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THE TESTING OF NEW OPTICAL COMBINATIONS FOR TAKING PHOTOGRAPHS AND PLOTTING AT THE "INSTITUT GEOGRAPHIQUE NATIONAL"

Submitted by the French Government

M66-984

TESTING OF NEW OPTICAL COMBINATIONS FOR TAKING PHOTOGRAPHS AND PLOTTING AT THE "INSTITUT GEOGRAPHIQUE NATIONAL"[1/]

Improvement in the quality of (air) photographic coverage is an essential factor in increasing the general output of photogrammetric work. Indeed, any gain in the definition of the image makes it possible to secure a survey of given accuracy from photographs on a smaller scale. This results in a great saving on all the operations involved in the survey, as a result of the reduction of the number of plates covering the same area.

For the past twenty years, the Institut Géographique National (IGN) has carried out all (air) photographic coverage with plate cameras equipped with Aquilor-S.O.M. lenses of 125 mm., focal length size 19 x 19 cm. Twenty years ago, this wide-angle lens represented a considerable advance on all previous lenses. Since then, the Aquilor which, in particular, had only 4 glasses has been superseded by lenses with more complex optical combinations.

The desire to modernize its equipment, and at the same time to keep the glass plate as the emulsion base, has induced the IGN to try to look for a plate camera of the same size with a more modern lens. This research has resulted in the making of Sopelem plate cameras equipped with Zeiss Pleogon lenses. The present report gives the first results obtained in 1965 and in early 1966.

The laboratory as well as the ground tests are extremely encouraging and, on the whole, confirm the qualities claimed by the manufacturer, which make Pleogon an orthoscopic lens with particularly good definition.

The pairing of the photographic lenses Pleogon with the new plotting lenses Sopelem Altor which are also orthoscopic lenses with good definition, has been justified, as is proved by the tests in

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1/ By the "Institut Géographique National".

plotting made on these photographs. Thus it is possible to use the photographs taken with the Pleogon for plotting on the Poivilliers-S.O.M. type B.P. Stereo-topographs in use at the Institut Géographique National.

I. CHARACTERISTICS OF THE PLEOGON

The Pleogon has 8 glasses, the two extreme ones being relatively remote from the bloc of the other 6. This makes the lens more cumbersome than the classical Aquilors with 4 glasses for an equal field. The rear glass is very near the plane of the photo plate (See Fig. 1).

Two types of Pleogon lenses are currently constructed by the firm of Zeiss, one with a focal length of 115 mm, and the other with a focal length of 153 mm. It was necessary to make a third type with a focal length of 120 mm, particularly to ensure a plate cover of 19 x 19 cm.

The Pleogon aperture is F/5.6 and its angular field 104 grades.

The original shutter was successfully mounted on the Sopelem camera. It consists of a motor which rotates at a constant speed, setting in motion by means of a mechanical variator, 5 rotating discs, each of which is punched with a hole.

At the required moment a shutter, controlled by the intervalometer unmarks the 5 holes in coincidence, thus making it possible to take the photograph. The exposure depends upon the position of the speed variator, and is given directly in milliseconds, by a tachymetric generator attached to the moving discs.

This shutter has therefore the double advantage: the time of exposure can be adjusted in a gradual scale and from 1 centisecond, to the theoretical time of 1 millisecond, due to the high speeds of the discs.

II. CHARACTERISTICS OF THE ALTOR

The Sopelem Altor plotting lenses also have 8 glasses, a focal length of 120 mm. and an angular field of 104 gr. (See Fig. 4).

The over-all dimensions of Altor, although slightly greater than those of the old type plotting lenses are much less than those of the Pleogon (approximately half) and this makes it possible to mount it on type B Poivilliers stereo-topograph plotting cameras.

III. LABORATORY TESTS

(a) Definition (sharpness)

Sharpness has been studied by taking photographs of a minutely graduated high contrast resolution target, at angles of incidence from -45° to $+45^{\circ}$. The emulsion used is an R.40 Ilford, a fine grain panchromatic plate. The shape of the resolution target made it possible to distinguish the radial and tangential directions, and express the sharpness in number of lines per millimetre.

