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ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES

Report 1174

Final Report

ENGINEERING TESTS OF EXPERIMENTAL AMMONIA PROCESS PRINTER-DEVELOPER

Project 8-35-09-005

6 July 1950

Submitted to

THE CHIEF OF ENGINEERS, U. S. Army

by

The Commanding Officer

Engineer Research and Development Laboratories

Prepared by

John H. Kelly
Project Engineer
Reproduction Studies Section
Photo-Litho Branch
Engineer Research and Development Laboratories
Fort Belvoir, Virginia

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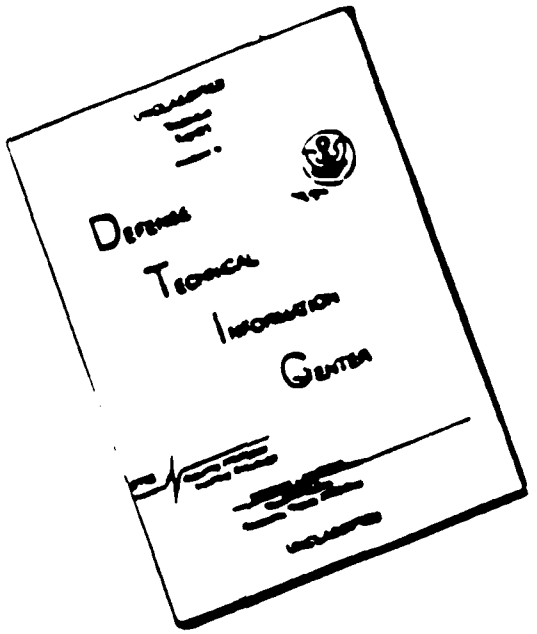

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SUMMARY

Subject. This report covers engineering tests conducted on an experimental 42-inch ammonia process printer-developer generally conforming to military characteristics established by the project. This particular machine was developed to fill what were, at the time of the initiation of this project, the following needs:

1. To provide an improved machine to replace the Ozalid Model E in Engineer Set No. 710-010. The Model E was no longer available commercially.

2. To provide a means for experimental testing and further developing under the same project of materials and processes for photo reproduction by the ammonia process.

3. It was expected that the new machine might also provide an interim means to field units for making diazotype prints in quantity if such a requirement developed.

The investigation covered by this report is limited to the experimental machine and its functioning; neither the ammonia process nor the diazotype sensitized materials were under test.

Investigation. An experimental ammonia process printer-developer was procured, inspected and subjected to tests of the functioning of its components and to production tests involving the reproduction of line-work, and of continuous-tone transparencies, both cut and roll. Operational and functional deficiencies of the machine were noted, and provisions were made to correct them.

Conclusions. The report concludes that:

1. With the modifications accomplished and those recommended under par. 15, the machine is a satisfactory replacement for present standard equipment used for the production of line-work prints, where the quantity of work necessitates the use of a high speed production machine.

2. The machine is satisfactory for the production of continuous-tone prints from cut sheet and aerial roll film, as an auxiliary feature to the line-work reproduction.

3. By reason of its width, this machine is not suitable for the exclusive production of continuous-tone photographic prints in rolls.

4. The machine is suitable for standardization as a Class IV item of issue.

5. Further investigation and development is necessary to provide ammonia process equipment suitable for the exclusive production of continuous-tone prints from aerial roll films.

Recommendations. The report recommends that:

1. The experimental ammonia process printer-developer, modified as noted in par. 15, be classified as adopted type, standard type, and as a Class IV item of issue.

2. Project 8-35-09-005 be modified to cover the development of a special ammonia process printer-developer suitable for the exclusive production of continuous-tone prints from aerial roll films.

NOTE

This report, including illustrations, was produced on the ERDL experimental printer-developer utilizing presently available commercial ammonia process materials. The text, Figures 5, 10, and 11, and all tables were produced on Ozalid Blue-line Paper, 205 S from Ozatran originals. Figures 3 and 9 were made on the blue-line paper using photo-mechanical film positives contact printed from the original line negatives. Figures 1, 2, 4, 6, 7, and 8 were made on Ozalid Sepia Dry-Photo Paper, 404 D, from commercial type film positives which were contact printed from the original negatives.

FINAL REPORT

ENGINEERING TESTS OF EXPERIMENTAL AMMONIA PROCESS PRINTER-DEVELOPER

I. INTRODUCTION

1. Subject. This report covers engineering tests conducted on an experimental 42-inch ammonia process[1] printer-developer generally conforming to military characteristics established by the project. This particular machine was developed to fill what were, at the time of the initiation of this project, the following needs:

a. To provide an improved machine to replace the Ozalid Model E in Engineer Set No. 710-010. The Model E was no longer available commercially.

b. To provide a means for experimental testing and further developing under the same project of materials and processes for photo reproduction by the ammonia process.

c. It was expected that the new machine might also provide an interim means to field units for making diazotype prints in quantity if such a requirement developed.

The investigation covered by this report is limited to the experimental machine and its functioning; neither the ammonia process nor the diazotype sensitized materials were under test.

2. Authority. The authority for this work is contained in Project 8-35-09-005, Reproduction Equipment, Ammonia Process.[2] A copy of the project card (RDB Form 1A) is contained in Appendix A.

3. Personnel. The engineering tests were conducted by John H. Kelly, project engineer, under the supervision of W. W. Davis, Chief, Reproduction Studies Section, Robert E. Rossell, Chief, Photo-Litho Branch, and William C. Cude, Chief, Topographic Engineering Department, ERDL, Fort Belvoir, Virginia.

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1. See Appendix B for definition of terms used in connection with ammonia process.

2. The following reports cover work also authorized under this project:
ERDL Report 1109, Interim Report, Light-Sensitive Diazotype Papers for Tropical Use, 8 April 1949.
ERDL Report 1122, Sensitizers for the Production, by the Diazo-Ammonia Process, of Non-Photographic Blue-Line Drafting Boards, 6 May 1949.

4. Background. Because of the ever increasing importance of aerial photography, military planning has had to investigate ways and means of providing large quantities of photographs quickly. Under combat conditions in World War II, it was found that aerial photography, to be of maximum value, had to be reproduced and readied for use within a few hours. (An AFF Board No. 2 Report 1400, Photo Reproduction Methods and Equipment, 3 February 1950, estimated that 50,000 photographic prints per army per day would be required.) Present methods for quantity production of continuous-tone photographic prints, and the methods employed during World War II, are confined in most cases to the use of the conventional silver halide photographic process. If this method is used in a future emergency, it means that a tremendous amount of photographic processing equipment must be employed together with sizable quantities of men and material. It was necessary, therefore, to find a simpler, more rapid process capable of quantity production with less manpower and with equipment of less size and weight. The ammonia process is one that shows promise of meeting these objectives. A description of the ammonia process and its comparison with the silver halide process is contained in Appendix C.

II. INVESTIGATION

5. Preliminary Investigation. Research was initiated to develop an ammonia process machine which would be capable of quantity reproduction of line drawings and continuous-tone photographs. Requirements were drawn up for an experimental ammonia process printer-developer to meet the military characteristics. This machine was procured under development contract W-44-009 eng-505, for the sum of $18,500, from Ozalid, Division of General Aniline and Film Corporation, Johnson City, New York, and was delivered to the ERDL on 23 March 1948.

6. Description. The experimental model, its various sections, and its special attachments are described in the following subparagraphs:

a. General. The machine, a self-contained, automatic, reproduction unit capable of exposing and developing ammonia process materials up to 42 inches wide, is 73 inches in width, 41½ inches in height, 47 inches in depth, and weighs 1885 pounds (Figs. 1 and 2). The machine is operated from a 110-120 volt, a-c, 60-cycle, single-phase power supply. It is permanently mounted on rotating casters, and is equipped with leveling bolts and anchor-bolt plates for semi-permanent installation. When the latter type of installation is used, the machine, including casters, is raised off the floor and leveled by adjusting the leveling bolts. For this purpose, a spirit level is located in the center of the feed-board, parallel with the face of the machine. The main framework

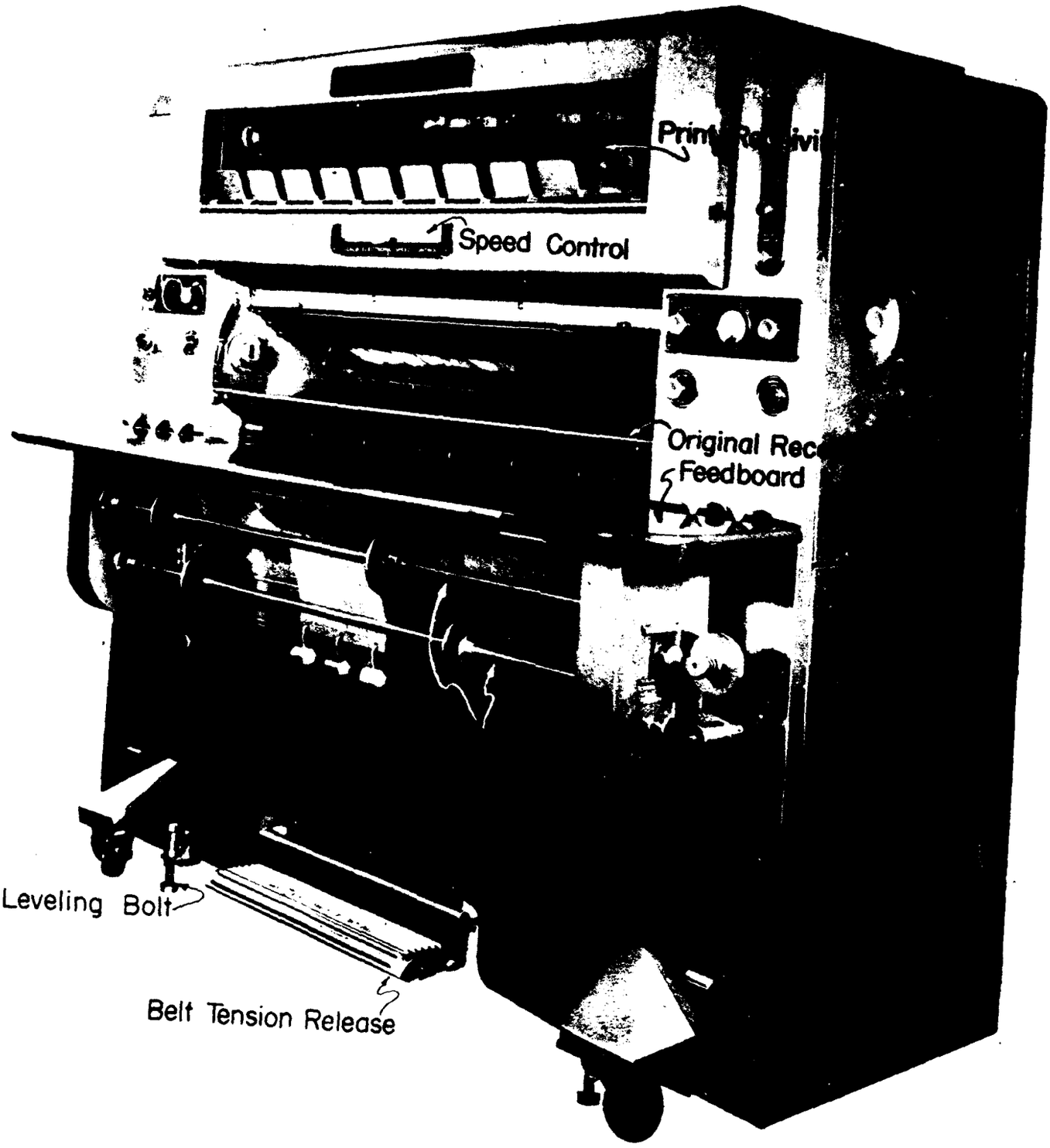

Fig. 1. Front and right side of experimental model ammonia process printer-developer. Supports for the feeding of roll stock are below feedboard.

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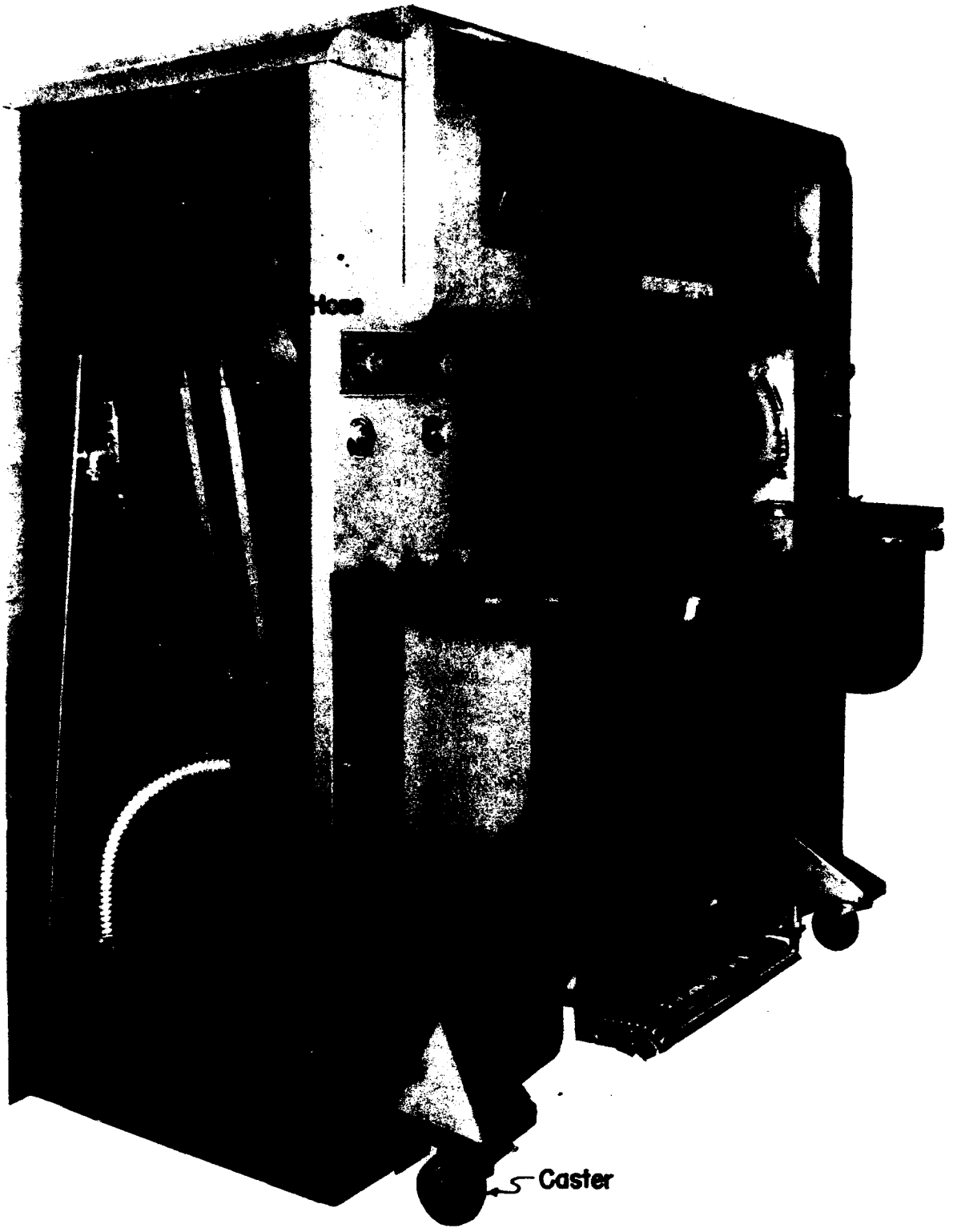

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Fig. 2. Front and left side of experimental model ammonia process printer-developer. Supply and reqind spools are for rolls of sensitized material, film, and processed prints.

of the machine consists of a rectangular base, four corner post uprights, and a rectangular top frame all of which are stiffened by the use of fabricated aluminum angle and plate construction. The rotating components, such as rollers and glass cylinder, plus the fixed components such as tanks and metal guides, are supported and/or connected to end plates which span the corner post uprights at each end of the machine. The framework is enclosed by easily removable sheet metal doors or panels. End sections extend from the framework forming end cabinets where access for maintenance and adjustment is gained to bearings, sprockets, chain drives, belt tension adjustment screws, air duct tubes, electrical terminals, ammonia feed, and ammonia tank. Space is available in the end cabinets for tools, spare parts, grease, oil, ammonia waste can, and attachments. A 6-inch diameter flexible tube is attached at the rear of the machine for carrying away the exhaust heat and ammonia fumes.

b. Stand Section. The stand section of the machine includes the base and that portion of the frame below the level of the feedboard and houses the drive unit, blower unit, and electrical components. The drive unit consists of a General Electric Junior Thymotrol electronic control, anode transformer, and 1/8-hp, d-c, gear-in-head motor. This unit drives the rollers and feed belts of both printer and developer sections at speeds ranging from 0.66 to 30 fpm and is controlled by a sliding knob (with indicator scale) located on the front panel just above the feedboard.

