RADIALTRIANGULATION MIT MARKIERSTEREOSKOP UND EINBILDTRIANGULATOR

(RADIAL TRIANGULATION WITH MARKING STEREOSCOPE AND SINGLE PHOTOGRAPH TRIANGULATOR).

by

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Radial triangulation is based on a combination of sets of directions relating to triangles and lozenges, whereby the center of the directions lies in the principal point, the focal point or the plumb point of approximately vertical photographs. As the determination of a new point in a chain of triangles or a rhomboid chain always requires at least three beams from three adjacent photographs, it is essential for the accuracy of the point determination, that for each exposure, the direction should always be observed towards the same sighting point.

With a view to the accurate identification of the aiming points in adjacent photographs a spatial collimating mark is placed on the chosen points and marked with a device connected mechanically to the collimating mark for the purpose of transmission to further photographs and ulterior measurements. The points may be any land points, so that no conspicious features of the planimetry such as cross roads, field angles should be adhered to, and be so arranged as to attain the regular geometric and favorable formation of the net, which is desired. This freedom is particularly necessary when the ground offers large and uniform areas covered with forests, sand or grass. As early as 1928, Aschenbrenner marked certain given points with the stereoscope, using for the purpose the transfer apparatus of the Photogrammetry C.m.b.H., of Munich.

This instrument, constructed by C.A. STEINHEIL and Sons, of Munich, and fitted with marking devices (D. R. P. and A. P.) apart from point identification and marking, serves also to measure directions, lateral and vertical parallaxes, polar and rectangular co-ordinates, it constitutes a large stationary apparatus on account of its many sided possibilities of application and suitable dimensions for larger size photographs (up to 30 cm. × 30 cm.). (1)

In practice, there is need for a light portable apparatus, restricted to the necessary measurements for radial triangulation and which can also be produced at a price inferior to that of the many sided transfer apparatus.

The solution lies in a division of labour, by assigning to two simple machines respectively, the identification and marking of points on the one part, and the measuring on the other part. This division has the further advantage of acceleration, as both operations can be conducted simultaneously and concurrently.

The marking stereoscope is used for point identification and marking. It consists of (Fig. 1) an illumination box with two support discs on which can be laid and fixed, films, plates or photoprints up to the size of 32 cm. × 33 cm., with the desired swing, suitably arranged for stereoscopic observation. A bridge running on two rails in Y direction supports the transfer stereoscope which can be moved in X direction.

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(1) *for the further application of the transfer apparatus to the restitution of contour maps, see* "Photogrammetrie" II, 1939, 2. "Ein neues Kartiergerät der Photogrammetrie G. m. b. H. München, by Dr. Ing. W. KUNG, Münich.

The stereoscope consists of a double telescope with Rhodium mirrors, a correction lens and removable field glass with fourfold magnification. Through a scissor like motion of both telescope by means of a cog wheel, the picture side ends of the double telescope are set on all possible principal point distances and lateral parallaxes. In order to remove vertical parallaxes, the eye piece part is shifted to a small extent by a cog wheel in X direction, whereby, the picture side ends of the telescope — being guide wielded — move in the opposite Y direction. All movements are so arranged that stereoscopic observation is secured over the whole photographic range even with photographs taken at extremely wide angles.

The diameter of the image field is 40 mm.

With a view to the stereoscopic setting of the collimating marks on a land point and its close marking, the punching devices are laid on the selected spot of the picture.

Each of the punching devices (see Fig. 2) consists of a strong stable basic plate, made motion proof by means of a rubber pad on the emulsion carrier and of a carrier which can be shifted right against the lower part by means of two screws working at right angles to each other. As regards the stereoscopic setting of a given point, the 40 mm. diameter marking plates with punctiform collimating mark are first placed on the carrier and are in the space adjusted by means of the above mentioned screws, on the point to be marked, after removing the lateral and vertical parallaxes. In this position, the carrier is then screwed to the lower part, with a punch fitted holder set in. A hole of about 2/10 mm. in diameter is cut in the emulsion of both images by turning the punch round, so that a sharp, lasting and unmistakable marking of identical points is secured. A three point arrangement prevents all twisting or shifting of the marking plate and punch holder. By a screw adjustment, the collimating mark can at any time and in the simplest way be made to correspond with a perforated point. All the marking plates and punch fittings are exchangeable for the two punching devices, as may be desired.

(see: FIG. 3).

1) Magnifying glass for the reading of the circle graduation.
2) Clamping screw for the rotation movement of the plate carrier.
3) Adjusting screw for the rotation movement of the plate carrier.
4) Cylinder guide for moving the telescope carrier.
5) Adjusting screw for shifting the telescope carrier.
6) Scale for measuring the radial point distances (X scale).
7) Magnifying glass for the vernier reading on the scale (6).

In order to transfer a point already perforated to a new picture, one of the collimating marks is first placed on the perforated point, the second one being then stereoscopically adjusted.

The points marked on a couple of stereoscopic photographs and which are brought out sharply from the emulsion, by illumination, like small clear circles, allow the extremely and strictly accurate examination of a ready identification. Under a stereoscopic observation, the two points are combined into a white illuminating disc, which lies on the ground, if the operation has been carried out in due order, else the disc looks like floating above the ground or sinking into it.

It should be mentioned, for the sake of completeness, that by a rotation of the path of rays to the extent of 100 grades with a suitable optical device, it would be possible to obtain a transformation of the residual vertical parallaxes into lateral parallaxes and consequently an additional check.

The single photograph triangulation (see Fig. 3) is used for measuring photographs. The apparatus consists essentially of the substructure with the illumination arrangement, of the revolving picture carrier with graduated circle and of the telescope carrier with sliding telescope and scale.

The graduated circle with a diameter of 52 cm. is divided into units of 20 c. A vernier allows 1 c. (one centisimal minute) readings.

Readings off the scale with a vernier datum of 0,02 mm., give the radial distances from the points to the center.

The measuring accuracy is secured by a careful construction of the rotating bed of the plate carrier and a cylindrical accurate guiding of the telescope carrier.

The telescope, the collimating mark of which, is adjustable on the rotation point of the plate carrier, has an oblique sighting direction, a magnification of 2.5 and a field of view of 24 mm. diameter on the image plane.

A connecting electric apparatus with resistance transformer allows the use of various tensions and the tuning down of the strength of illumination.

Through the introduction of suitable plate or film holders, any size whatever of plates or films up to 32 × 32 cm. can be measured. The measuring itself results from the fact that after centering the principal or focal or nadir point, the plate carrier is turned until the point to be observed is approximately in the direction of the telescope shifting. By means of the adjusting screws plate carrier and the telescope are turned or shifted until the punctiform collimating mark stands in the center of the circular marking. As the telescope can be shifted from the middle to both sides, this allows observation in two positions differing by 200 gr.

In order to judge of the accuracy of the measurement, it may be mentioned that the collimating mark can be set concentrically within one hundredth part of a millimeter in the circular marking. This accuracy of position corresponds to an angle value from 1 c. to 2 c., for a distance of 10 cm. between the center and the point observed. Numerous measurements taken with the single photograph triangulator have shown that this approximative limit is maintained in the course of practical working.