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Report No. IITRI-C6018-4
(Monthly Progress Report)

INVESTIGATION OF LIGHT SCATTERING IN HIGHLY REFLECTING PIGMENTED COATINGS

National Aeronautics
and Space Administration

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IIT RESEARCH INSTITUTE

Chicago, Ill.

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(Fourth Monthly Progress Report), 1 Oct. - 1 Nov. 1963

INVESTIGATION LIGHT SCATTERING IN HIGHLY REFLECTING PIGMENTED COATINGS

October 1 through November 1, 1963

National Aeronautics and Space Administration

(NASA Contract NASr-65(07))

IITRI Project C6018

Gene A. Zerlaut

[7]

I. INTRODUCTION

This is the fourth monthly progress report on IITRI Project C6018, Contract NAS-r65(07). The period covered is October 1 to November 1, 1963. The objectives during this period were (1) to prepare silver chloride suspensions of controlled particle size and uniformity, (2) to prepare thin coatings of uniform particle density from these suspensions, and (3) to develop reproducible methods for measuring the light transmission and reflectance of these coatings.

II. PREPARATION OF SUSPENSIONS

Several procedures were used to vary the particle size of the suspensions and at the same time retain uniformity. A summary of the suspensions prepared is shown in Table 1.

The precipitations were conducted under a red safety light in a darkroom. The silver chloride crystals were precipitated by the simultaneous addition at the rate of 2 ml/min of 30 ml each of potassium chloride and silver nitrate.

Table 1

PREPARATION OF SILVER CHLORIDE SUSPENSIONS

Batch No.	Normality of KCl, $AgNO_3$	Reaction Temp., °C	Reaction pH	Conc. of Gelatin, g/l	Excess of KCl, ml
1	1.96	50	6.0	30	None
2	1.96	50	6.0	30	2
3	1.96	50	6.0	15	2
4	1.96	61	9.0	30	2
5	1.96	61	10.5	30	2
6	1.96	61	9.0	5	2
7	1.96	61	9.0	5*	2**
8	3.00	56	6.0	30	$2^1/2$

* Added 40 ml of 30g/l gelatin solution after precipitation of silver chloride.
** The excess potassium chloride was added after precipitation of silver chloride.

The procedure is described in detail in Report No. IITRI-C6018-3. The gelatin, furnished by the Atlantic Gelatin Company, was lot 6314003 photographic emulsion grade for batches 1 through 7 and lot S-317303 for batch 8. Lot S-317303 is the more inert.

Figures 1 and 2 are electron photomicrographs of the silver chloride crystals obtained in each of the precipitations. Adding ammonium hydroxide to increase the reaction pH to 10.5 resulted in poor crystal growth (batch 5). On the other hand, reducing the amount of gelatin after the chemical addition did not aid particle segregation (batch 7). Particle size distribution of the crystals in batches 2 and 8 gave geometric mean diameters of 1.181 μ and 0.187 μ with geometric standard deviations of 1.13 and 1.12, respectively.

Although uniformity of size has been achieved, the desired control of size has not been obtained and will be the subject of further research in the next period. Growth modifiers, such as ethylenediamine, and other alterations in procedure will be investigated.

III. PREPARATION OF THIN COATINGS

Four concentrations of coatings were prepared from the batch 2 silver chloride suspension. The concentrations prepared were 0.062 M, 0.123 M, 0.185 M. and 0.246 M in silver chloride. The dilutions were made with gelatin solutions so that each contained an equal amount of gelatin.

These dilutions were spread on quartz plates with a Gardner knife and quickly dried in a hot-air stream to give a coating of uniform particle density and thickness.

IV. REFLECTANCE AND TRANSMITTANCE MEASUREMENTS

Reflectance and transmittance spectra were measured with the Cary spectrophotometer. Transmission measurements were made using monochromatic incident light with a quartz plate coated with gelatin in the reference beam. Only parallel transmission was monitored. Reflectance measurements were made using monochromatic incident light; the reflected light entered the intergrating sphere and was received by the phototube. A light trap was placed behind the specimen in the reflectance measurements.

