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I.—*Further Notes on the Monochromatic Illuminating Apparatus.*

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PLATE I.

SINCE my former paper on the subject I have made critical experiments with this method of illumination, the result being that I am so impressed with the advantages gained by the method that for all delicate work I intend to use it exclusively.

The accompanying diagrams illustrate wherein the efficacy of monochromatic illumination by prism dispersion excels that by absorption media. Fig. 1 shows the spectrum at the back of a 1/2-in. apochromatic objective, as seen when the eye-piece is removed, the object on the stage being a *P. formosum*, and the illumination a small cone of monochromatic red light, as in this case it is the spectra and not the object we require to examine.

The figure shows that we have a dioptric beam of monochromatic red light surrounded by four half-discs of red spectra of the first order.

Fig. 2 shows that, with precisely the same conditions, if we substitute monochromatic green light for the red we shall bring in the whole of the inner four spectra of the first order.

Fig. 3 shows the same thing with blue light substituted for green. We have now nearly half of the outer four spectra of the first order brought within the grip of the objective.

Fig. 4 shows the same object under the same conditions illuminated by so-called monochromatic blue light, obtained by absorption media. The red in the spectrum is still conspicuous. The blue edges of the four outlying spectra of the first order are apparently not brought so far within the grip of the objective. Theoretically they are of course precisely in the same position as in the other case, fig. 3, but practically they are not so conspicuous because of the existence of other kinds of light. Be that as it may, it stands to reason that they can have no possible visual effect in the presence of the much more powerful visual exciting rays such as orange and yellow-green.

[Mr. Haughton Gill has called my attention to the Zeltnow
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absorption medium,* which yields very approximately monochromatic yellow-green light (λ 560). It is a very simple and agreeable medium for visual work, and at the same time it greatly improves the definition of ordinary achromatic objectives. It must be remembered that as it only passes light low down the spectrum it will not increase the resolving power of an objective. The spectra are not quite so far in as those in fig. 2, and they are, moreover, tinged with blue on their inner, and with red on their outer edges.] †

I have not given a figure to show the spectra under the conditions of ordinary lamp-light illumination because it would be very similar to fig. 4; the only difference being that the dioptric beam would be white, the red would be a little brighter, and the blue a little dimmer than in fig. 4. In ordinary illumination the visual image is composed of neither the red nor the blue, but is that of rays such as orange and green. The advantage of the interposition of blue absorption media is due to the fact that the image-forming rays are sent higher up the spectrum, and consist of yellow and bluish-green. Any one carefully inspecting these figures will be convinced of the decided advantage gained by the use of monochromatic blue light. It will be noticed that I have adhered to Abbe's old nomenclature with regard to the spectra.

Before closing I will give a few words on the management of the apparatus and refer to fig. 7. The bull's-eye B will be found of great service as it requires great intensity of light to give a satisfactory illumination with the blue. The bull's-eye B should be attached to the lamp L, and the two first planos should be adjusted for parallel light before the third lens, the one remote from the lamp, is placed in position. In order to place the bull's-eye and lamp in a proper position with regard to the slit in the screen S, a piece of white card should be held in front of the prism P, and the light adjusted on it. It will then be easily seen if the prism P is evenly illuminated by the strongest part of the beam, and also whether the lamp and the bull's-eye are at a proper distance from the screen S.

The prism P should be of dense flint, as crown does not give sufficient dispersion. Very great care must be taken to place the prism P at minimum deviation. This is best accomplished by causing the spectrum to fall on the screen D when the lens R is turned out of the way. The prism is now rotated on its axis, and it will be seen that the spectrum on the screen D moves so that the angle D P S becomes either more obtuse or more acute. When the angle D P S is greatest, then the prism is at minimum deviation. The point where the centre of the spectrum falls on the screen D should now be noted. The lens R should next be turned into such a position that the spectrum may be in the same place as before. It is advisable to again move the prism, noticing particularly the slightest movements of the spectrum on the screen D to insure the deviation being at a minimum.

* See this Journal, 1889, pp. 133, 700.

† Added January 20th, 1892.

With regard to the management of the Microscope, the adjustments of the substage condenser for centering, &c., are precisely similar to those when a lamp is used in the ordinary way. In this case the slit in the screen D takes the place of the lamp-flame. When the condenser has been centered and the slit in the screen D brought to the centre of the field, the whole of the Microscope (or mirror if one is used) will probably require some movement before any light appears in the slit in the screen D. Even after the light has been obtained it will not be sufficient that the image of the lens R appears in the slit as in fig. 5, but it should be accurately centered by moving the whole Microscope until it is seen as in fig. 6.

I have placed another lens Q equal in focus to R on the other side of the prism P, which enables one with a more compact apparatus to obtain a spectrum the width of which equals the length of the slit, because the slits in the screens S and D are placed at the principal foci of the lenses, instead of double that distance as before. This plan also secures a more powerful illumination which enables work to be carried on deeper down into the blue. It is important that the screen D should be placed accurately in the focus of the lens R. It is a good plan to test the quality of the light by holding a white card between C and D before adjusting the Microscope. The size of the pencil after emergence from the screen D should be noted, and care should be exercised to see that the rays fill the back lens C of the substage condenser.

I have found that there is a considerable gain if the instrument is used direct, in other words the mirror abolished and the axis of the Microscope placed centrally in the pencil emerging from the screen D. To set this up is more troublesome, but by returning to my former wooden model it becomes easy. The whole apparatus, including the Microscope, stands on a plank of wood or base-board, but the lamp L, the bull's-eye B, the screen S, the lens Q, the prism P, and the lens R, are attached to another board which is pivoted on the base-board, and which is made capable of a slight rotation about the point P. The screen S and the second lens Q are fixed, and the prism P, which is on a turn-table, has a clamping screw so that it also may be fixed when the position for minimum deviation has been determined.

The lens R is as before capable of rotation about P, and it is likewise fitted with a clamping screw. The screen D is, however, fixed to the base-board on which the Microscope stands. The reason for this is that instead of moving the lens R in order to cause the movement of the spectrum across the slit in the screen D, which tends rather to disturb the adjustments, the whole board is rotated about its pivot P, and the light of the required colour brought in a line with the slit D. The whole apparatus is capable of being inclined to suit the inclination of the Microscope.