The blower unit consists of a 1-hp, 3450-rpm, constant speed motor with cylindrical blowers connected to each end of the motor shaft. Intake air for one blower is taken from the room through a disk-type shutter on the lower front panel (hinged door) and passed through flexible air ducts to the printer section where air under low pressure is used for cooling, ventilating, and air pick-off at the printing cylinder (Fig. 3). Intake air for the other blower is drawn through the suction tank in the printer section, thus creating the necessary vacuum, while the outlet air of this blower is used to create pressure in the main exhaust outlet of the machine. The blower unit and the drive unit are wired so that they may be operated independently of the burner and heaters to effect gradual cooling of the burner, removal of ammonia fumes and to prevent the warm belts from sticking to the printing cylinder.

The electrical components, mounted in the stand section, consist of switch gear, 1 to 2 step-up transformers[3] for converting line voltage to 220-240 volts a-c, and a reactive transformer

3. Since the basic components of the experimental model were adapted from a standard commercial machine which operates from 220-240 line voltage, a step-up transformer is required for their operation from a 110-120 line voltage.

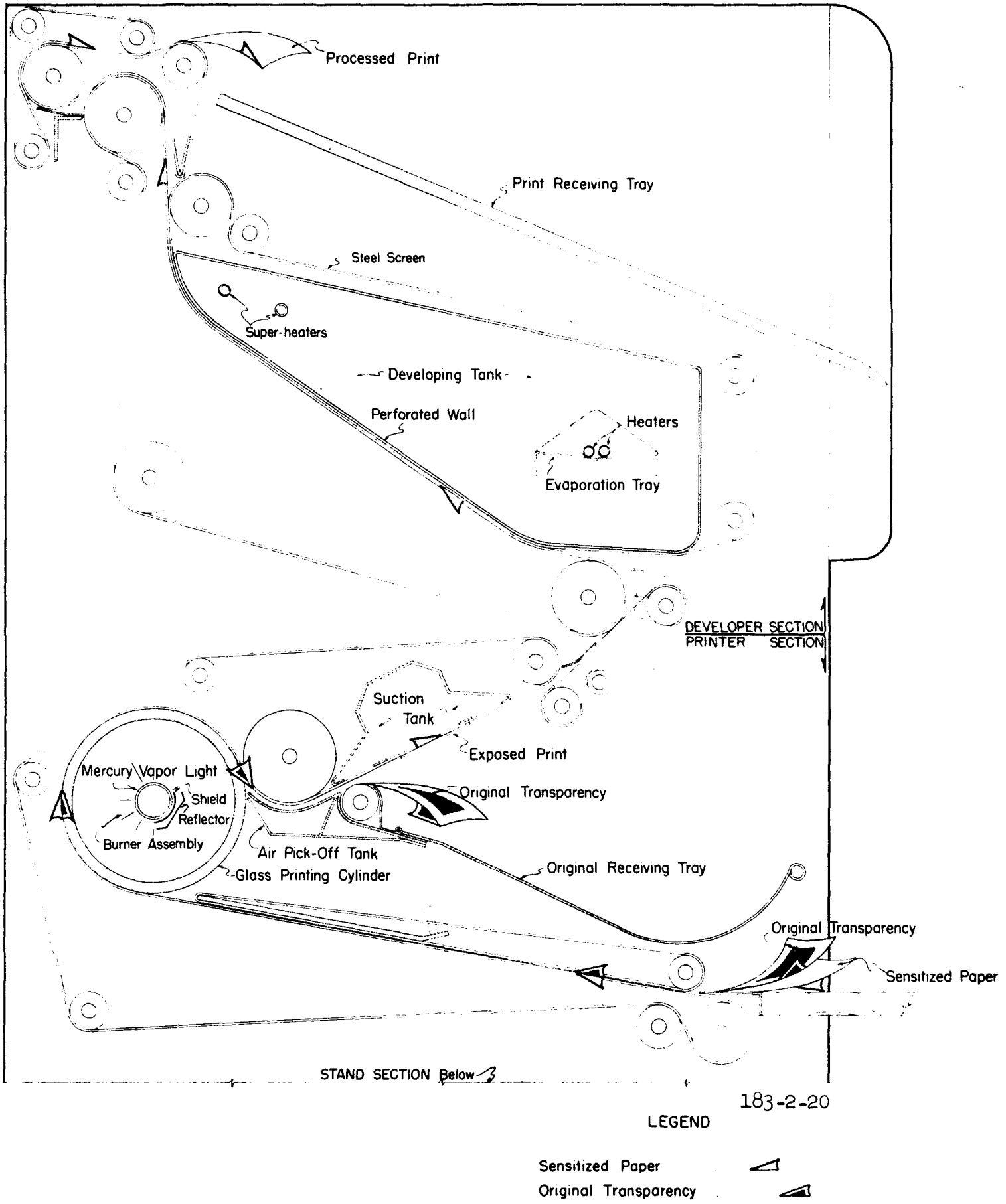


Fig. 3. Flow diagram for experimental model ammonia process printer-developer.

with capacitor for supplying power to the mercury-vapor lamp in the printer section. The switch gear includes three magnetic starters, remotely operated by switches, thermostats, and timer which controls the operation of the burner, various heaters, drive unit, and blower unit. These starters are equipped with protective devices replacing the conventional fuse, and thus prevent damage caused by an overload. They must be reset manually if inadvertently overloaded. A wiring diagram for the electrical circuits in the machine is shown in Appendix D.

A foot pedal, labelled "Tracing Release" is mounted beneath the feedboard at the base of the machine. Its operation releases the tension of the printing belts of the printer section. The stand section has a hinged door along the front to provide easy access to the units contained within.

c. Printer Section. The printer section (lower half of Fig. 3), designed on the rolling contact principle, consists of burner assembly, glass printing cylinder, air pick-off tank, feed belts, suction tank, feedboard, original receiving tray, and various attachments for use with roll materials. The burner assembly consists of a 60-watt-per-inch, dry cathode, high pressure, mercury-vapor lamp fixed to a stainless steel receptacle, which also contains an Alzac reflector and a movable light shield. The burner assembly is supported at each of its ends by the frame of the machine. Access to the burner is made through hinged doors on the upper half of the end cabinets. As required, the burner may be removed when tables or other surfaces 36 inches high are placed on both sides of the machine, and thus the space adjacent to the machine can be utilized for tables or cabinets. The entire burner assembly, including reflector and light shield, is mounted inside a rotating, polished pyrex glass cylinder, 6 inches in diameter and 47¼ inches long, with stainless steel ferrules on each end for supporting it on small rollers.

The original copy and sensitized material are guided through the printer section by a multiple perforated belt system. The auxiliary belts, driven by a knurled roller, help guide the materials from the feedboard to the printing cylinder (Fig. 3). The original copy and the exposed sensitized material are removed from the printing cylinder by an automatic-air pick-off. Air under pressure emerges from the slotted duct of this pick-off device which runs parallel to the cylinder; thus, the original and the exposed material are lifted from the printing cylinder.

The printer section is equipped with a suction tank which automatically separates the original and the exposed material. The exposed material is drawn up against the perforated printer belts and conveyed to the developing unit while the original drops by gravity into the receiving tray. Outlets to the suction

tank are equipped with valves which, when closed, let the sensitized material fall into the tray for receiving originals.

Supports for the feeding of roll stock are mounted beneath the feedboard; a spring-mounted, wire paper cutter is located on the feedboard for quickly severing the desired length of stock (Fig. 4).

d. Developer Section. The developer section (upper half of Fig. 3) consists of a developing tank, steel screen, sealing sleeve, heaters, evaporating trays, ammonia supply, ammonia feed, and print receiving tray. The developing tank has a perforated bottom and is fabricated of stainless steel. An endless flexible stainless steel screen revolves around the developing tank. A sealing sleeve which covers the screen and is driven in synchronization with the screen, prevents the escape of ammonia fumes. The developing tank contains two V-shaped, stainless steel ammonia evaporating trays, each having a rod heater to generate ammonia fumes. Making use of feed pipes, the aqua ammonia is admitted to the center of the developing tank. The aqua ammonia is evaporated as it flows along the trays to the ends of the tank. The fumes are then superheated by other rod heaters controlled by a thermostat switch.

The ammonia feed is governed by two factors; the speed of the machine and the setting of the manual ammonia supply indicator knob on the face plate of the machine. The 2-gal., cast-aluminum ammonia supply tank contains a bucket conveyor feed system which supplies liquid ammonia to the trays in the developing tank. An ammonia storage can, located at the base of the right end cabinet, is equipped with a special locking-type cap having a large rubber stopper which can be expanded when placed inside the can opening. The can is connected to the storage tank by a rubber hose. The ammonia is pumped up the hose by a small, manually operated pump, connected to the can stopper. The can is held in place by spring clips having a rolled end which clamps over the top of the can.

A small light on the front panel of the machine indicates when the level of the ammonia in the storage tank is such that refilling is required.

e. Attachments. Rewind devices are provided for roll film and paper operation. Originals and prints, up to 42 inches wide, may be rewound on hexagon bars driven by single-phase 220-volt, 60-cycle torque motors. The bars are mounted so as to be easily removable, one in the original-copy receiving tray and the other in the print receiving tray.

There are spindles provided for supply and rewind spools when aerial film and paper rolls of the same width are used

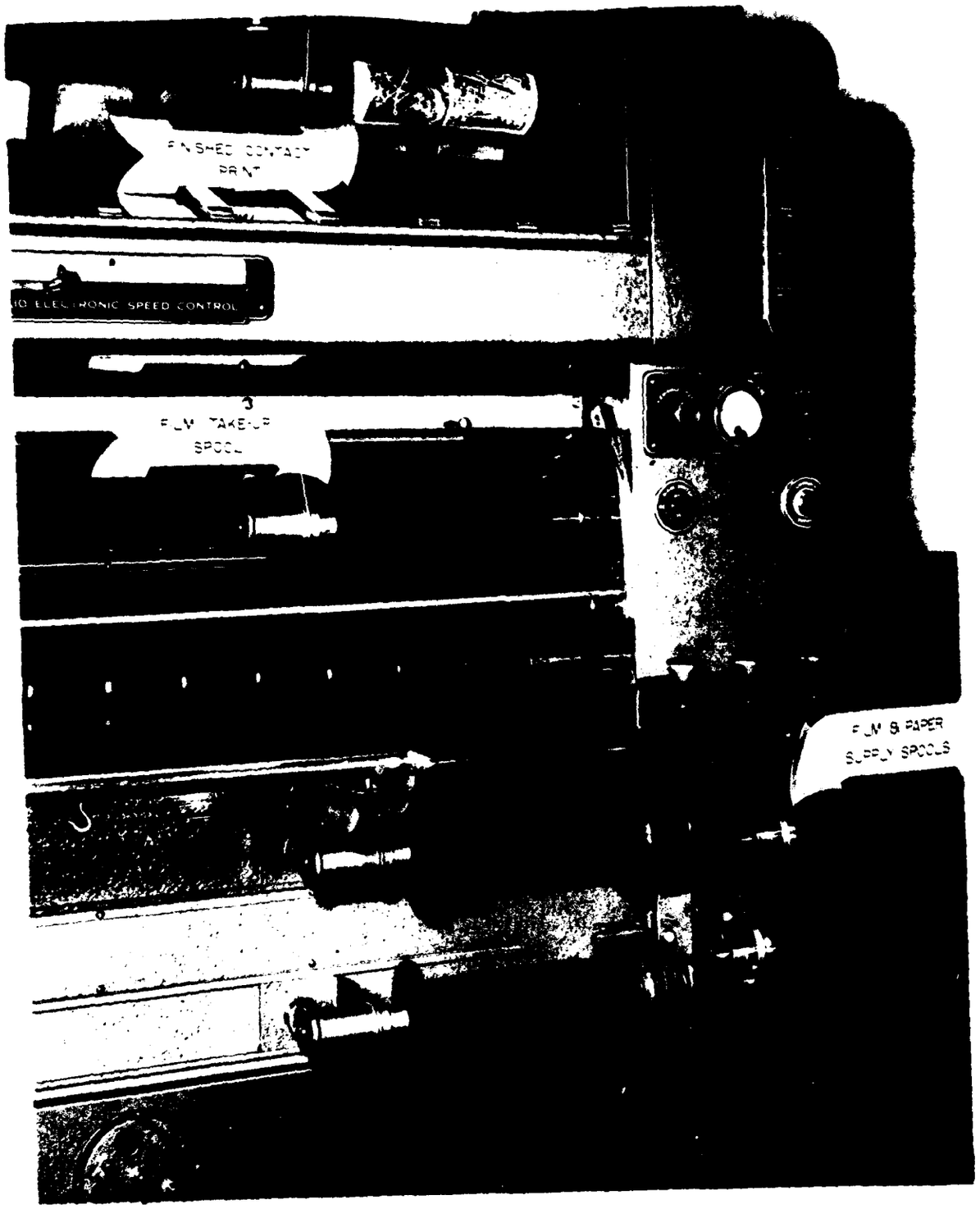


Fig. 1. Close-up of supply and take-up spools (standard Air Force) for rolls of sensitized material, film, and processed prints.

(Fig. 4). The spindles which accommodate standard size aerial film spools are also driven by the above-mentioned torque motors.

7. Test Procedures. All tests and investigations, except those requiring temperature and humidity control and the investigation into transportability, were conducted in the laboratories of the Photo-Litho Branch, tropical chamber exposure (temperature and humidity control) tests were conducted by the Materials Branch. Transportability tests were conducted in the vicinity of Fort Belvoir.

The investigations were conducted over a period of 1400 hours of machine operation. Observations were made during intermittent processing runs as well as during full scale production runs. The maximum time of continuous operation was 64 hours; however, the greater percentage of operating time was made up of 8-hour periods. During the test period, three large production runs of 36,000, 38,000, and 49,900 prints, respectively, were recorded. All types of original copy, such as line-work drawings on paper, linen and plastic, and continuous-tone film materials, were used. Sensitized papers and plastics, both line and continuous-tone, were used as reproduction mediums.

8. Operational Tests and Results. The following subparagraphs describe the tests of the experimental model and their results with regard to five considerations: electrical characteristics, printing cylinder surface temperature, thermostatic control for developing tank heaters, electronic speed control, and effect of tropical temperature and humidity conditions on exhaust tubing.

a. Electrical Characteristics. The purchase description stated that the machine shall operate from a 110- to 120-volt, a-c, 50- to 60-cycle, single-phase power supply, and that the total power consumption (line current) shall not exceed 75 amperes on starting and shall not exceed 60 amperes during operation.

A recording-type voltmeter, an ammeter, and a wattmeter were used to test electrical characteristics. The experimental model was connected to a 110-120-volt power line. In the first test the machine was started by operating the main switch which controls all heaters, blowers, drive motors, and lamps. The initial surge of current was found to be in excess of 100 amperes (scale on ammeter tape was calibrated to a maximum of 100). The line voltage varied between 108 and 118 volts during the test. The line current after starting with all heaters varied between 65 and 67 amperes. When the pre-set developing tank temperature was reached, the superheaters automatically cut out and the amperage then varied between 53 and 57. The line current reduced to between 45 and 49 amperes when the tray heaters were shut off by the action of the automatic control. The above starting current

is in excess of the specified 75 amperes and the operating current exceeded the specified limit of 60 amperes.

The second test used a two-step starting method by first operating the switch controlling the blowers and drive motor, and then immediately operating the main switch. This method produced the following results: initial current surge was 64 amperes, dropping to approximately 20 amperes; operating current after the main switch was turned on varied between 63 and 67 amperes. Operating current was reduced 5 amperes by switching off an auxiliary 700-watt heater, which may be independently controlled. A comparison of the line current during the initial surge of both methods of starting is shown in Fig. 5.

b. Printing Cylinder Surface Temperature. The purchase description stated that the printing cylinder temperature shall not exceed room temperature by more than 50 F.

The ends of the printing cylinder are open to allow for the dissipation of heat (generated by the burning of the 60-watt-per-inch, mercury-vapor lamp); this heat is drawn off and exhausted to the outside.

Cylinder surface temperatures with related room temperatures, machine speeds, and hours of operation recorded during three tests are given in detail in Appendix D, Tests of Cylinder Surface Temperatures. Readings were taken, approximately every 30 minutes, using an Alnor pyrometer, type 4200, with thermocouple 4040. All readings were made with the blower vent in the lower front panel of the machine open throughout the tests. Measurements were taken at three points along the cylinder surface: at the center, and approximately 6 inches from each end. The results obtained are presented in Table I.

