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## CONTENTS.

	PAGE		PAGE
On the Testing of Lenses .....	161	Ferrous-Tartrate—A Developer for Rapid Paper. By W. Lang, Jun. ....	169
The Utilisation of Silver Residues from Old Emulsions .....	162	The Production of a Brilliant Deposit of Platinum upon Glass, &c. By Professor Ralph Bottger .....	170
The Behaviour of the Haloid Salts of Silver in the Solar Spectrum, and the Exaltation of their Sensitiveness towards Certain Parts of the Spectrum. By Dr. Eder... ..	162	Patent Intelligence .....	170
Walter B. Woodbury .....	165	A Selenium Actinometer. By H. Morize .....	171
A Dictionary of Photography.....	166	Correspondence—Proceedings of Societies .....	172
Art in Photography. By J. K. Tulloch, M.D. ....	166	Talk .....	175
Notes .....	167	Answers to Correspondents .....	176

### ON THE TESTING OF LENSES.

In the *Photographischen Wochenblatt* of 26th February, there is an article on the testing of photographic lenses. In writing on "cheap lenses," we gave it as our opinion that comparatively few photographers know how to set about testing a lens. Bearing this in view, we would willingly give our readers the advantage of all that the editor of the *Wochenblatt* has to say on the subject; but, unfortunately, his article is very long. We shall, however, endeavour to give the gist of what he writes.

In the following four questions he conveys an idea of what direction the testing operations are to take—that is to say, what qualities we have to investigate in various lenses.

1. "What degree of definition will the lens give, and through what angle?"
2. "What is the relation between the aperture and the focal length—that is to say, what is the rapidity of the lens?"
3. "What is the relation to the focal length to the circle on the ground glass which the lens will illuminate?"
4. "How nearly do the chemical and visual foci of the lens coincide?"

The writer of the article pertinently remarks that although it might be supposed that we could find an answer to question No. 2, and that part of No. 1 which refers to the angle of view included, in the lists of opticians, such is not the case. The practice which some lens manufacturers have of stating as the apertures of their lenses the diameters of the combinations, instead of the opening of the stop; and of giving the back focus—which it is quite unnecessary to know—instead of the equivalent focus, renders their figures quite useless except for comparing the lenses of one particular list together. Again, some opticians, in stating the size of plate that a lens will cover, take care to be well within the mark, so that there will be fair definition to the very corners. Others mention the very largest plate that will come within the circle of illumination.

It will be noticed that in these questions nothing is said of curvature of field, depth of focus, or of presence or absence of distortion. It is, however, explained of depth of focus, that this is entirely determined by the focal length of the lens and the aperture, being quite independent of the form of the lens. It is pointed out that the investigation into the quality and extent of definition will naturally result in a discovery of what curvature of field exists.

It is often taken for granted that lack of marginal definition is synonymous with curvature of field. Now there can be no greater mistake than this. Lack of marginal definition may arise from curvature of field, but it may also be due to either of two other defects, namely, lack of correction

of marginal rays for spherical aberration, or astigmatism. It is easy to tell whether lack of marginal definition is due to roundness of field, or to either of the other two defects mentioned. If it be due to roundness of field, pure and simple, it will entirely disappear if the ground glass be brought into a certain position nearer the lens. The marginal definition will then be as good as the central definition was before the ground glass was shifted. If the lack of definition be due entirely to spherical aberration of oblique pencils, or to astigmatism, any change of the ground glass will only make it worse. With a given amount of lack of marginal definition, that lens will be the best in which the fault is entirely curvature of field. In this case, the form of the object may be such—as, for example, in the case of a group with the figures at the edge nearer the lens than those in the centre—that the fault will not be evident. Indeed, for certain subjects, the lens which exhibits, with a flat object, lack of marginal definition due to roundness of field only, will do better than one with a flat field; but with the other faults, no disposition of the subject will make matters better.

The difference of effect produced by spherical aberration of oblique pencils, and of astigmatism, may readily be seen if a cross thus: + be drawn on a piece of paper, and be focussed with a lens so that it falls on to the margin of the ground glass either near the top or near the bottom. If the lack of definition at the margin be due to spherical aberration, both the horizontal and the vertical line of the cross will show with equal distinctness. If it be due to astigmatism, one line will be sharper than the other.

In most cases, lack of definition at the margin of the ground glass when the centre is sharply focussed, is due to both curvature of field and spherical aberration of oblique pencils, often with some astigmatism superadded.

The test for absolute central definition should be made without the ground glass, a very short focus eye-piece being used, or still better, the focussing glass may have a clear spot in the middle. The quality of definition at a distance from the centre of the ground-glass is examined in the same way, the eye-piece being moved in the direction of the axis of oblique pencils nearer to or farther from the objective till the position of maximum sharpness is reached.

Extent of curvature of field is judged of by the aid of the ground-glass. An object such as a straight brick wall is selected, the camera is placed opposite it with the axis of the lens perpendicular to it, and the focussing is performed for the centre of the ground-glass. It is then observed how far it is necessary to approach the ground-glass to the lens to cause a spot of the image near the edge of the ground glass to be in as sharp focus as it is possible for it to be.

A good deal is said by the editor of the *Wochenblatt* on the disadvantage of the non-coincidence of visual and