9 September 1965

Please Reference:
A51-65-3340

U. S. Government

Subject: Contract 7032/100,675-65WR
Our Sales Order 1-10290-1

Gentlemen:

We are pleased to provide the second in a series of Monthly Progress Reports covering the effort expended on subject contract during the period of August 2, 1965 to September 1, 1965.

Manpower

[redacted]

[redacted] is a new hire, engaged to work on the film drying techniques program. [redacted] is an existent member of the [redacted] staff who has been transferred to the research group to assist in the thermal shock studies.

Clean Room Installation

The changes to the clean room control equipment necessary to enable the requirements of Fed. Std. No. 209 - "Clean Room and Work Station Requirements, Controlled Environment" to be met, were completed, and a test conducted by an independent organization. The results of the test showed that an average particle content of 65 particles per cubic foot of

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air. 50 microns or larger was obtained, thus exceeding the specification requirements. A copy of the report is enclosed. In the area of temperature and humidity control, changes to the control system and the humidification system were also completed, and a series of tests initiated. At the time of this report the relative humidity and temperature tests completed, showed that the systems were controlling within the specified tolerances. One test is outstanding, 85°F. at 45 percent R.H., but no difficulty is now anticipated in meeting this requirement. The final documents, the operating and maintenance instructions have been requested prior to signing off of the installation within the forthcoming week.

Future Programs

Recently, discussions were held with customer representatives at Houston Fearless. Proposals on the following equipment will be prepared and submitted. HTA/5. Film Processor, ABD4 Drier, Chip Processor. In preparation also by request, is a detailed breakdown of the requirements for an analytical study to determine the effect of contamination on photographic image quality and photographic interpretation. During this visit, a detailed briefing of other areas of research was given, including investigations conducted into dry film processing and printing. A descriptive precis of more than a dozen other areas of potential research was prepared for appraisal by the customer.

Included in this report are the results and/or status of the positive pressure transport capstan, intertank transfer bearing, rotary air and liquid bearing investigations, which have been curtailed at these points in order to concentrate the group efforts on the thermal shock, film drying and sensitometric studies. The new areas of the research program thermal shock and film drying are now under way with the literature search almost complete in both cases, and some preliminary experimental testing completed.

Research Program

1. Positive-Pressure Transport Capstan.

The preliminary performance evaluation of the Positive-Pressure Transport Capstan (recorded in Report 974-006-1) was essentially culminated and the finished report is in final draft stage. In this specific design, the venturi principle was used to create a vacuum in the rotating member of the capstan by moving a high velocity blast of air through a restricted annular opening where it produces suction through 57 effective 0.053-inch ports by aspiration.

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Prior to the test series, an exhaustive calibration of the Lamb pressure/vacuum blower, Model 17 11520, was made using the Roots-Connersville flowmeter outlined in the last monthly report. The blower was tested under conditions of both pressure and vacuum, and its capacity was higher in the latter mode of operation. The manufacturer's performance curves were secured so that test measurements could be compared directly with those figures.

Earlier tests had been made on a 3-inch diameter capstan and these are recorded. Subsequent experiments had shown the most efficient diameter to be between 5 and 6 inches and all of these tests were made on a 6-inch capstan. The first of the series of evaluative runs determined the most efficient gap width in the venturi to produce the highest vacuum attainable with the blower, since velocity is a function of gap width which in turn controls vacuum. The break in the curve occurred between 5 and 7 mils and the results were displayed graphically and tabularly.

The second of the series of tests proved that the capstan configuration was not sensitive to changes in the number of exposed orifi and, thus, did not require baffling to cut off suction in the open portion of its lower periphery. A number of tests were run with the blower in both its vacuum and also its positive-pressure mode, to determine maximum torque attainable with four different widths of film, 70mm, 5, 6.6 and 9-1/2-inch. Capstan speed was constant at 17 rpm. Results indicated that, while either mode was operable, higher torques were obtained with the blower operated as a vacuum pump.

Since atmospheric pressure operating on the outer surface of the film is thought to be almost totally responsible for cohesion between the film and the capstan, higher torque readings would be expected for the wider films. This was not the case. The 70mm film gave the highest, 72-inch-pounds, of the series and an explanation for this anomaly was advanced. The completed report is in its final form awaiting only a few illustrations and a mathematical analysis of the findings.