Table I. Tests of Cylinder Surface Temperatures

Test No.	Machine Speed (fpm)	Room Temperature (Deg F)	Cylinder Temperature (Deg F)	Difference (Deg F)
1	15	78 (avg)	137 (avg)	59
2	7	84 (avg)	147 (avg)	63
3	2 to 30	74 to 76	138 to 156*	64 to 80

* Highest cylinder temperature was recorded at lowest machine speed.

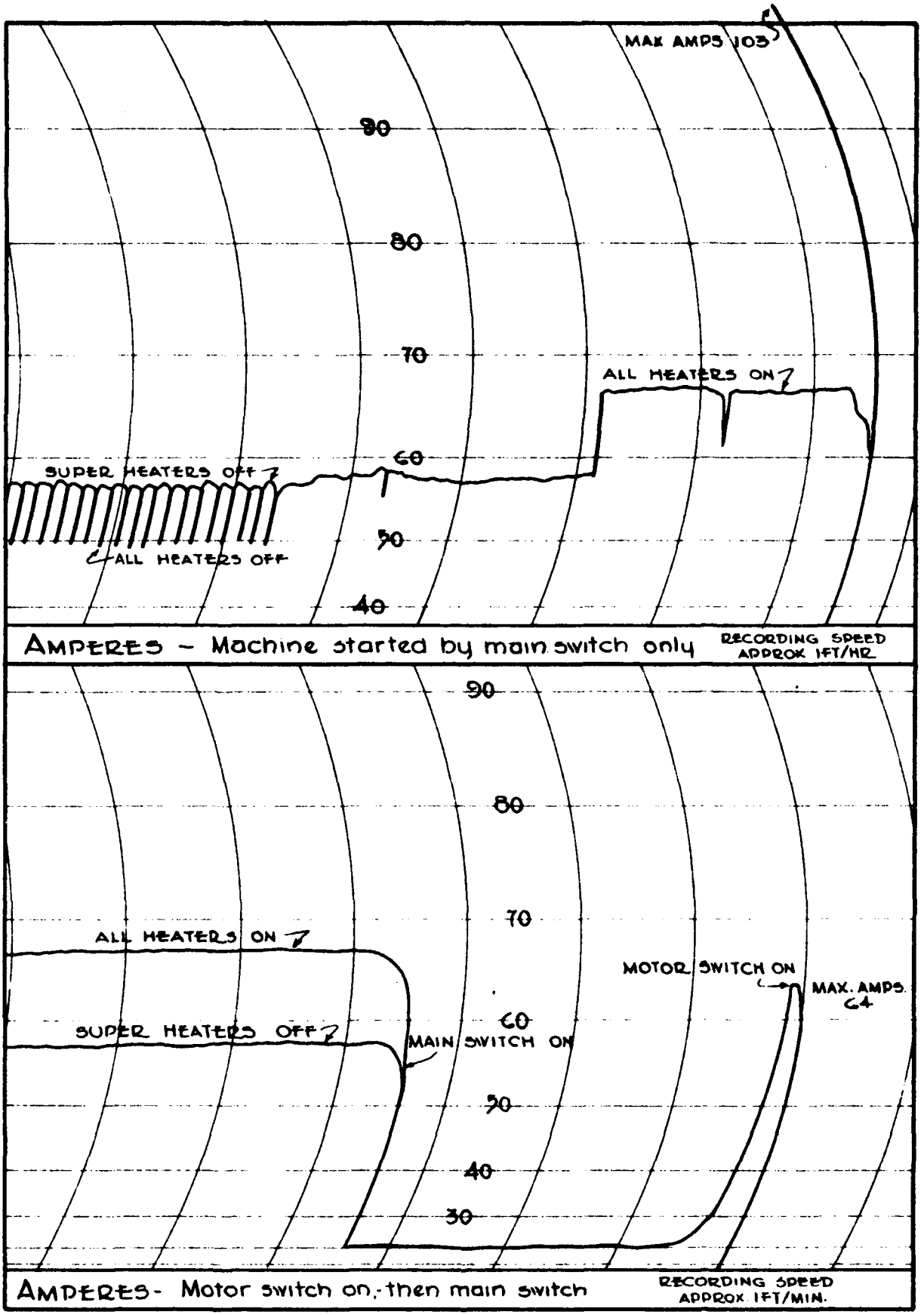


Fig. 5. Line current charts showing comparison of two starting methods.

To increase the suction in the suction tank so that slightly curled sensitized papers would be more effectively moved from the printer to the developer unit, the manufacturer recommended that the front blower vent be closed. The closing of the vent improves the tank suction; however, it limits the blower intake air to that which is inside the machine. When the machine was operated in this manner, the surface temperature rose to between 180 and 190 F, more than 100 degrees above room temperature. At surface temperatures above 190 F, it was noted that film materials because of their greatly increased tendency to adhere to the cylinder, were difficult to remove by the air pick-off. A number of films and sheets of paper were lost because the effectiveness of the air pick-off was insufficient to completely overcome the film's tendency to stick to the cylinder. Consequently, if one corner of the film was picked off and the other tended to stick to the cylinder, the film folded as it was delivered to the receiving tray. Occasionally, the leading edge of the film was picked off, the remaining portion sticking and causing a film jam between the cylinder, air pick-off, and belts.

c. Thermostatic Control (Developing Tank Heaters). The purchase description stated that the developer temperature shall be controlled by a thermostat. It shall be capable of maintaining the temperature indicated at ± 20 F.

The experimental model was originally equipped with a Scaico temperature control No. X109 to provide for the temperature control of the developing unit's superheaters. This control and a Weston rod-type thermometer were mounted in the left-end plate of the developer tank with the elements extending into the tank, the control knob and thermometer dial being visible inside the left end cabinet (Fig. 2).

The procedure for arriving at a desired temperature inside the developer tank proved to be a hit-and-miss proposition because there were no temperature settings indicated on the control dial and it was possible to rotate the knob through a number of turns, there being no stop on the shaft. In order to attain a desired temperature, it was necessary to set the knob at a definite spot on the dial, allow the machine to heat until the superheaters cut off, and then check the temperature by the Weston thermometer. Should the actual temperature not be that which was desired, the control knob was then readjusted and after the heaters cut off, another thermometer check was made. This procedure was repeated until the desired temperature was attained.

An investigation was made to find a thermostatic control that could be set at a desired temperature, achieve that temperature, and retain the specified differential of ± 20 F. It was also considered advantageous to have a control which could

be mounted on the face of the machine in full view of the operator. The Minneapolis-Honeywell Thermostat, Model T415A was tested for the purpose of giving this control.

The Minneapolis-Honeywell Model T415A, having a range of 160 to 280 F, together with its monel fittings and element, was installed in the opening previously occupied by the original control. The control unit was temporarily mounted inside the left end cabinet. The controlled differential of this thermostat is adjustable from 6 to 32 F, at low temperature settings (160 F); and from 4 to 15 F at high settings (280 F).

Readings were made from the Weston Thermometer each time the thermoswitch cut on or off. The temperature inside the tank before the machine was started was usually below the range of the thermometer. The humidity-percentage control, governing the percentage of time the tray heaters are on, was set at 100 percent until the initial warm-up was completed; it was then reduced to 75 or 50 percent. (Appendix D, Thermostatic Control Tests.)

Three tests were conducted, two of 8 hours' operation, and one of 6 hours. The temperature setting of the controller remained the same throughout each of the three tests. The settings were 200, 230, and 240 F. The differential scale on the thermo switch was set a position "B" (approximately ± 10 F) for all tests. The initial warm-up period is not included in the differential calculations. Test No. 1 (200 F setting) reduced a high of 211 F, 11 over; and a low of 189 F, 11 under. The average differential was 17 F. Test No. 2 (230 F setting) produced a high of 241 F, 11 over; and a low of 209 F, 21 under. The average differential was 14.9. Test No. 3 (240 F setting) produced a high of 244 F, 4 over; and a low of 227 F, 13 under. The average differential was 13.7. All tests produced temperature ranges within the specified ± 20 F.

Temperature readings taken intermittently indicate that the temperature of the developing tank reaches 240 to 250 F, after initial warm-up (15- to 30-minute period) without the aid of the superheaters, if the humidity percentage control (governing percentage of time ammonia tray heaters function) is maintained at 100 percent. Thus, the thermostatic control of the developing tank temperature is more or less voided when this control is set at temperatures of 240 F and less.

d. Electronic Speed Control. The purchase description, regarding the speed control, stipulated that the control shall be easily adjustable and equipped with a positive-locking device.

The speed control potentiometer, mounted on the front panel of the machine, is calibrated on a linear scale from

0.66 to 30 fpm. The sliding knob permits instantaneous changes to any point along the scale. Although no manual method of locking is provided, the control retains its set position at all times.

Three tests were conducted to determine the accuracy of the speed control with regard to the actual speed in feet per minute and the efficiency of the control to produce the same speed on repeated settings.

Footage measurements were marked off on the auxiliary belts, which assist in guiding the materials from the feedboard to the printing cylinder, and a zero point was established. Actual times were recorded using an Elgin Timer stopwatch. The time and distance was recorded for each setting of the control panel. Table II shows the control settings, the belt speeds, the percentage of error in repeated settings, and the percentage of error in the calibration.

The maximum error in repeated settings was 12.9 percent at 0.66 fpm; the three lowest settings, namely, 0.66, 1, and 2 fpm, produced higher percentage errors than were found in speeds of 3 fpm and greater. Only one setting, 28 fpm, produced exactly the same speed in all three tests.

e. Effect of Tropical Temperature and Humidity Conditions on Exhaust Tubing. As specified, the experimental model was originally equipped with ten lengths of flexible tubing (6 inches in diameter by 2 feet long) for exhausting fumes from the machine to the exterior.

Two sections of the tubing were placed in the ERDL Tropical Test Chamber to determine the effects of tropical temperature and humidity conditions. The conditions prevailing in the tropical chamber change periodically each daily cycle consisting of two periods, one having a temperature of 75 F and 95 percent humidity, and the other 85 F temperature and 90 percent humidity.

After 2 weeks' exposure in the chamber, the metal connecting collars of the tubing began to show signs of oxidation and the outer rubberlike covering of the tube began to blister. The blistering broke through after 3 weeks' exposure, causing small areas of the outer covering to peel, exposing the cord fabric used in the fabrication of the tube. The tubing was removed after 12 weeks' exposure, and the following conditions were noticed: the connecting collars were badly oxidized; the locking straps except for the screws were not affected; and, although the outer coating had peeled in a number of places, there were no actual holes.

9. Reproduction Tests and Results. The purchase description stated that the machine shall be capable of printing continuous-tone photomaps and contact prints, from cut film or aerial roll film on

Table II. Belt Speed versus Indicated Speed of Electronic Speed Control

Indicated Speed (Feet per Minute)	Belt Speeds (Feet per Minute) Test 1	Test 2	Test 3	Average	Error in Repeated Settings (%)[1]	Error in Calibration (%)[2]
.66	0.35	0.28	0.29	0.31	12.9	53.0
1	0.42	0.38	0.42	0,40	5.0	60.0
2	.130	1.41	1.46	1.39	6.5	31.0
3	2.41	2.47	2.51	2.46	2.0	18.0
4	3.59	3.49	3.53	3.53	1.7	11.5
5	4.61	4.51	4.46	4.53	1.8	9.4
6	5.36	5.36	5.41	5.37	0.7	10.5
7	6.28	6.26	6.40	6.31	1.4	9.9
8	7.36	7.36	7.41	7.37	0.5	7.9
9	8.31	8.08	8.31	8.23	1.8	8.6
10	9.61	9.43	9.31	9.45	1.7	5.5
11	10.24	10.28	10.18	10.23	0.5	7.0
12	11.08	11.01	11.18	11.09	0.8	7.6
13	12.22	12.26	12.19	12.22	0.3	6.0
14	13.04	13.29	13.21	13.18	1.0	5.9
15	14.28	14.15	14.28	14.23	0.6	5.1
16	15.19	15.09	15.19	15.16	0.5	5.3
17	15.94	16.03	16.13	16.03	0.6	5.7
18	16.87	16.98	16.87	16.91	0.4	6.1
19	17.87	18.04	18.09	18.00	0.7	5.3
20	19.35	19.48	19.23	19.35	0.7	3.3
21	19.87	19.93	19.84	19.88	0.3	5.3
22	20.82	20.75	21.01	20.86	0.7	5.2
23	22.40	21.90	21.90	22.07	1.5	4.0
24	23.56	23.07	23.07	23.23	1.4	3.2
25	24.27	23.50	23.80	23.86	1.7	4.6
26	25.32	24.60	24.84	24.92	1.6	4.2
27	26.20	25.51	25.63	25.78	1.6	4.5
28	26.58	26.58	26.58	26.58	0	5.1
29	28.06	27.27	27.44	27.59	1.7	4.8
30	29.41	28.85	28.57	28.94	1.6	3.5

1. Percentage of error of repeated settings computed by taking the ratio of the maximum deviation to the average recorded belt speed and multiplying by 100.

2. Percentage of error of calibration computed by taking the ratio of the difference between indicated speed and average speed to the indicated speed and multiplying by 100.

standard Air Force spools, without processing streaks. Protective material for the printing surfaces shall not be required. It was stipulated that the machine shall be capable of producing positive prints from line tracings or similar transparencies by the ammonia process, and that the machine shall be capable of printing up to 42 inches in width.

Various types of commercially produced and laboratory samples of cut sheets and rolls of continuous-tone reproduction materials were processed in the machine and good quality prints were produced with no difficulty other than that mentioned below. The sample print shown in Fig. 6 illustrates the result of printing from a silver halide film positive using Ozalid Dryphoto paper, Sepia, 404D.

a. Reproduction from Continuous-tone Cut Film Originals. Continuous-tone ammonia process prints (74,400 measuring 8 by 10½ inches) were produced for the Engineer School during two experimental production runs of 36,200 and 38,200 prints. The first run consisted of 18,100 prints each of two negatives and the second run, 19,100 prints each of two negatives, requiring 68.5 and 53.5 hours of machine operation, respectively. Film positive originals were made from negatives furnished by the School, utilizing the conventional silver halide photographic process. Adjustments of contrast and density were incorporated in the exposure and processing so as to produce positives which would have characteristics suitable for printing on Ozalid Dryphoto, sepia paper.

The actual exposure and development of the ammonia process prints were executed satisfactorily and produced final prints of good quality; however, two difficulties were experienced during the production runs and at other times when films and continuous-tone papers were used. High cylinder temperatures increased the tendency of the film to adhere to the cylinder, thus reducing the effectiveness of the air pick-off in the removal of the film and paper from the cylinder. Occasionally, the film and paper continued on around the cylinder two or more times, destroying not only the print involved but any other prints (in the printer section) which it might overlap. At other times, only one corner of the material would be picked off the cylinder, the remaining portion adhering to the cylinder. This resulted in a folded film and paper, or a jamming of the materials between the cylinder and the air pick-off. In either case, the film and paper were rendered unusable.

The automatic transporting of exposed paper from the printer to the developer section proved to be troublesome and constituted the second difficulty encountered during the two production runs. It was found that unless the paper had little or no curl, the suction of the suction tank was insufficient to hold the entire area (lead corners dropped downward) of the paper against the belts. As the paper moved into the auxiliary belts between

Fig. 1. Sample print made with Ozalid Drypholo paper, Sepia, MCD, using a silver halide sheet film positive.

the printer and developer belts, the dropped corners were folded, thus making the print unusable. The use of a roller against the rear edge of the suction tank to aid in holding the paper against the belting proved unsuccessful. In order to eliminate this difficulty, the suction was cut off (the prints dropping into the tray with the originals), and the prints manually fed into the developer unit. This procedure reduced production speed.

This difficulty is attributed to the curl of the Ozalid Dryphoto paper and not necessarily to a deficiency of the machine. The curling of the paper also made it impossible to stack prints in the final receiving tray. Flat (non-curl) papers and those having very little tendency to curl can be transported through the machine and stacked without difficulty.

