INVESTIGATION OF SURFACE UNIFORMITY OF A THIN SILVER WEDGE BY THE RECORDING INTERFEROMETER

THESIS FOR THE DEGREE OF M. S.

Ray L. Griffith

1934

Interferometer

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I wish to express my sincere appreciation to Dr. C. [illegible]. Chamberlain for his gracious assistance and personal interest as I worked on this thesis. I also wish to thank Professor C. [illegible]. Chapman for his cooperation and to Dr. C. D. Haus and Mr. Kenneth L. Warren for their helpful suggestions.

Ray L. Griffith

May 28, 1934.

The object of this thesis is to show how surface uniformity can be investigated by means of the Recording Interferometer; how an interferometer can be made to record its own number of bands by the addition of any spectograph, and to show the application to successive measurements of distances in the order of a fraction of a light wave.

CONTENTS

INTRODUCTION

Nature has placed limitations on the ability of the human eye to distinguish objects of magnitudes of less than a half a wave-length of light. With all objects that are less than this limit, interference and diffraction of light plays such havoc that objects may appear to be anything but what they actually are. All lens systems from the simplest telescope to the most complicated microscope are limited by their inability to resolve objects in the order of one-half a wave-length of light. Thus our best compound microscopes, when used with blue light, are limited to one-half a wave-length of blue light or about .00002 cm. This is equivalent to approximately a fifty-thousandth of an inch. Many times in research work it is necessary to go beyond this limit and work in the order of a small fraction of a light-wave. In this case, an interference system is used which can measure in the order of a millionth of an inch.

When a thin film is placed under the microscope it will show practically nothing, even the small scratches on its surface will become indistinguishable. Any mechanical means of measuring this thin film is out of the question because precision measurements by this means is in the order of ten-thousandths of an inch. Therefore, our two most common means of measurement are much too large to be of use on these films. The method of investigating the surface of a thin film then resolves itself into an optical problem. The best means is by an interference system.

The most common and perhaps the simplest of the instruments available is the Michelson Interferometer or some slight modification of it. Nearly all interferometers are based on some form of the original Michelson instrument. The theory of the instrument used in this thesis can best be explained by a description of the Michelson Interferometer.

A BRIEF SURVEY OF THE [illegible]

<u>Michelson's Interferometer:</u>

All interference systems are based on the following requirements:

1. Light from a single source split into two parts.
2. Each part led over different paths.
3. Reuniting the beams at a small angle.
4. Generally a monochromatic source of light.

Michelson was the first to give us an interferometer in a convenient form to use. Briefly, the instrument shown in figure 1, consists of a half silvered

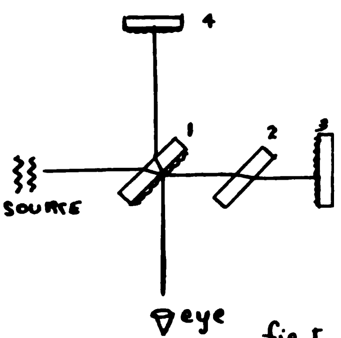


fig I

optically flat plate (1), a companion plate an exact duplicate of (1) as shown at (2); two full silvered mirrors, 90° apart, also made of optical glass as shown at (3) and (4). Light from a broad source is refracted at the half silvered plate, 50% of is transmitted, 50% is reflected and refracted to the full silvered mirror (4) which totally reflects the beam back to (1) where it is again refracted, 25% is transmitted in the direction of the eye and 25% reflected and refracted back to the source and is lost. The original 50% of the light transmitted passes through the compensating plate (2) to (3) and back on itself to (1) where 25% is reflected to the eye and 25% transmitted to the source which is lost.

All the conditions for interference have been fulfilled, the source has been divided into separate rays and led over separate paths to be reunited at a small angle. If the two paths are the same in length, the two beams will unite constructively and produce light. If the paths differ by half a wave-length of light, they then combine destructively and produce darkness. In general, when ever the difference in path is a multiple of whole or half wave-lengths, constructive or destructive interference, respectively, will take place. The purpose of the compensator plate is that each beam passes through glass three times before reaching the eye, thus making the paths optically the same.

Looking into the instrument one will see mirror (4) direct and the image of mirror (3) will appear to be superimposed on it. For purposes of analysis it is easier to think of both mirrors producing images, and being images they can be moved through each other as well as before or behind each other. This really constitutes an air film that can be thickened or thinned by moving one of the end mirrors. If the two images are parallel, the eye will see concentric circles called Fizeau Circular Fringes. The center of these circles are at the foot of the perpendicular

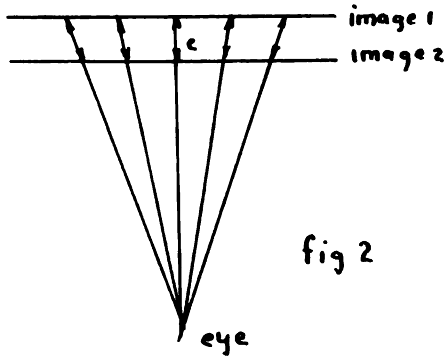


fig 2

from the eye to the images. Because the distance to the eye varies as one travels from the foot of the perpendicular to points away from the center, there will appear alternately light and dark circles as the distance varies by a whole or half wave-length. By moving one of the mirrors to change the thickness of the air film, the circles move towards or away from the center, depending upon the direction the mirror is moved. Fig. 2.