2. Air Bearing (Tunnel)

The experimental evaluation of the Tunnel-Type Air Intertank Transfer Bearing has been completed, and the report is in final draft form. As with the capstan report, some illustrations and a mathematical analysis remain to complete the package.

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3. Rotary Air Bearing.

Feasibility studies for a self powered air bearing were conducted using the air bearing test bed referred to in Report 974-312-1, Figures 4, 5 and 6. The first setup employed 4-4 inch diameter, four blades fans, 2 left hand in tandem and 2 right hand in tandem, each pair installed at opposite ends so that the air blast from each was directed into the bearing area proper. The bearing area was 4-1/2 inch diameter 10-1/2 inch long cylinder fabricated of 0.025 thick aluminum sheet with 0.040 dia. perforations evenly distributed over approximately 29 percent of its area. The bearing was first run at 3450 R.P.M. and it was immediately apparent that even if the fans were turned up to their maximum of 6200 R.P.M., that there would be insufficient pressure to support a significant load.

The next test was run with a pair of blower wheels installed within the bearing area. These blower wheels are of the squirrel cage configuration, 3.8 inches in diameter and 2-1/2 inches long with one solid end forming the supporting plate and the hub, the normal direction of flow being axial through the open end and exhausting radially. It had been noted that these fans tended to have a higher radial delivery at the back or closed end. Therefore, as expected, with the fans mounted back to back in the center of the bearing, a much higher cushion existed at the center. At 3450 R.P.M., the 9-1/2 inch film loop immediately slid off to one side. The fans were then moved outward in increments of 3/4 of-an-inch to observe the effect upon the distribution of pressure under the film, the idea being that a pressure gradient increasing from the center of the bearing would provide the desirable valley which would cause the film to stay (track) on center. This procedure produced the desired results with the exception that as the fans were moved outward, there was no air pressure to support the narrowest film (70mm) which was tested at this speed.

A second series of test runs were made with the same wheels at 5800 R.P.M., the bearing load capability increasing quite faithfully as the square of the velocity. Even at this higher R.P.M., there was insufficient air pressure to support the 70mm film. To overcome this, 2-2-1/2 inch dia. x .97 inches long blower wheels were installed 1/2 inch apart back to back in the center area of the bearing, between the two 3.8 inch diameter wheels. At the same time a 4-1/2 inch O.D. washer with an I.D equal to the intake diameter of the larger wheels was installed at each end of the perforated cage. The purpose of these

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washers was to prevent air from escaping from under the cage at each end, thereby causing sufficient air pressure at the ends of the bearing to keep the 9-1/2-inch film from wandering.

The results of this final setup were very encouraging. The 70mm film now lifted to a cushion depth of approximately 1/16 of-an-inch with a weight of 0.15 lbs.; the 5-inch film supported 0.40 lbs., the 6.6-inch film, 0.84 lbs., and the 9-1/2-inch tracked very well, returning immediately to center when manually offset. It seemed reasonable to assume that the 9-1/2-inch film would track equally well if there were more length to the bearing so that there would be more radial air flow from within at each end of the 9-1/2-inch width. To accomplish a similar effect, an edge flange approximately 4-inches in length, and 1/4-inch high, was installed at both ends at the top center of the bearing. The flanges acted as aerodynamic "fences" which restrained the air exhausting from under the film edge in this area. The "fences" brought about the desired results. The 9-1/2-inch film now tracked exceedingly well, returning to a central position when manually moved against either of the flanges.

Numerous flow and pressure tests were made of this final setup, the results of which will be fully covered in the final report.

4. Sensitometric Studies

Problem of Uniform Processing.

A literature survey conducted earlier in the program to determine the best possible method of agitation during processing, revealed that extensive investigative effort has been devoted to the subjects of time and temperature, but the problem of agitation has been less broadly explored, although a great deal of thought has been put into devising special agitation methods such as spray, nitrogen burst, and rocking trays. All these methods employ some means of consistent movement of the processing solution, to remove the unwanted by-products that diffuse from the emulsion during development. Good processing may be summarized as a situation in which every exposed silver halide grain has an equal probability of becoming developed.