On a third large production run for the Fifth Army under Project "Sweet Briar" 50 prints each of 998, 10- by 10-in. cut film positives were produced on the experimental model by troops of the 656th Engineer Topographic Battalion stationed at The Engineer Center. A total of 49,000 prints were produced in 153 machine hours. The aerial film in 9 rolls of various length was received by the ERDL on 20 December 1949 and the prints were completed on 30 December 1949. Film positives were made by two teams of three men each, one at ERDL and one at the Army Map Service, Washington D. C. One film positive was made for each aerial negative, but if this positive was destroyed before 50 prints were completed on the experimental model, a second film positive was furnished later to complete the prints. This method was used so as to conserve on film and labor in processing the film positives. (On previous productions runs, several positives of each original were furnished.) With this procedure, 10 percent of film positives had to be remade before 50 prints were completed. The difficulty was determined to be at the air-pick-off. As the result of this experience and study subsequently made on the cause of film breakage, adjustments of the air-pick-off tank were made which is believed will reduce film breakage to a minimum of perhaps 1 percent on a similar production. The continuous-tone print paper used on this production was Ozalid, 404D, Sepia, cut to 10- by 10-in. size by the manufacturer and furnished in 250-sheet packages. The difficulty of curling, as experienced in the two former production runs, was not a factor in this production.

b. Reproduction from Continuous-tone Roll Film Originals. The exposure and processing of rolls of sensitized continuous-tone papers, using roll film positives as original copy, was accomplished satisfactorily. The problem of curling paper encountered in the use of sheet material is eliminated by continuous processing; however, unless care is taken in feeding the beginning of the rolls of paper and film into the machine and the proper tension is applied to the paper and film feed spools, the materials will "walk," and

unsatisfactory printing will result.

c. Reproduction from Line-work Originals. Satisfactory positive prints were produced from such originals as line drawings (Fig. 3), films, and typewritten copy on Ozatran (a commercial parchment paper), using both cut sheets and roll stock up to 42 inches in width. The difficulties, noted under subpar. 9a, encountered using the continuous-tone reproduction paper did not present themselves during the use of line reproduction papers. The feed and take-up bars operated satisfactorily. It was noted that because the unused portions of roll stock on the feed bar is exposed to light and ammonia fumes, some loss of material occurred.

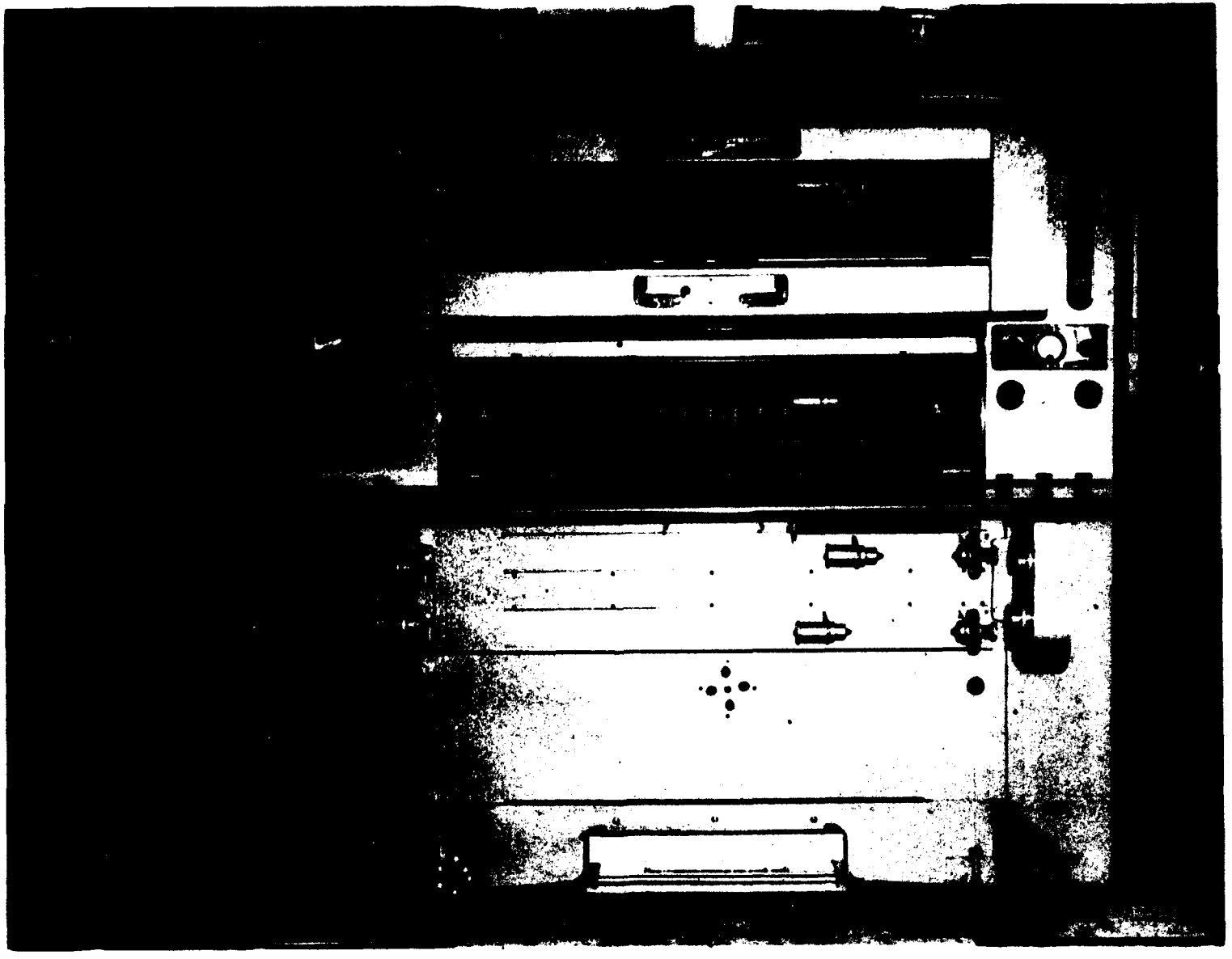
10. Transportability Tests and Results. The following describes the transportability tests and results.

a. Truck Mounting and Transporting. Requirements stipulate that the machine shall have a low center of gravity and shall be readily adaptable to mounting in a van-type truck body as used in the present mobile map reproduction train, and/or the proposed mobile photomapping train for Corps and Army topographic units.

As a means of determining compliance with the above-mentioned requirement, the experimental model was manually moved from the loading platform of the laboratory over a ramp leading up to the floor (or bed) of a 2½-ton, 6x6, van-type body truck. (The printing cylinder and burner assembly were removed prior to loading and unloading operations; however, both units were in their operating position in the machine during the 200-mile road shock test.) This operation was performed satisfactorily in spite of a difference of 15 inches in the levels of the platform and truck bed. With the experimental model placed parallel to the axles of the truck (Fig. 7), mounting was accomplished using the angle plates welded to each corner of the machine and the bed plates bolted to the planking of the truck, directly below the angle plates. This method allows a positive tie-down of the machine.

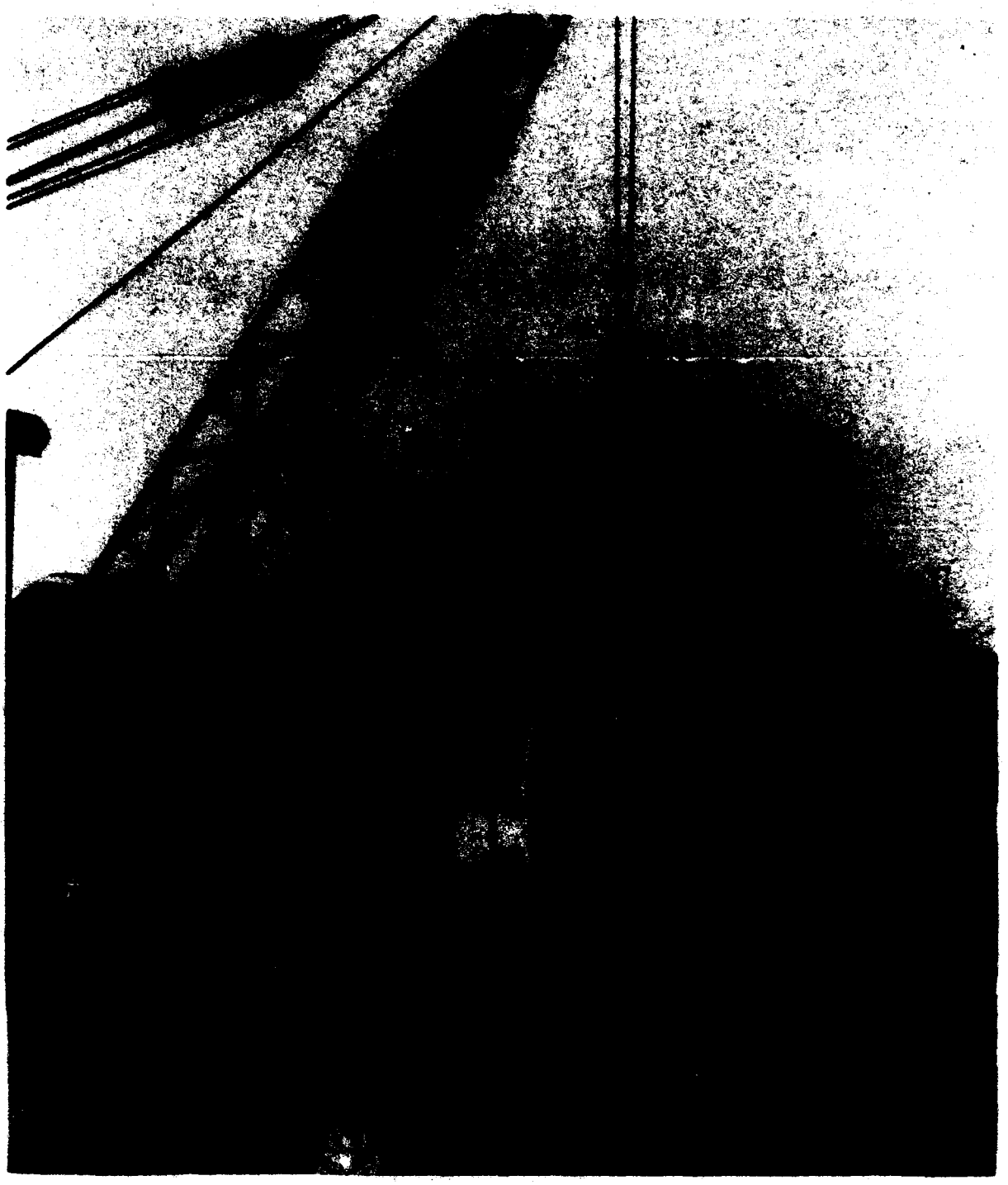
The truck was then driven over 200 miles (see Appendix D for map) of hard surface, dirt, and gravel roads (35 percent of the route was over the gravel and dirt roads). Speeds ranging as high as 30 mph on the rough roads (and higher on the smooth roads) were employed; however, on some occasions, it was necessary to detour because of an impassable route. After this road test was completed the machine was returned to the laboratory and unloaded from the truck in a manner similar to the loading procedure described above.

The experimental model was again loaded manually on a 2½-ton, 6x6, long-wheel-base truck and then lowered to the ground using a crane and rope sling (Fig. 8). (Again, it was deemed advisable to remove the printing cylinder and burner assembly prior to



183-2-22

Fig. 7. Experimental model ammonia process printer-developer mounted parallel to axle in a $2\frac{1}{2}$-ton, 6x6, van-type body truck.



183-2-25

Fig. 8. Unloading operations after truck transportability test. Printer-developer being lowered to ground using a crane and rope sling.

loading and unloading operations to prevent damage to these parts.) Although the crane's hoisting mechanism slipped and the experimental model dropped from a height of approximately 15 inches onto the truck floor, when the machine was placed in operation there were no indications of mechanical damage.

b. Air Transportability. Tests to determine whether the machine could be loaded and transported in standard cargo planes without dismantling major parts were not made. However, the weight (1865 lb), dimensions (73 by 71½ by 47-in.) and cubage (160 cu ft) are such that it can be carried in Phase I operations.

11. Operational Deficiencies. The operation and tests of the experimental ammonia process printer-developer revealed a number of deficiencies, most of which were not serious. A compilation of these, with the corrective action taken or needed, is given in Table III.

III. DISCUSSION

12. General. The evaluation of the experimental ammonia process printer-developer as a replacement for the existing, standard equipment was considered with regard to its capabilities, performance, and reproduction qualities as compared to the other commercial models of ammonia process machines.

A comparison of physical specifications for the experimental model with those of four commercial Ozalid ammonia process machines, the Printmaster, the Model B, the Streamliner, and Model E is shown in Table IV.

The Model E (no longer manufactured) and the Streamliner are both two-operation machines; that is, the printing and developing is not a continuous process. The sensitized material must be fed manually into the developing unit after exposure. With both of these models, the printing and developing speeds are not synchronized; in addition, satisfactory definition cannot be obtained in continuous-tone prints on the Streamliner and printing must be accomplished at one-third the machine speed employed with the experimental model. The Printmaster and the Model B are both single-operation machines, having synchronized printing and developing speeds. The weight of the Model B is slightly less than the ERDL experimental model; the Printmaster weighs almost 50 percent more than the experimental model. Neither the Printmaster nor the Model B are suitable for truck mounting because of the height of the machines. None of these models except the experimental model include facilities for aerial roll-film reproduction.

Table III. Operational Deficiencies

Item	Deficiency	Corrective Action	Remarks
Printing Cylinder	Ridges found on surface of glass printing cylinder caused non-uniform light transmission resulting in variations in density of continuous-tone prints.	A smooth, more perfect cylinder installed by manufacturer.	New cylinder provided uniform illumination.
Cylinder Pick-Off	Suction insufficient to separate print from original being copied.	Larger blower and tank with larger perforations installed.	Separation satisfactory except for paper which curled excessively.
Drive Control Tube	Thymotrol tube in drive control failed in less than 300 hours of operation.	New tube installed in proper manner.	New Thymotrol tube must be operated 20 minutes before metal cap is placed over tube.
Mercury Lamp (Burner)	Burner failed after 150 hours of operation.	Lamp replaced by manufacturer.	Replacement lamp has operated over 1300 hours.
Heater Control	Scaico temperature control unsatisfactory.	Minneapolis-Honeywell thermoswitch used as replacement.	Temperature of developing tank kept within ± 20 F.
Small Repairs	A number of small repairs were made, such as: coil in relay switch, seams in the developing tank, etc.	Simple repairs were made as needed. Welding, in place of soldering the tank, is suggested.	Routine repairs were no more than normal.
Ammonia Fumes	Excessive ammonia fumes.	T-connectors added to exhaust hoses in end cabinets.	Room ventilation needed to replace 700 cfm of air exhausted by machine blowers.
Timer and Drive Switch	Timer switch does not operate drive motors; operates blowers only.	See Remarks.	Rewire timer switch to include controlling of drive motor.

Table IV. Comparison of Characteristics of Printer-Developers Manufactured by Ozalid, Division of General Aniline & Film Corporation

Characteristics	ERDL Experimental Model	Printmaster	Model B	Streamliner	Model E
Capacity (inches)	42	42	42	42	42
Printing speed (inches per minute)	8 to 360	Up to 360	Up to 300	Up to 120	2 to 25
Developing speed (inches per minute)	Synchronized same as printing speed	Synchronized same as printing speed	Synchronized same as printing speed	60	30
Electrical	110 to 120v, a-c, 60-cycle, single phase	205 to 235v, a-c, 60-cycle, single phase	205 to 235v, a-c, 60-cycle, single phase	205 to 235v, a-c, 60-cycle, single phase	110v, a-c, 60-cycle, single phase
Starting Current	2-step start 65 amps @ 110 v	40 amps @ 220 v	32 amps @ 220 v	30 amps @ 220 v	12 amps @ 110 v
Operating Current	2-step start 65 amps @ 110 v	33.5 amps @ 220 v	26.5 amps @ 220 v	22.5 amps @ 220 v	10.5 amps @ 110 v
Width (inches)	73	74	78	62	56 - 3/8
Height (inches)	71½	83	79	51	53 - 3/8
Depth with feedboard (inches)	47[a]	68	38	36	19¼
Net Weight (pounds)	1900	2600	1728	750	4831
Cost (dollars)	20,000.00[b] 10,000.00[c]	6,965.00	3,890.00	1,498.00	Not known

Notes: a This includes casters which extend 6 inches beyond machine proper; feedboard overhangs front casters.

b Estimated for experimental models.

c Estimated for production models.

The following paragraph discusses the merits of individual components of the experimental model, which in general, functioned satisfactorily, having but a few breakdowns, the greater percentage of which were repaired by the operators of the machine following instructions given in the manual furnished by the manufacturer. Those imperfections traceable to design will be corrected in future models. Experience gained in the experimental production runs indicates clearly the advantages this machine has over the other available ammonia process equipment with respect to ease of training inexperienced personnel and rapid production speed.