The silver chloride coatings show a transmission peak at 2400 A and a minimum at about 2800 A (Figure 3). These peaks are probably due to the crystal array since a uniform silver chloride window would be expected to give a monatonic, uniform decrease in transmission as the wavelength of light decreases. Figure 4 is a plot of the absorbance at several wavelengths including the transmittance and absorption peaks for the four concentrations of silver chloride coatings. If Beer's law is obeyed, a straight line would be obtained.

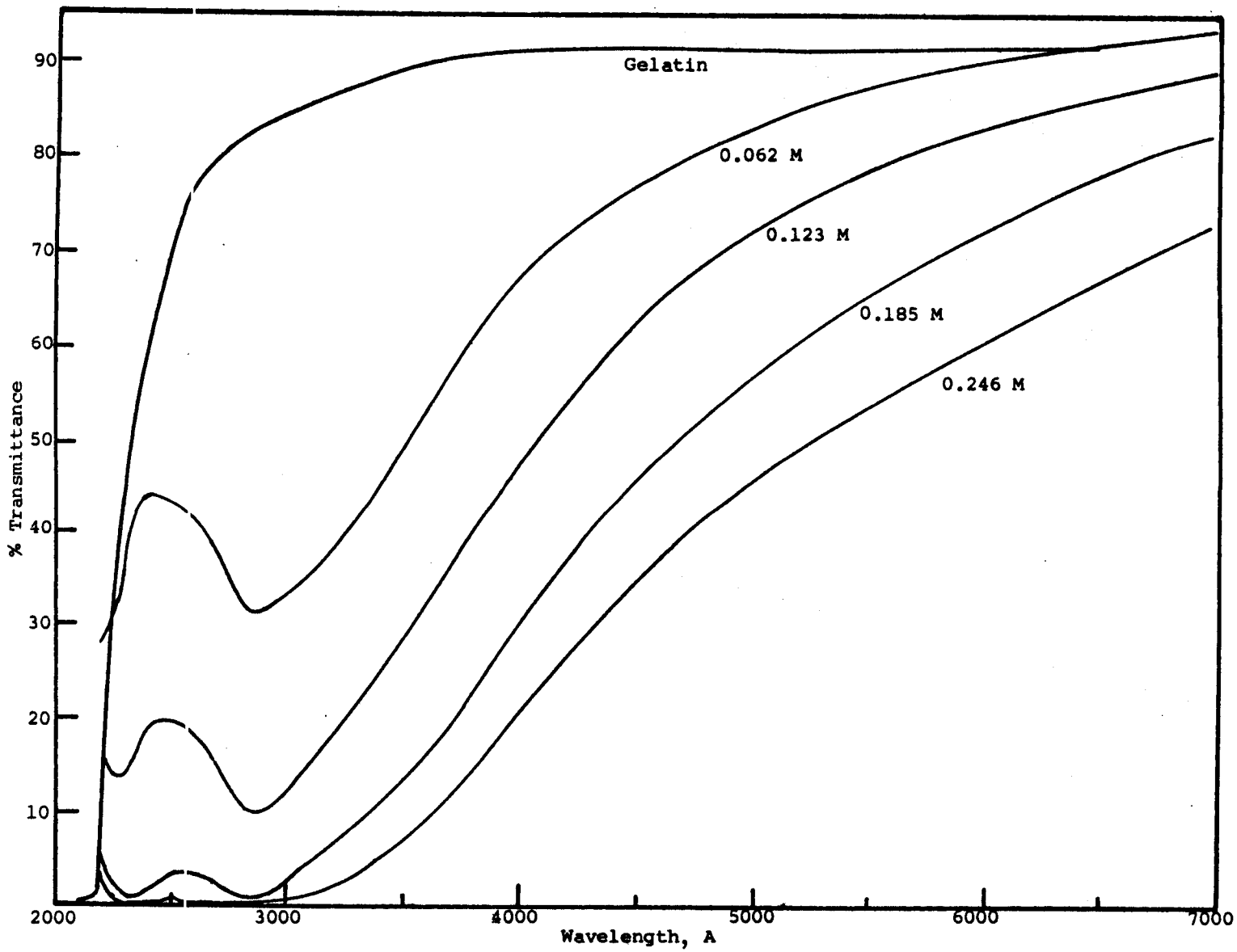

FIGURE 3

TRANSMITTANCE OF COATINGS OF SILVER CHLORIDE SUSPENSIONS IN GELATIN AT VARYING CONCENTRATIONS

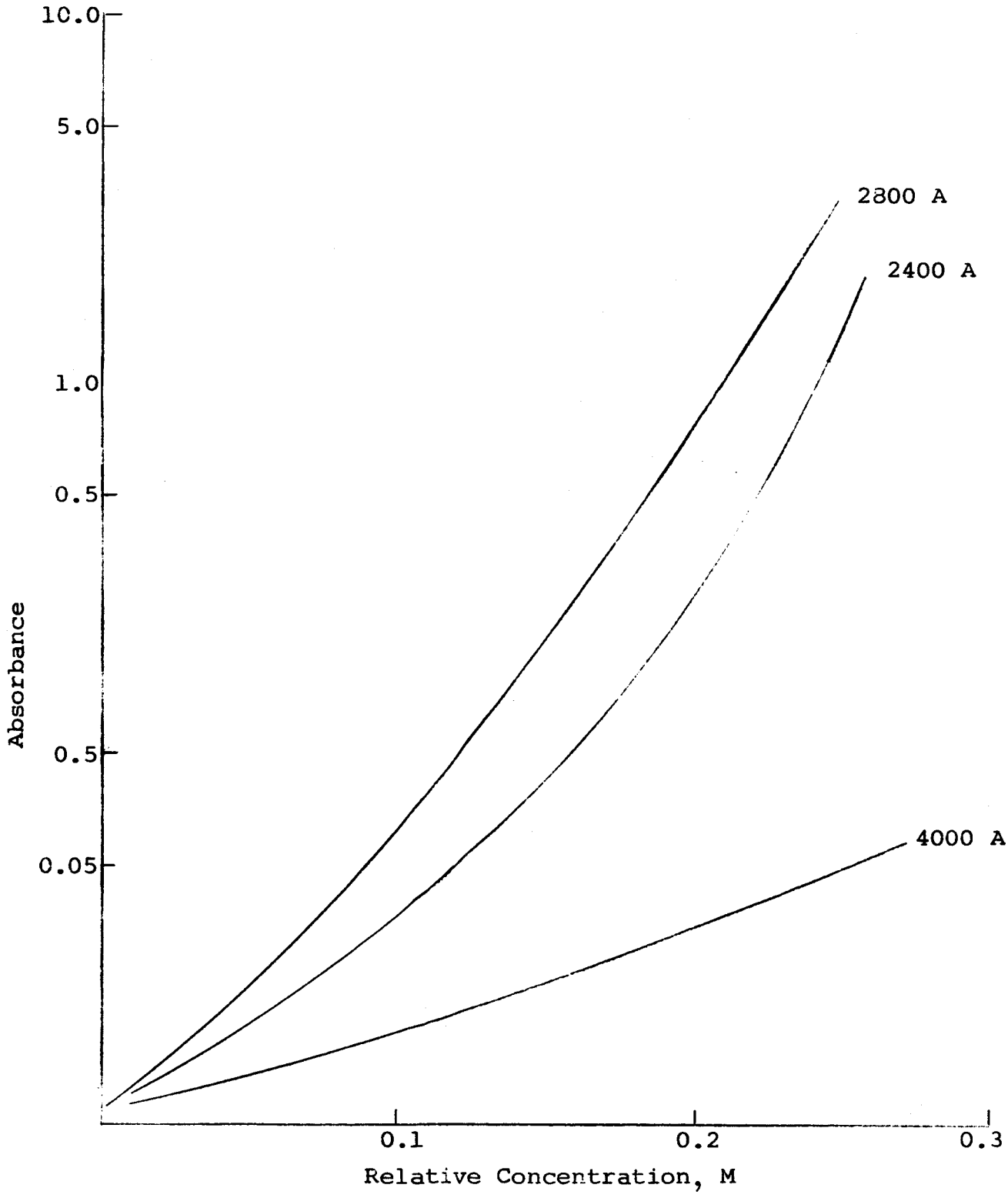

FIGURE 4

ABSORBANCE OF COATINGS OF SILVER CHLORIDE SUSPENSIONS IN GELATIN

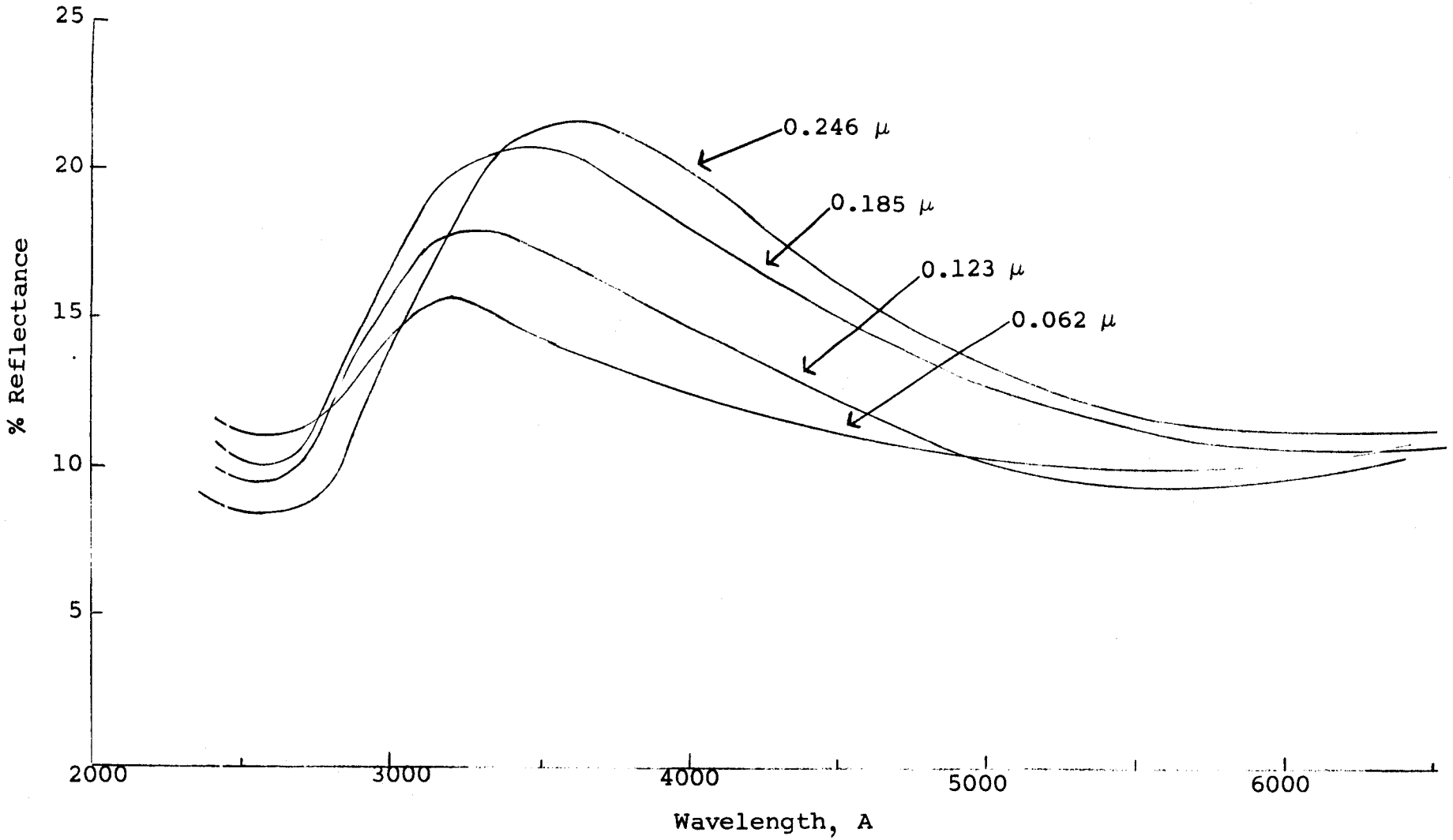

FIGURE 5
REFLECTANCE OF COATINGS OF SILVER CHLORIDE SUSPENSIONS
IN GELATIN AT VARYING CONCENTRATIONS (RELATIVE TO $MgCO_3$)

The reflectance of the coatings is plotted in Figure 5. The reflectance inverts with respect to the concentration in the ultraviolet region at approximately 2800 A, and the maximum reflectance shifts toward larger wavelengths as the concentration increases. It is postulated that this is due to interaction of the particles in the more concentrated coatings; they are effectively acting as larger particles. The light stability of the coatings during these measurements was not a problem.