In general practice, the mirrors are at a slight angle to each other and the images appear as in figure 3, if both beams were of the same length. At the point where

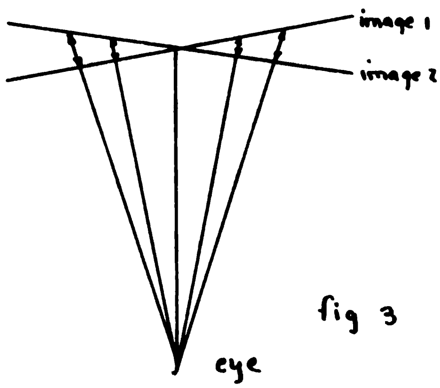


fig 3

the two images cross would ordinarily be in phase to produce light, but since one of the beams is refracted from glass and the other is reflected from silver, there is a half wave-length shift and the center line appears black instead of light. This is of little consequence, however, since the phase shift is consistent for all readings, and the net results or effect is the same. On each side of the center line will be lines or bands that tend to become more curved as the images are brought more nearly parallel. These lines or bands are really sections of circles with their centers somewhere out in space to the right or left of the field. It will be noted that moving the images further apart does not change the angle between them, and the number of bands in view will always remain the same as long as this angle remains fixed. The only effect noted as the images are separated will be the band moving across the field of view. These bands are generally referred to as Fizeau bands. More bands can be crowded in the field by increasing the angle between the images.

The Michelson instrument is used with a monochromatic source such as a sodium flame. The thickness of glass of any other transparent object to be measured is placed in one of the beams thereby introducing a change in optical path. Often transparent specimens are mounted on optical glass, in which case it is customary to insert a duplicate plate without the specimen, in the other beam at right angle. The two plates of glass being the same, one in each beam, has introduced the same change in each path making it unnecessary to correct for the glass.

The Compound Interferometer:

For research work it is often more convenient to have parallel beams as shown in figure 4. Here the specimen is mounted on one-half of the optical plate. In one beam there is glass alone, in the other, glass and the specimen. This later version of the Michelson Interferometer was developed by Dr. C. [illegible] Chamberlain at Columbia University in 191[illegible], while seeking a means of measuring the Radius of Molecular Attraction. Dr. Chamberlain added one very important feature, the ability to compound the effect of the ordinary Michelson instrument. Instead of reflecting the beam back directly on itself, the large end mirror

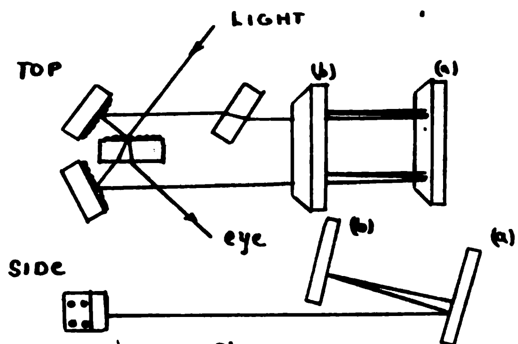


fig 4

is tilted slightly about the center horizontal axis, and the beams are reflected to a second mirror (b) figure 4. If the rays meet (b) normal, they are turned back over the same path, but mirror (b) may also be tilted about its center horizontal axis to reflect the rays to mirror (a). Thus the beam trapped between mirrors (b) and (a) may be reflected back and forth many times until it finally meets one of the mirrors normal and is turned back on itself. If the object being measured is placed between these two mirrors, the light will pass through the object twice when used as the ordinary Michelson instrument, or four times if reflected one to (b), or six times if reflected from (b) to (a) and then back on itself, and so on for each reflection between the two mirrors. When the light passes though the object only once as in the Michelson instrument, the instrument is said to be in the first order. If the light is reflected and passes though four, six, eight, etc., times the instrument is said to be in the first, second, third or fourth order. Each order or compounding tends to increase the sensitiveness over the usual Michelson arrangement by two in the second order, three times in the third order, four times in the fourth order, etc. Thus a band shifts in the first order would appear as two band shift in the second order and a three band shift in the third order.

What has been said about interference in monochromatic light is also true in white light, and if the difference of path of the two beams is very, very small or zero and the images are nearly parallel, white light fringes will appear, the center band being the only one black. The bands on each side of the center will be colored, the color of the band depending upon the position in the spectrum where the difference in the path of the two beams is half a wave. At the best only four or five fringes can be seen in white light since when the movement of the air film is slightly increased, more colors will be in condition to interfere, all of which will be superimposed on the field and the effect of the individual lines being so much weaker in comparison with the strong background of white light, will not be seen and the field will appear strongly illuminated but with no bands showing. Since white light fringes appear only when the path difference is small, practically all the work in interferometry has been carried out using monochromatic light.