13. Evaluation of Tests and Investigations. The following considerations are covered in this evaluation: electrical characteristics, printing cylinder surface temperature, thermostatic control, electronic speed control, exhaust tubing, reproduction of continuous-tone original copy, reproduction of line-work copy, construction and transportability, and ammonia supply.

a. Electrical Characteristics. An operating current of approximately 65 amperes was determined by tests to be required. For this reason, a generator with a larger capacity than the Corps of Engineers 5-kw Generator Set, Portable, (Stock No. 17-5405.500.000), may be required for the ammonia process van because of the additional power load of other components within the van.

b. Printing Cylinder Surface Temperature. Test results show that the printing cylinder surface temperatures are normally higher than the 50 F above room temperature, specified in the procurement description. Tests also disclosed that for production work involving the use of film materials, the cylinder temperature should not exceed 150 F. The cooling of the cylinder surface is dependent on room temperature as the air used for this cooling is drawn into the machine by the front blower. As the room temperature rises, it can be expected that the warmer air will have less cooling effect and the cylinder temperature will also rise. Air conditioning may be required for operating areas and a room temperature not exceeding 80 F maintained if film materials are to be used. However, in one production run several thousand satisfactory prints were obtained from film positives when the room temperature was as high as 100 F.

c. Thermostatic Control. The replacement of the original thermostatic control with the Minneapolis-Honeywell, Model T415A, proved satisfactory for the purpose of controlling the temperature of the developing tank within the limitations of ± 20 F of preset value.

d. Electronic Speed Control. The major requirement of the speed control is not that the machine run at the speed indicated, but that it accurately repeat the same speed on successive settings. The present control is considered satisfactory in all settings

except the three slowest speeds, that is, 0.66, 1 and 2 fpm. Although the 0.66 fpm setting was 12.9 percent in error in repeated settings, the present control is satisfactory for processing present commercial materials. Laboratory samples of new negative-working, diazotype, intermediate materials recently tested require slow speed exposures. The use of this type material will necessitate rigid specifications dealing with the accuracy of repeated settings and linear scale calibration.

e. Exhaust Tubes. The exhaust tubing of the machine is satisfactory except for the corrosion of metal components. This should be corrected by the use of a non-corroding alloy for these parts.

f. Reproduction of Continuous Tone Original Copy. Except for the difficulties noted under subpar. 9e, satisfactory reproduction from continuous-tone originals (both cut sheet and rolls) was accomplished without the use of protective materials. The problem of unsatisfactory transporting of sensitized paper from printing to developing units should be corrected by the production of non-curling papers. The vacuum within the suction tank is sufficient to satisfactorily transport flat paper; therefore, the use of papers which have been treated to counteract the curling would not only lead to satisfactory processing, but would result in satisfactory stacking and simplify the future handling of the prints. Although the transporting and stacking problem is not present in the use of roll materials, this non-curling treatment would work advantageously after the prints have been cut from the roll.

Roll film printing was accomplished satisfactorily and meets the purchase requirement. The quality of each print produced on roll stock may not be expected to be as good as that of individually produced prints, as the exposure (speed) used for continuous processing must necessarily be an average for the entire roll. The speed of the machine cannot be adjusted for each frame of the roll.

Although satisfactory continuous-tone photographic prints were produced from cut sheet and roll film it is felt that the experimental machine is not suitable for the exclusive production of continuous-tone roll film work. Any ammonia process equipment to be used exclusively for the production of continuous-tone prints in rolls should be the subject of a future investigation and would be especially designed for the purpose.

g. Reproduction of Line-work Copy. The experimental model machine meets the purchase requirements for producing prints equal in quality to those produced on the Printmaster Model. However, a slightly slower machine speed is required for production using the experimental model.

h. Construction and Transportability. The general construction of the machine is satisfactory; however, any refinements which have been included purely for beautification of the machine should be eliminated. The original electrical switch, guide knobs, and door pulls (made of plastic and easily broken) should be replaced by less fragile units.

Several components, such as take-up bar sockets and take-up spool spindles on the torque motors show signs of corrosion from ammonia fumes which causes difficulty in the replacement and removal of these parts. Fabrication from stainless steel would eliminate the corrosion problem.

When mounted in the standard map reproduction van-type body, the space available around the machine is limited. There is no access to the end cabinets or the rear of the machine. If the machine is mounted parallel to the axles, as it should be for proper load balance, it will be necessary to provide full-length access doors in each side of the van body or mount it in an expansible side van-type body.

i. Ammonia Supply. After approximately one month's operation, the seams of the ammonia supply cans separated; in addition, the cans showed signs of rusting. They were fabricated from material too light to withstand the pressure applied by the pump. The clamping device was found to be unsatisfactory for the purpose. The rubber stopper began to wear after repeated removals and insertions in the cans and was no longer effective in retaining the pressure within the can.

It was found that the problem of suitable supply cans and the need for a pump would be eliminated by feeding the ammonia directly into the top of the supply tank using a flexible spout attached to the original ammonia container.

14. Compliance with Military Characteristics. Table V shows the degree of compliance, of the ammonia process printer-developer, with the military characteristics specified.

15. Summary of Modifications Accomplished and/or Recommended. In any future procurement of an ammonia process machine of the type tested in this investigation, all of the following modifications are required:

a. Electrical Switches. All electrical switches should be toggle type with plate showing on and off positions clearly designated.

b. Cylinder Surface Temperatures. Cylinder surface temperatures should be lowered by increased cooling which may be accomplished by increasing the amount of air forced through the printing cylinder.

Table V. Compliance of Experimental Model Ammonia Process Printer-Developer with Military Characteristics

Military Characteristics	Degree of Compliance: Fully	Partially	Negative	Remarks
1. The machine shall be capable of producing positive prints from line tracings or similar transparencies by the ammonia process.	X			
2. The machine shall be capable of printing photomaps and contact prints from cut film or aerial roll film.	X			
3. The papers or medium used for printing photographic copy shall be capable of faithful rendition of the original subject matter.				Not applicable to Printer-Developer.
4. The photographic image, when properly printed and developed, shall be sufficiently stable for military field use.				Not applicable to Printer-Developer.
5. The machine shall be capable of printing up to 40 inches in width.	X			
6. The machine shall be as lightweight in design as practicable and yet shall be sufficiently rugged to withstand military field use. It shall be resistant to damage from corrosion and fungus attack.		X		Some metal components require additional surface treatment or substitution of material to prevent corrosion.
7. The machine shall have a low center of gravity and shall be readily adaptable to mounting in a van type truck body of the type used in the present mobile map reproduction train, and/or the proposed mobile photomapping train for Corps and Army Topographic Units.	X			
8. The machine shall be skid mounted for air transport and so designed that it can be loaded and transported in standard cargo planes without dismantling major parts.		X		Air transport not made a part of engineering tests.
9. The machine shall be capable of operation from a 110 volt A.C., 50-60 cycle power supply.	X			
10. The equipment shall operate satisfactorily within the extreme range of climatic conditions from tropic to arctic.	X			See footnote.
11. The machine shall be treated for elimination of interference with radio communication in accordance with applicable Signal Corps specifications.	X			Provisions for elimination of radio interference are being made in standard specifications.

NOTE: This type of equipment in field use will normally be operated in a van or shelter in which ambient temperature would be within range from 50 to 125 F. Tests showed that the printer-developer will operate satisfactorily in room temperatures ranging from 50 to 100 F.

c. Heater Control. Thermostatic control of superheaters should be accomplished with a control for directly setting the temperature, which will have a specified differential and be visible from the from of the machine.

d. Metal Components. All metal components should be treated to give resistance to ammonia fumes and corrosion.

e. Level Gauge for Ammonia Supply Tank. The ammonia supply tank should be equipped with a direct reading level gauge. It should be located so as to be visible from the front panel of the machine.

f. Loading of Ammonia Supply Tank. The loading of the ammonia supply tank should be accomplished directly from the container in which the ammonia is furnished, thus eliminating supply cans and pump.

g. Aerial Film Spool Spindles. The aerial film spool spindles should have rubber cushion strips, and locking device contact pins should have a stop to prevent slipping inside the spindle housing.

h. Covering for Roll Stock Paper. A means of covering the supply of roll stock paper mounted below the feedboard should be accomplished to prevent premature exposure.

i. Racks for Removable Components. Racks, containers, or locking devices should be provided for all removable components, roll stock bars, etc.

j. Replacement of Plastic Knobs. All plastic knobs should be replaced by a metal or other unbreakable material to avoid loss by breakage.

k. Auxiliary Belting Extension. The auxiliary belts in the printing section should be extended, or provided with a combination light shield and guide to prevent the exposure of materials before contacting the cylinder and provide a more satisfactory movement of materials.

l. Developing Tank Seams. All developing tank seams should be welded in preference to soldering.

m. Electronic Speed Control. The accuracy of the electronic speed control should be improved to provide the same speed with repeated settings at an identical position of the indicator for the speed control.

n. Timer Switch. The timer switch shoud be wired to provide for the governing of the drive motor, and intake and exhaust blowers, simultaneously.

o. Suction Tank. The suction tank should be of the type described under Table III, Cylinder Pick-Off, having 3/4-inch openings to effect a more efficient separation of original and sensitized material.

p. Blowers. The blowers and connecting hose system should be modified as accomplished by the manufacturer and described in Table III, Cylinder Pick-Off.

q. Frame. The frame of the printer-developer should be modified to provide for lifting attachments for rapid engagement of crane sling hooks.

r. End Cabinets. The doors of the end cabinets should include positive locking devices to prevent accidental opening of the doors because of vibrational causes. This also applies to the front door of the stand section. In addition, the walls of the end cabinets should be given more rigidity in order to make them withstand the shocks of rough handling. (The framework should be extended and a vertical support incorporated to accomplish this.)

s. Cylinder Removal. Removal and replacement of the printing cylinder was found to be difficult and time consuming. Provision should be made to allow more slack in the printing belts when released, so that the cylinder can be removed simply and quickly.

16. Standardization. After the engineering tests of the ammonia process printer-developer were completed, a directive dated 9 May 1950, was received from the Chief of Engineers requesting that ERDL prepare a final report on the printer-developer phase of Project 8-35-09-005 and proceed with the preparation of suitable procurement specifications. This directive pointed out that on the basis of engineering tests and the several production test runs accomplished by troops, the machine be classified as a Class IV item of issue. The directive stemmed from recommendations by Chief, Army Field Forces, contained in 3rd Ind to Chief of Engineers, File ATENG 413.5 (19 Jan 50), dated 9 March 1950, to basic communication from the Chief of Engineers to Chief, Army Field Forces, file ENGIE, dated 19 January 1950, subject: Ammonia Process Equipment Developed under Project 8-35-09-005. (See Appendix F)

Since the subject equipment, when modified in accordance with paragraph 15, meets the requirements of the military characteristics and because Army Field Forces have recommended its classification as a Class IV item of issue without further testing, it is considered to be suitable for standardization as adopted type, standard type.

a. Specifications. Suitable procurement specifications for the subject equipment are now under preparation by ERDL.

b. Additional Information Required for Standardization. Additional information required for standardization together with the approved military characteristics are shown in Appendix E.

17. Operations Personnel. Operation of the equipment does not require specialized personnel.

The instruction manual to be furnished by the manufacturer with the equipment will contain details of operation and maintenance. Additional training literature should not be required for machine operation. However, the processing of film positives from aerial negatives should be covered by a training publication. A technical report which will include the data that could be used as the basis for such a publication is now under preparation by the ERDL. Personnel to process these film positives should be skilled in photography. A Photographic Laboratory Technician, MOS (949) can perform this task.

18. New Requirements for an Ammonia Process Printer-Developer. Army Field Forces, after an extensive study of equipment and anticipated operational requirements, have recently submitted to the Chief of Engineers military characteristics for, and requested development of, a smaller portable ammonia process printer-developer more adaptable for field use than the 42-inch machine. (Reference Army Field Force Board No. 2, Report of Project No. 1400, Photo Reproduction Methods and Equipment, 3 February 1950.) This machine would be designed specifically for the production of continuous-tone photographic prints from aerial roll film. Action has been initiated by the Chief of Engineers and the Engineer Research and Development Laboratories for the preparation of necessary revisions to Project 8-39-09-00, and for their submission at an early date to the Corps of Engineers Technical Committee to cover this new equipment requirement.

IV. CONCLUSIONS

19. Conclusions. It is concluded that:

a. With the modifications accomplished and those recommended under par. 15, the machine is a satisfactory replacement for present standard equipment used for the production of line-work prints, where the quantity of work necessitates the use of a high speed production machine.

b. The machine is satisfactory for the production of continuous-tone prints from cut sheet and aerial roll film, as an auxiliary feature to the line-work reproduction.

c. By reason of its width, this machine is not suitable for the exclusive production of continuous-tone photographic prints in rolls.

d. The machine is suitable for standardization as a Class IV item of issue.

e. Further investigation and development is necessary to provide ammonia process equipment suitable for the exclusive production of continuous-tone prints from aerial roll films.

V. RECOMMENDATIONS

20. Recommendations. It is recommended that:

a. The experimental ammonia process printer-developer, modified as noted in par. 15, be classified as adopted type, standard type, and as a Class IV item of issue.

b. Project 8-39-09-005 be modified to cover the development of a special ammonia process printer-developer suitable for the exclusive production of continuous-tone prints from aerial roll films.

Submitted by:

JOHN H. KELLY, JR.
Project Engineer

Forwarded by:

W. W. DAVIS
Chief, Reproduction Studies Section

ROBERT E. ROSSELL
Chief, Photo-Litho Branch

Approved 6 July 1950 by:

WILLIAM C. CUDE
Chief, Topographic Engineering
Department

APPENDICES

APPENDIX A

AUTHORITY

RESEARCH AND DEVELOPMENT PROJECT CARD (NON-PROJECTS) | 2. SEC. U | 3. PROJ. NO. 8-35-09-005

1. PROJECT TITLE
REPRODUCTION EQUIPMENT, AMMONIA PROCESS

4. OLD PROJ. NO. MP739

5. REPORT DATE 30 Sept 47

6. BASIC FIELD OR SUBJECT
Mapping, Charting, and Geodesy

7. SUB FIELD OR SUBJECT GROUP
Map and Chart Reproduction

8. CONTRACT AGENCY
Office, Chief of Engineers

12. CONTRACTOR AND/OR LABORATORY
Engr. Res. & Dev. Laboratories
Ozalid Corporation
Keuffel & Esser

CONTRACT/W. O. NO.
W44-009ENG505
W44-009ENG537

9. DIRECTING AGENCY
Engr. Intell. Div., MO, OCE

10. REQUESTING AGENCY
Office, Chief of Engineers

13. RELATED PROJECTS

17. EST. COMPL. DATES
RES. June 46
DEV. Aug. 49
TEST June 50
OP EVAL ?

11. PARTICIPATION AND/OR COORDINATION
Army Air Forces (C)
Army Ground Forces (C)

14. DATE APPROVED
31 January 1947 by WDGS

15. PRIORITY 2-C | 16. AC-12

FY 18. FISCAL EST'S.
48 5
49 10
T 40

19. 1-C
Item No. 1086, CETC Meeting #169

20. REQUIREMENT AND/OR JUSTIFICATION A compact, lightweight ammonia process machine suitable for truck mounting and air transport is required by topographic units and for general Army use in the reproduction of line tracings and similar transparencies. In addition improved diazo papers are required which will render the equipment suitable for rapid reproduction of photomaps by the dry process. This project is necessary to develop and test new material designed to replace existing types in the near future.

21. BRIEF OF PROJECT AND OBJECTIVE

a. REFERENCES:

(1) Letter from the President, the Engineer Board to the Chief of Engineers dated 19 August 1944, subject: Quantity Reproduction of Photo-Mosaic Maps and Some Contact Prints by Ammonia Process.

(2) Letter from Chief of Engineers to the President, the Engineer Board dated 21 July 1945, subject: Ammonia Process, (Work Order No. EMP 3300, MPS 409) with 7 indorsements and 2 comments.

b. OBJECTIVE:

(1) The purpose of this project is to provide a compact, lightweight ammonia process machine which will be suitable for truck mounting and air transport, and to develop diazo papers and perfect a process which will render the equipment suitable for the reproduction of photomaps and aerial contact prints used as photomaps in addition to the current normal use of this type of equipment for the production of positive prints from line tracings and similar transparencies.

c. MILITARY CHARACTERISTICS:

(1) The machine shall be capable of producing positive prints from line tracings or similar transparencies by the ammonia process.

(2) The machine shall be capable of printing photomaps and contact prints from cut film or aerial roll film.

(3) The papers or medium used for printing photographic copy shall be capable of faithful rendition of the original subject matter.

(4) The photographic image, when properly printed and developed, shall be sufficiently stable for military field use.

(5) The machine shall be capable of printing up to 40 inches in width.

22. JNCB SH. | PC. | IC & P. | I. | I. | C.

c. MILITARY CHARACTERISTICS (Continued):

(6) The machine shall be as lightweight in design as practicable and yet shall be sufficiently rugged to withstand military field use. It shall be resistant to damage from corrosion and fungus attack.

(7) The machine shall have a low center of gravity and shall be readily adaptable to mounting in a van type truck body of the type used in the present mobile map reproduction train, and/or the proposed mobile photomapping train for Corps and Army Topographic Units.

(8) The machine shall be skid mounted for air transport and so designed that it can be loaded and transported in standard cargo planes without dismantling major parts.

(9) The machine shall be capable of operation from a 110 volt A.C., 50-60 cycle power supply.

(10) The equipment shall operate satisfactorily within the extreme range of climatic conditions from tropic to arctic.