V. LOGBOOK AND PERSONNEL

Data are recorded in Logbook C14085. Personnel who contributed to the work are Dr. Sidney Katz, Mrs. Jean Allen, and Messrs. Victor Raziunas and John Stockham.

Respectfully submitted,

IIT RESEARCH INSTITUTE

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GAZ:jmh
11/13/63

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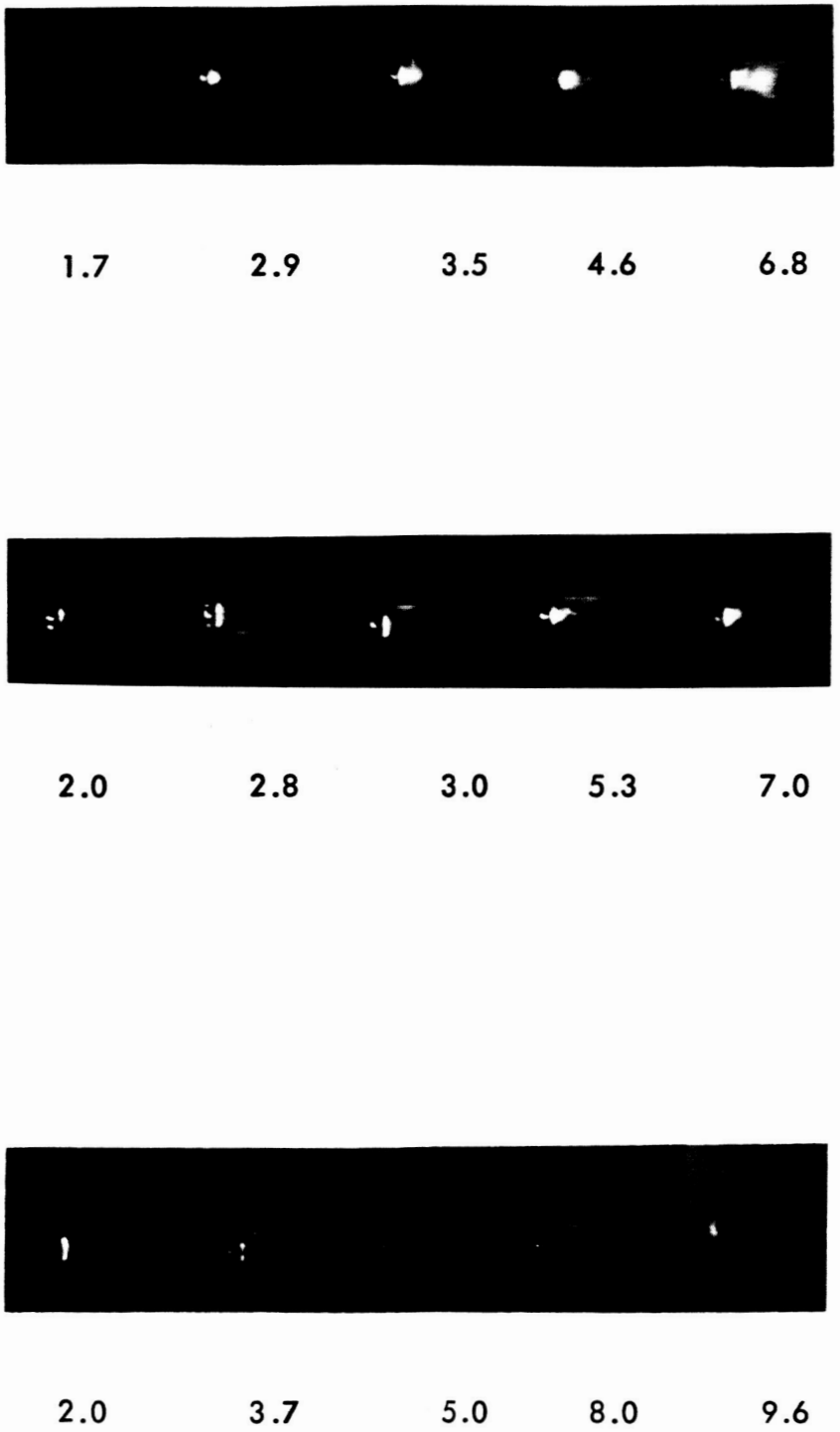
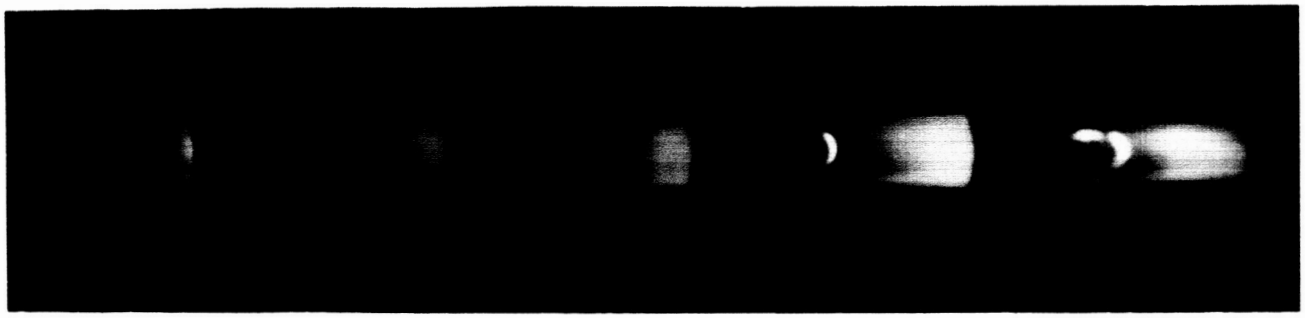


