing Solution Flow Control Valves | 13. Print Wash Water Control Valve |
| 7. Waste Line | 14. Print Transport Drive |
| | 15. Print Dryer Heater and Blower |

Figure 5 Photopolymer Processor

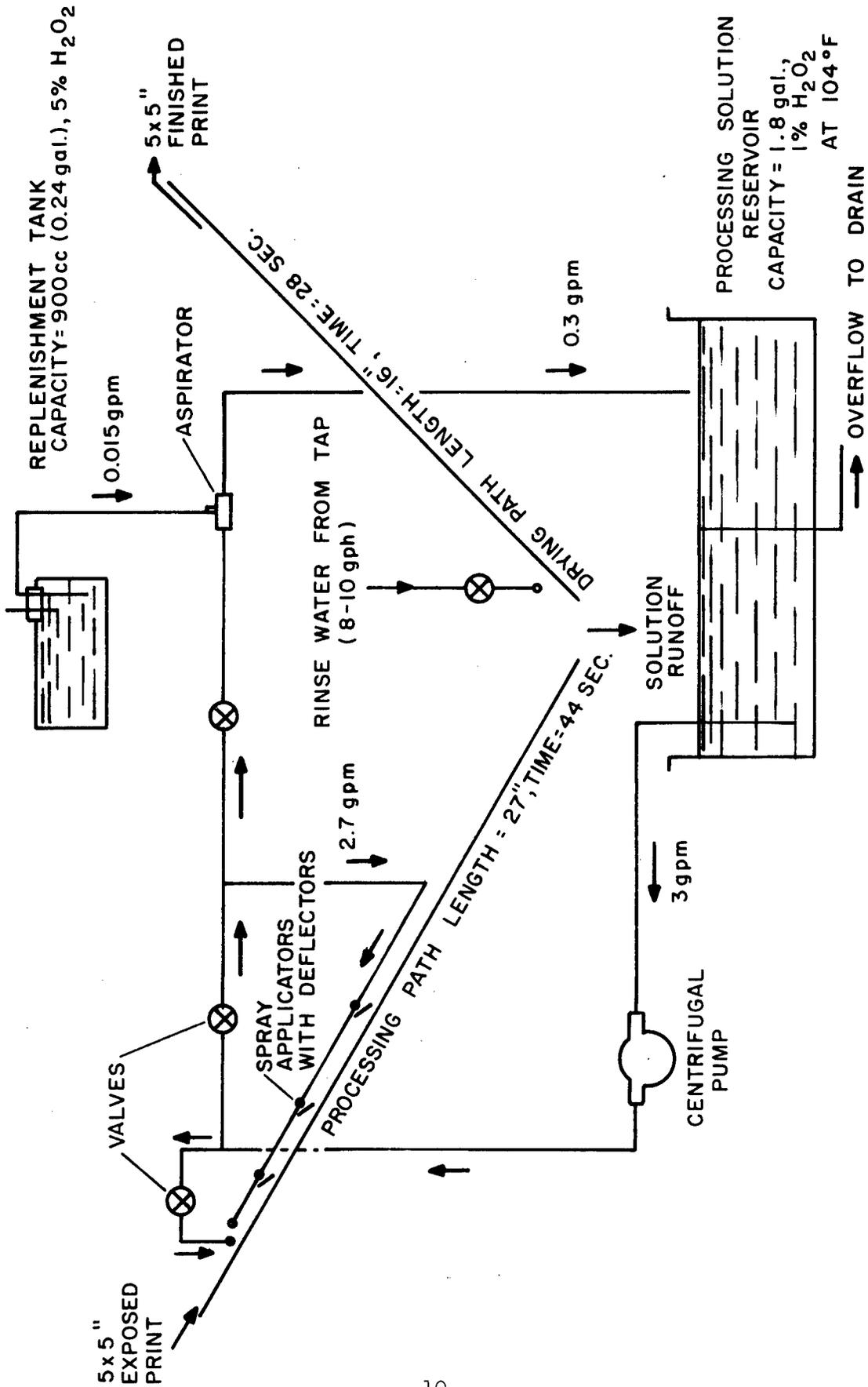


FIG. 6 PROCESSOR FLOW CHART

by a needle valve in each line; each valve requires constant readjustment, probably because of vibration of the equipment. Originally, it was planned to feed fresh 1 percent H_2O_2 solution into the first spray applicator from a separate, closed H_2O_2 supply tank (capacity = 900cc); the run-off was to flow down the incline mixing with fresh tap water from the other spray applicators. However, it was found that more even development resulted by filling the processing solution reservoir, into which all of the run-off flows, with 1.8 gallons of 1 percent H_2O_2 and pumping this solution to all of the spray applicators.