Monochromatic light has the disadvantages of being weaker than white light, it is often hard to obtain photographs without long exposures, and it is sometimes difficult to obtain a good source of monochromatic light. On the other hand, white light is extremely easy to obtain, only requiring a small incandescent lamp such as an automobile headlamp.

The Recording Interferometer:

Perhaps the most valuable contribution to the use of the interferometer is the converting the ordinary Michelson or Chamberlain Compound Interferometer into a Recording Interferometer using white light. This instrument was perfected by Dr. C. [illegible]. Chamberlain at Michigan State College in 1926, and a commercial instrument is now being built which will soon be available for industrial purposes.

If any interference system is carefully adjusted for circular fringe bands by making the mirrors parallel and the path difference rather small, white light can be collimated and passed through the interferometer and focused on the slit of a spectrograph or spectrometer. This will separate the white light into the spectrum and show lines that are images of the slit, at points in the spectrum where-ever the path differences of the two beams in the interfer-ometer differ by a half a wave of light of any color. Unless the air film is zero, it would be expected that in white light there would be several positions in the spectrum that for a particular color or wave-length the difference in path would be just half a wave, and would show a dark band in the spectrum at this color. Also, increasing the path would show more lines, or decreasing the air film would take out lines thus giving a direct relation to the thickness of the air film by the number of bands in the field. These lines or bands are called recording bands. This is the fund-amental principle upon which the Recording Interferometer is based.

Calibration of the Recording Interferometer:

The calibration of the instrument is based on the fact that whenever two beams destructively interfere a black line appears in the spectrum at the point corresponding to the wave-length of the beams.

$$\text{Then: } 2e = (n - 1/2)\, L \qquad (1)$$

Where: 2e = the optical path
L = wave-length of interfering beams
n = any integer

If the wave-length of any two of these lines are known, then the distance of the air film can be expressed in terms of the number of bands between the two known lines.

Let L' and L" be the known wave-lengths
n' and n" be the corresponding integers

$$\text{Then: } 2e = (n' - 1/2)L' \quad \text{or} \quad 2e/L' = n' - 1/2 \qquad (2)$$

$$2e = (n'' - 1/2)L'' \quad \text{or} \quad 2e/L'' = n'' - 1/2 \qquad (3)$$

Subtracting (3) from (2):

$$2e(1/L' - 1/L'') = n' - n'' \qquad (4)$$

This is the general equation used with recording bands. e is the actual thickness of the air film measured. n' -n" is the actual number of bands between the two known wave-lengths.

INVESTIGATION OF THE [illegible] UNIFORMITY OF A SILVER WEDGE BY A CORNING BAND

<u>Making the Silver Wedge:</u>

A thin silver wedge was made by placing two optical plates as shown in figure 5. These plates had been cleaned very carefully with acid and thoroughly washed with distilled water of room temperature. Standard silvering solution of the Rochelle Salt process was used. The solution was poured at the corner nearest the wedge and shot almost instantly between the plates. The deposit started rather rapid at the point of the wedge and gradually deposited in the thicker part. Care was taken not to jar or move the plates. Before enough of the silver deposited to bond the two plates, they were separated so as not to ruin the wedges. The top plate was used in later measurements. With a straight edge and a dull knife part of the silver was removed beyond a certain point of the thick end, leaving a true wedge varying from zero thickness to some definite thickness at the base of the wedge.

