THEODOR SCHEIMPFLUG

J. Radford

The full effective use of large format cameras requires the provision of up to six movements of the lens panel and/or standard and up to an equal number of movements of the back standard of the camera. The use of this technique has in this country always been referred to as 'camera movements', while in the USA it was referred to as 'tilts and swings', but on the continent, notably in Germany, it is called 'The Scheimpflug Rule or Condition'.

After the Second World War the Japanese invasion commenced and built up until the large format plate camera was reaching the stage of the 'collector's piece', but a hard core of quality-dedicated amateurs and top echelon professionals refused to drop to the level of 'machine-gun' photography with the result that a new generation of large format cameras appeared with improved lenses. The large format workers then complained that all the magazines were small-format minded and Linhof, the quality large format camera manufacturer, sponsored a company to publish a magazine to cover the large format. So *International Photo Technik* published by Grossbild Technik appeared in German, French, and English, a quality production, the 'English' version really being aimed at the American market. The magazine in comparison with other photo magazines is somewhat expensive but it has a limited sale in this country, and it was from this magazine that the phrase 'The Scheimpflug Rule' was introduced here.

The phrase was picked up by an English glossy monthly amateur photo magazine and I noticed a number of my professional friends had started to use the phrase in their conversation, but whenever I asked: 'What is a Scheimpflug?' the only answer I could get was, 'Oh it's a German word meaning lens swings!' It was astonishing the number of British professionals who used the term with no idea of its origin.

Theodor Scheimpflug was born on 7 October 1865 in Vienna. He went to the Austrian Naval Academy in Pola and became a naval lieutenant. In 1897 he applied for, and obtained, a transfer to the Military Geographic Institute in Vienna where he studied geodesy and photogrammetry under Professor Dolezal. The following year he was transferred to the army, detailed to the M-G Institute and promoted to the rank of captain. He was a competent photographer and had developed geometric solutions for the correction of aerial obliques. His superiors were not interested in his theories and as he luckily had private means he went to the Graphische Lehr-und Versuchsanstalt, in Vienna where he carried out his experimental work. In 1904 he invented the photoperspectograph and the first rectification apparatus. He developed the theory of photographic maps in a paper given to the Vienna Academy of Sciences in 1907[1]. A keen photogrammetrist he suggested an extended survey of the colonies[2]. He was a pioneer of scientific aerophotography and, like so many pioneers, received scant recognition for his work until he died, on 22 August 1911[3].

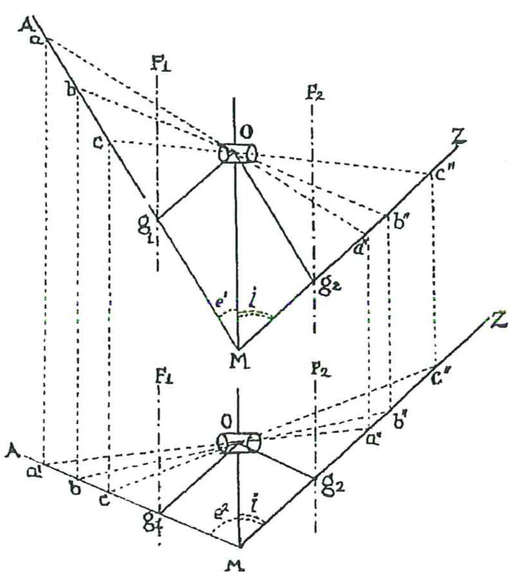

Fig 1. Illustration No 14 of British Patent Application No 1196 of 16 January 1904 in the name of Captain T. Scheimpflug.