Fig. 1: INITIAL FORMATION AND FLOW OF THE PLASMA STREAM.

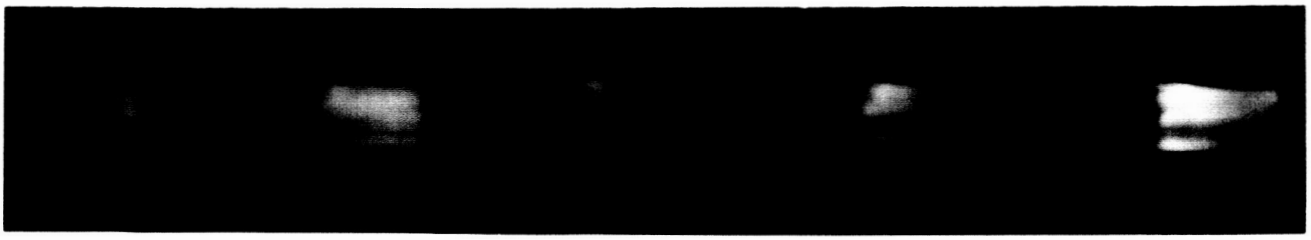
For gun capacitor voltages of +7 KV, -7 KV, and -5 KV, these sequences show the first 35 cm of flow beyond mouth of the gun. Under each picture is the number of microseconds from initiation of the gun discharge until the application of the 0.160 μsec image converter gate.



4.2 4.7 4.9 5.9 6.7

Fig. 2: PLASMA FLOW NEAR COIL WITHOUT MAGNETIC FIELD.