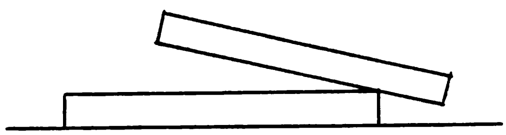
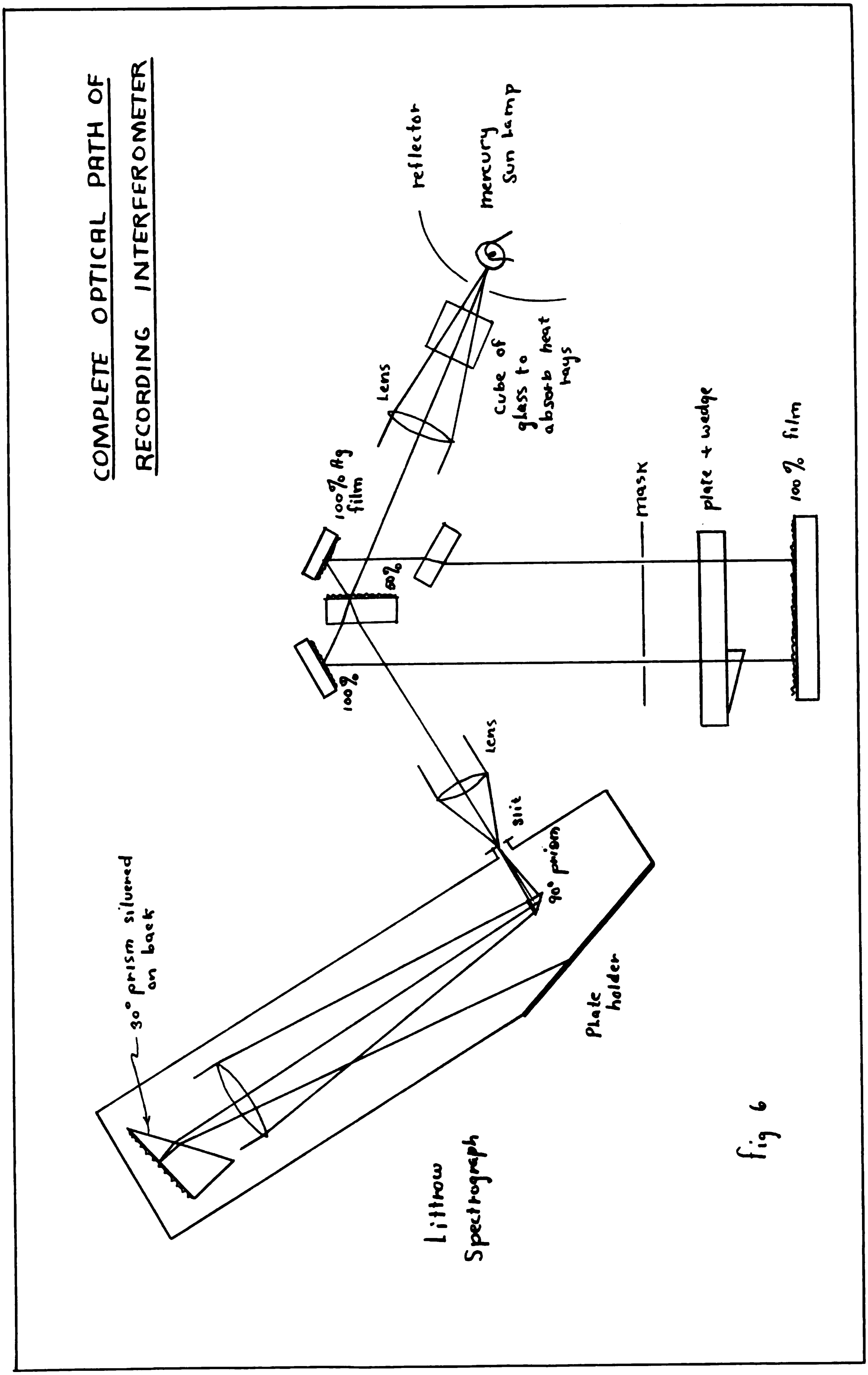


fig. 5

Due to the fact that the silver cut down the intensity than obtained in the interferometer, the wedge was changed to a transparent one by converting to AgI. A small crystal of Iodine was placed on the wedge and pushed gently over the surface changing the silver to silver-iodide.

Equipment Used:

A Universal Compound Interferometer with parallel light beams was used. A Littrow Quartz Spectrograph was used for the dispersion system, the light from the interferometer being focused on the slit by a lens. After trying several light sources, it was found that a Mercury Sun Lamp such as manufactured by General Electric served very satisfactory, as the tungsten filament furnishes an intense source of white light while the mercury in the lamp gives standard lines in the spectrum. Thus in one operation, bands and the standards were recorded by a photographic plate. The reflector of the lamp was removed and turned around to act as a shield against stray light and also to protect from sunburn when working with the instrument. The lamp was placed directly behind the hole in the center of the reflector and a cube of glass placed before the hole to absorb some of the heat rays of the light. The light was collimated by a lens before reaching the interferometer. Complete optical path is shown in figure C.



COMPLETE OPTICAL PATH OF RECORDING INTERFEROMETER

fig 6

Adjustment of the Instrument:

The angles of the two small mirrors were set at approximately 67° by a small triangle cut from cardboard. The light was adjusted such that the two reflections from the small mirrors were seen in the large end mirror near the bottom and outer edge. One of the mirrors was covered to see that the two rays were not crossed, as it is very important that these rays be parallel. Mirror (a) was tilted to see if the reflections seen on mirror (b) moved up parallel. The light and small mirrors were adjusted until they did. The final adjustment was done in sodium light. The usual method is to place a small obstacle such as a pin in the path of the light to the interferometer. Two images of the pin will be seen, one from each beam. It is necessary to rotate one of the small mirrors slightly until the two images superimpose. On the back of the small mirror is two screws, one to turn the mirror about a vertical axis, and the other to tilt the mirror about a horizontal axis. The tops of the two images of the pin was made to coincide by moving one of these screws. Bands now appeared in the field and the number could be varied by turning one of the back screws which rotated the mirror slightly. The other back screw tended to straighten the bands so that they could be made to appear either in a horizontal or vertical position. The carriage screw that moves the entire mirror backwards or forwards was turned in such a direction as to cause the curved bands to straighten up. That is, so the bands move out of the field towards their center. This is literally moving the center out to infinity at which place the bands in the field appear straight, as these bands are really small sections of great circles with centers at infinity.