(11) The machine shall be treated for elimination of interference with radio communication in accordance with applicable Signal Corps specifications.

d. DISCUSSION:

(1) Reference a (1) reports on a preliminary investigation of the Engineer Board into the possibilities of reproducing photomaps by the diazo process.

(2) Reference a (2) directs continuation of the preliminary investigation, which finally culminated in the establishment of this development project. This correspondence also indicates coordination with Army Air Forces and Army Ground Forces prior to formal establishment of the project and assignment of the approved project to the Engineer Board for prosecution.

(3) Agencies interested in this project other than the Office, Chief of Engineers are Army Air Forces and Army Ground Forces.

e. PROJECT PLAN:

(1) Initially stress will be placed on obtaining an improved air and truck transportable ammonia process machine to perform present conventional functions of this type equipment.

(2) Subsequent development will provide for the addition of improved diazo papers to this equipment to allow printing and developing of photographic copy.

(3) Equipment and materials will be subjected to engineering tests.

(4) Service tests will be conducted by interested agencies.

(5) Specifications covering the machine and accessories, with recommendations regarding equipment classification action, basis of issue and existing production facilities will be submitted to the Chief of Engineers.

APPENDIX B

DEFINITION OF TERMS USED IN CONNECTION WITH THE AMMONIA PROCESS

aerial negative - A photographic negative which has been exposed from an aircraft in flight in a camera built specially for the purpose.

ammonia process - A diazotype process of direct positive printing and developing of photographic prints from translucent line drawings, film positives, and the like; this process employs paper or other media upon which a diazo compound, a coupler, and an organic acid are coated together, the latter preventing premature coupling before development. Exposure is usually accomplished by a mercury vapor or other ultraviolet source of light while development consists of passing the exposed media through ammonia fumes. The diazotype material used with the ammonia process is referred to as the two component type. (See Ozalid process.)

azo compound - One of a series of compounds containing nitrogen, many of which yield brilliant dyes and form part of the basic structure of light-sensitive coatings for materials; such materials are then used to produce photographic prints by the diazotype process.

continuous-tone - A term designating an image containing tones of indefinite variation from white (transparent) through greys, to black (opaque).

contrast - The inherent characteristic of a photographic material to adjust or change the density difference of the original; thus, a high contrast photographic paper would increase the density difference of a negative as exhibited in the print. The inherent contrast can be varied between limits by varying the exposure, development time, or composition of developer. (See also density.)

cut film - Sheets of photographic film with the base generally thicker than that used for roll or pack film.

definition - The distinctness or clarity of detail or outline of a photographic image.

density - A measure of the degree of blackening of an exposed film, plate, or paper after development, or a measure of the direct image in the case of a print-out material. It is defined strictly as the logarithm of the optical opacity where the opacity is the ratio of the incident to the transmitted (or reflected) light. Thus, a medium which transmits all of the

incident light has a density of 0, a deposit passing 1/10th of the incident light has a density of 1, a deposit passing 1/100th of the incident light has a density of 2, and the like.

developer - A chemical reagent used in the development of a photographic image.

development - The production of a visible image from an invisible or latent image formed on light-sensitive material by exposure.

diapositive - An ordinary positive photographic image on a transparent support for viewing by transmitted light or projection.

diazo - A prefix indicating the presence of the bivalent - N = N - radical.

diazotype - A prefix applied to equipment, materials, sensitizers, and the like which may be used in producing photographic images by the diazotype process.

dry-photo - A term applied to continuous-tone diazotype papers requiring dry development by ammonia fumes.

exposure - The action of submitting any light-sensitive surface to the action of actinic light. In sensitometric work the term "exposure" means "total light action" rather than "exposure time"; thus, exposure may be defined as the product obtained by multiplying the intensity of illumination at the sensitized surface by the time during which the surface is exposed to this illumination.

film (photographic) - A thin flexible transparent sheet of cellulose nitrate, acetate, or similar material which may be coated with a light sensitive emulsion.

fixing - The process of converting the silver compounds of a photographic emulsion, which have not been acted upon by light or development, into soluble compounds that can be removed by the subsequent water wash, thus rendering the emulsion unalterable by further action of light.

flat - Pertaining to photographic images it implies that the image lacks contrast; little difference in density between the various tones.

image - The deposit of silver or other substance by which a picture representation of the original subject is formed.

intermediate - Any transparent or translucent material carrying a photographic image, the main purpose of which is to aid in the production of an end product, a positive photographic print, from an original negative.

line drawings, copies, negatives, etc. - Drawings, copies, etc., the image of which consists of lines and has only two tones, corresponding to black and white; a line negative, one having only transparent and opaque areas, no variation of tones.

mercury-vapor lamp - A quartz tube containing mercury vapor which produces light by the passage of electric current. The light given off by the lamp is blue-white in appearance (harmful to the eyes) and is lacking in red rays.

negative - A photographic image which has the lights and shades in inverse order to those of the original subject.

negative-working - A sensitized material which reproduces lights and shades in reverse of those of the original from which the reproduction is made.

ozalid process - A commercial process utilizing the ammonia process as defined above.

positive - A photographic image having approximately the same rendition of light and shade as the original subject.

positive-working - A sensitized material which reproduces lights and shades which are the same as those of the original from which the reproduction is made.

processing machine - An automatic or semi-automatic machine, the purpose of which is to expose and process photographic materials.

silver halide - A compound of halogen with silver as a bromide or chloride. Used as a prefix when referring to equipment, materials, sensitizers, and the like, which may be used in producing photographic images by the conventional photographic process.

tone reproduction - The ability of a material to reproduce monochrome tones, or colors in monochrome, in satisfactory relationship with those of the original subject.

translucent - Admitting passage of light but diffusing it so that objects beyond cannot be clearly distinguished; partly transparent.

transparency - A picture on a transparent or translucent material (line tracing, photographic slides, and the like).

APPENDIX C

DESCRIPTION OF THE AMMONIA PROCESS AND COMPARISON WITH THE SILVER HALIDE PROCESS

The ammonia process is one of two diazotype processes now being used commercially for the reproduction of line drawings. The diazotype processes are based on the light sensitivity of a class of organic substances known as diazonium compounds. These compounds are capable of reacting with certain coupling compounds to form dyes; however, this property is destroyed if the diazo substance is exposed to light. In the ammonia process, the diazonium compound is coated onto paper or other suitable support together with the coupler and a weak acid to prevent premature coupling. If the coated support is exposed to light while in contact with a line drawing or other transparent or translucent original, the diazo compound is destroyed in those areas which receive light, thus preventing the formation of a dye during development. In those areas which have not received light, the coupling can be made to take place by neutralization of the acid component in the coating, thus forming a dye image. This neutralization is accomplished by submitting the exposed material to an alkaline atmosphere such as that produced by the volatilization of liquid ammonia. Because of the nature of development of this type material by ammonia fumes, it is described as a dry process, thus differentiating from the other commercially used diazotype process in which the sensitizer does not contain the coupling compound and the formation of the dye is accomplished by applying the coupling substance to the surface of the material. The diazotype process requiring a liquid developer is described as a semi-wet process. In both of these diazotype processes the dye image formed is a direct positive reproduction of the original copy, since the dye is formed only in those areas in which the light-sensitive substance has been protected from the light rays by the dense areas of the original.

By the use of certain diazonium compounds which are capable of a gradual destruction by light action depending upon the intensity of the light, thus reproducing tones intermediate of the extremes of typical line-work reproduction, it is now possible to produce continuous-tone photographs by the ammonia process.

SILVER HALIDE PROCESS	AMMONIA PROCESS
Print Materials	
Negative-working. Direct printing from original negative. Four to seven different contrasts to cover a wide range of negative contrasts. Darkroom and safelights are required.	Positive-working. Direct printing from a positive. Single contrast. Neither darkroom nor safelights are required.
Processing	
Exposure, development, rinsing, fixing, washing, and drying are required. Single print processing time (from a film negative), using the fastest commercial method, is approx. 7 minutes.	Exposure and development only. No other processing or drying is required. Single print processing time from an available film positive is approx. 1½ minutes.
Processing Chemicals, Water, etc.	
Developer. Approx. 1 gallon per 100, 10" x 10" prints[1].	Developer. Ammonia [illegible], approx. 1 gallon per 2500, 10" x 10" prints.
Water. That required for preparation of developer and fixer plus that needed for washing. Recommended wash, a minimum of 20 minutes in a flow of water giving a complete change every few minutes.	Water. None required.
Fixer. When used in large quantity, the yield per gallon would probably be slightly higher than that of the developer.	Fixer. None required.
Equipment	
Contact printer or other suitable method of exposure; trays; and sinks, possibly temperature controlled.	Single automatic machine for exposure and processing. Floor space, 20 sq ft.
Personnel	
Highly trained, specialized personnel required.	No specialized personnel required for print production. Training for operation of ammonia process

1. See Photo-Lab Index, Morgan & Lester.

SILVER HALIDE PROCESS	AMMONIA PROCESS
Personnel (Cont)	
	machine requires only a few days. (Production of silver positives requires highly trained and specialized personnel.)
Print Quality	
Very good. Good definition, excellent image stability, etc. Some indication of grain.	Good. Good definition, fair image stability, satisfactory for military use. No grain other than that in the original.
Other Factors	
Produces a positive print directly from a film negative.	Requires the production of a film positive from a negative for printing. At present, this positive is made by the conventional silver halide process.
Possible to produce prints from negatives of low, normal, or high contrast by correct selection of paper.	Present materials require positives of a specified contrast for satisfactory reproduction.

Submitted 1 January 1950

APPENDIX D

TEST DATA AND DRAWINGS

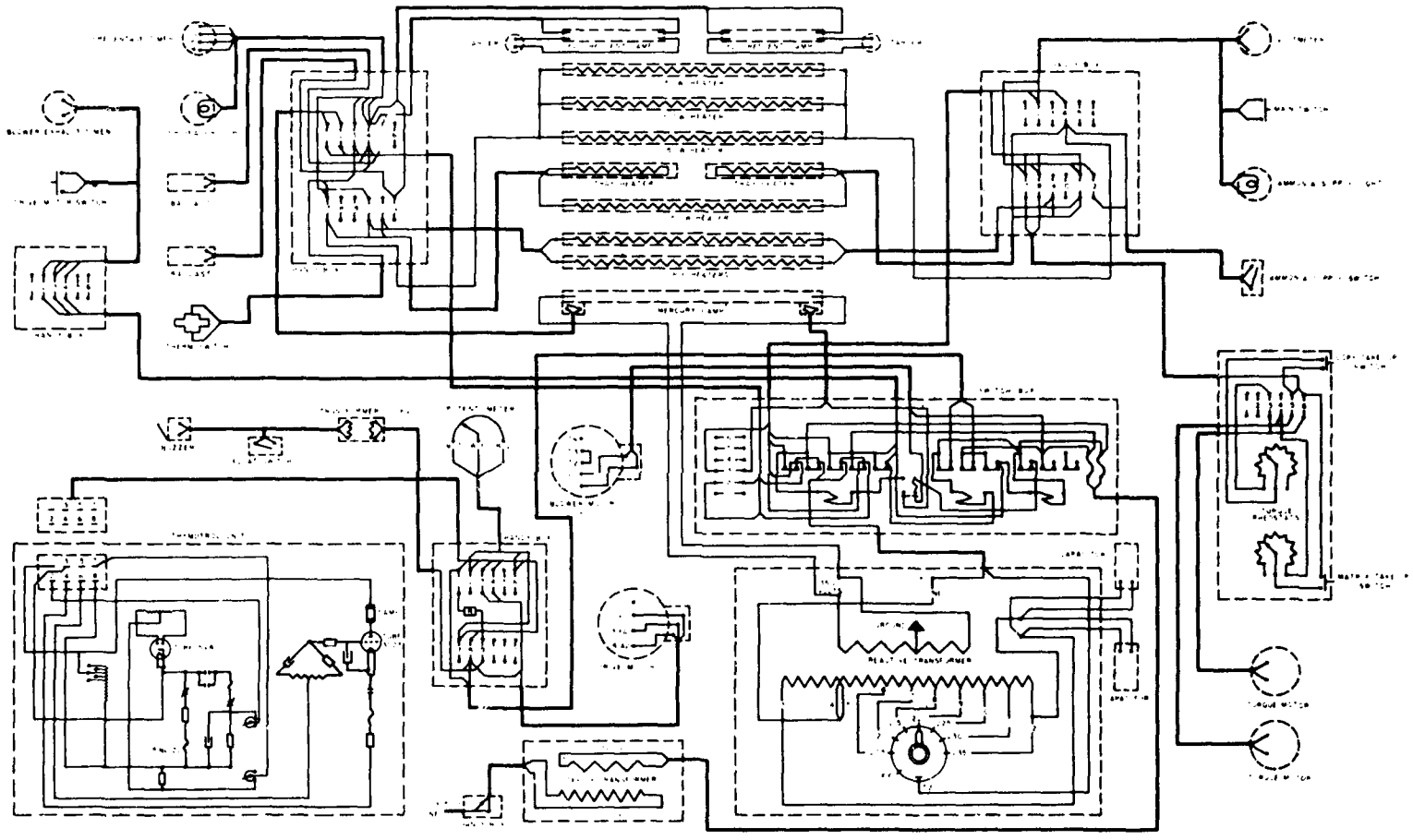
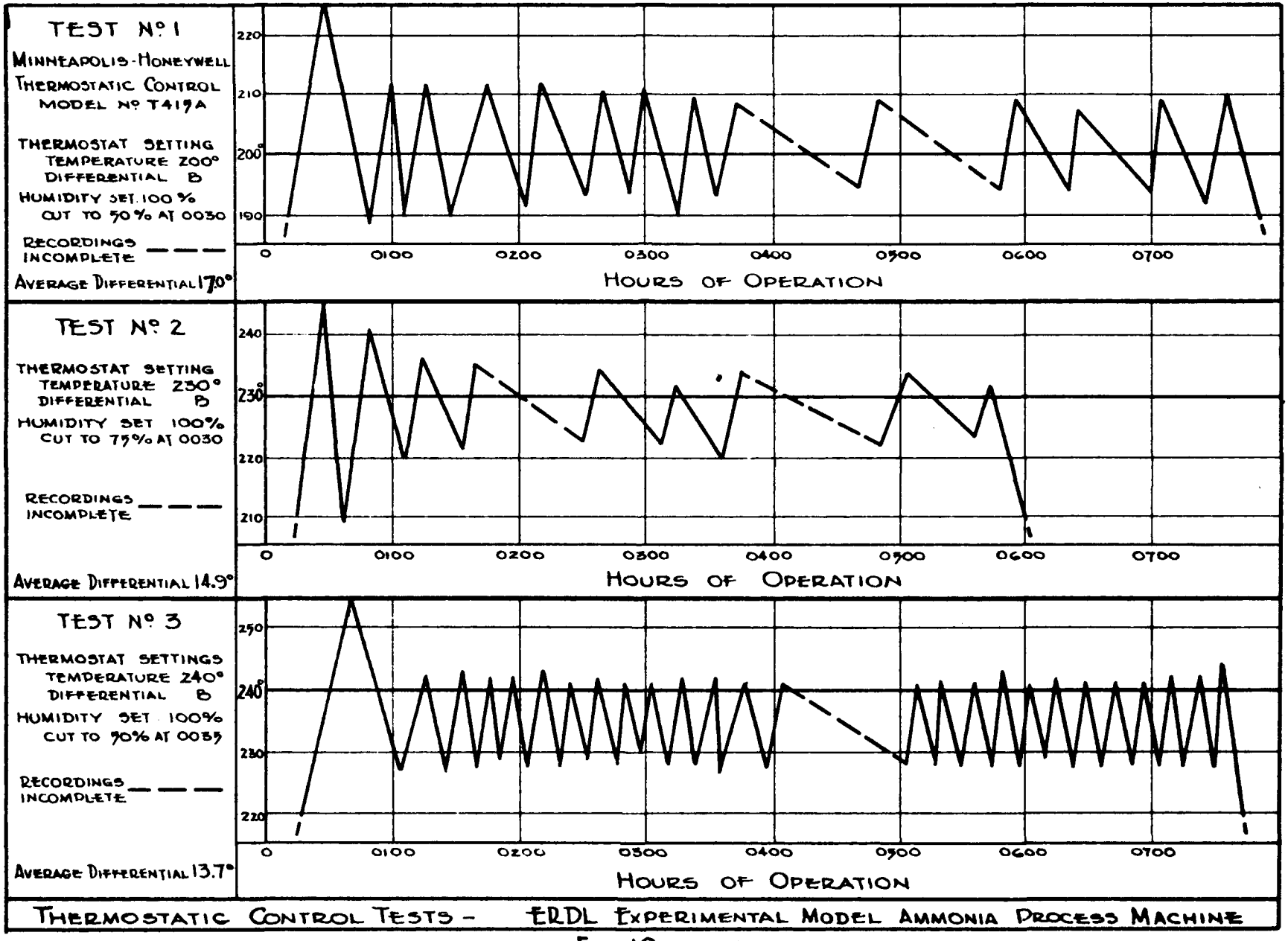


Fig. 9. Wiring diagram for experimental model ammonia process printer-developer.



