DEFECTS INCIDENT TO THE CONSTRUCTION AND USE OF RAPID COMBINATION LENSES.

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I SHALL confine myself to principles, not individual productions, as none of the cemented and so-called rapid lenses of the present day differ in any essential respect from each other or from that of 1866, which was evoked into being by a Munich professor on the requirement of the late Dr. Van Monckhoven. Already this lens bears from twenty to thirty different names, each dealer or each manufacturer introducing modifications in curves or form of mount to warrant the coinage of a special designation.

The distinctive characteristic of the objective is that it is *aplanatic*, or capable of being employed with full aperture, like a portrait lens; it is *rectilinear*, reproducing an object without curvilinear distortion; it is *symmetrical*, its front and back lenses being similar. The virtues of this lens are numerous and well recognised. There is, therefore, no need that I should treat of them. I therefore speak of certain defects met with occasionally in the productions of even the very best makers of this rapid and most useful class of lens.

A serious element of danger is to be found in the endeavours of some makers to produce lenses having what opticians term a greater intensity ratio than in those of others. The aperture of a lens is limited by the density of the glass of which it is formed. The large aperture of the modern aplanatic doublet is owing to its being formed of glass of much greater density than the ordinary optical flint and crown. The greater the density of the glass, the more may the aperture be increased, while still retaining those qualities for which this lens is famous, viz., good transmission of oblique rays.

But glass of this enhanced degree of density is unfortunately liable to decomposition with more or less rapidity. It seems impossible hitherto to get glass makers to prepare glass of great density in which, if it does not possess a well-marked degree of colour from the beginning, it soon acquires it by time, hastened by the action of light.

I have never yet known glass of this nature which, if ground into a lens, would not show a well-marked degradation of colour if removed from its tube, and pressed down upon a sheet of white paper. Rapidity of action obtained at such a cost is delusive. It is quite possible by employing flat curves to make a lens of safe glass which will define well in the centre of the field, and for a moderate distance away from the centre; but the definition invariably gives way rapidly towards the margin.

A well-known London optician once submitted to the notice of the Photographic Society of Great Britain, three lenses all of the same class—that now under consideration. One of them represented an aperture of about the eighth of its focus, a second a sixth, and a third a fourth. The first of these he had manufactured in the regular way. Knowing that at that time a continental maker of a justly celebrated name was introducing a lens reported to have greater illumination, I inquired why he allowed these quick-acting lenses to remain in abeyance. "Look here," he said, proceeding to a cupboard, from a shelf of which he brought down certain lenses which he handed me for examination; "these are the individual lenses I submitted to the Photographic Society. Observe how the glass has changed colour! Anticipating this, I would not risk my reputation by making one for sale." The discolouration was of a most pronounced nature. The deduction from this is obvious: Let those who possess lenses for which special claims for rapidity are made, be careful to keep them under cover from the action of light when not in use, as the glass of which they are made contains so much lead or analogous density-conferring bodies as will ensure serious discolouration, and consequent slowness of action before many years have elapsed. A lens having what may be considered a rather small aperture may work more quickly than one having an actual aperture larger in relation to its focus.

Lenses prepared by the very best and most fastidious manufacturers occasionally show this defect, and in two lenses ranking in precisely the same category, one may have it, and the other be quite free from the defect. This often arises, singular as it may seem, from the very perfection to which lens-testing has been carried in the better class of manufacturing establishments. A watch dial placed at a certain distance forms the test for definition, and when the central or axial definition of the lens has been found to be correct, then is the eye-piece (one of great power) by which the image is tested removed in a line strictly rectangular to the axis until the image of the dial transmitted obliquely is found in line. It is here where the skill of the examiner is displayed. He has to adjust the lenses so as to strike the golden mean between flatness of field and astigmation. It is a peculiarity of all combinations of lenses that if the field be made too flat, this quality is secured at the expense of astigmation, or the inability of the lens to transmit an oblique ray under circumstances giving absolute sharpness. For example: If the object to be delineated near the margin of the plate be a white cross upon a dark ground, it will be found that when the vertical lines are focussed to sharpness, the horizontal lines will be out of focus, while by racking the lens in or out, to ensure the sharpness of the horizontal line, the vertical one goes so far out of focus as in many cases to vanish altogether, the full aperture of the lens being employed.

With the most perfectly-corrected lens it often happens that when employed for out-of-door work, and used with a small diaphragm, there will be a distressing spot of luminousness on the centre of the plate. This is not peculiar alone to the cemented rapid lens, but was a well-recognized characteristic of the now unused globe lens. It is a peculiarity of almost every existing portrait combination, and sometimes also of single landscape lenses. When lenses are used in the studio for portraiture or groups, it is never seen but when a bright sky forms a portion of the included subject; then it is apparent, but mainly so only when there is a small stop, for the smaller the diaphragm the more pronounced will be the flare or ghost-spot.

I observe here, although slightly outside of my subject, that there is no lens made, even the simplest magnifying glass, that has not two foci, one of them the principal focus, caused by the refraction of the transmitted rays, the other being much closer to the lens, and caused by an internal reflection to which a portion of the light has been subjected. This it is which operates in the case of a ghost produced by a single landscape lens, and it is remedied by displacing the diaphragm from its position to the extent of from a quarter to a half inch, the ghost in such a case being the image of the stop, which is in one conjugate of the abnormal transmission, the sensitive plate being in the other. Disturb the relation of the first, and the second vanishes.

This explanation does not meet the case where a combination is concerned. Premising that the ghost is never discernible when working inside a studio, but only when operating outside with a moderately bright sky, or when taking the interior of a church or similar building, I here repeat what I have recommended as being the best means by which to discover whether a lens possesses this propensity. Screw it on to a camera, and bring it into a room lit by a gas flame. Go to a distance of several feet, and examine the flame on the ground glass. The image will be sharp, bright, and inverted. Now move the camera slightly, so as to cause the inverted image to be a little to one side of the centre of the focussing screen, and in nine cases out of ten there will be seen a ghostly image at the opposite side of the centre. This secondary image is non-inverted, and upon rotating the camera it moves in the opposite direction to the primary image. The nature of this secondary image or ghost, and the cause of its formation, may be examined in the following way:—Move the camera so that the ghost shall be near the margin, and then, placing the eye in the line of that image and the lens, withdraw the ground glass, when the posterior surface of the lens will be found to be quite luminous.

That the false image is, in this case, caused by a reflection from the back surface of the anterior lens, is demonstrable by unscrewing the cell containing it until it almost drops out of the tube, and then, keeping an eye upon both the primary and secondary images on the ground glass, move or slightly wriggle the front cell, which by its being nearly unscrewed may now be easily done, when it will be seen that when the primary or legitimate image of the flame remains motionless, the ghostly image caused by the reflection from the front lens dances about all over the plate. But observe, further, there is a certain distance between the front and back lenses at which this secondary image is sharp and bright, and in proportion as either the front or the back lens cells is screwed in or out, so does the image become more attenuated and expanded, till at last it ceases to be seen altogether, while all this time the real image is not seen to suffer in any way. This tendency of the ghostly image to pass out of focus with such extreme rapidity, upon separating the lenses by a few turns of the screw, or by making them come nearer to each other, provides the means by which this evil may be cured. A rapid doublet may be excellent for portraits, groups, copying, and every other purpose, and yet break down when employed with a small stop in landscape work.

Within the past few weeks I am aware of a lens, recently im-