As this position was approached the white light was turned up and bands looked for off to one side out of the field, by means of a grating. When these bands first occurred, which are white light fringes, they were very carefully brought into the field by turning the large carriage screw. These white light fringes now appeared in the field without the aid of the grating. The screw was backed off slightly such that the white light fringes appeared a little ways out of the field when viewed through the grating. Sodium light was now turned up and the instrument very carefully adjusted for circular Fizeau bands by making the air film with parallel sides. A small fraction of a turn on the back of the small mirror was enough to bring the circular bands in view. <u>It is very, very important that circular bands be obtained to produce Recording Bands. No Recording Bands can possibly be seen unless the instrument is adjusted</u>

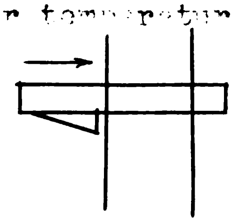
for circular Fizeau bands.

The Mercury Arc Lamp was now substituted for the sodium burner, and for convenience a small hand spectroscope was used to view the recording bands which appeared in the field when viewed through this spectroscope. The screw on the back of the small mirror was very carefully adjusted for maximum intensity. When the large carriage screw which moves the small mirror was moved bands could be put in or taken out of the field. More bands come in at the blue end than go out of the red, thus always leaving some in the field except when the paths are exactly equal and the air film is zero thickness. These recording bands are very sharp compared with Fizeau bands. With five or six bands in the field the hand spectroscope was removed and the light focused by a lens on the slit of the Spectrograph. The recording bands could then be viewed with a ground glass at the place where the photographic plate goes. The slit was made as narrow as possible without cutting down the light appreciably.

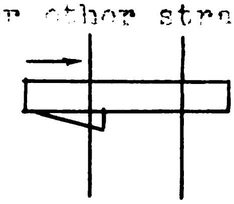
Exploring the Surface of the Silver Wedge:

To explore the surface of the silver wedge two narrow slits about a millimeter were cut in a sheet of black paper and mounted such that it acted as a mask. The two slits were placed on the platform in front of the large mirror so that a slit came in the center of each beam and was in a vertical position. It was necessary to use a slit for each beam to keep the intensity of the two beams nearly equal. The plate with the silver-iodide wedge was placed on a strip of paper which had lines ruled a millimeter apart and set on the platform behind the mask. The glass plate was large enough to be in each beam, thereby introducing the same change in each. No correction was then necessary for the glass. The wedge was in one of the beams only, and by moving the plate a millimeter at a time the slit of light from the mask could cover the whole surface in the course of many settings.

Photographs were first taken with only glass in both beams. Then a series of photographs were taken as the plate was moved a millimeter at a time so that the slit of light traveled from the thick part of the wedge to and the point and back onto the glass, thus starting and ending with the glass. This gave a splendid means of correcting for temperature or other strains that took place during the