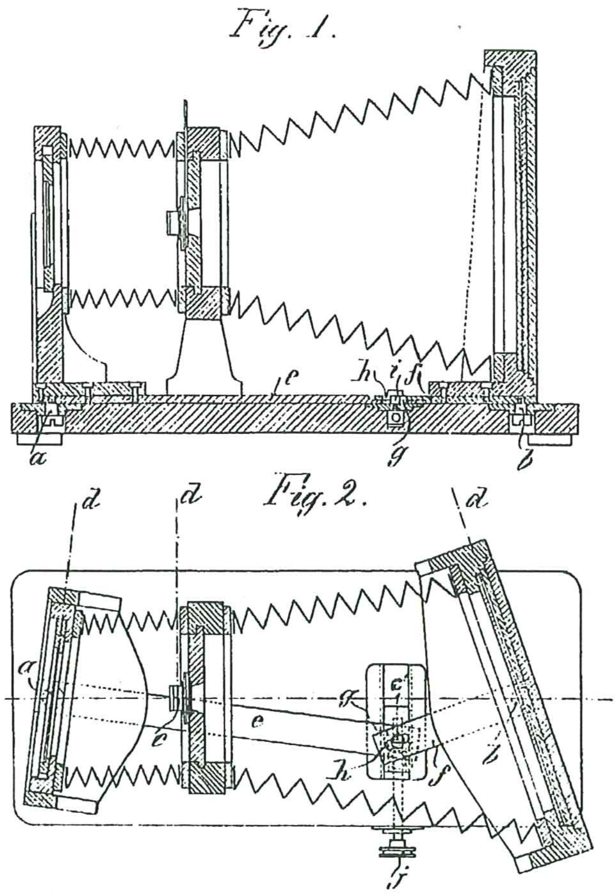

Fig 2. The 'amplificateur rectifieur' of Jules Carpentier, Paris, from his British Patent Application No 1139 of 17 January 1901. Carpentier's work was acknowledged by Scheimpflug.

In 1904 he was granted a British Patent[4] which described a method and apparatus for reducing or enlarging the dimensions of a photograph, or other plane picture in one direction by inclining the original picture and the receiving-plate to the axis of the objective.

The theoretical conditions to be fulfilled are discussed in the full specification:
e.g. In Fig 1, if *A-M* is the plane of the image *a b c* to be copied and *Z-M* the plane of the receiving plate *a" b" c"*, the planes *A-M*, *Z-M*, and the normal plane passing through the centre of the objective *O*, must intersect in the same line *M*, and lines *Og'*, *Og"* drawn parallel to *Z-M* and *A-M* must intersect *A-M* and *Z-M* in the same points as the principal focal planes *F'*, *F'*.

Capt Scheimpflug was well aware that the principle of inclining the plate in relation to the subject plane was quite well known and that reproduction apparatus had been made to do just this but, as he pointed out in his patent application,

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TECHNIQUES IN APPLIED PHOTOGRAPHY

A NON-DESTRUCTIVE METHOD OF MEASURING LAYER THICKNESS

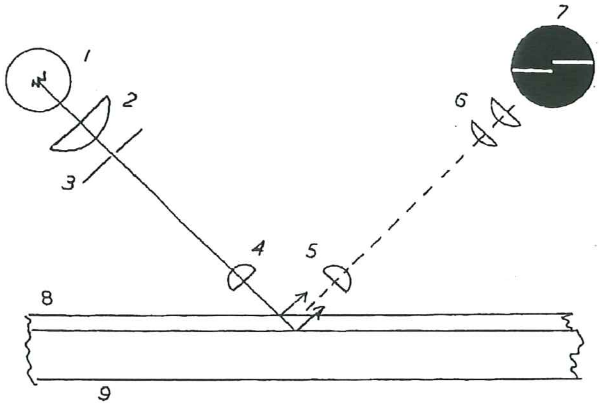
P. C. Smethurst

In all photo-processes the thickness of resist or other protective layers is of primary importance, and as it is very desirable on occasion to know whether these layers swell, shrink, or remain unaltered during a sequence of chemical or physical operations, a non-destructive method by which layer thickness may be followed in the various stages of a process is an essential. The writer's firm originally experimented with several such methods, mostly embodying electrical or magnetic principles, but at that time all of them seemed to need a larger area for making a test than that of our samples. Eventually, the development staff of Taylor-Hobson suggested the method described below, and it has been in very satisfactory use for some fifteen years.

The optical/principle used is that the roughness-measuring microscope, and is shown diagrammatically in the figure. A small lamp and condenser illuminates a slit, the image of which is projected by a microscope objective on to the surface of the layer under examination at an angle of 45° to the normal. The slit image on the layer surface is viewed at 45° to normal on the far side of the lamp and slit assembly (i.e. at right angles to the projected beam) by an ordinary compound microscope. It will be obvious that the slit image on the surface of the layer and that on the surface of support on which the layer has been coated are displaced from one another in the eyepiece of the viewing microscope, and that this displacement is a measure of the layer thickness.

