NOTE.

Grayson's Photomicrographs of his Rulings.

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PLATE XIV.

IN Grayson's beautiful photographs, exhibited at the Meeting on June 15, there are points of interest which deserve special notice. Pl. XIV. fig. 1 is a reproduction of his photomicrograph of his own 90,000 band, amplified 1930 diameters, and pl. XIV. fig. 2 is a copy of his enlargement of his own negative, in which the total amplification amounts to 7750 diameters.*

It will be apparent to everyone that by any examination of the photomicrograph (pl. XIV. fig. 1) it is quite impossible to determine the number of the lines Grayson has actually ruled in that band, because no one can tell where the ruling begins or where it ends. The band has been photographed by oblique light; on the left-hand side, at *a*, fig. 1, there is a very dark broad line, and next to it a thin faint one, and upon the other side of the band, at *c*, the lines fade off in three or four "ripples." In pl. XIV. fig. 2 Grayson has cut off the "ripples" at *d*.

It does not appear that these phenomena have been noticed by anyone, but, be that as it may, no account has been published either of them or of the source of their origin. Both the strong and the faint lines and the "ripples" owe their presence to oblique illumination in one azimuth, and are examples of the "diffraction phenomena" usually present with that kind of illumination. When ruled lines and diatomic striæ are examined by oblique light in one azimuth, two images can be produced (these are usually perceived at once, if not, a little special manipulation will always cause them to appear): the one image is that of the band or diatom unresolved, the other is that of the resolved lines or striæ, which seemingly float over the unresolved band. In brief, they are examples of Professor Abbe's absorption and diffraction images. Now the law in respect to these images is this: upon focal alteration the upper, or diffraction image will roll over the lower, or absorption image. (The word roll precisely describes this phenomenon, which is exactly like that of the roll-top of an escritoire: the lines appear to

* These amplifications refer to the reproductions which differ but slightly from the original prints.

shut up on one side and roll out upon the other.) When the focus is raised, the "ripples" always advance towards the incident light.

If, therefore, Grayson's photomicrograph was taken with the focus slightly raised, then the light was coming in a direction from right to left, but if depressed, in the opposite direction.

Whether the image of the lines or striae is stronger with an elevated or depressed focus will depend upon the correction of the object-glass, i.e. tube-length. Now let it be assumed that Grayson had such a length of tube that the stronger image was obtained with a slightly depressed focus, in which case the light will be coming from left to right, and the "ripples" running away from it, as at *c* (pl. XIV. fig. 1).

At *a* the lines will be rolling up, and it may be assumed that they have rolled up as far as the right-hand edge of the left-hand border of the absorption image of the band.

The absorption image of this edge will consist of a black line with its complementary white lines on either side of it.*

We have then an absorption black line of the border of the band, and on top, and rather to the right of it, the first diffraction line of the ruling; these two reinforce each other and originate the wide black line seen at *a* and *b* (pl. XIV. figs. 1, 2). The second line of the ruling falls on top of the white border of the absorption line, and, being weakened, appears as a faint line to the right of the broad black line.

At *c* (pl. XIV. fig. 1), on the other side of the band, are the "ripples," which are running off the lower right-hand absorption band, and the farther off they get the weaker they become. Also at *c* a rather wide white line followed by a blacker line may be detected; these are due to the influence of the border of the absorption band underneath them. I do not know the reason why the same phenomena on the right hand at *c* should be so much less pronounced than they are on the left hand at *a* (pl. XIV. fig. 1).

If a photomicrograph of ruled lines is taken by a direct axial cone of wide angle—that is, if the illumination is critical—the print will truly represent the original. Thus pl. XIV. fig. 3. represents one of a band containing 34 ruled lines; but the moment oblique light in one azimuth is used the image may no longer reproduce the original, the rate of ruling only excepted. In other words, while it is possible in an image of rulings obtained by oblique illumination to determine the rate per inch of the ruling,

* Another example of an interference phenomenon. These white lines are of necessity not easy to detect, because they are viewed upon a bright field, but they are often to be found in photomicrographs on account of their exaggerated contrasts. But even in the Microscope, when looked for with attention, they may be seen; at the same time, it is quite easy to overlook them.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

it is not always possible to correctly count the number of lines actually ruled.*

In practice it is important so to adjust the object-glass, either by collar or tube-length, that the strongest image is formed before the upper diffraction image has begun to roll.

Together with these photographs, Grayson has sent some additional examples of his beautiful rulings. They consist of a whole inch divided into hundredths, and they are ruled upon glass, quartz, silver film, and speculum metal.

The material which contains the ruling is in the first three attached to an ordinary 3 by 1 glass slip, but that upon speculum metal is attached to a 3 by 1 brass slip.

Pl. XIV. fig. 4, drawn to a scale of two-thirds, shows the manner in which they are mounted.

The rulings upon glass are similar to those upon ordinary micro-meters, but the lines are much finer in that ruled upon quartz. The lines on the metallic plates, when a strong light is thrown upon them, look like very fine incandescent wires.

These new rulings will be found to be useful for a variety of purposes; for example, shortly after their arrival a particular divided lens-micrometer was calibrated, which would not have been so easily done without their aid.

* Upon numerous occasions I have counted one more line with oblique than with axial large cone illumination, even when the adjustments were as perfect as possible. It would seem that to have one more line than actually exists is a normal condition of oblique light resolutions.