1st Photo
glass only

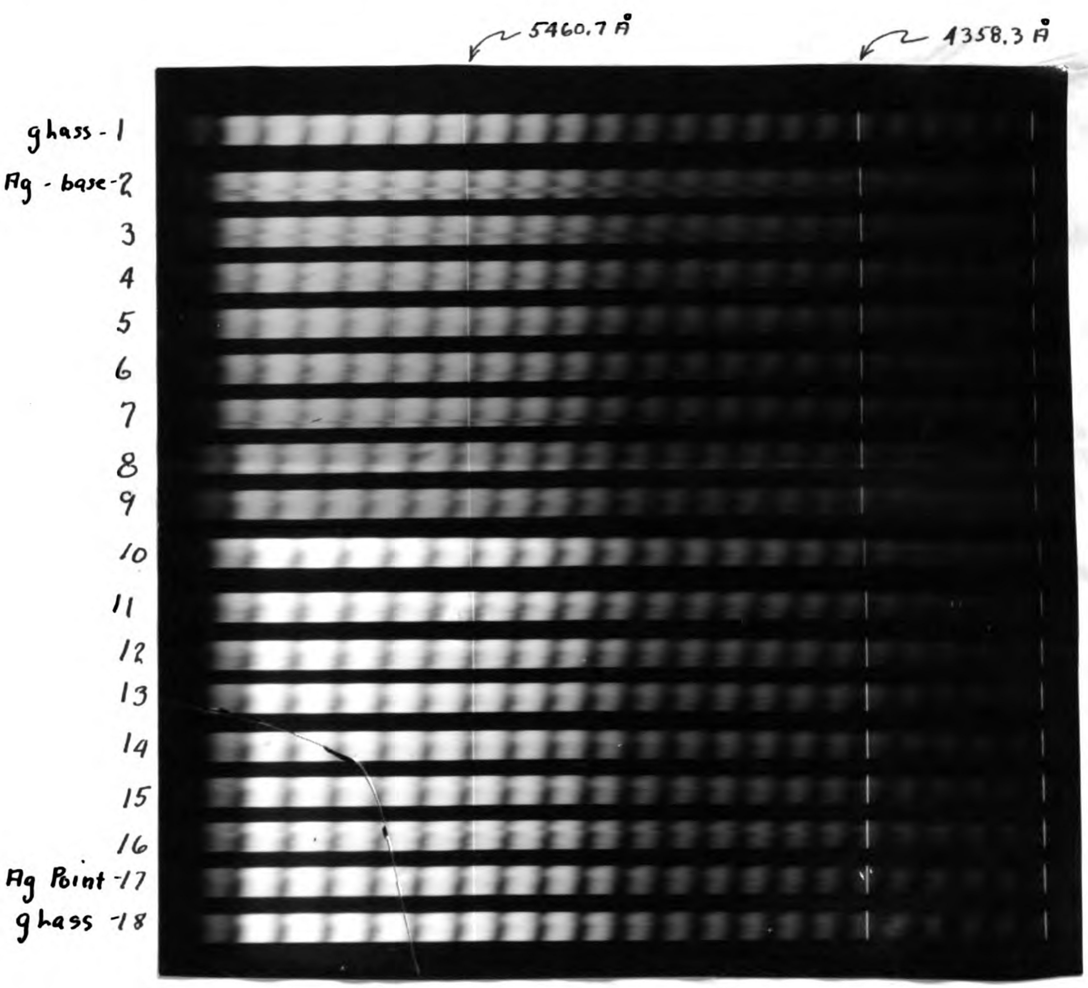


Series of photos
glass + wedge

process of taking the pictures, since the difference in the number of bands between fiducial marks for the start on glass to the ending on glass must be due to temperature or strains. In the final analysis it was found necessary to make this correction.

For the Littrow Spectrograph, using Pancromatic plates, a slit opening of 3.0 and a time of 2 1/4 minutes for each photograph was about right. All photographs of Recording Bands were masked down at the slit so that the pictures were obtained on two plates.

The following picture is a composite print taken from the plates used in calculation.



Determining the Number of Receding Bands:

The number of bands between fiducial marks was determined by placing the plate on a comparator, which reads in thousandths of a millimeter. The beginning and the end of the band before the fiducial mark was read on the comparator. Also the position of the fiducial mark and the beginning and the end of the band following the fiducial mark was read. This was done for the other fiducial mark also. From this data the center of each band was determined, and the distance between the two bands computed, from which the percentage of a band that moved past the fiducial mark was determined. Likewise for the other fiducial mark. The total number of bands between the two marks were counted and added to the fractions of a band at each end. See tabulated data.

Determining the Thickness of the Wedge:

The effect of the silver-iodide was to increase the thickness of the wedge about four times. The actual relation between the thickness of silver D and the thickness of the silver-iodide e is:

$$D = \frac{Ag}{AgI} \times \frac{d'}{d^3} e$$

Chem. equiv. of Ag	107.9
" " " AgI	234.8
Density of AgI = d'	5.602
" " Ag = d''	10.55
Index of refraction AgI = n'	2.246

$$D = \frac{Ag}{AgI} \times \frac{d'}{d''} e$$

$$= \frac{107.9}{234.8} \times \frac{5.602}{10.55} e$$

$$= .2439 e$$

Since the Recording Bands actually give a measurement of the change in air path, it is necessary to correct for the different index of refraction of the AgI.

If e is the actual thickness of the AgI wedge as measured by the Recording Bands, and N is the number of times the light passed through the wedge, and n' is the index of refraction of AgI, then

$$D = \frac{.2439}{N(n' - 1)} e \qquad (5)$$

Since $n' = 2.246$

$N = 2$

$$D = .0978 e \qquad (6)$$

D = thickness of silver wedge

From the general equation developed (eq. 4)

$$2e(1/L' - 1/L'') = n' - n''$$

$$e = \frac{n' - n''}{2} \times \frac{L'L''}{L'' - L'}$$

$$D = .0968\ e$$

$$= \frac{.0968(n' - n'')}{2} \times \frac{L'L''}{L'' - L'}$$

$$= K(n' - n'') \text{ or a constant times a band shift} \quad (7)$$

Where $$K = \frac{.0968}{2} \times \frac{L'L''}{L'' - L'}$$

The two standard mercury lines used on the plate were:

$$L' = .000043583 \text{ or } 4358.3\ A$$

$$L'' = .000054607 \text{ or } 5460.7\ A$$

$$K = .0484 \times \frac{4358.3 \times 5460.7}{5460.7 - 4358.3} \times 10^{-8}$$

$$K = 1040 \times 10^{-8}$$

$$D = 1040 \times 10^{-8}\ (n' - n'')$$

Example: From Photograph No. 3
Total band shift = .232

$$D = (1040 \times 10^{-8})\ (.232)$$
$$= 2.42 \times 10^{-6}$$
$$= .00000242 \text{ cm}$$ average thickness of silver wedge at this point without temperature correction