Subsequently, it was found that a final fresh water rinse had to be added to wash away redeposited residues acquired from the processing solution. Since this need was not foreseen and there was no room for another spray applicator in the processing section it was placed in the base of the dryer section. It was designed to be attached to a tap water supply by means of a flexible line; the run-off drained into the processing tank. To be effective, a flow rate of about 8 to 10 gallons per hour of fresh water was required. This, of course, upset the goal of water conservation but was apparently unavoidable. Since this water drained into the processing tank and diluted it at a rapid rate the hydrogen peroxide solution required replenishment. The 900cc hydrogen peroxide supply tank was used as a replenishment tank and replenishment solution (5% hydrogen peroxide) was fed into the by-pass line to the processing tank by means of aspirator suction. A sight gauge was installed in the line to permit a rough measurement of replenishment by counting the drip rate. However, the valve controlling the drip rate required constant readjustment, hence, this system was unsatisfactory. Furthermore, if the equipment is to be operated as designed, the 900cc replenishment tank would have to be refilled at least ten times per hour with the recommended 5 percent hydrogen peroxide solution to compensate for the 8 to 10 gallon per hour rate of introduction of fresh water.

The maximum rate of replenishment was 0.015 ~~gal~~ per minute (gpm). Replenishment should, however, be two to three times greater. This could be achieved by creating more suction at the aspirator. This would require a greater flow rate, hence, larger diameter tubing and a larger pump would be required. At present, the flow rate through the by-pass is only 0.32 gpm. A larger pump is required because close to the total capacity of the pump, 3 gpm is required for the spray applicators, leaving very little for recirculation through the by-pass back to the processing tank. However, the need for replenishment could be eliminated or greatly reduced by redesigning the equipment as suggested under Recommendations.

The design originally called for two distinct processing steps: (1) polymerization of the latent image by the application of one percent hydrogen peroxide solution, (2) wash-off of the unpolymerized monomer by means of warm water. This process, which may be called the two-step or two-solution process, has the great advantage of requiring a very small amount of hydrogen peroxide. However, if a one-step or one-solution process is used, as in the case of the present equipment, it is necessary to use a large initial quantity of hydrogen peroxide to fill the processing tank (1.8 gallons) with 1 percent solution. Furthermore, as previously mentioned, a final fresh water rinse is required so that there is actually no saving of water.

A practical laboratory test was performed to determine how many prints could be processed by a given volume of 1 percent H_2O_2 . Each print bore an aerial scene and a step wedge. Twenty 5-inch x 5-inch prints were processed (including wash-off) in 200cc of 1 percent H_2O_2 without a visible change in the number of steps. The volume of solution dropped from 200cc to 140cc because of loss by carryover; however, more could have been processed despite heavy contamination of the remaining solution by dissolved monomer, gelatin and dye. The number of prints processed was equivalent to 700 prints for 1.8 gallons (processing tank capacity) of 1 percent H_2O_2 or 6 hours of operation without replenishment. Wash-off was performed in the same tray to simulate the one-step process used in the present equipment. The prints were not given a final rinse to see if the use of 8 - 10 gpm of rinse water could be eliminated. However, all of the prints were stained due to redeposited solutes; hence, the final rinse is a required step. It was concluded from the above experiment that the equipment can be operated for one day with solution replenishment limited to periodic replacement of loss by carryover provided that the required 8 to 10 gpm of rinse water was not allowed to run into the processing tank as in the present design.

The time required for processing a print is about 44 seconds. Drying adds 28 seconds. The total processing time is 72 seconds. The processing rate for the 43-inch path length (Fig. 5) is 0.6 inch per second, which is too slow. It should be noted that the printing time adds about 40 seconds to the above figure of 72 seconds to yield a total access time of almost 2 minutes to view a finished print.

The processing time in the present equipment could be reduced by the direct application of several heavy streams of processing solution, precisely directed, rather than the present uneven application of three or four light streams of solution from each of the spray deflectors. At present, the flow rate from the spray jets is approximately 3 gallons per minute.