If the material composing the coated layer happens to be transparent, the apparent widening of the slit in the viewing microscope eyepiece is a direct measure of layer thickness. In technical practice, this convenient state of affairs is uncommon, and it is usually much more satisfactory to utilise the fact that process images, in principle, consist of resist areas and areas of bared support without resist on them. If the boundary between a resist area and a support area is placed in the field centre, then the appearance of the displaced and normal slit images in the microscope eyepiece is as shown in the insert on the right of the diagram. This not only shows the degree of displacement very plainly, but also allows examination of other interesting matters such as the quality of the resist edge.

The actual optical values necessary will depend on the layers under examination. In our own case, layers between 5 and 20µm came into question, so that a viewing microscope of 100x power was ample. Using a 16mm objective and 10x eyepiece with normal tube length gave a system which focused far enough forward from the objective to avoid the risk of damaging the sample, provided reasonable care were taken when lowering the optical system into the correct position for focus. For similar mechanical reasons, the projecting objective was also 16mm EFL, and if a higher viewing microscope



1 lamp; 2 condenser; 3 slit; 4 & 5 microscope objectives; 6 eyepiece of viewing microscope; 7 split image of slit in eyepiece; 8 coated layer, on 9 support.

power were essential, it would be preferable to increase the eyepiece power than reduce the focal length of the objective though it is true one can today get extra-long range objectives. in quite a number of useful focal lengths, to special order.

As regards the actual measurement, it appeared to us simplest to make our own slit, and arrange that its image on the layer (allowing for the 45° projection angle) was precisely 20µm wide. A 20µm layer thus displaces the slit image its own width; 10µm layer half its width, and a 5µm layer a quarter of its width. This method may not be as accurate as using a divided eyepiece graticule scale, but it is much less equivocal to semi-skilled people, and is very rapid indeed in use. One might, however, elaborate, and make a stepped slit with three widths, so that rather precise values for three fixed layer thicknesses would be immediately available.

The ultimate sensitivity of the instrument has been shown in an interesting way. When plates for high-resolution photography are processed the dense lines never shrink back to quite their original dimensions, and remain very slightly proud of the rest of the gelatine. This permanent swelling can plainly be seen in our own version of the instrument, and is of the order of $1\text{-}1\frac{1}{2}\mu m$.

The construction of our version is very simple. The two optical tubes were mounted on a flat piece of Dural, which in turn was bolted to the coarse-focusing action of an old microscope stand. The coarse-focus wheel racks the entire optical system up and down, and thus allows samples of very varied thickness to be placed on the stage of the original microscope stand, and brought into focus for test.

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all previous work had been done on an empirical basis. He also referred to what he described as the best previous apparatus of which he had knowledge, i.e. the 'amplificateur rectifieur' of Jules Carpentier of Paris[5]. He pointed out that Carpentier's apparatus 'enables only the rectification of obliquely taken photographs to be effected and it cannot be used for other purposes, and it has therefore only a very limited scope of use.'

References

1 'Die Herstellung von Karten und Planen auf photographischem Wege' read to Vienna Academy of Sciences, 1907.

2 'Denkschrift der ersten Internationalen Luftschiffahrtsausstellung' in *Wissenschaftliche Vortrage*, Berlin, 1910, Vol 1.

3 a 'Th. Scheimpflug, sein Leben und seine Arbeiten' by Prof Dolezal in *International Archiv für Photogrammetrie*, 1911.

b 'A Method of Aerographic Mapping' by Moffit in *Geog Review* 1920.

4 British Patent No 1196. Application 16 January 1904, Complete 20 February 1904, Accepted 12 May 1904. Application and Complete Specification 37 pages and 28 drawings.

5 British Patent No 1139. Jules Carpentier of Paris. Application 17 January 1901, Complete 26 September 1901, Accepted 2 November 1901. 'Improvements in enlarging or like cameras'. Application and Complete Specification 2 pages, one page drawings (6 figures).