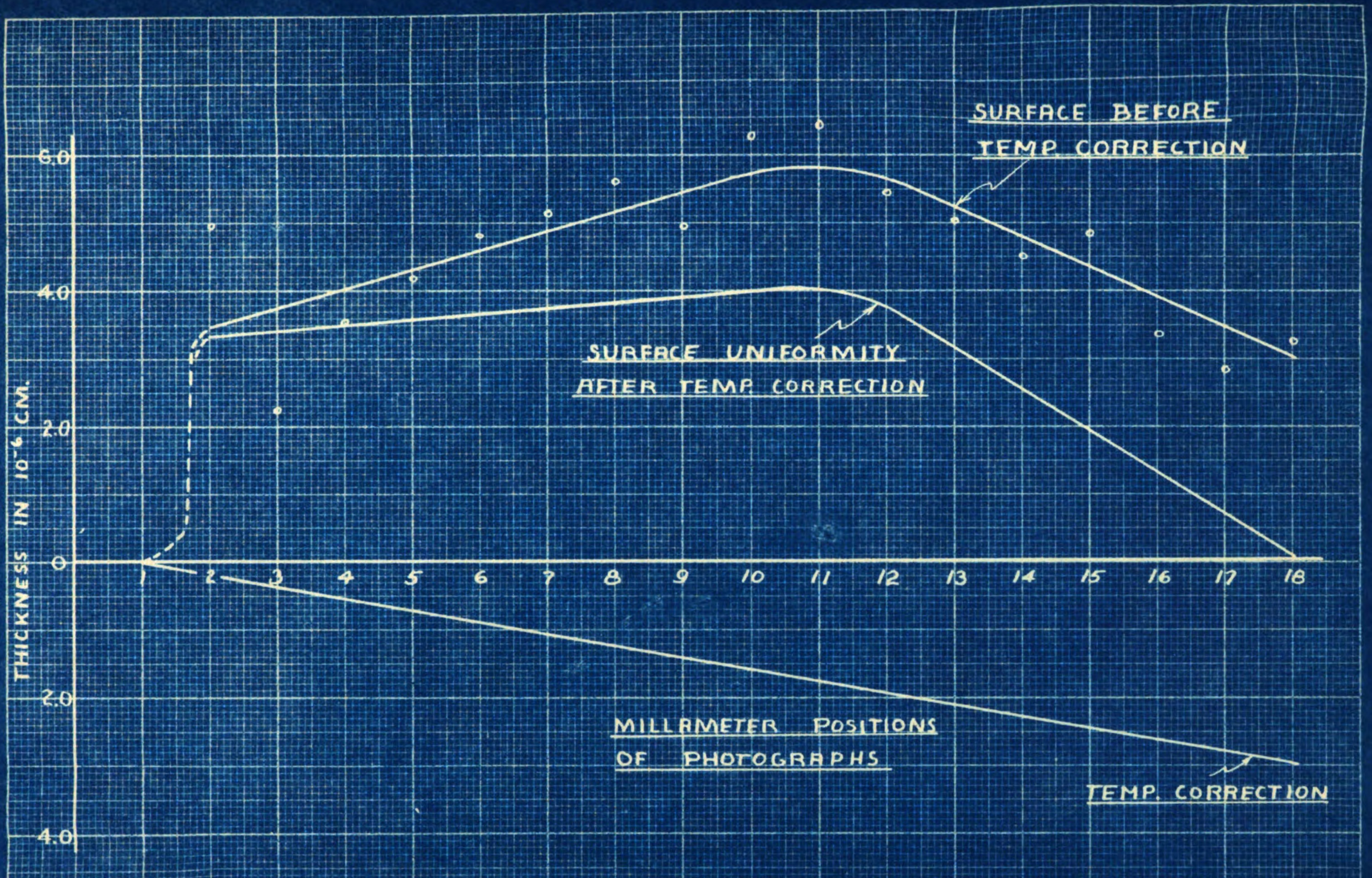
These values are really average values, since the slit tends to integrate the actual thickness over a distance one millimeter wide.

no.	STANDARD	BEGAN	END	CENTER	DIFF. BETWEEN CENTERS	DIFF. BETWEEN BAND + STD.	FRACTION OF A BAND	TOTAL NO. OF BANDS	NET BAND SHIFT	THICKNESS OF WEDGE 10^{-6} cm
1	78.024 129.261	75.861 80.507 123.272 128.689	79.542 84.297 127.975 133.318	77.702 82.402 125.624 131.004	4.687 5.380	4.378 3.578	.934 .665	11.599	0	0
2	77.435 128.447	73.727 78.337 123.366 128.865	77.231 82.775 127.965 133.474	75.479 80.556 125.665 131.169	5.077 5.504	3.121 2.782	.614 .505	11.119	.480	5.00
3	77.574 129.653	74.244 79.117 123.874 129.075	77.947 83.724 128.515 134.026	76.094 81.422 126.194 131.550	5.327 5.356	3.848 3.459	.722 .645	11.367	.232	2.42
4	79.014 130.064	75.370 79.978 124.778 130.505	79.014 84.662 129.508 135.015	77.192 82.320 127.143 132.760	5.128 5.617	3.306 3.457	.644 .615	11.259	.340	3.54
5	79.427 130.482	75.986 80.585 124.986 130.482	79.142 84.812 129.896 135.201	77.560 82.698 127.441 132.841	5.134 5.400	3.271 3.041	.637 .563	11.200	.399	4.15
6	79.148 130.207	75.211 79.965 124.683 130.207	78.754 83.666 129.304 134.784	76.982 81.815 126.993 132.459	4.833 5.502	2.667 3.214	.551 .584	11.135	.464	4.83
7	79.333 130.415	74.990 80.548 125.322 130.718	78.939 85.145 130.142 135.301	76.964 82.851 127.732 133.009	5.887 5.277	3.518 2.683	.597 .508	11.105	.494	5.14
8	79.304 130.412	72.483 77.796 127.167 132.764	76.606 81.183 132.010 138.286	74.544 79.495 129.588 135.525	4.955 5.937	.195 .824	.0393 .0139	11.0532	.546	5.67
9	79.080 130.137	72.864 77.736 127.182 133.145	76.694 81.251 132.227 137.893	74.779 79.493 129.704 135.519	4.714 5.815	.413 .433	.0875 .0744	11.1622	.477	4.96