The tests were carried out at F/5, 6 and F/8 for the Pleogon, and on 2 diametres each time.

The result is that the Pleogon definition increases rapidly from the edge of the field (approximately 20 lines/mm. at 45°) reaching 45 to 50 lines/mm. at 30°, and this value remains fixed up to 15°. Finally, from 15° to 0° the definition further improves and reaches from 55 to 65 lines/mm. at the centre. The reference is to mean values, the definition at F/8 being better than at F/5, 6 and the tangential better at the centre than the radial.

If Pleogon is compared with the old type Aquilor lens, it will be seen that a substantial gain in definition is registered, because the Aquilor did not exceed 40 lines/mm at the centre, and remained constantly below the Pleogon value, catching up with them only at the edge at 45° with 15 to 20 lines/mm. (see Fig. 2).

As regards the Altor plotting lenses, the mean results are shown in Fig. 5. The Altor definition which is comparable if not superior to those of Pleogon at the edges of the field, does not attain the same

value as the Pleogon definition at the centre, although it greatly exceeds the Aquilor definition throughout the whole field.

(b) Distortion

Distortion was studied by taking photographs of a collimator cross at incidences measured accurately between -45° and $+45^{\circ}$.

By comparing the intervals measured on the plate with their corresponding theoretical values, the radial distortion is deduced. Tests were made on 2 diametres for F/5, 6 and F/11, with or without the use of a monochromatic light.

The result so far as the Pleogon is concerned was that in the case of angles of incidence less than $\pm 42^{\circ}$, the distortion remains less than 4 or 5 microns, and is smaller at F/11 than at F/5, 6.

In the neighbourhood of 45°, a rapid variation in distortion seems to take it to about 7 to 10 microns.

On the whole, these measurements provide ample confirmation of the excellent orthoscopy of the lenses.

As regards the Altor (see Fig. 6), its radial distortion throughout the whole field is very little. Although it is very slightly higher than the radial distortion of the Pleogon up to 40°, it does not exceed 7 to 8 microns, and thus makes the Altor practically orthoscopic, its residual distortion very nearly approaching that of the Pleogon.

(c) Shutter

Its output is excellent: 80 to 90 per cent on the average (exposure measurements between 5 ms. and 1.25 ms.).

IV. TAKING OF PHOTOGRAPHS

Photography tests were carried out by an IGN aircraft, equipped with two air survey cameras (one with an F/5,6 Pleogon, and the other with an F/6 Aquilor), working simultaneously.

The aircraft flew over the territory at 4 different altitudes, from 1,060 m. to 4,900 m. making it possible to obtain original negatives on the scales of 1:8,000; 1:13,000; 1:25,000, and 1:40,000.

From the entire set of these photographs, as for each scale, two photographs of the same part of the terrain were selected, one taken with the Aquilor, the other with the Pleogon.

Similarly, enlargements ranging from 1.6 times to 4.8 times were made for a portion of each of these photographs. In spite of an inevitable loss of sharpness in the positive printing on paper, it was possible to assess the very good Pleogon definition, as compared with the result given by the old type Aquilor. They corroborate the results obtained in laboratories, particularly the study of the definition of lenses, the Pleogon definition being superior over the greater portion of each photograph taken.

V. PLOTTING TESTS

Two pairs on the scale of 1:40,000 taken simultaneously with Aquilor and Pleogon were studied, comparatively against each other and against the previous plotting of negatives on the scale of 1:25,000 taken with an Aquilor lens.

The pairs of photographs taken with Pleogon were plotted with Altor lenses, while those taken with the Aquilor were plotted with an Aquilor.

The pairs were oriented on the same control points. Ninety ground points which could be accurately identified, on both the old photographs taken at 1:25,000 and on the new ones at 1:40,000 were used as altimetric points for comparison.

The comparison of the heights determined at these 90 points shows the excellent degree of agreement in both systems. The association of Pleogon and Altor does not reveal any systematic difference in the results, which would have occurred if there had been any substantial residual distortion.