1. The developer must diffuse into the entire depth of the emulsion at the same rate.

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2. The reaction products of development should diffuse from the area of development to allow adsorption of fresh developer so that reduction of the silver halide can continue.

3. The reaction products should be dispersed into the bulk developer as soon as they appear on the emulsion surface.

With these known facts in mind, many methods of agitation were evaluated that would best produce good consistency and reproducibility, especially when high processing temperature and short processing time are involved.

During the first phase of this project, a newer instrument was constructed which provided even better reproducibility. This system which is a modified version of PH 2.5 1960 in which the oscillating movements are performed mechanically, was utilized throughout this phase. Many repetitive tests were made to meet the rigid standards adopted for this project. Gammas were required to be held to a tolerance of $\pm$ 0.10.

Current tests are being conducted to provide the photographic technician with a complete cross section of gammas, or family of curves. Using this family of curves which will consist of 4 curves for each emulsion (4400, 4401, and 4404), the operator may select any gamma that will best suit the subject matter being processed over the wide range of time-temperature combinations, with the resultant effects upon resolution, fog, speed, and granularity.

The modified version of PH 2.5 1960, was again utilized to produce a time-gamma curve for each emulsion investigated. Starting with the control of 68°F. with a processing time of 8, 5, 3 and 2 minutes which indicated that gamma infinity can be reached in 5 minutes at 68°F.

In producing this time-gamma curve, it was noted that a considerable overlapping effect occurred, indicating a need for a tighter gamma control, beyond the capability of this apparatus to achieve.

In order to separate the overlapping effect, a gamma tolerance of $\pm$ 0.05 or less is necessary. In order to obtain this tolerance a search for suitable off-the-shelf equipment was made, with the result that a Kodak Rapid Color Processor was selected as having a good potential for this purpose.

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5. Evaluation of the Kodak Rapid Color Processor as a High-Temperature Sensitometric Processor

This Processor is a new motorized drum processor for rapid processing of 8 x 10 and 11 x 14-inch color prints on Kodak Ektacolor Professional Paper. This processor was primarily designed to process Ektacolor Prints and since the color processing requires stringent control, it was believed that it would produce the rigid standards of ± 0.05 or less gamma control necessary to satisfy this program.

The film samples were held stationary against the rotating drum which constantly picks up and transfers fresh solution to the emulsion with vigorous agitation. A small hinged tray receives the chemical or water in proper sequence. The change from one processing solution to another is made by tilting the tray, rinsing it, and refilling with new solution. Uniform processing temperatures were maintained by circulating thermostatically controlled water, through the interior of the drum. The processing solutions were automatically controlled to ± 1/20°F.

The sensitometric results produced by the drum processor at the 5 min., 68°F. level, were very satisfactory. Gamma tolerances of ± 0.03 were maintained from one film sample to another. However, at the 15 second, 115°F. level, the gamma tolerance widened to an unexceptable ± 0.15, which was caused by the decrease in viscosity of the developer as the temperature was increased. This loss in viscosity produced a very thin meniscus over the drum surface. The weight of the film being processed was enough to permit the film sample to drag on the surface of the drum resulting in a streaking effect. Since the corrective measures necessary to overcome this effect were beyond a simple change to the processor, this method of sensitometric processing has been reluctantly abandoned.

As an alternative to the procurement and modification of an off-the-shelf item of equipment, a relatively simple concept for a sensitometric processor was conceived, and a mock-up model built as shown in the enclosed photograph. This processor consists briefly of a balance arm on the end of which is a rotating wheel to which the film sample is attached. Three small tanks, immersed in a temperature controlled bath of water, are provided for the processing solutions. By lifting the arm, the wheel can be lowered into the solutions for the required time of immersion. The trays are pulled forward to bring the required solution into position under the wheel at the time of change.

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Tests are now in progress to evaluate this equipment, which if successful in holding the required gamma tolerance, will be manufactured for use on this program. This requirement illustrates the lack of suitable equipment in this field.

Funds expended during the reporting period are approximately $19,090.

If you should have any questions or desire further information, please do not hesitate to contact us.

Very truly yours,

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