The greater effectiveness of a heavy stream of liquid directly applied was demonstrated by exposing a print, dipping it into 1 percent H_2O_2 for 2 - 3 seconds and washing it under hot (100°) tap water at a 6-inch distance. The total processing time was reduced to about 12 seconds at 1.3 gpm flow rate and to 7 seconds at 6.3 gpm. A visual quality check made with a control print which was thoroughly washed for 30 seconds under a light flow of hot ($100^\circ F$) tap water indicated that the test prints had been washed sufficiently to dissolve all of the unexposed monomer. It was also observed that the prints obtained in this way were evenly processed in contrast with those obtained from the equipment being discussed.

The effectiveness of drying is marginal. Drying is by hot air impingement at about $140^\circ F$. Two blowers with built-in resistance heating elements provide the hot air. The dryer must be allowed to warm up for about 15 minutes before use, otherwise the prints will not be dry when they emerge. Prints are moved through the dryer emulsion side up by elastomeric (urethane) belts identical to the belts used in the processor section. The prints are held by two edge-gripping belts on the emulsion side and nine narrow belts underneath which are staggered so that **no portion of print's surface area is covered at all times. The rollers and**

pulleys used with the conveyor belts have adjustments to compensate for stretching of the belts. Power is transmitted to this system by a drive roller at the base of the dryer which is driven by the same motor used to drive the processor's conveyor belts. Two ejection rollers at the exit point are covered with a blotting paper surface to blot up droplets of water clinging to the prints.

The belts generally move out of position during prolonged operation and print movement is impaired or halted.

The noise level of the equipment is far too high, and it would be intolerable in the confined space of a mobile shelter. The principal source of noise is the pump.

CONCLUSIONS

The printer-processor requires an excessive amount of water: 1.8 gallons for the initial charge and 8 to 10 gpm during continuous operation.

The one-solution process used in the equipment requires an excessive amount of H_2O_2 for initial operation. Furthermore, the fact that the rinse water drains into the processing tank at a rate of 8 to 10 gpm makes it necessary to add additional H_2O_2 solution to replace unexhausted solution lost as overflow. Initial charging requires 5 bottles (1 pint each) of 3 percent H_2O_2 for charging the solution reservoir and 1/3 bottle (1 pint) of 30 percent H_2O_2 for charging the replenishment tank. Replenishment requires about 2-1/2 bottles (1 pint each) of 30 percent H_2O_2 per hour, diluted to 5 percent H_2O_2 , for continuous operation. Obviously, the need for stocking 30 percent H_2O_2 , which requires refrigeration and is hazardous to handle, could be eliminated by using a larger replenishment tank and charging it with 3 percent H_2O_2 , which is also more readily obtainable.

The present processing technique requires improvement. The processed prints are generally streaked because of uneven processing. Furthermore, the present equipment does not lend itself to compactness or reliability in operation. The movement of the prints through the processor and the dryer requires the use of specially fabricated urethane rubber belts, which often mistrack, and require take-up adjustments for stretch.

The weight and size are excessive. The equipment weighs about 195 pounds, and requires about 58 inches of lateral bench space, which constitutes about 42 percent of the available bench space on one side of an S-280() shelter.

Drying is marginal, and the conveyor belt transport system is not reliable.

RECOMMENDATIONS

Water from the final rinse should not be allowed to dilute the contents of the processing tank. This would eliminate the replenishment tank and associated plumbing. Replenishment could be confined to replacement of carryover and could be accomplished by intermittent addition of

1 percent H_2O_2 solution by the operator to the open processing tank when necessary.

The present modified aluminum spray applicators should be replaced by stainless steel applicators with larger outlets to eliminate clogging caused by corrosion and to decrease processing time by permitting a heavier flow of solution. A larger capacity pump may be required.

The excessive weight of the processor could be decreased by substituting standard structural members for the 1/2-inch-thick aluminum plate used to support the components. The excessive amount of bench space occupied by the equipment could be decreased by use of a floor-mounted design and by placing the printer above the processor rather than adjacent to it.

The dryer's efficiency could be improved by lengthening the path length to allow more time for drying. The method of transport should be redesigned so as to be more positive and more reliable. Edge-gripping rollers or a porous web transport should be tried.

Consideration should be given to replacing the one-solution process now used by a two-solution process. Hydrogen peroxide solution should be applied in a dip tray ahead of the processor incline. The prints, held by edge-gripping rollers, would pass rapidly through the H_2O_2 solution before entering the incline section where the wash-off step would take place. Replenishment of the H_2O_2 in the dip tray would be confined to replacement of carryover, about 3cc per print. The wash-off step would utilize ordinary tap water.

