CAMERAS FOR AERIAL PHOTOGRAPHY

(Extract from the article of Dipl. Franz HERUNTER, published in the *Allgemeine Vermessungsnachrichten*, Berlin, N° 5 of 1 March 1941, page 68 and N° 6 of 15 March 1941, p. 81).

From the standpoint of technique in aerial photography, we can manage to cover large areas by the following methods in the enumeration of which we indicate briefly the principle characteristics of the largest German and foreign cameras.

1) *USE OF LARGE ANGLE OBJECTIVES :—*

Enlargement of the angular field by means of a relative diminution of the ratio focal distance to size of image, the latter remaining as distinct as possible out to the edges. The greater the angular field the greater the lack of light near the edges.

Zeiss-Topogon	18 × 18 cm.	1 : 6,3	f = 10 cm.	angular fields	= 94°
Zeiss-Topogon	30 × 30	1 : 6,3	f = 20 cm.	»	= 94°
Liar-6 (U.S.S.R.) (1)	18 × 18	1.45	f = 10 cm.	»	= 100°
Wild R.C. 3/12	18 × 18	1 : 7.7	f = 12 cm.	»	= 93°
Ross (Angleterre)	12.5 × 12.5	1 : 4	f = 12.5	»	= 70°

2) *THE USE OF CAMERAS WITH MULTIPLE OBJECTIVES.*

Augmentation of the surface area photographed by combining several objectives, or, in a similar manner, several individual cameras, to form a whole, as the two following arrangements show.

a) Arrangement in the form of a wreath of lenses around a central objective and the simultaneous projection upon the same image-plane.

Photogrammetry G.M.B.H. Munich.

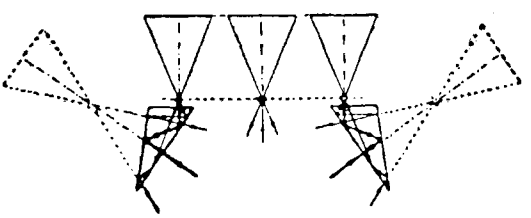

Fig. 3. Panorama Camera P.K. 33 1 : 5.3 f= 5.35 cm.; size of film 18 × 18 cm., size of image 30 × 30 cm. Eight simple lenses arranged in form of wreath around a central lense, angular field about 140°, weight about 50 kilograms.

Coast and Geodetic Survey, U.S.A. (17)

Nine lense Camera; f = 21 cm., film size 58 cm., assembled image having size of 90 cm. square. Arrangement of lenses similar to that of the P.K. 33. From the interposed metallic mirrors proceeds the luminous beam in the angular field of 130° where the loss of light reaches 20%. Weight of the total assembly 340 kgs., weight of camera along 160 kgs.

(See the figures and the description of this apparatus in the Hydrographic Review Vol. XIII, N° 2 November 1936, pages 131-138).

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(1) RUSSINOW. — *The new orthoscopic objective with large "Liar-6" for aerial photography.*
(Report of the Institute for Photographic Research; Leningrad-Moscow 1935-36).

Barr and Stroud; England. (2)

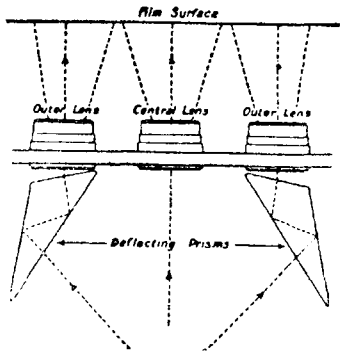

Fig. 5. Seven lense Camera. f = 4.3 cm. Film size 13 cm.; after transformation 23 × 23 cm.; six lenses in the form of a wreath around an objective in the middle; in front of the objectives are six prisms the deviation of which provide an angular field of 120°.

Drobyscheff, U.S.S.R. (3)

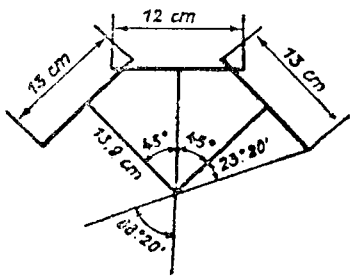

Fig. 6. Nine-lense Camera. f = 13.9, central image of the format 12 × 12 cm.; image of the crown 12 × 13 cm. angular field of about 136°.

b) Grouping of several inclined cameras.

T — 3 A — *Quintuple Camera; U.S.A.* (4)

Four inclined Cameras (1: 6.8 f = 15 cm. 14 × 15 cm.) are combined into one forming a cross around the central camera; after transformation one obtains a single vertical view in the form of a cross having a diameter of 72 cm. The camera was used among other things for the aviation construction work at Wright Field. It should be noted that the General Staff of the Corps of Engineers of the U.S. Army as well as the aviators make use of German restitution apparatus. For this service to there is available one Aerocartographic Instrument and a Multiplex Aeroprojector.

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(2) Lieut. E.H. THOMSON, R.E. — *The Seven Lens Air-Survey Camera.* (Empire Survey Review, London, 1938, N°s 26 and 27).