THERMOSTATIC CONTROL TESTS – ERDL EXPERIMENTAL MODEL AMMONIA PROCESS MACHINE

Fig. 10.

TABLE VI. Tests of Cylinder Surface Temperature.

CYLINDER SURFACE TEMPERATURE TESTS				CYLINDER SURFACE TEMPERATURES F					
	HOURS OF OPERATION		ROOM TEMP F	LEFT END TEMP.	READING DIFF.*	CENTER TEMP.	READING DIFF.*	RIGHT END TEMP.	READING DIFF.*
TEST No. 1	0130	Constant Speed 15 fpm	75	130	55	131	56	131	56
	0200		75	130	55	132	57	133	58
	0230		77	132	55	134	57	135	58
	0300		77	133	56	135	58	136	59
	0330		78	136	58	137	59	138	60
	0400		79	136	57	138	59	140	61
	0500		80	138	58	139	59	139	59
	0530		80	138	58	139	59	141	61
	0600		80	139	59	140	60	141	61
	0630		80	138	58	140	60	141	61
	0700		80	138	58	140	60	141	61
	0730		81	139	58	140	59	140	59
	0800		81	136	55	138	57	138	57
	AVERAGES – Cylinder 137 / Room 78 / Cylinder above room 59 F								
TEST No. 2	0115	Constant Speed 7 fpm	78	131	53	129	51	130	52
	0145		80	134	54	133	53	132	52
	0215		81	148	67	147	66	148	67
	0245		82	147	65	145	63	146	64
	0315		83	147	64	146	63	147	64
	0345		84	148	64	146	62	150	66
	0500		86	148	62	146	60	153	67
	0530		87	154	67	150	63	153	66
	0600		88	156	68	154	66	154	66
	0630		88	157	67	154	66	157	69
	0730		89	157	68	156	67	156	67
	AVERAGES - Cylinder 147 / Room 84 / Cylinder above room 63 F								
TEST No. 3		10	74	138	64	142	68	142	68
		2	74	144	70	151	77	150	76
		12	74	138	64	144	70	140	66
		15	75	140	65	142	67	141	66
		30	75	142	67	144	69	142	67
		5	75	142	67	144	69	144	69
		2	76	153	77	156	80	156	80
		20	76	140	64	143	67	143	67
		20	76	143	67	147	71	147	71

*CYLINDER TEMP. MINUS ROOM TEMP.

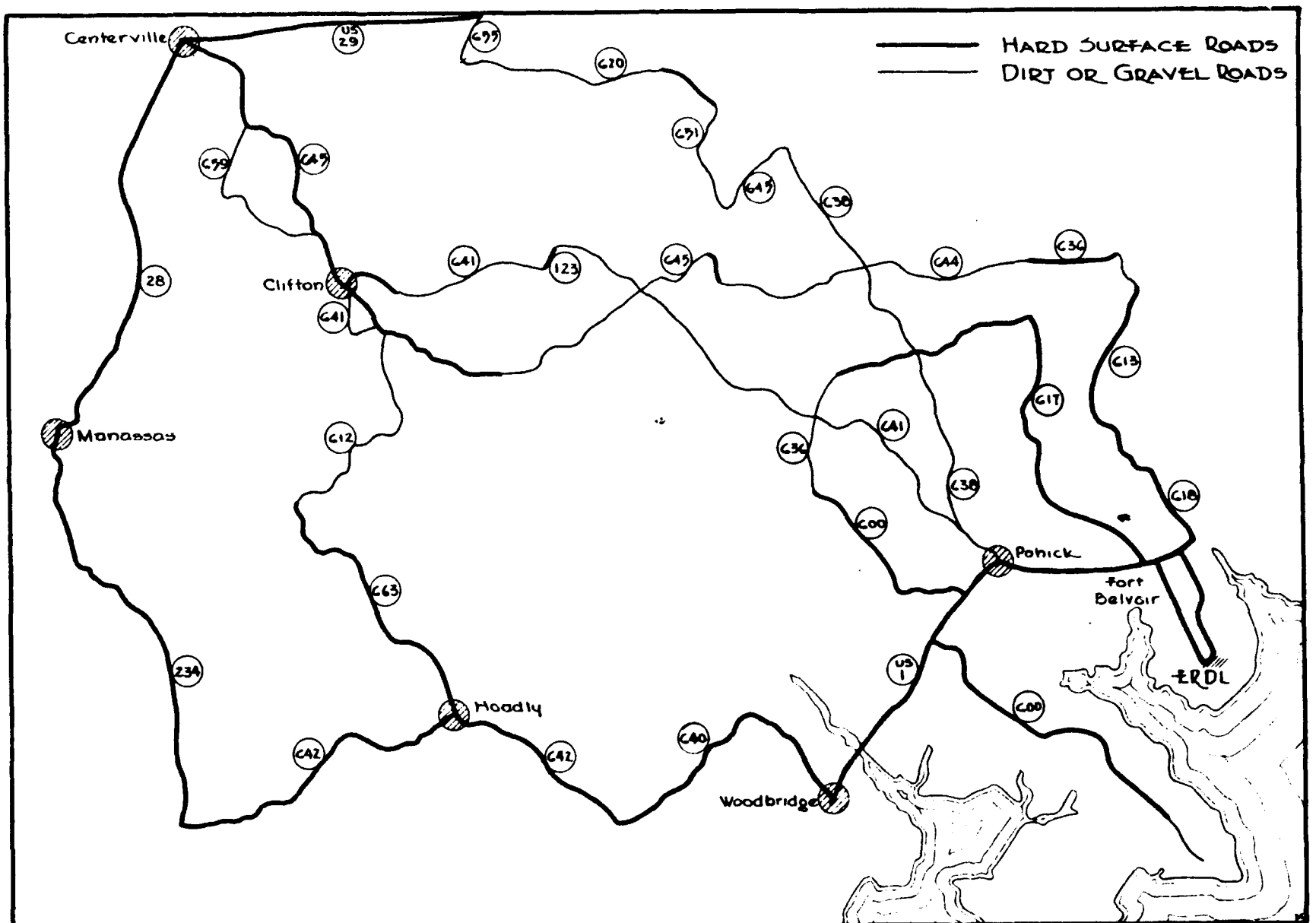


FIG. 11. ROUTE OF ROAD SHOCK TEST

APPENDIX E

INFORMATION REQUIRED FOR STANDARDIZATION

Information required for classification of a new item of equipment is given below:

1. Approved Military Characteristics. The approved military characteristics for the Printer-Developer, Ammonia Process, 110 volt, 50-60 cycle, single phase, 42-inch capacity are as follows:

a. The machine shall be capable of producing positive prints from line tracings or similar transparencies by the ammonia process.

b. The machine shall be capable of printing photomaps and contact prints from cut film or aerial roll film.

c. The papers or medium used for printing photographic copy shall be capable of faithful rendition of the original subject matter.

d. The photographic image, when properly printed and developed, shall be sufficiently stable for military field use.

e. The machine shall be capable of printing up to 40 inches in width.

f. The machine shall be as lightweight in design as practicable and yet shall be sufficiently rugged to withstand military field use. It shall be resistant to damage from corrosion and fungus attack.

g. The machine shall have a low center of gravity and shall be readily adaptable to mounting in a van-type truck body of the type used in the present mobile map reproduction train, and/or the proposed mobile photomapping train for Corps and Army Topographic Units.

h. The machine shall be skid mounted for air transport and so designed that it can be loaded and transported in standard cargo planes without dismantling major parts.

i. The machine shall be capable of operation from a 110 volt A. C., 50-60 cycle power supply.

j. The equipment shall operate satisfactorily within the extreme range of climatic conditions from tropic to arctic.

k. The machine shall be treated for elimination of interference with radio communication in accordance with applicable Signal Corps specifications.

2. Dimensions and Weight. Dimensions and weight of the complete Printer-Developer, Ammonia Process, 110 volt, 50-60 cycle, single phase, 42-inch capacity are as follows:

a. Dimensions.

73 inches wide, 71½ inches high, and 47 inches deep.

b. Weight

1885 pounds.

3. Cost to Fabricate Single Unit. Estimated cost of production of one complete Printer-Developer, Ammonia Process, 110 volt, 50-60 cycle, single phase, 42 inch capacity is $20,000.

4. Cost in Quantity Production. Estimated cost of the Printer-Developer, Ammonia Process, 110 volt, 50-60 cycle, single phase, 42-inch capacity, in quantity production of 10 or more is $10,000.

5. Production Data. It is estimated that an established manufacturer such as the Ozalid, Division of General Aniline and Film Corporation could initiate production of the Printer-Developer, Ammonia Process, 110 volt, 50-60 cycle, single phase, 42-inch capacity, in 90 days and could produce 10 complete units in the next 12 months thereafter.

6. Overseas Use. The Printer-Developer, Ammonia Process, 110 volt, 50-60 cycle, single phase, 42-inch capacity is satisfactory from a development point of view for use overseas.

7. Standardization and Interchangeability of Parts. The design of the Printer-Developer, Ammonia Process, 110 volt, 50-60 cycle, single phase, 42-inch capacity does accomplish the objectives of maximum standardization and interchangeability of parts.

8. Spare Parts List. The following is a list of first echelon spare parts for the Printer-Developer, Ammonia Process, 110 volt, 50-60 cycle, single phase, 42-inch capacity:

Item	Quantity
Cylinder and Ring Assembly, Pyrex glass, 47¼ in. long by 6 in. diameter for 42-in. printer-developer, ammonia process	1
Lamp, Fluorescent, 15-watt, 1-inch diameter, 17 inches long	2
Tube, Amperite Relay (G. E. No. 115N020K)	1
Tube, Electronic, Type 5V4 G	1
Tube, Thyratron, (G. E. No. GL-3C23)	1
Fuse, Cartridge type, 60 ampere capacity 13/16 inch diam. by 3 inches long	4
Fuse, Cartridge type, 3 ampere capacity, ½-inch dia. by 2 inches long (G. E. No. 1454)	2
Lamp, (for burner assembly), High Pressure Mercury Vapor, 220-volt A.C., 60-watts per inch for 42-in. printer-developer, ammonia process	1
Lamp, indicator, Candelabra base, 6-watt, 120-volt.	2

Engineer Research & Development Labs.
The Engineer Center and Fort Belvoir
Fort Belvoir, Virginia

TECRD TEL
400.1 (8-35-09-005)

20 June 1950

(PROPOSED SET LISTING)
Reproduction Equipment, Ammonia Process,
Continuous-tone, Set No. 7

Nomenclature	Unit of Measure	Expendable	Stock No.	Quantity
Ammonia Aqua, Ammonia Hydroxide, USP, ammonia water, strong solution 27 to 29 percent at 26° Baume, 7-lb. jug, packed 10 to a wooden case	lb.	X	51-2456.700.600	140
Film, photographic, cut sheets, safety base, commercial type w/antihalation backing, blue and violet sensitive, speed group 12.5, gamma group 1.30 fog not exceeding 0.12				
10x12 in., 25 sheets to box	bx.	X	NSN	10
24x30 in., 25 sheets to box	bx.	X	NSN	5
Film, photographic, roll, safety base, commercial type with antihalation backing, blue and violet sensitive, speed group 12.5, gamma group 1.30, fog not exceeding 0.12				
9½ in. x 150 ft.	ro.	X	NSN	5
Paper, printing, ammonia process, gelatin coated, continuous-tone, single weight, sepia, in sheets				
10x10 in., 100 sheets	pk.	X	NSN	50
24x30 in., 100 sheets	pk.	X	NSN	3
Paper, printing, ammonia process, gelatin coated, continuous-tone, single weight, sepia, in rolls				
9½ in. x 50 yds.	ro.	X	NSN	10
Paper, printing, ammonia process, rapid speed, 17-lb. weight, blue, in rolls				
40 in. x 50 yds.	ro.	X	NSN	2

(PROPOSED SET LISTING)
Reproduction Equipment, Ammonia Process,
Continuous-tone, Set No. 7 (continued)

Nomenclature	Unit of Measure	Expend-able	Stock No.	Quantity
Paper, printing, ammonia process, rapid speed, 17-lb. weight, blue, in sheets 24 x 30 in., 100 sheets	pk.	X	NSN	10
Paper, printing, ammonia process, intermediate (translucent), 14-lb. weight, sepia, in rolls 40 in. x 50 yds.	ro.	X	NSN	2
Powder, conditioning, sealing sleeve, for printer-developer, ammonia process, ½-pt. can	cn.	X	NSN	3
Printer-Developer, Ammonia Process, 110 volt, 50-60 cycle, single phase, 42-inch capacity	ea.		18-5735.200-420	1

APPENDIX F

CORRESPONDENCE REGARDING CLASSIFICATION OF AMMONIA PROCESS EQUIPMENT

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON

ENGIE

19 January 1950

SUBJECT: Ammonia Process Equipment Developed Under Project 8-35-09-005

TO: Chief, Army Field Forces
Fort Monroe, Virginia

1. Reference is made to the following:

a. Item No. 1086, Corps of Engineers Technical Meeting No. 169, establishing Project No. MP 739 (project number later changed to 8-35-09-005).

b. Letter from Director of Logistics, General Staff, to the Chief of Engineers, dated 7 February 1949, subject: "Quantity Reproduction of Aerial Photographs for Intelligence Use in the Field Armies," with inclosed letter from Army Field Forces Board No. 2 to the Chief, Army Field Forces, dated 12 November 1948, same subject.

2. The scope of the project and possible applications for equipment and materials being developed thereunder are discussed at some length in the above references.

3. Engineering tests are nearing completion on an experimental 42-inch ammonia process printer-developer generally conforming to military characteristics established by reference 1a. This particular machine was developed to fill what were, at the time of initiation of the project, the following needs:

a. To provide an improved machine to replace the Czalid Model E in Engineer Set No. 710-010. The Model E was no longer available commercially.

b. To provide a means for experimental testing and further developing under the same project of materials and processes for photo reproduction by the ammonia process.

c. It was expected that the new machine might also provide an interim means to field units for making diazo type prints in quantity if such a requirement developed.

4. The experimental machine has filled requirement 3b very well and will be retained indefinitely at the Engineer Research and Development Laboratories to permit continued use for this purpose. It also meets requirement 3a more than adequately from the technical standpoint but preliminary indications are that the special features required to facilitate

photo reproduction will render such a machine too large and costly to permit its issue to all units now issued Set No. 710-010. Also, since the initiation of the project, an improved commercial machine, the Ozalid "Streamliner," has become available which is suitable replacement for the Model E for "run-of-the-mill" reproduction of drawings, etc., and has currently replaced the Model E in Set No. 710-010. It appears then that the best field of application of the newly developed machine now lies in category 3c; i.e., to provide selected units with a means for reproducing conventional material at a much higher rate (from three to five times) than the Streamliner, and in the same machine to provide an interim means for reproducing aerial photographs by the ammonia process pending further perfection of materials and processes and development of a special ammonia process multiprinter as proposed by Army Field Forces in the inclosure to reference 1b.

5. Attached for your further information in connection with this correspondence are:

a. Table showing the general authorized distribution of Set No. 710-010, Reproduction Equipment, Ammonia Process (Inclosure No. 2).

b. Table showing comparative physical and technical features and capabilities of the Streamliner, the Experimental Model, and the Printmaster; the latter machine being the nearest commercial equivalent to the Experimental Model (Inclosure No. 3).

c. Data sheet, dated 6 January 1950, on activities of the Engineer Research and Development Laboratories with respect to Reproduction of Continuous Tone Photographic Prints by means of Diazo Type Materials. Attention is invited to paragraph 4 of the data sheet indicating results of a recent operational job on which the Experimental model machine and the 656th Engineer Topographic Battalion were utilized (Inclosure No. 4).

6. Service test procurement of the new printer-developer, if required, has been proposed for initiation this fiscal year (F. Y. 1950). However, before presenting this proposal to the Corps of Engineers Technical Committee, confirmation of the following is requested:

a. Army Field Forces' requirement for this particular machine. A tentative indication of probable distribution within Army Field Forces, if the machine should be adopted, would be most helpful.

b. Army Field Forces' service test requirements, if any, for the machine. Unit cost in procurement involving only one or two machines is estimated at $20,000. An estimated additional $10,000 would be required to cover cost of ammonia process materials needed for an extended service test by field troops.

SUBJECT: Ammonia Process Equipment Developed Under Project 8-35-09-005
19 Jan 50

7. An early reply would be required in order to process a service test project through the CETC and initiate service test procurement this fiscal year.