Consideration should also be given to a basic change in design from a cut sheet to a roll film printer and processor. Replacement of the present continuous, low intensity ultra-violet light source by a pulsed high intensity ultra-violet source is feasible and would greatly decrease printing time. A continuous printer could be designed by placing the pulsed light source inside a rotating glass cylinder bearing the film and the photopolymer copy film. The film would enter the processor directly from the printer as originally planned for the present equipment. The requisite coating H_2O_2 solution could be applied directly to the emulsion by means of a slotted tube applicator. Wash-off could be accomplished by several heavy jets of warm tap water, followed by drying by direct hot air impingement. The attainment of a high rate of production, about 20 prints per minute, is feasible.

The equipment described in this report was developed by General Aniline and Film Corporation under Contract No. DA36 039 AMC 02292(E). The contractor published the Final Report, "Photopolymer Printer and Processor" in September 1965.

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) U. S. Army Electronics Command Fort Monmouth, New Jersey 07703		2a. REPORT SECURITY CLASSIFICATION Unclassified	
		2b. GROUP --	
3. REPORT TITLE Photopolymer Printer-Processor (Exploratory Development)			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates)			
5. AUTHOR(S) (Last name, first name, initial) Townsend, Pierre			
6. REPORT DATE June 1966		7a. TOTAL NO. OF PAGES 14	7b. NO. OF REFS 0
8a. CONTRACT OR GRANT NO. DA36 039 AMC 02292(E)		9a. ORIGINATOR'S REPORT NUMBER(S) ECOM-2721	
b. PROJECT NO. 1Z6 34401 D248		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
c. Task No. 1Z6 34401 D248 01			
d.			
10. AVAILABILITY/LIMITATION NOTICES Distribution of this document is unlimited.			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY U. S. Army Electronics Command AMSEL-HL-CT-0 Fort Monmouth, New Jersey 07703	
13. ABSTRACT An exploratory development model of a Photopolymer Printer-Processor, designed to make positive transparencies from 5-inch-wide aerial roll film by means of the photopolymer process, is evaluated. The equipment is contained in two separate units: a printer, viewer, and chopper in one unit; a processor and dryer in the second unit. The units weigh 80 pounds and 115 pounds, respectively. The light source in the printer is a 100-watt mercury arc tube; about 40 seconds are required for printing. After printing and chopping, the print is manually fed into the processor where it is gripped at the edges by conveyor belts and carried, emulsion side up, down an incline under a stream of 1 percent hydrogen peroxide. Processing and drying require 72 seconds per print. As presently designed, the equipment requires an amount of hydrogen peroxide and water that is excessive.			

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Photopolymer Printer-Processor Polymerization Monomer Wash-off Vinyl Monomer Drying Transparencies (Negative to Positive) Photography Printing						

INSTRUCTIONS

1. **ORIGINATING ACTIVITY:** Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization (*corporate author*) issuing the report.

2a. **REPORT SECURITY CLASSIFICATION:** Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. **GROUP:** Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. **REPORT TITLE:** Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. **DESCRIPTIVE NOTES:** If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. **AUTHOR(S):** Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. **REPORT DATE:** Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. **TOTAL NUMBER OF PAGES:** The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. **NUMBER OF REFERENCES:** Enter the total number of references cited in the report.

8a. **CONTRACT OR GRANT NUMBER:** If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. **PROJECT NUMBER:** Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. **ORIGINATOR'S REPORT NUMBER(S):** Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. **OTHER REPORT NUMBER(S):** If the report has been assigned any other report numbers (*either by the originator or by the sponsor*), also enter this number(s).

10. **AVAILABILITY/LIMITATION NOTICES:** Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

- (1) "Qualified requesters may obtain copies of this report from DDC."
- (2) "Foreign announcement and dissemination of this report by DDC is not authorized."
- (3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through _____."
- (4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through _____."
- (5) "All distribution of this report is controlled. Qualified DDC users shall request through _____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. **SUPPLEMENTARY NOTES:** Use for additional explanatory notes.

12. **SPONSORING MILITARY ACTIVITY:** Enter the name of the departmental project office or laboratory sponsoring (*paying for*) the research and development. Include address.

13. **ABSTRACT:** Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as (TS), (S), (C), or (U).

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. **KEY WORDS:** Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.