NO.	STANDARD	BEGAN	END	CENTER	DIFF. BETWEEN CENTERS	DIFF. BETWEEN BAND + STD.	FRACTION OF A BAND	TOTAL NO. OF BANDS	NET BAND SHIFT	THICKNESS OF WEDGE 10^{-6}cm
10	90.930 137.978	86.600 91.557 132.655 138.290	89.875 95.309 137.597 142.990	88.237 93.433 135.116 140.640	5.196 5.524	2.503 2.862	.481 .518	10.999	.600	6.24
11	90.579 136.912	86.248 91.072 131.674 137.233	89.582 94.761 136.252 142.024	87.915 92.916 133.963 139.628	5.001 5.665	2.337 2.949	.467 .520	10.987	.612	6.36
12	91.330 136.697	87.952 93.148 131.926 137.784	91.610 96.713 137.144 142.760	89.781 94.930 134.535 140.272	5.149 5.737	3.600 2.162	.699 .376	11.075	.524	5.45
13	91.590 137.342	88.774 93.699 133.211 138.896	92.635 97.284 138.143 143.706	90.404 95.491 135.677 141.301	4.787 5.624	3.901 1.665	.814 .296	11.110	.489	5.04
14	90.985 137.031	88.141 92.883 132.171 138.105	91.749 96.640 137.506 143.064	89.945 94.761 134.838 140.584	4.816 5.746	3.776 .2193	.784 .381	11.165	.434	4.52
15	91.592 136.759	89.130 94.246 133.117 138.611	93.088 97.935 137.935 143.394	91.109 96.090 135.526 140.947	4.981 5.421	4.498 1.233	.903 .227	11.130	.469	4.88
16	91.600 137.323	85.038 90.200 133.529 139.113	88.841 93.492 138.530 144.201	86.939 91.846 136.029 141.657	4.907 5.628	.246 1.294	.0501 .229	11.279	.320	3.33
17	91.792 137.051	86.031 90.518 133.687 139.327	89.467 94.106 138.615 144.403	87.749 92.310 136.151 141.657	4.561 5.506	.518 .900	.135 .193	11.328	.271	2.82
18	91.932 134.894	86.442 91.220 131.989 137.734	90.035 94.756 137.073 142.590	88.238 92.988 134.506 140.162	4.750 5.656	1.056 .386	.222 .0682	11.290	.309	3.21

Temperature Correction and Resultant Curve:

The thickness at the various positions as determined from the photograph of the bands were plotted and an average curve drawn. Since the last point which was taken on glass did not agree with the first point which was also taken on glass, this difference was due to temperature change. All photographs were timed at two and one-half minutes, also the time between exposures was practically the same. Under these conditions it was as-sumed the correction was a function of time only, that is, a straight line. The correction at any one point depends upon the time elapsed since the first picture. Applying the correction to the average curve gave a true picture of the surface.



SURFACE UNIFORMITY OF A THIN SILVER WEDGE

CONCLUSION

It is seen that the curve shows a decided flat portion. The following is an explanation of how the flat portion was formed. When the wedge was made the silver deposited first at the point as shown in figure 7. At the thicker part of the wedge the silver deposited in a flat layer but sufficient silver had not deposited to bond the top and bottom plate as at the point. This left a space filled with silver solution that had not deposited at the time plates were separated. It so happened when the silver was scraped off with the cell knife to form the base, this position was some distance from the point and well along on the flat portion.

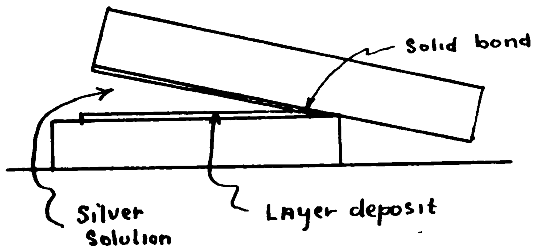


fig. 7

When the companion plate or bottom plate was iodized, real fine lines quite close together were noticed running parallel with the edge of the wedge. These lines seemed to have definite structure when viewed under a magnifying glass and suggests the possibility of definite steps or layer structure of the wedge. The color of the lines varied as did the color of the wedge at the various thicknesses.

While the Recording Bands gave an integral effect due to the width of the exploring slit, they did not resolve these small colored lines, but they did, however, show the general surface uniformity of the wedge. Perhaps under extremely favorable conditions, and working with the higher orders of compounding and a very narrow exploring slit, it maybe possible to resolve still further and determine the nature of this line structure.

The value of Recording Bands for the measurement of this wedge can be better appreciated when it is stated that the method gave a gradual means of measurement from zero thickness at the very point to the thickest point measured, which was .000005 cm or about two millionth of an inch.

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