FOR THE CHIEF OF ENGINEERS:

/s/ D. G. Hammond
D. G. HAMMOND
Lt Colonel, Corps of Engineers
Chief, Engr Research & Development Div
Military Operations

4 Incls
1. Cy Item 1086, CETC Meeting 169
2. List showing Distribution of Set 710-010 (dup)
3. Table of comparison of characteristics of Streamliner, Printmaster & Exp. Model (dup)
4. Paper, dtd 6 Jan 50, on activities of ERDL with respect to reproduction by means of Diazotype Materials

ATENG 413.5(19 Jan 50) 1st Ind
Subject: Ammonia Process Equipment Developed Under Project 8-35-09-005

Office, Chief, Army Field Forces, Fort Monroe, Virginia 30 January 1950

TO: President, AFF Board No. 2, Fort Knox, Kentucky

Your comments and recommendations reference paragraph 6 of basic correspondence are requested.

FOR THE CHIEF, ARMY FIELD FORCES:

/s/ Neil M. Matzger
NEIL M. MATZGER
Lt Col AGD
Asst. Adj. Gen.

4 Incls
n/c

AKCE P-1400 (19 Jan 50) 2d Ind
SUBJECT: Ammonia Process Equipment Developed Under Project 8-35-09-005

Army Field Forces Board No. 2, Fort Knox, Kentucky 17 February 1950

TO: Chief, Army Field Forces, Fort Monroe, Virginia
ATTENTION: Assistant Chief for Research and Development

1. References.

a. Ltr, AFF Bd No. 2, P-1136, AKCE, 12 Nov 1948, subject: "Quantity Reproductionof Aerial Photographs for Intelligence Use in the Field Armies."

b. Ltr, R & D Group, Logistics Division, General Staff, CS GLD/F3 062.3, 7 February 1949, to Ch ief of Engineers, subject: "Quantity Reproduction of Aerial Photographs for Intelligence Use in the Field Armies," w/1 inclosure and 7 indorsements.

c. AFF Bd No. 2 Third Partial Report of Projects No. 1146 and 1150, Military Characteristics of Surveying Equipment, Map Making and Reproduction Equipment, and Changes to T/O & E, 13 January 1949.

d. AFF Bd No. 2 Report of Project No. 1400, Photo Reproduction Methods and Equipment, 3 February 1950.

e. Department of the Army Field Manual 100-10, Field Service Regulations, Administrative, September 1949.

2. This board agrees with the statement in paragraph 4 basic letter concerning the experimental machine as being "... too large and costly to permit its issue to all units now issued Set No. 710.010." The replacement of the Ozalid machine Model E in this set by the new Ozalid "Streamliner" machine should provide adequate reproduction equipment for all normal uses of this set.

3. This board believes that the experimental machine developed under DA Project 8-35-09-005 should be accepted as an item of photographic reproduction equipment only for the short term period, since no other satisfactory mobile equipment is now available. However, immediate procurement of this item, except in an emergency, is not believed warranted, since it appears possible to develop within the next 2 years a special ammonia process multiprinter more suitable for the reproduction of aerial photographs.

4. Military characteristics for this special ammonia process multiprinter are included in a recent report prepared by this board (see reference 1d, above). It should be noted that this board, starting in November 1948, has consistently recommended the initiation of a separate project for the development of the diazo process and ammonia process multiprinter (see reference 1a, above). Attention is called to paragraph 6b, Project No. 1400 (reference 1d) which concludes that "the development of this unconventional dry process (diazo) should be expedited by providing higher priority and more funds than are presently allotted in order that it may be tested as soon as possible by Army Field Forces." It is believed that every effort should be made to accomplish full development of this process and the required multiprinter equipment during the next 2 years. Development costs have been estimated at approximately $100,000 (see paragraph 3 of 4th indorsement to reference 1b, above).

5. The proposed procurement of the experimental machine for selected units, as noted in the concluding sentence of paragraph 4, basic letter, is not concurred in. The higher rate in reproducing conventional materials (line drawings) is not believed to be important enough to warrant the

difference in cost over the commercially produced Ozalid Streamliner, which is now available in Set No. 710.010. Further, there seems to be no justification for providing a large and expensive photo processing machine to other than the one unit assigned the basic mission of reproducing large quantities of aerial photos for the field army. Any unit having Set No. 710.010 can print aerial photos in limited quantities when desired.

6. At present writing, this board cannot give definite information on the number of ammonia process multiprinters required by a field army. Studies have indicated that a field army will require multiprinting equipment capable of reproducing a maximum of 50,000 photo prints per day from aerial film exposed by the Air Force (see reference 1d, above). At present no requirement can be seen for ammonia process multiprinters outside of this one company in each field army. It should be noted, however, that the above excludes the reproduction of aerial photos taken from liaison aircraft assigned to the field army. The Signal Corps has been assigned this mission recently (see paragraph 4b(2), reference 1e, above) and this board has no information on the process or equipment which they plan to use. Since the quantities involved in liaison photos normally are much smaller than those obtained from the Air Force, it may be presumed that the Signal Corps will employ the conventional silver halide process and equipment.

7. It is believed that no service tests of the experimental machine should be conducted for the following reasons:

a. The engineering tests, as noted in inclosure 4, indicate that the machine will reproduce satisfactory photo prints in large quantities, when operated by army enlisted personnel.

b. The cost of procuring a service test model and the necessary test material, as noted in the basic letter, are considered excessive in view of the current economy program, especially for a short term item of equipment which probably can be replaced within 2 years.

c. The machine should be standardized for the short term period based on the results of engineering tests. Procurement should be limited to emergencies.

8. In view of the above this board recommends that:

a. No Army Field Forces service tests be conducted with the 42-inch ammonia process machine developed under DA Project 8-35-09-005.

b. The 42-inch ammonia process machine be standardized as an item of short term equipment but that no procurement be authorized except in an emergency.

c. Adequate funds be made available during the next fiscal year for expediting the development of an ammonia process photographic multiprinter.

FOR THE PRESIDENT:

/s/ S. G. Brown, Jr.
S. G. BROWN, JR.
Lt Col, Cav - Executive

4 Incls
n/c

ATENG 413.5(19 Jan 50) 3rd Ind 61
Subject: Ammonia Process Equipment Developed Under Project 8-35-09-005

Office, Chief, Army Field Forces, Fort Monroe, Virginia 9 March 1950

TO: Chief of Engineers, Department of the Army, Washington 25, D. C.
ATTENTION: Engineer Research and Development Division

1. Your attention is invited to the preceding indorsement. This Office concurs, in principle, with the recommendations contained in paragraph 8.

2. It is believed that the recent production run of some 50,000 photographic prints for exercise "Sweetbriar" constitutes an adequate service test of the 42-inch machine, considering its limited application. Accordingly, no AFF service test of this equipment is anticipated.

3. The recommendation contained in paragraph 8c of the preceding indorsement is being treated in separate correspondence.

4. It is recommended that:

a. No Army Field Forces service test of the 42-inch machine developed under the subject project be performed.

b. The 42-inch ammonia process machine be classified as a Class IV item of issue.

FOR THE CHIEF, ARMY FIELD FORCES:

/s/ Neil M. Matzger
NEIL M. MATZGER
Lt Col AGD
Asst. Adj. Gen.

4 Incls
n/c

Copy furnished:
Pres, AFF Bd 2

SUBJECT: Ammonia Process Equipment Developed under Project 8-35-09-005(1)

ENGIE (19 Jan 50) 4th Ind

Office of the Chief of Engineers, Washington 25, D. C., 9 May 1950

TO: Commanding General, The Engineer Center, Fort Belvoir, Virginia

1. Forwarded inviting attention of the Engineer Research and Development Laboratories to the recommendations of the Chief, Army Field Forces, in the preceding 3rd Indorsement. This office concurs in these recommendations.

2. Unless recommended otherwise by the Engineer Research and Development Laboratories, it is now proposed that the machine be classified as a Class IV item of issue on the basis of engineering tests which are understood to be complete, and of the several production test runs which have been made. The item has been deleted from the Engineer Service Test Procurement Program for F. Y. 1950.

3. It is requested that the Engineer Research and Development Laboratories prepare their report on this machine in the form of a final report on this particular phase of Project 8-35-09-005 and proceed with the preparation of specifications suitable for use in procurement.

BY ORDER OF THE CHIEF OF ENGINEERS:

4 Incls
1. Cy Item 1086, CETC Meeting 169
2. List showing Distribution of Set 710-010
3. Table of comparison of characteristics of Streamliner, Printmaster & Exp. Model
4. Paper, dtd 6 Jan 50, on activities of FPDL with respect to reproduction by means of Diazotype Materials

/s/ D. G. Hammond
D. G. HAMMOND
Lt Colonel, Corps of Engineers
Chief, Engr Research & Development Div
Military Operations

TECAG 400.1
(19 Jan 50) 5th Ind
SUBJECT: Ammonia Process Equipment Developed Under Project 8-35-09-005
12 May 1950

Headquarters, The Engineer Center & Fort Belvoir, Fort Belvoir, Virginia

TO: Commanding Officer, Engineer Research & Development Laboratories, Fort Belvoir, Virginia

4 Incls
n/c

/s/ B

Authorized Distribution of Set No. 710-01, Reproduction Equipment, Ammonia Process

T/O&E	5-52	Hq & Hq Co., Port Construction and Repair
	5-55	Topographic Bn, Army
	5-166T	Hq & Hq Co., Engr Survey Bn
	5-189	Engr Base Photomapping Co., Engr Base Topo Bn
	5-250-1	Hq & Hq Co., Engr Brigade
	5-312	Hq & Hq Co., Engr Constr Grp
	5-400	Engr Aviation Topo Org
	5-412	Hq & Hq & Service Co., Engr Aviation Group
	5-652S	Hq & Hq Co., Engr (Petroleum Prod. Depot)
T/A	4-2	Coast Artillery School
	5-1600	Camp Gordon Engineer Aviation Unit
	250-12	Army FF Bd. No. 2
	20-69	Joint Mil. Adm. Grp., Phil. Is
	20-120	European Command
	250-11	Army Field Forces Board No. 1
	250-14	Army Field Forces Board No. 4
	85-5	ORC
	20-74	Ryukyus Command
	5-1100	Engineer School, Ft Belvoir

Comparison of Characteristics of Streamliner, Printmaster, and Experimental Model

The following shows a comparison of the characteristics of the Streamliner, Printmaster, and the Experimental Model. All are products of Ozalid, Division of General Aniline & Film Corporation, Johnson City, New York:

	Characteristics	Streamliner Model	Experimental Model	Printmaster Model
a.	Width of material that can be printed	42 inches	42 inches	42 inches
b.	Printing speed range	0 to 10 ft/min	8 in. to 30 ft/min	0 to 30 ft/min
c.	Developing speed range	Fixed at 5 ft/min	Synchronized with printing speed	Synchronized with printing speed
d.	Ammonia Feed	Manual adjustment	Automatic feed	Automatic feed
e.	Light Source	40 watts per inch	60 watts per inch	75 watts per inch
f.	Exposure Time	Streamliner requires 3 times as much time as Experimental Model for a given exposure due to lower intensity light source.	Experimental model takes 1/3 the time to expose a given material in comparison to Streamliner Model.	Approximately the same as Experimental Model.
g.	Continuous Tone Print Production (cut film)	Machine not designed for continuous-tone work. To develop continuous tone print, a paper towel must be passed through with print to protect gelatin surface from scratching. Two or more passes through developer are required to develop the print.	Machine especially designed for continuous-tone work. Machine developer section equipped with stainless steel endless apron to protect gelatin of print. One pass through developer is sufficient to develop print. Print quality is excellent.	Although not especially designed for this purpose, it will accommodate continuous-tone cut film originals. Some difficulty may be encountered in separation of original and copy material. Double development produces satisfactory prints.

Incl 3

	Characteristics	Streamliner	Experimental	Printmaster
h.	Continuous Tone Print Production (Roll Film)	Not equipped.	Equipped with feed spools and take-up spools for standard aerial film negatives and diazotype roll print materials and film materials.	Not equipped.
i.	Width	62 inches	73 inches	74 inches
j.	Height	51 inches	71½ inches	83 inches
k.	Depth with feedboard	36 inches	47 inches	68 inches
l.	Net weight	750 pounds	1900 pounds	2600 pounds
m.	Line work reproduction	Very good quality work possible at low production rate. (One-third capacity of Experimental Model.)	Very good quality work possible at high production rate	Very good quality work at high production rate
n.	Unit Cost (approximate)	$1740	$20,000 in service test quantities. Data not available on cost in quantity production but cost would probably be greater than that of Printmaster.	$7,000
o.	In Quantity Production and Available Commercially	Yes	No	Yes
	Mountable in Standard Map Reproduction Van	Yes	Yes	No (too high)

APPROVAL OF

Report 1174

Final Report

ENGINEERING TESTS OF EXPERIMENTAL

AMMONIA PROCESS PRINTER-DEVELOPER

6 July 1950

and

Distribution

ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES
THE ENGINEER CENTER AND FORT BELVOIR
FORT BELVOIR, VA.

ADDRESS REPLY TO
COMMANDING OFFICER
ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES
FORT BELVOIR, VA.

1 SEP 1950

IN REPLY REFER TO: TECRD ASI
400.1 (8-35-09-005)

SUBJECT: Transmittal of Report 1174, Final Report, Engineering Tests of Experimental Ammonia Process Printer-Developer

THRU: Commanding General
The Engineer Center and Fort Belvoir
Fort Belvoir, Virginia

TO: Chief of Engineers
Department of the Army
Washington 25, D. C.
ATTENTION: Chief, Engineer Research and Development Division

1. Transmitted herewith is Report 1174, "Final Report, Engineering Tests of Experimental Ammonia Process Printer-Developer," dated 6 July 1950, which was prepared by the Technical Staff of the Engineer Research and Development Laboratories. This report covers engineering tests conducted on an experimental 42-inch ammonia process printer-developer generally conforming to military characteristics established by the project.

2. The report concludes that:

a. With the modifications accomplished and those recommended under par. 15 of the report, the machine is a satisfactory replacement for present standard equipment used for the production of line-work prints, where the quantity of work necessitates the use of a high speed production machine.

b. The machine is satisfactory for the production of continuous-tone prints from cut sheet and aerial roll film, as an auxiliary feature to the line-work reproduction.

c. By reason of its width, this machine is not suitable for the exclusive production of continuous-tone photographic prints in rolls.

TECHD ASI
400.1 (8-35-09-005)
Subject: Transmittal of Report 1174, Final Report, Engineering Tests of Experimental Ammonia Process Printer-Developer

d. The machine is suitable for standardization as a Class IV item of issue.

e. Further investigation and development is necessary to provide ammonia process equipment suitable for the exclusive production of continuous-tone prints from aerial roll films.

3. The report recommends that:

a. The experimental ammonia process printer-developer, modified as noted in par. 15 of the report, be classified as adopted type, standard type, and as a Class IV item of issue.

b. Project 8-35-09-005 be modified to cover the development of a special ammonia process printer-developer suitable for the exclusive production of continuous-tone prints from aerial roll films.

4. The report with its conclusions and recommendations is approved.

O. B. BEASLEY
Colonel, CE
Commanding

2 Incls
1. Proposed distr list (in quint)
2. Rpt 1174 (in quad)

TECAG 400.1 1st Ind

Hq, The Engr Cen & Ft Belvoir, Ft Belvoir, Va. 5 SEP 1950

TO: C of Engrs, DA, Washington 25, D. C.

2 incls
N/C

NMW

SUBJECT: Transmittal of Report 1174, Final Report, Engineering Tests of Experimental Ammonia Process Printer-Developer

ENGIE (1 Sep 50) 2nd Ind

Office of the Chief of Engineers, Washington 25, D. C., 25 Sep 50

TO: Commanding General, The Engineer Center, Fort Belvoir, Virginia

1. Engineer Research and Development Laboratories Report No. 1174 and the proposed distribution are approved, with the exception that the use of the word "exclusive" in the conclusions and recommendations is considered inappropriate and subject to ambiguous interpretation. However, there is believed to be complete understanding on this matter between this office, the Army Field Forces and the Engineer Research and Development Laboratories, in that the production of continuous-tone prints was a secondary requirement of the printer-developer reported on, whereas a unit is now required with this as the primary design objective.

2. With regard to the recommendations of the report, the following action has been taken:

a. Necessary logistical data are being assembled to classify as standard, Reproduction Equipment, Set No. 7, Ammonia Process, Continuous-Tone. The printer-developer described in Report 1174 is the major component of this set.

b. A subcommittee report recommending revision of Project 8-35-09-005 to cover development of a 22-inch printer-developer suitable for quantity production of continuous-tone prints in the field has been submitted to the Corps of Engineers Technical Committee for consideration at an early meeting.

BY ORDER OF THE CHIEF OF ENGINEERS:

D. G. Hammond

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D. G. HAMMOND
Lt. Colonel, Corps of Engineers
Chief, Engr Research & Development Div
Military Operations

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