VI. CONCLUSION

The adoption by the IGN of the Pleogon photographic lenses combined with the Altor plotting lenses makes it possible to apply in a strict sense the principle of Porro-Koppe when using type B Poivilliers SOM stereo-topographs, now in use at the IGN. Since both lenses may be regarded as orthoscopic, the requirements of photogrammetric plotting are clearly fulfilled.

Similarly, by equipping photographic cameras with Pleogon lenses, it is possible to improve the plotting of photographs on superficial observation apparatus, which are simpler to use, by doing away with the cams on the type B Poivilliers stereo-topographs and the distortion correction plates on the Presa.

In addition, the high quality of definition of the Pleogon makes it possible to obtain a cartographic result, of good quality starting with smaller scale plates, and this represents a very substantial gain on all the operations relating to the survey: stereoscopic ground control, aero triangulation and plotting.

The great degree of sharpness in the plates also makes it possible to meet the needs of specialists in photo-interpretation and, generally speaking, of all users whose constant care is that the quality of photographs should remain high.

So the IGN is progressively increasing its possibilities and the efficiency of its cartographic work, without impairing the precision and accuracy of its surveys, which remain its major objective.

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TAKING SNAPSHOTS • PLEOGON LENS

PRISE DE VUES • OBJECTIF PLEOGON

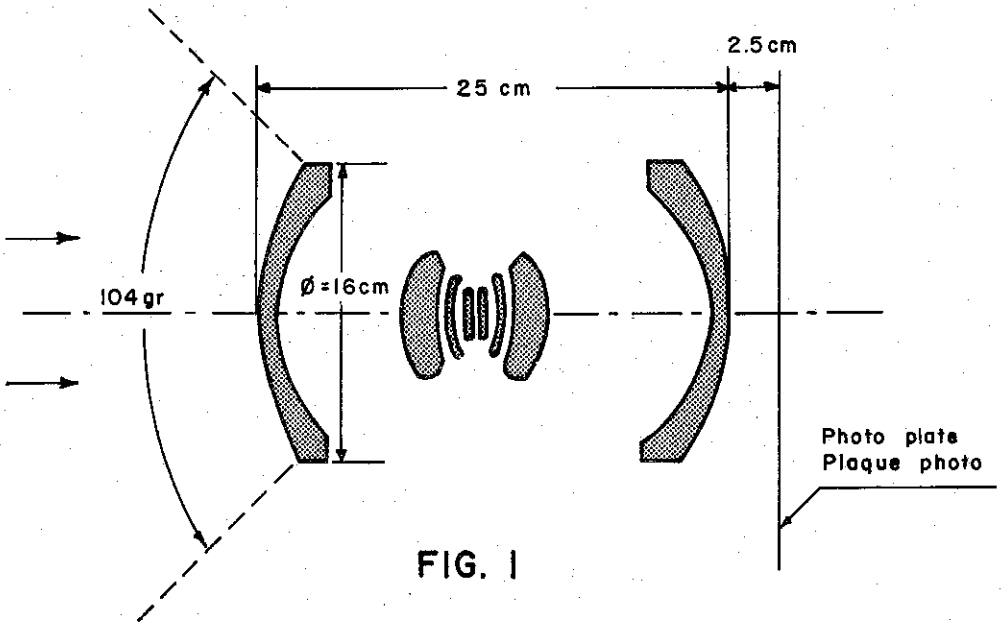

FIG. 1

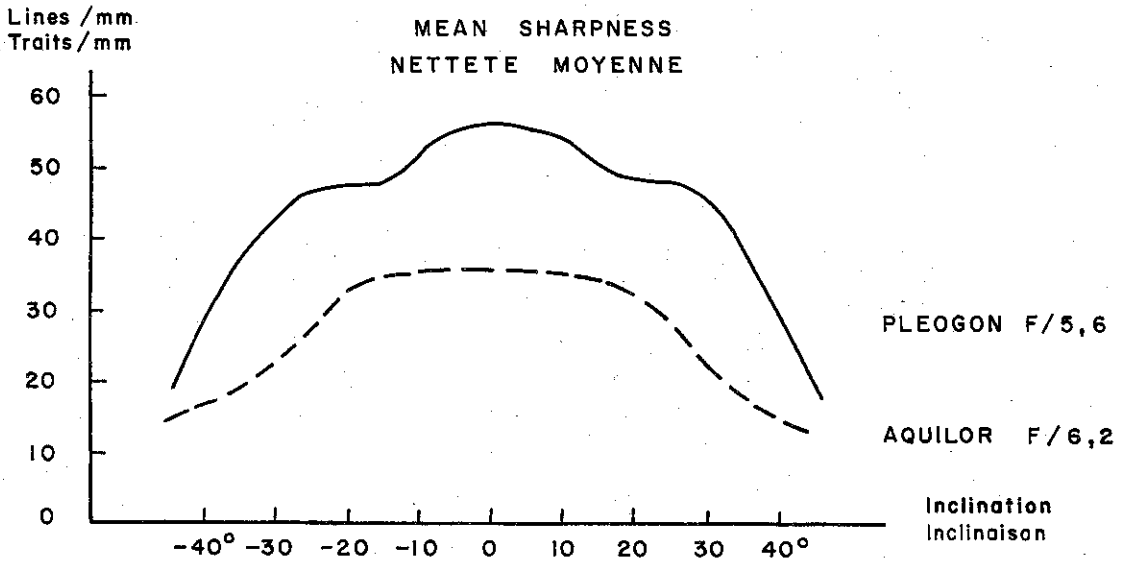

FIG. 2

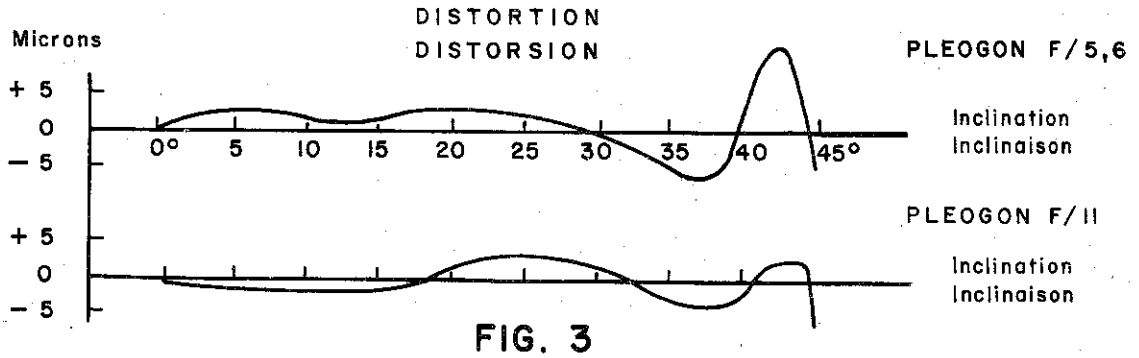

FIG. 3

PLOTTING RESTITUTION

ALTOR LENS
OBJECTIF ALTOR

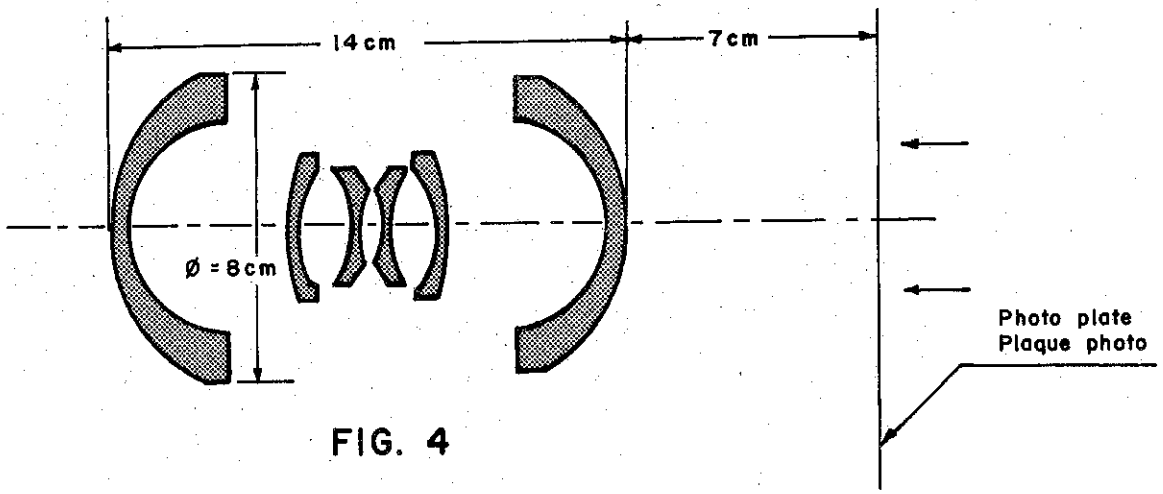

FIG. 4

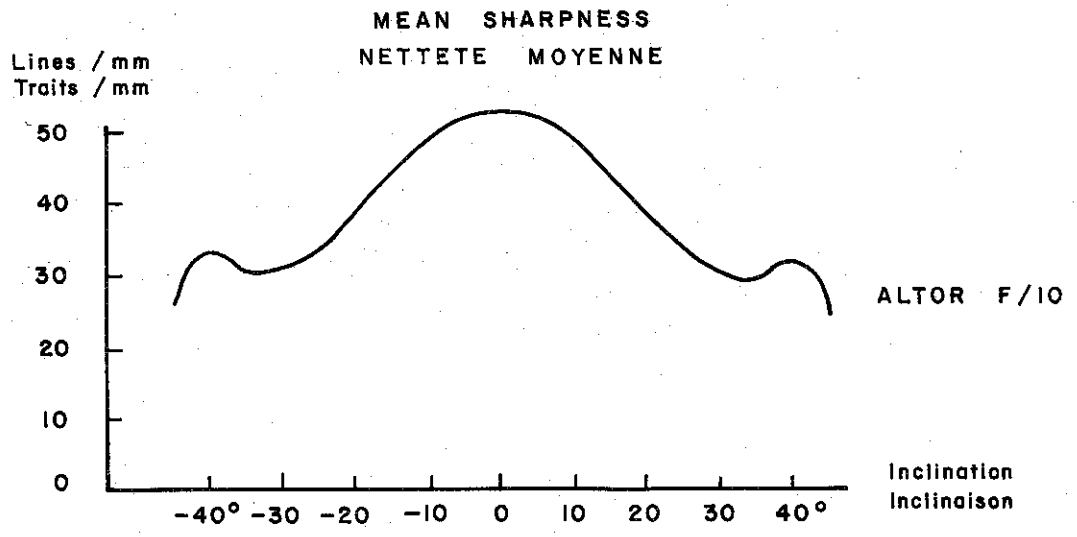

FIG. 5

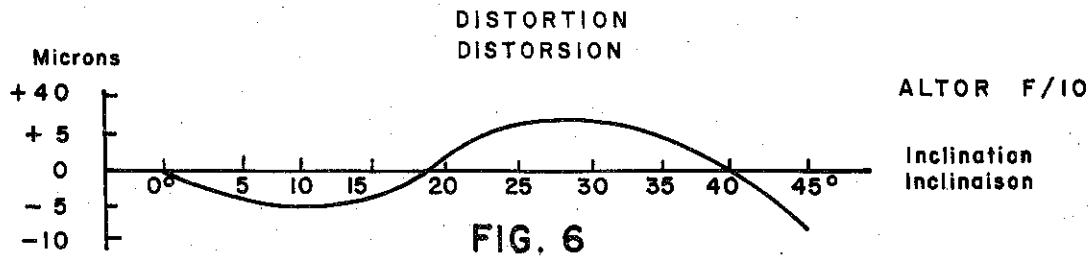

FIG. 6