(3) BELFIORE. — *Cartografie Coloniale e impiego della Fotogrammetria.* (Riv. d. Catasto e dei Servizi Tecnici Erariali, 1936/XIV).

(4) TALLEY. — *Aerial Mapping at the Material Division.* (News notes of the American Society of Photography, 1935/7).

SANTONI; *Triple Camera with solar periscope;* Italy. (5)

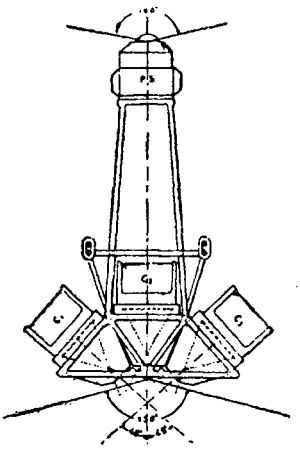

Fig. 7. Format 18 × 20 cm. Focal distance 16.5 cm.; the angular field reaches 150° normal to the direction of flight and 62° in the line of flight; the camera has been especially designed for use in colonial surveys. (See Hydrographic Review, Vol. IV, Nov. 1927, page 101).

3) *PHOTOGRAPHY AT HIGH ALTITUDES OF FLIGHT.*

For the same focal distance one obtains a reduction of scale proportional to the altitude of flight and therefore a greater ground area can be covered.

4) *USE OF INCLINED PHOTOGRAPHS.*

The scale of the photograph diminishes rapidly from front to back; the rays which are too horizontal produce a dead space. Inclined photographs are most suitable for very extended regions and flat areas with very distinct characteristics (rivers and lakes in Canada).

This method not only permits the photographing of large areas but it is also a good and appropriate procedure for extensive and unknown regions.

EXTERNAL REQUIREMENTS OF FLIGHT.

Constant flying altitude and steady course are maintained by means of mechanical aids. For maintaining a fixed altitude of flight use is made of the statoscope, a barometric pressure recorder. In unknown regions with unbroken forests and jungle landscape a flight along a straight line is difficult to maintain. Since the flight strongly influences the final restitution (the systematic curvature of the aerial triangulation) efforts have been made to find a mechanical solution.

In America FAIRCHILD (6) constructed his so called "solar navigator" a solar compass (7) with axis turned to the north, in order to solve this problem. With the aid of a beam of sunlight thrown on a lense and a photoelectric cell the deviations from the course are registered by means of deflections of a galvanometer. The drift is then compensated in the compass binnacle. The necessary data for this correction such as declination and

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(5) SANTONI. — *Il nuovo Periscopio Solare Santoni per la triangulazione aerea e l'organizzazione delle presse coloniali.* (Istituto Geografico Militare, Firenze, 1938, XVI).

(6) ELIEL. — *Fairchild Solar Navigator.* (Photogrammetric Engineering, Washington, 1938/3).

(7) See : *Hydrographic Review,* Vol. VIII, N° 2, November 1931, page 158).

equation of time are taken from the tables. In this manner flights were undertaken in the tropical areas of Central America over monotonous stretches of brush and jungle. In a flight of over 70 miles distances a deviation of only 400 meters was recorded. This is to be ascribed primarily to the change in the geographical latitude. In areas where there are considerable elevated masses the deviation of the vertical causes a great deal of difficulty in fixing the position with certainty. Therefore experiments were undertaken with the above-mentioned apparatus in flying on a straight line to a new point from two known points and to determine the common points passed in flight by forward resection. The angular accuracy attained was found to be 15 minutes, which equals 450 meters in 100 klm. By combining several flights a greater accuracy can be obtained.

A similar sclution is shown in the Santoni Periscope (20). This is composed of a solar camera (160° objective aperature) and a gyroscopic compass, a magnetic compass, a drift indicator and chronometer and a statoscope. The latter is not essential but is only an auxiliary. In between every two photographs of the landscape five positions of the gyroscopic compass are simultaneously photographed. In the photogoniometer which is supplied with it the bearing of the sun and the heading of the magnetic compass are measured.

The indications of the gyroscope and the statoscope, being photographed on the film, the direction of the sun's rays are equally fixed at the same time on the photograph.

Further mechanical aids in the external orientation are provided by the picture cameras, which in addition to the bubble showing angle of inclination also show simultaneously on the photograph the apparent horizon in one or two directions. As example we cite the new Wide angle series camera of Zeiss BMKHS 18 × 18 f = 10 cm. with a total format 18 × 24 cm. and a photographic image of 18 × 18 cm.

PHOTOGRAPHY AND THE SCALE OF THE PHOTOGRAPH.

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It is peculiar to aerial photography that the final restitution leaves considerable latitude in the choice of different scales for the charts. Photographs to the scale of 1: 40,000 permit the making on the one hand of charts with scales between 1: 25,000 and 1: 50,000, and on the other hand, with corresponding generalisation to successfully complete charts with a scale of 1: 100,000 and less. A single flight may therefore be utilized for several purposes. But, for reasons of economy it is necessary and more practicable not to chose too small a scale for the photographs.

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