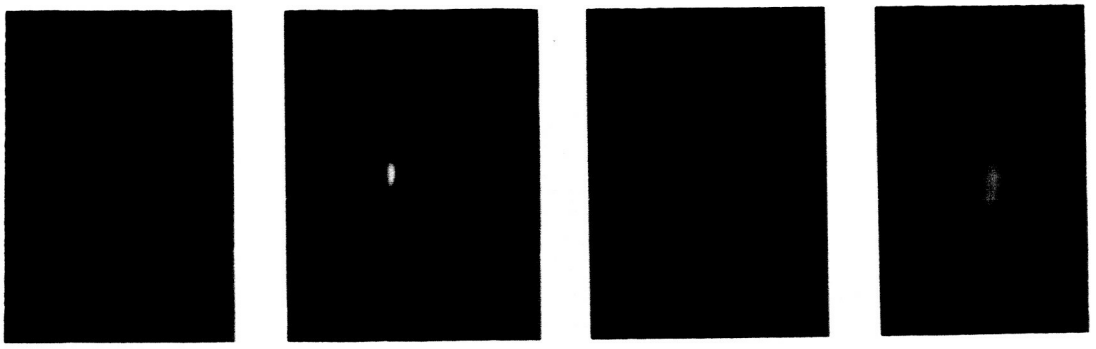
The time interval from initiation of gun discharge until opening of the 0.160 μsec image converter shutter is shown below each picture. The 11.5 by 27 cm field of view is through a 11.5 wide cut in the aluminum liner which is in place for these pictures.



5.6 6.2 6.6 7.3 7.7

Fig. 3: PLASMA FLOW WITH MAGNETIC FIELD.

The operating conditions are similar to those of Fig. 2, but the pictures are taken during the flat portion of the first maximum of the sinusoidal magnetic field. The coil current is 240,000 amps.



5.2 μsec 5.6 μsec 6.4 μsec 7.4 μsec

Fig. 4: PLASMA FLOW AGAINST MAGNETIC FIELD WITHOUT ALUMINUM LINER.

The flow is from right to left and is viewed from above the equatorial plane. The white dot seen in the pictures is the front of the field coil. The field of view is now 20 cm (the i.d. of the glass cylinder) by 28 cm. The time interval from initiation of the gun discharge until opening of the 0.160 μsec image converter shutter is shown below each picture. Note curvature of the plasma front.

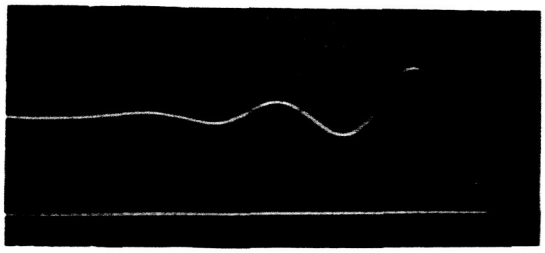


Fig. 5: Magnetic probe measurement of field near the coil without firing plasma gun (upper trace). The lower trace is the response of a photomultiplier placed 24 cm "upstream" to observe arrival of plasma. (Trace sweeps right to left at 10 μsec/cm.)

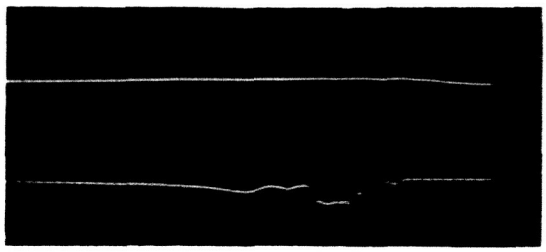


Fig. 6: Magnetic probe measurement near the coil when plasma is injected with no magnetic field. The lower trace is the photomultiplier's observation of the plasma flow.

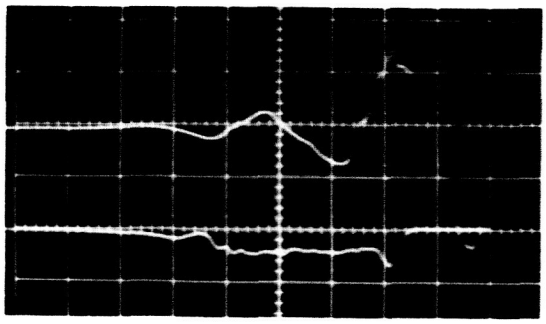


Fig. 7: Magnetic probe measurement of the magnetic field and its compressional increase due to the impinging plasma stream. The photomultiplier's upstream observation shows the plasma arriving during the flat portion of the second half cycle of the magnetic field.